THE GEOCHEMISTRY AND ORIGIN OF XENOLITHS FROM THE ROBERTS VICTOR MINE

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ABSTRACT

The results of an investigation into the geochemistry of xenoliths from the Roberts Victor mine are reported. 750 nodules were examined in hand specimen at the Roberts Victor mine, and in accordance with previous observations greater than 95% are eclogite xenoliths. The paucity of peridotite nodules is attributed to selective sampling by the kimberlite, and to the preferential abrasion of the more readily altered peridotites. 250 samples were selected for further study in slabbed section. Mineral analyses by electron microprobe of 100 samples, and whole rock analyses by X-ray fluorescence of 40 samples were carried out. Orthopyroxene bearing eclogites (garnet websterites) constitute a significant portion of the eclogite suite, and orthopyroxene plays an important role in the evolution of the Roberts Victor eclogites. Three categories of inhomogeneous eclogites, clinopyroxene-megacryst-bearing eclogites, inhomogeneous kyanite eclogites and chrome-rich eclogites were examined in detail.

(i) Megacryst-bearing eclogites originated by crystallisation of clinopyroxene megacrysts within volatile-rich portions of an eclogite magma and the subsequent entrapment of the megacryst within bimineralic eclogite.

(ii) Inhomogeneous kyanite eclogites consist of bimineralic eclogite enclosing a kyanite eclogite zone of markedly different mineral and whole rock chemistry. The kyanite eclogite zone most likely originated by liquid immiscibility.

(iii) Most chrome-rich eclogites examined exhibit marked variation in chemistry over very short distances. These variations have been attributed to fluctuations in volatile content during crystallisation, disequilibrium partial melting of garnet lherzolite and to the preservation of a diffusion gradient between two bodies of different composition.

The diverse peridotite suite at Roberts Victor includes dunite, wehrlite, harzburgite, garnet harzburgite, lherzolite and garnet lherzolite. A connecting link between peridotite and eclogite is represented by an altered garnet lherzolite in which a thin layer of bimineralic eclogite is preserved on one edge.

Detailed studies of the mineral chemistry of an eclogite containing both diamond and graphite indicate that this rock equilibrated at 40 to 45 kbar in the temperature range 1000 to 1150°C. Diamond and graphite are thought to have formed by the reduction of CO_2, introduced together with Ti, K and S, during the melting of garnet lherzolite to produce the eclogitic magma from which the rock crystallised.

The Roberts Victor eclogite suite is thought to have originated by volatile induced partial melting of garnet lherzolite. The diversity of the eclogite suite is related to the relative importance of the volatile input and the thermal input during partial melting, with high volatile, low temperature melting leading to the production of heterogeneous, rapidly crystallised eclogite bodies (type II eclogites) and low volatile, higher temperature melting leading to the production of a larger, relatively homogeneous eclogite body (type I eclogite).

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I INTRODUCTION

The study of igneous rocks exposed at the outer surface of the earth inevitably led earth scientists to speculate about the nature and composition of the primary material from which the magmas producing these rocks were ultimately derived. Bowen (1928) argued that most rocks encountered in the crustal environment could be derived from a primary basaltic magma by fractional crystallisation. Considering the source of this basaltic magma Bowen (1928, p.311) stated

> "we can see little chance of escape from the necessity of deriving all magmas ultimately from matter much more basic than basalt and probably from peridotitic substance as represented in stony meteorites."

Thus Bowen believed that basalt was derived, as a primary magma, from a deep-seated reservoir of peridotitic composition. The primary nature of basaltic magma has since been questioned (e.g. O'Hara, 1965) but before considering this problem, it is useful for the purposes of this study to first review the related problem of the composition of the reservoir from which basalts are generated.

The crust of the earth is too thin to have played a significant role in basalt generation throughout the span of geological time, and it is generally considered that basalt is generated in the upper mantle. Physical and chemical properties suggest that the upper mantle is peridotitic in overall composition.

Physical properties determining the mineralogy of the upper mantle are inferred from seismological and gravity measurements. An important seismological observation is that the subcratonic mantle, and the mantle beneath deep oceanic basins has a P-wave velocity which can be satisfied only by some combination of the dense minerals, olivine, pyroxene and garnet (Ringwood, 1975). The two principal rock types with these components are peridotite and eclogite. In general the measured physical properties of the upper mantle are more consistent with the less dense peridotite mineralogy (Ringwood, 1975, pp. 74-85).

The chemical properties, which determine the elemental composition of the upper mantle can be deduced by three methods, designated the

extraterrestrial, terrestrial and hypothetical by Wyllie (1970, 1971). Mantle compositions derived by these three approaches are presented in Table 1. Which of the compositions presented is chosen as representative of the upper mantle composition depends in large measure on the model adopted to explain basalt genesis. In the formulation of the pyrolite model Ringwood (1962a) proposed that undepleted mantle should be able to yield basalt on melting, and therefore in estimating mantle compositions combined a basaltic liquid extract with suggested residual compositions (Green and Ringwood, 1963; Ringwood, 1966b; Ringwood, 1975; Table 1, cols 15-18). In contrast O'Hara (1965) argued that basalt was not in general a primary magma, and that basalts were derived compositions produced by evolution of primary picritic compositions en route to surface. Accordingly O'Hara et al. (1975) suggested that garnet lherzolite which has lower alkali concentrations than pyrolite, represents primary mantle (Table 1, cols 3-6).

The difference between the approaches of Ringwood and Green and of O'Hara was illustrated by Wyllie (1970, 1971) in terms of alkali and CaO contents. The liquid extract line from residual compositions through pyrolite compositions coincides with basalt compositions with approximately 2 wt.% Na_2O+K_2O. However the liquid extract line through terrestrial estimates of upper mantle composition passes through picritic compositions with 1 wt.% Na_2O+K_2O. Thus a picritic primary magma may be extracted from rock types such as garnet or spinel lherzolite, but not from pyrolite compositions. Basalt may be extracted directly from a pyrolite composition without subsequent fractionation to raise the alkali contents.

That many basalts are not primary magmas which could coexist with mantle material is evidenced by a consideration of K_D relations between olivine and coexisting liquid. Roedder and Enslie (1970) demonstrated that

$$K_D = (Fe/Mg)\ \text{liquid} / (Fe/Mg)\ \text{olivine} = 0.3.$$

Of the different pyrolite models that of Ringwood (1966b, Table 1, col 16) has the highest FeO/MgO ratio (wt.% FeO/MgO = 0.23). Assuming a $K_D = 0.3$ the highest FeO/MgO ratio that the liquid extract may have is 0.63. The putative primary basalts used in the experiments of Green and Ringwood (1967a) all have FeO/MgO wt.% ratios significantly greater than 0.67.

On the other hand there is evidence that primary liquids from mantle compositions are picritic. Studies of ultramafic bodies purportedly emplaced from depth contain trapped liquid which is of picrite composition (Dickey, 1970; Carswell, 1968a).

If the primary liquid produced on melting of the primitive mantle is picritic, some process must exist to explain the common occurrence of basaltic liquids at surface. O'Hara et al. (1975) considered a two stage process in which some modification of the primary melt took place at depth by eclogite fractionation, while further extensive olivine fractionation during ascent resulted in evolution of the magma to basaltic compositions. Eclogite fractionating at depth was thought to be of similar major element composition to the picrite extract, and variation in minor and trace element concentrations only was expected as a result. O'Hara and Yoder (1967) have suggested that extensive eclogite fractionation at depth might lead to a large build up of volatile and trace element concentrations and result in the production of a kimberlite magma.

A study of eclogites should therefore yield information concerning the genesis and modification of basaltic magmas, and indirectly should restrict the possible composition of the mantle. Trace element studies might be expected to indicate whether the process of kimberlite generation by eclogite fractionation is feasible.

Eclogite nodules are encountered as inclusions in most kimberlites although in some kimberlites the proportion of eclogites may be quite small. In most cases the eclogite portion of a kimberlite xenolith suite is minor, and the peridotite xenolith suite is the more abundant. The preponderance of peridotite supports the commonly held hypothesis that peridotite is the dominant component of the subcratonic mantle. However, in certain pipes, Zagadochnaya in Siberia and Roberts Victor in South Africa in particular, eclogite is the most abundant xenolith found.

The unusual abundance and the exceptionally large size of eclogites at Roberts Victor has attracted the attention of many investigators, and many studies have been carried out on the eclogites from this locality. Two recent investigations which considered the origin of the eclogites at Roberts Victor, reached different conclusions (Kushiro and Aoki, 1968; MacGregor and Carter, 1970). Kushiro and Aoki (1968) suggested that the simplest hypothesis to explain the observed element variations was that the eclogites represented a series of partial melts derived from garnet peridotite. MacGregor and Carter (1970) recognised two eclogite types at Roberts Victor and suggested that the type I eclogites were cumulates from a melt, while the type II eclogites represented the residual liquids

after settling of the cumulates.

Specific features of individual Roberts Victor eclogites are of especial interest.

Diamondiferous eclogites were recorded in the early stages of mining at Roberts Victor (Corstorphine, 1908, 1911), and excited speculation about the relation of eclogites to diamonds. Recent compositional studies of garnet and clinopyroxene in diamond-bearing eclogites from Roberts Victor and other localities have led to the hypothesis that diamond bearing eclogites might form at two distinct levels in the upper mantle (Reid et al., 1976).

Although diamondiferous eclogites constitute the most common diamond bearing xenolith type found in kimberlites, eclogite inclusions in diamonds are subordinate in amount to the peridotitic inclusions (Gurney et al., 1977a; Harris and Gurney, 1978; Sobolev, 1977), and diamonds derived from eclogites are thought to constitute only a minor fraction of the diamonds recovered. Nevertheless a study of diamond-bearing eclogite should be relevant to the problem of diamond formation.

Kyanite is found in a number of eclogites at Roberts Victor, and in many cases kyanite is restricted to a specific portion of the rock. The kyanite-bearing portion of the rock is of a different composition to the rest of the rock (Lappin and Dawson, 1975; Chinner and Cornell, 1974). The origin of these inhomogeneous kyanite eclogites has been interpreted differently by various studies (Chinner and Cornell, 1974; Lappin and Dawson, 1975; Cox, 1975).

A third interesting eclogite type found at Roberts Victor is represented by megacryst-bearing eclogites (Harte and Gurney, 1975). The megacryst is found as an integral part of the eclogite xenolith, and appears to bear no relation to the discrete megacrysts found in other kimberlite pipes, most abundantly at Monastery (cf. Gurney et al, 1977b). The discrete megacryst suite appears to be very poorly represented at Roberts Victor.

The Roberts Victor peridotite xenolith suite, though more abundant than the discrete megacryst suite, is nevertheless scarce when compared to other localities. If eclogites are partial melt

products of garnet lherzolite, the olivine-bearing residua should be more abundant than the eclogite extracts and the mantle below Roberts Victor should contain a greater proportion of peridotite than eclogite. If eclogite is derived from peridotite the scarcity of peridotites may be caused by preferential sampling of eclogite horizons in the mantle by kimberlite, or by some process operating during transport of the xenoliths in kimberlite which results in the preferential destruction of the peridotite nodules.

The features outlined in the foregoing discussion illustrate the nature of the Roberts Victor xenolith suite, and suggest which avenues of approach should be followed in a study of xenoliths from this locality.

The present study of the Roberts Victor eclogites was undertaken in order to examine the relationaship of eclogite nodules from a specific, subcontinental locality to the broad process of petrogenesis in general, and to the process of kimberlite genesis and emplacement in particular. Initially it was decided to examine the relations between the eclogites, and thence to deduce whether the eclogites could be derived as a series of partial melts (Kushiro and Aoki, 1968), as a set of cumulates and related liquids (MacGregor and Carter, 1970), as a series of cumulates (O'Hara et al., 1975) or whether the eclogites were formed by some other process. Further possibilities are that eclogite represents subducted crust (Helmstaedt and Doig, 1975; Smyth, 1977), the residua after extraction of andesite from subducted oceanic crust (T. Green and Ringwood, 1968) or that eclogite is primary mantle material (Press, 1970). In examining the Roberts Victor eclogites more emphasis was placed on mineral than on whole rock chemistry, because the eclogites are layered and statistically meaningful whole rock analyses are difficult to obtain, and because the eclogites have been contaminated by kimberlite (Berg, 1968; and references in Gurney and Berg, 1969).

II DATA COLLECTION, REDUCTION AND PRESENTATION

INTRODUCTION

Most of the data on which this study is based was obtained by electron microprobe analysis. Over 1000 mineral analyses, principally of garnet and clinopyroxene were completed. A review of the operating conditions under which microprobe analyses are carried out on the Cambridge Microscan 5 at U.C.T. has been presented by Lawless (1974), and in this study only the analytical accuracy of the method is presented in any detail.

Forty whole rock analyses, including major and trace element analyses of three kimberlites and trace element analyses only of two peridotites were carried out by X-ray fluorescence techniques. Major element concentrations (except Na) were determined from fusion discs, and trace element concentrations on pressed briquettes. The analytical procedures followed are those adopted by the Geochemistry Department for routine analysis of lunar, terrestrial and extraterrestrial samples (Willis et al., 1971, 1972). Estimates of the precision of the data are given in Table 2.

ELECTRON MICROPROBE

Standards with similar or higher concentrations than the unknown were used, except in the case of Na in clinopyroxenes where a standard with lower concentrations was used in order to maintain internal consistency in the standards used. End member calculations at high Na levels are satisfactory. Concentrations of elements in the standards and estimates of the analytical precision at the different concentration levels encountered in the unknowns are presented in Table 3. Estimates of the analytical precision were calculated on the assumption that fluctuation in background counts could be disregarded. At very low concentrations this assumption is invalid, and the coefficients of variation will be larger. Lower limits of detection at the 99% confidence level are presented in Table 4.

In the period March 1975 - September 1976 raw electron microprobe data was punched onto paper tape and reduced off line by the program ABFAN (see Lawless, 1974).

From December, 1976 on line data reduction was carried out on a Varian mini computer using the program MICROSCAN written by A.R. Duncan, and including a subroutine to calculate ionic proportions prepared by the writer. Replicate analyses corrected by the empirical method of Bence and Albee (1968) in the program MICROSCAN and analyses corrected for atomic number (backscatter and stopping power), absorbtion and fluorescence effects by the program ABFAN match within the limits of analytical error, for the closely matched standard-sample pairs used in this study.

REDUCTION OF MINERAL ANALYSES

The variations in the concentrations of oxides in minerals reflects the changes in the activities of mineral components. Concentrations of mineral components are usually expressed in terms of hypothetical end members which may or may not be represented in nature. The calculation of end members, although guided by the naturally occurring components is in large measure arbitary. The procedure adopted in this study for calculating garnet and clinopyroxene end members is outlined below.

GARNET SOLID SOLUTION

The general garnet formula is $X_3Y_2Z_3O_{12}$ where the sites are occupied by the ions $(Ca,Mg,Fe^{2+},Mn,Na)_3(Al,Cr,Fe^{3+},Ti^{4+})_2(Si,Al,P)_3O_{12}$. The major components of eclogite garnets are pyrope, almandine and grossular - $(Mg,Fe,Ca)_3Al_2Si_3O_{12}$. In some garnets Cr is a major component and the uvarovite end member - $Ca_3Cr_2Si_3O_{12}$, is calculated. The chrome concentration is rarely high enough to warrant calculation of the knorringite end member.

The four end members pyrope, almandine, grossular and sometimes uvarovite make up over 99% of observed garnet components at Roberts Victor and the minor elements can be ignored in end member calculation. Concentrations of these end members can be simply calculated from the Ca:Mg:Fe ratios with appropriate reductions in Ca content to account for the uvarovite end member.

Fe^{3+} is not believed to be present in the Roberts Victor garnets in amounts greater than 5% of iron present. Wet chemical analyses of garnets in Roberts Victor eclogites reveal low non-systematic concentrations

of Fe_2O_3 (<5% of Fe present) which may result from oxidation during sample dissolution. The amounts of Fe^{3+} in a mineral can be estimated by calculating the amounts of Fe^{3+} necessary to reduce a cation excess to stoichiometric proportions (e.g. Ryburn et al., 1976). Estimates by this method confirm that ferric ion contents in garnets are low.

CLINOPYROXENE SOLID SOLUTION

The general clinopyroxene formula is XYZ_2O_6 and the following cations may occupy the different sites: $(Ca,Mn,Mg,Fe,Na,K)(Mg,Fe,Al,Cr,Fe^{3+},Ti)(Al,Si)_2O_6$. In the Roberts Victor eclogites clinopyroxene is dominantly a solid solution of diopside-hedenbergite ($Ca(Mg,Fe)Si_2O_6$), and jadeite, ($NaAlSi_2O_6$), which two end members normally comprise 90% of eclogite omphacites. The enstatite-ferrosilite ($(Mg,Fe)_2Si_2O_6$) end member is present at levels of 4 to 20%. Besides jadeite, diopside-hedenbergite and enstatite-ferrosilite three other members may be present at significant levels in certain clinopyroxenes.

i) Ferric iron is present in the acmite molecule ($NaFe^{3+}Si_2O_6$). Wet chemical analyses indicate that Fe^{3+} in clinopyroxene is significantly greater than in garnet, and may comprise 25% or more of the iron present (O'Hara et al., 1975).

ii) In the calcium tschermak's molecule $CaAlAlSiO_6$, aluminium substitutes for silicon in the four fold site. The Al^{3+} ion is substantially larger than the Si^{4+} ion, thus the amount of calcium tschermak's molecule in solid solution decreases with increase in pressure. With increase in temperature the volume of the oxygen anion expands and proportionately larger cations may enter a given coordination site. Thus at higher temperature aluminium is more likely to substitute for silicon in the four fold coordinate site, and the proportion of calcium tschermak's molecule increases with temperature. This effect is of considerable importance in the paragenesis of eclogites. The amount of calcium tschermak's molecule is equivalent to the amount of garnet in solid solution in clinopyroxene according to reactions of the type:

$$3CaAl_2SiO_{6(cpx)} + 3CaMgSi_2O_{6(cpx)} = 2Ca_3Al_2Si_3O_{12(gt)} + Mg_3Al_2Si_3O_{12(gt)}$$

A clinopyroxene crystallised at high temperature may on cooling exsolve considerable amounts of garnet, thus the possibility that much of the garnet in certain eclogites is of subsolidus origin is indicated.

iii) Several clinopyroxene analyses show negative deviations from the theoretical 4.000 cations per 6.000 oxygens. These negative deviations are most commonly found in aluminuous clinopyroxenes (Cawthorn and Collerson, 1974; Wood, 1976a). The presence of Eskola's "pseudojadeite" molecule, $Ca_{0.5}AlSi_2O_6$ has been invoked as a possible explanation of this site deficiency (Smyth, 1977a; Cawthorn and Collerson, 1974). In the present study it was found that the amount of pseudojadeite present correlated well with the size of the site deficiency, when clinopyroxene end members were calculated according to the method outlined below. Pseudojadeite was found to be present in appreciable amounts in eclogites containing grossular rich garnets, and in the kyanite-bearing eclogites. Pseudojadeite is stable only at high pressures and is very readily altered to calcium tschermak's molecule and quartz in near surface environments (Smyth, 1977a). $2Ca_{0.5}AlSi_2O_6 = CaAl_2SiO_6 + 3SiO_2$

In the high pressure environment in which the pyroxenes originally formed, pseudojadeite-rich clinopyroxene may exsolve kyanite by the reaction:

$$4Ca_{0.5}AlSi_2O_{6(cpx)} + 7CaAl_2SiO_{6(cpx)} = 3Ca_3Al_2Si_3O_{12} + 6Al_2SiO_5$$

According to this reaction it is theoretically possible for clinopyroxene to exsolve garnet and kyanite on cooling.

The calculation scheme used here was evolved in order to allow calculation of the pseudojadeite molecule. Pseudojadeite is calculated by allocating aluminium to calcium tschermak's molecule, then to jadeite. After these two steps either:

i) There is an excess of sodium. An amount of iron equal to the excess of sodium is converted to ferric ion and combined in the acmite end member.

ii) There is an excess amount of aluminium. Excess aluminium is calculated as pseudojadeite. The number of site vacancies is equal to half the amount of pseudojadeite.

The remaining ions Ca, Mg, Fe and Mn are components of end members in the pyroxene quadrilateral DiHdEnFs. In most end member calculation schemes the end members Wo ($Ca_2Si_2O_6$), En ($Mg_2Si_2O_6$) and Fs($Fe_2Si_2O_6$) are calculated. In this study it is assumed that Ca and Mn occur only in the M2 site. Mg and Fe are considered to be distributed between M1 and M2 sites. It is probable that the larger Fe^{2+} ion is incorporated into the larger M2 site in greater amounts than is the smaller Mg ion.

However, Wood and Banno (1973) concluded that the preference of Fe for the M2 site is not significant for purposes of site allocation. Thus Mg+Fe are combined, and Ca is allocated to the diopside-hedenburgite molecule. The remaining Mg+Fe is equally divided between the M2 and M1 sites in the enstatite-ferrosilite molecule. In this study, as in the Wood and Banno calculation it is implicity assumed that (Mg/Fe) M2 is equal to (Mg/Fe) M1.

Eleven clinopyroxene end members are recognised but minor end members are incorporated into major components and only five end members are calculated. Only one of acmite or pseudojadeite is calculated.

The end members are:	$CaAlAlSiO_6$	Ca Tschermak's molecule
	$NaAlSi_2O_6$	
	$KAlSi_2O_6$	Jadeite-Ureyite
	$NaCrSi_2O_6$	
	$NaTiAlSiO_6$	
	$NaFeSi_2O_6$	Acmite
	$Ca_{0.5}AlSi_2O_6$	Pseudojadeite
	$CaMgSi_2O_6$	Diopside-Hedenbergite
	$CaFeSi_2O_6$	
	$MgMgSi_2O_6$	
	$FeFeSi_2O_6$	Enstatite-Ferrosilite

The end member calculation scheme is presented below.

1. Ca Tschermak's molecule = 2.000 - (Si+Ti).
   If Tschermak's molecule is negative by a small amount it is set equal to zero. If CaTs is a large negative number greater than that attributable to analytical error then clearly this calculation procedure is invalid. However, in high pressure low Ti pyroxenes CaTs is usually positive.
2. Jadeite = (Al+Cr) - 2CaTs.
3. Acmite = (Na+K) - Jadeite.
   Acmite is negative if there is excess alumina. In this case the pseudojadeite is set equal to the negative amount of acmite calculated, and jadeite is set equal to (Na+K).

i.e. if Acmite 0.0

Pseudojadeite = - Acmite

Acmite = 0.0

Jadeite = (Na+K)

4. Diopside = (Ca+Mn) - CaTs - 1/2 $Ca_{0.5}AlSi_2O_6$

5. Enstatite = ((Mg+Fe) - (Acmite+Diopside))/2.

This calculation procedure has been found to be internally consistent in that if the cation sum is less than 4.000 it is found that amounts of pseudojadeite are present. The amount of pseudojadeite is found to be very nearly equal to that expected from the size of the site deficiency. (Site deficiency = 1/2 $Ca_{0.5}AlSi_2O_6$). On the other hand if the cation sum is greater than 4.000 it is found that the acmite end member is calculated. The amount of acmite = Fe^{3+} calculated is normally less than that calculated by the program FERRIC which assumes that the pyroxenes are perfectly stoichiometric.

DATA PRESENTATION

Mineral analyses are presented in tables produced by the program MINCALC. All the analyses of the eclogites and garnet websterites carried out in this study are presented in alphnumerical order in Table 4. Analyses of minerals in the ultramafic rocks, and in a unique clinopyroxene-magnetite rock are presented in Table 5.

Whole rock analyses have been listed by use of the program LIST/ALR. Eclogite analyses are presented in Table 6, peridotite analyses in Table 7 and kimberlite analyses in Table 8.

The meaning of abbreviations used are outlined at the beginning of the relevant table.

III SAMPLE COLLECTION : THE ROLE OF KIMBERLITE

INTRODUCTION

An important factor in the choice of Roberts Victor as the locality on which to focus the study of eclogites was the presence at U.C.T. of a large collection of nodules from this pipe. Many of the nodules described by Williams (1932) were presented to U.C.T. and formed the nucleus of the kimberlite xenolith collection. Participation by U.C.T. in the Upper Mantle Project led to several collecting expeditions by members of the Geology and Geochemistry Departments, which greatly enlarged the collection of nodules and kimberlites from Roberts Victor and other localities. Upon completion of the Upper Mantle Project, J.J. Gurney continued the collection as part of a program for the study of kimberlite xenoliths. Thus at the inception of this study in 1975 there was at U.C.T. a collection comprising over two hundred Roberts Victor eclogites. After a preliminary survey of these nodules, the writer accompanied by J.J. Gurney travelled to Roberts Victor to augment this collection.

A problem encountered in the study of xenoliths in kimberlite is that, however extensive the sampling by human agency, the initial composition of the nodule suite is determined by the kimberlite sampling process, and it is thought to be a dubious assumption that the nodule suite encountered in a particular kimberlite pipe is a representative cross section of the mantle through which the kimberlite has passed. The nature of the xenolith suite in a given kimberlite depends on the nature of the mantle through which kimberlite has passed; whether the kimberlite includes portions of the material through which it passes at regular intervals or whether it gathers larger portions at specific horizons; the extent to which materials vulnerable to chemical or physical attack by kimberlite have been eroded; and finally, the number of kimberlite intrusions present, given that each intrusive event may have sampled preferentially a different portion of the mantle. The problems of kimberlite sampling are partially evaluated in this chapter by consideration of possible mantle configurations, and of the kimberlite types present at Roberts Victor.

Features visible in hand specimen, size, shape and sphericity are to some extent controlled by the kimberlite sampling process and examination of these features sheds some light on the nature of this process.

The possible role of alteration and abrasion by kimberlite in reducing the abundance of peridotite at Roberts Victor is considered in Chapter IX.

COLLECTION OF NODULES BY THE WRITER

Eclogite xenoliths are extremely resistent when compared to the kimberlite in which they are found. Large eclogite xenoliths at Roberts Victor are consequently removed from the kimberlite prior to crushing. When a pile of eclogites has accumulated, they are simultaneously fed to the crusher in a batch of equal resistance. The frequency of crushing of eclogites may vary, especially since the miners have found that eclogites do not in general yield large diamonds. Consequently the crushing of eclogites is an event of no great urgency.

At the request of J.J. Gurney, the mine manager, W.C. Prozesky had allowed a large number of eclogites to accumulate prior to the writer's first collecting trip. The 750 eclogites available for examination far exceeded that available to previous collectors and afforded an opportunity to assemble a representative collection of Roberts Victor xenoliths from the kimberlite being mined at that time.

Although the large number of xenoliths available increases the likelihood that a representative sample of the eclogites present in the Roberts Victor pipe was obtained it must be accepted that the xenoliths present in the pipe may not truly represent the mantle and crust through which the kimberlite has passed.

SAMPLING OF THE MANTLE BY KIMBERLITE

Two models of the manner in which kimberlite includes the material through which it passes may be considered.

i) A continuous and statistically random cross-section of mantle and crust is sampled.

ii) Disproportionate amounts are sampled at crucial stages in the ascent of the kimberlite from depth. These crucial stages may be the beginning of rapid ascent of the kimberlite; encounter of a body of different density or competence in the eruption path; unmixing of the gaseous phase near surface, and encounter of ground water by the kimberlite.

That some portion of the material through which the kimberlite passes is continuously sampled cannot be disproved without very intensive studies of the nodule suites of particular pipes. However, available evidence indicates that the nodule suite of particular pipes is usually biased toward a specific type which can be differentiated from the nodule suite of other pipes (which may be in close geographical proximity). For example, at the Matsoku pipe the peridotite suite appears to have equilibrated to a narrow temperature and pressure range while the nearby Thaba Putsoa pipe appears to have equilibrated over a wide temperature and pressure range (Cox et al., 1973; Nixon and Boyd, 1973).

In South Africa the Roberts Victor pipe is dominated by abundant eclogite nodules. In the nearby New Elands pipe upper mantle xenoliths of any kind are virtually absent, while in the pipes in the Kimberley area, approximately 50 kilometres from Roberts Victor, eclogite nodules are extremely rare among the abundant peridotite suite.

Geographical inhomogeneity in the mantle is clearly indicated, but the exact nature of this inhomogeneity is open to several interpretations. Vertical inhomogeneity may be due to the presence of faults or dykes. The presence of such features is at present a matter of conjecture. Horizontal inhomogeneity would be manifested by the presence of layers of different compositions. These layers may be continuous or discontinuous, and may be of varying thickness. Clearly there are available a number of parameters with which to explain the biased nature of the sample presented at different pipes. The feasibility of various models can be weighed if the simplifying assumption that all kimberlites originate from roughly the same depth in the mantle, is made.

A model of a mantle with laterally continuous layers of eclogite, sheared peridotite and granular peridotite of constant thickness sampled continuously and evenly by kimberlite can be rejected (Figure 1, Model I). However a similar mantle model with biased sampling by the kimberlite at crucial stages can explain the varied nature of xenoliths found in different pipes (Figure 1, Model II).

A model of a mantle with continuous layers, but of varying thickness which is sampled continuously and evenly by kimberlite (Figure 1, Model III) can only be rejected if it can be shown that a specific nodule type is

entirely absent from certain pipes. Although certain nodule types are very rare at certain pipes, it is a difficult task to ascertain that a nodule type is completely absent. In this model in which the proportion of nodule suites below different pipes varies, it is not of direct import if the kimberlite samples evenly throughout ascent or samples selectively at certain stages.

The model in which the layers in the mantle are not continuous but occur as separate lenses or pods, (Figure 1, model IV) is perhaps most widely accepted and corresponds closely to that envisaged by Wagner (1914, p.130). As in the previous model the nature of sampling by the kimberlite is not crucial in determining the relative abundance of nodules. Such a model explains limited domination of a nodule suite by a particular nodule type.

Hence only one mantle model, I, requires that kimberlite samples selectively on its path to surface. Nevertheless consideration of the relative percentages of nodule types in particular pipes does lend weight to a selective sampling hypothesis. At Roberts Victor greater than 98% of the upper mantle xenoliths are eclogitic. Continuous, even sampling by the kimberlite then requires that 98% of the mantle through which the kimberlite passes is eclogitic. The proportion of eclogite at the Kimberley mines is less than 1%. It follows that a continuous, even sampling hypothesis is tenable only if a major discontinuity exists between Roberts Victor and Kimberley, or if dyke like bodies dominate the mantle. A model of selective sampling is the preferred alternative.

More direct evidence of selective sampling by the kimberlite is afforded by the present study. Since the reasoning depends extensively on the proposed genesis of the eclogites it is best considered in detail in the appropriate chapter (Chapter V, Phlogopitised eclogites and the nature of kimberlite sampling).

If it is accepted that each kimberlite contains a biased sample of the upper mantle, it is then a possibility that different kimberlite types within the same pipe may similarly contain different proportions of various nodule types. This consideration points to the possibility that in a pipe with several kimberlite types the proportions of nodule types available for examination may vary according to the relative amounts of each kimberlite

type that is being mined at a given time. The identification of several kimberlite pipes at Roberts Victor points to a possible bias in the sample examined dependent on the time at which the mine was visited. Although very little data pertaining to this question are available, it none the less is useful to consider the setting and mining history of the Roberts Victor kimberlite.

THE ROBERTS VICTOR KIMBERLITE

The mining areas at Roberts Victor are divided into the No.1 mine and No.3 mine which form discrete outcrops at surface. The No.1 mine consists of the No.1 pipe. The No.3 mine has been divided into:

(i) the S.W. arm
(ii) the Jewel box
(iii) the No.3 pipe which is further subdivided into:
a) the NE section and
b) the SW section (Melville, 1909)(Figure 2).

Mining began in May 1906 and was initially confined to the No.3 mine area, and in particular the Jewel Box which had a very high grade. After 1909 the No.1 mine was developed. Mining became less profitable as the deposit diminished in size and was halted in 1914 with the advent of the First World War. The average grade for the period 1906 - 1911 was 42.7 carats per hundred loads. (Guide book to First Int. Kimb. Conf., 1973).

Mining was resumed in 1963 and progressed to a depth of 643 feet. It was shown that the No.1 and No.3 pipes were part of a single pipe separated at surface by a fall of waste rock. Mining in this second period of mining has yielded an average of 20 carats per 100 loads.

Melville (1909) suggested that the Jewel Box and SW arm comprised the oldest and richest intrusion. A second period of eruption produced the S.W. portion of the No.3 pipe. The third and final eruption intruded the N.E. portion of the No.3 pipe. The linking of the No.1 pipe and No.3 pipe at depth suggests that the kimberlite of the No.1 pipe was also intruded in this final period. Williams (1932) largely accepted Melville's interpretation but suggested that the initial intrusion filled the entire volume of the pipe. The comparatively narrow volume of the Jewel Box solidified while the magma in the larger pipe was in a plastic

or semiplastic state. Subsequent kimberlite intrusion then occurred preferentially into the unsolidified area of the larger pipe.

A sample of kimberlite from the vicinity of the Jewel Box proved to be far less altered than other kimberlite from the Roberts Victor. The olivines in the Jewel Box kimberlite are relatively fresh showing only limited serpentinisation. Inclusions in olivine suggest that their origin might be sought in a dunite horizon in the upper mantle, which horizon is possibly an important source of the diamonds. (See Chapter IX).

At the present time mining is largely confined to the No.1 pipe, the Jewel Box having been virtually worked out in the first period of mining (1906 - 1914).

COMPARISON WITH PREVIOUS COLLECTIONS

The identification of several kimberlite types at Roberts Victor indicates that various collections might have sampled different proportions of nodule types. There is some evidence that previous collectors had access to a sample suite which differed in some respects from that available to the writer.

Gurney (pers comm) recorded that in 1968, 14% of the nodules examined contained kyanite. In March, 1975 less than 6% of the nodules sliced and examined in detail contained kyanite.

Comparison with published data on rocks collected and described in MacGregor and Carter (1970) and with data on rocks collected by J.B. Dawson (Bishop et al., in prep.) reveals that these collections contained a higher proportion of type II calcium-iron rich eclogites than the present collection.

DESCRIPTION OF NODULES IN HAND SPECIMEN

SIZE

The eclogite nodules from Roberts Victor are generally of a large size averaging about 20 cm in the longest dimension. The largest are greater than 30 cm but probably less than 50 cm in the long axis. Nodules less than 10 cm long are rare, but this is no doubt due to the removal of large nodules prior to crushing. Small nodules will be

allowed to pass through with the kimberlite to the crushing plant, while the larger ones are removed. For this reason and because more features can be examined in large samples, there may be a bias against smaller samples in this study. Examination of the concentrate dump where all samples are of a uniform (2 - 3 cm) size indicates that little bias in the eclogite sample is introduced. Orthopyroxene and chromiferous diopside megacrysts, and a clinopyroxene magnetite intergrowth have been found in the concentrate dump, but have not been found as large samples. This may be due to the original small size of these particular nodules.

INDENTATION ALONG CLINOPYROXENE RICH LAYERS

It was observed that eclogite boulders were indented externally along clinopyroxene rich layers, suggesting that clinopyroxene is more susceptible to attack by kimberlite than garnet. Preferential erosion of clinopyroxene leads to the dominance of garnet on the outer surface of the nodule, giving the impression that garnet is modally more abundant than clinopyroxene. Estimates by eye of the modal abundance indicate that of 124 sliced samples 27% had equal amounts of garnet and clinopyroxene, 34% had more garnet than clinopyroxene while 39% had clinopyroxene as the dominant mineral (Figure 3). Clinopyroxene therefore appears to be slightly more abundant than garnet in the samples examined and given the preferential erosion of clinopyroxene, it is likely that clinopyroxene was the dominant mineral in the eclogite body (or bodies) at depth. 5% of the samples have less than 20% garnet and may be described as garnet clinopyroxenites rather than eclogites.

The state of kimberlite during intrusion has been described as a system of particulate materials fluidised by an upward moving gas of high velocity (Woolsey et al., 1975). Given that kimberlite during intrusion behaves as a fluid, transport of eclogite boulders in this medium can be compared, albeit imperfectly to the transport of particles in an aqueous medium. The techniques and descriptions of sedimentary petrology will then be applicable, although the danger of identifying two fundamentally different systems must always be borne in mind. The shape of the nodules was determined within these terms of reference.

SHAPES AND THEIR GENESIS

During examination on site at Roberts Victor the long (a), short (b) and intermediate (c) axes of 625 nodules were measured to the nearest centimetre (Figure 4). Zingg's shape classification (Krumbein and Sloss, 1963) was used to divide the nodules into spheres (a=b=c), discs (a=b c), rollers (a b=c) and blades (a b c)(Figure 5). It was found that 57.9% of the nodules could be classified as discs, 15.1% as blades, 14.5% as spheres and 12.5% as rollers. Three explanations for the overwhelming preponderence of discs have been entertained.

1. Kimberlite intrusives at depth probably propagate as relatively narrow dykes. The large eclogite boulders (long axis = 30 cm and greater) could orientate parallel to the dyke wall. This process is considered to be unimportant since particles tend to settle with the area of maximum volume perpendicular to the settling direction (Flemming, pers. comm.)

Upon disruption of the eclogite body at depth parting may have occurred along preferential planes producing tabular bodies which would erode to produce blade or disc shaped bodies. Blade shaped bodies would be more susceptible to destruction than discs and would rapidly tend to become disc-shaped. Hence if tabular bodies were formed during disruption, discs would probably dominate the final population.

2. Tabular bodies could be formed by preferential disruption along igneous layers. If this were the case the angle formed by the intersection of the plane of layering and the plane of flattening ab (plane in which the long and intermediate axes lie, Figure 4) would be close to 0. To test this possibility measurements were carried out on 120 slices cut parallel to the plane bc (plane in which the short and intermediate axes lie). The intersection of ab with this plane defines a line parallel to the long sides of the slice (Figure 6a). In slices where layering was clearly defined the angle between ab and the layering was measured. 43 slices showed unambiguous layering features. The results are illustrated in the histogram, Figure 7a. In 14% of the samples measured the angle between ab and the layering is between 0° and 10°. The majority of the samples have large angles between ab and the layering. Thus there is no convincing evidence that the eclogite body was disrupted preferentially along the plane of layering. A further possibility was considered.

3. It has been assumed that at depth kimberlite intrudes as a dyke like body. Propagation of a dyke at high temperatures and pressures occurs by ductile faulting of the host rock (Pollard, 1973. Figure 8). Ductile faulting is therefore likely to be an important mechanism in disruption of an eclogite body at depth. Planes of parting may occur parallel to the ductile faults and produce tabular shaped bodies. If the above process was important in the disruption of the Roberts Victor eclogite body (or bodies) and the subsequent production of disc shaped boulders then the dominant plane of jointing would be roughly parallel to the long edges of the slices cut. In hand specimen jointing could be observed in twenty three slices. In one case two planes of jointing could be observed, but in the rest only one plane of jointing could be discerned. The measurements presented in Figure 7b provide some support for the hypothesis that ductile faulting of the eclogite body by the intrusive kimberlite dyke was the dominant process in the initial production of tabular shaped eclogite fragments, since the angles between the plane of jointing and the plane of flattening (ab) are usually small; less than 10° in 38% of the samples measured. Thus the tabular shape of the nodules is more likely to have been produced by jointing induced during kimberlite eruption than by preferential disruption along planes of layering.

If it is assumed that the eclogite body at depth was flat lying. and that more samples were gathered at the nose of the dyke than at the sides, then the angle between layering and jointing is expected to be large. (See Figure 8). Measurements carried out on the small number of samples (12) in which layering and jointing both could be clearly discerned supports this suggestion.

ROUNDNESS

A visual estimation of the roundness indicates that the boulders are well rounded (Krumbein and Sloss, 1963, p. 111). In aqueous environments large nodules are rapidly rounded, while smaller particles take correspondingly longer times to attain a similar state of roundness. However the size that comprises a "large" particle in an aqueous medium may be very different from the size of a "large" particle in the fluidised kimberlite. Little significance can be attached to the good rounding of the nodules.

SPHERICITY

Lines of equal sphericity may be plotted on Zingg's diagram. Samples have sphericity of 5 or greater. Most nodules have sphericity of 6, and a rough trend parallel to this line can be observed in Figure 5b. Abrasion or hydrodynamic selection will lead to a population of similar sphericity. The intermediate sphericity suggests that abrasion, rather than selection produced the present population and provides further, albeit indirect, evidence for the role of abrasion during transport of the eclogite boulders to surface. The most important effect of abrasion is the loss of clinopyroxene which can lead to an unrepresentative bulk analysis of a sample.

IV MINERALS PRESENT IN THE ROBERTS VICTOR ECLOGITE SUITE

GENERAL FEATURES

Eclogites at Roberts Victor are typically of large grain size and in the terminology applied to crustal rocks would normally be described as coarse grained, (grain size>2 mm). Grain size varies from 2 mm to greater than 6 mm. Convenient subdivisions in this range are 2 - 3 mm, 4 - 5 mm, and 6 mm - 10 mm. It is something of a problem to decide on the terminology applicable to these subdivisions for the terms fine-grained, medium grained and coarse grained, though convenient are inappropriate, since strictly speaking all the eclogites are coarse grained. Thus when discussing grain size the approximate grain size of the mineral described will normally be specified, rather than employing a general term.

The colour of the minerals varies widely. Clinopyroxenes are shades of green, or white, and eclogitic garnets are shades of orange or red. The colour variations depend to a great extent on the chemistry of the phases. Diopside rich clinopyroxenes with only small amounts of jadeite are pale translucent green. An increase in the jadeite content results in an increasingly colourless appearance. The transition metals, chromium and iron are the most important chromophores. Trivalent chromium imparts to clinopyroxene a bright apple green colour, while iron rich clinopyroxene is dark green.

Garnet colours have been well defined as a result of intensive study by the De Beers organisation during diamond prospecting. Pyropic garnets with moderate chrome contents (1-3 wt.%) are red. Almandine garnets usually have low chrome, but moderate titanium contents, and are orange to dark orange. Grossular garnets with low chrome contents are light to very light orange.

Translucency of garnet and clinopyroxene appears to depend on the degree of alteration and on the presence of microscopic and possibly submicroscopic inclusions. Clinopyroxenes are conspicuously more prone to alteration than garnet. Jadeitic pyroxenes are often, though not always altered to an opaque milky white material. Alteration of the jadeitic pyroxenes may depend to a large extent on the amounts of pseudojadeite present.

The shape of minerals is intimately related to their solidus and subsolidus crystallisation history. Euhedral crystals are generally rare in upper mantle xenoliths. A single specimen from Roberts Victor, BD1185 contains apparently euhedral garnet with intercumulus clinopyroxene. The general rarity of euhedral grains indicates that, if the eclogites originated as cumulates, there has been reaction between crystals and liquid, or the crystals have reequilibrated below the solidus.

In the following pages, eclogites will be discussed according to the accessory minerals present, and within the groups so defined, subdivisions are made on textural features.

Subdivisions of Roberts Victor eclogites on the basis of textures have been made previously (Siebert, 1968; Whitfield, 1971; MacGregor and Carter, 1970). The two principal groups may be very briefly defined as eclogites containing cloudy clinopyroxene with rounded garnet (Group I of MacGregor and Carter)and clinopyroxene and eclogites containing clear clinopyroxenes with straight edged garnet and clinopyroxene (Group II of MacGregor and Carter)(see Plate 1). The type I eclogites are distinctive and the approach adopted in this study has been to assign all eclogites which were not recognised as type I eclogites, to the type II eclogites. The range in textures is illustrated in plate 1. It should be realised that intermediate features in eclogites which cannot be obviously related to either group often occur (Whitfield, 1971; Sobolev, 1977). Erlank (1970) pointed out that the two groups could be chemically distinguished by the amounts of potassium in the clinopyroxenes; the cloudy clinopyroxenes generally contain more than 100 ppm K_2O and the clear clinopyroxenes generally less than 20 ppm. This distinction was broadly confirmed by the present study and the potassium content of the clinopyroxene was found to be a very useful feature in the categorisation of the eclogites.

The basic subdivision into relatively fresh group II eclogites and altered Group I eclogites is followed in this study.

MINERALS PRESENT

Garnet and clinopyroxene usually make up more than 99% of the primary minerals present in an eclogite. Several minerals which, with the notable exception of phlogopite, can normally be regarded as primary constituents, occur as minor accessories. Before describing these minerals it is worth noting that olivine was not observed in any of the seven hundred and fifty eclogites examined. This feature is of considerable importance when considering the petrogenetic scheme outlined by O'Hara (1968).

ORTHOPYROXENES

The presence of orthopyroxene in an eclogite leads to some confusion in nomenclature, for such a rock may be described either as an orthopyroxene eclogite (see Rickwood et al., 1969 p.389) or as a garnet websterite depending on the amount of opx present. It is the presence of a mineral, rather than the amount that is of importance in partial melting and crystallisation processes (see O'Hara et al., 1975), hence the term garnet websterite will be applied to all eclogites which contain orthopyroxene as a primary phase.

Orthopyroxene in eclogite assemblages appears to be extremely prone to alteration to an amphibole like material. Fresh orthopyroxene has been found in only one rock (HRV243); but an altered mineral which is thought to be orthopyroxene, (and was confirmed by probe analysis in some cases) is present in several eclogites.

Type I garnet websterites are uncommon. Three samples have been found.

i) The sample HRV249 is well rounded but for an irregular basal surface which is thought to represent a weaker orthopyroxene bearing layer which broke off subsequent to rounding of the nodule. Small amounts of altered orthopyroxene are visible along this layer (Plate 2).

ii) HRV110 and JJG306 are typical group I eclogites but contain approximately 5 modal % of altered orthopyroxene. Grain size of the garnet is 4 mm, garnet is orange and the clinopyroxene is blue green.

Type II garnet websterites are relatively abundant.

i) JJG307 contains more than 5 modal % of orthopyroxene (Plate 3).

ii) HRV267 is layered with respect to modal amounts of low calcium pyroxene,

clinopyroxene and garnet. 30 modal % of low calcium pyroxene occurs in the central layer. The chemistry of the low calcium pyroxene is unusual in that exsolution of jadeitic pyroxene appears to have occurred (Plate 4).

iii) HRV180 is a friable nodule containing relict magnesium amphibole (Figure 9).

iv) Orthopyroxene in HRV243 is found as very small grains in the intergranular mineralogy, therefore it may conceivably be a secondary mineral (Figure 10, Plate 1k).

v) Bright apple green, chrome rich clinopyroxenes occur in HRV132, HRV166, HRV171 and JJG183. Small grains of altered orthopyroxene are visible in these samples, with the exception of HRV132. Mica, possibly primary is present in HRV132 and HRV166.

vi) HRV42, HRV131, HRV134, HRV135, HRV137, HRV158, HRV187, HRV309 and JJG312 are included in a broad group containing orange red garnets, bright apple green clinopyroxene and small grains of altered orthopyroxene. Garnet grain size is generally greater than 5 mm. The nodules in this group are generally large (>15 cm long axis). Jointing in the minerals is unusually prominent.

vii) In contrast to the above grouping, which includes probably unrelated samples, HRV39, HRV98 and HRV143 are so similar in appearance that a common genetic origin appears certain. Garnet grain size of 2 - 3 mm is smaller than the average Roberts Victor eclogite grain size.

viii) 9 samples were collected from a single mine face. 4 of these, HRV261, HRV263, HRV265 and HRV269 fall into a group recognisable by the 3 mm clear red garnets and flaky khaki green clinopyroxenes. No samples which could be directly related to this group were collected on surface, hence it is possible that xenolith type may be related to a spatial distribution within the kimberlite, and that samples from a specific horizon in the mantle may remain in reasonable proximity within the kimberlite.

ix) HRV19,HRV248, HRV43, HRV145 and HRV268 are similar to the above but differ in exhibiting well defined layering.

MICA

Three generations of mica are proposed.

1. Mica crystallising together with garnet and clinopyroxene is a primary component of the eclogite.
   i) Chrome rich garnet websterite HRV166 and HRV132 (Orthopyroxene v, p. 25) contain mica, which especially in HRV166 appears to be primary.
   ii) Mica is present as part of the primary assemblage garnet, clinopyroxene, "orthopyroxene", mica, sulphide and rutile in HRV42 (see p. 25).
   iii) HRV274 and HRV312 are eclogites with light green clinopyroxene, and orange garnets which are very similar in appearance and which both contain primary mica (Plate 6).

   Primary mica is always less than 5 modal % in amount.

   Intercumulus liquid may recrystallise to phlogopite and other phases. The intercumulus mineralogy is obscured by pervasive alteration along grain boundaries, and no intercumulus phlogopite can be positively identified.

2. Metasomatism in the upper mantle is well documented (Harte et al., 1975; Harte and Gurney, 1975a; Lloyd and Bailey, 1975; Erlank and Shimizu, 1977).

   The products of mantle metasomatism are referred to as primary metasomatic minerals (Harte et al., 1975). HRV47 (Plate 5) exhibits good evidence of mantle metasomatism. A vein penetrates two thirds of the nodule and is terminated by a layer of phlogopite. The grain size of primary metasomatic phlogopite is equal to or greater than the garnet and clinopyroxene grains. Primary metasomatic phlogopite is restricted to type I eclogites and occurs most abundantly in JJG181, JJG309, JJG339 and HRV207.

3. Intergranular phlogopite is found in almost all Roberts Victor eclogites. This secondary mica is thought to crystallise from fluids introduced by the kimberlite during transport or immediately prior to disruption, but may also have formed during metasomatism prior to kimberlite eruption.

The time at which each generation of mica was formed is indicated by isotopic work carried out on Roberts Victor eclogites.

AGES OF POSSIBLE PHLOGOPITE CRYSTALLISATION

i) Primary mica may have formed during the thermal event in which the Roberts Victor eclogites were originally formed. This event has been dated at 2.5 X 10 years B.P. (Kramers, 1977; Manton and Tatsumoto, 1971).

ii) Allsopp and Barrett (1975) dated micas in eclogites using Rb-Sr isotopes. A range in values was reported, but an age of 127 $\pm$ 3 m.y.B.P. was indicated. $^{40}Ar^{39}Ar$ determination of garnet and omphacite gave an age of 120 $\pm$ 1 m.y. B.P. while whole rock data gave an approximate isochron of 130 m.y. B.P. (Ozima and Saito, 1975). Thus the primary metasomatic event may have occurred at 120 - 130 m.y. B.P.

iii) An age of 92.2 x 10^6 years B.P. from a single zircon believed to be the pipe emplacement age agrees well with ages for other pipes in the vicinity. Secondary interstitial mica may have formed at the time of pipe emplacement.

KYANITE

In crustal environments kyanite is found in metamorphic rocks where it is indicative of a high pressure of origin. In high pressure assemblages kyanite crystallises as a primary phase from relatively siliceous magmas of eclogitic affinity.

Kyanite occurs in group I and group II eclogites. Several different types of occurrence can be noted within each group on the basis of the amount of kyanite present, and on the nature of the distribution of kyanite in the eclogite.

INHOMOGENEOUS KYANITE ECLOGITE

i) The most common occurrence of kyanite is in a zone together with white, altered clinopyroxene and brown garnet. This zone is bounded on at least one side by typical group I eclogite with blue green clinopyroxene and orange garnet. These rocks are termed type I inhomogeneous kyanite eclogites. Grain size of the minerals is approximately 4 millimetres. (Plate 1i,j). These samples are considered in more detail in chapter VII.

ii) A different type of inhomogeneous kyanite eclogite may be distinguished by the relatively small grain size(1.5 mm) of constituent minerals. Kyanite coexists with white pyroxene and brown garnet which is bounded

on at least one side by eclogite with a greyish purple garnet and cloudy green to apple green clinopyroxene. In sample HRV116 the kyanite eclogite bleb is entirely surrounded by biminerallic eclogite (Plate 1m). These rocks are termed finegrained kyanite corundum eclogites and are classified as type II eclogites.

iii) Typically the clinopyroxene in the kyanite eclogite zones is entirely altered. An unusual sample (HRV147) was found in which the pyroxene was only half altered. In the adjacent biminerallic eclogite the clinopyroxene is virtually unaltered. On the basis of its very fresh appearance this rock is related to the type II eclogites.

iv) Type I inhomogeneous eclogites without kyanite.

Inhomogeneous kyanite eclogites often contain within the kyanite eclogite zone a layer of white pyroxene and brown garnet without kyanite. Two specimens HRV118 and JJG23 contain a white pyroxene, brown garnet zone which is bounded on <u>both</u> sides by ordinary biminerallic eclogite, and no kyanite eclogite zone is present. The process which produced the inhomogeneous kyanite zone must therefore be capable of producing inhomogeneous zones <u>without</u> kyanite.

CORUNDUM

Corundum can normally be found as rare small grains ($<$1 mm) associated with kyanite in most kyanite eclogites. In these rocks it is probably of sub-solidus origin. However, in two samples described below corundum is more abundant.

i) Clinopyroxene in JJG60 has the altered appearance characteristic of group I eclogites. Colourless corundum is abundant ($>$10 modal %) and is often mantled by garnet. Garnet also occurs in exsolution lamellae from clinopyroxene and as discrete grains. Garnet in this rock occurs as a near liquidus (discrete grains), sub-liquidus (garnet mantling corundum) and a subsolidus phase (garnet exsolution lamellae). The compositions of the garnet may be expected to vary considerably.

ii) RV372 has a fresh appearance and on that account is related to the group II eclogites. The corundum is ruby red, with light green clinopyroxene and pale pinkish garnet. Experimental work was carried out on this rock (O'Hara and Yoder, 1967) and it was found to melt over

a 100°C range. Spinel previously reported in this sample (Williams, 1932) was not observed in the small fragments and two thin sections available to the writer.

SPINEL

HRV15, a fresh, distinctly layered eclogite with interlocking, elongate fabric typical of type II eclogites (MacGregor and Carter, 1970) contains a layer in which spinel occurs within a peculiar pink-purple garnet. Clinopyroxene is light green. Although secondary spinel is a very common constituent of the secondary, intergranular mineralogy, HRV15 is the only specimen in which primary spinel was observed. (Plate 1p,q; plate 7).

SULPHIDE

A few grains of sulphide can be observed in many eclogites. Without intensive examination it is very difficult to conclude that these few grains of sulphide are more abundant in one eclogite type than another. However, in certain specimens sulphide is particularly abundant (>5 modal %).

i) WM7 is a slightly altered eclogite with light green clinopyroxene and red-orange garnet. 10 modal % pyrhottite occurs evenly dispersed throughout the specimen, with grain size ($\pm$3 mm) approximately equal to the primary silicates. (Plate 8).

ii) HRV161 consists of layers of megacrystic clinopyroxene (2-3 cms) interspersed with layers of light green clinopyroxene and orange garnet of normal grain size ($\pm$4 mm). Sulphide appears to be closely associated with the clinopyroxene megacryst, in irregular grains up to 5 mm. Sulphide may occur within the megacryst.

The association of sulphide with clinopyroxene megacrysts is observed in HRV344, a sample of similar appearance to HRV161. The megacryst in HRV344 is 15 cm in the long dimension. HRV161 and HRV344 are generally unaltered and are better related to group II eclogites, although the K_2O content of the clinopyroxene in HRV161 suggests some relation to group I eclogites.

iii) HRV77 is a typical group I eclogite which encloses a large clinopyroxene megacryst. Sulphide occurs within the megacryst. (Plate 1e).

The presence of sulphide in HRV161, HRV344 and HRV77 indicates that there may be some relationship between the megacrysts and sulphides.

RUTILE

Rutile, like sulphide is present in a large number of eclogites, and rutile is commonly found together with sulphide. The presence of rutile is noteworthy in two rocks.

i) A diamond-graphite eclogite XRV22 contains rutile inclusions in diamond (Gurney et al., 1969).

ii) CSRV2 contains abundant rutile. In reflected light small ilmenite lamellae can be observed within the rutile, with a thin rim of ilmenite on the outer margins of the grains.

CARBONATE

Small blebs (100 micrometers) of calcium carbonate are found on the margins of sulphide in sulphide eclogite WM7 (Plate 8). The occurrence of primary carbonate in an upper mantle nodule indicates that carbonate may be related to diamond formation. The association of the carbonate with the sulphide suggests that it existed in an immiscible liquid within the silicate magma. It is possible that the carbonate originally occurred as graphite dissolved in sulphide droplets (Brett et al., 1977).

GRAPHITE

Graphite (without diamond) was observed in 3 Roberts Victor eclogites.

i) HRV309 is a group II layered eclogite with slightly elongate light green clinopyroxene and orange garnet. Abundant graphite (10 modal %) is present in the central portion of the rock. Rutile inclusions in graphite are present.(Plate 9).

ii) Graphite is found in a typical group I eclogite (bottle green clinopyroxene, rounded grain size orange garnet) HRV317, in a layer of large grained (8 mm) clinopyroxene.

ii) Graphite is also reported to occur in eclogite, BD6914 with white, altered clinopyroxene and orange brown garnet (Lappin and Dawson, 1975).

GRAPHITE-DIAMOND

The diamond graphite equilibrium curve has been experimentally established (Bundy et al., 1961; Kennedy and Kennedy, 1977). The coexistence of both phases in a single rock may be expected to place narrow constraints on the temperature and pressure of formation of the coexisting assemblage, accordingly much interest is attached to those rocks in which both diamond and graphite occur. Somewhat surprisingly a number of these rocks have been discovered; two from Roberts Victor.

Small diamonds, up to 1/10 carat are found in a restricted portion of XRV22 (Gurney, Siebert and Whitfield, 1970). Graphite and rutile are also present. The silicate phases were analysed during a survey of diamondiferous eclogites from African kimberlite pipes (Reid et al., 1976).

HRV247 has been described in detail by Robinson (1976) and Hatton and Gurney (1977c). Diamond and graphite make up .15 wt.% of the rock. Indeed diamond is so abundant that several slices through the specimen were halted when the saw encountered a diamond. In addition to diamond, graphite, garnet and clinopyroxene, pyrhottite, rutile and possibly mica are present as primary minerals. Layering can be discerned in the sample, and it has been found that diamond is concentrated in one portion, and graphite in another portion of the rock. (Plate 1u,v,w, Plate 10).

DIAMOND

A number of diamondiferous eclogites (without graphite) have been recovered from Roberts Victor (Corstorphine, 1908, 1911; Reid et al., 1976). Three samples were available for examination by the writer; WRV4, PJL18 and HRV313.

WRV4 (Whitfield) and PJL18 (Lawless) are of similar appearance with white altered clinopyroxene and brown-orange garnet. Sulphide coating on diamond was noted during examination of PJL18.

HRV313 has a blue green clinopyroxene and is less altered than the above samples.

All three samples are group I eclogites with grossular rich garnets and jadeitic rich clinopyroxenes, relative to the bulk of group I eclogites,

and are classified as type I calcium-rich eclogites.

SILICON

A very small inclusion (10 μm) of an anistropic mineral was noted within graphite in diamond graphite eclogite HRV247. Probe analysis of this phase indicates that it is very rich in silicon. Calculation as SiO_2 yields a value of 175 wt.% SiO_2. It is possible that this is a small grain of moissanite (SiC)(Wyatt pers. comm.).

CLINOPYROXENE MEGACRYSTS

Large clinopyroxene megacrysts have been observed in several different types of nodule. A megacryst may occur on the side of the nodule where it is entirely enclosed by biminerallic eclogite. Some nodules appear to have originally existed as discrete clinopyroxene megacrysts, with garnet forming by subsolidus exsolution.

Megacryst bearing types can be distinguished in the type I eclogites

HRV233, HRV252 and HRV77 contain clinopyroxene megacrysts 2 cm, 5 cm and 15 cm long respectively. In HRV233 the megacryst appears to have been consumed by surrounding eclogite to a large extent, since the margin between megacryst and eclogite is not well defined. HRV252 contains a larger megacryst which appears not to have reacted with surrounding eclogite to the same extent as HRV233.

HRV77 contains a very large clinopyroxene megacryst entirely surrounded by eclogite.

In all type I eclogites garnet exsolution lamellae are absent in the megacryst. Granular garnet, possibly of exsolution origin can however be observed.

Four megacryst bearing types can be distinguished in type II eclogites.

i) The biminerallic eclogite component in JJG41 and HRV244 (plate 11) consists of light green clinopyroxene and orange garnet. The grain boundaries are approximately straight edged, and triple boundaries are common. Copious exsolution lamellae of garnet occur in the clinopyroxene megacryst with orientations controlled by clinopyroxene crystallographic planes.

In some parts of the megacryst the exsolved garnet appears to have formed discrete grains whose shape is no longer controlled by the crystallagraphy of the clinopyroxene. For sample JJG41 it has been shown that the granular garnets in the megacryst have formed earlier, and at higher temperatures than the garnet lamellae (Harte and Gurney, 1975). The granular garnets appear to be concentrated at planes of weakness in the clinopyroxene megacryst.

ii) Remnants of a bright green clinopyroxene megacryst adhere to the surface of nodule HRV314. The colour of the megacryst indicates that it is chrome rich; in contrast to all other clinopyroxene megacrysts at Roberts Victor, which are chrome poor. Garnet exsolution is not apparent in hand specimen.

iii) HRV161 and HRV344 are megacryst bearing eclogites with light green clinopyroxene. Garnet exsolution from the megacryst is absent.

iv) HRV316 is a unique sample in that two megacrysts are present at the top and bottom of the nodule. The clinopyroxene is dark bottle green and the garnet a dark orange red. The grains are somewhat elongated in the plane of layering. The colour and texture indicate that the eclogite is an iron rich member of the group II eclogites. Garnet exsolution in locally parallel lamellae is copious in both megacrysts.

V CHEMICAL VARIATION IN THE ECLOGITES

INTRODUCTION

There are two approaches to the study of the chemical variation of a given rock system. The first approach is to examine the variation in whole rock chemistry, and the second is to consider the changes in mineral compositions. In the particular case of the Roberts Victor eclogites the first approach is complicated by two factors

i) The eclogites have been extensively contaminated either by the kimberlite (Berg, 1968) or by metasomatism prior to kimberlite eruption (Kushiro and Aoki, 1968).

ii) Many of the eclogites are distinctly layered, and since the sample size is restricted by the size of the nodule it is not possible to be sure that the bulk chemistry of a particular eclogite is a true reflection of the bulk chemistry of the system from which the eclogite was sampled, or whether the eclogite whole rock composition is biased by the modal proportions of minerals preserved in a particular sample.

For the above two reasons the chemical variation of eclogites is considered mainly in terms of variations in mineral chemistry. Analysis by electron microprobe can ensure that only fresh material is analysed, and in most cases the problem of contamination is overcome.

Compositions are considered in terms of weight percents of the oxides. Although it is probably more correct to consider thermodynamic components, i.e. end members or ionic ratios in particular mineral sites, the weight percents of the oxides are by convention the primary data determined and are more readily communicable than an internally defined set of mineral components. The weight percents of the oxides are in many cases proportional to the concentrations of particular end members, and since the purpose of this chapter is to consider the relations between broad subdivisions of rocks a consideration of weight percents is sufficient.

Besides a general discussion of elemental variation the topics discussed in the relation to the type I eclogites are:

the role of orthopyroxene in eclogite evolution;

the nature of phlogopitisation and the relevance of phlogopitised eclogites to the kimberlite sampling process;

and the implications of the presence of kyanite as a primary phase in the homogeneous kyanite eclogites.

In considering the type II eclogites the role of orthopyroxene is emphasised, and the different processes exhibited by the type I and type II eclogites are compared and contrasted.

CLASSIFICATION OF ECLOGITES

The primary subdivision of Roberts Victor eclogites is into types I and II corresponding to the two types recognised by MacGregor and Carter, previously discussed in chapter IV. The type I eclogites are readily recognised by the altered appearance of the rocks, the coarse equant grains and the bottle green colour of the clinopyroxene. More altered clinopyroxenes (with high pseudojadetite content) are white in appearance. The type II eclogites are usually fresh, with coarse elongate grains and apple green to light green clinopyroxene.

However, many eclogites deviate from the type II description outlined above and yet are clearly not type I eclogites. Several other types can be recognised but it is found sufficient, in a preliminary consideration to recognise only the type I eclogites and to categorise the others as type II. Textures are illustrated in Plate 1.

The type I eclogites are considered first.

PART 1

TYPE I ECLOGITES

The subdivisions recognised within type I are outlined below. The inhomogeneous kyanite eclogites are classified according to the composition of the garnet in the biminerallic eclogite in which they occur. Three out of five fall into the calcium rich group, and two into the Main group.

i) Phlogopitised eclogites containing significant amounts ($>$ 5 modal %) of secondary mica.

ii) Garnet websterites, characterised by the presence of orthopyroxene.

iii) Eclogites which contain garnets with less than 18 wt.% FeO and less than

6 wt.% CaO. These are included in the Main Group of type I eclogites.

iv) Eclogites in which the garnets have greater than 18 wt.% FeO are classified as iron-rich eclogites.

v) Eclogites in which the garnets have greater than 6 wt.% CaO are classified as calcium-rich eclogites.

vi) Homogeneous kyanite eclogites have garnets with greater than 10wt.% CaO and are distinguished by the presence of kyanite.

vii) A corundum eclogite (JJG60) with garnet exsolution is assigned to the type I eclogites on the basis of the white alteration of the clinopyroxene.

viii) Similar garnet exsolution is observed in a small sample of corundum free eclogite (HRV335).

Representative analyses of samples in each subdivision are listed in Table 9.

COMPOSITIONAL TRENDS OF TYPE I GARNETS

In the Ca-Mg-Fe diagram depicting garnet compositions (Figure 12) two trends are apparent. An iron enrichment trend is defined by the sequence

phlogopitised eclogites and garnet websterites,

main group eclogites, and

iron rich eclogites.

A calcium enrichment trend is defined by the sequence

main group eclogites,
calcium rich eclogites and
homogeneous kyanite eclogites.

In order to examine the relationship between the calcium and iron enrichment trends it is useful first to consider the relative positions of the iron rich and calcium rich eclogites in a sequence defined by some differentiation index.

CHOICE OF A DIFFERENTIATION INDEX

A convenient and simple index is wt.% Na_2O in clinopyroxene. In upper mantle mineralogies Na_2O is present at high levels only in

clinopyroxene, thus exchange reactions between solid phases at various P T conditions will have little effect on the behaviour of sodium. (This is not the case for FeO and MgO, two elements commonly employed in differentiation indices, since the concentrations of these elements in garnet and clinopyroxene has been shown to be temperature and pressure dependent (Raheim and Green, 1974).

It is assumed that in an equilibrium between clinopyroxene and liquid, sodium is preferentially partitioned into the liquid phase. This assumption is supported by the work of Mysen and Kushiro (1976) which illustrated that at 20kbar Na_2O content of the liquid was higher than that in the residua while clinopyroxene was a residual phase. At low degrees of partial melting the Na_2O content of clinopyroxene is high and decreases with increase of partial melting. Similarly with the evolution of a magma by fractional crystallisation, Na_2O content of the liquid, and of the clinopyroxene in equilibrium with the liquid will increase.

The Na_2O content of clinopyroxene in the calcium rich and kyanite eclogites is higher than in the iron rich, eclogites or the phlogipitised eclogites and garnet websterites. The calcium enrichment trend appears to be a product of more evolved compositions than the iron enrichment trend.

CHEMICAL VARIATION OF GARNET AND CLINOPYROXENE DURING DIFFERENTIATION

Weight percents of oxides in garnet and clinopyroxene are plotted against wt.% Na_2O in clinopyroxene in Figures 12 and 13.

SiO_2, TiO_2 and Al_2O_3 in garnet show a broad scatter of points with no discernible trend.

MgO and Cr_2O_3 in garnet and clinopyroxene generally decrease with increasing sodium content in accordance with the expected depletion of these elements during differentiation, and support the use of Na_2O in cpx as a differentiation index.

The well defined increase of Al_2O_3 and decrease of CaO and MgO contents in clinopyroxene is related to the increase in jadeite

component at the expense of the diopside component. The broad increase in SiO_2 in the clinopyroxene is probably related to the decrease in mean atomic weight as the clinopyroxene becomes enriched in the jadeite component.

FeO in garnet and clinopyroxene reaches maximum levels in the iron rich eclogites, but thereafter declines in the calcium rich and kyanite eclogites.

CaO in garnet shows the reverse pattern, reaching minimum values in the iron rich eclogites, and thereafter increasing in the calcium rich and kyanite eclogites.

The behaviour of CaO and FeO is examined in more detail in the following section which considers the possible concentrations of oxides in the whole rock.

ESTIMATION OF BULK ROCK CHEMISTRY

For biminerallic eclogites bulk rock chemistry can be simply estimated by combining garnet and clinopyroxene in the appropriate amounts. Errors in the estimated bulk rock composition stem from two factors:

i) the presence of primary minerals other than garnet and clinopyroxene, and

ii) the accuracy of the modal determination.

i) The presence of primary minerals other than garnet and clinopyroxene was documented in Chapter IV. The effect on major element chemistry of minerals other than garnet and clinopyroxene is most obvious in kyanite and corundum eclogites but is less severe in other eclogite types where modal abundances of the other primary phases are less than 5%. For the purposes of obtaining a qualitative model of the variation of the major elements, the effects of other components were not considered.

ii) The mean modal proportions of garnet and clinopyroxene in Roberts Victor was shown by the present study (Chapter III) and by MacGregor and Carter (1970) to be approximately 50:50. There is a wide range

in modal abundances, both within a single nodule and between nodules. It is therefore difficult to decide whether a modal estimate of a single nodule is representative of the bulk composition of the horizon from which that eclogite was derived. A further problem is the preferential erosion of clinopyroxene by kimberlite as noted in Chapter III. In view of the difficulties outlined above it was decided to initially estimate bulk compositions using the mean modal estimate of equal amounts of garnet and clinopyroxene.

Estimated bulk rock compositions of type I eclogites are plotted against wt.% Na_2O in clinopyroxene in Figure 14.

VARIATION OF ESTIMATED BULK ROCK CHEMISTRY

Bulk SiO_2 shows a range between 46 and 49 wt.% SiO_2 but no consistent trend, reflecting the approximately constant amounts of SiO_2 in garnet and clinopyroxene.

Bulk Al_2O_3 steadily increases from 12wt.% to 22wt.% as the Al_2O_3 content of clinopyroxene increases.

Cr_2O_3 is relatively high in some phlogopitised eclogites and garnet websterites (up to .7wt.% Cr_2O_3 in phlogopitised eclogite JJG309) but is normally below .3wt.% and declines to lower values (.1wt.% Cr_2O_3) in the calcium rich and kyanite eclogites.

MgO in the whole rock steadily decreases as MgO in garnet and in clinopyroxene decreases, from 18wt.% in garnet websterite HRV249 to 10.5wt.% in calcium rich eclogites.

Bulk FeO is present at levels below 8wt.% in garnet websterite HRV249, and between 9 and 12 wt.% in the phlogopitised eclogites. In the iron rich eclogites bulk FeO lies between 12 and 14 wt.% and declines to less than 7 wt.% FeO in the calcium rich eclogites.

Bulk CaO declines from about 12wt.% in the phlogopitised eclogites to less than 8wt.% in two iron rich eclogites KRV5 and JJG11. In the calcium rich eclogites bulk CaO is between 9½ and 12wt.%.

In the sequence phlogopitised eclogites and garnet websterites,

iron rich eclogites,

calcium rich eclogites,

FeO initially increases then drops in amount, while CaO initially decreases then rises in amount.

Curves were fitted by eye to the bulk oxide vs Na_2O in cpx plots in Figure 14 and are illustrated in Figure 15.

MECHANISM OF ECLOGITE FRACTIONATION TRENDS

In the preceding discussion the evolution of type I eclogites was shown to follow two extreme trends - the iron enrichment trend was shown to occur in the less evolved, magnesian rich eclogites while the calcium enrichment trend was followed by more evolved, sodium rich eclogites. An interesting feature of the two trends is the <u>decrease</u> in CaO in garnet with increase in Na_2O in cpx observed in those eclogites following the iron enrichment trend, and the <u>increase</u> in CaO in garnet with increase in Na_2O in cpx observed in eclogites following the calcium enrichment trend. In the following section it is suggested that iron enrichment occurs in the presence of orthopyroxene and calcium enrichment in the absence of orthopyroxene.

Two features, the presence or absence of orthopyroxene, and a changing jadeite diopside ratio are considered, and are shown to be capable of producing the relations between Na_2O in cpx and CaO in garnet.

1. INCREASE IN JADEITE CONCENTRATION IN CLINOPYROXENE AT THE EXPENSE OF DIOPSIDE

In Figure 12h it can be seen that as Na_2O in cpx increases there is a general decrease of CaO in cpx although there is a scatter of points in the range 3.5 to 5.5wt.% Na_2O in cpx. However the overall trend is that of decreasing CaO with increasing Na_2O in cpx.

The CaTs end member is present at low concentrations in most type I eclogites thus CaO in cpx $\approx$ diopside in cpx. Similarly, acmite, ureyite and $NaTiAlSiO_6$ concentrations are usually low and Na_2O in cpx $\approx$ jadeite in cpx. Thus as jadeite increases diopside in cpx decreases.

2. PRESENCE OF A BUFFER REACTION MAINTAINING EQUILIBRIUM CONCENTRATIONS OF Ca, Mg AND Fe BETWEEN GARNET AND CLINOPYROXENE

In the presence of orthopyroxene the grossular contents of garnet are buffered by the reactions

$$3CaMgSi_2O_{6\,cpx} + Mg_3Al_2Si_3O_{12\,gt} = 3Mg_2Si_2O_{6\,opx} + Ca_3Al_2Si_3O_{12\,gt} \quad (1)$$

and

$$3CaFeSi_2O_{6\,cpx} + Fe_3Al_2Si_3O_{12\,gt} = 3Fe_2Si_2O_{6\,opx} + Ca_3Al_2Si_3O_{12\,gt} \quad (2)$$

Examination of garnet lherzolites has shown that for wide ranges of MgO/FeO ratios CaO content of garnet remains constant at values near 13 mol% (Sobolev, 1977). Thus to a first approximation CaO content of garnet in equilibrium with orthopyroxene and clinopyroxene is independent of the MgO/FeO ratio of the system and reactions (1) and (2) above can be simplified to

$$3Ca(Mg,Fe)Si_2O_{6\,cpx} + (Mg,Fe)_3Al_2Si_3O_{12\,gt} = 3(Mg,Fe)_2Si_2O_{6\,opx} + Ca_3Al_2Si_3O_{12\,gt} \quad (3)$$

The equilibrium constant for the reaction above is

$$K_3 = \frac{\left(a^{opx}_{En + Fs}\right)^3 \left(a^{gt}_{Gross}\right)}{\left(a^{cpx}_{Di + Hd}\right)^3 \left(a^{gt}_{Py + Alm}\right)}$$

Assuming that the solid solutions are ideal, and that Ca is coupled to (Mg, Fe) in clinopyroxene solid solution (cf Banno, 1969) a simplified equilibrium constant can be written;

$$K = \frac{\left(X^{opx}_{En + Fs}\right)\left(X^{gt}_{Ca}\right)}{\left(X^{cpx}_{Di + Hd}\right)\left(X^{gt}_{Mg + Fe}\right)} \quad \text{and} \quad K = (K_3)^{\frac{1}{3}}$$

Enstatite and ferrosilite comprise very nearly 100% of orthopyroxene solid solution thus $X^{Opx}_{En + Fs}$ is very nearly equal to 1, and

$$\frac{X_{Ca}^{gt}}{X_{Mg + Fe}^{gt}} = K.X_{Di + Hd}^{cpx}$$

In the evolution of peridotite rock suites $X_{Di + Hd}^{cpx}$ is relatively constant hence X_{Ca}^{gt} remains constant, and garnet composition varies in the proportions of MgO and FeO. Decrease in MgO contents thus results in enrichment of FeO contents of garnet in peridotites and pyroxenites (Cox etal., 1973). Similarly the Roberts Victor garnet websterites follow an iron enrichment trend. However, because of the high and increasing jadeite concentrations in eclogites $X_{Di + Hd}^{cpx}$ is not constant but decreases, as shown above, and with evolution of the eclogite system

$$\frac{X_{Ca}^{gt}}{X_{Mg + Fe}^{gt}} = K.X_{Di + Hd}^{cpx}$$ will decrease.

Because of the equilibrium established by the presence of orthopyroxene X_{Ca}^{gt} will decrease as X_{Ca}^{cpx} decreases, and because increased X_{Na}^{cpx} decreases X_{Ca}^{cpx}, X_{Ca}^{gt} will decrease as X_{Na}^{cpx} increases.

A plot of CaO in gt vs Na_2O in cpx (Figure 12h) for garnet websterites which follow the iron enrichment trend will be negative. Because of the small number of orthopyroxene bearing rocks in the type I eclogite suite this trend is not well illustrated in Figure 12h, but with the exception of phlogopitised eclogite HRV207, the phlogopitised eclogites, garnet websterites, and two iron-rich eclogites KRV5 and JJG11 define a trend of decreasing CaO in garnet with increasing Na_2O in cpx. This trend is better illustrated by the more abundant type II garnet websterites (Figure 17h).

With increase in Na_2O content of clinopyroxene, CaO in clinopyroxene and CaO in garnet decrease, hence CaO of the eclogite cumulate decreases. CaO in the coexisting liquid increases until CaO/(MgO + FeO) liquid is so high that orthopyroxene ceases to

crystallise. With the breakdown of the buffer reaction the CaO content of garnet is then free to increase, and with increasing Na_2O in cpx, CaO in garnet increases.

There is a gradual change in the roles of garnet and clinopyroxene with respect to CaO. In the iron enrichment trend CaO content of clinopyroxene is four times that of garnet. As the available clinopyroxene sites become blocked by increasing amounts of jadeite CaO increasingly occupies the available garnet sites in the calcium enrichment trend. This process continues to such an extent that in the more evolved calcium rich eclogites and homogeneous kyanite eclogites CaO content of garnet is actually higher than that of clinopyroxene, because much of the M2 site in clinopyroxene is occupied by sodium, while garnet is able to take up the available CaO.

BREAKDOWN OF THE BUFFER REACTION

The breakdown of the buffer reaction is marked by

i) the point at which the slope of CaO in garnet vs Na_2O in cpx changes, and

ii) the disappearance of orthopyroxene from the system.

The disappearance of orthopyroxene from the system is most obviously manifested by the absence of orthopyroxene from the eclogite cumulate or eclogite residium. However, if orthopyroxene is present in the system as a liquidus phase, and disappears by reaction with the liquid just above the solidus, garnet and clinopyroxene may nevertheless preserve the effects of equilibration against orthopyroxene. Thus there may be a transitional period where the rocks exhibit the chemistry of garnet websterites with respect to CaO in garnet but do not contain orthopyroxene as a sub-solidus phase. Orthopyroxene free eclogites such as JJG11 and KRV5 which exhibit the features of the garnet websterites following the iron enrichment trend may be examples of such rocks.

PHLOGOPITISED ECLOGITES

POSSIBLE PRESENCE OF ORTHOPYROXENE IN PHLOGOPITISED ECLOGITES

The phlogopitised eclogites have been shown to exhibit chemical behaviour similar to the garnet websterites, suggesting that orthopyroxene was a primary phase of the phlogopitised eclogites.

Phlogopitisation of the eclogites is thought to have occurred in a metasomatic process which predated kimberlite emplacement (Chapter IV). Kushiro and Aoki (1968) suggested that phlogopitisation occurred by the reaction

$$2K_2O_{(fluid)} + 4H_2O_{(fluid)} + 2Mg_3Al_2Si_3O_{12} + 3Mg_2Si_2O_6$$

$$= 2K_2Mg_6Si_6Al_2O_{20}(OH)_4$$

The presence of orthopyroxene in the above reaction suggests that garnet websterites would be particularly prone to alteration by potassium rich metasomatic fluids. The phlogopitised eclogites may therefore represent garnet websterites in which the orthopyroxene has been entirely altered to phlogopite.

The effects of phlogopitisation on garnet have been observed in phlogopitised eclogite JJG181 (see Table 4). In this sample the edges of the garnet are iron rich while the centre is magnesium rich. The nature of the zoning is quite unlike that observed in other eclogites where there is a variation in CaO in garnet, in that CaO remains constant, while FeO and MgO vary. It appears that MgO was preferentially "leached" out of the garnet by the metasomatising fluid.

Of the orthopyroxene bearing garnet websterites type II garnet websterites and three of the type I garnet websterites described here have not undergone phlogopitisation, suggesting that the metasomatising fluids attacked some garnet websterites but not others. The metasomatising fluids appear to have been present in greatest amount at a particular horizon in the eclogite complex. This particular horizon is marked by the phlogopitised eclogites as

shown by the relatively restricted compositions of the phlogopitised eclogites.

ii) PHLOGOPITISED ECLOGITES AND THE NATURE OF KIMBERLITE SAMPLING

A further notable feature is that the bulk of the Roberts Victor eclogites, (that is the type I main group), and the calcium rich and iron rich eclogites have compositions which are related to, but have higher Na_2O in cpx than the phlogopitised eclogites. If the type I eclogites represent cumulates from a magma chamber then the MgO poor, Na_2O rich compositions are expected to lie stratigraphically above the more primitive phlogopitised eclogites.

The proposed sequence of events may be related to events delineated by isotopic age dating. Pipe emplacement has been dated at 92 m.g.B.P. (Davis 1977). Dating of mica in eclogites by Rb-Sr (Allsopp and Barrett 1975) and of potassium in garnets clinopyroxene and whole rock by K-Ar (Ozima and Saito, 1975) yield ages between 120 and 130 m.y. B.P. This date is thought to refer to a mantle metasomatic event rather than to kimberlite emplacement.

Prior to kimberlite eruption (90 m.y. B.P) the components comprising the kimberlite may have percolated up a similar pathway to that followed earlier by the metasomatising fluid (130 m.y.B.P.) and become concentrated below the same resistant eclogite horizons which had previously blocked the path of the metasomatising fluid. Due to some factor, such as the sufficient build up of volatiles, the kimberlite eventually disrupted the overlying horizons and began an ascent to surface which was sufficiently rapid to carry up samples of the disrupted horizons. The bulk of the sample brought to surface appears to be derived from layers immediately above the point from which rapid ascent of the kimberlite began.

Thus it is proposed that rapid ascent of the kimberlite began at the horizon marked by the phlogopitised eclogites, and that the bulk of the sample brought to surface was derived from more evolved eclogites lying above the phlogopitised eclogites.

THE RELEVANCE OF HOMOGENEOUS KYANITE ECLOGITES TO THE ECLOGITE THERMAL DIVIDE

The mineralogy of upper mantle materials can be conveniently represented in terms of the components CaO-MgO-Al_2O_3-SiO_2. (e.g. Boyd, 1970; O'Hara, 1968; O'Hara et al., 1975; Wyllie, 1971). These components are plotted as the apices of a tetrahedron (Figure 15). Garnet and clinopyroxene end members all plot in the plane Al_2O_3-$CaSiO_3$-$MgSiO_3$(Co-Wo-En) within the CMAS tetrahedron. In the dry system this plane is a thermal divide (O'Hara and Yoder, 1967) at pressures above 26 kbars (Kushiro and Yoder, 1975). Compositions on the MgO rich side of the eclogite thermal divide cannot evolve to compositions on the SiO_2 rich side of the thermal divide, and vice versa.

On the grounds of textural similarity and the coherent relation between CaO in gt and Na_2O in cpx, it is likely that the type I eclogites are a related set of rocks. The mineralogy of the group I eclogites has evolved through the sequence

garnet-clinopyroxene-orthopyroxene,
garnet-clinopyroxene to
garnet-clinopyroxene-kyanite.

The features of type I eclogites can be explained on the basis that they are sets of cumulates from a liquid which initially lay on the SiO_2 rich side of the eclogite thermal divide and evolved toward compositions increasingly rich in SiO_2 eventually crystallising kyanite as a primary phase.

If the liquid from which the type I eclogites formed lay on the MgO rich side of the eclogite thermal divide, crystallisation of garnet and pyroxenes could not enrich the liquid in SiO_2 and kyanite could never crystallise as a primary phase (Figure 15). The obvious conclusion is that the liquid lay on the SiO_2 rich side of the eclogite thermal divide.

The presence of diamond in type I calcium rich eclogites restricts the origin of the type I eclogites to pressures greater than 40 kilobars. At these pressures the eclogite composition plane is a thermal divide in the dry system and liquids derived from garnet lherzolite are restricted to the MgO rich side of this thermal divide (Kushiro and Yoder, 1975; O'Hara and Yoder, 1967). If the type I eclogites are derived from a

liquid initially in equilibrium with garnet lherzolite some feature must have allowed the eclogite thermal divide to be pierced so that liquids could form on the SiO_2 rich side. Water expands the primary phase volume of olivine (Kushiro, 1975; Fraser, 1977). It is proposed that the type I eclogite liquid formed from garnet lherzolite in the presence of water (and other volatiles) which expanded the primary phase volume of olivine such that the first formed liquid lay on the silica rich side of the eclogite thermal divide.

Evolution of the SiO_2 rich liquid proceeded by precipitation of garnet websterite, eclogite and kyanite eclogite. The type I eclogites thus represent a set of cumulates.

PART 2

THE TYPE II ECLOGITES

The subdivision of the Roberts Victor eclogites into two types was made by MacGreor and Carter (1970). The type I eclogites are the most abundant and comprise three-quarters of the eclogite population. These eclogites with rounded, cloudy garnets and altered cpx form a distinctive group. The type II texture described by MacGregor and Carter (1970) was recognised in the present study by the elongate nature of the grains and the distinctively fresh appearance of the minerals (mainly the calcium-iron-rich eclogites below). However many eclogites which do not match the description of the type II eclogites given by MacGreor and Carter (1970) but which are clearly not type I eclogites, were recovered during the present study. To avoid a proliferation of eclogite types it was decided to initially consider all eclogites other than the abundant type I eclogites together as type II eclogites, in spite of the textural variations within the type II eclogites. Subdivision within the type II eclogites is outlined below. Analyses are presented in Table 10.

i) Altered orthopyroxene is present in a number of texturally dissimilar type II garnet websterites.

ii) Type II eclogites with less than 6 wt.% CaO and less than 18 wt.% FeO in garnet are classified as magnesian eclogites.

iii) The type II fine-grained kyanite corundum eclogites are readily recognised

by the small grain size (1.5 mm) of the minerals. Kyanite eclogite blebs are common, and abundant mica may be a primary phase. These rocks are similar to the fine-grained layers visible in a nodule from Obnazhennaya (Sobolev, 1977, photo 4a).

iv) Type II iron-rich eclogites (FeO in gt > 18 wt.%) always contain > 6 wt.% CaO in the garnet, and are classified as calcium-iron-rich eclogites.

v) Calcium-rich eclogites contain > 6 wt.% CaO and < 18 wt.% FeO in garnet.

vi) Kyanite is present in two type II calcium-rich eclogites. Gross compositional discontinuities are not present in these rocks. They are distinctly less altered than the type I homogeneous kyanite eclogites. In common with many other type II eclogites, composition varies across the rock, but the variation is considerably less than the compositional changes observed in the type I inhomogeneous kyanite eclogites, and in the type II fine-grained kyanite corundum eclogites HRV116 and HRV18.

vii) Corundum is present in a zoned eclogite, RV372 in which primary spinel was observed by Williams (1932).

viii) A coesite-sanidine grospydite HRV277 (Smyth and Hatton, 1977) although containing altered clinopyroxene, has a smaller grain size (2 - 3 mm) than the type I eclogites (mean grain size 4 - 5 mm) and has whole rock chemistry similar to the type II eclogites (See Chapter XI).

GARNET COMPOSITIONS

In the Ca-Mg-Fe triangular diagram (Figure 16) three trends are discernible. An iron-enrichment trend is defined by the garnet websterites and magnesian eclogites, a calcium-iron-enrichment trend is defined by the calcium-iron-rich eclogites and a calcium-enrichment trend is defined by the calcium-rich eclogites.

Most of the garnets in type II eclogites of MacGregor and Carter (1970) have Ca:Mg:Fe ratios which overlap the calcium-iron rich garnets described here. One type II garnet analysed by MacGregor and Carter would plot together with the magnesian eclogites and garnet websterites.

CHEMICAL VARIATION OF GARNET AND CLINOPYROXENE

Oxide plots against Na_2O in cpx are presented in figures 17 and 18. In general the oxide trends observed in type I eclogites are repeated in the type II eclogites, except for the elements FeO and CaO.

FeO in garnet and clinopyroxene shows only a broad increase, as opposed to the initial increase followed by decrease in the type I eclogites.

CaO in cpx decreases with increasing Na_2O in cpx as in the type I eclogites, but CaO in garnet differs markedly in behaviour. Two trends are apparent in the plot of CaO in garnet against Na_2O in cpx for type II eclogites (Figure 17h).

i) Magnesian eclogites and garnet websterites show a <u>decrease</u> of CaO in garnet, with increased Na_2O in cpx. This trend is similar to that defined by type I garnet websterites and phlogopitised eclogites, but is better illustrated by the type II eclogites. Garnets in these eclogites follow an iron enrichment trend.

ii) Iron rich and calcium rich eclogites show <u>increasing</u> CaO in gt with increasing Na_2O in cpx, but it should be noted that the calcium rich and iron rich eclogites do <u>not</u> form a continuation of the trend defined by magnesian eclogites and garnet websterites as did the type I eclogites. Thus in the type II eclogites the calcium and iron rich eclogites do not appear to be directly related to the garnet websterites. Garnets in these eclogites follow a trend of enrichment in both CaO and FeO.

VARIATION OF ESTIMATED BULK ROCK CHEMISTRY

Bulk rock chemistry is estimated from the combination of equal amounts of garnet and clinopyroxene as in the type I eclogites (Figure 19). Bulk SiO_2 varies between 46 and 49 wt.% except for calcium rich eclogite JJG41 which contains high amounts of calcium tschermaks molecule in clinopyroxene.

Al_2O_3 generally increases with Na_2O in cpx.

The amount of chromium in type II eclogites is notably higher than in the type I eclogites. Many eclogites contain greater than 4 wt.% Cr_2O_3, and even evolved compositions such as kyanite corundum eclogite

HRV272 have high Cr_2O_3 contents.

FeO in the whole rock generally increases continuously so that no decrease in FeO with more evolved compositions is observed as in the type I eclogites. For a given Na_2O in cpx the amounts of FeO are often less than in the type I eclogites.

MgO declines with increasing Na_2O in cpx. The type II garnet websterites and magnesian eclogites generally show higher MgO for a given Na_2O in cpx than do the type I eclogites. In contrast the type II iron rich eclogites have lower MgO contents for a given Na_2O in cpx than do the type I iron rich eclogites.

The whole rock CaO in the garnet websterites and magnesian eclogites shows a decline from 13 wt.% CaO to 9 wt.% CaO, with increasing Na_2O in cpx. In the calcium and iron rich eclogites CaO shows a scatter in values between 11 and 14 wt.% CaO.

EVOLUTION OF THE TYPE II ECLOGITES

In this study the type II eclogite category was defined as a sack category into which all eclogites which clearly differed from the texturally distinctive type I eclogites were relegated. Most of the eclogites in the type II category bear distinctive features which can be recognised in only a handful of other eclogites. Within the type II eclogites the magnesian eclogites and garnet websterites are chemically similar but texturally diverse, while the calcium-rich eclogites are both chemically and texturally diverse. The calcium-iron rich eclogites however form a relatively coherent grouping and may represent a sustained event during petrogenesis of the Roberts Victor eclogites.

The compositional heterogeneity of individual magnesian eclogites, garnet websterites and calcium rich eclogites (discussed in Chapters VI, VIII and IX) and the textural diversity of these rocks suggest that they formed from limited volumes of magma. They may represent partial melts which crystallised completely before addition of a further pulse.

Type II magnesian eclogite HRV173 contains a 5 cm thick garnet rich layer and a 5 cm thick clinopyroxene rich layer. Layering in this and similar rocks (HRV132, HRV267) is probably of cumulate origin, for chemical differences between the layers are large (see Table 7).

Planar foliation in other type II eclogites (e.g. calcium-iron rich eclogite JJG6, plate 12) is not necessarily a cumulate texture (see MacGregor and Carter, 1970) and some type II eclogites may be liquids which crystallised rapidly enough to prevent settling of crystals.

The suggestion that some type II eclogites are liquid compositions is in accord with that of MacGregor and Carter, but these author's conclusion that the type II liquids are related to type I cumulates is not confirmed by the present study, because in order for both cumulates and liquids to crystallise as biminerallic eclogites the bulk composition must lie in the eclogite composition plane. The presence of kyanite indicates that the bulk composition could not lie in this plane only (see Figure 15). High K_2O in cpx of the type I eclogites and low K_2O in cpx of type II eclogites (Erlank, 1970; this study Figures 12i, 17i) are the reverse of that expected from a cumulate-liquid relation. Origins of individual type II eclogites are discussed in detail in subsequent chapters, and further discussion of the origins of type II eclogites is therefore deferred until Chapter XII.

VI INHOMOGENEITIES IN ECLOGITES

1. MEGACRYST BEARING ECLOGITES

Of the eclogites examined several were found to possess unusual features not before reported in upper mantle xenoliths (nor often encountered in crustal rocks). These features are usually manifested by the presence of a gross mineralogical, chemical or textural discontinuity, and are most often encountered in the type II eclogites; although a number of type I eclogites also illustrate inhomogeneities within a single specimen.

Textural inhomogeneities are manifested by

i) the presence of large clinopyroxene megacrysts within biminerallic eclogite, and

ii) kyanite eclogite blebs within biminerallic eclogite.

Chemical inhomogeneities across layers in an eclogite are most often related by variations in chrome content only, but variations in concentrations of other elements can occur. Mineral zoning is usually observed when other types of inhomogeneity occur within a rock, but may be present in the absence of larger scale inhomogeneity.

Mineralogical inhomogeneity is observed in certain highly altered orthopyroxenes which are exsolving jadeite rich areas. Exsolution of garnet is observed in the clinopyroxene megacrysts, but may be encountered in rocks which at present appear to be biminerallic.

Both allotropes of carbon, graphite and diamond are observed in some eclogites. Chemical inhomogeneity of garnet and clinopyroxene across the eclogite layers is observed in diamond-graphite eclogite, HRV247, but does not appear to be present in another diamond graphite sample XRV22.

A consequence of the preservation of compositional inhomogeneities within a single rock is that a wide range of apparent temperatures (or pressures) are also preserved. Since these apparent temperatures form a significant part of the discussion of the inhomogeneous rocks, it will be convenient to initially consider the validity of the preserved temperatures.

TEMPERATURES OF EQUILIBRATION AND THEIR RELATION TO SOLIDUS AND SOLVUS TEMPERATURES

Equilibration processes are greatly facilitated by the presence of liquid in which ions can diffuse significantly more rapidly than in the solid state (e.g. Yardley, 1977). The equilibration temperatures preserved in a rock are therefore more likely to represent subsolidus, than solidus temperatures of equilibration.

The extent to which subsolidus equilibration has proceeded is usually unknown. Recent studies of temperatures and pressures of equilibration of upper mantle peridotites have implicitly assumed that the minerals equilibrate to the ambient geotherm (e.g. Boyd and Nixon, 1975, p.432; Hearn and Boyd, 1975, p.253; MacGregor, 1975, p.461). The wide range of K_D values preserved in clinopyroxene megacrysts indicates that equilibration with the geotherm was at best partial, if indeed it occurred at all.

If nodules have not equilibrated with the ambient geotherm, the question remains, to what extent has subsolidus equilibration proceeded?

EXTENT OF EQUILIBRATION OF ECLOGITE

The reaction determining the temperature and pressure of equilibration of eclogites is the exchange reaction of Fe and Mg between garnet and clinopyroxene.

$$CaMgSi_2O_6 + Fe_3Al_2Si_3O_{12} = CaFeSi_2O_6 + MgAl_2Si_3O_{12}$$

with declining temperature the ratio

$$K_D = (Fe/Mg)gt/(Fe/Mg)cpx \text{ increases as } (Fe/Mg)gt$$

increases and (Fe/Mg/cpx) decreases (Raheim and Green, 1974). Thus in order to continuously equilibrate with the prevailing temperature conditions Fe must leave the clinopyroxene structure and enter the garnet structure, while Mg must leave the garnet and enter the clinopyroxene structure. This process of cross diffusion between garnet and clinopyroxene is probably an equilibrium process for growing crystals in the presence of a magma sink. However, in the solid phase a metastable equilibrium may persist for long periods of time, depending on the rate of ionic diffusion.

Rates of diffusion in minerals at high pressure are higher than at low pressure (Yardley, 1977) and diffusion in high pressure minerals will cease at correspondingly higher temperatures. Yardley (1977) illustrated that for metamorphic garnets formed at low pressures no intracrystalline diffusion occurred at temperatures below 700°C. Garnets formed at temperatures below this preserve any heterogeneities created during growth, while garnets formed at higher temperatures will be homogeneous as there is then sufficient thermal energy to permit intracrystalline diffusion. Subsequent heating of inhomogeneous garnets above 700°C serves to remove any inhomogeneities in the crystal. At the pressures prevailing in the mantle the critical temperature below which the rate of intracrystalline diffusion drops rapidly (the Tammann temperature, Mason, 1966, p.251) may be significantly greater than 700°C.

Intercrystalline diffusion of ions between two minerals, say garnet and clinopyroxene can proceed only as fast as the diffusing ions are supplied to the garnet/clinopyroxene interface by intracrystalline diffusion of the ions within the two minerals. If the rates of intercrystalline diffusion for the two minerals are different, it is the crystal in which ions diffuse more slowly which will control the rate of intercrystalline diffusion (Wood, 1977, p.341). If an equilibration temperature has been reached by subsolidus diffusion, the temperature preserved is the Tammann temperature of the mineral with the slowest rates of intercrystalline diffusion. Where a range of temperatures is preserved, this range may represent the Tammann temperatures of different mineral compositions, but for similar compositions only the highest temperature preserved can be the Tammann temperature, and the other, lower temperatures are the temperatures of formation of those minerals by subsolidus or subsolvus reactions.

In this chapter textural and chemical inhomogeneities exhibited by the megacryst bearing eclogites are considered.

CLINOPYROXENE MEGACRYSTS

For the purposes of this discussion a megacryst is considered to be a grain whose initial diameter was 2 cm or more. The initial diameter of a clinopyroxene megacryst may not be readily apparent, for subsolidus exsolution of garnet from clinopyroxene may fracture the original megacryst into subgrains. Further exsolution of garnet may result in the formation of rounded, rather than lamellar shaped garnets. Rounded garnets of subsolidus origin set in a mosaic of cpx subgrains derived from an initial megacryst may be texturally indistinguishable from a biminerallic eclogite in which both garnet and clinopyroxene were liquidus phases.

Recognition of the shape of the initial clinopyroxene is simplest when limited amounts of garnet have been exsolved. The amount of garnet exsolution is related to the initial concentration of Ca Tschermak's molecule thus clinopyroxene megacryst with low initial amounts of Ca Tschermak's molecule will be most easily recognised.

Clinopyroxene megacrysts are found in both type I and type II eclogites. Within each group identification of a clinopyroxene megacryst may be by inference rather than direct observation.

A type I eclogite with a clinopyroxene megacryst is described first since in this rock there is no ambiguity about the presence or outline of the clinopyroxene megacryst.

CLINOPYROXENE MEGACRYST BEARING ECLOGITE HRV77

DESCRIPTION OF THE SPECIMEN

The initial size of the nodule was 30 x 28 x 8.5 cm. It has been broken into 9 pieces labelled A to I illustrated in Figure 20. The megacryst is present to the right of the centre of the nodule and the margins of the megacryst are clearly demarcated. The lengths of the short and intermediate axes of the megacryst can be estimated, but the length of the long axis is unknown since the megacryst is not entirely within the confines of the nodule. The texture of the surrounding biminerallic eclogite is typical of type I eclogites. The grain size of biminerallic eclogite does not vary markedly. The orientation of layering could not be observed.

Probe slide HRV77A was cut across the boundary between megacryst and biminerallic eclogite, while slide HRV77D was cut from a section of the nodule away from the megacryst.

PROBE ANALYSES

In slide HRV77A four garnet grains were analysed. Grains 1 and 2 lie within the clinopyroxene megacryst, grain 3 is on the border and grain 4 is surrounding biminerallic eclogite. Top edge (303), right edge (403) and centre (103) of garnet 3 were analysed. Four analyses of clinopyroxene adjacent to the garnet rims were carried out. The cpx and adjacent garnet pairs are CP301/GT301, CP502/GT302, CP503/GT303, CP604/GT403 and CP404/GT604. Of the other cpx analyses, unpaired with garnet, CP102 is within the megacryst, CP403 is on the edge of the megacryst and CP304 is the edge of a clinopyroxene grain within the surrounding eclogite, immediately adjacent to CP403 (Figure 21).

Analyses of a garnet edge and adjacent clinopyroxene in HRV77D represent the composition of the eclogite away from the megacryst.

The results of the probe analyses are tabulated in the alphanumeric listing (Table 4) and presented graphically in Figure 22 in which weight percent of elements in clinopyroxene and garnet and plotted distance perpendicular to the megacryst/eclogite contact. A point to notice is the sharp chemical discontinuity at the boundary between the megacryst and surrounding eclogite. For the clinopyroxenes Na_2O, Al_2O_3 and CaO contents are higher in the megacryst while MgO and FeO are lower in the megacryst than in adjacent eclogite. CaO and MgO contents are higher in clinopyroxene far removed from the megacryst than in clinopyroxene near to the megacryst while Na_2O, Al_2O_3 and FeO are lower in clinopyroxene far from the megacryst than in clinopyroxene near to the megacryst. For the garnets FeO and MgO are higher in the megacryst than surrounding eclogite while CaO is lower. CaO is present at the same level in garnet near to the megacryst and in garnet further removed from the megacryst, while MgO is lower and FeO higher in garnet near to the megacryst.

BULK ANALYSES - EVIDENCE FOR THE PRESENCE OF VOLATILES

Portions of the megacryst and of the surrounding eclogite were separated and prepared for XRF analysis of major and trace elements. Results are given in Table 6. The results obtained for Ga and Al yield evidence for the presence of a concentration of volatiles during growth of the megacryst.

Gallium may be preferentially partitioned into the volatile phase in an equilibrium between volatiles and melt (Willis pers. comm., 1978). The geochemical behaviour of Ga is in many respects similar to Al, thus the ratio Ga/Al provides a good comparison of the levels of Ga in different bulk compositions.

Ga concentration in the megacryst (18.9 ppm) is significantly higher than in the surrounding eclogite (11.5 ppm) while the ratio Ga/Al x 10^5 in the megacryst (37.8) is twice that in the eclogite (18.9). Ga is preferentially partitioned into cpx thus the high Ga content may simply be the result of high modal cpx in the megacrystic portion.

The high concentrations of Ga in the megacryst suggest that the megacryst grew in the presence of high concentrations of volatiles, although this evidence is not conclusive. Nevertheless (if the megacryst was initially a single crystal and has fragmented into subgrains during exsolution of garnet), some factor must have allowed the megacryst to attain its extremely coarse grain size and it is widely accepted that the presence of volatiles encourages rapid crystal growth (Kirkpatrick 1975).

TEMPERATURES OF EQUILIBRATION

The ratio K_D = (FeO/MgO)gt/(FeO/MgO)cpx has been shown to be a function of temperature and pressure according to the equation

$$T = \frac{3686 + 28.35P}{2.33 + \ln K_D}$$ (Raheim and Green, 1974)

Temperature can be uniquely defined by the K_D value only if the pressure is known by an independent method. The coexistence of diamond and graphite in another Roberts Victor nodule, HRV247, yields an independent constraint and suggests that the pressure of equilibration of that nodule is in the range 40 - 45 kilobars. For convenience of discussion

of temperatures of equilibration it will be assumed throughout this narrative that the pressure of equilibration of Roberts Victor nodules was 40 kilobars.

The $\ln K_D$ values and T at 40kb for garnet-cpx pairs within the megacryst are (location of analyses in Figure 21)

1.25 and 1073°C for the pair GT301/CP301, and

1.18 and 1100°C for the pair GT302/CP502.

For the garnet grain on the megacryst/eclogite interface the values are

1.20 and 1092°C for the pair GT303/CP503, the top edge of the garnet.

1.17 and 1106°C for the pair GT103/CP502, the centre of the garnet, assumed to be in equilibrium with the cpx megacryst, and

.88 and 1229°C for the pair GT403/CP604, the right edge of the garnet adjacent to surrounding eclogite.

The garnet-cpx pair near to the megacryst has values .86 and 1238°C, and the garnet-cpx pair 5 cm from the megacryst has values .76 and 1287°C.

SUBSOLIDUS HISTORY OF THE MEGACRYST

The sharp chemical boundary between megacryst and eclogite established by probe analyses has two implications:

i) The present outlines of the megacryst are very nearly equivalent to the original outlines of the megacryst;

ii) The megacryst and eclogite formed in two chemically distinct environments.

The discontinuity between the two chemical environments has been blurred (but only to a limited extent) by subsolidus processes.

Small straight edged garnet grains within the clinopyroxene megacryst appear to be of exsolution origin. These garnets (1 and 2) are of similar composition. The absence of lamellar exsolution garnets, so abundant in type II clinopyroxene megacrysts (JJG41, Harte and Gurney, 1975; HRV244, this chapter) is notable. In contrast to the other megacrysts mentioned, HRV77 contains very low levels of Ca Tschermak's molecule (<1%). The amount of Ca Tschermak's molecule calculated is a function of the analytical accuracy of the Si determination and the

amounts calculated in HRV77 may be the result of anlytical error. The limited amount of garnet within the megacryst suggests that the initial content of Ca Tschermak's molecule was also low.

Garnet 3 lies abreast the megacryst/eclogite interface and shows effects of equilibration with both megacryst and eclogite. The centre has composition similar to the exsolved garnets in the clinopyroxene, while the right edge has composition similar to the surrounding eclogite, and the top edge has composition similar to exsolved garnets but shows a bias toward the composition of the surrounding eclogite. The fact that the centre of the garnet has composition similar to the exsolved garnets suggests that garnet 3 was initially formed by exsolution from the megacryst. There is a concentration of garnet at the megacryst/eclogite interface, and it appears that the bulk of the exsolved garnet migrated to the outer edges of the megacryst.

While garnets within the surrounding eclogite may have formed by subsolidus processes, it is possible that they crystallised as liquidus phases.

The highest temperature preserved is 1286°C ($\ln K_D$ = .76), calculated from garnet and cpx 5 cm from the megacryst. Any temperatures below this must represent temperatures of formation of the minerals since, as discussed at the beginning of the chapter, they could not attain their present compositions by intracrystallisation diffusion below the Tammann temperature which is at least 1286°C. Thus for HRV77 the liquidus temperature, or the temperature of cessation of intracrystalline diffusion is 1286°C. The solvus temperature of the clinopyroxene megacryst is given by the exsolved garnets as approximately 1100°C.

The inhomogeneous garnet 3 at the megacryst/eclogite interface presents a range of temperature which may be the result of exsolution from the megacryst and equilibration with the surrounding eclogite. It may be supposed that the centre of garnet 3 formed by exsolution almost entirely within the clinopyroxene megacryst since compositions and calculated temperatures are similar to those of garnets exsolved within the megacryst. The edges of the garnet exsolved later were influenced by the surrounding eclogite, and the composition of the

garnet exsolved was determined by the chemical potential of each element in the megacryst and in the clinopyroxenes (and garnets) of the surrounding eclogite. In consequence the garnets equilibrating with surrounding eclogite are more iron rich than those that equilibrated with the megacryst alone, hence Fe/Mg garnet is higher, (Fe/Mg) garnet/(Fe/Mg) cpx is higher, and consequently calculated temperatures are lower. The temperatures calculated from the edges of garnet 3 are therefore believed to be spurious in that the garnets formed in the unequilibrated environment of the megacryst/eclogite interface.

The temperature given by the K_D ratio for garnet/cpx in the eclogite immediately adjacent to the megacryst may be the reflection of either of two possible processes.

i) The temperature given by the K_D ratio of garnet and clinopyroxene adjacent to the megacryst may be the result of subsolidus re-equilibration with the megacryst below the Tammann temperature. Subsolidus equilibration below the Tammann temperature may have proceeded further owing to the very great difference in chemical potential of components in megacryst and eclogite.

ii) Alternatively the eclogite adjacent to the megacryst may actually have crystallised at lower temperatures than the rest of the eclogite as a consequence of a high local concentration of elements excluded from the growing megacryst, at the megacryst edge (Kirkpatrick, 1975). One of these impurities would be FeO, and it is to be expected from the usual behaviour of FeO-MgO solid solutions, that FeO rich minerals crystallise at lower temperatures.

A SINGLE STAGE ORIGIN FOR MEGACRYST AND ECLOGITE IN HRV77

A preliminary hypothesis, which may be refined or rejected when all the megacrysts studied have been discussed, is considered here. This hypothesis assumes that both megacryst and eclogite crystallised from the same magma. The mechanisms whereby a megacryst of notably different composition from surrounding clinopyroxene, can grow from the same magma, are considered at the end of the chapter. However, given the initial nucleation and growth of a clinopyroxene megacryst,

it is expected that clinopyroxene impurities, notably FeO which is more strongly partitioned into garnet, would build up at the edge of the megacryst, and an iron rich subdomain with the eclogite magma would be built up. Crystals in this Fe rich liquid would have a lower liquidus temperature than those in the surrounding (comparatively) MgO rich liquid. Thus it is suggested that megacryst and distant eclogite initially formed at temperatures above 1280°C by crystallisation from a liquid. Fe rich eclogite adjacent to the megacryst formed at about 1230°C, and garnet exsolved from the megacryst at 1100°C. These temperatures are not believed to be absolutely correct, as the K_D values are subject to errors, for example the difficulty of estimating Fe^{3+} correctly, but the relations between the temperatures are thought to be correct. The temperatures 1280°C and 1230°C are presented as a simple and more easily intelligible means of conveying the K_D values in the framework of stated assumptions.

XRV6 - A RESORBED MEGACRYST?

DESCRIPTION OF THE SAMPLE

The rock is a typical type I eclogite with rounded orange garnets and bottle green clinopyroxene. No obvious discontinuities are visible in hand specimen.

In thin section garnet on one side of the slide is clear, while other garnet is cloudy. Throughout the slide the grain size of garnet varies from small rounded blebs within clinopyroxene to large discrete garnet grains. Irregular intergrowths of garnet and clinopyroxene are present and may well have formed by unmixing of clinopyroxene.

Probe analyses were carried out on clear and cloudy garnets. Analysis points GT101, GT501 and CP301 are located at the centre and lower edge of a large cloudy garnet and the edge of the adjacent clinopyroxene; points GT102 and CP102 are located at the centre of a small cloudy garnet; and GT303, GT503 and CP303 are analysis points at the top and bottom edges of a clear garnet and top edge of the adjacent clinopyroxene.

RESULTS OF PROBE ANALYSES

For the garnets FeO is constant, MgO is lower while CaO is higher in the clear garnets than in the cloudy garnet. Comparing clinopyroxenes adjacent to clear and cloudy garnet, Na_2O and Al_2O_3 are higher while CaO, MgO and FeO are lower in the clinopyroxene adjacent to clear garnets.

CALCULATED TEMPERATURES

$\ln K_D$ ratios for the pairs GT303/CP503, GT102/CP102 and GT501/CP301 are 1.05, .85 and .85 and calculated temperatures at 40kb are 1153°C, 1243°C and 1243°C respectively.

ORIGIN OF HETEROGENEITY

While it is accepted that there are a number of factors and processes which may have given rise to the inhomogeneity in this sample, the undoubted subsolidus origin of many of the garnets within the slide, and the broad similarity of the chemical variation with that shown in nodule HRV77 suggests that the inhomogeneity may have formed as a result of heterogeneous exsolution of an original megacryst.

MEGACRYST BEARING ECLOGITE HRV252

A slab through the specimen measures 16 x 9 cm, and a clinopyroxene megacryst is present parallel to the short axis in the top 3 to 6 cm of the nodule. A crudely defined layering is present parallel to the megacryst. Surrounding eclogite has typical type I texture.

The sample was cursorily analysed during a program in which single grains were removed from slabs in order to fill in the overall trends which appeared to be emerging from analyses of thin sections.

The chemistry of a small rounded garnet in the megacryst was compared to a garnet in the surrounding eclogite by probe analysis of single grains. Garnet in the megacryst has higher FeO and CaO but lower MgO than garnet in the surrounding eclogite. This pattern is similar to that observed in HRV77 for garnet in the megacryst and garnet in eclogite at some distance from the megacryst.

The MnO contents of garnets in HRV252 is the highest observed in Roberts Victor eclogites (0.9 wt.% MnO).

CORUNDUM ECLOGITE JJG60

DESCRIPTION OF THE NODULE

The sample was recovered from the oversize concentrate dump at Roberts Victor, after it had passed through the rock crushing plant. Probably it is a fragment of a larger nodule. As recovered the sample was approximately 2 x 2 x 2 cm. Because of the small size, details of the whole rock relationships could not be ascertained. One slide was examined in thin section and analysed by electron microprobe.

Points analysed by electron microprobe are noted in Figure 23, drawn from a photograph of the slide.

The dominant mineral present is clinopyroxene altered pervasively to a brown, glass-like material although relicts of fresh clinopyroxene are present throughout the slide. A large area of unaltered clinopyroxene is present at the top of the slide. Analyses CP109 and CP309 were carried out at the centre and edge of this large, fresh grain.

Corundum has an irregular shape and is present at clinopyroxene grain boundaries. It is mantled to a greater or lesser extent by garnet overgrowths. The irregular shape suggests that the corundum was formed by exsolution.

Four garnet textures representing various stages of growth have been captured in the slide.

i) Fine, longitudinal lamellae (GT102) represent the first stages of exsolution. These first exsolution lamellae are crystallographically controlled (Harte and Gurney, 1975, p. 371).

ii) As the degree of exsolution increases the lamellae coarsen and become more rounded (GT101).

iii) Larger irregular shaped garnets are products of exsolution. These irregular garnets may occur as overgrowths on corundum (GT105, GT108).

iv) Large rounded garnets may either be products of copious exsolution, or may have crystallised as liquidus phases (GT106, GT107).

MICROPROBE ANALYSES

The analyses are presented in the alphanumerical listing of all analyses completed during this project (Table 4).

Garnet compositions are very variable and may be related to the degree of exsolution. CaO increases from 13.2 wt.% in rounded garnet GT106 to 20.9 wt.% in the fine exsolution lamellae GT102. FeO and MgO decrease as CaO increases.

The centre of the fresh clinopyroxene at CP309 represents the clinopyroxene which has undergone least exsolution, while clinopyroxene CP102 adjacent to the fine lamellar garnets has undergone most exsolution. With increasing degrees of exsolution SiO_2 and Na_2O increases while FeO, MgO and CaO decrease. Al_2O_3 shows a slight decrease.

EXSOLUTION REACTIONS

Exsolution of garnet proceeds by the reaction

$$CaAl_2SiO_6 + (Ca,Mg,Fe)_2Si_2O_6 = (Ca,Mg,Fe)Al_2Si_3O_{12}$$

As a result jadeite increases in clinopyroxene, but the exsolution of Al_2O_3 in Ca Tschermak's molecule ensures that Al_2O_3 levels do not increase.

Corundum appears to have an exsolution origin. It may form by the reaction

$$CaAl_2SiO_6 = Al_2O_3 + CaSiO_3$$

CALCULATED TEMPERATURES

Clinopyroxene was analysed adjacent to exsolved lamella GT102 and adjacent to garnet overgrowth GT105. Both pairs give a $\ln K_D$ ratio of 1.58 which corresponds to a temperature at 40 kilobars of 960°C.

Although it is difficult to determine what compositions are in equilibrium when the centres of grains are considered, it is assumed that the centres of the largest garnet and largest clinopyroxene grains (GT106 and CP109 respectively) were in equilibrium. $\ln K_D$ for this pair is 1.26 which corresponds to a temperature at 40kb of 1071°C.

It may be inferred that the rock crystallised at 1071°C, or that the Tammann temperature of cpx or garnet in this rock is 1071°C. The solvus temperature is 960°C.

ECLOGITE WITH GARNET EXSOLUTION, HRV335

DESCRIPTION OF THE NODULE

The sample was recovered from the oversize concentrate dump, and has dimensions of 3 x 2 x 2 cm. The sample does not appear to have been broken after removal from the kimberlite and the above measurements may represent the original dimensions of the sample.

Large rounded garnet and clinopyroxene grains are present. Parallel lamellae of garnet are exsolved from a large altered clinopyroxene grain.

PROBE ANALYSES

The probe analyses are presented in the alphanumerical listing (Table 4).

Analyses GT102 and CP102 were carried out in the centre of a large garnet grain and a large clinopyroxene grain which lacked exsolution lamellae. Analyses GT601 and CP401 are of an exsolved garnet lamella and adjacent clinopyroxene. CP403 is at the edge of a large clinopyroxene grain.

Exsolved garnet has higher CaO and lower FeO and MgO than the large garnet. Clinopyroxene adjacent to exsolved garnet has higher SiO_2, FeO, MgO and Na_2O and lower CaO and Al_2O_3 than the large clinopyroxene grain.

These results are entirely consistent with exsolution of Ca Tschermak's molecule from clinopyroxene to produce garnet.

TYPE II CLINOPYROXENE MEGACRYST BEARING ECLOGITE, HRV244

DESCRIPTION OF THE NODULE

The original size of the nodule was Z axis = 26 cm, Y axis = 13 cm and X axis = 12 cm. It has been sliced into 11 blocks illustrated in Figure 24a, a view down the X axis of the YZ plane. In the plane YZ the megacryst dips at 45° to the right, but is horizontal in the plane XZ (Figure 24b). The megacryst may have extended beyond the confines of the nodule as illustrated in Figure 24c.

The biminerallic eclogite surrounding the megacryst consists of equigranular straight edged garnet and clinopyroxene of a texture very similar to that described for nodule JJG41 (Harte and Gurney, 1975). Coarse grained garnets with the texture of the biminerallic eclogite extend up cracks into the megacryst, and may either have originated from the biminerallic eclogite or by exsolution from the megacryst.

Garnet exsolution ranges from the fine parallel lamellae (too small for electron microprobe analysis; Plate 11a) and elongate rods whose orientation is controlled by clinopyroxene crystallography (Plate 11b) to the coarse straight edged garnets which occur in cracks and deformities in the megacryst.

Layering is not apparent in the nodule, but the chemical analyses suggest that there is a compositional gradation in the biminerallic eclogite.

Clinopyroxene grains adjacent to the megacryst differ only slightly from the clinopyroxene megacryst in the orientation of the (slow) ray across the megacryst/eclogite interface (3 - 7^{o}). The clinopyroxene grains in the eclogite may thus represent subgrains from the megacryst formed during exsolution.

Two probe slides HRV244 about 7 cm from the megacryst, and HRV244A across the megacryst/eclogite interface were prepared. In slide HRV244 in the biminerallic eclogite centres and edges of two garnets and the edges of the two adjacent clinopyroxenes were analysed.

In slide HRV244A analyses GT101, GT501, CP101 and CP301 were carried out on the centre and edge of a garnet and adjacent clinopyroxene grain respectively. Within the megacryst GT102 is an analysis of a six sided exsolved garnet, possibly a cross section through a rod shaped garnet, CP302 is cpx adjacent to GT102 and analysis point CP102 is of cpx near to CP302 but as far removed from exsolved garnet as possible. Similarly CP303 was taken adjacent to exsolved garnet and CP103 as far from exsolved garnet as possible. GT104 is of another six sided garnet (Plate 11b). The elongate garnet lamellae could not be analysed because their size is too small to preclude the possibility of edge interference from cpx during analysis.

RESULTS OF PROBE ANALYSES

Individual garnets have homogeneous compositions but there is a variation in garnet composition across the rock (Figure 25). Garnets away from the megacryst are higher in FeO but lower in CaO than garnets near the megacryst. Garnets adjacent to the megacryst have lower FeO but higher CaO than small exsolved garnets in the megacryst. MgO content declines away from the megacryst toward the megacryst and continues to decline in the small exsolved garnets in the megacryst.

Na_2O and Al_2O_3 consistently decrease while CaO and MgO consistently increase sequentially in clinopyroxene edges away from the megacryst, adjacent to the megacryst and within the megacryst (Figure 25). FeO and SiO_2 decrease toward the megacryst but increase again within the clinopyroxene megacryst.

Clinopyroxene in the megacryst removed from exsolved garnet has higher Na_2O, Al_2O_3 and FeO but lower CaO, MgO and SiO_2 than clinopyroxene adjacent to exsolved garnet (Figure 25).

CALCULATED TEMPERATURES

$\ln K_D$ ratios for adjacent garnet-clinopyroxene pairs (GT501-CP501, GT602-CP402 in slide HRV244 and GT501/CP301, GT102, CP302 and GT104/CP303 in HRV244) proceeding toward and into the megacryst consistently increase. Respective values are 1.17, 1.23, 1.32, 1.48 and 1.53. Calculated temperatures at 40kb in the same sequence are 1104, 1081, 1048, 992 and 976°C. Equilibration temperatures progressively decrease as one approaches the megacryst and crosses the megacryst/eclogite interface.

SUBSOLIDUS HISTORY

i) EXSOLUTION ORIGIN FOR BIMINERALLIC ECLOGITE

There is no sharp discontinuity in clinopyroxene composition across the megacryst/eclogite interface, thus it is possible that the present boundary of the megacryst represents only the outlines of what remains from an originally much larger megacryst which may have been bigger than the entire nodule. If the megacryst was originally much larger then the sequence of compositions and temperatures toward the present megacryst represent progressive stages in the exsolution

history of this formerly larger megacryst. The first garnets exsolved are high in FeO and MgO but these amounts decrease with consequent increase in CaO as exsolution proceeds (Figure 25). The Na_2O, Al_2O_3 and FeO contents of clinopyroxene edges decrease, while CaO and MgO contents increase with progressive exsolution (Figure 25). The results for Na_2O are at first glance unexpected as with increasing exsolution the proportion of jadeite components in the residual clinopyroxene megacryst is expected to <u>increase</u>, as Na_2O does not enter into the garnet structure.

It is possible that the original megacryst was not homogeneous but had higher Na_2O, Al_2O_3 and FeO at the edge than towards the centre. This feature would be expected if the megacryst grew in a small volume of magma in which the magma composition changed during growth. Na_2O and Al_2O_3 would progressively increase in the liquid hence the edge of the megacryst would be higher in these components. Another possibility is considered below.

ii) INTRACRYSTALLINE DIFFUSION DURING EXSOLUTION

Within the megacryst Na_2O, Al_2O_3 and FeO are lowest, while CaO and MgO are highest in clinopyroxene adjacent to exsolved garnet. This pattern is similar to that noted above for the eclogite outside the present megacryst, in that the proportion of Na_2O in clinopyroxene adjacent to exsolving garnet decreases rather than increases during exsolution. However, the centres of residual megacryst have the highest values of Na_2O in the nodule, and a possible explanation of the anomalous decrease of Na_2O during exsolution is that Na_2O migrates away from exsolving garnet. This feature would explain the decreasing amounts of Na_2O in clinopyroxene, with increasing exsolution observed in surrounding eclogite, for if the surrounding eclogite also formed by exsolution, Na_2O would decrease as it progressively migrated away from the exsolving garnet toward the centre of the megacryst.

The reason why Na_2O should migrate away from exsolving garnet is not at first apparent, but may be related to the nature in which intracrystalline diffusion occurs during the exsolution of garnet.

The essential component in garnet exsolution from clinopyroxene is CaTschermak's molecule which reacts with an equal amount of diopside, hedenbergite, enstatite or ferrosilite to produce garnet. Exsolution of

garnet at the edge of the megacryst depletes the clinopyroxene in Ca Tschermak's molecule and requires that the Ca Tschermak's molecule diffuses from the centre of the megacryst. The data suggest that not all components of CaTschermak's molecule, $CaAlAlSiO_6$, but only Ca and Al in four fold coordination diffuse outwards, and that outward diffusion is compensated by inward diffusion of Na and Si. Al in six fold coordination and one of the Si ions is common to both jadeite and Ca Tschermak's molecule and do not need to migrate. The relative ease of diffusion may be related to the field strength = charge/ionic radius. The field strengths of ions in the different clinopyroxene sites are, from low field strength to high field strength:

Na < Ca < Mg in eight fold co-ordination
Mg < Al in six fold co-ordination
Al < Si in four fold co-ordination.

The octahedral site preference energy of the transition metal ions complicates the picture, but for the purposes of this discussion it is sufficient only to consider non-transition metal ions.

Garnets in HRV244 are Mg rich hence the contribution of the enstatite end member to garnet exsolution must be substantial. Exsolution proceeds largely by the reaction

$$Mg_2Si_2O_{6\ cpx} + MgAlAlSiO_{6\ cpx} \rightleftharpoons Mg_3Al_2Si_3O_{12\ gt}$$

If it is assumed that clinopyroxene near to exsolving garnet provides most of the molecules required for this reaction, there will be a local deficiency of Ca in eight fold co-ordination, of Mg in six fold co-ordination and of Al in four fold co-ordination in the clinopyroxene adjacent to exsolving garnet. The supply of four fold co-ordinate Al to exsolving garnet is probably the rate controlling step in this reaction, as Al in tetrahedral co-ordination is probably much slower to diffuse than are ions in six and eight fold co-ordination.

The ion with lowest field strength in six fold co-ordination is Mg, which will diffuse more rapidly than Al, while Na will diffuse more rapidly than other ions in eight fold co-ordination. Thus intracrystalline diffusion will proceed most rapidly if Al in four fold co-ordination, Mg in six fold co-ordination, and Na in eight fold co-ordination are involved in diffusion.

The following diffusion reaction is envisaged

$$MgMgSi_2O_{6centre} + CaAlAlSiO_{6centre} + NaAlSi_2O_{6edge} \rightleftharpoons$$

$$CaMgSi_2O_{6centre} + NaAlSi_2O_{6centre} + MgAlAlSiO_{6edge}$$

Steps in this reaction are indicated in Figure 26. This reaction proceeds by

1. outward diffusion of Al^{IV} and inward diffusion of Si^{IV} in the rate controlling step.
2. Mg in six fold co-ordination in enstatite diffuses outwards, to eight fold co-ordination in Mg Tschermak's molecule.
3. Ca in CaTs displaces Mg in eight fold co-ordination in enstatite into six fold co-ordination with the production of diopside molecule.
4. Na diffuses inward to replace Ca, with formation of jadeite.

The significance of the rather complicated process outlined above is that only the ions with lowest field strength in six and eight fold co-ordination diffuse across the megacryst, while those ions with higher field strength need only move to nearby molecules.

iii) TEMPERATURES OF EXSOLUTION

The history of the rock is interpreted in the light of subsolidus processes only and it is not thought that the liquidus or solidus temperatures are preserved. The temperatures calculated from the data represent stages in the unmixing history of a megacryst which decreased in size by formation of subgrains, became poorer in potential garnet (CaTs) as exsolution proceeded. The highest solvus temperature recorded is 1104°C for parts of the rock furtherest from the present megacryst while the lowest solvus temperature is 976°C for small exsolved garnets within the present megacryst.

ORIGIN OF THE MEGACRYSTS

The two jadeite-rich rocks, HRV335 and corundum eclogite JJG60 were discussed in this chapter as they exhibit garnet exsolution. However there is no evidence that these rocks were ever megacrystic. The high concentrations of Al^{VI} in these rocks may have resulted in a high concentration of Al^{IV}, and high Al^{IV} concentrations may have been a feature of aluminous clinopyroxene crystallising together with garnet, rather than a feature of a clinopyroxene megacryst.

In the type I megacryst bearing eclogite, HRV77, HRV252 and XRV6 the megacrysts appear to have been surrounded by bimineralic eclogite, thus their origin must be intimately related to processes occurring during genesis of the eclogites. There is no evidence of veins radiating away from the megacryst and it thus appears unlikely that they have formed by late stage local segregation of residual fluids in a manner analogous to pegmatite formation; rather it appears that the megacryst formed together with or prior to surrounding eclogite.

The large grain size of the megacryst demands that there was some process which facilitated crystal growth. The most likely process is that there was a high local concentration of volatiles within an environment which permitted free crystal growth. It is suggested that megacrysts grew in a volatile-rich localised environment, within a magma chamber.

A concentration of volatiles may develop locally in any portion of a magma chamber, but the most likely environment for build up of volatiles is at the roof. As a general process for the origin of the Roberts Victor megacrysts it may be stated that they grew by igneous processes in a volatile rich environment, usually the top of the magma chamber, subsequently settled, and were incorporated in the crystal pile at the base of the chamber. The relative abundance of megacrysts at Roberts Victor suggests that during the event or events in which many of the eclogites formed high concentrations of volatiles were present.

Settling of megacrysts into a crystal pile is a feasible process to explain the origin of type I megacryst bearing eclogites HRV77,

HRV252 and XRV6.

In the type II megacryst bearing eclogite, HRV244 compositions in the megacryst overlap those of surrounding biminerallic eclogite and it is possible that the entire nodule was initially a large megacryst. It is therefore not certain that the megacryst was ever surrounded by biminerallic eclogite, and this rock may represent a disrupted portion from a horizon which consisted entirely of megacrysts.

The postulate that a volatile component was an essential feature of the genesis of the type I megacryst bearing eclogites is in accord with the suggestion in Chapter V that high concentrations of volatiles were necessary to allow piercing of the eclogite thermal divide during partial melting to produce the liquid from which type I eclogites crystallised.

VII INHOMOGENEITIES IN ECLOGITES

II INHOMOGENEOUS KYANITE ECLOGITES

Kyanite is present in several rocks in both type I and type II eclogites (Chapter IV). In some of these rocks kyanite occurs only in a distinctive zone whose margins are marked by gross chemical heterogeneity. This heterogeneity may be manifested by a change in garnet composition across a single grain. These rocks are here termed inhomogeneous kyanite eclogites. When inhomogeneous kyanite eclogites are found in the type I eclogites, the eclogite surrounding the kyanite eclogite zone is texturally similar to other type I eclogites. In contrast inhomogeneous kyanite eclogites in the type II eclogites have a distinctly finer grained texture (average grain size 1 - 2 mm) than the coarser grained eclogites eclogites more normal to Roberts Victor.

Type I inhomogeneous kyanite eclogites which have been chemically analysed are HRV17, JJG40, JJG143, JJG177, JJG178 and JJG179. Eclogites HRV30, HRV31 and HRV44 contain kyanite eclogite zones but have not been analysed.

The type II inhomogeneous kyanite eclogites are represented by samples HRV18 and HRV116. Sample JJG520 is texturally similar to these two but does not contain a discrete kyanite eclogite zone. However, the chemistry and texture is similar to the other two samples, and JJG520 is considered to be a type II inhomogeneous kyanite eclogite. These three samples have been chemically analysed and are plotted with the other type II eclogites as "fine grained kyanite corundum eclogites" abbreviated FGKCE in Chapter V, Figures 17 and 18.

TYPE I INHOMOGENEOUS KYANITE ECLOGITES

Previous studies of Roberts Victor kyanite eclogites were carried out on samples which can be identified as type I inhomogeneous kyanite eclogites. These studies reached different conclusions as to the origin of the inhomogeneities found within the kyanite eclogites. Chinner and Cornell (1974) attributed the imhomogeneity to reaction of the kyanite eclogite nodule with the host kimberlite magma; Lappin and Dawson (1975)

argued that the kyanite eclogite studied by them recorded the complex tectonic history which the nodule was purported to have undergone and Cox (1975) suggested that the kyanite eclogite zone within biminerallic eclogite may have formed by subsolidus reaction between coarser cpx, garnet and coesite. The different conclusions arrived at in these studies can be ascribed to the different geometry of the kyanite eclogite zone in the samples studied by these authors.

For the present study it was possible to assemble a wide range of samples which illustrates the variable geometry of the kyanite eclogite zones, and their relationship to the kyanite bearing rocks in which they occur.

CONFIGURATIONS OF KYANITE ECLOGITE ZONES

In the kyanite eclogite zone garnets are brown or black in contrast to the orange colour of garnets in biminerallic eclogites. Clinopyroxenes are altered to a grey white turbid mass in the kyanite eclogite zone but are blue green in biminerallic eclogites. In certain samples grey clinopyroxene and brown garnet of a similar appearance to the mineral in kyanite eclogite zones occur without kyanite. This unit is termed the brown garnet-grey cpx unit.

For the purposes of this description the following component units are recognised

i) Ordinary eclogite comprising orange garnet and blue green clinopyroxene.

ii) A garnet rich layer consisting of greater than 90 modal % orange garnet.

iii) A garnet-kyanite unit consisting of 90% modal orange garnet and kyanite.

iv) A kyanite-eclogite unit (kyanite, grey clinopyroxene and brown garnet).

v) Brown garnet-grey clinopyroxene describes a unit in which these two minerals occur without kyanite. Brown garnet-grey clinopyroxene usually occurs adjacent to the kyanite eclogite unit, and together these units comprise the kyanite eclogite zone.

These units are combined in different ways in the rocks described below.

1. ORDINARY ECLOGITE/KYANITE ECLOGITE

Most inhomogeneous kyanite eclogites are found as samples in which the kyanite eclogite unit is preserved only on an edge of the nodule.

In sample HRV31 variations in modal amounts of orange garnet and green clinopyroxene in the ordinary eclogite define a crude layering. In a slice cut transverse to the plane of flattening of the nodule the ordinary eclogite unit is 11 cm thick. 4 cm of the kyanite eclogite unit is preserved at the bottom of the sample. The inner edge of the kyanite eclogite unit parallels the layering in the ordinary eclogite. The nodule thins noticeably around the kyanite eclogite unit suggesting this unit to be more readily eroded during transport in the kimberlite (Chapter III).

Samples JJG177 and JJG143 have in general features similar to HRV31, although JJG177 is rather more fine grained (2 mm grain size) than typical type I eclogites (4 mm grain size).

BD6913 is described by Lappin and Dawson (1975) as consisting of a 3.5 cm ordinary eclogite layer, a 1 cm garnet-clinopyroxene layer in which garnets form overgrowths on kyanite and a 3 cm kyanite eclogite layer (A photo of this sample is presented by Dawson, 1968).

2. ORDINARY ECLOGITE/GARNET-KYANITE/KYANITE ECLOGITE LAYERS

KC-RV-1 (Cox 1975; Cox et al., 1975) consists of biminerallic eclogite, a 2 - 3 cm thick garnet rich layer which is locally kyanite bearing, and a kyanite eclogite unit. Kyanite is apparently locally concentrated within the kyanite eclogite unit (Cox et al., 1975). This sample was not examined by the writer.

JJG178 has a 1 cm thick ordinary eclogite unit, a 3.5 cm thick garnet kyanite band, and 1 cm kyanite eclogite band. Kyanite occurs sporadically throughout the sample (a few grains being noted in the ordinary eclogite) but is concentrated especially in the centre of the garnet-kyanite unit and toward the edge of the nodule within the kyanite eclogite unit.

JJG179 is similar in appearance to JJG178, consisting of garnet-kyanite and kyanite eclogite layers. The chemistry of JJG178 and JJG179 is similar.

3. ORDINARY ECLOGITE/GARNET RICH BAND/GREY CPX-BROWN GARNET/KYANITE ECLOGITE/ORDINARY ECLOGITE

Sample HRV17 may be considered to represent the complete vertical section through a rock in which a kyanite eclogite zone occurs, for all those units encountered in the various inhomogeneous kyanite eclogites, with the exception of the garnet-kyanite band, are to be found in this specimen. The specimens described above are considered to represent fragments of the vertical sequence preserved in its entirety in HRV17.

The various layers in HRV17 are indicated in Figure 27 and Plate 16 where

B is ordinary eclogite,
B_1 is a sporadically developed garnet rich band,
C is grey cpx-brown garnet,
D is the kyanite eclogite unit and
A is ordinary eclogite of similar mineral composition to B.

The preceding samples illustrate the vertical succession of units that may be encountered, but an important feature of the kyanite eclogite zone, namely that it is of limited horizontal, as well as limited vertical extent, is illustrated by the following samples.

4. ORDINARY ECLOGITE WITH AN ENCLOSED CYLINDRICAL KYANITE ECLOGITE ZONE

Sample HRV44 is a type I eclogite with layers defined by varying modal amounts of garnet and clinopyroxene. Sectioning of the nodule revealed an inner circular area with grey cpx, brown garnet and occasional kyanite grains. On further examination it was noted that this kyanite eclogite zone extends through the nodule as a cylinder shaped body of approximately 2 cm radius. The length of this cylinder cannot be ascertained as it extends beyond the nodule, lying below and parallel to a garnet rich layer.

While it is possible that the cylinder is of great horizontal extent, (resembling a pipe-like body) it is more likely that the kyanite eclogite zone dies out horizontally along the length of the cylinder. This sample illustrates that a kyanite eclogite zone is certainly of limited extent in at least two dimensions and probably in all three.

5. ECLOGITE WITH "DOMED" GARNET RICH LAYER, AND TWO DISCRETE KYANITE ECLOGITE ZONES

In outline nodule HRV30 is of a peculiar shape. Viewed down the long (a) axis the sample is pear shaped (Figure 28b). The thicker layers consist of an ordinary eclogite and a garnet rich unit. The sample thins markedly into a kyanite eclogite zone which in turn overlies a second ordinary eclogite layer. The succession observed is similar to that found in HRV17.

A notable feature of HRV30 is that the garnet rich unit has a concave surface toward the kyanite eclogite zone (Figure 28b). It appears that the kyanite eclogite zone may have forced upward the overlying garnet rich layer. The impression of a curved surface is enhanced by the parallel, curved orientation of kyanite rich layers within the kyanite eclogite zone.

A further notable and unique feature is revealed in progressive slices through the nodule, for the kyanite eclogite zone bifurcates horizontally into two discrete kyanite eclogite zones with ordinary eclogite appearing between (Figures 28a, 28b; Plate 13).

6. KYANITE ECLOGITE DISRUPTING A GARNET RICH LAYER

In sample JJG40 (see Rickwood et al., 1969) a garnet rich layer can be observed within the ordinary eclogite portion of the rock. Ordinary eclogite in this sample comprises only an outer "coating" over most of the nodule for in the centre of the nodule is a kyanite eclogite zone with irregular boundaries (Plate 14).

GENERAL

In summary the inhomogeneous kyanite eclogites can be considered in terms of a progression from the horizontal layers or cylinders in HRV17 and HRV44 to the slightly upward bulging (against a garnet rich layer) zone in HRV30 to JJG40 in which the kyanite eclogite zone has entirely disrupted layers of overlying ordinary eclogite.

CHEMISTRY OF INHOMOGENEOUS ECLOGITES

1. VARIATION ACROSS BOUNDARY OF KYANITE ECLOGITE ZONE

Probe analyses were carried out across the ordinary eclogite/kyanite eclogite interface in six samples, HRV17, JJG40, JJG177, JJG143, JJG178 and JJG179. The results are essentially similar to those of Chinner and Cornell (1974) and Lappin and Dawson (1975) in showing a marked fluctuation in chemistry at the kyanite eclogite/eclogite interfaces. The data are summarised in Figure 29 in which wt.% of the oxides is plotted against the distance from the interface between the ordinary eclogite and the kyanite eclogite zone.

The following concentrations decrease as one crosses into the kyanite eclogite zone; FeO in gt, FeO in cpx, MgO in gt, MgO in cpx and CaO in cpx. On the other hand Na_2O and Al_2O_3 in cpx and CaO in garnet increase in the kyanite eclogite zone (Figure 29). The changes in concentration indicate that grossular in garnet and jadeite in cpx increase markedly in the kyanite eclogite zone.

The change in concentration occurs across a very narrow interval, some 2 cms wide. CaO in garnet exhibits the most extreme variation; for example in the transition from ordinary eclogite HRV17B to grey cpx-brown garnet in layer HRV17C CaO changes from 8 to 20 wt.% over a 2 cm interval. A similar sudden change is noticeable in other components and in the other rocks.

Clinopyroxene compositions in the pervasively altered grey turbid zone are variable. K_2O and SiO_2 in certain analyses suggests that secondary feldspar may have formed. Notwithstanding the possibility that many clinopyroxenes in the kyanite eclogite zone are secondary the Al_2O_3 content of clinopyroxenes thought to be primary is high; 16 wt.% in JJG40 and 23 wt.% in JJG177.

2. VARIATION ACROSS THE LAYERS

Lappin and Dawson (1975) in their examination of a nodule in which the kyanite eclogite zone was preserved only at the edge of the nodule, noted that concentrations of elements in the kyanite eclogite zone at the edge of the nodule appeared to approach again those levels in the ordinary eclogite, as the edge of the nodule distant from the

preserved ordinary eclogite unit was approached. They suggested that the nodule may have broken along a discontinuity. The present study of HRV17 illustrates a completed traverse and illustrates that the discontinuity alluded to by Lappin and Dawson is that between kyanite eclogite and a second layer of surrounding ordinary eclogite. The compositions of minerals in ordinary eclogite on either side of the kyanite eclogite zone are identical in HRV17. Thus the kyanite eclogite zone represents only a local heterogeneity surrounded on all sides by ordinary eclogite.

3. ZONING IN THE GARNETS

Garnets in the ordinary eclogite portion of HRV17 are zoned, and have Ca rich, MgO, FeO poor edges. This feature is observed in HRV17A and HRV17B, on either side of the eclogite zone (See Table 2). The change in concentration between centre and edge is statistically significant (See Table 2). In JJG40 two garnets in ordinary eclogite have CaO poor and MgO rich edges. FeO remains constant. This pattern is the reverse of HRV17.

4. WHOLE ROCK CHEMISTRY

The four portions of HRV17, that is ordinary eclogite A, kyanite eclogite unit D, grey cpx-brown garnet unit C, and ordinary eclogite B were separated by slabbing with a diamond saw, and analysed by XRF (Table 6).

The chemistry of the ordinary eclogite units A and B confirms what was indicated by the mineral analyses; that the two portions are chemically the same.

The grey cpx-brown garnet unit C affords an interesting comparison for kyanite is absent from this unit, and changes in bulk chemisty, between this portion and units A and B arise only from the changes in the mineral chemistry of garnet and clinopyroxene. Similarity of SiO_2 contents in A, B and C indicates that modal variations are small. In the zone represented by HRV17C Al_2O_3, Na_2O and CaO and SiO_2 are higher, and FeO and MgO are lower than in the ordinary eclogite. Significant variations in minor and trace

element concentrations can be noted for MnO, Zr, Y, Co, Cr and V which are lower, and Sr which is higher in 17C than in ordinary eclogite.

The kyanite eclogite unit HRV17D shows the same general relationships to ordinary eclogite, as HRV17C, possessing higher Na_2O, Al_2O_3, CaO, SiO_2 and Sr and lower FeO, MnO, MgO, P_2O_5, Zr, Y, Co, Cr and V than the ordinary eclogite. Compared to the grey cpx-brown garnet unit HRV17C, kyanite eclogite unit HRV17D has higher Al_2O_3 and Na_2O but has lower concentrations of TiO_2, FeO, MnO, MgO, CaO, P_2O_5, Zr, Y, Sr, Zn, Co, Cr and V. The trace element concentrations are interpreted in the following section as evidence that the kyanite eclogite zone formed by a process of liquid immiscibility.

ORIGIN OF INHOMOGENEOUS KYANITE ECLOGITES

1. REACTION OF FOREIGN KYANITE ECLOGITE XENOLITH WITH KIMBERLITE

Chinner and Cornell (1974) proposed that kyanite eclogite nodules were accidental xenoliths which were included by, and which reacted with kimberlite. The more abundant biminerallic eclogites were thought to be cognate xenoliths from kimberlite. The inhomogeneity between eclogite and kyanite eclogite could then represent reaction of accidental kyanite eclogite with kimberlite to produce the overgrowth of ordinary eclogite.

The configurations of inhomogeneous kyanite eclogites (especially HRV30) studied by the writer cannot be considered to be compatible with such an origin, nor is the postulate that biminerallic eclogite is a cognate xenolith in kimberlite tenable in the light of recent isotope work which suggests that the eclogites are of a considerably older age than the Roberts Victor kimberlite (Lovering and Richards, 1964; Manton and Tatsumoto, 1971; Allsopp and Barrett, 1975; Davis, 1977; Kramers, 1977).

2. KYANITE ECLOGITE AS CUMULATE, MODIFIED BY TECTONIC PROCESSES

Lappin and Dawson (1975) suggested that imhomogeneous kyanite eclogite BD6913 (Figure 3, Dawson, 1968) initially formed by

sequential precipitation of cpx and minor garnet,
cpx and minor kyanite and
cpx, kyanite and garnet.

After crystallisation, the rock developed compositional variations in a higher pressure regime to which it was transported by tectonic processes. The compositional variations were thought to arise by reaction of a high temperature clinopyroxene to produce a more sodic cpx and calcium rich garnet. It was argued that the reaction was promoted by an increase of pressure, but it is at least equally likely that exsolution during cooling of a clinopyroxene megacryst would produce minerals of similar composition.

3. RECRYSTALLISATION OF COARSER GRAINED CLINOPYROXENE RICH ECLOGITE

Cox et al.(1975) proposed that the kyanite eclogite might have formed by tectonic mixing and reaction of coarser grained clinopyroxene and garnet with some other phase such as coesite, corundum or kyanite itself.

Reactions between any of stoichiometric clinopyroxene, garnet and corundum cannot produce kyanite for all these phases have metal/oxygen ratios of 2/3 and cannot give rise to a phase which has a different metal/oxygen ratio (kyanite has 3 metal/5 oxygen). The existence of non-stoichiometric clinopyroxenes has been long supposed (Eskola, 1928; Cawthorn and Collerson, 1974), and recent studies indicated the presence of $Ca_{0.5}AlSi_2O_6$, the pseudojadeite molecule of Eskola (1928), in Roberts Victor kyanite eclogites (Smyth, 1977b), and in synthetic clinopyroxenes (Wood, 1977b).

It is possible to write a reaction for the exsolution of grossular and kyanite from a clinopyroxene with high contents of pseudojadeite and Ca Tschermak's molecule:

$$4Ca_{0.5}AlSi_2O_6 + 7CaAl_2SiO_6 = 3Ca_3Al_2Si_3O_{12} + 6Al_2SiO_5$$

$$4Psjd + 7CaTs = 3Gross + 6\ Kyanite$$

Kyanite appears to dissolve in clinopyroxene on heating of kyanite eclogite (O'Hara and Yoder, 1967), and hand specimen examination of a kyanite eclogite from the Bellsbank mine indicates that kyanite

has exsolved from clinopyroxene. Yet, although it is proposed that kyanite may in some cases be a subsolidus phase, the configuration of the kyanite eclogite zones examined here does not support a subsolidus origin. The curved surface of the kyanite eclogite zone in HRV30, and the suggestion that the kyanite eclogite zone has disrupted a garnet rich layer in JJG40, indicate that the kyanite eclogite zone was in a fluid state while ordinary eclogite was semi-consolidated. These features indicate that the kyanite eclogite zone may be the crystallised product of a late stage liquid.

4. FILTER PRESSING OF RESIDUAL LIQUID

An attractive and simple hypothesis is that the kyanite eclogite zone results from filter pressing of intercumulus liquid trapped in a crystal pile of biminerallic eclogite. Compaction of the crystal pile might cause the intercumulus liquid to progressively coalesce into ever larger droplets which may attain sufficient volume to eventually disrupt portions of the semi-consolidated crystal pile.

The kyanite eclogite zone would then represent the residual liquid, or the primary liquid from which nearby biminerallic eclogite originally precipitated, and those trace elements with higher concentrations in the kyanite eclogite zone would have distribution coefficients, D crystals/liquid of less than 1, while those elements with lower concentrations in kyanite eclogite than in surrounding biminerallic eclogite would have distribution coefficients greater than 1. For HRV17 D_{Sr} is therefore less than 1, but D_{Zr}, D_{V}, D_{Co} and D_{V} must be greater than 1. D_{Co} may indeed be greater than 1, but while it is conceivable that Y is so strongly partitioned into garnet that the bulk distribution coefficient is greater than 1, it is contrary to the known properties of Zr crystal/liquid distribution that the quadrivalent ion be more strongly partitioned into clinopyroxene and garnet than into the liquid.

On the basis of the required but unlikely bulk distribution coefficients of Zr and V between eclogite and liquid in HRV17 it is considered that the kyanite eclogite zone does not represent the residual liquid from which biminerallic eclogite precipitated.

5. SEPARATION OF IMMISCIBLE LIQUID

The geometry of inhomogeneous kyanite eclogites suggest that the kyanite eclogite zone was a liquid surrounded by semiconsolidated biminerallic eclogite, but the behaviour of Zr and V suggests that it was not a residual liquid. The hypothesis that the kyanite eclogite zone formed by separation of an immiscible liquid will be discussed.

There is a distinct difference between the size ranges of the cations concentrated in the kyanite eclogite zone and in the biminerallic eclogite. The ionic radii (after Whittaker and Muntus, 1970) of cations concentrated in the kyanite eclogite zone, Na, Ca and Sr, are greater than 1Å while cations concentrated in biminerallic eclogite, Fe, Mn, Mg, Zr, Y, Co and V are less than 1Å. The difference in sizes is related to the co-ordination requirements of the cations. Large cations tend to occur in eight-fold and higher concentrations while the smaller cations prefer six-fold co-ordinate sites.

The short range order of silicate liquids is similar to crystalline phases (Waff, 1975), thus an analogy between the olivine and clinopyroxene structure, and liquids enriched in SiO_4^{4-} and in SiO_3^{2-} can be drawn. Liquids with SiO_4^{4-} have only octahedral sites, while liquids rich in SiO_3^{2-} ions have both six-fold and eight-fold sites.

The driving force behind liquid immiscibility, if it occurs, in the inhomogeneous kyanite eclogites is thought to be the shortage of eight fold sites available in the liquid coexisting with biminerallic eclogite. The mechanism by which numbers of eight-fold co-ordinate sites are made available is suggested to be the transfer of Al from octahedral to tetrahedral co-ordination. A sharp contrast between the model proposed here, and observations on liquid immiscibility at low pressure (e.g. Levin, 1966) is that at atmospheric pressure the immiscible liquid is formed by local high concentrations of SiO_2 while Al_2O_3 in the two liquids is <u>similar</u>. In the kyanite eclogite zones, wt.% SiO_2 is equal to, or lower than in the biminerallic eclogite, while Al_2O_3 is <u>higher</u> in the kyanite eclogite. The reason for this contrast could be the effect of pressure on co-ordination of Al.

At atmospheric pressure Al can exist as a network modifier in octahedral co-ordination or as a network former in tetrahedral co-ordination. In a liquid with a high abundance of large cations there will be a tendancy for Al to occur as a network former in order to increase the polymerisation (SiO_3^{2-}/SiO_4^{4-}) of the liquid, hence providing a larger number of high co-ordination sites. Conversely where the number of small cations is high, Al will occur as a network modifier, decreasing the polymerisation of the liquid and increasing the availability of octahedral sites. As an example the solution of grossular, containing the large cation, Ca^{2+}, and of pyrope, which contains the small cation, Mg^{2+}, will be considered.

In order to increase the number of octahedral sites pyrope will tend to dissolve with Al occurring as a network modifier:

$$Mg_3Al_2Si_3O_{12} = 3Mg^{2+} + 2Al^{3+} + 3SiO_4^{4-}$$

Grossular components will tend to melt by the reaction

$$Ca_3Al_2Si_3O_{12} = 3Ca^{2+} + Al^{3+} + AlO_3^{3-} + 3SiO_3^{2-}$$

in order to supply eight-fold co-ordinate sites in the liquid. The equilibrium by which Al enters into the network is thus

$$Al^{3+} + 3SiO_4^{4-} = AlO_3^{3-} + 3SiO_3^{2-} \quad (\text{or } Al^{3+} + 3SiO_3^{2-} = AlO_3^{3-} + 3SiO_2).$$

At atmospheric pressure the requisite number of eight-fold and six-fold co-ordinate sites can be supplied by appropriate shifts in the equilibrium above. However, at high pressures the O^{2+} anion is compressed relatively more than the cations, so that the cation size appropriate to a specific co-ordination site is decreased (Waff, 1975). As a result Al becomes too large for tetrahedral co-ordination, and higher energies are required to stabilise Al in tetrahedral co-ordination. It is argued that the destabilisation of tetrahedrally co-ordinated Al by high pressure can be overcome by local, high concentrations of octrahedrally co-ordinated Al. There is an equilibrium between the amounts of Al in tetrahedral and in octahedral co-ordination so that local high concentrations of octahedrally co-ordinated Al will also increase the concentration of tetrahedrally co-ordinated Al, and so oppose the effect of pressure.

An immiscible liquid is formed when the concentrations of large cations Na and Ca are larger than the number of available eight-fold sites. By building up high local concentrations of Al, the concentration of tetrahedrally co-ordinated Al increases, and a more polymerised, immiscible liquid with higher abundances of eight-fold co-ordinate sites is formed. Since this liquid contains high concentrations of the low melting end members jadeite and grossular, the crystallisation temperature of this liquid is lower than the surrounding liquid. Thus while pyropic garnet and diopsidic clinopyroxene crystallise from surrounding liquid, the Al-rich liquid remains fluid, and may become trapped by settling crystals while still in the liquid state. The textures observed in the inhomogeneous kyanite eclogites are entirely consistent with the hypothesis outlined above.

"TYPE II" INHOMOGENEOUS KYANITE ECLOGITES HRV18 AND HRV116

The rocks HRV18 and HRV116 are readily distinguished by the unusually small grain size which is usually 1.5 mm and the rocks have been classified as fine-grained kyanite corundum eclogites (See Chapter V). In the configuration of the kyanite eclogite zone these rocks are similar to the type I inhomogeneous kyanite eclogites in that the kyanite eclogite zone is entirely surrounded by biminerallic eclogite. However, HRV18 and HRV116 differ from the type I inhomogeneous kyanite eclogites in the chemistry of the biminerallic eclogite unit, as Na_2O, Al_2O_3 and FeO in the biminerallic eclogite are lower in HRV18 and HRV116 than in the biminerallic eclogite portion of the type I inhomogeneous kyanite eclogites. This difference suggests that the magmas from which HRV18 and HRV116 were derived were more primitive than the type I magma.

HRV18 and HRV116 illustrate that the variation in composition away from the kyanite eclogite zone is observed parallel, as well as perpendicular to the layering. A slide from HRV116 was cut parallel to the layering, and the pattern of compositional variation (Figure 30) is essentially identical to that of the type I inhomogeneous kyanite eclogites. In the slide prepared from HRV18, cut perpendicular to

layering, the kyanite eclogite zone dies out horizontally. Garnet analysis GT101 was taken from garnet in the biminerallic eclogite zone, on the same horizontal level. The change in composition between GT101 and garnet in the kyanite eclogite zone is of a similar magnitude to the vertical variation in composition away from the kyanite eclogite zone in HRV18.

In biminerallic eclogite in the fine-grained kyanite eclogites garnet and clinopyroxene have irregular, interlocking margins, and the general texture is not suggestive of a cumulate origin (See Plate 1o,r). The rock may have formed by crystallisation of a liquid with little crystal settling. However the kyanite eclogite zone is thought to have originated by the same process which produced the type I kyanite eclogite zones within the type I homogeneous kyanite eclogites; by liquid immiscibility during cooling of the magma. If HRV18 and HRV16 represent crystallised liquids rather than cumulates, the immiscible liquid would be trapped in situ, and is not necessary to assume that the immiscible liquid was trapped by descending garnet and clinopyroxene crystals, as in the type I inhomogeneous kyanite eclogites.

VIII INHOMOGENEITIES IN ECLOGITES

III COMPOSITIONAL VARIATIONS IN CHROME-RICH ECLOGITES

INTRODUCTION

In the previous two chapters local inhomogeneities manifested by the presence of a kyanite eclogite zone or of a clinopyroxene megacryst, have been discussed. Variation in composition may also be expressed by compositional changes across the layers of a rock. In this chapter chrome-rich eclogites, related either to the type II garnet websterites or to the type II magnesian eclogites are considered.

Chrome-rich eclogites are commonly inhomogeneous; of seven chrome-rich eclogites examined in detail, only one (JJG307) was found to be homogeneous, the rest show some degree of inhomogeneity. Cr_2O_3 alone may vary, but usually concentrations of other elements vary together with Cr_2O_3.

In this chapter the inhomogeneous chrome-rich eclogites are considered. Two other eclogites in which cryptic layering is present within the nodule, diamond-graphite bearing eclogite (HRV247) and graphite bearing eclogite (HRV309) are considered in the chapter dealing with the presence of diamond in the Robert Victor xenoliths. These rocks are chrome-poor and variation in chrome content are not discernible.

The rocks are subdivided on the basis of textural features, and considered in the following order:

HRV173 consists of two thick (<10 cm) garnet-rich and clinopyroxene rich layers (Plate 1f,o).

HRV132 has alternating 1 cm thick layers of garnet and clinopyroxene.

JJG183 is too small to discern whether layering is present. However, the texture is similar to HRV132 (Plate 1h).

Grains in the above rocks are rounded and equigranular, and may be thought to represent cumulates.

HRV243 has straight edged, but generally rounded grains. The rock cannot be definitely described as a cumulate, but the fact that the

grains are not elongate distinguishes this rock from eclogites with the type II texture of MacGregor and Carter (1970) (Plate 1k).

HRV15 possesses the typical type II texture of straight edged, elongate grains. The type II texture is thought to indicate crystallisation of a liquid (MacGregor and Carter, 1970) (Plate 1p, q).

HRV310 is a carbonated and silicified nodule with a 1 - 2 cm layer of micaceous eclogite at one edge. The rock is thought to have originally consisted of garnet lherzolite and eclogite in contact, and affords a connecting link between peridotites and eclogites (Plate 15).

HRV180 contains rounded grains of garnet and cpx, and irregular grains of orthoamphibole, thought to be an alteration product of orthopyroxene. This rock is distinguished by the extreme change in composition across the 2 cm thin section. The compositional variation is thought to represent a quenched diffusion gradient.

The rocks above may represent: cumulates, (HRV173, HRV132, JJG183); quenched liquids, (HRV15, JJG520); a liquid extract and residuum (HRV310); and there is an unclassified rock which preserves a very steep concentration gradient (HRV180). None of these rocks can be classified as type I eclogites.

Analyses of rocks described in this chapter are presented in Table 4 (mineral compositions) and Table 6 (whole rock compositions).

HRV173

DESCRIPTION OF THE NODULE

The nodule consists of separate garnet-rich and clinopyroxene-rich layers. The clinopyroxene is noticeably greener in the garnet-rich layer suggesting a higher chrome content, confirmed by probe analysis, in the garnet-rich portion. The distinctive layering present appears to be the result of cumulate processes, and for this reason and because the garnets are equigranular it is likely that subsolidus processes played little part in the creation of the present mineral compositions.

Grains are rounded, but the equigranular texture, red garnets and fresh apple green clinopyroxene readily distinguish this rock from type I eclogites.

Slide HRV173A was cut from the garnet-rich portion and HRV173B from the clinopyroxene-rich portion.

MICROPROBE ANALYSES

Wt.% of oxides in garnet and cpx are plotted against distance perpendicular to layering in Figure 31. Cr_2O_3 in garnet increases regularly from .6 wt.% in the cpx-rich portion to 1.7 wt.% in the garnet-rich portion. Cr_2O_3 in cpx increases together with Cr_2O_3 in garnet, but the pattern of variation of other oxides is obscured by the presence of zoning.

Zoning is present, but was not observed in every grain, certain grains showing no difference between core and rim compositions. However the apparent absence of zoning in a zoned garnet grain might be caused by analysis of a section which cut through the edge of a garnet grain, rather than through the centre. The following elements showed variations greater than the 6 range calculated from counting statistics. Garnet 5 has a CaO poor rim. CaO poor and Al_2O_3, FeO, MgO rich rims are present in cpx 4. Cpx 2 has a CaO poor, and Cr_2O_3 rich rim.

Taking regard of the zoning, overall variations in concentrations of the oxides across the rock can be discerned. As Cr_2O_3 in garnet increases Cr_2O_3 and Na_2O in cpx increase, while FeO in garnet and FeO, Al_2O_3 and CaO in clinopyroxene decrease.

WHOLE ROCK ANALYSES

Portions of the garnet-rich and of the cpx-rich layers were separated and prepared for whole rock analysis.

The major element concentrations reflect the relative model abundances of garnet and cpx in the two layers. Cr_2O_3 is distinctly higher in the garnet-rich layer. Higher TiO_2 in the garnet-rich layer illustrates that TiO_2 is preferentially partitioned into garnet in this rock.

Of the trace elements the higher concentrations of Rb in the garnet-rich layer is unexpected, for Rb should be preferentially partitioned into clinopyroxene. The higher Rb concentrations

probably arise from a higher concentration of secondary mica in the garnet-rich layer. Rb concentration in the eclogite would in this case be dependent on the degree of alteration of the eclogite rather than the concentration of Rb in the primary minerals garnet and cpx. The relatively high levels of Rb (24 and 21 ppm) present in HRV173 are compatible with a dominantly secondary source for Rb.

HRV132

DESCRIPTION OF THE NODULE

Layering is defined by alternate garnet and cpx layers. Cpx is a very bright green throughout, suggestive of a high chrome content, while the garnets are a dark red. The grains are rounded to irregular and have a mean grain size of 5 mm.

Phlogopite is present and may be of primary origin.

MICROPROBE ANALYSES

Two slides HRV132A and HRV132B, from opposite edges of the nodule were prepared. The slides polished badly due to plucking of mica and the resultant analyses are of poor quality. However, for the purposes of comparison of analyses from the same rock, carried out during the same session, the data have some use. Imprecision of the data is most notable for SiO_2. There does not appear to be a consistent change in comparison across the rock for the range in composition of a single grain may be as great as that of the entire nodule. An unusual feature in a rock of variable composition is the relative constancy of Cr_2O_3 content within single grains of cpx (Figure 32).

A garnet in HRV132A has Cr_2O_3 and MgO rich edges. FeO is slightly richer at the edges but the variation is within the 6 range. In HRV132B a garnet has an MgO, FeO rich but Cr_2O_3 poor edge. Clinopyroxenes in HRV132A and HRV132B show distinctly opposite patterns. In HRV132A the edges are Na_2O, Al_2O_3 rich and CaO, MgO, FeO poor while in HRV132B edges are Na_2O, Al_2O_3 poor and CaO, MgO, FeO rich (Figure 32).

JJG183

DESCRIPTION OF THE NODULE

The nodule is similar in general appearance to HRV132, with bright green cpx and rounded garnet. Relict "orthopyroxene" is present.

MICROPROBE ANALYSES

The centre and two edges of a large garnet, and the centre and edge of two adjacent clinopyroxenes were analysed (Figure 33). The edges of the garnet are Cr_2O_3, CaO rich and FeO, MgO poor. Cr_2O_3 in one cpx is slightly higher at the edge, but is lower at the edge of the other cpx. Both clinopyroxenes have CaO, MgO, FeO rich and Na_2O, Al_2O_3 poor edges.

HRV243

DESCRIPTION OF THE SAMPLE

The nodule is discoidal but has fractured along a layer containing bright green (chrome-rich) cpx, garnet and small relict crystals of orthopyroxene. Crystals in the rock are straight edged, but are rounded rather than elongate. The bright green clinopyroxene is present only in a 1 cm thick band at the fractured edge of the nodule. In thin section very small grains (.05 mm) of unaltered orthopyroxene can be observed in the interstitial material. The presence of larger crystals of relict orthopyroxene, visible in hand specimen on the fractured edge, suggest that the interstitial orthopyroxene is a primary mineral, but on the other hand the association with minerals of undoubtedly secondary origin, such as plagioclase, indicate that the small grains of orthopyroxene may be secondary.

MICROPROBE ANALYSES

A slide was cut from the bright green clinopyroxene bearing band into the nodule. Analyses are presented graphically in Figure 34.

Cr_2O_3 in garnet increases from .25 wt.% to 1.2 wt.% at the fractured edge of the nodule. MgO in garnet and MgO and Cr_2O_3 in cpx increase with increasing Cr_2O_3 while FeO in gt and FeO and Al_2O_3 in cpx decrease.

WHOLE ROCK ANALYSES

The 1 cm bright green cpx bearing band at the edge of the nodule, (HRV243CR), eclogite near to this band (HRV243M) and eclogite from the centre of the nodule were separated and analysed.

Major element analyses indicate a high modal portion of garnet in HRV243CR, high modal cpx in HRV243M and roughly equal amounts of garnet and cpx in HRV243OE. The trace element abundances are in accord with the modal abundances, although Ni is unusually low in HRV243CR. Low Cu in HRV243CR may reflect the absence of sulphides in this portion.

HRV15

DESCRIPTION OF THE SAMPLE

The nodule has an unusually rectangular outline with very distinct edges and perpendicular faces (Plate 7). The original shape of the nodule must have been produced by joint patterns intersecting at very nearly right angles. Distinct layering is parallel to a face of the nodule suggesting that one set of jointing was parallel to the plane of layering. One side of the nodule is defined by a layer of chrome-rich clinopyroxene and garnet. This face has not been smoothed by erosion in the kimberlite, and the nodule must have broken along this layer at a late stage of kimberlite emplacement, or during mining operations.

Spinel grains in the centre of garnet grains are present in a layer 2 cm from that face of the nodule, opposite to the chrome-rich layer.

The grains are elongate, and the overall texture (type II of MacGregor and Carter, 1970), is not suggestive of a cumulate origin. MacGregor and Carter (1970) considered that the type II texture formed by direct crystallisation of liquids.

MICROPROBE ANALYSES

Slide HRV15A was cut from the edge of the nodule, perpendicular to the layering to include the spinel bearing layer. Slide HRV15B was cut from the opposite, chrome-rich edge into the nodule.

Analyses are presented in graphical form in a plot of wt.% vs distance perpendicular to layering in Figure 35 Cr_2O_3 in garnet increases from .13 wt.% in the spinel bearing portion HRV15A, to .83 wt.% at the fractured chrome-rich edge of the nodule. FeO and MgO increase and CaO in garnet decreases as Cr_2O_3 in garnet increases.

Clinopyroxenes show two patterns of variation, from the edge of the nodule to the spinel bearing zone, then from the spinel bearing zone to the chrome-rich edge of the nodule. From the edge of the nodule to the spinel bearing zone Cr_2O_3, Na_2O and Al_2O_3 increase, while CaO, MgO and FeO decrease. From the spinel bearing zone to the chrome-rich edge Cr_2O_3, FeO and MgO increase, while Na_2O and Al_2O_3 decrease. CaO initially increases but decreases again close to the chrome-rich edge of the nodule. Na_2O and Al_2O_3 show a slight increase while MgO decreases slightly with CaO in the last ½ cm at the chrome-rich edge of the nodule. An unusual feature is that those clinopyroxenes between the edge of the nodule and spinel bearing zone have high concentrations of the Ca Tschermak end member. The presence of Ca Tschermak's molecule may be related to the precipitation of spinel in this portion of the nodule. Away from the spinel bearing zone the concentrations of Ca Tschermak's molecule are at low levels. The possible presence of primary spinel in RV372 (Williams, 1932) and the high CaTs content of clinopyroxene in this rock, suggests that it may be related to HRV15.

HRV310

DESCRIPTION OF THE SAMPLE

The nodule has the rounded discoidal shape common to many Roberts Victor xenoliths. The bulk of the sample consists of secondary calcite and quartz, with the sporadic presence of garnet grains and a few cpx grains visible only in this section. The parallel outline of an elongate

zone of contiguous garnet grains produces a foliation within the nodule. On the one edge of the nodule, parallel to this foliation there is preserved a one to two cm thick layer of garnet, clinopyroxene and minor mica which may be of primary origin (Plate 15).

The primary material of which the bulk of the nodule was originally comprised is thought to be olivine and orthopyroxene. In the next chapter, which deals with the Roberts Victor peridotites, reasons will be given for supposing that olivine is altered to quartz and orthopyroxene to calcite during a metasomatic event, while garnet and cpx remain unaltered. The nodule is therefore thought to have consisted dominantly of garnet lherzolite (with very minor cpx) and a minor layer of eclogite before the lherzolite was altered. The original thickness of the two components is not known, so it does not necessarily follow that the eclogite layer should have been thinner than the "garnet lherzolite" layer, although from the origin suggested for this rock it is likely that this was the case.

Garnets in the "garnet lherzolite" layer are generally small (2 mm) and irregular, but larger (4 mm) rectangular shaped garnets are also present. In the eclogite layer the garnets are large, rounded and equigranular. Clinopyroxene grains in the "garnet lherzolite" are extremely small (.1 mm) and very scarce; only one grain is present in two thin sections. In the eclogite clinopyroxene occurs as large rounded grains, and as small grains in the interstices of garnet grains. Mica has a tabular habit and may be primary.

Garnet is more abundant in "garnet lherzolite" close to eclogite than in "garnet lherzolite" at the edge of the nodule opposite to the eclogite, where garnet is virtually absent in hand specimen.

MICROPROBE ANALYSES

Three slides, HRV310C of the eclogite layer, HRV310B of adjacent "garnet lherzolite" and HRV310A of distant "garnet lherzolite", were prepared. The results of probe analyses are presented graphically in Figure 36. Clinopyroxenes in the eclogite and in "garnet lherzolite" have rather similar compositions, but Cr_2O_3 in the eclogite is distinctly lower. CaO and MgO are slightly lower, while Na_2O, Al_2O_3 and FeO are

slightly higher in the eclogite than in the "garnet lherzolite".

The garnets show an irregular pattern. From the distant "garnet lherzolite" adjacent to the eclogite itself, Cr_2O_3, CaO and MgO increase while FeO decreases. Comparison of garnet in the "garnet lherzolite" adjacent to the eclogite with garnet in the eclogite itself shows that Cr_2O_3 and CaO decrease while FeO increases. MgO remains constant.

HRV180

DESCRIPTION OF THE SAMPLE

The nodule is altered and is very friable in hand specimen. Clinopyroxene and garnet are relatively fresh, but ortho-amphibole present is thought to be formed by complete alteration of orthopyroxene. Irregular to rounded garnet grains of 2 mm grain size constitute the bulk of the sample. Clinopyroxene grains have a similar size and shape, although certain clinopyroxene grains in the interstices of garnet grains are elongate and may have crystallised after garnet. Seven grains of ortho-amphibole, which has been extensively plucked during polishing are present in the 2 cm square slide and have very irregular grain boundaries. Calcite, possibly associated with alteration of orthopyroxene is present (See Figure 9).

Although the compositional variation outlined below follows a regular pattern, layering could not be discerned in hand specimen or in thin section.

MICROPROBE ANALYSES

The results of microprobe analyses are illustrated in Figure 37 in plots of wt.% against distance. Cr_2O_3 in garnet shows an extreme variation in concentration from 1.4 wt.% at the left edge of the slide to 7.4 wt.% at the right edge. As Cr_2O_3 in garnet increases CaO and FeO in garnet, and Na_2O and Cr_2O_3 in cpx also increases. FeO in cpx follows an erratic trend but shows an overall increase. MgO in garnet and MgO and CaO in cpx decrease as Cr_2O_3 in garnet increases. Al_2O_3 in cpx remains surprisingly constant.

Individual garnets do not show radial zoning but rather follow the overall trend of compositional variation across the rock so that as one traverses from the left, Cr-poor (relatively) to the right, Cr-rich edge of the slide the left edge of a garnet is Cr-poor, the centre has intermediate values, and the right edge is Cr-rich. The same pattern is observed for the other elements in garnet.

DISCUSSION

The compositional variations outlined in this chapter are tabulated in Table 11 where the concentrations of oxides in the most chrome-rich garnet or clinopyroxene, relative to the most chrome-poor mineral, garnet or clinopyroxene are expressed. For zoned minerals the concentration of the core relative to the rim is noted. The largest variation in Cr_2O_3 is present in HRV310 where chrome in garnet in the "garnet lherzolite" is 12 times that of the eclogite.

The patterns of variation displayed are unique for each rock, in that no two rocks show the same pattern of increase or decrease for each specific element. Thus in HRV243 and HRV15 CaO in garnet decreases as Cr_2O_3 in garnet increases, but whereas FeO in garnet in HRV243 decreases with chrome, FeO in garnet in HRV15 increases. These differences in the patterns of variation of the rocks suggest that the inhomogeneities are derived by different processes.
Of the possible processes whereby an inhomogeneous rock might be produced, the following are considered here:

i) changes in the liquid structure during crystallisation;

ii) localised partial melting;

iii) preservation of a diffusion gradient between two bodies of markedly different composition. This last hypothesis may be related to the other two.

1. THE LIQUID STRUCTURE

The structure of the liquid exerts a fundamental control on the composition of minerals crystallising from it. Studies of silicate liquids have shown them to consist of relatively immobile network

formers and relatively mobile network modifiers (Levin, 1967; Bottinga and Weill, 1972). The basic structural units from which the the network of a silicate melt is built up are ^{04}Si, ^{13}Si, ^{22}Si, ^{31}Si and ^{40}Si (Fraser, 1977) or respectively SiO_2, SiO_5^{2-}, SiO_3^{2-}, SiO_7^{6-} and SiO_4^{4-}. In the notation of Fraser, ^{ij}Si, i is the number of unshared, or singly bound oxygens, and j is the number of shared, or bridging oxygens. Aluminium may also occur in tetrahedral co-ordination to produce the anions ^{04}Al, ^{13}Al, ^{22}Al, ^{31}Al and ^{40}Al which have different charges to the silicon analogues; AlO_2^{3-}, $Al_2O_5^{4-}$, AlO_2^{-}, AlO_3^{3-}, $Al_2O_7^{8-}$ and AlO_4^{5-}. Titanium and phosphorus are other elements which can also occur in tetrahedral co-ordination and so contribute to formation of the network. Silicon and phosphorus are very small ions and always occur in tetrahedral co-ordination, but aluminium and titanium can also occur in higher co-ordination. Such ions are termed homogenisers (Levin, 1967).

The other common major elements, Cr, Fe, Mn, Mg, Ca, Na and K occur in octahedral or higher co-ordination, and in a silicate melt they are always present as network modifiers.

In a silicate melt an equilibrium will control the relative concentrations of the network formers SiO_4^{4-}, SiO_3^{2-} and SiO_2. This equilibrium will be controlled by the prevailing P, T and X, where X represents the bulk composition. Changes in any of these parameters may affect the relative concentrations of network modifiers.

The effect of pressure is illustrated by the melting of enstatite which can be represented by the series of equilibria.

$$2MgSiO_{3(En)} = (2Mg^{2+} + 2SiO_3^{2-})_{(liq)}$$

$$= (2Mg^{2+} + SiO_4^{4-} + SiO_2)_{(liq)} = Mg_2SiO_{4(Fo)} + SiO_{2(liq)}$$

At atmospheric pressure enstatite melts incongruently to forsterite and liquid (Bowen, 1928), thus the equilibrium proceeds to the far right. However, at five kilobars enstatite melts congruently (Boyd et al., 1964) and the equilibrium does not reach the far right. For the simplified equilibrium reactions

$$2SiO_3^{2-} = SiO_4^{4-} + SiO_2 \quad \text{or}$$

$$2O^- = O^{2-} + O^0,$$

pressure shifts equilibrium to the left.

The equilibrium between SiO_2, SiO_3^{2-} and SiO_4^{4-} is also affected by the volatile components H_2O and CO_2.

Addition of H_2O depolymerises the liquid by the reaction

$$SiO_{2(liq)} + H_2O = SiO(OH)_2 = SiO_3^{2-} + 2H^+$$

and

$$SiO_3^{2-} + H_2O = SiO_2(OH)_2^{2-} = SiO_4^{4-} + 2H^+$$

Similar effects are produced by addition of other oxides (K_2O, Na_2O, CaO) which dissociate to provide oxygen anions for the network forming anions (Kushiro, 1975).

CO_2 increases the degree of polymerisation of the liquid by the reactions

$$SiO_4^{4-} + CO_2 = SiO_3^{2-} + CO_3^{2-}$$

and

$$SiO_3^{2-} + CO_2 = SiO_2 + CO_3$$

Thus H_2O acts as a base in providing oxygen anions, while CO_2 acts as an acid in removing oxygen anions from the silicate network (Fraser, 1977; Kushiro, 1975).

The degree of polymerisation of the liquid affects the numbers of six and eight-fold co-ordinate sites which are available in the liquid (Ridley, 1977). By analogy between melt structure and the crystal structures of olivine, clinopyroxene and feldspar, an analogy based on the similarity of short range order of silicate melts and crystalline structures (Waff, 1975), high SiO_4^{4-} concentrations imply an abundance of octahedral sites as in olivine, high SiO_3^{2-} concentrations decrease the number of available octahedral sites and increase the number of available eight-fold co-ordinate sites, as in clinopyroxene, and high $SiO_2(^{04}Si)$ (or high AlO_2^-) concentrations

provide no octahedral sites as in feldspars. Thus a decrease in the degree of polymerisation by addition of H_2O will increase SiO_4^{4-} relative to SiO_3^{2-} and so increase the number of available octahedral sites. Similarly if H_2O is exsolved from a liquid, the liquid will become more polymerised and the number of octahedral sites will decrease.

The variation in chrome content of a cumulate can be related to the role of volatiles in changing the number of available octahedral sites in the liquid. Chromium has a strong preference for the octahedral site (Burns, 1970) and should the number of octahedral sites in the liquid decrease, chromium will be strongly partitioned into octahedral sites in the crystal phases.

The presence of volatiles during the crystallisation of the Roberts Victor eclogites is suggested by

i) the presence of megacrysts (Chapter VI),

ii) the presence of graphite and diamond suggestive of the prior existence of CO_2 (Chapter X),

iii) the presence of calcite (Chapter IV),

iv) the possible presence of primary mica (ChapterIV) and

v) the presence of compositions (i.e. homogeneous kyanite eclogites) on the silica rich side of the eclogite thermal divide, suggesting that partial melting of garnet lherzolite occurred under water rich conditions (Kushiro and Yoder, 1974) to allow the eclogite thermal divide (O'Hara and Yoder, 1967) to be transgressed (Chapter V).

It is proposed that eclogites HRV173, HRV132 and JJG183 with cumulate textures formed by crystallisation from a volatile rich melt, and that the concentrations of volatiles varied during crystallisation, so producing the variable chrome contents in the cumulates. Variation in volatile content may be the result of exsolution of a volatile rich fluid phase, or crystallisation of phlogopite and carbonates.

2. PARTIAL MELTING

The composition of the liquid produced by partial melting of garnet lherzolite changes as the degree of partial melting increases. The first formed liquids have lower Mg/Fe ratios and are enriched in the less refractory elements, relative to later liquids (Mysen and Kushiro, 1976).

The degree of melting necessary before the interstitial melt is able to coalesce and separate appears to be rather low; for example nephelinite is thought to represent a 1% partial melt (Ringwood, 1975). In the model considered here, based largely on the inferred origin of nodule HRV310, partial melts are considered to have moved a matter of centimetres from the source area, and the degree of melting necessary to allow migration of the interstitial melt over this small interval is therefore considered to be small.

It is proposed that access of water and other volatiles to garnet lherzolite heated to temperatures below the dry solidus will induce partial melting. The effect of water on lowering the peridotite solidus has been documented by Kushiro et al., (1968). Garnet lherzolites may have been heated by intrusion of the magma from which the type I eclogites crystallised (no chrome rich eclogites can be related to the type I eclogites), and the volatiles, too, may have been associated with emplacement of the type I magma. Access of volatiles is thought to have been by percolation along planes of weakness in the rock, rather than by general diffusion in all directions, so that localised zones in the country rock were melted. The first formed partial melt percolated upward as the residual crystals settled. With continued partial melting more magnesian partial melts were produced and percolated upwards. The inhomogeneous nature of the eclogites leads to the hypothesis that these later more magnesian melts did not mix with earlier melts, but that the successive increments were accreted below earlier melts to produce a compositionally stratified magma. It is likely that if these small volumes of magma migrated any distance from their source the melt would become well mixed, and be homogenised. However, if the melt were to lose volatiles by exsolution or by precipitation of

volatile bearing phases, the stratified melt would be effectively quenched in situ and the inhomogeneities preserved. It is proposed that eclogites HRV15 and HRV243 may have formed by a sequence of events similar to that outlined above. The coarser-grained (5 - 7 mm) eclogites HRV173, HRV132 and JJG183 may have formed by similar processes, but for these rocks the volume of magma produced may have been larger and less rapidly quenched by volatile loss and so allowed cumulate settling to occur.

In the context of the model outlined above the Mg-poor layer should represent the earlier formed liquid. The Mg-rich layer would represent later formed liquids and should possess mineral compositions similar to those of the parent material.

In HRV243 the Mg-poor layer is rich in FeO and Al_2O_3 and poor in Cr_2O_3. The Mg-rich layer has a garnet composition (22% MgO, 7.9% FeO and 3.9% CaO) which is similar to that of garnet lherzolite. Cr_2O_3 is considerably lower, but if garnet remained in the source rock it may be expected that chrome would have been concentrated in this residual garnet rather than the liquid. These features of the rock are consistent with the hypothesis outlined.

In HRV15 the Mg-poor layer is rich in CaO, Na_2O, and Al_2O_3 and poor in Cr_2O_3 and FeO. Low FeO in the MgO-poor layer contrasts with HRV243 in which the MgO-poor layer was high in iron. However, in HRV15 MgO in the Mg-poor layer is considerably lower than in HRV243, and this layer would therefore represent much smaller degrees of partial melting in which different equilibria may have been involved. The cpx in HRV15 is high in Na_2O content. Mysen and Kushiro (1976) showed that the alkalis present in natural garnet lherzolite induced small amounts of partial melting at temperatures well below those at which the rock would melt in their absence. The effect was ascribed to the behaviour of alkalis as depolymerisers (Kushiro 1975; Waff, 1975). The high alkali content of HRV15 is therefore consistent with the suggestion that this rock originated by small degrees of partial melting.

The spinel bearing zone in HRV15 contains a high concentration of Al in tetrahedral co-ordination. The clinopyroxene in this portion of the rock has a high proportion Ca Tschermak's molecule in which

half of the Al is in tetrahedral co-ordination, and the spinel is close in composition to $MgAl_2O_4$, a spinel with normal structure in which Al is in the tetrahedral site. The reasons for the high concentrations of tetrahedrally co-ordinated Al in the earlier formed melt are not clear, but may be the result of high concentrations of Al in the melt. The equilibrium $Al^{VI} = Al^{IV}$ may be expected to shift to the right as the concentration of Al in octahedral co-ordination increases with increase of Al content.

A comparison between the mineral compositions in the Cr-rich portion of HRV15 and the eclogite portion of the third rock thought to have formed by localised partial melting, HRV310, is interesting. Compositions are compared in Table 12.

The clinopyroxene compositions differ in that cpx in HRV15 contains a higher jadeite, and lower diopside concentrations than cpx in HRV310. However, the garnet compositions are very similar and indicate that if more of the eclogitic portion of HRV310 were preserved, its evolution of composition might have resembled that of HRV15. It therefore seems possible to link the source of the magma from which HRV15 formed to garnet lherzolite, through the apparent connecting link afforded by HRV310.

The hypothesis that the eclogite portion of HRV310 was derived from adjacent garnet lherzolite rests largely on the close proximity of eclogite and inferred "garnet lherzolite". The similarity in chemistry between garnet and cpx in eclogite and in "garnet lherzolite" in HRV310 (Figure 36) illustrates that the two portions of the rock are related, and a daughter-parent relationship between eclogite and garnet lherzolite is well established in the literature (e.g. Kushiro and Aoki, 1968; Carswell, 1968). Thus a partial melting hypothesis seems reasonable. However, the pattern of Cr variation in HRV310 is unusual.

It is expected that during partial melting chrome should be preferentially partitioned into the residual crystal phases. The chrome content of residual garnet is therefore expected to increase during partial melting. The high chrome content of garnet in "garnet lherzolite" adjacent to eclogite is consistent with the above supposition, but the lower chrome content of garnet in "garnet lherzolite" further from the eclogite than in "garnet lherzolite" adjacent to eclogite is unexpected.

Two possible explanations were considered; preferential inclusion of chrome into chromite and exsolution of garnet from orthopyroxene. Chromite may nucleate during partial melting, and compete for chrome with residual garnet. Where chromite failed to nucleate the garnet would have higher chrome contents. Thus if chromite nucleated in "garnet lherzolite" distant from the eclogite but not in "garnet lherzolite" adjacent to eclogite, the observed low-chrome and high-chrome garnets in these two portions might be produced. However no evidence in support of this hypothesis was found as chromite is not present in the two slides cut from the "garnet lherzolite" portion of the rock. The second possibility is that during partial melting garnet remained as a residual phase in "garnet lherzolite" adjacent to eclogite, but that all garnet in "garnet lherzolite" distant from the eclogite is of subsolidus origin, formed by exsolution from orthopyroxene. The residual garnet in "garnet lherzolite" adjacent to eclogite would have high chrome contents and during exsolution of garnet, equilibration between residual garnets and exsolved garnets would maintain these high chrome contents, while garnet of exsolution origin only, in "garnet lherzolite" distant from eclogite would reflect the low chrome content of the orthopyroxene parent. The observation that garnet is more abundant in "garnet lherzolite" adjacent to eclogite supports this explanation, but the presence of large garnet grains in "garnet lherzolite" distant from the eclogite is not entirely compatible with a purely exsolution origin for garnet in this portion.

Although the detailed nature of the processes operating during formation of this rock are poorly understood, the hypothesis that the liquid extract from "garnet lherzolite" crystallises to biminerallic eclogite (phlogopite?) is of fundamental importance, for it suggests that a reaction relationship exists between liquid and olivine and between liquid and orthopyroxene and that a liquid derived by partial melting of "garnet lherzolite" may not necessarily crystallise olivine. The partial melting process considered here is similar to that proposed for the origin of the type I eclogite magma in that in both cases olivine does not crystallise from the liquid extract.

3. PRESERVATION OF A DIFFUSION GRADIENT

A feature common to the chrome eclogites which are thought to have originated by partial melting or by cumulate processes, is that the Cr-rich layer is also Mg-rich. The covariance of these refractory elements would be expected during fractional crystallisation or partial melting. In the remaining chrome rich eclogite, HRV180, Mg and Cr bear an antipathetic relation and for this reason the origin of the rock cannot be directly ascribed to the above processes.

The chrome-rich edge of HRV180 is rich in Na_2O and FeO and poor in MgO. The pattern for CaO is ambiguous for while garnet in the chrome-rich portion is CaO-rich, cpx is CaO poor. Estimates of the bulk variation using modes estimated from thin section (74% garnet, 26% cpx) indicate that the variation of CaO in garnet will determine the overall variation, so that the Cr_2O_3-rich edge will be CaO-rich.

The compositional variation in HRV180 may be caused by diffusion along a concentration gradient between a Cr_2O_3, FeO, CaO, Na_2O-rich and an MgO-rich layer. The origin of layers with these contrasting compositions is not readily apparent, since, as mentioned above, MgO is expected to vary together with Cr_2O_3. The chrome-rich kyanite eclogites found at Zagadochnaya (Sobolev et al., 1968) and chrome-rich kyanite eclogite HRV272 (Table 4) from Roberts Victor may be related to HRV180 as these rocks are also rich in both calcium and chromium.

IX THE ULTRAMAFIC ROCKS OF THE ROBERTS VICTOR MINE

INTRODUCTION

The ultramafic rocks brought up in kimberlites occupy a central position in recent researches on the petrology of the upper mantle. The thrust behind the revival of interest in the xenoliths found in kimberlites was provided by papers by Boyd and Nixon coincident with the convention of the First International Kimberlite Conference (Boyd and Nixon, 1973; Nixon and Boyd, 1973; Boyd, 1973). These authors related temperatures and pressures preserved in "sheared" and granular peridotites to mid-Cretaceous plate motions of the African craton. The geothermometer (Ca/Ca+Mg in cpx; Davis and Boyd, 1966) and the geobarometer (Al_2O_3; MacGregor, 1974) employed by Boyd and Nixon have been criticised on the grounds that equilibrium may not have been attained in the original experiments (Howells and O'Hara, 1977), and because the direct extrapolation to natural systems from the simple synthetic systems is believed to be invalid without application of thermodynamic corrections (Wood, 1974; Wood and Banno, 1973; Wells, 1977). Furthermore it has been argued that the shearing of the nodules can only have been preserved for at most a matter of days in the upper mantle, and is therefore more likely to be related to kimberlite emplacement than to plate movements (Green and Guegen, 1974; Goetze, 1975). Nevertheless the interest generated by Boyd and Nixon's paper has stimulated a wider interest in upper mantle peridotites, and has stimulated ongoing research of peridotite nodules as samples of the upper mantle from which basalts may ultimately have been derived (O'Hara and Mercy, 1963; O'Hara, 1965; O'Hara et al., 1975).

A first step in the generation of basalt from garnet lherzolite is the production of a picritic magma. Via eclogite precipitation at depth, and olivine fractionation en route to surface this picritic magma evolves to basaltic compositions (O'Hara, 1965; O'Hara et al., 1975).

If eclogites are indeed the cumulates from partial melts of garnet lherzolite as suggested by O'Hara, or if eclogites represent the partial melts themselves (Kushiro and Aoki, 1968; Carswell, 1968), then residual peridotite compositions should be common at Roberts

Victor, where the abundance of eclogites is exceptional. Thus one approach to the study of the Roberts Victor peridotites will be to compare mineral compositions with peridotites from other kimberlites, in order to determine whether minerals in Roberts Victor peridotites represent more refractory compositions. Related to this approach will be the comparison with minerals found as inclusions in diamond, in order to evaluate the possibility that Roberts Victor peridotites are a source for diamond.This approach is prompted by the observation that while eclogite is the dominant xenolith in the kimberlite, inclusions in Roberts Victor diamonds appear to belong dominantly to ultramafic parageneses (Harris and Gurney, pers. comm; Rickard, unpublished analyses).

The third topic considered in connection with the peridotites is the nature of alteration of olivine and orthopyroxene, for many Roberts Victor peridotites are extensively carbonated and silicated.

A fourth topic to be considered is the subordinate amounts of garnet peridotite in the Roberts Victor xenolith suite. In connection with this topic, the possibility of preferential abrasion of peridotite by kimberlite will be examined.

Before considering these four topics individual peridotites studied will be briefly described. The rocks examined and presented in the following order are

silicified "garnet dunite" BD1195
chromite-clinopyroxene-dunite JJG503
chromite harzburgite RV12
garnet harzburgite KRV19
lherzolite KRV10
garnet lherzolites RV16 and KRV9 and
silicified and carbonated "garnet lherzolites"
HRV20 and RVGRIFFIN and HRV310 was described in the previous chapter.

Analyses of samples described in this chapter are presented in Table 5.

SILICIFIED "GARNET DUNITE" BD1195

DESCRIPTION OF THE SAMPLE

The nodule was collected by J.B, Dawson, and described by Carswell and Dawson (1970). A bulk rock analysis and an analysis of garnet in BD1195 was presented (Carswell and Dawson, 1970, p. 169, p.172). The garnet analysis is incorrectly labelled as BD1355.

A thin section of BD1195 was made available to the writer. Rounded, irregular garnets with thin kelyphitic rims make up about 10% of the slide. The only other mineral present in any abundance is silica which comprises the rest of the slide. The grain boundaries of silica are generally well defined and the shape of the original ol/opx grains can be clearly discerned. The silica grains appear to be pseudomorphs after serpentised olivine, for textures present are similar to those described by Williams (1932, Plate 135 facing p.392), who suggested that "the olivines had not been completely changed to serpentine at the time the rock was attacked by silicification. Both the olivine and the serpentine were attacked alike without any alteration in the shape of the minerals".

MICROPROBE ANALYSES

Eight analyses of four garnet grains were carried out. Zoning was found with edges having higher CaO contents than centres. Cr_2O_3 is generally higher in the edges, although the left edge of garnet 2 has a Cr_2O_3 content roughly equal to the centre, but the right edge does have the higher Cr_2O_3 content.

The low calcium (1.22 - 1.63 wt.%) relates the garnets to the "subcalcic" garnets commonly found as inclusions in diamonds. The "subcalcic" garnets can be most easily identified by plots of CaO vs Cr_2O_3 in garnets (Figure 38).

CHROMITE WEHRLITE JJG503

COLLECTION OF THE SAMPLE

The sample was collected at surface by J.J. Gurney in November, 1973. The manager of the Roberts Victor mine, W.G. Prozesky, identified

the rock as kimberlite from a development drive constructed at the 600 ft. level, in the region of the Jewel Box kimberlite. The Jewel Box kimberlite was, in the first phase of mining operations from 1909 to 1914, the richest area of the Roberts Victor mine (see Chapter III). Melville (1909) proposed that the Jewel Box kimberlite was the first emplaced and that the other kimberlite types of the Roberts Victor mine derived many of their diamonds by admixture of the Jewel Box kimberlite. If this theory is correct the Jewel Box kimberlite must have provided a large proportion of the diamonds mined at Roberts Victor. Since sample JJG503 was derived from the vicinity of the Jewel Box it is possible that if diamonds are accidental xenoliths in kimberlite, inclusions in this sample are derived from a portion of the mantle in which diamonds are relatively abundant.

DESCRIPTION OF THE SAMPLE

The sample is a hard, black kimberlite with olivine and minor phlogopite xenocrysts. In hand specimen olivine xenocrysts make up between 25 and 30% of the sample.

The fine grained kimberlite matrix is dominantly phlogopite with perovskite, calcite and olivine.

Phlogopite is present as larger xenocrysts ranging up to a grain size of 1.5 mm. Certain phlogopites are strained. The olivine xenocrysts are slightly serpentised. The largest olivine grain present has been broken at one end but was at least 3 x 2 x 1.5 cm in size. The olivine xenocrysts are rounded.

The larger but variable size and the rounded nature of the olivine grains are taken as evidence that olivine xenocrysts are accidental. The presence of strain features in phlogopites suggests that these too may have been accidental inclusions. However there is no evidence that olivine and phlogopite coexisted at depth.

The thin section prepared includes the largest olivine xenocryst. A very interesting feature is the presence of 1 mm euhedral chromite grains within this olivine xenocryst. Also included is clinopyroxene. Chromite is associated with the clinopyroxene inclusion and a small olivine grain occurs as an inclusion within clinopyroxene (See Plate 1s).

MINERAL COMPOSITIONS

The composition of the olivine xenocryst and of olivine included in cpx were found to be identical. Chrome in the olivine is below the detection limit of 0.04 wt.% Cr_2O_3. Forsterite content (94.4) is higher than that of olivine in other Roberts Victor peridotites, but matches that of olivines found as inclusions in Roberts Victor diamonds (See Table 13).

Cr_2O_3 content in chromite is greater than 60 wt.%, and in this respect is similar to chromite inclusions in diamonds (Meyer and Boyd, 1972; Sobolev, 1977). TiO_2 contents are low as in the chromite inclusions in diamond.

The clinopyroxene composition is broadly similar to that of clinopyroxene in peridotite xenoliths, but is somewhat higher in Cr_2O_3 content.

Of the matrix minerals only phlogopite was analysed. There is a continuum in size range between matrix and xenocrysts of phlogopite. Five micas were analysed, and from smallest to largest these are 103, 104, 102, 105 and 101. The smaller matrix micas have higher TiO_2 than the larger xenocryst micas.

CHROMITE HARZBURGITE RV12

DESCRIPTION OF THE SAMPLE

The sample was collected by G. Whitfield who presented a whole rock analysis (Whitfield, 1971). Secondary metasomatic mica is present along cracks and some chromite associated with mica may be secondary (CR102). However chromite in the centre of olivine grains appears to be primary (CR101).

MINERAL COMPOSITIONS

The forsterite content in the olivine is 93.6 which is higher than diamond inclusion RV3, but lower than diamond inclusions RV4 and RV7 (Table 13).

Enstatite is less magnesian than the three diamond inclusions

analysed.

Cr_2O_3 in chromite is greater than 60 wt.%, but has TiO_2 = 1.49 wt.% and in this respect differs from chromite inclusions in diamond (Sobolev, 1977, Table 30, p.119).

GARNET HARZBURGITE KRV19

DESCRIPTION OF THE NODULE

Large, irregular grains of olivine and orthopyroxene make up over 90% of the sample. Garnet grains are smaller and their association with orthopyroxene grains suggests that they may have formed by exsolution from orthopyroxene. Garnets are strongly kelyphitised, with the smallest grains entirely altered. Phlogopite is associated with altered garnet and may be secondary. Cpx is not present in the thin section examined.

MINERAL COMPOSITIONS

Olivine and orthopyroxene compositions are rather typical of peridotite compositions, with Fo_{93} and En_{94} in olivine and opx respectively.

On the CaO vs Cr_2O_3 plot (Figure 38) the garnet falls into the lherzolite field, although cpx was not found in either thin section or hand specimen.

LHERZOLITE KRV10

DESCRIPTION OF THE SAMPLE

In hand specimen irregular veinlets and stringers of phlogopite are scattered randomly throughout the rock. Local areas of a milky grey-green material are identified as serpentine (Lawless and Wyatt, pers. comm.).

In thin section evidence of strain is visible in the development of small tabular subgrains of olivine, and in the disruption of orthopyroxene grains. Phlogopite is present as irregular poorly

crystallised grains adjacent to clinopyroxene. A small grain of chromite occurs within a clinopyroxene grain. The overall texture of the rock is weakly porphyroclastic in the terminology of Harte (1977).

MINERAL COMPOSITIONS

A large undeformed olivine (003), a tabular olivine (001) and a very small mosaic olivine (007) were analysed and found to have similar compositions. Two orthopyroxene grains have identical compositions. Olivine, orthopyroxene and clinopyroxene compositions are typically lherzolitic.

The chromite grain within clinopyroxene has a high Cr_2O_3 content (60 wt.%) but has high TiO_2 and is thus dissimilar from chromite inclusions in diamonds.

GARNET LHERZOLITES RV16 AND KRV9

These samples are granular textured rocks with typical garnet lherzolite compositions.

ALTERED GARNET "LHERZOLITE" HRV20

DESCRIPTION OF THE SAMPLE

The nodule has been extensively altered to carbonate and serpentine. However garnet and clinopyroxene are less affected by the alteration and retain their original grain boundaries. The garnets have keltphite rims but kelyphitisation may have preceded carbonation.

MINERAL COMPOSITIONS

The clinopyroxene has a composition similar to other lherzolite clinopyroxenes.

On the CaO-Cr_2O_3 plot (Figure 38) garnet composition falls somewhat above the Ca-rich margin of the lherzolite field.

ALTERED GARNET LHERZOLITE RVGRIFFIN

DESCRIPTION OF THE NODULE

A thin section was made available to the writer by D.A. Carswell. The degree of preservation of the original grain boundaries in this sample is remarkable (Figure 39, Plate 1x).

The garnets are rounded and are relatively unaltered, although mica, perhaps secondary, is preserved within cracks in the garnet.

An irregular fresh grain of clinopyroxene is present in the slide.

Carbonate with irregular but well-defined grain boundaries is the second most abundant mineral, while inequigranular grains of silica make up over half of the slide.

Four small sulphide grains occur together within a silica grain and may be primary.

Small magnetic grains within carbonate are probably secondary.

MINERAL COMPOSITIONS

Garnet and clinopyroxene are similar to garnet lherzolite compositions. Garnet plots in the garnet-lherzolite field in Figure 38.

DISCUSSION

1. COMPARISON WITH OTHER PERIDOTITES

Mineral compositions in garnet lherzolites RV16 and KRV9, and in altered garnet "lherzolites" HRV20 and RVGRIFFIN do not possess any compositional peculiarities which might distinguish them from garnet lherzolite compositions from other kimberlites.

Garnet harzburgite KRV19 has garnet compositions which plot in the lherzolite field on the CaO-Cr_2O_3 diagram (Figure 38) although clinopyroxene is not present in this sample. In this respect it is similar to Premier garnet harzburgite RVD146 (Danchin and Boyd, 1976)

and Bultfontein garnet harzburgite BD2368 (Lawless, 1978).

Chromite harzburgite RV12 has olivine and orthopyroxene compositions very similar to Premier chromite harzburgite RVD182 (Danchin and Boyd, 1976) but chromite in RV12 is higher in TiO_2, and lower in Cr_2O_3.

Mineral compositions in BD1195 and JJG503 are matched most closely by inclusions in diamonds.

2. COMPARISON WITH DIAMONDIFEROUS PERIDOTITES

Sobolev (1977, Table 36, p.138) recognised three ultramafic parageneses to which diamond inclusions may be assigned:

i) Harzburgite-dunite
ii) Lherzolite
iii) Wehrlite

Garnets from the three parageneses may be distinguished on the basis of CaO and Cr_2O_3 contents.

Lherzolitic garnets have been shown to plot in a restricted range of CaO-Cr_2O_3 compositions (Sobolev, Lavrentiev et al., 1973; Sobolev, 1977). An equation has been fitted to the field of lherzolite compositions, and most lherzolitic garnets fall in the range

$$CaO - Cr_2O_3 = 3 \text{ to } 4. \text{ (Oxides as wt.\%).}$$

Garnets in harzburgite and dunites are subcalcic and

$$CaO - \tfrac{1}{3}Cr_2O_3 < 3$$

Garnets in wehrlites may have variable CaO and Cr_2O_3 contents, but may be distinguished from garnets in harzburgite and dunites by higher Na_2O contents in the garnets.

Diamondiferous ultramafic rocks are most commonly harzburgite or dunitic. Eleven xenoliths from Udachnaya (Pokhilenko et al., 1977), five from Aykhal (V.S. Sobolev et al., 1969) and one from Sloan (MacCallum and Eggler, 1976) are diamond bearing harzburgites or

dunites. The altered peridotite from the Sloan diatreme contains primary garnet and chromite. Clinopyroxene was thought to have been present and to have altered to a greenish material (MacCallum and Eggler, 1976) but in altered peridotites HRV20, HRV310 and RVGRIFFIN clinopyroxene is unaffected by alteration. Furthermore chromite in the Sloan sample contains 60 wt.% Cr_2O_3, a feature of the harzburgite paragenesis. Thus the Sloan sample is thought to represent harzburgite rather than a lherzolite paragenesis.

Two diamondiferous lherzolites from Mothae (Dawson and Smith, 1975) and Udachnaya (Pokhilenko et al., 1977) have been recovered.

The wehrlite paragenesis has been identified by the presence of garnet, clinopyroxene and olivine in a single diamond from the Udachnaya pipe (Sobolev, Bartoshinsky et al., 1970). Garnet in this sample has both high CaO (13.5 wt.%) and Cr_2O_3 (8 wt.%). Clinopyroxene has Ca/Ca+Mg = 0.48 and olivine is Fe 93.1. The wehrlite paragenesis is also sparsely documented in xenolith suites, for only one sample, D332 from the Dalnaya pipe, has been recorded (Sobolev et al., 1973, Table 1).

Garnet in BD1195 is subcalcic and clearly belongs to the harzburgite-dunite paragenesis. The extremely subcalcic nature of the garnet ($CaO-\frac{1}{3}Cr_2O_3 < 0$) is similar only to six other rocks, four from Udachnaya (Pokhilenko et al., 1977), and one from Aykhal (V.S. Sobolev et al., 1969) which are diamondiferous and one other, JJG484, from the Finsch mine is not diamond bearing (Gurney and Shee, unpublished data). BD1195 is therefore very likely to be representative of a rock type from which many diamonds are derived.

The xenocryst of olivine in JJG503 possesses two features which relate it to the diamond bearing rocks; the high chrome content of the chromite is characteristic of chromite inclusions in diamonds (Meyer and Boyd, 1972; Sobolev, 1977), and the high Fo content of olivine matched at Roberts Victor only by diamond inclusions. The xenocrysts may be derived by disruption of a diamond bearing chromite wehrlite layer in the upper mantle. Alternatively olivines with chromite and clinopyroxene inclusions may have crystallised, together

with diamond directly from kimberlite, and may then have been emplaced as cognate xenocrysts. Whether the olivine is a cognate or an accidental xenocryst can only be resolved with certainty by dating the clinopyroxene inclusions to test whether they match the age of the kimberlite, or if they were formed in an earlier event, possibly related to the origin of the Roberts Victor eclogites.

There is no compelling evidence to relate the lherzolites examined to the diamond-bearing suites for, when compared to the number of lherzolites examined, the presence of diamond in only two (Dawson and Smith, 1975; Pokhilenko et al., 1976) suggests that diamond is a very uncommon accessory in the lherzolite paragenesis.

3. ALTERATION OF PERIDOTITES

The altered peridotite RVGRIFFIN consists of garnet, clinopyroxene, calcite and quartz. The garnet composition indicates that the rock was originally a lherzolite, thus calcite and quartz are probably alteration products after orthopyroxene and olivine. Calcite is less abundant in the slide than quartz, and since orthopyroxene is usually less abundant than olivine in garnet lherzolites, calcite appears to have replaced orthopyroxene, while olivine was replaced by quartz.

The garnet composition of BD1195 suggests that the rock originally belonged to the harzburgite-dunite paragenesis. Unaltered harzburgites and dunites from the Udachnaya pipe comprise 10 dunites and 1 harzburgite (Pokhilenko et al., 1977), thus dunites may be more common than harzburgites in parageneses with subcalcic garnet, and it is likely that BD1195 was initially a garnet dunite rather than a garnet harzburgite. If BD1195 was initially a garnet dunite, olivine has been entirely replaced by quartz. The replacement of olivine by quartz is in accord with the alteration pattern suggested for RVGRIFFIN where it was proposed that quartz replaces olivine and calcite replaces orthopyroxene. A similar alteration pattern has been suggested for peridotites in the State-line kimberlites (MacCallum, pers. comm.).

HRV20 has been silicified and carbonated but during alteration grain boundaries were not preserved to the same extent as in RVGRIFFIN or BD1195, and it is not possible to identify the original grain boundaries.

Alteration of the peridotites may have occurred in the mantle or near surface. Quartz and calcite are not stable at high pressures, but the high pressure polymorphs, coesite and aragonite, may have formed in the mantle. Inversion of coesite to quartz has been shown to occur relatively rapidly. Coesite has been found in a Roberts Victor eclogite, but has largely reverted to quartz, and in other eclogites the presence of coesite can only be inferred from the presence of quartz grains (Smyth and Hatton, 1977; Smyth, 1977c). Aragonite may similarly revert to calcite during emplacement of the kimberlite.

No firm evidence relating alteration to a near surface or mantle process can be adduced, but the alteration of some peridotites, but not others, may be more readily explained if alteration occurred in the mantle where the peridotites were horizontally separated. In the mantle reacting fluids may have had access to specific horizons only, but in the turbulent kimberlite magma it is perhaps more likely that the alteration would have affected all nodules alike. However if alteration occurred at surface, after kimberlite emplacement, reacting fluids may again have had access to only restricted portions of the kimberlite body.

An interesting point which theories of the alteration process must take into account is the fact that only olivine and orthopyroxene appear to have been altered while garnet and clinopyroxene are unaffected. Wyllie (1976) has shown that in the system CaO-MgO-SiO_2-H_2O-CO_2 at high pressures clinopyroxene is the first phase to be carbonated. This feature is in direct contrast to the alteration process observed in the Roberts Victor peridotites, where in lherzolites RVGRIFFIN, HRV310 and HRV20 clinopyroxene is observed to be immune to carbonation. A possible reason for this discrepancy is that Al_2O_3 was not present in the synthetic system, and that Al_2O_3 has a profound effect on the nature of the carbonation reactions. Alternatively alteration may have occurred at low pressures where clinopyroxene and garnet might be immune to carbonation, while olivine and orthopyroxene are not.

4. SCARCITY OF PERIDOTITE

One of the striking features of the xenolith suite from the Roberts Victor mine is the relative scarcity of peridotites, in

contrast to the abundance of eclogites. The rarity of peridotite may be only relative, in that peridotite may be present in the kimberlite at levels comparable to other kimberlites, but the overwhelming abundance of eclogite may mask the presence of peridotite. The xenolith density in the Roberts Victor kimberlite was estimated at about 1% during a survey of mining faces. Xenolith density in the Kimberley kimberlites is probably well below 1%, but other pipes, for example the Matsoku pipe (Cox et al., 1973) have considerably higher xenolith densities. However whether peridotite is present at levels comparable to other pipes or not, the preponderance of eclogites over peridotites in the xenolith suite is not in doubt.

Preferential sampling of a denser eclogite horizon in the mantle has been mooted (Chapter III), as a possible explanation of the preponderance of eclogites at Roberts Victor. This explanation is sufficient to account for the abundances of type I eclogites. However the proposed origin of certain inhomogeneous type II eclogites as localised partial melts of garnet lherzolite (e.g. HRV15, HRV310, Chapter VIII) implies that the residual peridotite was in close proximity to the eclogite sampled. Garnet and clinopyroxene normally comprise less than 16 volume % of common peridotite as defined by Cox et al., (1973), thus the volume of an eclogite extract must be associated with at least five times the volume of residual peridotite. If a significant number of the type II eclogites originated as localised partial melts in close proximity to their source, then the quantity of adjacent peridotite sampled should be correspondingly large. The alteration of Roberts Victor peridotite may result in a significant number being overlooked during collection of xenoliths, since the altered material may possess only small amounts of relict garnet and clinopyroxene, which identify these rocks as upper mantle xenoliths. Alteration may play a further role in obscuring the actual abundance of peridotites in the Roberts Victor kimberlite by rendering the peridotites more vulnerable to destruction in the kimberlite. If the alteration was a post-emplacement feature, then only chemical alteration would have affected the nodules, but if the nodules were carbonated and silicified before inclusion in the kimberlite, or at a comparatively early stage of kimberlite emplacement, then mechanical abrasion of the xenoliths would have been significant.

Carbonate is a very soft mineral (hardness = 3), and carbonated nodules would be abraded much more rapidly than unaltered, or even silicified nodules.

Some estimates of the extent to which abrasion may be a factor in decreasing the quantity of nodules observed may be made from a consideration of eclogites which contain layers of less resistant material. These eclogites are the inhomogeneous kyanite eclogites which contain layers of altered clinopyroxene (HRV17, Plate 16), and eclogites with clinopyroxene rich layers (HRV23, Plate 17).

The parameters involved in considering abrasion of nodules are diagramatically presented in Figure 39 where

To = initial thickness of nodule,
T = present thickness of slowly abrading layer, usually biminerallic eclogite,
t = present thickness of rapidly abrading layer.

The following parameters are also considered:

R = rate of abrasion of slowly eroding layer,
r = rate of abrasion of rapidly eroding layer, and
$x = \frac{r}{R}$, the relative rate of erosion
s = time during which the nodules have undergone abrasion.

The parameters of interest are

$\frac{r}{R}$, the rate of abrasion of the rapidly eroding layer relative to the rate of abrasion of the slowly abrading layer;

$\frac{To}{T}$, the initial thickness of the nodule relative to the present thickness of the slowly abrading layer; and

$\frac{t}{T}$, the present thickness of the rapidly abrading layer, relative to the present thickness of the slowly abrading layer.

The amount abraded will be equal to the length of abrasion multiplied by the rate of abrasion:

$$sR = To - T \text{ and} \qquad \ldots\ldots(1)$$
$$sr = To - t, \qquad \ldots\ldots(2)$$

where s, the length of abrasion is equal for all layers in a given nodule.

Dividing (2) by (1) gives

$$\frac{r}{R} = \frac{To-t}{To-T}$$

and multiplying by $\frac{1}{T} / \frac{1}{T}$ gives

$$\frac{r}{R} = \frac{\frac{To}{T} - \frac{t}{T}}{\frac{To}{T} - 1} \qquad \ldots\ldots(3)$$

Some limits can be placed on the above parameters.

To/T, the initial thickness of the nodule compared to the present thickness of the eclogite layer is probably less than 2. The square shape of eclogite nodule HRV15 indicates that this nodule has been abraded to a limited extent only.

To/T for this sample is probably 1.2 or less, but this nodule may be unduly competent.

$\frac{r}{R}$, for alternate garnet-rich and cpx-rich layers is probably less than two, i.e. cpx is abraded no more than twice as fast as garnet. For fresh cpx this factor is undoubtedly very much less than 2, but cpx in eclogites is somewhat more prone to alteration than garnet and is then more susceptible to abrasion. In kyanite eclogite layers in inhomogeneous kyanite eclogites, the highly aluminous cpx is altered to a far greater extent than cpx in biminerallic layers. $\frac{r}{R}$ for a biminerallic eclogite relative to a kyanite may be greater than 2.

$\frac{t}{T}$, the thickness of a cpx-rich layer relative to surrounding eclogite was measured in nodule HRV23 as .77. For HRV17 the kyanite eclogite layer relative to the adjacent biminerallic eclogite $\frac{t}{T}$ was measured as .66. Using these values for HRV23 and HRV17 values for a series of $\frac{r}{R}$ and $\frac{To}{T}$ were determined from the equation (3),

$$\frac{r}{R} = (To/T - t/T) / (To/T - 1)$$

Applying the limit that $\frac{r}{R}$ for the rate of abrasion of cpx relative to eclogite be no greater than 2 a minimum value of To/T = 1.23 was established (Table 14), i.e. at least 23% of the biminerallic eclogite layer in HRV23 has been lost by abrasion. Assuming that the ordinary eclogite layer in kyanite eclogite HRV17 with t/1 = .66 is similarly 23% smaller as a result of abrasion, the rate of abrasion of the kyanite eclogite layer was 2.48 times more rapid than the rate of abrasion of ordinary eclogite.

Nodule HRV17 is strongly indented at the kyanite eclogite layer, which is two-thirds the thickness of biminerallic eclogite (Figure 40a,2). A point might be reached when the indented layer was so thin that the nodule would break along this layer (Figure 40a,3). The stage at which a dumbell shaped nodule would break in two is estimated to be at that point when the rapidly abrading layer is between a half and a third as thick as the slowly abrading layer. Once the nodule breaks the separate portions would have much larger surface areas exposed to abrasion and would therefore abrade very much more rapidly. Thus nodules would tend to become separated into their less resistant and more resistant layers by preferential abrasion of, and disruption along the less resistant layers. The less resistant layers may be abraded to extinction. Further abrasion patterns of nodules with layers of different hardness are illustrated in Figure 40.

The relative rates of abrasion may be compared to the rate of abrasion of a cpx layer relative to biminerallic eclogite. For the case where the cpx layer abrades twice as fast as the biminerallic eclogite, the thickness of the biminerallic eclogite layer has been reduced by 23%, and for this case kyanite eclogite abrades 2.48 times as rapidly as biminerallic eclogite, as illustrated above Table 14. In order for a rapidly abrading layer of carbonated peridotite to be reduced to half the thickness of biminerallic eclogite the carbonated peridotite must abrade 3.17 times more rapidly than biminerallic eclogite. To be reduced to a third of the thickness of biminerallic eclogite the abrasion rate need only be 3.91 times as rapid.

Taking the upper limit of the original size of the nodule, i.e. assuming that the biminerallic eclogite layers were initially twice their present size, the cpx-rich layer in HRV23 need only abrade 1.23 times faster and the kyanite eclogite layer in HRV17, 1.33 times faster than biminerallic eclogite in order to attain their present dimensions. For a carbonated peridotite to be reduced to half and to a third of the thickness of biminerallic eclogite, carbonated peridotite must abrade 1.5 and 1.67 times more rapidly.

Although no absolute estimates of abrasion rates in kimberlite are available to the writer, the relative rates of abrasion discussed above seem reasonable, and suggest that the abundances of carbonated peridotite in kimberlite will be considerably reduced by abrasion.

The abundances of nodules recovered at Roberts Victor are directly related to their size, for smaller nodules pass through with the kimberlite to the crushing plant, and only the larger nodules are removed before crushing, hence available for examination as unbroken nodules. Since the size of the nodules determines their abundance in the rock suite sampled, the abundance of rock types relative to resistant eclogite will be proportional to t/T. t/T for the clinopyroxene-rich layer in HRV23 (Plate 17) is .77, thus clinopyroxene-rich rocks will be underrepresented by a factor of 1/.77 relative to biminerallic eclogite. Similarly it can be estimated from inhomogeneous kyanite eclogite HRV17 (Plate 16) that kyanite eclogites will be underrepresented by a factor of 1/.66. The above are likely to be minimum estimates since in HRV17 and HRV23 the softer layers are protected by layers of more resistant biminerallic eclogite on either side, and for nodules consisting entirely of an easily abraded material, rates of abrasion will be more rapid. Carbonated peridotites are thought to be considerably less resistant to abrasion than kyanite eclogite or cpx-rich eclogites and are thought to be under-represented by factors of at least 1/.33. Protective layers of biminerallic eclogite are probably present in contact with carbonated peridotite in only a few cases, e.g. HRV310 (Figure 40c), and only exceptionally large samples of carbonated peridotite may survive abrasion by the kimberlite.

The rarity of peridotite at Roberts Victor is suggested to be the result of a combination of the selective sampling of the mantle

by the kimberlite, and the preferential alteration of olivine and orthopyroxene which considerably reduces the resistance of peridotite to abrasion by kimberlite.

X DIAMONDIFEROUS ECLOGITES AND THE ORIGIN OF DIAMOND AT ROBERTS VICTOR

INTRODUCTION

The ultimate origin of many diamonds found in kimberlite is not known with any degree of certainty. Diamonds may have crystallised directly from kimberlite at depth (e.g. Gurney et al., 1977) or en route to the surface (e.g. Mitchell, 1974), or diamonds may be accidental xenocrysts in kimberlite, derived by disaggregation of accidental xenoliths. A third possibility is that diamond is a cognate xenocryst in kimberlite derived by disaggregation of cognate xenoliths which crystallised from kimberlite at depth. This latter possibility is related to the problem of determining whether the xenoliths themselves are cognate or accidental. There is strong evidence, based on isotopic data and on age determinations that the eclogites in the Roberts Victor kimberlite are accidental (Allsopp and Barret, 1975; Kramers, 1977; Davis, 1977), and it is widely accepted that garnet lherzolite is the dominant component of the subcratonic material traversed by kimberlite, and that garnet lherzolite is therefore also an accidental inclusion in kimberlite. There is ambiguity as to the origin of the poorly known harzburgite-dunite and the even less well known wehrlite paragenesis, for although their mineralogical relation to the lherzolite paragenesis suggests that these rocks may similarly be accidental inclusions, it has been supposed that the wehrlite and dunite-harzburgite parageneses originate by direct crystallisation from kimberlite (Sobolev, 1977 p. 152). Gurney et al.,(1977) suggested that subcalcic garnet inclusions in diamonds from the Finsch mine, most of which can be certainly related to the dunite-harzburgite paragenesis, formed during kimberlite genesis. Thus these authors also suggest that the dunite-harzburgite paragenesis crystallised from kimberlite. The question of a cognate or accidental origin for the dunite-harzburgite and wehrlite parageneses will only be satisfactorily settled by isotopic work on both xenoliths and kimberlite.

For the present study of Roberts Victor diamondiferous eclogites it can be assumed that the eclogites are accidental inclusions, although the possibility exists that the diamonds crystallised after the eclogite from interstitial fluids introduced from the kimberlite or from some other metasomatic source.

If a genetic link exists between eclogite and diamond the presence of diamond allows two pressure-temperature constraints to be placed on the conditions of formation of diamond and eclogite. The first constraint is imposed by the diamond-graphite equilibrium curve which restricts P, T conditions to the relatively large field of diamond stability. However in some cases the conditions of formation are further constrained to some point on the diamond-graphite reaction curve, by the coexistence of diamond and graphite. The diamond-graphite reaction curve has been determined with fairly good agreement between different workers, and with the theoretical Bernel-Simon curve (Bundy et al., 1961; Kennedy and Kennedy, 1977). The relatively pure compositions of diamond and graphite suggest that the position of the diamond-graphite curve will be virtually independent of bulk composition, although the strong retention of noble gases by graphite (Basu, pers. comm.) does raise the possibility that the presence of large amounts of noble gases may allow graphite to form within the diamond stability field.

A second pressure-temperature constraint can be applied if it is assumed that diamond (or graphite) originate by reduction of carbon oxide gases to elemental carbon. If the buffer reaction controlling the oxygen fugacity of the eclogite magma system is known it is possible to calculate the pressure-temperature conditions at which the oxygen fugacity of the controlling buffer will reduce carbon gases to elemental carbon. This constraint reduces P, T conditions under which diamond is stable to a univariant curve. In the special case where diamond and graphite coexist the appropriate pressure and temperature is uniquely defined by the intersection of the diamond graphite reaction curve and the curve defined by the oxygen fugacity buffer equation.

At present this approach is subject to large inaccuracies for the equations defining the various oxygen buffers can be extrapolated to the pressures prevailing in the upper mantle with only limited degrees of confidence as the experimental data were largely determined at near atmospheric pressures. Furthermore the oxygen fugacity prevailing during eclogite crystallisation is not well known. However determinations of oxygen fugacity at high pressures are currently being carried out (e.g. Woerman et al., 1977; Ulmer, pers. comm.) and the constraints supplied by oxygen fugacity considerations may soon be applied with a fair degree of precision.

Knowledge of the pressure and temperatures prevailing during diamond formation determines whether the various types of diamond bearing xenolith may be interrelated, or whether each type of diamond bearing xenolith formed under different physical conditions. Possible interrelationships between the wehrlite sample JJG503 and the garnet "dunite" BD1195, (both of which show relationships to diamond bearing rocks as discussed in the previous chapter) and the Roberts Victor diamondiferous eclogites are examined in this chapter.

The diamondiferous eclogites at Roberts Victor are of different types and can be assigned to both the type I and type II categories. The type I eclogites may be related in large part to fractional crystallisation processes, whereas partial melting appears to have played a more dominant role in the genesis of the type II eclogites (Chapter V), thus the origin of the diamond in the different rock types may be related to different processes.

A total of twelve diamondiferous eclogites from Roberts Victor have been analysed by various authors. Switzer and Melson (1969) and Sobolev (1977) report analyses of a kyanite eclogite, 111060. Reid et al.(1976) analysed eight diamondiferous eclogites of which two, XRV22 and WRV4, were also analysed during this study. In addition a further three samples, HRV247, HRV313 and PJL18 were analysed by the writer. Of the samples analysed by the writer three, WRV4, HRV313 and PJL18, are texturally related to the type I eclogite while the other two, HRV247 and XRV22 are assigned to the type II eclogites.

Although the other seven samples were not examined by the writer, on the basis of K_2O in cpx (Figures 13i, 18i) and CaO in garnet vs Na_2O in cpx (Figures 12h, 17h), it is possible to assign three, AMR5, AMR8 and 111060 to the type I eclogites and four, AMR3, AMR4, AMR6 and AMR7 to the type II eclogites.

Three graphite eclogites, AMR9=BD1190 (Reid et al., 1976; Bishop et al., in prep), BD6914 (Lappin and Dawson, 1975) and HRV309 (this study) have been analysed. The chemistry and textural description of BD6914 suggests that this rock is a type I eclogite. BD1190=AMR9 was examined by the writer and can be texturally related to a chrome-rich kyanite eclogite HRV272 studied by the writer and assigned to the type II eclogites. Analyses of BD1190=AMR9 by Reid et al (1976) and by Bishop et al (in prep.) show differences, particularly in the Cr_2O_3 contents, and suggest that this sample is inhomogeneous; a common characteristic of the type II eclogites. HRV309 is also allocated to the type II eclogites.

In this chapter the type I diamond-graphite eclogites are examined first. Because the type I eclogites are generally homogeneous more emphasis is placed on the relation of the mineral compositions to other type I eclogites, than on individual descriptions of each rock. For the type II eclogites the relation of diamondiferous eclogites to other type II eclogites is examined, but more emphasis is placed on the variation in mineral compositions where these are present. In particular, HRV247 an inhomogeneous type II eclogite which contains both diamond and graphite was examined in great detail, chemically by the writer (Hatton and Gurney, 1977c, in press) and morphologically by Robinson (1976, 1977). The description and discussion of this rock occupies a large portion of this chapter. Conclusions deduced from this rock have an important bearing both on diamond genesis in Roberts Victor xenoliths, and on the genesis of many of the type II eclogites.

TYPE I DIAMONDIFEROUS ECLOGITES

DESCRIPTION

Three type I diamondiferous eclogites, WRV4, PJL18 and HRV313 were examined. WRV4 could be examined only in thin section. In hand specimen PJL18 and HRV313 possess the type I texture of rounded garnets and clinopyroxene. The colour of the clinopyroxene is whiter than the bulk of the type I eclogites, and this feature can be related to the increased amounts of jadeite in these samples. In thin section clinopyroxene in all three samples is rather more extensively altered than in most type I eclogites, and this feature is probably also related to high jadeite content which renders the clinopyroxenes more prone to alteration. Accessory minerals present are rutile in WRV4 and sulphide in PJL18. The sulphide in PJL18 occurs as rounded blebs in clinopyroxene, but was also observed in the cast of a diamond. The close proximity of sulphide and diamond suggests that a genetic link may exist between these two minerals. In this connection it is interesting to note that calcium carbonate in a Roberts Victor sulphide rich nodule WM7, is found as blebs on the margins of sulphide grains (Plate 8).

CHEMISTRY

WRV4 and PJL18 are homogeneous rocks with chemical variations within the 6σ error bars, HRV313 has a homogeneous garnet composition but the clinopyroxene analysed has a CaO, MgO, FeO, TiO_2-rich and a Na_2O, Al_2O_3 -poor edge.

CaO in the garnets is in all cases greater than 6 wt.% thus these rocks are classified as type I calcium rich eclogites. No special features distinguish the diamondiferous eclogites from other type I calcium rich eclogites.

Of the three type I diamondiferous eclogites examined by other workers, AMR8 is a type I calcium rich eclogite; 111060 is kyanite bearing but the garnet compositions relate the type I kyanite eclogites to the calcium rich members. AMR5 is a unique specimen for as indicated by the K_2O content of cpx, it is a type I eclogite. It is

the only diamond bearing eclogite belonging to the type I Main Group. In the absence of textural evidence the possibility that AMR5 is related to those rare type II Main Group eclogites with high K_2O in cpx cannot be excluded. The graphite eclogite BD6914 (Lappin and Dawson, 1975) is recognised as a type I calcium-rich eclogite on the basis of examination in hand specimen by the writer and on the calcium content of the garnet.

TYPE II DIAMONDIFEROUS ECLOGITES

XRV22

The sample was described in detail by Gurney et al. (1969) who pointed out the rare occurrence of rutile as an inclusion in the centre of many diamonds in this rock. Graphite is also present (Gurney, pers. comm.). The sample was very friable and has been largely disaggregated during examination.

Four analyses of garnet and four of clinopyroxene were carried out by Gurney (during this study), and garnet and cpx were analysed by Reid et al. (1976). There does not appear to be any significant difference between the different analyses, and the rock may be considered to be homogeneous.

Mineral compositions are those of evolved compositions in the Main Group of Type II eclogites.

HRV247

DESCRIPTION OF THE NODULE

The nodule was collected at Roberts Victor and had original dimensions of 20 x 14 x 7 cm. A number of graphite crystals and fifteen diamonds were observed on broken surfaces. On further examination and solution of three portions of the nodule over two hundred stones and fragments were recovered (Robinson, 1977). Six slides were cut from four portions of the rock (Figure 41).

Layering is a common feature of Roberts Victor eclogites although it cannot always be readily seen in hand specimen. HRV247 proved to be a sample in which layering was not readily apparent. Nine fragments were broken from precisely determined positions in the nodule, and planes of constant garnet composition were defined (Figure 41). On re-examination of the nodule a clinopyroxene layer was observed and the orientation of the layer was found to approximately coincide with the plane of constant garnet composition. Thus the planes of constant composition can be equated with planes of igneous layering. The location of the fragments and approximate location of the slides is illustrated in Figure 41 where sample locations have been projected into a plane perpendicular to the layering.

Clear, rounded garnet of 5 mm mean grain size makes up 70% of the nodule. Fresh, grass-green clinopyroxene comprises the only other major component and is normally interstitial to the garnet. Besides diamond and graphite, pyrrhotite and rutile are present as primary, minor constituents. The inter-granular mineralogy is dominantly phlogopite with amphibole and minor opaque phases. Some of the phlogopite may be primary. The graphite crystals are euhedral with grain size equal to the garnets, and appear to be of a clearly igneous origin. Detailed descriptions of the diamond and graphite are found in Robinson (1977), but it should be noted that there is no evidence of reversion of diamond to graphite or vice versa, and it appears that both diamond and graphite are primary constituents of the eclogite.

ZONING OF THE GARNETS

All garnets analysed show quite distinct differences between cores and rims. These differences are most marked for the elements Ca, Mg and Ti. Rims are enriched in Mg principally at the expense of Ca which is concentrated in the cores (Figure 42). Fe tends to be enriched in the cores though less markedly than Ca. Ti shows a marked enrichment in cores by a factor of 50% or more. SiO_2, Al_2O_3, Cr_2O_3, MnO and Na_2O show little variation in concentration. The relative constancy of Na_2O and the variation in TiO_2 is of interest, for it might be expected that Na_2O would vary

sympathetically with TiO_2 (Bishop et al., 1976; Reid et al., 1976). In terms of end members the variation in garnet composition can be described as enrichment of the rims in pyrope content with concomitant depletion of grossular and to a lesser extent, of almandine.

ZONING OF THE CLINOPYROXENES

With respect to MgO and TiO_2, the clinopyroxenes exhibit a similar pattern to the garnets in that MgO is enriched in the rims, and TiO_2 is enriched in the cores. However, CaO and FeO contents are higher in the rims, rather than in the cores as is the case for the garnets. The Ca:Mg:Fe ratio of cores and rims, and indeed of clinopyroxenes throughout the specimen, remains relatively constant (Figure 43). SiO_2, Cr_2O_3, MnO and K_2O remain constant but Na_2O and Al_2O_3 contents are highest in the cores. Zoning of clinopyroxenes may therefore be described as the enrichment of the rims in diopsidic pyroxene components at the expense of jadeite.

VARIATION ACROSS THE LAYERS

There is a continuous variation in the chemical composition of garnet and clinopyroxene across the nodule. Composition is plotted against distance perpendicular to the plane of constant composition in Figure 44. The two ends of the nodule are represented by portions A and F. From F to A MgO in garnet increases while CaO, FeO and TiO_2 decrease. In the clinopyroxenes CaO and MgO increase while Na_2O, Al_2O_3, FeO and TiO_2 decrease. The pattern of variation from F to A is in the same sense as the variation in individual grains from core to rim. Since the rims necessarily crystallised after the cores, it may be assumed that portion A crystallised after portion F, but it is also possible that F and A crystallised simultaneously. The variation in TiO_2 content may be interpreted as evidence that grains throughout the rock nucleated at the same time and grew together.

The magnitude of the variation of TiO_2 content between cores and rims is considerably greater than that of other elements which exhibit maximum variations between 2 and 28%. The maximum variation of TiO_2 in garnet, in garnet grain 3, is 61%. Some factor, other than

the general compositional variation may control the fluctuation in TiO_2 content. Rutile is present throughout the rock and it is suggested that rutile crystallised after garnet. Garnet cores nucleating before rutile would not compete with rutile for available TiO_2 and would have relatively high TiO_2 contents. After rutile nucleated, the edges of the garnet would become progressively poorer in TiO_2, as the growth of rutile decreased the supply of available TiO_2. A similar effect to that proposed here has been noted in megacrysts from Monastery mine, in which garnet and clinopyroxenes formed together with ilmenite, have lower TiO_2 contents than those that grew before crystallisation of ilmenite, even though bulk TiO_2 was higher when ilmenite crystallised (Jakob, 1977). The presence of zoning with respect to TiO_2 garnets throughout the rock indicates that if crystallisation of rutile controlled the zoning, nucleation of the garnets throughout the rock must have occurred before nucleation of rutile, for if some garnets nucleated after rutile, cores of these garnets would be low in TiO_2. However there is a roughly parallel trend of core and rim TiO_2 contents.

GARNET INCLUSION IN GARNET

In the centre of garnet crystal 5 a garnet inclusion of quite dissimilar composition is present. The MgO of the garnet inclusion is higher than that of any other garnet in HRV247. The margins of the garnet inclusion are defined by cracks along which secondary minerals are present. Garnet crystal 5 is 5 x 3 mm in size and the garnet inclusion is 1 x 3 mm.

The origin of the garnet inclusion is problematical but it may be a crystal carried up in the source magma.

HRV309

The initial size of the nodule was approximately 30 x 20 x 10 cm. Garnet and cpx grains are large with a mean grain size of 8 mms. The grains are irregular and rounded to elongate. Elongate grains are subparallel and define a layering in the sample. Graphite is particularly abundant in a 5 cm layer parallel to the elongate grains, although smaller

amounts of graphite appear to be present throughout the rock. Graphite crystals occur mainly within the grain boundaries between garnet and cpx, but graphite is also present in cpx grains, and commonly as embayments in the margins of garnet grains. A dark, friable mineral, thought to be an alteration product of primary orthopyroxene is present in small amounts throughout the rock as irregular grains up to 4 mm in diameter. Four slides HRV309 A,B. C and D were prepared from a slice through the rock perpendicular to the layering. Slide A was cut from above the graphite rich layer, B from the graphite rich layer and C and D from below the graphite rich layer. Graphite is present in all these slides. In slide A rutile occurs as numerous small grains, many of which are in optical continuity, included in an elongate graphite grain. The intimate association of rutile and graphite in HRV309 recalls the occurrence of rutile inclusions in diamond in XRV22 and suggests that there may be an association between titanium and carbon in these eclogites.

CHEMISTRY

Compositions of core and rim of a garnet and of adjacent rim of a clinopyroxene in each of the four slides were determined, and the results plotted in Figure 45. Variation in most elements is very small. From A to D FeO and TiO_2 in garnet decrease while MgO increases. In clinopyroxenes FeO, Na_2O, Al_2O_3 and TiO_2 decrease while CaO and MgO increase. In most cases the change in composition is only slightly greater than the 6σ error bars, but for FeO in garnet there is a distinct decrease in concentration from A to D.

The mineral compositions and texture of HRV309 are those of an evolved type II Main Group eclogite.

DISCUSSION

1. ORIGIN OF CARBON IN THE UPPER MANTLE

The concentrations of carbon in minerals in garnet peridotite are extremely low, for carbon is very weakly partitioned into the crystal phases in equilibria between crystals and melt ($D^{CO_2} = 0.0008$, Eggler et al., 1974).

Thus the minerals themselves are unlikely to be able to provide the necessary carbon for diamond formation, and if carbon is present in garnet peridotite most must occur in interstitial material. Unfortunately the nature of the original interstitial material in garnet peridotite is not well known for there has been extensive contamination of the interstices both by kimberlite and by metasomatising fluids. The possibility that carbon is derived from interstitial material in common garnet peridotite cannot be proved or disproved. However there is a growing body of evidence that metasomatising fluids, derived from greater depths than subcratonic garnet lherzolite in the mantle are important in the modification of (and "fertilisation" of "sterile") garnet peridotite compositions (Lloyd and Bailey, 1975; Harte and Gurney, 1975b; Erlank and Rickard, 1977). Elements thought to be introduced by these metasomatising fluids are K, Ti, Nb, Zr (Harte and Gurney, 1975b; Lloyd and Bailey, 1975; Erlank and Rickard, 1977), Rb, Ba, Na, Sr, (Lloyd and Bailey, 1975; Erlank and Rickard, 1977), Al, Mn, Ca, La, H_2O and CO_2 (Lloyd and Bailey, 1975), S, Ni, Cu, (Harte and Gurnet, 1975b) and Fe (Lloyd and Bailey, 1975; Harte and Gurney, 1975b). It is a distinct possibility that in many cases the carbon necessary for diamond formation in the "sterile" upper mantle is introduced in the form of CO_2 by these metasomatising fluids. Ti and S are associated with diamond-graphite bearing rocks XRV22, HRV309, HRV247 and PJL18 in the form of rutile and sulphide and the association of these elements, thought to be components of metasomatising fluids supports a metasomatic origin for carbon.

It is not suggested that the diamonds present in diamondiferous eclogite have formed directly from a metasomatising fluid, for there is evidence that diamond and graphite crystallised together with eclogite. This evidence rests on the presence of graphite as large undeformed crystals in HRV247. Graphite is a soft mineral and as hardness can be related to crystallising power, it is not likely that graphite could displace pre-existing garnet and clinopyroxene grains. Graphite in this rock is more likely to have grown in a liquid medium.

In HRV309 graphite commonly occurs in the indented margins of garnet grains and it appears that garnet crystallised after graphite. In some cases clinopyroxene grains in this rock have enclosed crystals of (presumably) pre-existing graphite.

Direct evidence of co-crystallisation of diamond and eclogite is provided by a sample of diamondiferous eclogite from the Mir pipe, Russia in which garnet and clinopyroxene of similar composition to matrix eclogite occurred as inclusions in the diamond. Clinopyroxene inclusions were thought to be present in diamond inclusions in HRV247 but were lost during polishing and could not be conclusively identified.

Diamond and graphite in Roberts Victor eclogites may be associated with the metasomatising fluid in a more indirect manner than by metasomatism of pre-existing eclogites.

2. VOLATILE INDUCED PARTIAL MELTING

Important components of the metasomatising fluid envisaged by Lloyd and Bailey (1975) are H_2O and CO_2. The role of H_2O in lowering the temperatures of melting of garnet peridotite has been experimentally demonstrated (Kushiro et al., 1968), and has been theoretically related to the ability of water to disrupt Si-O-Si bonds by formation of two Si-OH bonds (e.g. Kushiro, 1975; Fraser, 1977). Kushiro (1975) suggested that the basic oxides, K_2O and Na_2O behaved in a similar way in depolymerising silicate liquids. Access of volatiles to garnet peridotite heated either by the heat carrying volatiles themselves, or by some other thermal input may induce partial melting with production of a liquid of eclogitic composition at temperatures below the anhydrous solidus. On crystallisation of this liquid diamond or graphite, derived from CO_2 may form together with garnet and clinopyroxene. The reduction of CO_2, to elemental carbon will depend largely on the prevailing oxygen fugacity which is in turn dependent on pressure, temperature and bulk composition of the system.

3. OXYGEN FUGACITY DURING DIAMOND/GRAPHITE FORMATION

The oxygen fugacity prevailing during the reduction of carbon gases to elemental carbon is a constant at a given temperature and pressure

so long as both carbon gases and elemental carbon are present. An equation describing fO_2 of this buffer reaction was given by French and Eugster (1965) who extrapolated to high pressure and temperature for conditions where the partial pressure of CO_2 equalled total pressure and on the assumption that CO behaved as an ideal gas. Woermann et al.,(1977) on the basis of the demonstrated non-ideality of carbon dioxide at high pressure, experimentally determined the equilibrium under oxygen fugacities defined by the quartz-fayalite-magnetite and wustite-magnetite buffers and by least squares fit of the data determined the equation

$$\log fO_2 = 2.74 - \frac{19559}{T} + \frac{0.13(P-1)}{T}$$

where P is expressed in bars. Carbon gases are reduced to elemental carbon when fO_2 defined by the CCO buffer is equal to the fO_2 of the system, provided that the partial pressure of carbon gases is equal to the total pressure. The oxygen fugacity prevailing during eclogite crystallisation is not known, but some estimate may be obtained by calculating P,T curves when the oxygen fugacity defined by various experimentally determined buffer reactions is equal to the carbon-gas buffer. The equations used in calculating the P,T curves defined by equivalence of oxygen fugacity of the various buffers are presented in Heubner (1971). These equations are set equal to the equation of Woermann et al.,(1977) and the P,T curves calculated are presented below.

$$fO_2(IW) = fO_2(CCO): \quad T = \frac{7756 + .75(P-1)}{3.83}$$

$$fO_2(IM) = fO_2(CCO): \quad T = \frac{9701 + .069(P-1)}{6.25}$$

$$fO_2(WM) = fO_2(CCO): \quad T = \frac{13171 + .047(P-1)}{10.38}$$

$$fO_2(MH) = fO_2(CCO): \quad T = \frac{4805 + .111(P-1)}{11.226}$$

$$fO_2(NNO) = fO_2(CCO): \quad T = \frac{5371 + .084(P-1)}{6.62}$$

$$fO_2(FMQ) = fO_2(CCO): \quad T = \frac{6179 + .037(P-1)}{6.26}$$

$$fO_2(Mn_{1-x}O{=}Mn_3O_4) = fO_2(CCO): \quad T = \frac{6121 + .049(P-1)}{11.64}$$

In the above equations P is expressed in bars. The equations are presented graphically in Figure 46.

In the broad pressure-temperature range 30 - 60kbars, 800 - 1600°C in which eclogite crystallisation probably occurred three buffers have oxygen fugacities equal to the carbon-gas buffer: these buffers are

$$\text{FMQ:}\quad 3Fe_2SiO_4 + O_2 = 2Fe_3O_4 + 3SiO_2$$

$$\text{NNO:}\quad 2Ni + O_2 = 2NiO$$

$$\text{WM:}\quad 6FeO + O_2 = 2Fe_3O_4$$

The above reactions are geologically reasonable for they indicate that in this range iron is in the Fe^{2+} and Fe^{3+} states, and that nickel may be in the Ni^{2+} state or may occur as native metal. The FMQ buffer is thought to be the controlling buffer in the crystallisation of basalts at atmospheric pressure. It appears likely that during the crystallisation of eclogite oxygen fugacities may have been very near to the carbon-gas buffer, and that by changes in temperature carbon gases may have been reduced to elemental carbon.

The temperature and pressure of crystallisation of eclogite may be more closely fixed by combination of the P-T curves defined by K_D ratios (Raheim and Green, 1974) and the graphite-diamond reaction curve (Bundy et al., 1961).

A point which may be noted from the P,T curves of equivalent oxygen fugacities of various buffers and the CCO buffer is that dP/dT of all these curves is positive. Assuming the mantle to be buffered by a similar assemblage throughout, release of pressure will result in the oxidation of elemental carbon to carbon gas (Figure 46). If CO_2 is to exist at depth, percolate upwards and be reduced to elemental carbon, it is necessary that either there is a decrease in temperature with decreasing pressure, or if temperature remains constant, that the oxygen fugacity at depth be more oxidising than the oxygen fugacity prevailing during diamond formation. It is generally accepted that temperature increases with depth (e.g. Clark and Ringwood, 1964). However Harte and Gurney (1975b) suggest that the metasomatising fluid at Matsoku had a lower oxygen fugacity than garnet peridotite into which it intruded. Thus available evidence suggests that if CO_2 is stable relative to elemental carbon at great depths, but not at lower depths, this stability is promoted by higher temperatures at great depths, rather than by a higher oxygen fugacity at depth.

4. TEMPERATURE AND PRESSURE OF CRYSTALLISATION OF DIAMONDIFEROUS ECLOGITES

The three type I diamondiferous eclogites studied, HRV313, PJL18 and WRV4 have $\ln K_D$ ratios of 1.05 - 1.07, 1.20 - 1.23 and 1.27 respectively. The intersection of the K_D curves with the diamond-graphite reaction curve may be calculated by mutual solution of the Raheim and Green (1974) equation

$$T = \frac{3686 + 28.35P}{\ln K_D + 2.33}$$

and the Bundy et al. (1961) diamond-graphite reaction equation

$$P = 7.1 + .027T \quad \text{to yield}$$

$$T = \frac{3887}{\ln K_D + 1.56}$$

Minimum temperatures and pressures of these rocks are 1205°C - 47kb, 1120°C - 44.7kb and 1100°C - 44.2kb respectively, assuming that diamond formed contemporaneously with eclogite.

The two type II diamond-graphite bearing eclogites HRV247 and XRV22 have $\ln K_D$ ratios of 1.21 - 1.44 and .97. Coexistence of diamond and graphite in these two rocks confines the temperature and pressure of equilibration to within a limited range from the diamond-graphite reaction curve. Indicated conditions of formation are 1130°C - 45kb to 1023°C - 42kb for HRV247 and 1263°C - 48.6kb for XRV22.

Type II graphite bearing eclogite HRV309 has an $\ln K_D$ ratio of .83 and indicated maximum temperature and pressure of equilibration of 1353°C - 51kb.

The pressure range indicated for the type I eclogites is 44 to 47kb, and for the type II eclogites the range indicated is 42 to 48.6kb with an upper limit from graphite eclogite HRV309 of 51kb. The type II eclogite, XRV22 appears to have crystallised at higher pressures than the other rocks. However it is possible that the Raheim-Green equation is not applicable to this rock or to HRV309, for orthopyroxene appears to have been present in these rocks. The presence of orthopyroxene in HRV309 is indicated by the friable

dark mineral thought to be an alteration product of orthopyroxene which constitutes about 2% of the rock. XRV22 was of similar appearance, and also belongs to this group on the basis of mineral compositions. Theoretical evidence for the presence of orthopyroxene rests on the Ca_{gt} - Na_{cpx} plot in which these rocks plot on the trend line controlled by the orthopyroxene buffer reaction (Chapter V, reaction 3).

In the presence of orthopyroxene, the Ca content of garnet and clinopyroxene is buffered and the strong pressure dependence of the garnet-cpx Fe-Mg exchange reaction disappears (Wood, 1976a). The Raheim-Green equation is no longer valid. Akella and Boyd (1974) have determined K_D values for orthopyroxene bearing rocks. The equation

$$T = \frac{4620}{2.31 + \ln K_D}$$

can be fitted to the data of Akella and Boyd (1974). Temperatures from the above equation for XRV22 and HRV309 are 1135°C and 1198°C respectively. In the presence of orthopyroxene temperature can also be estimated from the diopside-enstatite solvus. Using the data of Davis and Boyd (1966) to which the equation

$$T = 1174 + 287(Ca/Ca+Mg) - 712(Ca/Ca+Mg)^2$$

can be fitted temperatures of 1156°C and 1158°C for (Ca/Ca+Mg) ratios of .457 and .451 for XRV22 and HRV309 can be estimated. As orthopyroxene cannot be analysed recent correction procedures (e.g. Wood and Banno, 1973; Wells, 1977) cannot be applied. Temperatures from the Di-En solvus match well with those calculated according to the Fe-Mg exchange reaction using Akella and Boyd's determinations, and strengthen the evidence for the presence of orthopyroxene in HRV309 and XRV22. An equilibration temperature of 1156°C (for XRV22) yields, on intersection with the diamond-graphite reaction curve, a pressure of 45.7 kb. This pressure is 2.9 kb less than that calculated from the Raheim and Green equation, and narrows the pressure range (by 1.6 kb) over which Roberts Victor diamond bearing eclogites appear to have equilibrated. A narrower pressure range is in accord with the occurrence of the Roberts Victor eclogites at a discrete depth within the mantle, rather than as isolated and unrelated bodies occurring over a wide depth range in the mantle.

Accepting that primary orthopyroxene was present in the nodule the P,T range of equilibration of Roberts Victor diamondiferous eclogites is 42 to 47 kb and 1023°C to 1205°C. The temperature and pressure at which the curve fO_2(NNO) = fO_2(CCO) intersects the diamond-graphite reaction curve is encompassed by this range, thus if oxygen fugacity during eclogite crystallisation is approximated by the nickel-nickel oxide buffer, diamond, graphite and carbon gas may coexist.

5. ORIGIN OF TYPE I DIAMONDIFEROUS ECLOGITES

The origin of the type I diamond bearing eclogites may be related to the general sequence of events deduced for this group. In Chapter V it was argued that because of the textural similarity of the rocks in this group, and because the iron enrichment trend could be shown to evolve into the calcium enrichment trend, the type I eclogites formed, in large measure, by fractional crystallisation processes; and hence a magma chamber existed throughout the evolution of these rocks. The concentrations of volatiles in this magma chamber would increase during crystallisation, and higher CO_2 concentrations would build up in the evolved compositions.

Of the 6 type I diamondiferous eclogites from Roberts Victor, 5 belong to the evolved calcium-rich group.

At a constant pressure, say 45 kbars graphite will be stable at higher temperatures (above 1100°C) while diamond will be stable at lower temperatures. Thus the type I diamondiferous eclogites are thought to form in the later stages of evolution of the type I magma both because of the increased concentrations of CO_2, and because of the lower temperatures of crystallisation in the evolved magma.

6. ORIGIN OF TYPE II DIAMONDIFEROUS ECLOGITES

The type II eclogites are of variable texture, and individually of variable composition. These rocks are thought to have formed from a series of partial melts which were largely crystallised before

addition of the next pulse, and volatiles built up during crystallisation of a particular magma may have dissipated before addition of the next pulse.

Melting to produce the Roberts Victor eclogite magmas resulted from a thermal input and a volatile input which lowered solidus temperatures (Kushiro et al., 1968). A high volatile input appears to have been necessary in the genesis of certain type II eclogite magmas in order to produce the compositionally varied, rapidly quenched chrome-rich eclogites (ChapterVIII) and to allow crystallisation of primary mica in type II eclogites HRV274 and others (Chapter IV). Volatile input may have been relatively more important than thermal input in the genesis of the type II eclogites when compared with the type I eclogites and high concentrations of carbon dioxide in the type II eclogites may simply be a consequence of high volatile input during melting.

High concentrations of CO_2 during melting results in the production of calcium-rich melts (Harte et al., in prep.). Calcium-rich eclogites should crystallise from melts formed in the presence of high CO_2 concentrations, and in fact 5 of the 6 type II diamond bearing eclogites are calcium-rich members.

7. RELATION OF DIAMOND BEARING ECLOGITES TO OTHER DIAMONDIFEROUS ROCKS

In this chapter it has been proposed that carbon necessary for diamond formation is introduced in a mobile phase which originates at depths below subcontinental garnet lherzolite. The garnet lherzolite itself is thought to possess negligible amounts of carbon prior to input of this mobile phase. Eclogite forms by partial melting of garnet lherzolite, extracting much of the garnet and clinopyroxene in garnet lherzolite. The residuum may be garnet lherzolite, garnet harzburgite, harzburgite, garnet dunite or dunite. Chromite may form during melting and crystallise in the residuum in association with any of the above assemblages. Garnet "dunite" BD1195 and chrome harzburgite RV12 may represent residual phases after extraction of eclogite. BD1195 contains the subcalcic garnet so commonly found included in diamonds.

The two most common diamond bearing parageneses, eclogite and dunite-harzburgite are thought to be related in that eclogite represents the liquid extract from sub-continental garnet lherzolite and dunite-harzburgite the corresponding residua.

The residual dunite-harzburgites may be expected to be far more abundant than the eclogite extract since potential eclogite in garnet lherzolite (garnet plus cpx) is generally less than 16% (Cox et al., 1973). The relative proportions are strongly weighted in favour of the dunite-harzburgite suite in diamond inclusions, but of diamond bearing rocks eclogites are the most abundant and it is only recently that diamond bearing lherzolites (Dawson and Smith, 1975; Pokhilenko et al., 1976) and dunite-harzburgites (MacCallum and Eggler, 1976; Sobolev et al., 1969 ; Pokhilenko et al., 1977) have been recorded. Many of the diamond bearing dunite-harzburgites are extensively altered (Sobolev et al., 1969 ; MacCallum and Eggler, 1976) and this alteration may result in their easier destruction during transport in kimberlite (See ChapterIII) and consequently their rare recovery from kimberlite.

XI WHOLE ROCK CHEMISTRY

INTRODUCTION

In discussing the whole rock chemistry of the Roberts Victor eclogites, some consideration must be given to the nature of the samples analysed, and to the several factors which impede the determination of a statistically valid whole rock analysis.

Many of the eclogites brought to surface are not homogeneous on the 10 cm scale (i.e. nodule size), and in extreme cases, on the 1 cm scale. Inhomogeneities are present in the form of layers of varying modal amounts of garnet and cpx varying in thickness from 1 cm to an unknown upper limit, as chemical inhomogeneities in individual mineral grains and as localised heterogeneities represented by megacrysts and kyanite eclogite zones.

Abrasion and alteration in kimberlite has further obscured the bulk chemistry of the eclogites. Clinopyroxenes are more readily altered than garnets, and altered clinopyroxene is more prone to abrasion by kimberlite, so that eclogite samples brought to surface may be biased in favour of garnet rich compositions (Chapter III).

Because of alteration by the kimberlite and metasomatism in the mantle the intergranular mineralogy of eclogite may not reflect the bulk composition prevailing during eclogite genesis. Provided that the bulk chemistry of eclogite has not been too severely modified by this process, bulk rock analyses may be employed to examine

i) the differences between type I and type II eclogites,

ii) the variation of major and trace elements during evolution of the magmas,

iii) the nature of the compositional variation in individual inhomogeneous eclogites,

iv) whether different eclogite types are cumulates, eclogite liquids associated with eclogite cumulates (MacGregor and Carter, 1970) or whether eclogites represent quenched partial melts derived from garnet peridotite, and

v) the relationship of eclogites to basalts.

The type I eclogites analysed in this study are KRV1 - 8 (S.C. Davids, major element analysis), HRV17, HRV77, HRV110, HRV127, JJG2, JJG4 and JJG181. HRV17 is an inhomogeneous kyanite eclogite. Four portions of this rock, A, B, C, D were analysed, and the results have been discussed in Chapter VII. HRV77 is a megacryst bearing rock described in Chapter VI. HRV110 contains altered orthopyroxene in one portion of the rock, HRV110M. JJG4 is a homogeneous kyanite eclogite. JJG181 is a phlogopitised eclogite. The other rocks are typical type I eclogites.

The type II eclogites analysed are RV372, JJG41 (S.C. Davids, major element analysis), HRV173, HRV267, HRV116, HRV132, HRV147, HRV158, HRV180, HRV243, HRV272, HRV309, JJG5, HRV277.

RV372 is an inhomogeneous corundum-spinel eclogite. Spinel was identified by Williams (1932) but was not present in the slides available to the writer.

JJG41 is a megacryst bearing eclogite described by Harte and Gurney (1975a).

HRV173, HRV132, HRV180 and HRV243 are inhomogeneous chrome-rich eclogites described in Chapter VIII. Garnet-rich and cpx-rich portions of HRV173 and HRV132 and three portions of HRV243 were analysed.

HRV243CR is the chrome rich layer, HRV243M is adjacent to and HRV243OE is further from the chrome rich layer.

HRV267 contains altered orthopyroxene which was fresh enough to be qualitatively analysed and exhibits jadeite rich and jadeite poor zones in individual grains (Table 4). A garnet rich layer, HRV267GT and a clinopyroxene-orthopyroxene rich layer HRV267CP were analysed.

HRV116 is a fine grained corundum-kyanite eclogite. Only the bimineralic portion of this rock was analysed as the kyanite eclogite zone was too small to be removed without irreparably destroying the textural features illustrated by this rock.

HRV147 contains a kyanite rich layer. The kyanite free portion was analysed, but although four analyses of the kyanite rich portion were carried out a satisfactory major element analysis could not be obtained.

HRV158 is an homogeneous type II main group eclogite.

HRV272 is a coarse grained corundum-kyanite eclogite, which

although evolved in terms of Ca, Mg, Fe, Na contents, contains high levels of Cr_2O_3.

HRV309 is a graphite bearing eclogite (Chapter X). The graphite rich portion, HRV309G, and the graphite poor portion, HRV3090E, were analysed.

JJG5 ia an inhomogeneous rock with mineral compositions ranging from evolved main group compositions toward compositions of the calcium-iron rich eclogites.

HRV277 is a coesite-sanidine grospydite described by Smyth and Hatton (1977).

The samples are grouped as follows:

Type I
- Phlogopitised eclogite, JJG181;
- Garnet websterite, HRV110;
- Main group, KRV3, KRV6, KRV7, KRV8, JJG2, HRV77;
- Iron rich eclogites, KRV1, KRV2, KRV4, KRV5;
- Calcium rich eclogites, HRV17, HRV127;
- Homogeneous kyanite eclogite, JJG4.

KRV7 has zoned garnet compositions varying from 5½ to 6½ wt.% CaO, i.e. across the boundary between main group and calcium rich eclogites. HRV77 has garnet compositions (17 - 18%) across the boundary between calcium rich and iron rich eclogites.

Type II
- Garnet websterites, HRV267, HRV158, HRV180, HRV243, HRV309;
- Magnesian eclogites, HRV173, HRV132, JJG5;
- Calcium-iron rich eclogites; RV372, HRV147, HRV272, JJG41;
- Fine grained corundum kyanite eclogite, HRV277;
- Coesite-sanidine grospydite, HRV277.

In addition to the eclogites whole rock analyses of three kimberlites, JJG1, JJG28, JJG29 (J.J. Gurney, major element analyses), and trace element analyses of a garnet lherzolite, KRV9, and a lherzolite, KRV10 were carried out. Values of Co, Cr and V in the peridotites may be inaccurate as the mass absorption coefficients were calculated from estimated whole rock analyses.

COMPARISON OF TYPE I AND TYPE II ECLOGITES

There are large variations in the concentrations of particular elements within individual eclogites, and for this reason mean values calculated for this group are statistically of limited value. The type I eclogites are usually homogeneous. Existing inhomogeneities in this type are represented by megacrysts or kyanite eclogite zones and analyses of these have been excluded from calculation of mean values. More reliance can therefore be placed on the mean values calculated for type I eclogites than on those calculated for type II. The mean and extreme values are depicted in Figure 47 where the values for type I eclogites are placed above the oxide or trace element symbol, and the values for type II eclogites placed below. The ranges of concentrations in the two groups overlap in most cases.

Significant differences in the concentration of zinc are noted. Although the ranges overlap, only three type II eclogites, all kyanite bearing; HRV277 (38 ppmw Zn), HRV147 (46 ppmw Zn) and HRV272 (86 ppmw Zn) have Zn concentrations above 30 ppmw Zn. The type I eclogites examined have greater than 30 ppmw Zn, with the exception of kyanite eclogite JJG4 (18 ppmw Zn).

Differences in the concentrations of other elements are less clear. Concentrations of Fe (as Fe_2O_3), TiO_2, Cu are usually higher in the type I eclogites, while concentrations of Cr_2O_3 are usually higher in the type II eclogites.

Mean values of MnO, Na_2O, Zr, Co and V are higher in type I eclogites while SiO_2, MgO, CaO, K_2O, Sr and Ni are higher in the type II eclogites.

Higher K_2O in type II eclogites is thought to be due to the more common occurrence of garnet websterites in the type II eclogites. Orthopyroxene is more readily altered to phlogopite than cpx or garnet, thus during phlogopitisation more K_2O is fixed in the garnet websterites than in eclogites. All garnet websterites contain greater than .6 wt.% K_2O.

COMPOSITIONAL VARIATION DURING EVOLUTION

During the evolution of a magma by fractional crystallisation, or with decreasing degrees of partial melting the concentration of MgO should decrease. Within the range of MgO contents exhibited by the eclogites no systematic changes in the concentrations of trace elements was discerned. The absence of any good correlation between MgO and trace elements may be due to the processes of abrasion and alteration discussed previously, but it is thought to be more likely that inconsistent trends reflect the complex nature of the formation of the Roberts Victor eclogites.

COMPOSITIONAL VARIATION IN INHOMOGENEOUS ECLOGITES

Compositional differences between different portions of inhomogeneous eclogites have been documented in the relevant chapters (VI, VII, VIII).

CUMULATE-LIQUID RELATIONS

Previous studies have regarded the Roberts Victor eclogites as a series of partial melts (Kushiro and Aoki, 1968) or as cumulates from an eclogitic magma, and the associated liquids (MacGregor and Carter, 1970). Whole rock data of rocks studied by MacGregor and Carter (1970) has been presented by Chen (1972).

In contrast to the clustering of type II eclogites at low Zn values observed in this study, type II eclogites analysed by Chen have Zn values greater than 30 ppmw, with the exception of one rock, R-8A, which has 27 ppmw Zn, in common with most of the type II eclogites examined in this study. The discrepancy is clarified by a consideration of MgO contents.

Most of the type II eclogites analysed by Chen (1972) have MgO contents below 10 wt.%. Only one sample, R-8a, has the high MgO values of the type II magnesian eclogites and garnet websterites. It appears that the sample suite analysed by Chen contained a higher proportion of the low MgO, type II calcium-iron rich eclogites than the present study.

The two studies are compared in a plot of Zn vs MgO (Figure 48). For convenience this plot has been divided into four fields, high Zn, low MgO (Zn 30, MgO 10), high Zn, high MgO (Zn 30, MgO 10), low Zn, high MgO (Zn 30, MgO 15), and low Zn, low MgO (Zn 30, MgO 15).

The high Zn, low MgO field includes all the type II eclogites (except R-8a), and includes a type I eclogite analysed by Chen (1972). Coesite sanidine grospydite HRV277 and corundum kyanite eclogite HRV272 fall in this field.

All the type I eclogites analysed in this study, except kyanite eclogite JJG4, and all but two of Chen's type I eclogites fall in the high Zn, high MgO field. Type II kyanite bearing eclogite HRV147 falls in this field but has lower MgO and Zn than the other members.

The type II magnesian eclogites and garnet websterites all plot in the low Zn, high MgO field. Chen's type II eclogite R-8a, and type I eclogite R-3a also plot in this field.

Three samples, type I kyanite eclogite JJG4, type II corundum eclogite RV372 and type II megacryst bearing eclogite JJG41 plot in the low Zn, low MgO field.

The Roberts Victor eclogites can be assigned to three principal groups which have restricted MgO and Zn contents.

Most Roberts Victor eclogites can be assigned to the type I category. These eclogites usually have 10 wt.% MgO and 30 ppm Zn. Three samples identified as type I eclogites fall outside this range (kyanite eclogite R-14 and phlogopite rich eclogite R-3a of Chen (1972), and kyanite eclogite JJG4 of the present study), and only one type II eclogite, kyanite eclogite HRV147, falls within this range. The type I eclogites appear to be a well-defined group with the two independent categorisations in good agreement.

Type II magnesian eclogites have 15 wt.% MgO, and 30 ppm Zn. Sample R-3a was assigned by Chen to the type I eclogites but falls within this range.

Type II calcium-iron rich eclogites have MgO 10 wt.% and Zn 30 ppmw. All but one of the type II eclogites analysed by Chen fall within this range. Mineral analyses of calcium-iron rich eclogites carried

out in this study suggest that in many cases the MgO content is greater than 10 wt.%. Thus there would be overlap of type II calcium-iron rich eclogites with type I eclogites.

MacGregor and Carter (1970) stated that the type II eclogites might represent liquids left after the extraction of the type I eclogites as cumulates. From a consideration of the analyses of the rocks by Chen (1972) it is apparent that MacGregor and Carter referred in particular to the type II calcium-iron rich eclogites. Magnesian eclogite R-8A and the magnesian eclogites examined in this study cannot represent liquids from type II eclogites unless Zn is partitioned into the crystal phase or MgO into the liquid. Neither of these possibilities is thought to be likely and the type II magnesian eclogites are therefore not thought to be residual liquids after extraction of the type I eclogites as cumulates. On the basis of whole rock chemistry the hypothesis that the type II calcium-rich eclogites are liquid extracts cannot be disproved, but mineral chemistry indicates that this too is unlikely. Calcium-iron eclogites HRV15 and HRV247 display compositional variations toward MgO rich compositions typical of the type II magnesian eclogites and indicate that the type II magnesium and calcium-iron rich eclogites formed by similar processes. The type II eclogites are thought in this study to represent a series of quenched partial melts. Kushiro and Aoki (1968) have previously proposed a similar hypothesis. Some settling of crystals may have occurred as the layering in certain type II magnesian eclogites and garnet websterites (e.g. HRV267, Plate 3) may be of cumulate origin. In general, however, the variable composition displayed by individual type II eclogites is most readily explained by the hypothesis that the type II eclogites represent a series of partial melts derived by localised melting of garnet lherzolite.

The type I eclogites are thought to represent a set of cumulates from a magma chamber which persisted for the entire period of formation of the type I eclogites (Chapter V). The magma from which the type I eclogites precipitated need not necessarily have been of great volume for fresh pulses of magma may have been periodically added to a relatively small magma volume. Mixing of fresh pulses of magma would modify the simple process of settling of cumulates, but the persistence of a liquid throughout the evolution of the type I eclogites would

ensure that they followed a single broad trend. Thus the calcium enrichment trend in the type I eclogites begins when Na_2O in cpx = 4½ wt.%, and continues after the iron enrichment trend (Figure 12h, CaO in garnet vs. Na_2O in cpx). In contrast the calcium-enrichment trend in the type II eclogites does not continue from the iron-enrichment trend, and begins when Na_2O in cpx = 2 wt.% (Figure 17h).

The type II calcium-iron rich eclogites are thought to be derived directly by low degrees of partial melting of garnet lherzolite. At these low degrees of melting a liquid with a high Ca/Mg+Fe ratio is produced and orthopyroxene does not crystallise from the liquid extract. In consequence the calcium content of garnet and cpx is unbuffered (Chapter V) and CaO in garnet increases with increasing Na_2O in cpx.

The type II garnet websterites and magnesian eclogites are thought to be derived by higher degrees of partial melting during which a liquid with a low Ca/Mg+Fe ratio is produced. Orthopyroxene crystallises from the liquid extract. The calcium content of garnet and cpx is buffered and CaO in garnet decreases with increasing Na_2O in cpx.

The type I eclogites are thought to be derived by extensive melting and orthopyroxene crystallises from the liquid. Because the type I eclogite magma chamber persists throughout the formation of the eclogites and when, after precipitation of garnet websterites, the magma attains a Ca/Mg+Fe ratio high enough to inhibit orthopyroxene crystallisation, high levels of Na_2O have been built up in the magma chamber and the calcium enrichment trend commences at high levels of Na_2O in cpx.

The pattern of evolution of the type I eclogites reflects the evolution of a persistent magma chamber through garnet websterite precipitation, the evolution of biminerallic eclogite with increasing CaO in garnet and the final precipitation of kyanite eclogite.

The pattern of evolution of the type II eclogites reflects the crystallisation of independent magma chambers derived by differing degrees of partial melting.

RELATION OF ECLOGITES TO BASALTS

Kushiro and Aoki (1968) illustrated a similarity between the major element chemistry of picritic basalt and their analyses of six Roberts Victor eclogites (See Nixon, 1973). The data from the present study obtained from a larger number of rocks essentially supports this conclusion, for type I eclogites, and indicates that there is also a reasonable agreement in terms of trace element concentrations.

The type II eclogites are excluded from comparison because of the inhomogeneous nature of many of these samples, and because the inferred origin of these rocks, by localised partial melting, suggests that their extrusion at surface is unlikely.

For the type I eclogites, the range in compositions overlaps with the composition of a putative primary picritic basalt from Baffin Bay (Clarke, 1970) for the elements Si, Al, Cr, Fe, Mn, Ca, Na, Sr, Y and Zn. However the Baffin Bay picrite has higher Mg and Ti and lower K than any rock in the range of type I eclogite compositions. The content of K_2O in the eclogites is largely due to alteration and the formation of secondary phlogopite (Berg, 1968). It might be considered that higher Ti in the Baffin Bay picrite is produced by evolution of the magma en route to surface, but precipitation of olivine, orthopyroxene and/or clinopyroxene would lower the Mg content. Higher contents of both Mg and Ti in the Baffin Bay picrite indicate that there was an initially higher Ti content in the source area for the latter.

Comparison with average Karroo dolerite and average Lesotho basalt (Cox et al., 1973) indicates an overlap for most elements in the type I Roberts Victor eclogites, except for higher Ti, Zr and Y and lower Mg, Ni, Co and Cr in the basalt and dolerite compositions. The overlap in K content may not be real as most of the K in the eclogites is of secondary origin. Loss of olivine and chromite from the basalt and dolerite is indicated. The necessary amount of olivine lost in order to decrease the MgO content is approximately 15%. Even if the initial liquid had the highest MgO content of the type I eclogites (16 wt.%) the amount of olivine lost can be no greater than

20%. Ti in the basalts and dolerites is twice that in the type I eclogites, so resultant depletion in Mg content by loss of 50% of a Ti-free precipitate such as olivine would lower Mg contents to levels considerably below those observed in the basalts and dolerites. It is thus indicated that the magma from which the basalts and dolerites originated originally had a higher Ti content than the type I eclogites and Zr and Y contents too were probably initially higher.

The relatively high Ti content of magmas extruded at surface may be due to higher Ti in the source area, or Ti may have been introduced during the melting event which produced the primitive basalt compositions. The Ti may have been introduced in a mobile fluid akin to the metasomatising fluid postulated by various authors (Harte and Gurney, 1975. Lloyd and Bailey, 1975; Erlank and Rickard, 1977) and invoked in this study as an explanation for the localised melting of type II eclogites (Chapter VIII) and to account for the addition of Ti, C and S to diamondiferous eclogite HRV247 (Chapter X). Certainly, the titanium levels reported in the bulk compositions and minerals of the common peridotite commonly accepted to predominate in the mantle are completely inadequate to provide the observed abundance of this element in basalts, presuming some reasonable degree of partial melting occurs. The titanium problem is therefore not confined to Roberts Victor eclogite, and is much more severe for the generation of bulk compositions of up to 9 wt.% TiO_2 in Namaqualand olivine melilitites, if these rocks have a mantle origin.

XII DISCUSSION AND CONCLUSION

INTRODUCTION

In this final chapter the broad features displayed by the Roberts Victor eclogites are discussed. The physical conditions which may have prevailed during the formation of the Roberts Victor eclogites are briefly outlined, but the bulk of the chapter is devoted to a consideration of the petrogenesis of the Roberts Victor eclogites.

TEMPERATURE AND PRESSURE OF FORMATION

The conditions of equilibration of eclogite assemblages can be estimated from the equation presented by Raheim and Green (1974) based on the exchange reaction of iron and magnesium between garnet and cpx. In order to apply this equation the amounts of ferrous iron in garnet and clinopyroxene must be known. Ferrous iron is not directly determined during microprobe analysis, but can be estimated from stoichiometric considerations. However the amount of ferrous iron determined by this method is a function of the analytical accuracy of the mineral analysis. In clinopyroxenes total iron is low and small variations in the analytical accuracy of the mineral analysis result in a relatively large variation in the amount of ferrous iron calculated. These consequently lead to large variations in the calculated K_D ratio. Due to the variability in calculated ferrous iron it was decided to calculate K_D values on the basis that all iron exists as ferrous iron. Wet chemical determinations of the amount of ferric iron present in garnet and cpx from Robert Victor eclogites have been carried out by O'Hara et al. (1975) and indicate that between 25 and 33% of iron in clinopyroxene and less than 5% of iron in garnet is in the ferric state. From these determinations of the amounts of ferric iron, the temperatures calculated from K_D ratios on the assumption that total iron equals ferrous iron are usually between 50 and 100^{o}C too high.

A further possible inaccuracy in the temperatures and pressures calculated from the Raheim and Green equation may result from compositional effects. Raheim and Green's empirical determination is directly applicable

only to compositions similar to the experimental material, i.e. quartz tholeiite. The Roberts Victor eclogites are generally closer to olivine tholeiite and picrite than to quartz tholeiite compositions. However, more important than the bulk composition of the system is the nature of the phases crystallising during eclogite formation. It has been argued in this study that the crystallisation of orthopyroxene buffers the calcium content of garnet and clinopyroxene. This buffer reaction appears to remove the pressure dependence of the K_D ratio. In the orthopyroxene bearing system examined by Akella and Boyd (1975) no pressure effect was observed, whereas Raheim and Green's data in an orthopyroxene-free system indicate a strong pressure dependence of the K_D ratio. Some of the rocks examined in this study were found to contain altered orthopyroxene, and in other cases whilst orthopyroxene was not observed, the relation of CaO in garnet to Na_2O in cpx suggested that orthopyroxene may have been present at some stage in the crystallisation history of the rock. Thus it was not always clear whether a particular rock should be regarded as a garnet websterite or as a bimineralic eclogite and whether the temperature-pressure calculations should be carried out using the data of Akella and Boyd or of Raheim and Green.

Another consideration is whether temperatures and pressures calculated reflect the conditions of crystallisation of the rock or whether they reflect equilibration of the rock below the solidus. A general assumption in the geological literature has been that the temperatures and pressures calculated reflect the prevailing geotherm at the time of sampling of the nodules by kimberlite (e.g. Boyd, 1973). However in the present study a number of samples were found to illustrate a range of apparent temperatures within the same nodule. If a rock failed to reach internal equilibrium it is unlikely that it could have reached equilibrium with its surroundings, and therefore it cannot reflect the prevailing geotherm. If the range of apparent temperatures preserved in a single nodule is valid then these temperatures must reflect equilibration under conditions which are unrelated to the geotherm, but may be related to the temperatures of formation of minerals at the solidus, or to formation of minerals below the solidus by exsolution. Subsolidus equilibration of the minerals by processes other

than exsolution of newly formed minerals may have been insignificant, and the temperatures preserved would therefore reflect the temperatures of formation of the minerals.

In view of the uncertainties in the temperature and pressure estimates it is difficult to estimate the physical conditions of formation of the Roberts Victor eclogites with any degree of certainty. The best estimate is provided by the diamond-graphite eclogite HRV247. This rock is inhomogeneous and exhibits a range of K_D values. However the intersection of the range of K_D values with the diamond-graphite reaction curve defines the range of temperatures and pressures over which this particular rock may have formed. Assuming all iron is ferrous iron and using the theoretical diamond-graphite reaction curve of Bundy et al (1961) the conditions of formation of this nodule are 1040 to 1130°C and 42 to 45 kbar. It can thus be estimated that the Roberts Victor eclogites formed at a depth of approximately 130 km. The temperatures over which all the Roberts Victor eclogites formed are between 900 and 1300°C at these pressures.

PETROGENESIS OF THE ROBERTS VICTOR ECLOGITES

The Roberts Victor eclogites are thought to have originated by igneous processes related to the partial melting of garnet lherzolite. Other possible modes of formation are considered to be less likely.

ECLOGITE AS PRIMITIVE MANTLE

Eclogite is unlikely to represent primitive mantle material because the mean Roberts Victor eclogite composition is similar to primitive basaltic liquids (Chapter XI), and in order to derive basalt from eclogite inordinately high degrees of partial melting would be required. The unlikelihood of eclogite representing primitive mantle material is further underlined by the fact that the primitive Baffin Bay magma is more magnesian than mean Roberts Victor eclogite compositions, and similarly komatiite is too magnesian to have been derived from eclogite. Garnet lherzolite represents a more satisfactory mantle composition since only low degrees of melting and subsequent fractionation would be necessary to generate basaltic liquids from this

rock type. The physical properties of garnet lherzolite, its abundance in kimberlite pipes, and the similarity of composition between garnet lherzolite and estimates of mantle compositions derived from meteoritic compositions are further lines of evidence which indicate that the bulk of the upper mantle is far more likely to consist of garnet lherzolite than of eclogite.

ECLOGITE AS SUBDUCTED OCEANIC CRUST

Roberts Victor eclogite is not thought to represent subducted oceanic crust (Helmstaedt and Doig, 1975) because certain eclogites, particularly the type II magnesian eclogites and garnet websterites contain chrome contents in excess of 1 wt.% which are too high to be equated with chrome contents of transformed oceanic crust.

The possibility that the eclogites are residua from subducted oceanic crust after extraction of andesite magma (Green and Ringwood, 1967) is also unlikely because even assuming that oceanic basalt had the high Cr_2O_3 content of the Baffin Bay picrite (.28 wt.%), 72% of chrome-free andesite would have to be extracted in order to increase the chrome content to 1 wt.%. These high degrees of melting are thought to be unlikely.

The most likely alternatives for eclogite formation having been considered and rejected, the origin of eclogite by igneous processes is now considered.

ORIGIN OF ECLOGITE BY IGNEOUS PROCESSES

In general igneous rocks derived from primitive garnet lherzolite may represent the crystallised liquid extract, cumulates from the liquid extract, the residual liquid left after settling of cumulates or combinations of these.

Kushiro and Aoki (1968) considered that the Roberts Victor eclogites represent a series of partial melts derived by partial melting of garnet lherzolite. Although these authors indicated that the eclogites might represent a set of cumulates derived by fractional crystallisation of a liquid extract from garnet lherzolite this alternative was considered to be less likely.

MacGregor and Carter (1970) recognised two chemically and texturally distinctive types of Roberts Victor eclogite. Since both types were found at the same locality they argued the likelihood of a genetic relationship between them. The type I eclogites appeared to exhibit cumulate textures and the type II eclogites (largely type II calcium-rich eclogites of the present study) liquid textures, thus MacGregor and Carter proposed that the Roberts Victor eclogites were a related set of cumulates and the residual liquids related to these cumulates. An objection to this elegant hypothesis is that clinopyroxenes in the type I eclogites have higher K_2O contents than clinopyroxenes in the type II eclogites. If clinopyroxene is the principal potassium bearing phase in unaltered eclogite, the implication is that the liquid (type II eclogite) contains lower K_2O contents than the associated cumulate (type I eclogite). Such a pattern is contrary to the recognised behaviour of potassium as an incompatible element which is normally preferentially partitioned into the liquid. Further evidence against a cumulate-liquid relation between the type I and type II eclogites is that it is a type II eclogite that has the highest magnesian content of all the eclogites examined by MacGregor and Carter. The melt normally contains lower MgO contents than the associated cumulate thus if the type II magnesium-rich eclogite is to represent a liquid, a type I eclogite cumulate with a higher MgO content should exist. However, both in MacGregor and Carter's study and in the present study the most magnesium rich compositions are found in the type II eclogites.

Although the cumulate-liquid relation proposed by MacGregor and Carter is thought to be invalid, their argument that the geographical propinquity of the different eclogites suggests a genetic relationship between them is supported by the present study.

The Roberts Victor eclogites are thought to have originated in the same thermal event, but the mode of formation of each eclogite type is thought to have differed as a result of the interplay of a number of factors. The principal difference between the type I and type II eclogites is thought to depend on the length of time during which the liquid phase from which the eclogites crystallised persisted. During the evolution of the type II eclogites it is thought that a particular magma pulse had crystallised entirely before addition of the next pulse, and that the

type II eclogites therefore represent a series of independently crystallised partial melts. In contrast the type I eclogites are thought to have crystallised from a liquid phase which by continual addition of fresh magma, persisted throughout the formation of all of the type I eclogites. The type I eclogites can therefore be regarded as a set of cumulates related by fractional crystallisation.

THE ROLE OF VOLATILES

The melting event in which the Roberts Victor eclogites were generated is thought to have been induced both by heating of garnet lherzolite, and by the input of volatile phases during heating which served to lower the temperature of melting of garnet lherzolite. The relative importance of the volatile and thermal inputs varied during the formation of the type I and type II eclogites, with volatiles playing a larger role in the genesis of the type II eclogites.

The type II eclogites may have formed in the early stages of the Roberts Victor event. In these early stages the country rock was only heated to temperatures well below the dry solidus of garnet lherzolite. Sporadic access of volatiles to restricted volumes of garnet lherzolite would have served to induce localised partial melting. Because the volatile components would tend to preferentially migrate along planes of weakness in garnet lherzolite melting would tend to be localised in these zones. Loss of the volatile phase by exsolution and escape along fractures in adjacent rock would promote relatively rapid crystallisation of the melt. A further effect of a changing concentration of volatiles during crystallisation would be that the composition of the crystallising phases would vary as the proportion of sites of different co-ordination varied with the change in liquid structure caused by a fluctuating volatile content (Chapter VIII).

MELTING RELATIONSHIPS OF TYPE II CALCIUM-RICH AND CALCIUM-IRON-RICH ECLOGITES

The type II calcium rich and calcium-iron rich eclogites are thought to have formed by small degrees of partial melting of garnet lherzolite with garnet and clinopyroxene acting as the source of the liquid. The

contribution of olivine and orthopyroxene to the liquid was in most cases negligible, and it is thought that the amounts of olivine and orthopyroxene probably increased in the residuum during melting. In order to derive Ca, Na, Al or Fe rich liquids from garnet and clinopyroxene compositions in garnet lherzolite, melting must have occurred incongruently. The general melting relationship by which the type II calcium-rich and calcium-iron-rich eclogites were formed is

$$\text{garnet} + \text{cpx} = \text{opx} + \text{liquid}$$

with increased amounts of opx forming in the source area during melting.

The above melting relationships produce Ca-rich and Al-rich liquids by the individual melting relationships below:

$$CaMgSi_2O_6{}_{cpx} = MgSiO_3{}_{opx} + (CaSiO_3)_{liquid}$$

and

$$Mg_3Al_2Si_3O_{12}{}_{gt} = 3MgSiO_3{}_{opx} + (Al_2O_3)_{liquid}$$

In the production of biminerallic eclogites olivine appears to have played no part in the production of the liquids since the bulk composition of the crystallised liquid lies entirely within the eclogite composition plane (Figure 15). However in the production of kyanite - bearing and spinel-bearing eclogites, whose compositions lie respectively on the SiO_2-rich and MgO-rich side of the eclogite composition plane, the amount of olivine in the residuum increased in the case of the kyanite-bearing eclogites, and decreased in the case of the spinel-bearing eclogites.

In the production of kyanite-bearing eclogites orthopyroxene (or clinopyroxene or garnet) must melt incongruently with the formation of olivine in the residuum. The reaction relation is illustrated most simply for orthopyroxene:

$$Mg_2Si_2O_6{}_{opx} = Mg_2SiO_4{}_{olivine} + (SiO_2)_{liquid}$$

Kyanite, rather than coesite generally precipitates from the siliceous liquid since these liquids are generally high in alumina as well as silica:

$$(Al_2O_3)_{liquid} + (SiO_2)_{liquid} = Al_2SiO_5 \text{ kyanite}$$

In the production of spinel-bearing eclogites olivine must dissolve in the liquid:

$$Mg_2SiO_4\ \text{olivine} = (Mg_2SiO_4)\ \text{liquid}$$

Spinel precipitates by reaction of alumina with dissolved olivine:

$$(Mg_2SiO_4)\ \text{liquid} + 2(Al_2O_3)\ \text{liquid} = 2MgAl_2O_4\ \text{spinel}$$

Volatiles may have played an important role in determining whether the liquid compositions produced lay on the MgO-rich side or on the SiO_2-rich side of the eclogite composition plane. A water-rich volatile phase would increase the primary phase volume of olivine so increasing the amount of olivine in the residuum and allowing siliceous liquids to be produced, while a CO_2-rich volatile phase, or dry melting would result in the depletion of olivine in the residuum during melting and so lead to the production of silica-poor liquids.

MELTING RELATIONSHIPS OF THE TYPE II GARNET WEBSTERITES AND MAGNESIAN ECLOGITES

The type II garnet websterites and many of the type II magnesian eclogites originated by higher degrees of melting in which orthopyroxene entered the liquid phase. In these rocks orthopyroxene did <u>not</u> bear a reaction relationship with the liquid, and Na and Fe rich compositions were produced by melting of garnet and cpx to Fe-poor garnet and Na-poor opx with formation of opx in the residuum.

The presence of orthopyroxene as a dissolved phase in the liquid from which the type II garnet websterites crystallised resulted in the buffering of CaO contents of garnet and clinopyroxene by the reaction previously discussed in Chapter V:

$$3(Mg,Fe)_2Si_2O_6\ \text{opx} + Ca_3Al_2Si_3O_{12}\ \text{garnet} = 3Ca(Mg,Fe)Si_2O_6\ \text{cpx} + (Mg,Fe)_3Al_2Si_3O_{12}\ \text{garnet}$$

Because of the buffering reaction established by the low CaO/(MgO+FeO) ratio of the liquid Na_2O contents of cpx are related to CaO contents of garnet and as Na_2O in cpx increases, CaO in garnet decreases.

The type II magnesian eclogites exhibit a similar relation between Na_2O in cpx and CaO in garnet and it is possible that these rocks may have crystallised orthopyroxene which is not present in the sample size represented by the nodule collected by kimberlite.

Although the type II eclogites are interpreted as a series of crystallised partial melts the volume and time span of crystallisation of some melts does appear to have allowed some measure of crystal settling to have occurred. In particular certain of the magnesian eclogites and garnet websterites exhibit marked chemical differences between different parts of the rock as a result of variation in modal amounts of garnet and cpx across the rock.

ORIGIN OF HIGH CHROME CONTENTS

Chrome-rich compositions are often encountered in type II garnet websterites and magnesian eclogites, and in one type II calcium-rich eclogite, kyanite eclogite HRV272. High chrome contents are thought to arise when either of the principal chrome bearing phases, garnet or clinopyroxene disappears from the residuum during the melting event. While garnet or clinopyroxene remain in the source rock the chrome contents of these phases increases during melting and the chrome content of the associated liquid remains low. When either of garnet or clinopyroxene is entirely consumed the chrome content of the liquid increases markedly.

A correlate of this argument is that for the chrome-poor type II calcium-rich and calcium-iron-rich eclogites the degree of melting must have been considerably less than the total modal amount of garnet and clinopyroxene in the source rock, since a portion of garnet and clinopyroxene must have remained in the residuum as orthopyroxene after incongruent melting of garnet and cpx, and since some free garnet and clinopyroxene must have remained in the residuum in order to maintain the low chrome contents of the liquid. For the chrome-rich type II garnet websterites most of the garnet and clinopyroxene and small amounts of orthopyroxene entered the liquid thus the degree of melting must have been considerably higher.

The modal estimates of total garnet and cpx in the common peridotite of Cox et al. (1973) is 16%. From this estimate the degree of partial melting necessary to form the type II calcium-rich eclogites was probably less than 10%, while the type II garnet websterites and magnesian eclogites probably formed by 15 - 18% melting. The upper limit is approximately 20%, since the modal amounts of orthopyroxene in garnet websterites rarely exceeds 4%.

GENESIS OF THE TYPE I ECLOGITES

Fractional crystallisation is considered to have been relatively unimportant in the evolution of the type II eclogites, but for the type I eclogites fractional crystallisation is thought to have been more important than partial melting in determining the evolution of the rocks.

The type I eclogites may have formed after the type II eclogites in the following chronological sequence of events.

1. Type II calcium-rich and calcium-iron-rich eclogites formed by volatile induced partial melting of slightly heated garnet lherzolite. The volume of melt produced during each episode of melting was never large enough to persist long enough to allow interaction between the different melts produced.

2. Type II garnet websterites and magnesian eclogites formed by volatile induced partial melting of garnet lherzolite which had been heated to higher temperatures than those prevailing during formation of the type II calcium-rich eclogites. Consequently the degree of melting was higher and orthopyroxene entered the melt in appreciable amounts. Although the liquids produced persisted long enough to allow some degree of crystal settling, individual melts had largely crystallised before addition of the next pulse and the type II garnet websterites and magnesian eclogites similarly represent a series of partial melts.

3. The type I eclogites formed from strongly heated garnet lherzolite. Melt was produced in sufficient volumes and at sufficiently close intervals to ensure that a fresh pulse of magma was added to the magma chamber before a preceding pulse had entirely crystallised. Although some degree of evolution of individual magma pulses may have occurred, the broad trend exhibited by the type I eclogites is that of a set of cumulates whose

evolution was controlled by fractional crystallisation from the same magma chamber.

The type I eclogites as a group have a similar, easily recognisable texture, and many of the samples show distinctive mineralogical layering, but perhaps the best evidence for a fractional crystallisation origin is afforded by the pattern displayed by the concentrations of CaO in garnet and Na_2O in cpx. This pattern in the type I eclogites differs significantly from that displayed by the type II eclogites.

For the type II eclogites two distinctive patterns were observed.

The type II calcium-rich and calcium-iron-rich eclogites show a trend of increasing CaO in garnet with increasing Na_2O in cpx. This trend can be extended back to the low Na_2O contents (1 - 2 wt.%) typical of clinopyroxene in garnet lherzolite (Figure 17h).

The type II garnet websterites and magnesian eclogites exhibit a trend of decreasing CaO in garnet with increasing Na_2O in cpx. However this trend can similarly be extended back to the Na_2O contents typical of clinopyroxenes in garnet lherzolite (Figure 17h).

The type I garnet websterites and phlogopitised eclogites illustrate a poorly defined trend of decreasing CaO in garnet with increasing Na_2O in cpx which overlaps to some extent the trend exhibited by the type II garnet websterites and magnesian eclogites (Figure 12h). However the type I calcium-rich eclogites and certain of the iron-rich and main group eclogites exhibit a trend of increasing CaO in garnet with increasing Na_2O in cpx, but this trend is displaced to higher Na_2O contents when compared with the type II calcium-rich and calcium-iron-rich eclogites (See Figure 12h and Figure 17h). The trend exhibited by the type I calcium-rich eclogites can be extended back to 4 wt.% Na_2O in cpx. These high levels of Na_2O in cpx are not typical of clinopyroxenes in garnet lherzolites and those type I eclogites following the trend of increasing CaO in garnet with increasing Na_2O in cpx cannot be partial melts derived directly by melting of garnet lherzolite.

The high Na_2O contents of cpx combined with the low CaO contents of garnet at the beginning of the trend of increasing CaO in garnet with increasing Na_2O in cpx in the type I eclogites could only have been

produced by evolution of a liquid which crystallised orthopyroxene, clinopyroxene and garnet until the CaO/(MgO+FeO) ratio of the liquid became too high to permit further orthopyroxene crystallisation. At this point (at approximately 4 wt.% Na_2O in cpx) the buffering effect of orthopyroxene was lost and the CaO contents of garnet were free to increase along the calcium enrichment trend.

The evolution of the liquid in this manner can have been accomplished by fractional crystallisation but not by varying degrees of partial melting. The type I eclogites are therefore thought to represent a set of cumulates which crystallised from a persistent magma chamber, periodically replenished by fresh pulses of magma. The average composition of the magma from which the type I eclogites crystallised lay on the SiO_2 rich side of the eclogite composition plane so that in the later stages of evolution of the magma, possibly after the addition of fresh pulses had ceased, kyanite crystallised as a primary phase. In order for the mean composition of the liquid to lie on the SiO_2-rich side of the eclogite composition plane olivine must have formed during melting of garnet lherzolite, and the generalised melting relationship by which the type I eclogite magma formed can be represented as

garnet + cpx + opx = olivine + liquid.

Formation of olivine in the residuum suggests that melting took place in the presence of an H_2O-rich volatile phase.

The type I eclogites formed after a relatively long period of volatile input into the garnet lherzolite from which the type I eclogites were derived. One consequence of this preceding metasomatic input may have been the enrichment of garnet lherzolite in K_2O so that the liquids formed had high potassium contents which are reflected in the high K_2O contents of clinopyroxenes in the type I eclogites.

CONCLUSION

The Roberts Victor eclogites formed during a partial melting event in the mantle 2.5 billion years B.P. (Kramers, 1977). The depth at which melting took place has been estimated as 42 - 45 kbar

from the intersection of the diamond-graphite reaction curve with the K_D curves defined by phases in diamond-graphite eclogite HRV247.

In the initail stages sporadic access of volatiles to slightly heated garnet lherzolite induced localised partial melting and led to the production of the melts from which the type II calcium-rich and calcium-iron-rich eclogites crystallised. Three types of melting process by which these eclogites were produced have been identified.

1. In most cases melting proceeded by the incongruent melting of garnet and clinopyroxene to orthopyroxene and liquid. The liquid produced crystallised as biminerallic eclogite.
2. The type II kyanite eclogites formed by the incongruent melting of garnet and cpx to olivine, orthopyroxene and a siliceous liquid.
3. The type II spinel-bearing eclogites formed by the incongruent melting of garnet and cpx to orthopyroxene and liquid together with the melting of olivine to produce a silica poor liquid.

In 1 above the amount of olivine in the residuum remained constant, in 2 the amount of olivine in the residuum increased and in 3 the amount of olivine in the residuum decreased. The amount of olivine in the residuum can be related to the process and composition of the volatile phase present during melting. An H_2O-rich volatile phase increases the primary phase volume of olivine and results in an increased olivine in the residuum with the consequent production of silica-rich liquids. Dry melting or melting in the presence of a CO_2-rich volatile phase decreases the primary phase volume of olivine and results in the entry of olivine into the liquid with the consequent production of silica-poor liquids.

In the later stages of the Roberts Victor event the thermal input into garnet lherzolite increased and consequently the degree of partial melting increased. At these higher degrees of melting orthopyroxene entered the liquid phase with the production of the liquids from which the type II garnet websterites and magnesian eclogites crystallised. Although the thermal input was more important than in the production of the type II calcium-rich eclogites, volatile fluxing remained essential to the production of a liquid phase during formation

of the type II garnet websterites and magnesian eclogites.

During melting to produce the type II garnet websterites and magnesian eclogites garnet and clinopyroxene were sometimes eliminated from the residuum and chrome-rich liquids were produced. These chrome-rich compositions are characteristically inhomogeneous.

In the final stages of the Roberts Victor event the type I eclogites were produced when the thermal input increased to the extent that pervasive melting occurred throughout a large volume of metasomatised garnet lherzolite. Volatile fluxing was less important in these final stages, although the presence of an H_2O-rich volatile phase remained essentail to the production of a siliceous liquid composition. The magma produced evolved by precipitation of garnet websterite until the CaO/(MgO+FeO) ratio of the liquid increased to the point where orthopyroxene ceased to crystallise. Subsequent evolution of the magma occurred by the precipitation of biminerallic eclogite cumulates, until kyanite eclogite crystallised from the late-stage silica-rich liquids.

Stratigraphically the type I eclogites formed a vertical sequence with the first-formed garnet websterites at the base, biminerallic eclogite above and kyanite eclogite at the top of the sequence. The stratigraphic relations of the type II eclogites are difficult to estimate since they represent a series of partial melts which need not necessarily be present in a consistent vertical sequence. However the type II eclogites more probably lie in an irregular sequence above the type I eclogites since if they lay below the type I eclogites they would probably have been remelted during the pervasive melting event which is thought to have led to the production of the type I eclogites.

After the formation of the eclogites, the next event which can be discerned at Roberts Victor is the phlogopitisation of the eclogites. Phlogopitisation was concentrated near the base of the type I eclogite cumulate pile. Phlogopitisation appears to have affected the garnet websterites most strongly and resulted in the complete alteration of orthopyroxene in many cases. Dating of the mica by Allsopp and Barrett (1975) and Ozima and Saito (1975) suggests that phlogopitisation occurred in a mantle-metasomatic event 120 - 130 m.y. B.P.

Sampling of the eclogite and emplacement of the kimberlite took place 92 m.y. B.P. at roughly the same time that the kimberlite pipes around the town of Kimberley were emplaced (Davis, 1977). The kimberlite appears to have preferentially sampled eclogite above and within the phlogopitised horizon since very few samples of type I eclogites more magnesian than the phlogopitised eclogites have been brought to the surface.

Garnet peridotite appears to have been very sparsely sampled although the scarcity of garnet peridotite at the Roberts Victor mine may be related to alteration and abrasion in the kimberlite as discussed in Chapter IX.

Visual comparison of the Roberts Victor eclogites with eclogites from other South African localities indicates that the type I eclogites are abundant only at Roberts Victor. In the light of the interpretation of the melting events outlined in this study, this observation suggests that eclogites are commonly produced by volatile induced partial melting of localised zones of garnet lherzolite (type II eclogites) rather than by extensive melting of large volumes of garnet lherzolite by a pervasive thermal input (type I eclogites). Hence in the production of eclogites volatile induced partial melting appears to be more important than thermally induced partial melting in the subcontinental upper mantle below South Africa.

The importance of the volatile input in the production of liquids in the upper mantle is indicated by the presence in eclogite of phases such as diamond, graphite, sulphide, rutile, phlogopite and calcium carbonate which contain high concentrations of elements (C,S,Ti,K,H) not present in any great amount in subcontinental garnet lherzolite. These elements appear to be introduced from more fertile material lying below sterile garnet lherzolite. Sheared lherzolites have been suggested as this fertile material, but it is at least a possibility that this fertile material was trapped below the continental craton at an early stage in the earth's history, and has been relatively unmodified by the processes which led to separation of the core and the formation of the sterile subcontinental upper mantle. Consequently this material may be close in comparison to the carbonaceous chondrite from which the earth is

believed to have originally formed (Ringwood, 1975).

The high concentrations of K and Ti in the Karroo tholeiites and dolerites relative to the Roberts Victor eclogites (Chapter XI) suggests that the input of material from a source other than sub-continental garnet lherzolite was important also in the generation of continental basalt magmas. Furthermore kimberlites contain unusually high concentrations of incompatible elements which are present at very low levels in subcontinental garnet lherzolite. It therefore appears that the mobilisation of elements in the deep seated "fertile" material lying below sterile subcontinental garnet lherzolite may be a general feature of magmatism in subcontinental environments, and that the interface between subcontinental garnet lherzolite and underlying material has been the locus for a diversity of igneous processes throughout the geological record.

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THE GEOCHEMISTRY AND ORIGIN OF XENOLITHS FROM THE ROBERTS VICTOR MINE

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PLATES

1. Thin sections of a range of Roberts Victor rock types
2. Type II garnet websterite JJG307
3. Type II garnet websterite HRV267
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6. Type II magnesian eclogite HRV274
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10. Type II diamond-graphite eclogite HRV247
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14. Type I main group, inhomogeneous kyanite eclogite JJG40
15. Silicified and carbonated "garnet lherzolite" HRV310
16. Type I inhomogeneous kyanite eclogite HRV17
17. Type I eclogite HRV23

PLATE 1

Thin sections of a range of Roberts Victor rock types. Prints referred to are as labelled: from bottom to top, left to right. The illustrations are approximately 20% larger than the actual size.

1a. KRV4, type I iron-rich eclogite. Garnets contain inclusions. Cpx grains are generally altered. Cleavage is visible in a number of cpx grains.

1b. KRV1, type I iron-rich eclogite. Large rounded garnets in altered cpx.

1c. HRV77D, type I iron-rich eclogite in megacryst bearing rock. A slide of the megacryst is illustrated in 1e (Chapter VI).

1d. KRV2, type I main group eclogite with large garnet grains in a single crystal of cpx (showing distinct cleavage).

1e. HRV77A, cpx megacryst in HRV77. Clear garnet grains can be discerned within the megacryst while larger cloudy garnet grains are present at the edge of the megacryst (Chapter VI).

1f. HRV173A, garnet-rich portion of type II magnesian eclogite HRV173. (The cpx-rich portion is depicted in 1o). The garnets have been kelyphitised along prominent jointing planes in the rock (Chapter VIII).

1g. JJG318, type I calcium-rich eclogite illustrating the extensive alteration of jadeite-rich clinopyroxene in the type I calcium-rich eclogites.

1h. JJG183, type II magnesian eclogite with chrome-rich compositions. Garnets have high relief and contain numerous inclusions (Chapter VIII).

1i. JJG177, kyanite-eclogite portion of type I main group, inhomogeneous kyanite eclogite. (The biminerallic portion is illustrated in 1j). Garnets have been altered along jointing planes, kyanite is the clear high relief mineral and the clinopyroxene has reverted to an opaque turbid mass (Chapter VII).

1j. JJG177, type I main group eclogite, biminerallic eclogite portion of inhomogeneous kyanite eclogite. Clinopyroxenes in this portion are relatively unaltered. Cleavage is present in a large clinopyroxene grain at the lower edge of the Plate (Chapter VII).

1k. HRV243, type II garnet websterite with variable chrome content. Chrome is highest in minerals at the lower edge of the slide (Chapter VIII).

1l. JJG179, type I calcium-rich eclogite. The slice was cut across the interface between biminerallic eclogite and an inhomogeneous kyanite eclogite zone present in this rock. Relict grains of clinopyroxenes are visible in the upper (biminerallic eclogite) portion of the slide, but in the lower portion all clinopyroxene has reverted to the turbid opaque alteration product.

1m. HRV116, "type II" inhomogeneous kyanite eclogite. The lower quarter of the slide consists of fine-grained biminerallic eclogite, with extensive phlogopitisation of the lower right, and the upper three quarters consists of kyanite eclogite (Chapter VII).

1n. HRV67, type II calcium-rich eclogite with elongate clear garnet grains, and altered cpx grains. In hand specimen the rock is of a fresh appearance. The texture of this rock matches most closely with the type II texture of MacGregor and Carter (1970).

1o. HRV173B, cpx-rich portion of type II magnesian eclogite HRV173. (Garnet-rich portion is illustrated in 1f).

1p. HRV15A type I magnesian eclogite with compositional variations. The low chrome contents in minerals of the upper portion of the slide increase steadily to relatively high values in the lower portion. Garnets have the higher relief.

1q. HRV15B. Chrome increases from upper to lower ends of the slide with the highest chrome contents in the rock present at the lower edge of this slide (Chapter VIII).

1r. JJG520, "type II" fine-grained corundum kyanite eclogite with a texture very similar to the biminerallic eclogite portion of HRV116 (1m).

1s. JJG503, the lower portion of the slide includes a large olivine xenocryst present in the hard black kimberlite recovered in the vicinity of the "Jewel Box" (Chapter IX). Chromite inclusions in the olivine xenocryst are readily visible, but a clinopyroxene inclusion to the bottom of the central cluster of chromite grains is hard to discern (Chapter IX).

1t. HRV161, type II magnesian eclogite with a large garnet grain occupying the lower third of the slide. Three sulphide grains adjacent to clinopyroxene in the centre-right of the slide can be discerned (Chapter IV).

1u,v,w. Slides B(b), F2(a) and B(a) from type II diamond-graphite eclogite HRV247. Garnet and clinopyroxene grains have a similar appearance, although clinopyroxene grains are slightly more altered than garnet. Opaque grains of graphite and rutile are present (Chapter X).

1x. RVGRIFFIN, silicified and carbonated "garnet lherzolite". Four grains of garnet with distinct jointing are present. The grey mineral is calcium carbonate which is thought to be an alteration product after orthopyroxene. The clear mineral is silica, thought to be an alteration product after olivine. A clinopyroxene grain is present in the centre-right of the slide, but it is difficult to discern in the plate (Chapter IX).

1y. HRV20, silicified carbonated garnet lherzolite. Clear grains are garnet. Extensive alteration has obscured the original grain margins (Chapter IX).

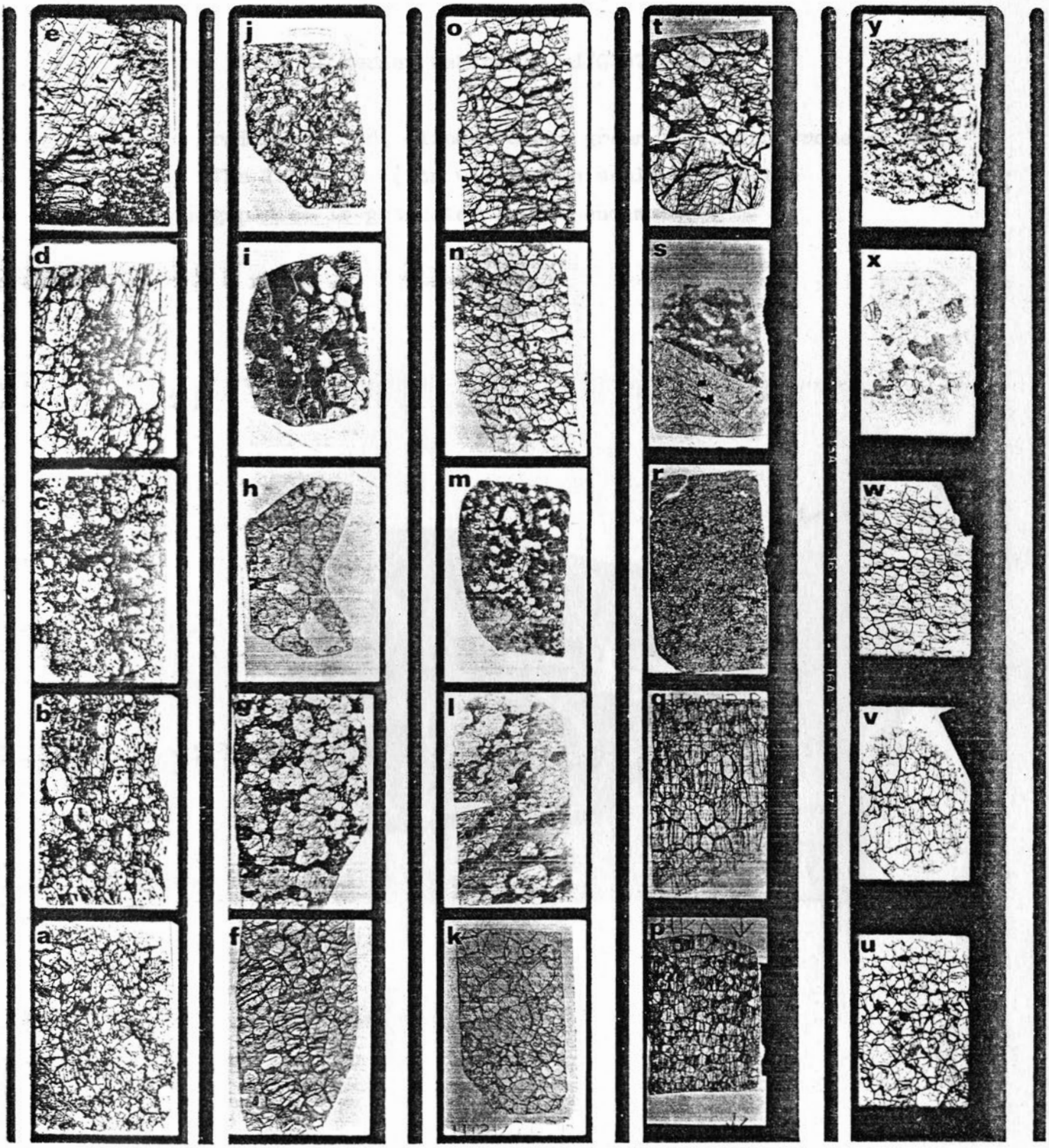


PLATE 1

PLATE 2

Type II garnet websterite JJG307

Garnet grains are red, clinopyroxene green and orthopyroxene brown. The label is $1\frac{1}{4}$ cm wide. The scale bar in the following plates is graduated in cms and mms.

PLATE 3a, b.

Type II garnet websterite HRV267

Garnet grains are red, clinopyroxene green and orthopyroxene black. Orthopyroxene is strongly altered in the centre of the nodule.

PLATE 4

Type I garnet websterite HRV249

The presence of orthopyroxene is inferred from altered relicts present along the broken layer at the bottom of the nodule.

PLATE 5

Type I phlogopitised eclogite HRV47

Phlogopite is concentrated in a layer at the top of the nodule. Access of the phlogopitising fluid is thought to have been via the vertical vein in the centre of the nodule. Phlogopitisation is thought to have occurred prior to inclusion of the nodule in kimberlite (Chapter V).

PLATE 6

Type II magnesian eclogite HRV274

Black phlogopite grains are thought to be primary (Chapter IV).

PLATE 7a,b,c.

Type II magnesian eclogite HRV15

7a. The bottom edge of the nodule contains bright green clinopyroxene which becomes lighter green toward the top. The change in clinopyroxene colour reflects the decreasing content of clinopyroxene from the bottom to the top of the nodule. Small black spinel grains are present in garnet in a layer 2 cm from the top of the nodule (Chapter VIII).

7b. Close-up view of the spinel bearing layer visible at the top of the plate.

7c. Photomicrograph of spinel in garnet. Photo width 1 mm.

PLATE 8

Type II magnesian eclogite WM7

Photomicrograph of black sulphide grain adjacent to altered clinopyroxene. Clear garnet grains to right and below sulphide grain. The two small white inclusions at the right edge of the sulphide are calcium carbonate.

PLATE 9

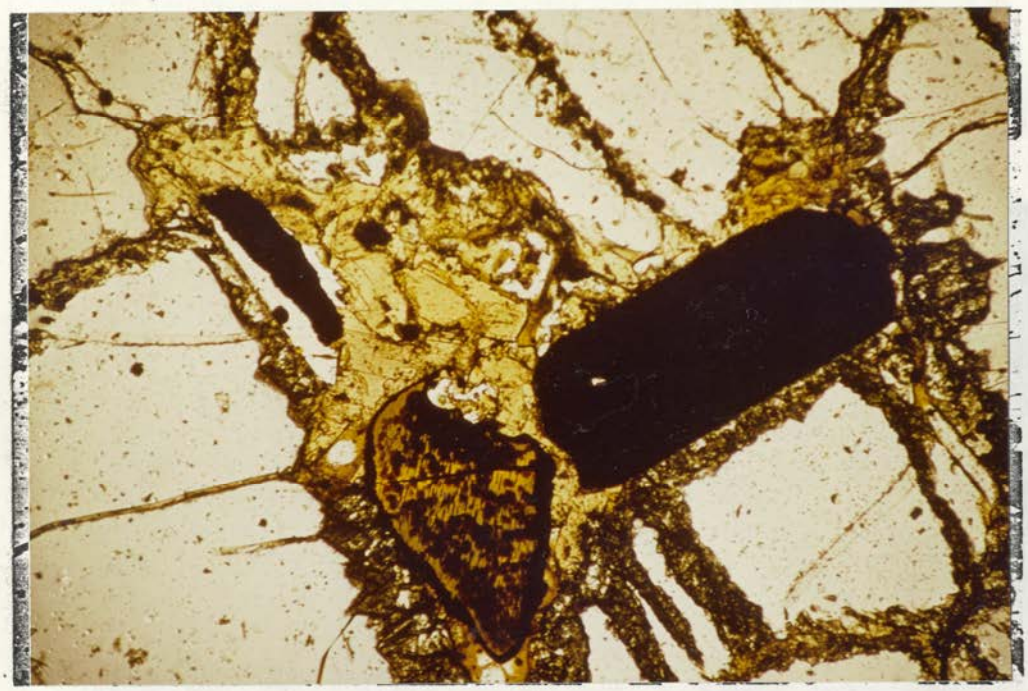
Type II graphite eclogite HRV309

Black grains of altered orthopyroxene are sporadically distributed across the slab. A blue grey grain of graphite in the centre left of the middle is ringed.

PLATE 10a,b.

Type II diamond-graphite eclogite HRV247

10a. Photomicrograph of black graphite crystal in slide HRV247G. The small white inclusion in the graphite crystal is thought to be moissanite (SiC). The black and brown rutile grain to the left of the graphite is thought to be a primary component, as is graphite but the origin of the light brown mica is problematical. The surrounding clear white grain is garnet (Chapters IV, X).

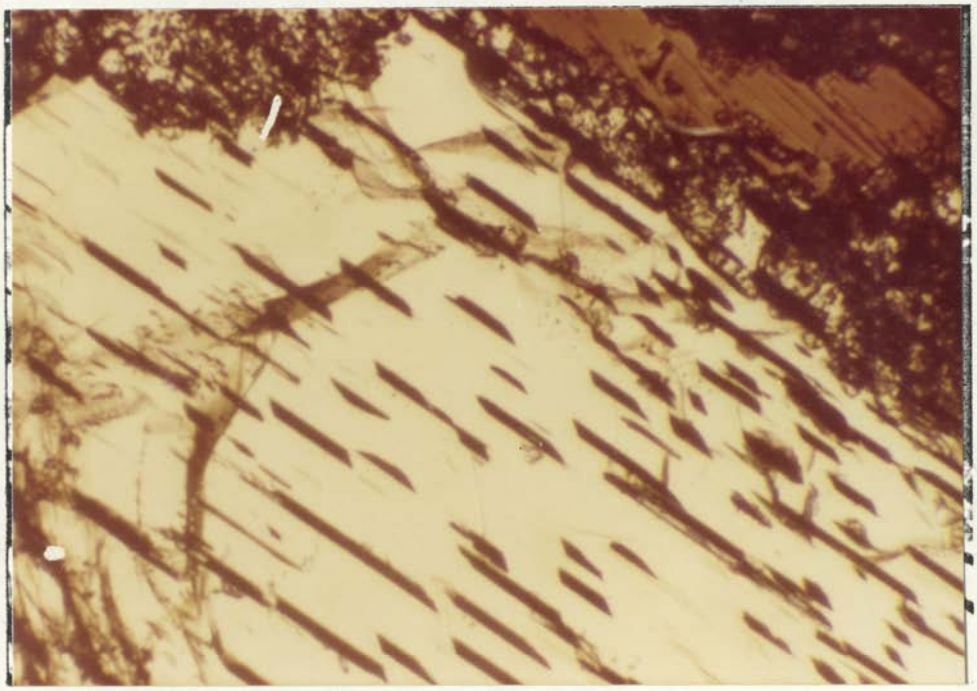


10b. Diamond crystal in HRV247. The width of the diamond at the bottom of the octahedral face is 2 mm.

PLATE 11 a, b.

Type II megacryst bearing eclogite HRV244

11a. Small lamellae of garnet, too small for microprobe analysis, exsolved from the clinopyroxene megacryst at the megacryst/eclogite interface. The red mineral is phlogopite.



11b. Lamellar exsolution of garnet from clinopyroxene megacryst. Analysis localities are indicated on the accompanying figure (Chapter VI). The plate depicts an area of 1 mm by .7 mm.

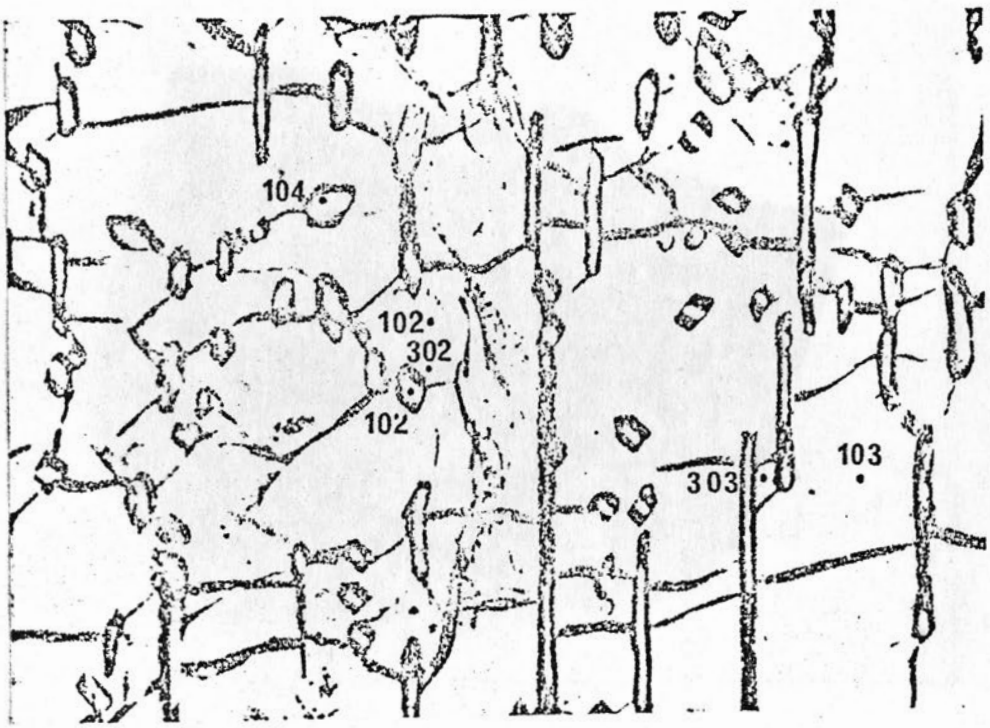


PLATE 12

Type II calcium-iron rich eclogite JJG6

The sample illustrates well developed foliation. The size of the nodule is 26 cm by 19 cm.

PLATE 13

Type I inhomogeneous kyanite eclogite HRV30

Two isolated blebs of kyanite eclogite with brown garnet, white cpx and blue kyanite are present below the garnet-rich layer (Figure 28b).

PLATE 14

Type I main group, inhomogeneous kyanite eclogite JJG40

A layer of orange garnet can be discerned at the bottom left of the nodule in the biminerallic eclogite portion. This layer appears to have been disrupted (from below) by the kyanite eclogite bleb.

PLATE 15

Silicified and carbonated "garnet lherzolite" HRV310

At the top of the nodule is a small layer of green clinopyroxene, overlying a garnet rich layer. Minerals in these two layers have eclogite (low-chrome) compositions. Below the eclogite portion of the rock garnet is present in well defined layers, associated with grey-white calcium carbonate and silica. The vertical white calcite veins are thought to be of near surface origin, but the grey-white calcium carbonate and silica may have formed at high pressures by alteration of orthopyroxene and olivine (Chapters VIII, IX).

PLATE 16

Type I inhomogeneous kyanite eclogite HRV17

The nodule consists of four portions from the top B, downwards; (Figure 27).

B, biminerallic eclogite with a garnet rich layer sporadically developed adjacent to,

C, consisting of brown garnet and white cpx and grading into

D, a kyanite eclogite zone with brown garnet, white cpx and blue kyanite, overlying

A, biminerallic eclogite.

The kyanite eclogite layer is .66 as (left to right) wide as the overlying biminerallic eclogite layer B. (Chapter IX).

PLATE 17

Type I eclogite HRV23

with a clinopyroxene rich layer which is .77 times as thick as adjacent biminerallic eclogite.

FIGURES

1. Models of mantle sampled by kimberlite.
2. The Roberts Victor kimberlite pipe.
3. Modal % clinopyroxene in Roberts Victor eclogites.
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7. Histogram of measured angles between plane of flattening of nodule and layering, and between plane of flattening and jointing.
8. Mechanism of kimberlite dyke propagation.
9. Drawing from slide of type II garnet websterite HRV180.
10. Drawing from slide of type II garnet websterite HRV243.
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12. Type I eclogites. Wt.% oxides in garnet vs. wt.% Na_2O in cpx.
13. Type I eclogites. Wt.% oxides in cpx vs. wt.% Na_2O in cpx.
14. Type I eclogites. Wt.% oxides in estimated whole rock vs. wt.% Na_2O in cpx.
15. CMAS tetrahedron.
16. Ca-Mg-Fe diagram of garnet in type II eclogites.
17. Type II eclogites. Wt.% oxides in garnet vs. wt.% Na_2O in cpx.
18. Type II eclogites. Wt.% oxides in cpx vs. wt.% Na_2O in cpx.
19. Type II eclogites. Wt.% oxides in estimated whole rock vs. wt.% Na_2O in cpx.
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21. Type I megacryst bearing eclogite HRV77, slide HRV77A.
22. Compositional variation in HRV77.
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28. Type II inhomogeneous kyanite eclogite HRV30.
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37. Garnet websterite HRV180.
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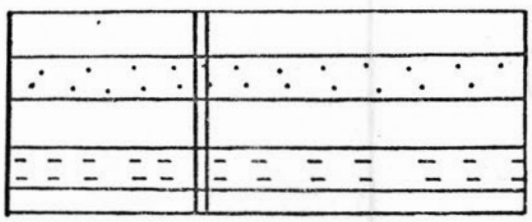
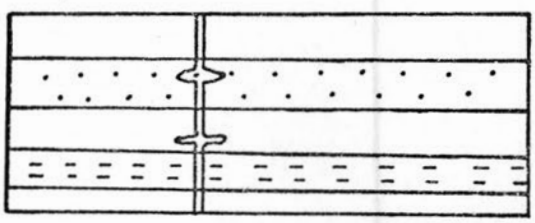
39. Parameters considered in the abrasion of nodules.
40. Abrasion of nodules with layers of different hardness.
41. Analysis localities in diamond-graphite eclogite HRV247.
42. Wt.% MgO vs wt.% CaO in garnets in HRV247.
43. Wt.% CaO vs wt.% Na_2O in cpx in HRV247.
44. Compositional variation across HRV247.
45. Compositional variation across graphite bearing type II magnesian eclogite HRV309.
46. Oxygen fugacities defined by geophysically important mineralogic reactions.
47. Mean and ranges of whole rock analyses of type I and type II eclogites
48. ppmw Zn vs wt.% MgO in type I and type II Roberts Victor eclogites.

FIGURE 1

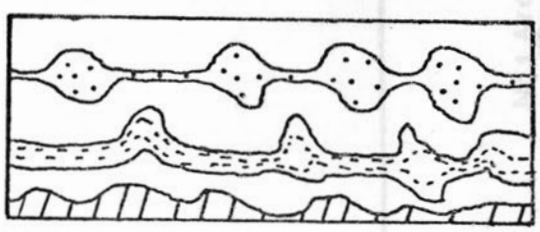
Models of mantle sampled by kimberlite



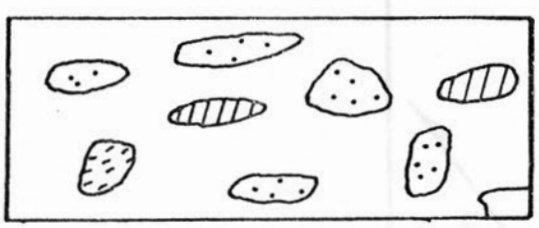
I Model of mantle with layers of constant thickness, sampled evenly by kimberlite.



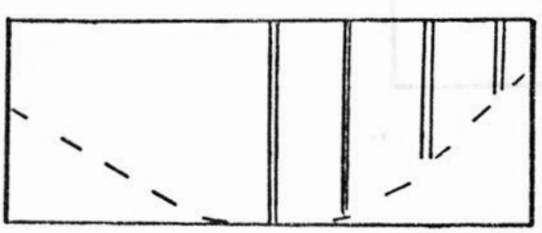
II Model of mantle with layers of constant thickness, sampled unevenly by kimberlite.



III Model of mantle with continuous layers of differing thickness.



IV Model of mantle with isolated pods.



V Model in which kimberlite starts sampling at shallower levels toward edge of craton.

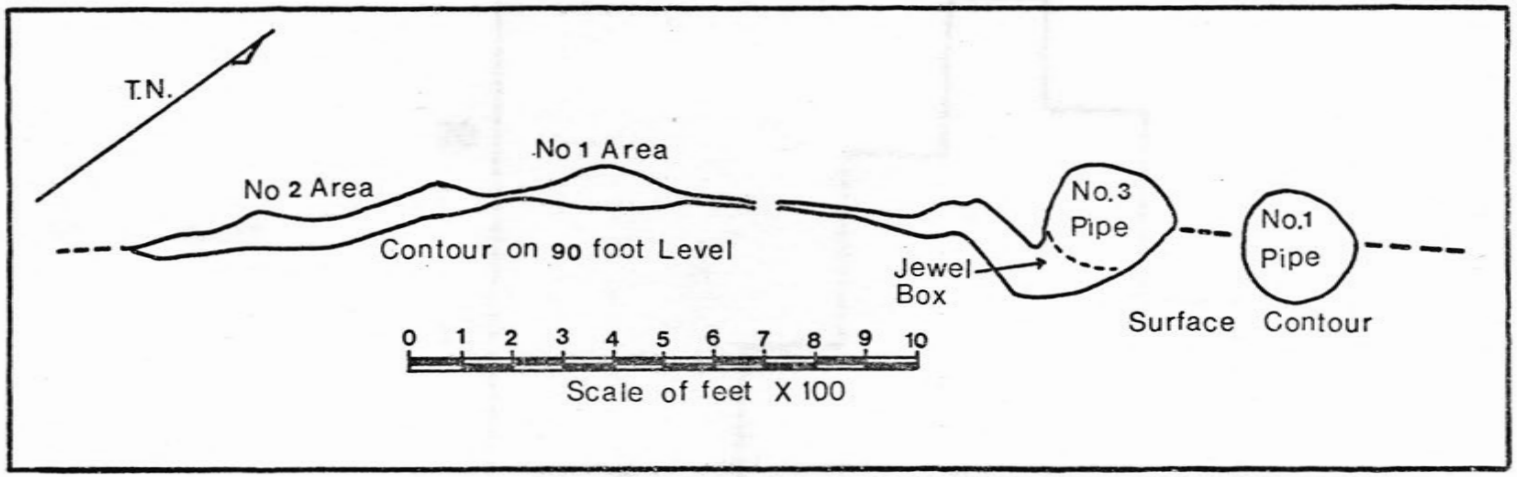


Figure 2. Plan of the Roberts Victor Mine. (After Wagner (1914) p48).

FIGURE 3

Modal % clinopyroxene in Roberts Victor eclogites

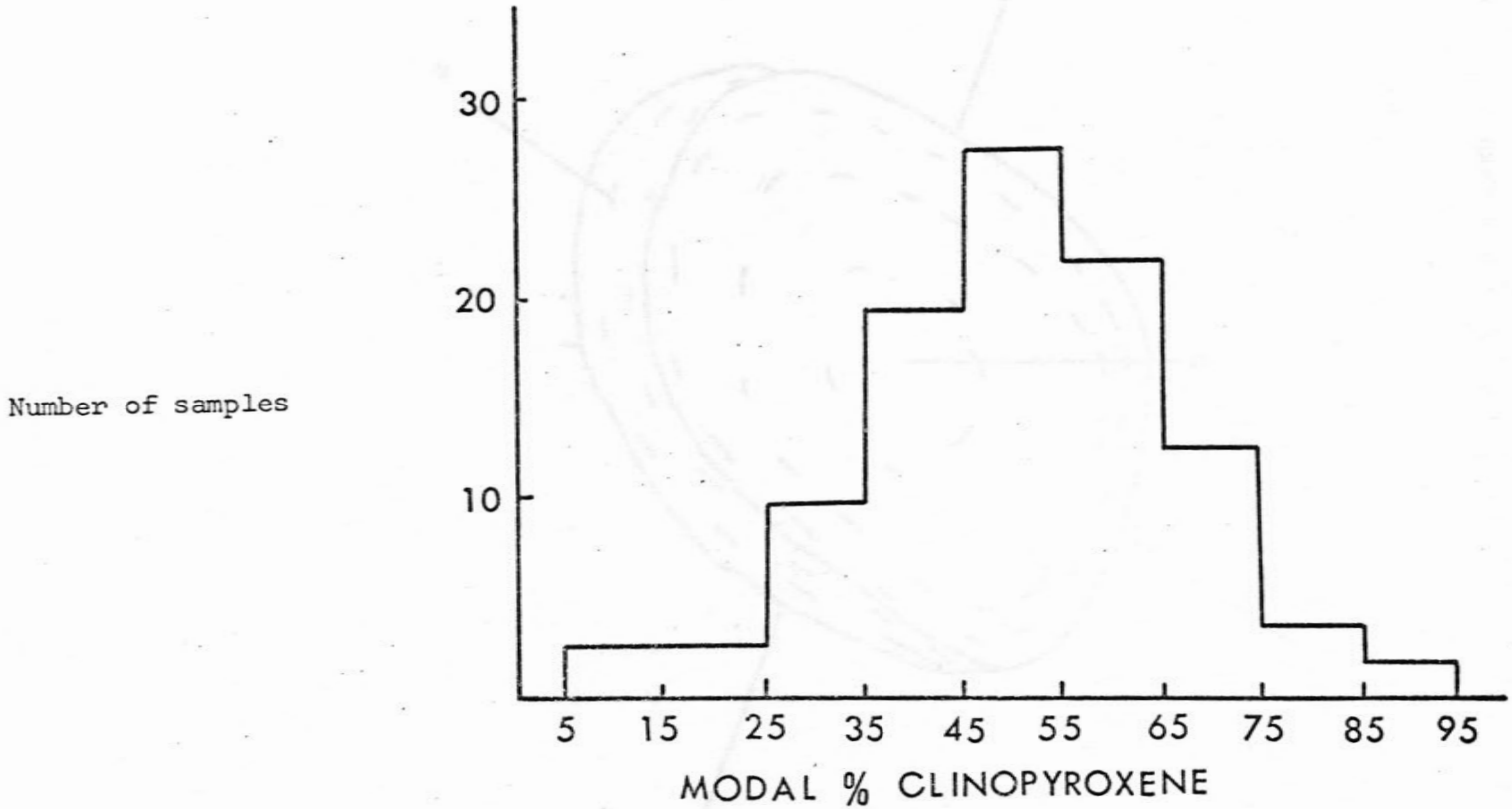


FIGURE 4

Axes measured on nodules

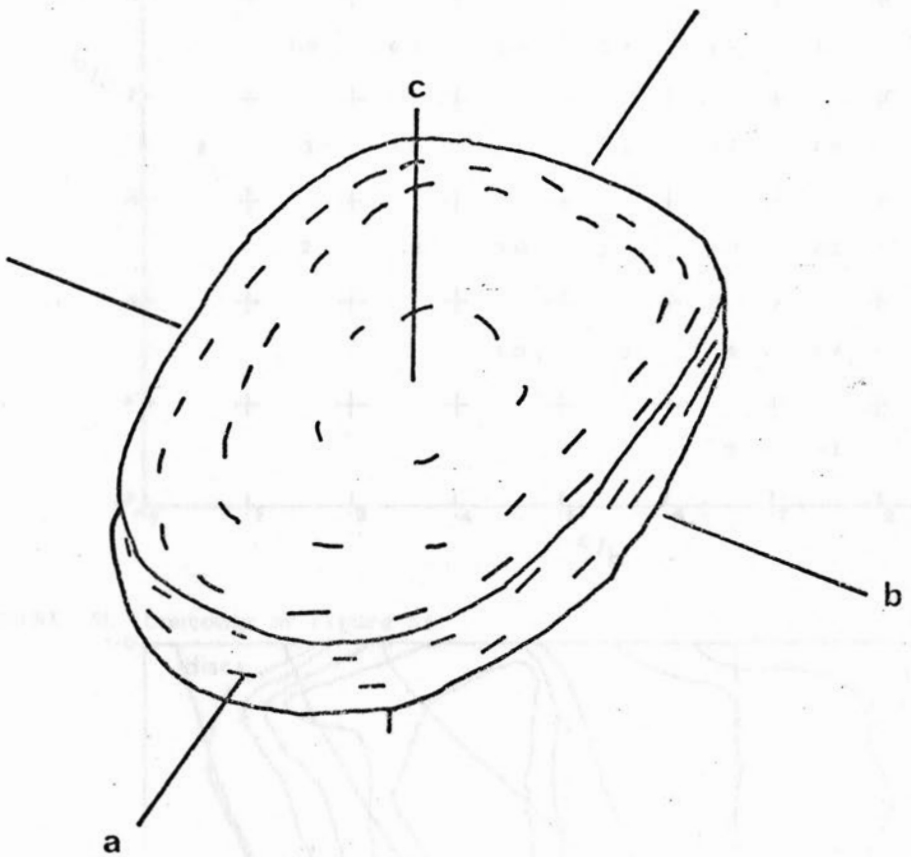


FIGURE 5a

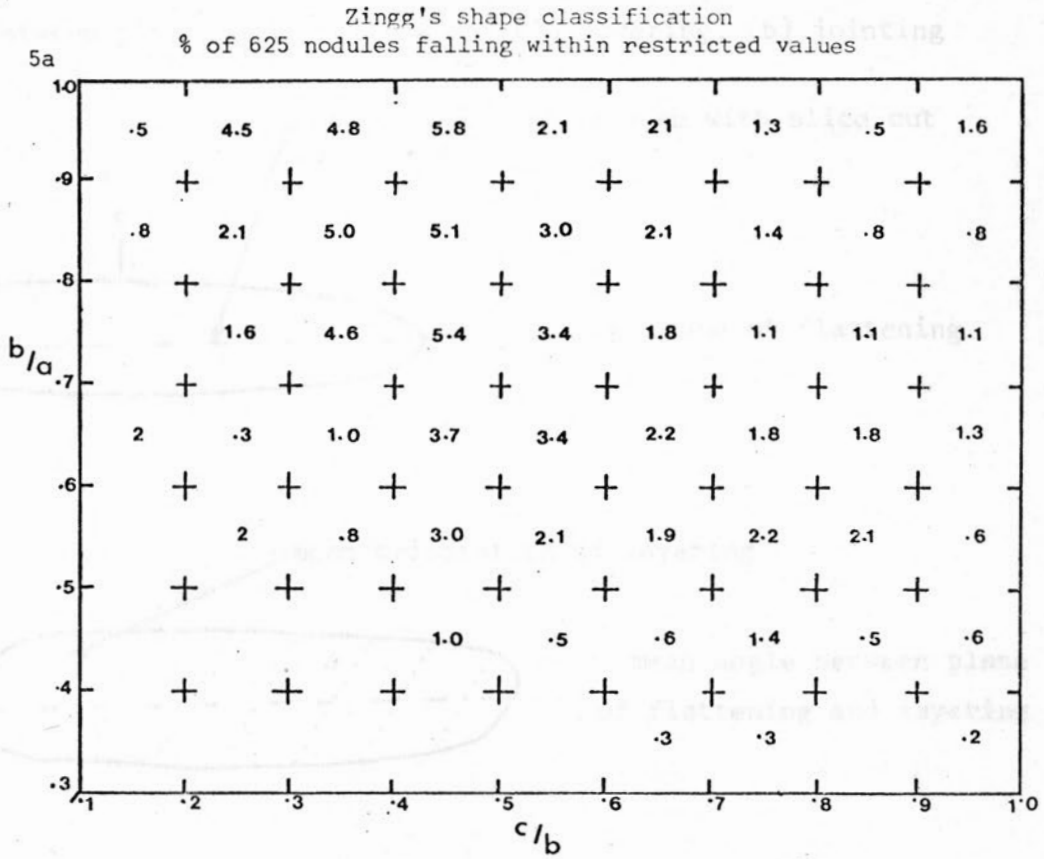


FIGURE 5b Contours of Figure 5a

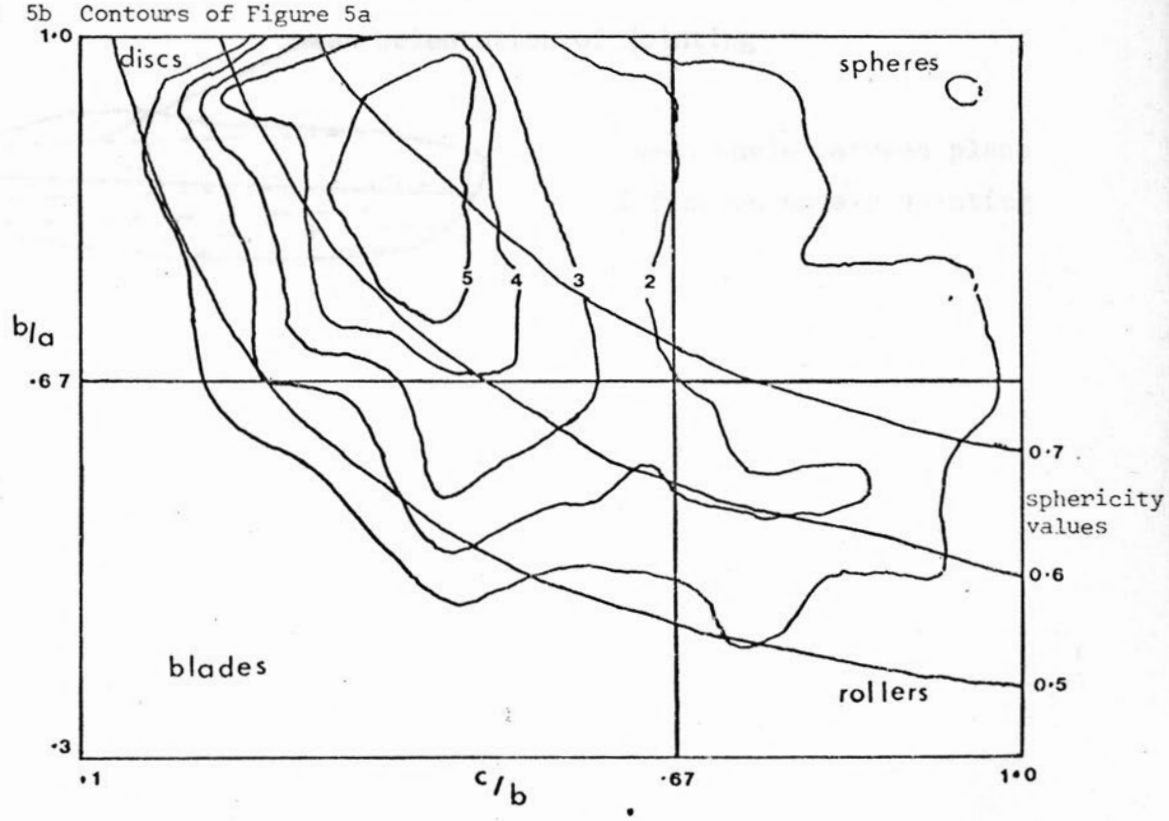
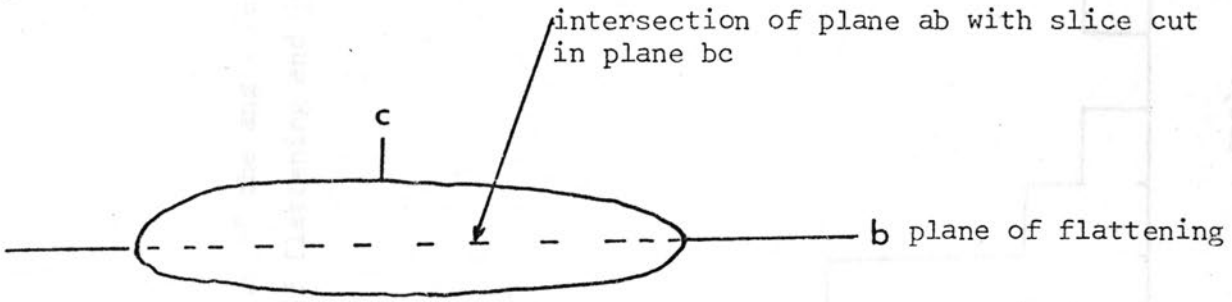
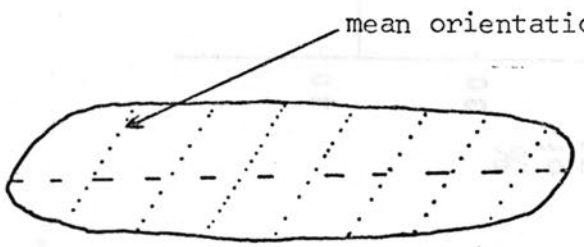


FIGURE 6

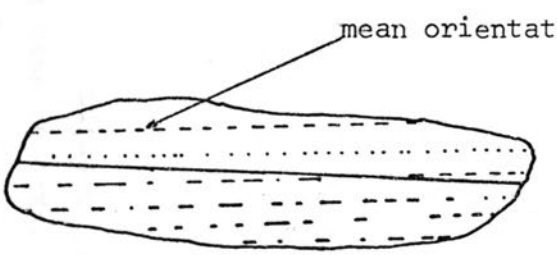
Mean angles between plane of flattening and (a) layering, (b) jointing





6 (a)

mean angle between plane of flattening and layering

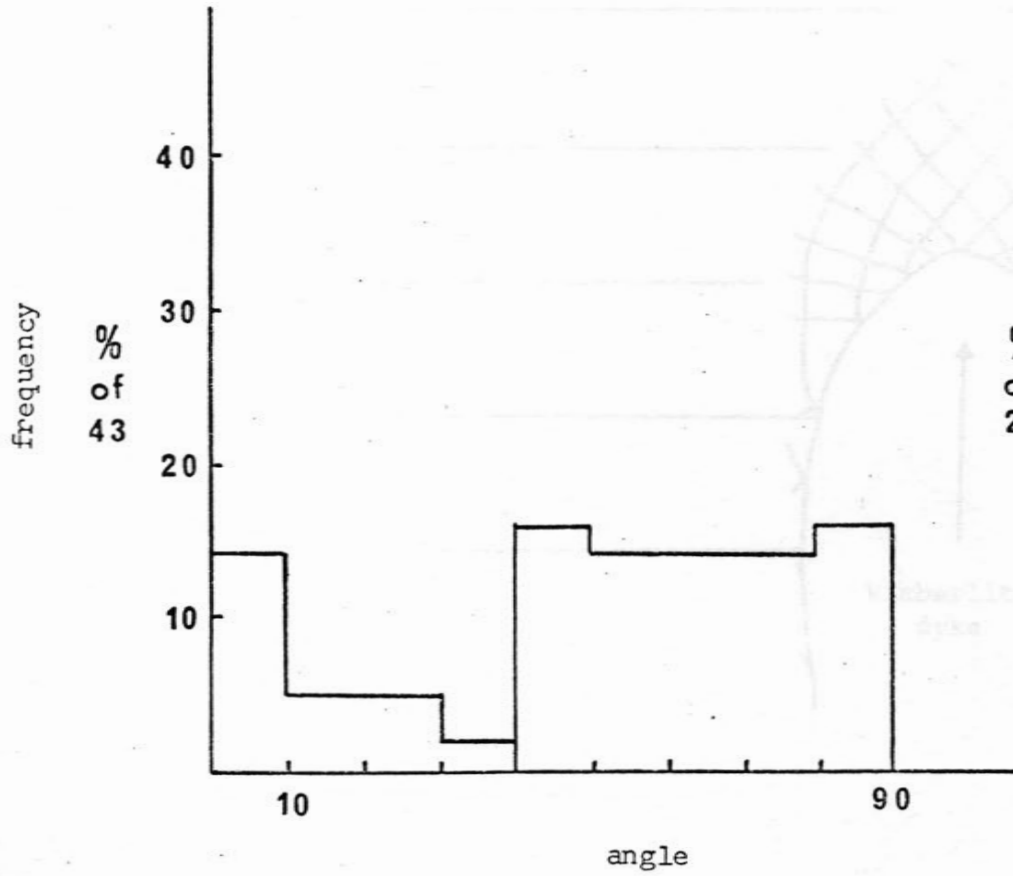


6 (b)

mean angle between plane of flattening and jointing

FIGURE 7

Histogram of the angle between the plane of flattening and layering



Histogram of the angle between the plane of flattening and jointing

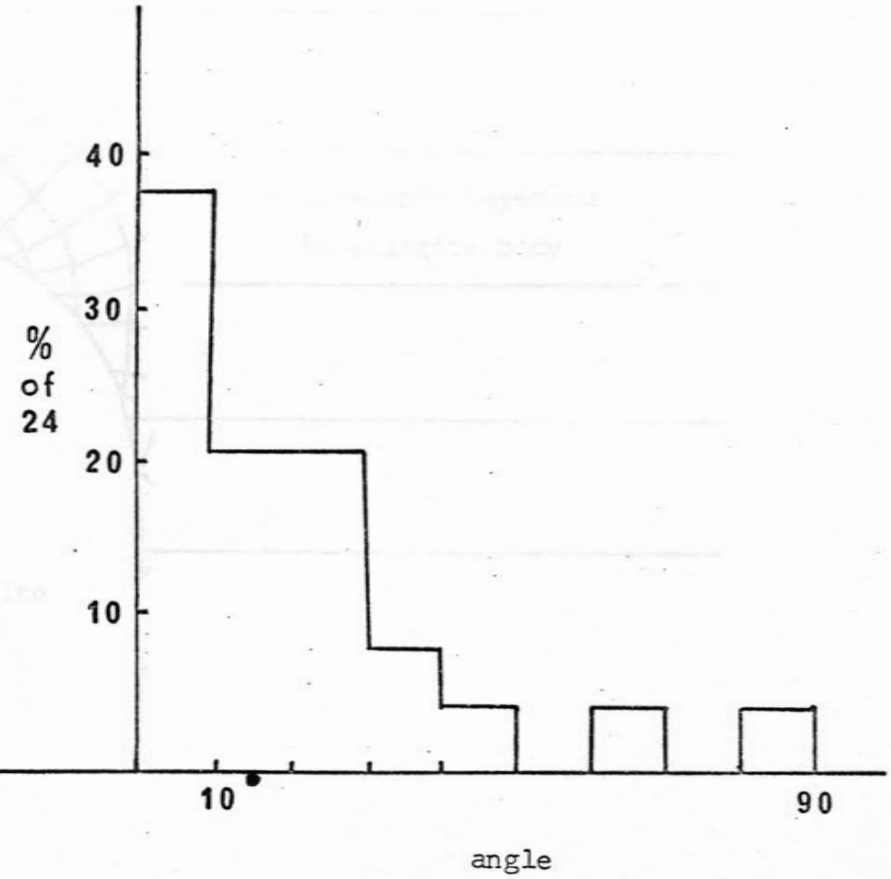


FIGURE 8 Mechanism of dyke propagation in a ductile medium (after Pollard, 1973)

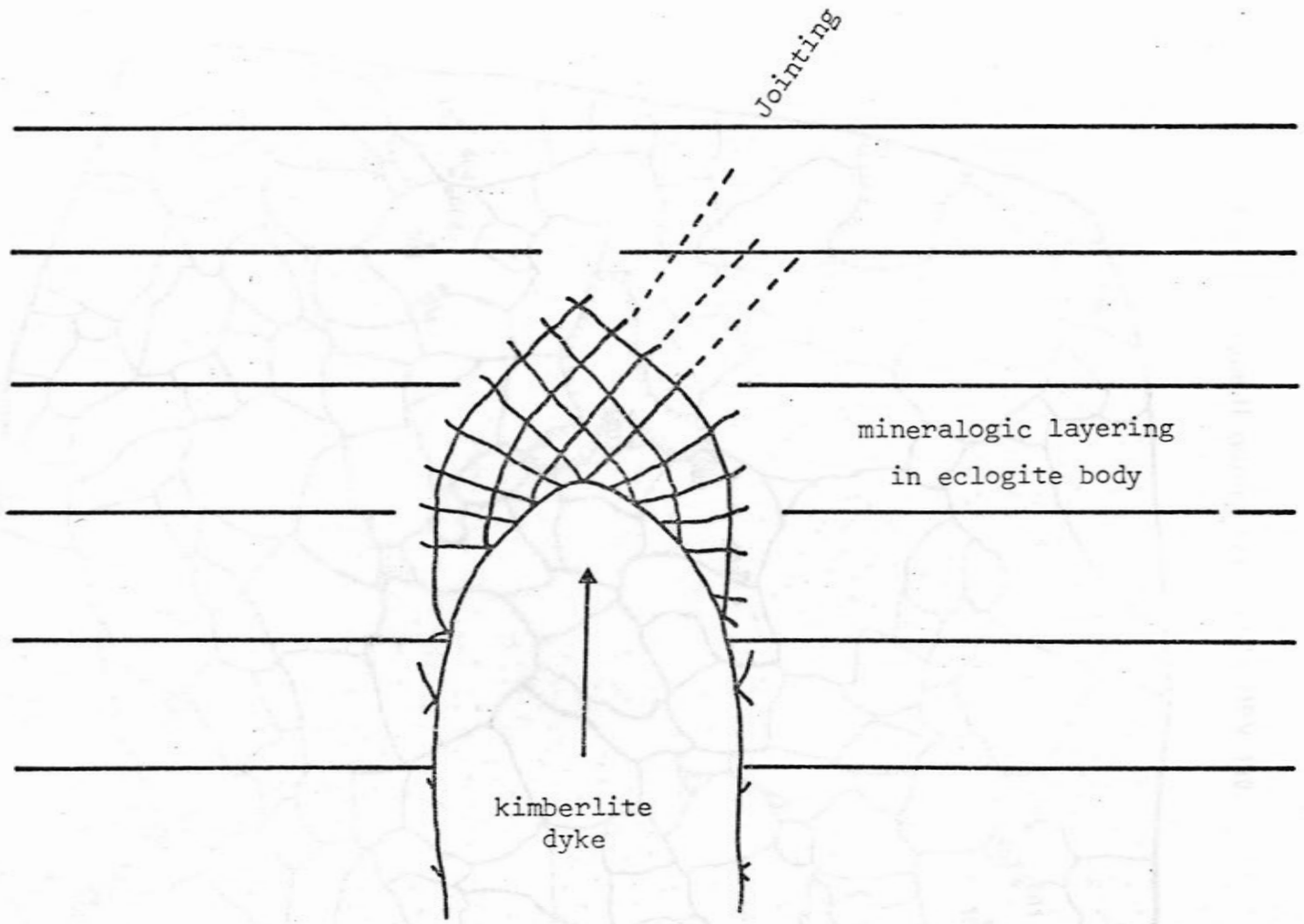


Figure 9. Type II garnet websterite HRV 180.

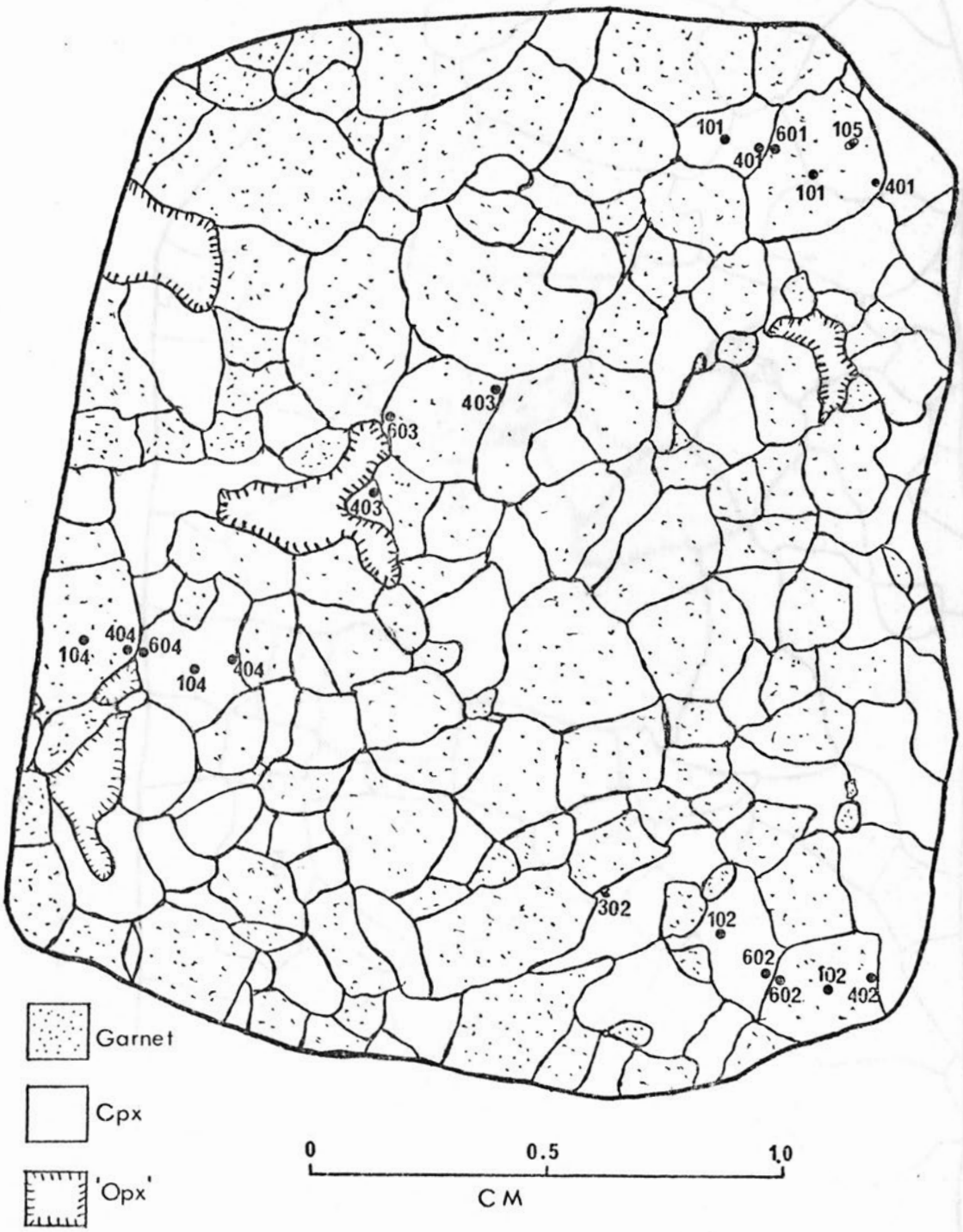
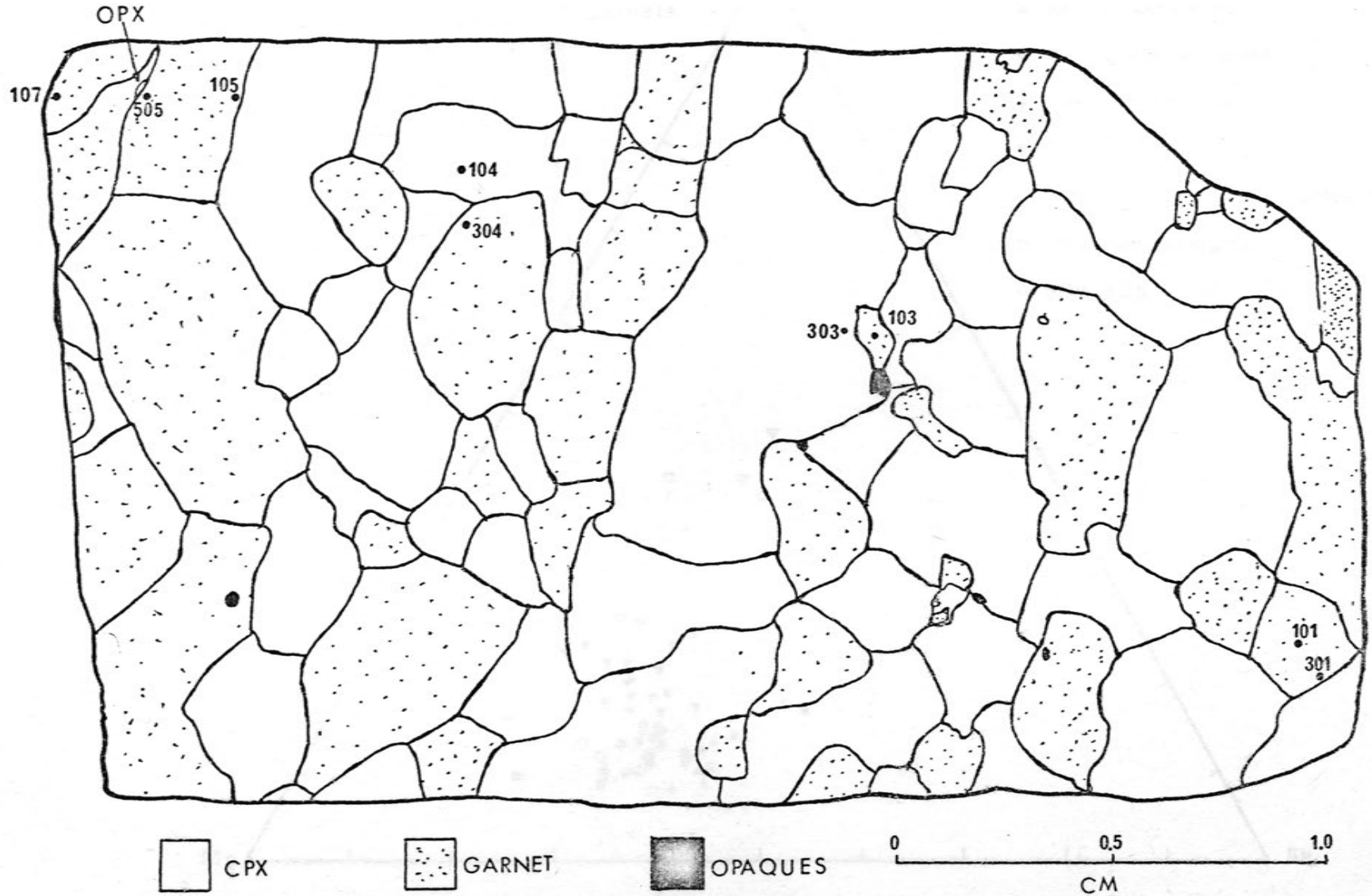


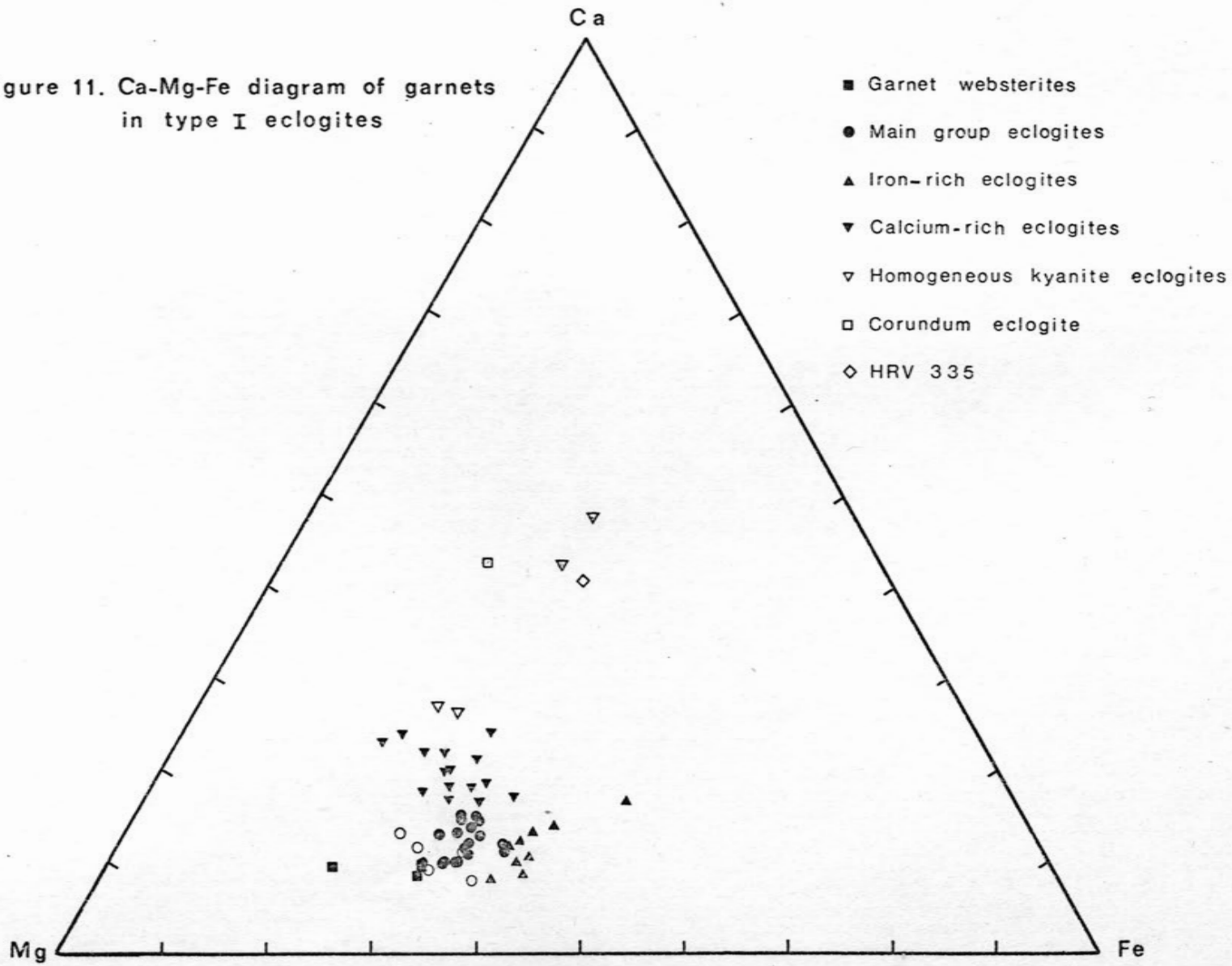
FIGURE 10. Type II garnet websterite HRV 243



HRV 243

HRV243

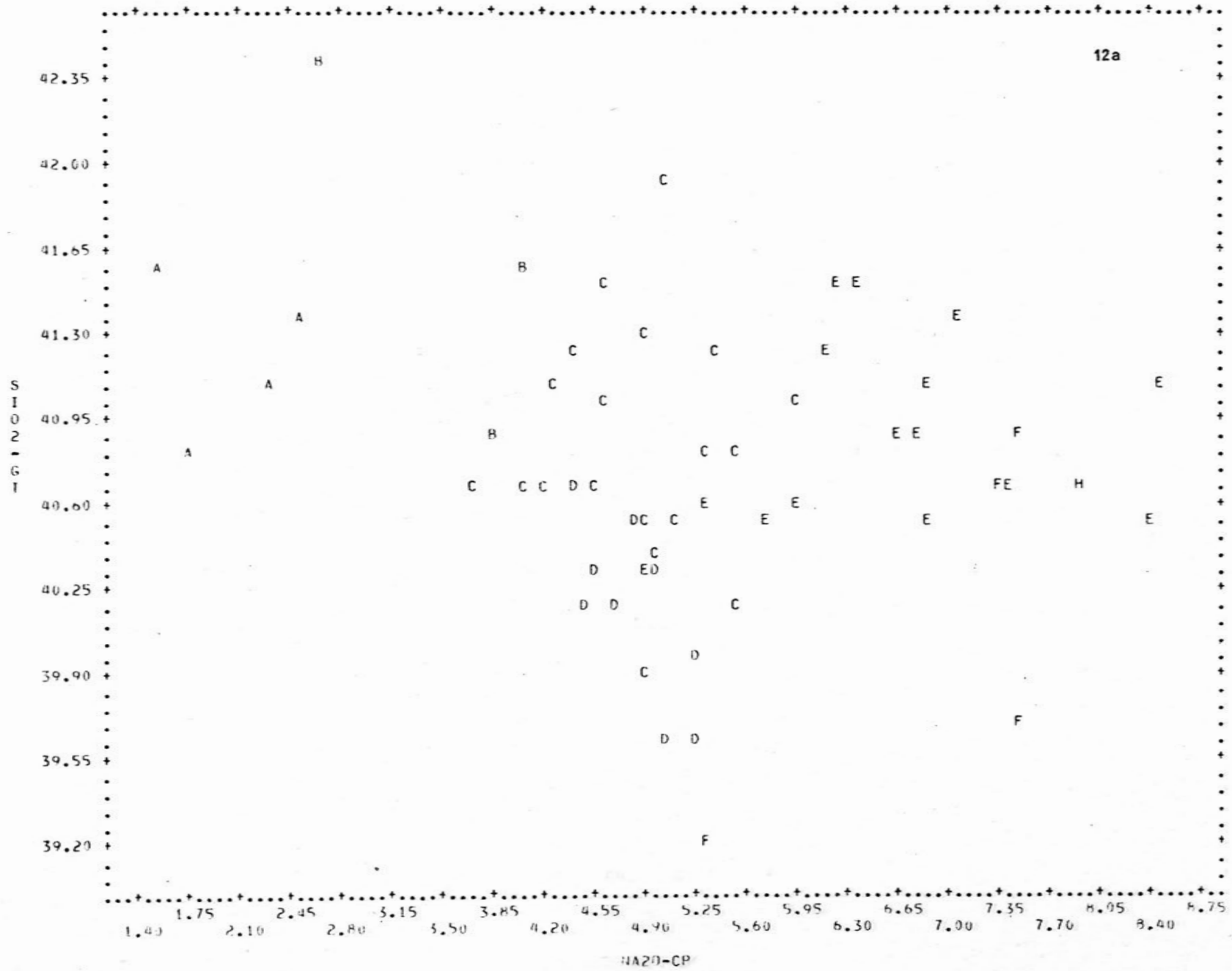
Figure 11. Ca-Mg-Fe diagram of garnets in type I eclogites



Preface to figures 12 to 14

The symbols in figures 12 to 14 refer to the following subgroups in the type I eclogites:

A	Phlogopitised eclogites
B	Garnet websterites
C	Main group eclogites
D	Iron-rich eclogites
E	Calcium-rich eclogites
F	Homogeneous kyanite eclogites
H	Corundum eclogite JJG60
I	HRV335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1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
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4.90
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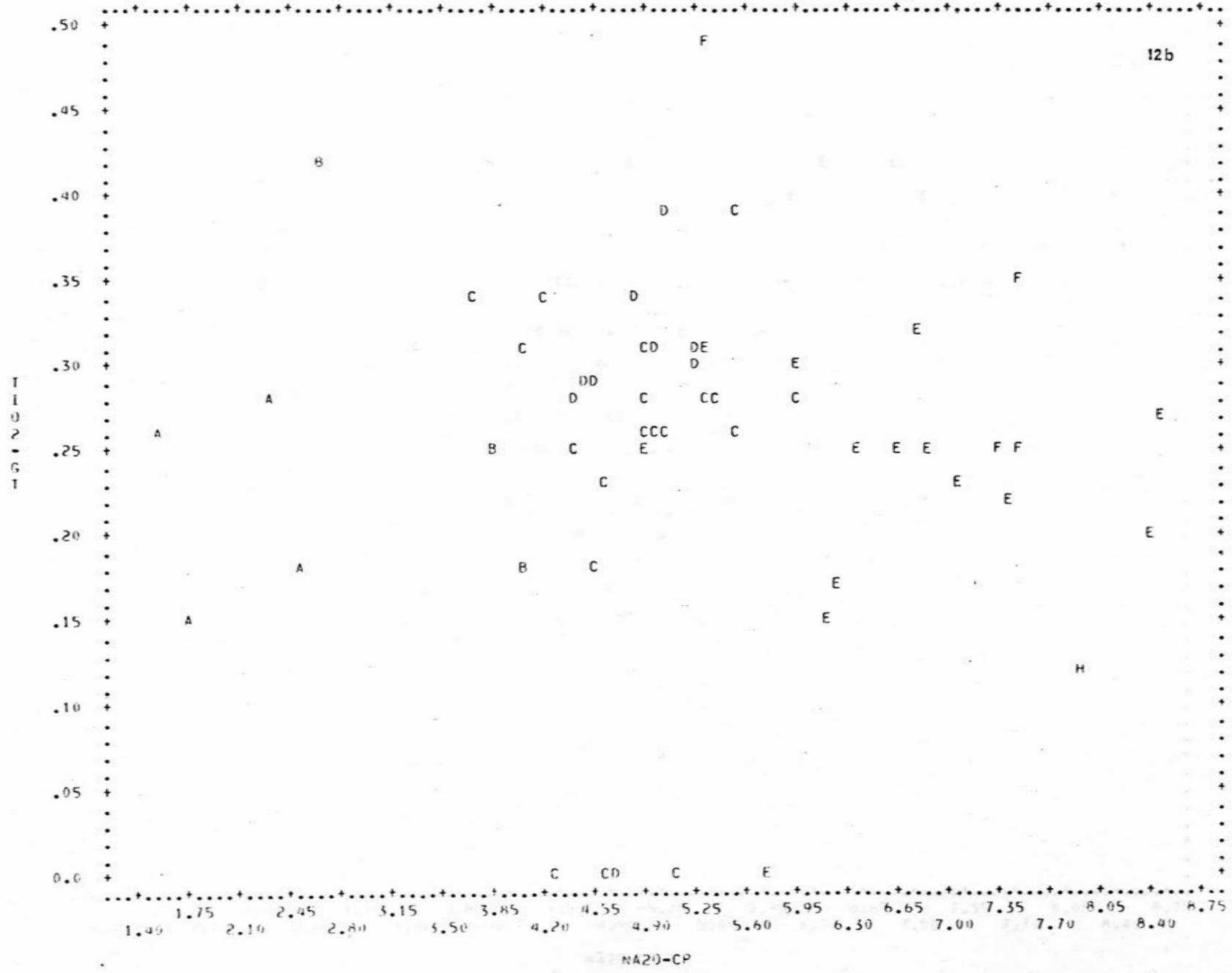
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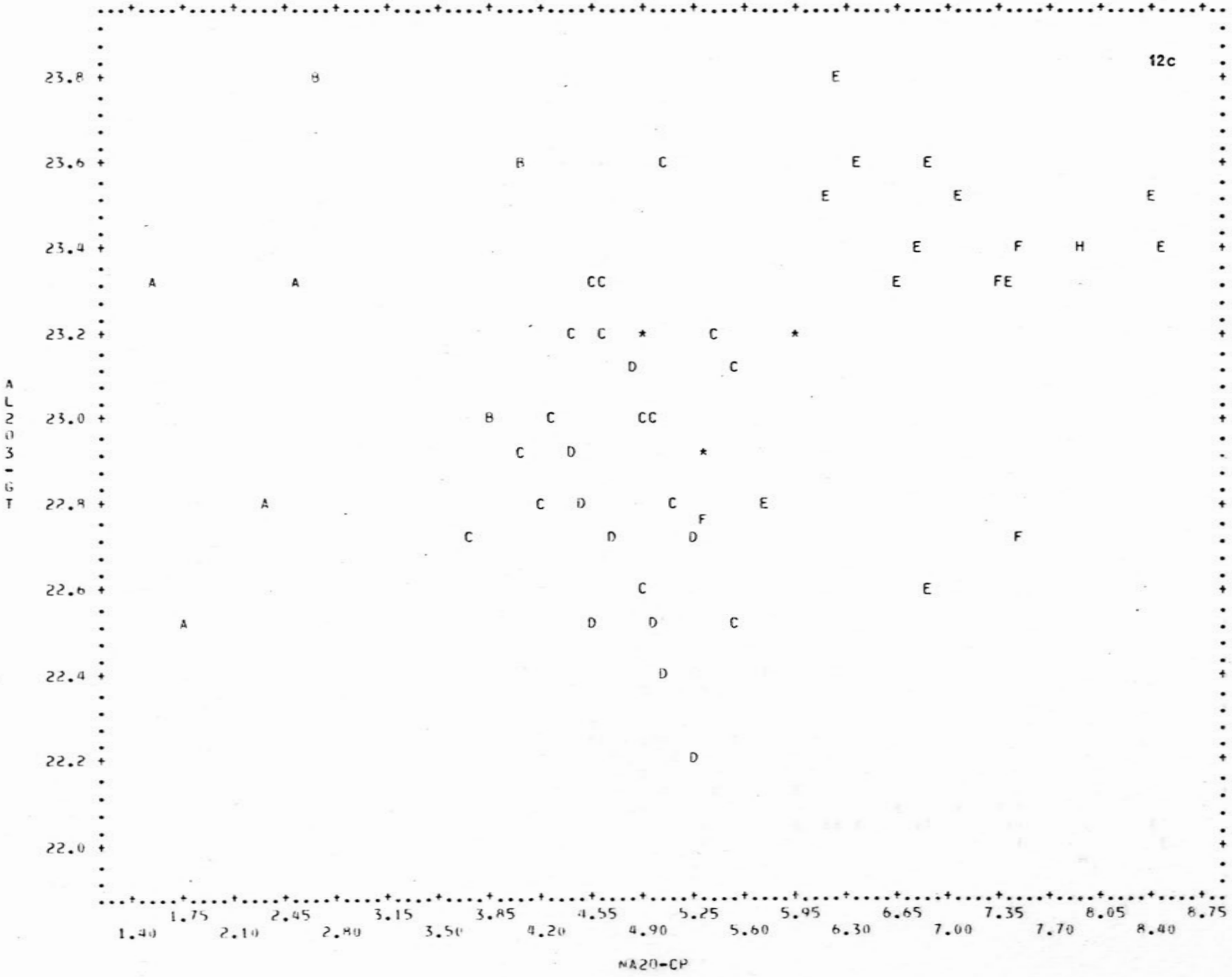
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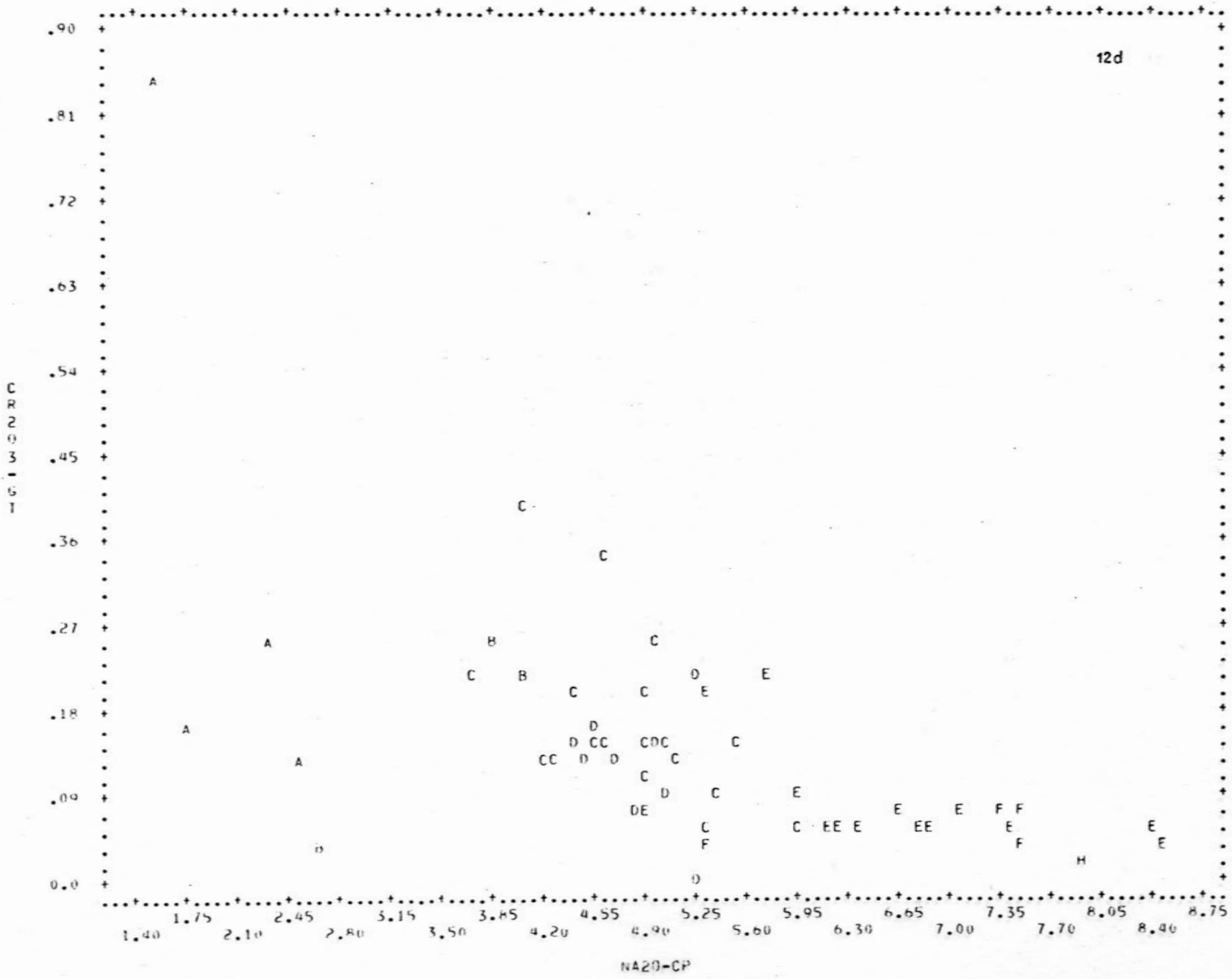
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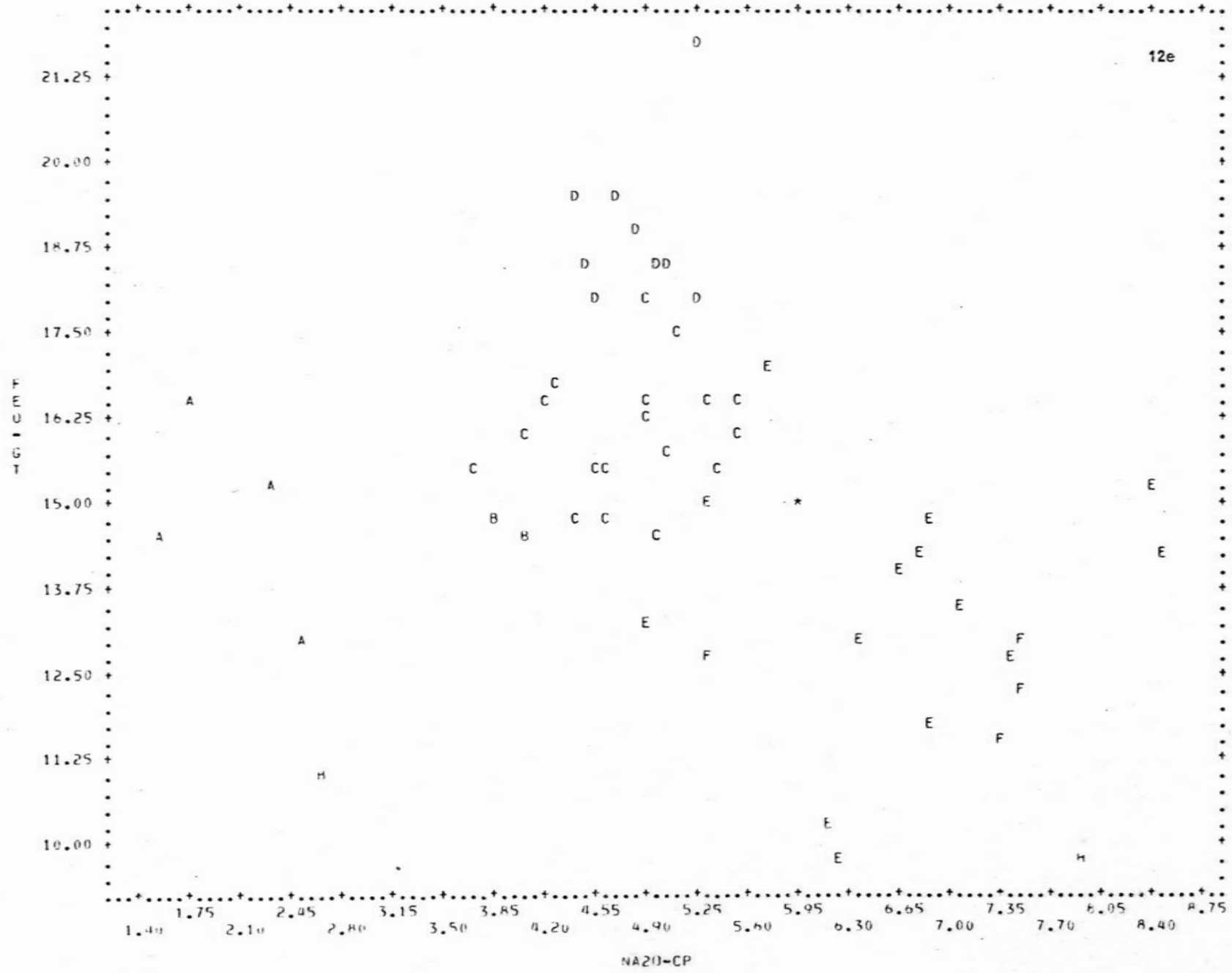
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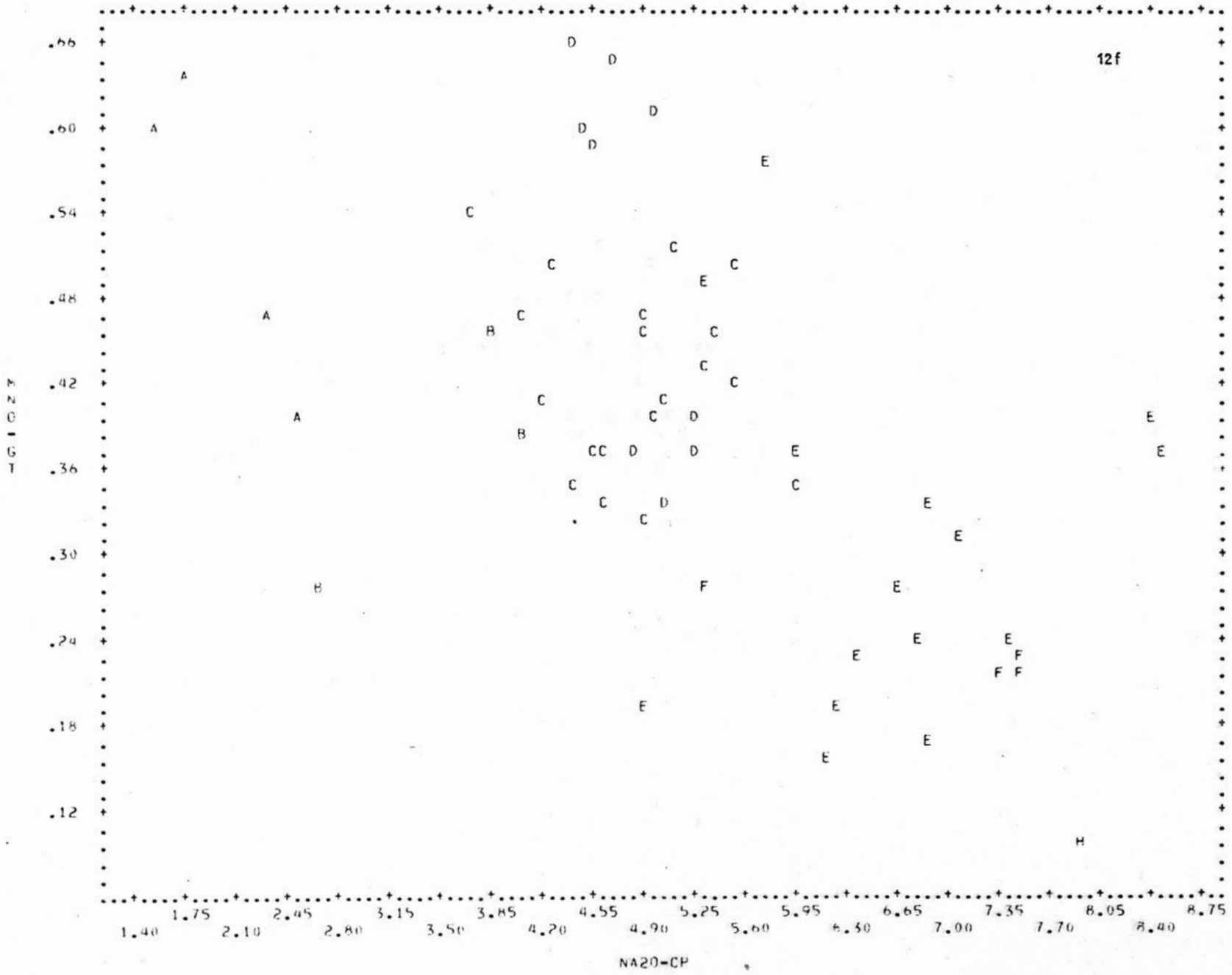
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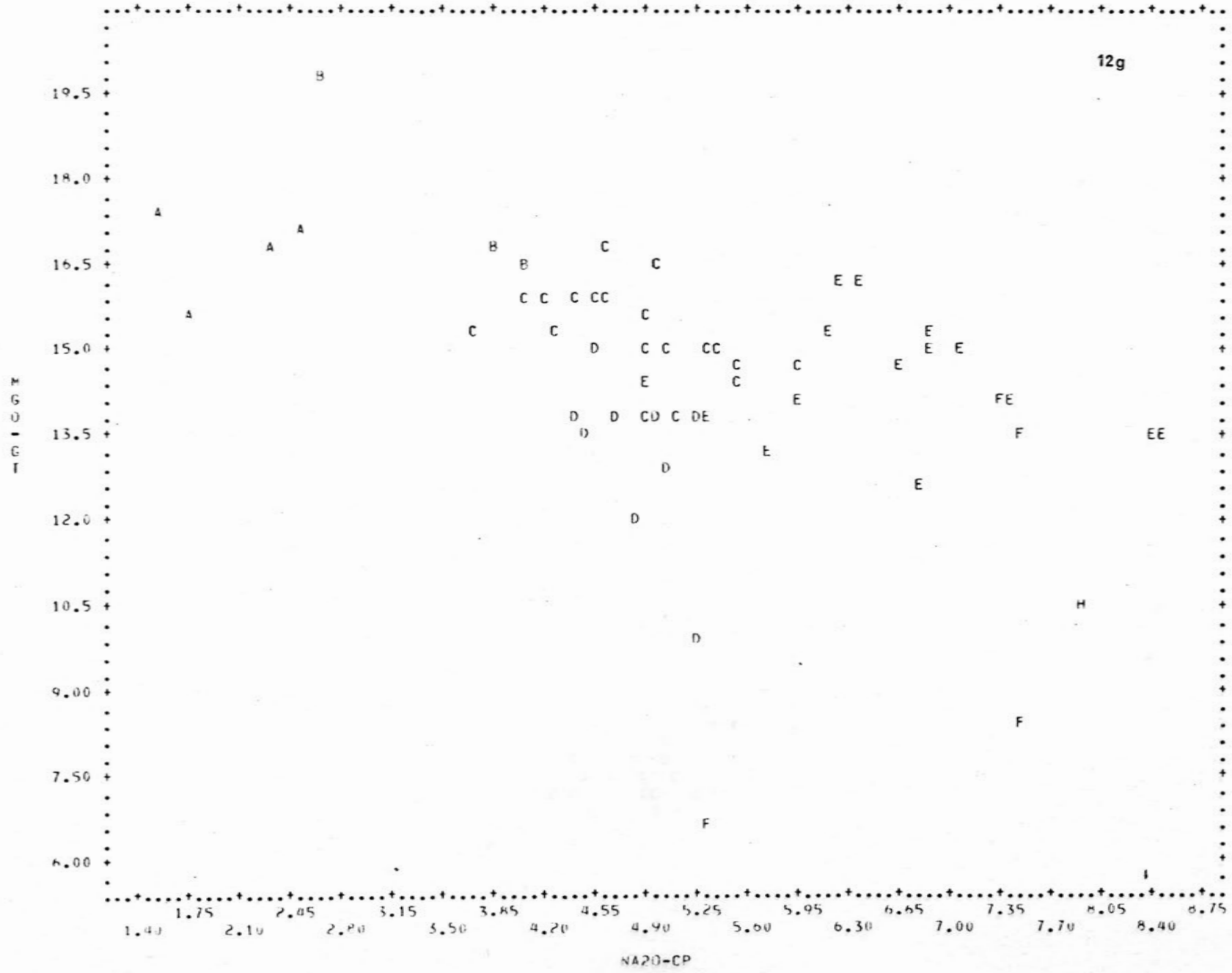
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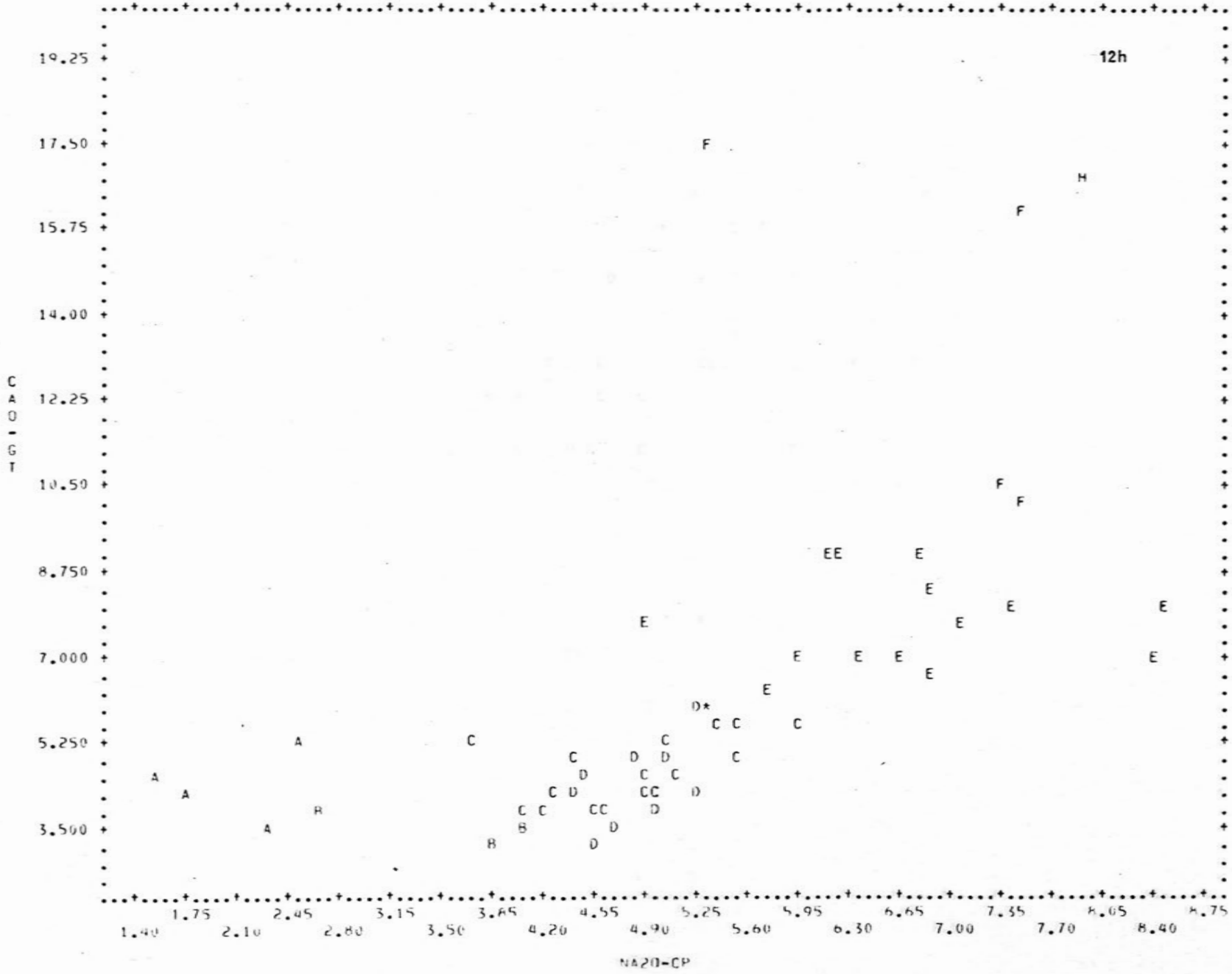
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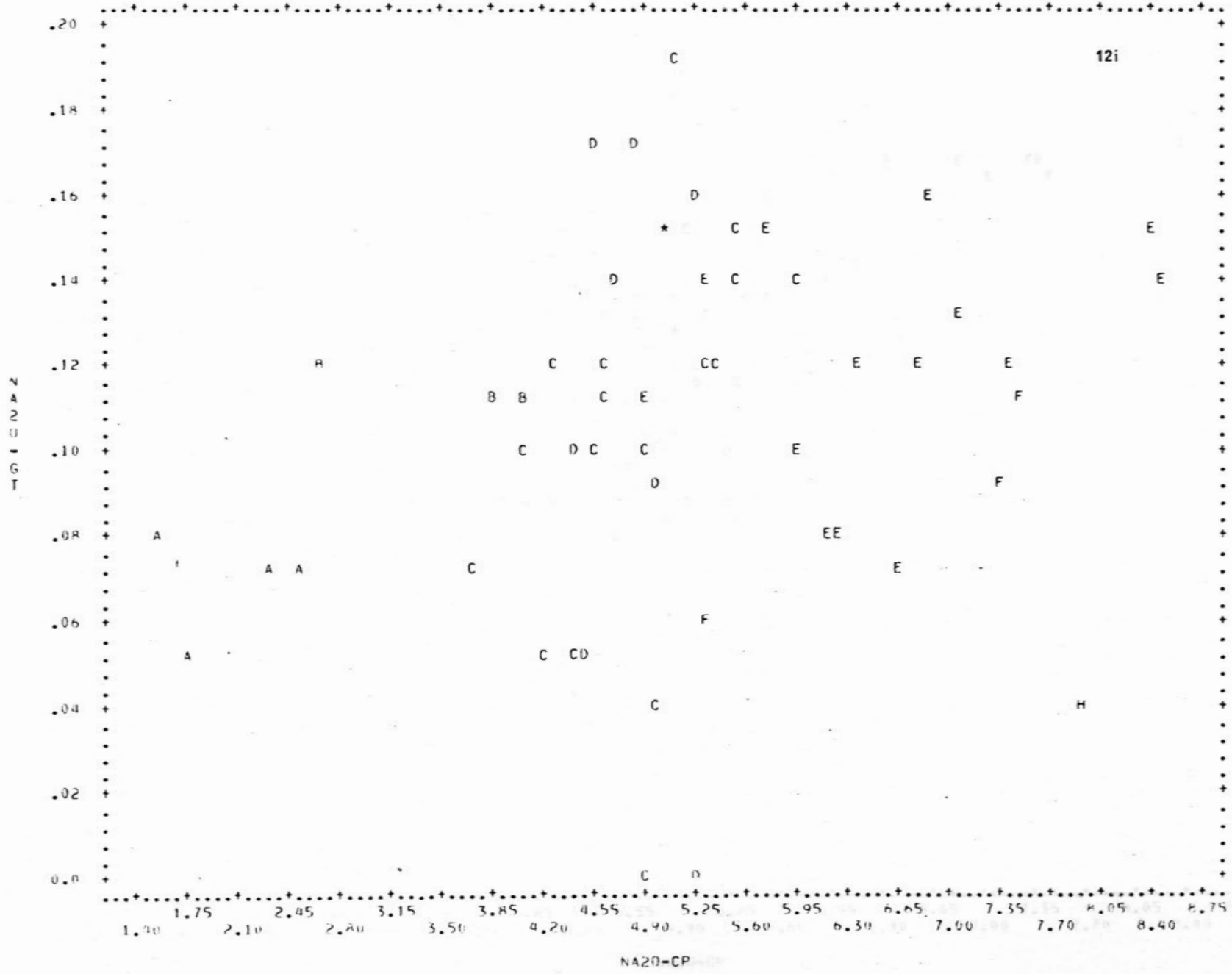
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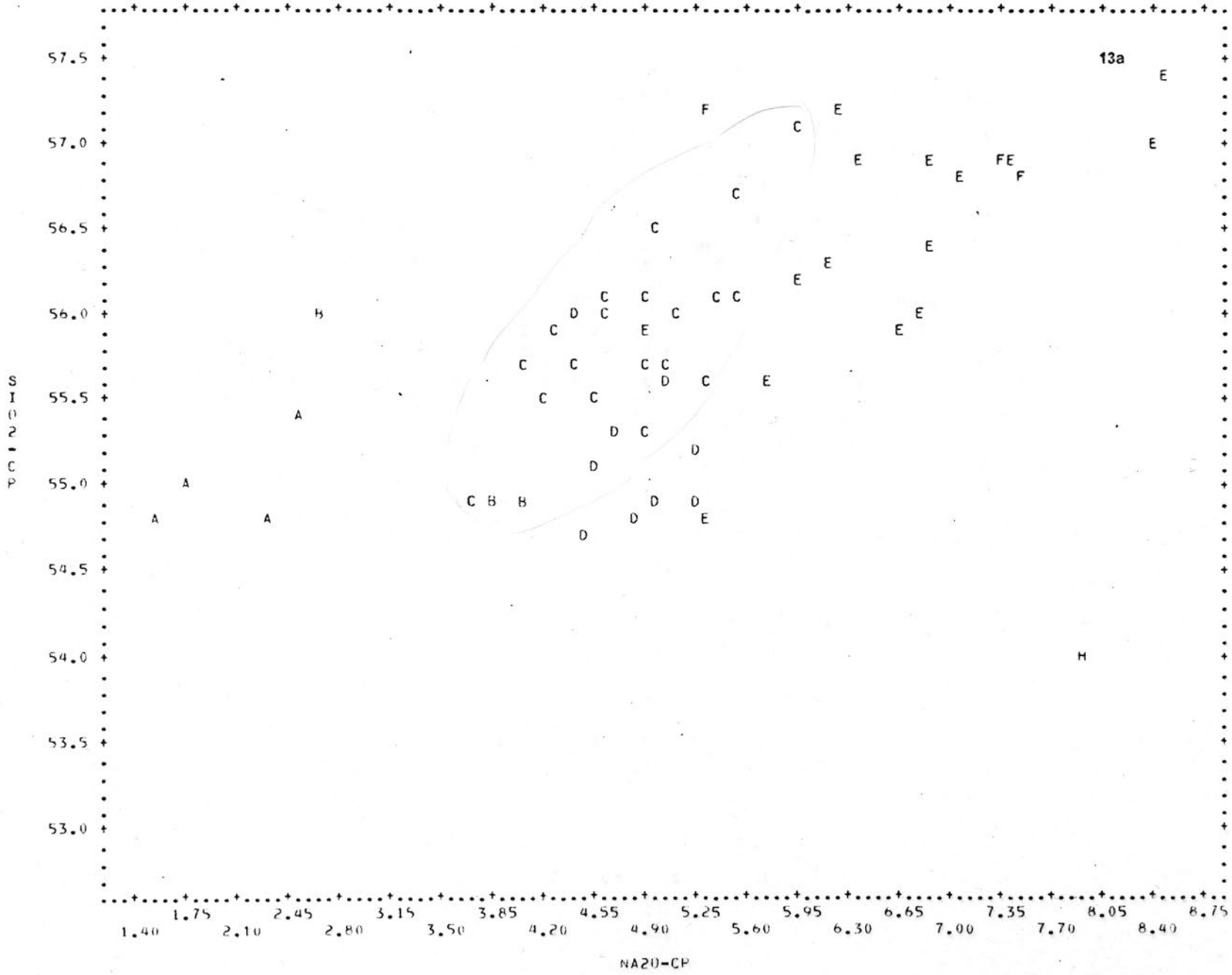
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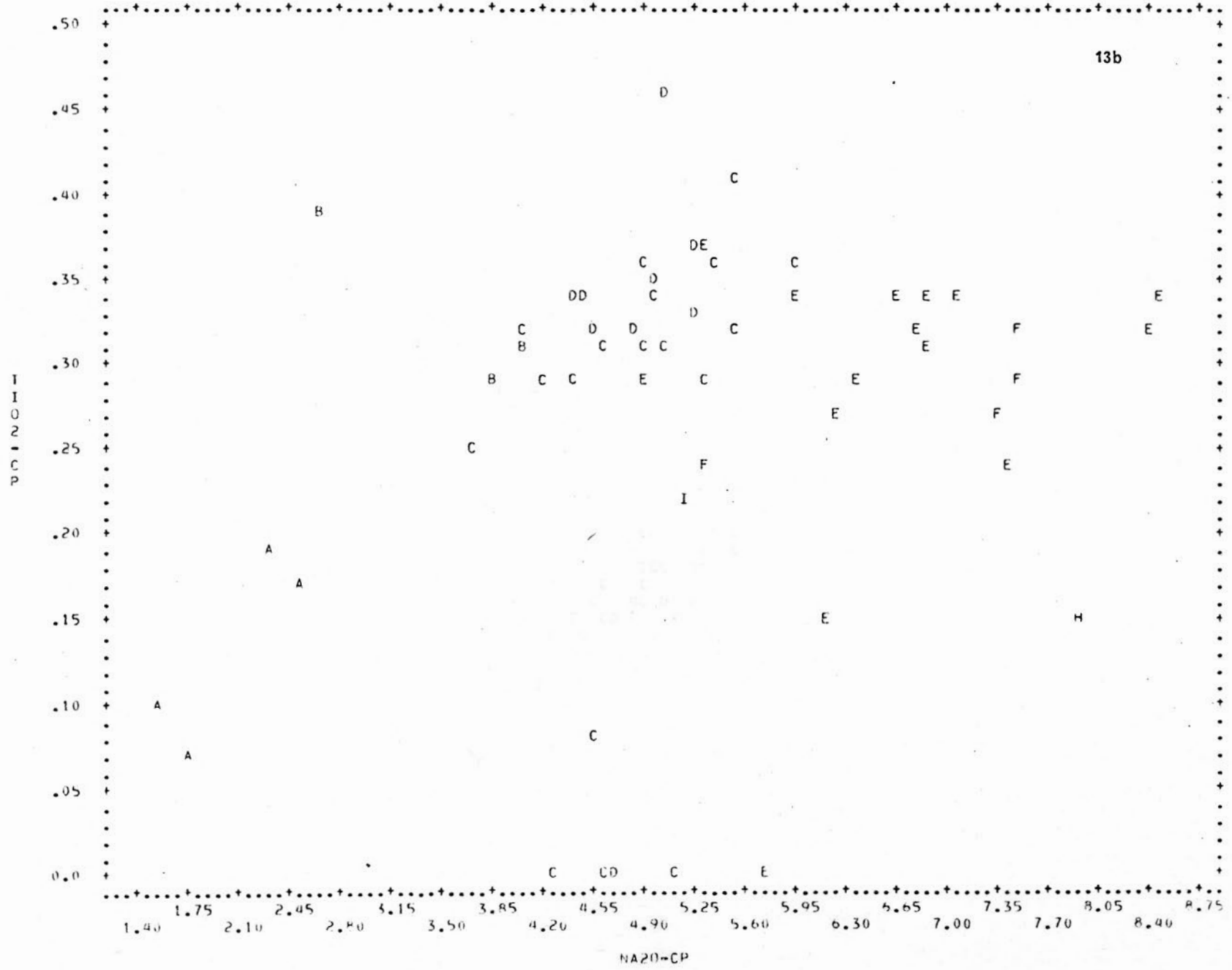
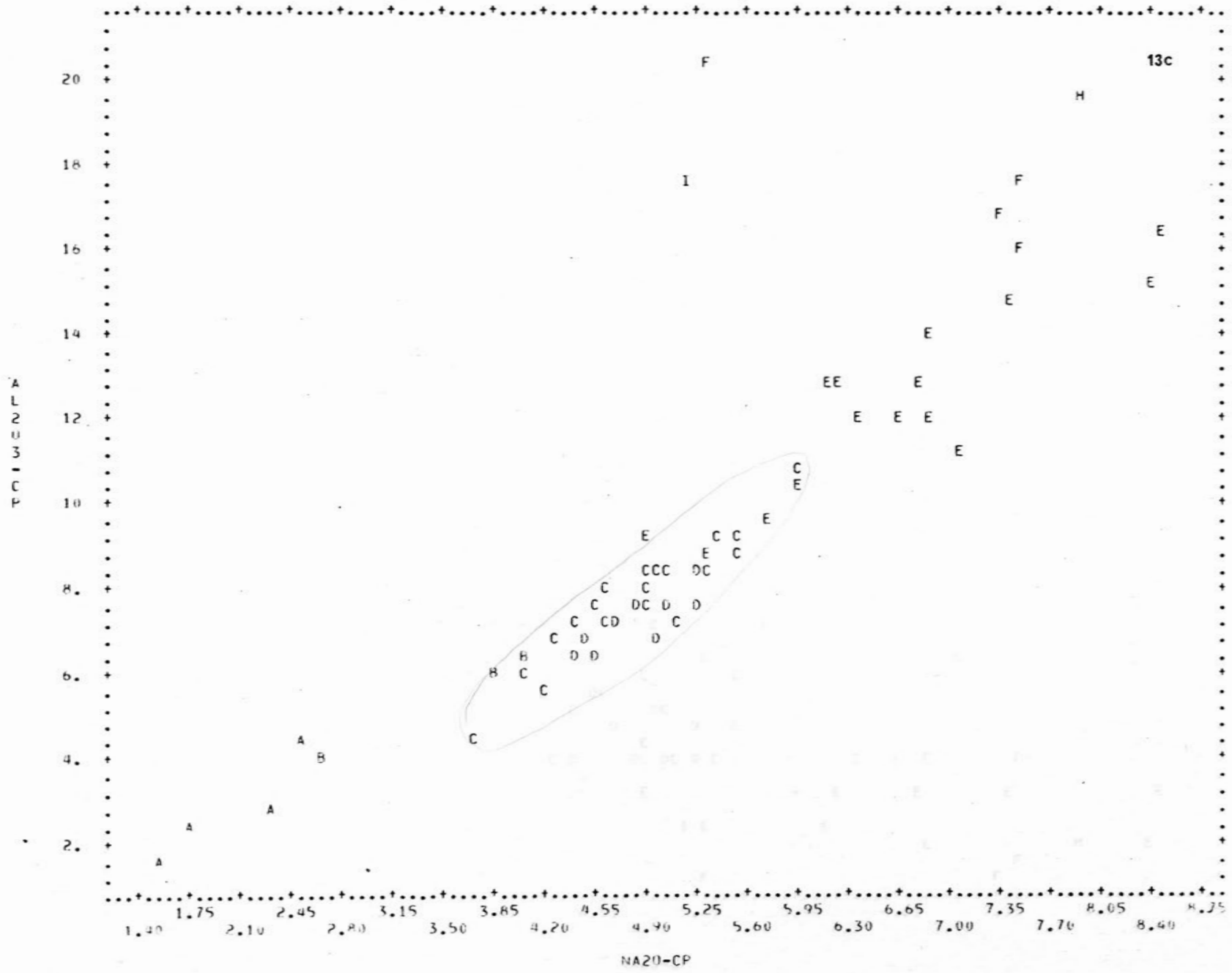
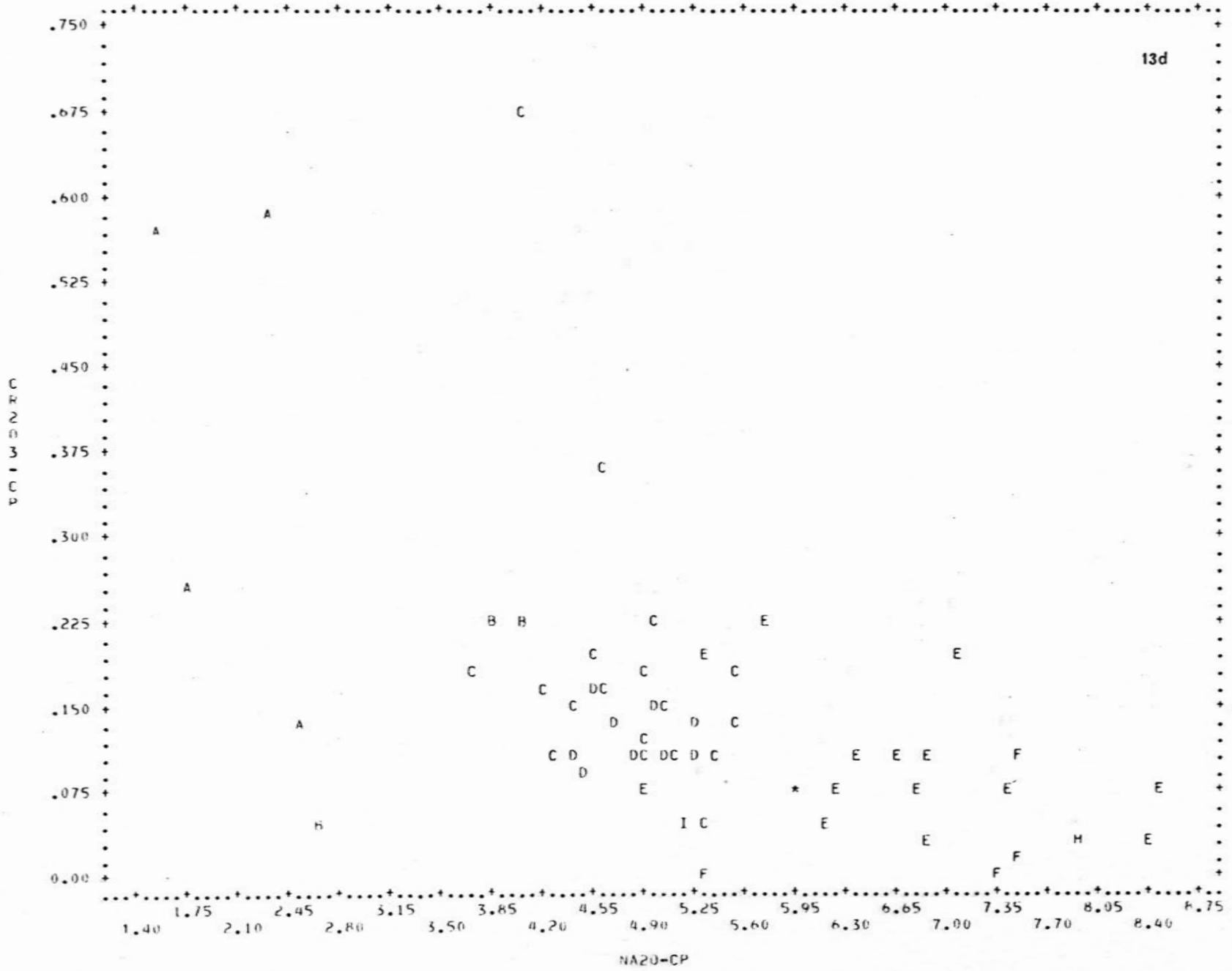
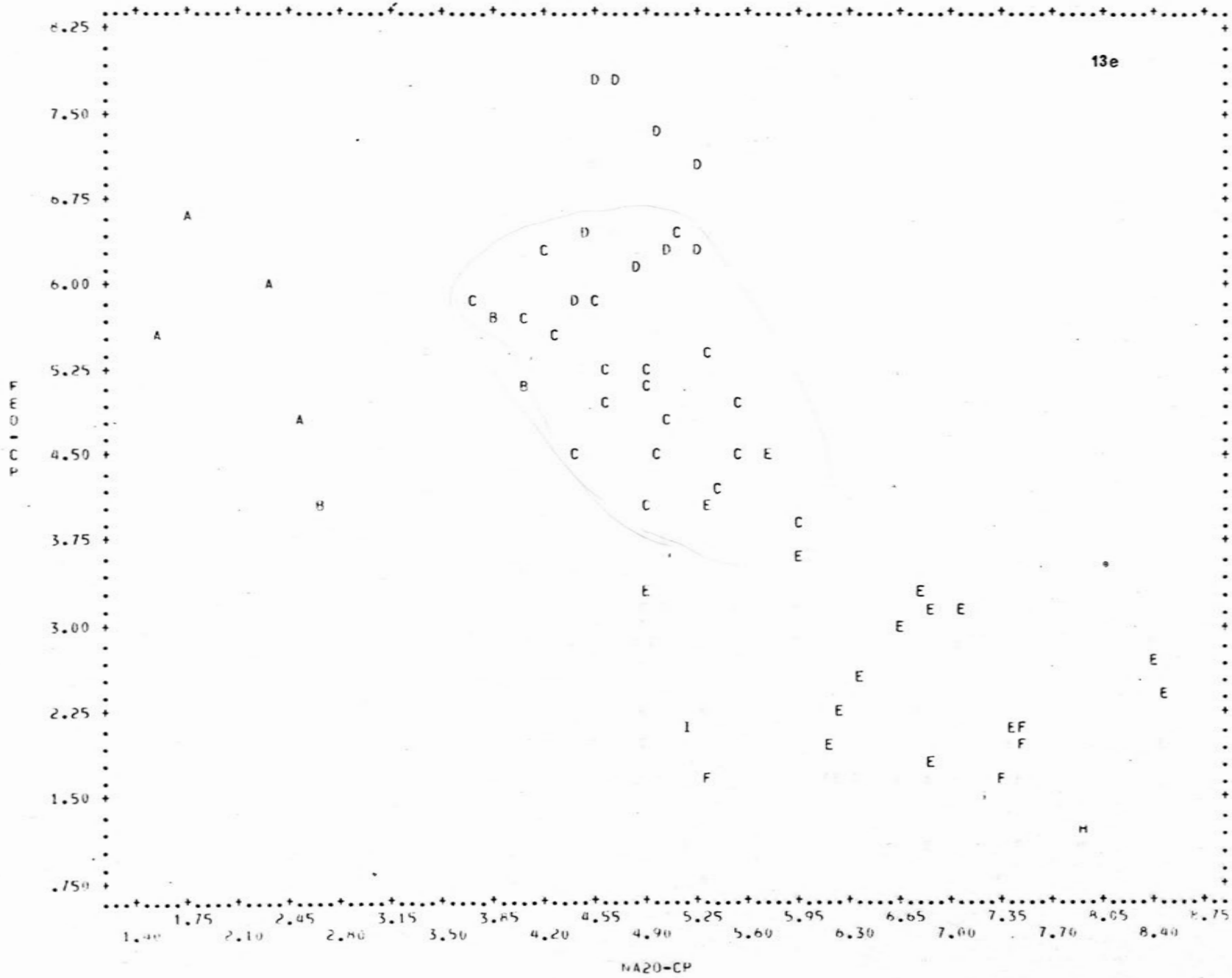
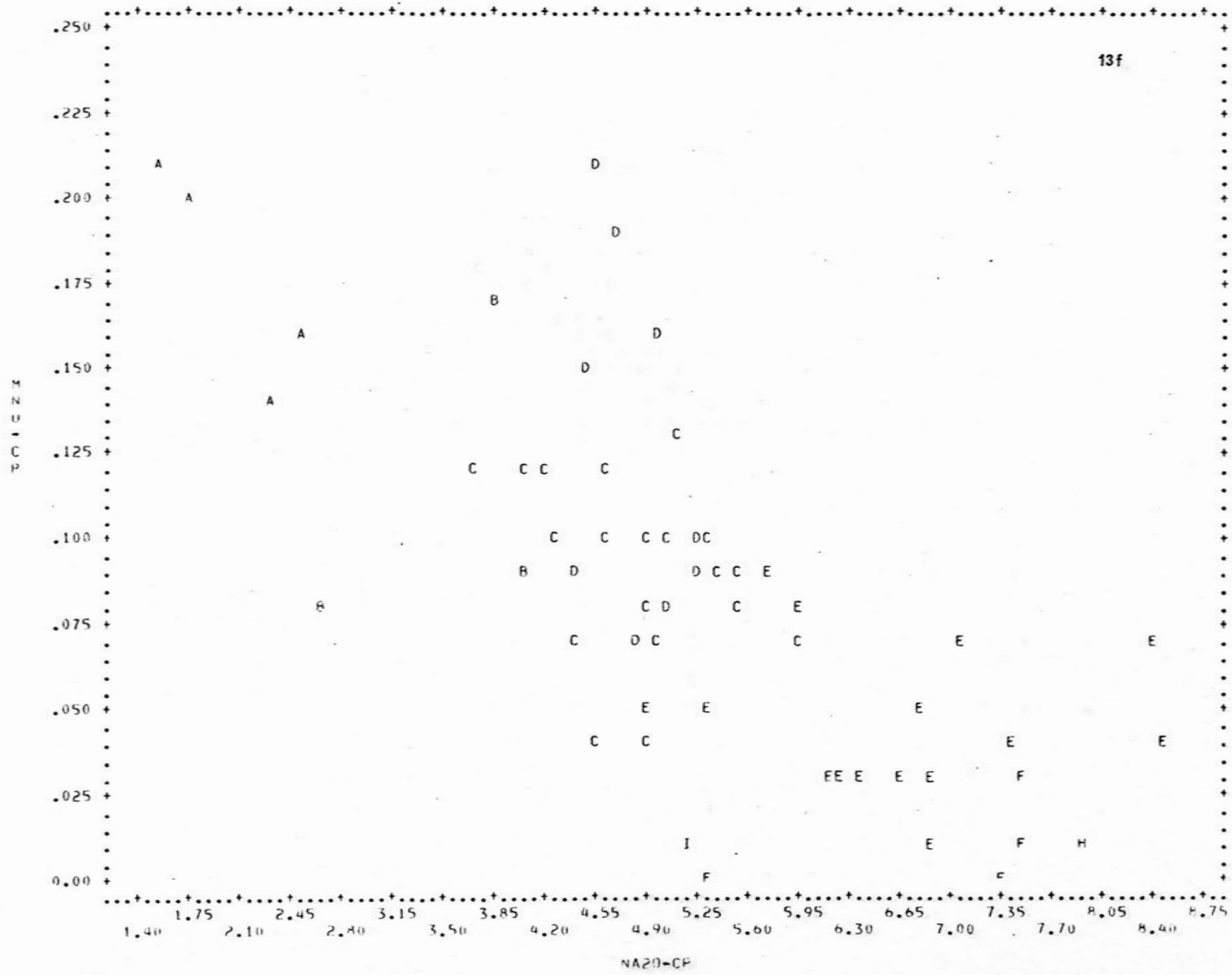
NA2O-CP
57.5
57.0
56.5
56.0
55.5
55.0
54.5
54.0
53.5
53.0
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
8.75

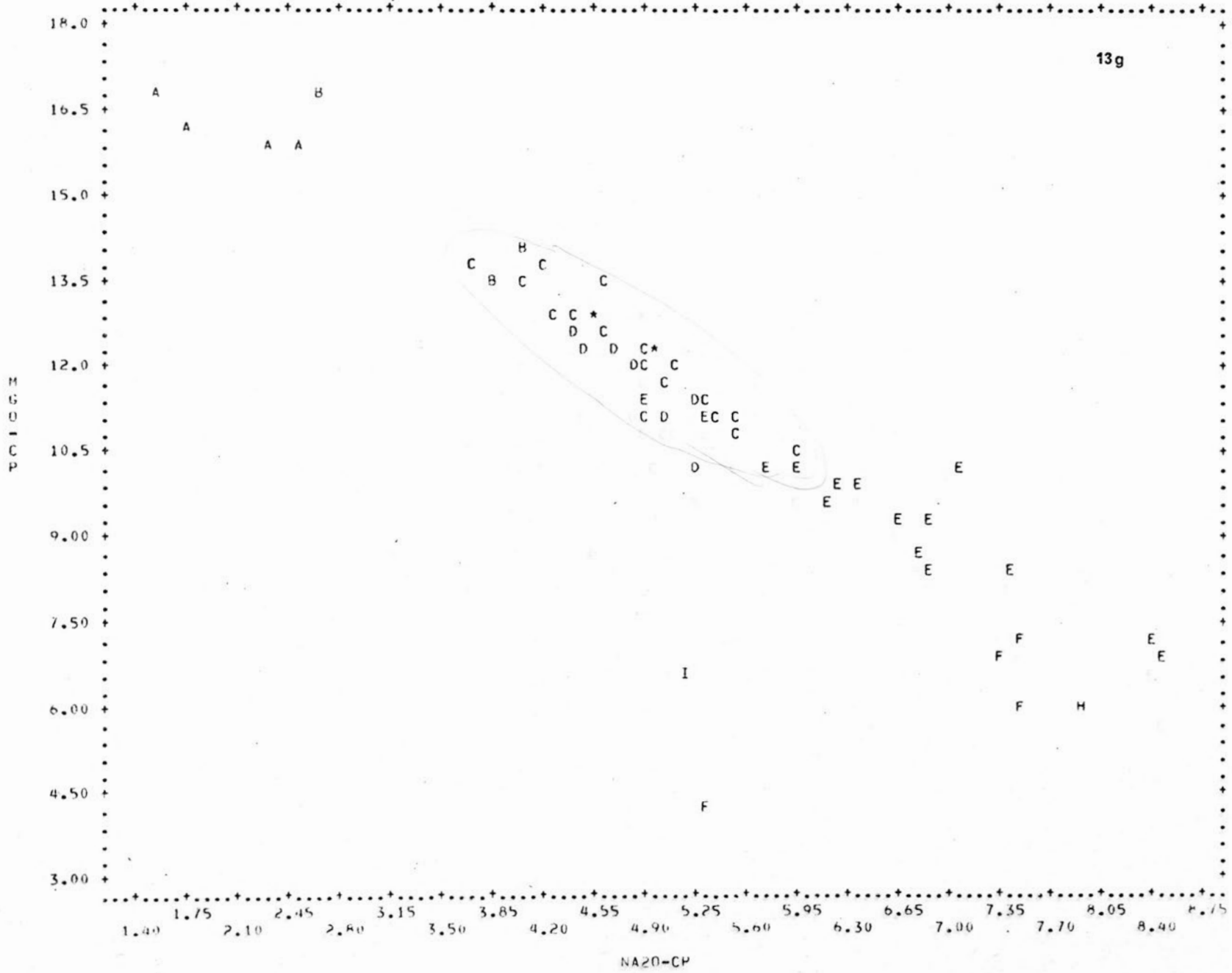

13b
TIO2-CP
NA2O-CP
.50
.45
.40
.35
.30
.25
.20
.15
.10
.05
0.0
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
8.75

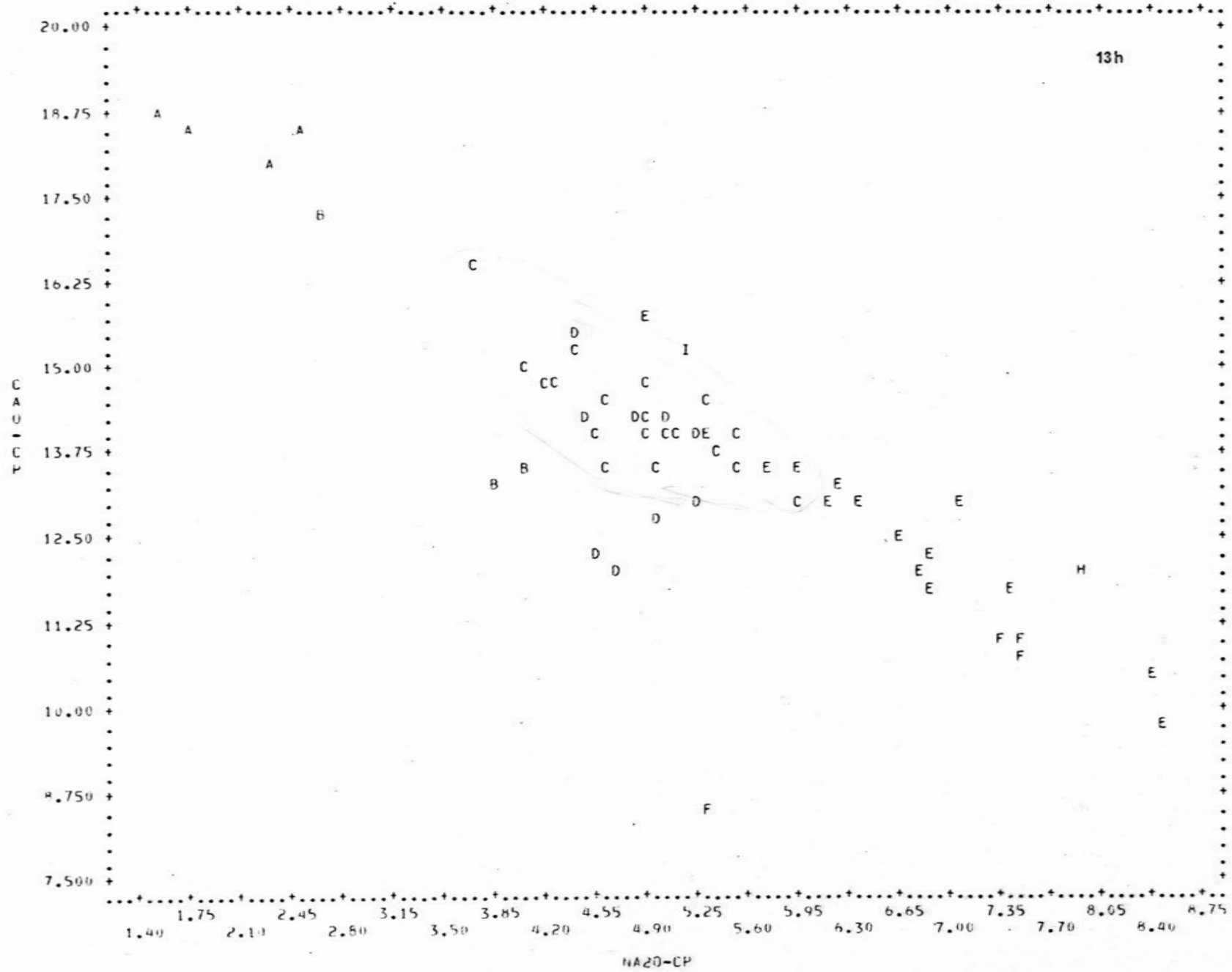

13c
AL2O3-CP
NA2O-CP
20
18
16
14
12
10
8.
6.
4.
2.
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
8.75

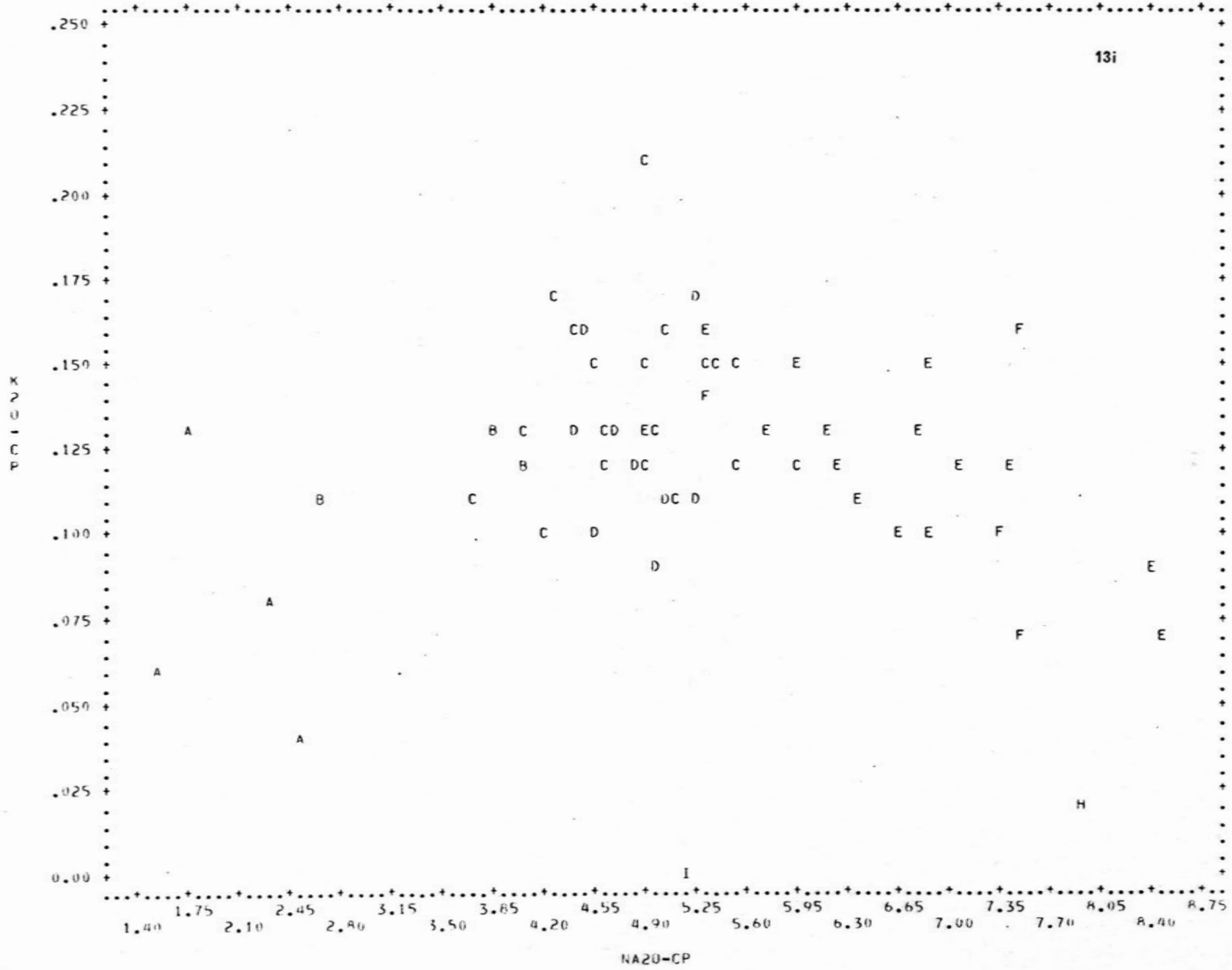

13d
CR2O3-CP
NA2O-CP
.750
.675
.600
.525
.450
.375
.300
.225
.150
.075
0.00
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
8.75

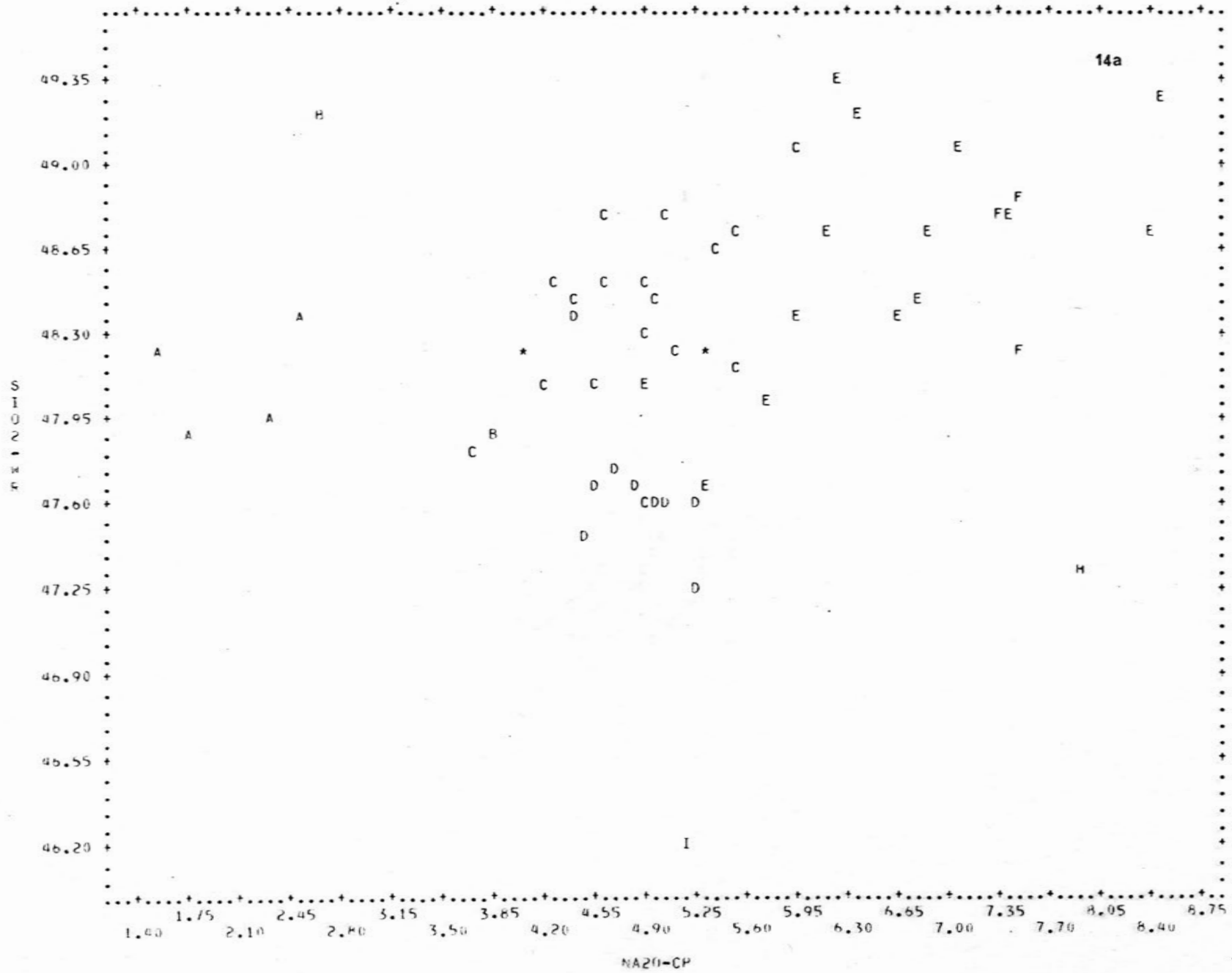

13e
FEO-CP
NA2O-CP
8.25
7.50
6.75
6.00
5.25
4.50
3.75
3.00
2.25
1.50
.750
1.75
2.45
3.15
3.85
4.55
5.25
5.95
6.65
7.35
8.05
8.75
1.40
2.10
2.80
3.50
4.20
4.90
5.60
6.30
7.00
7.70
8.40

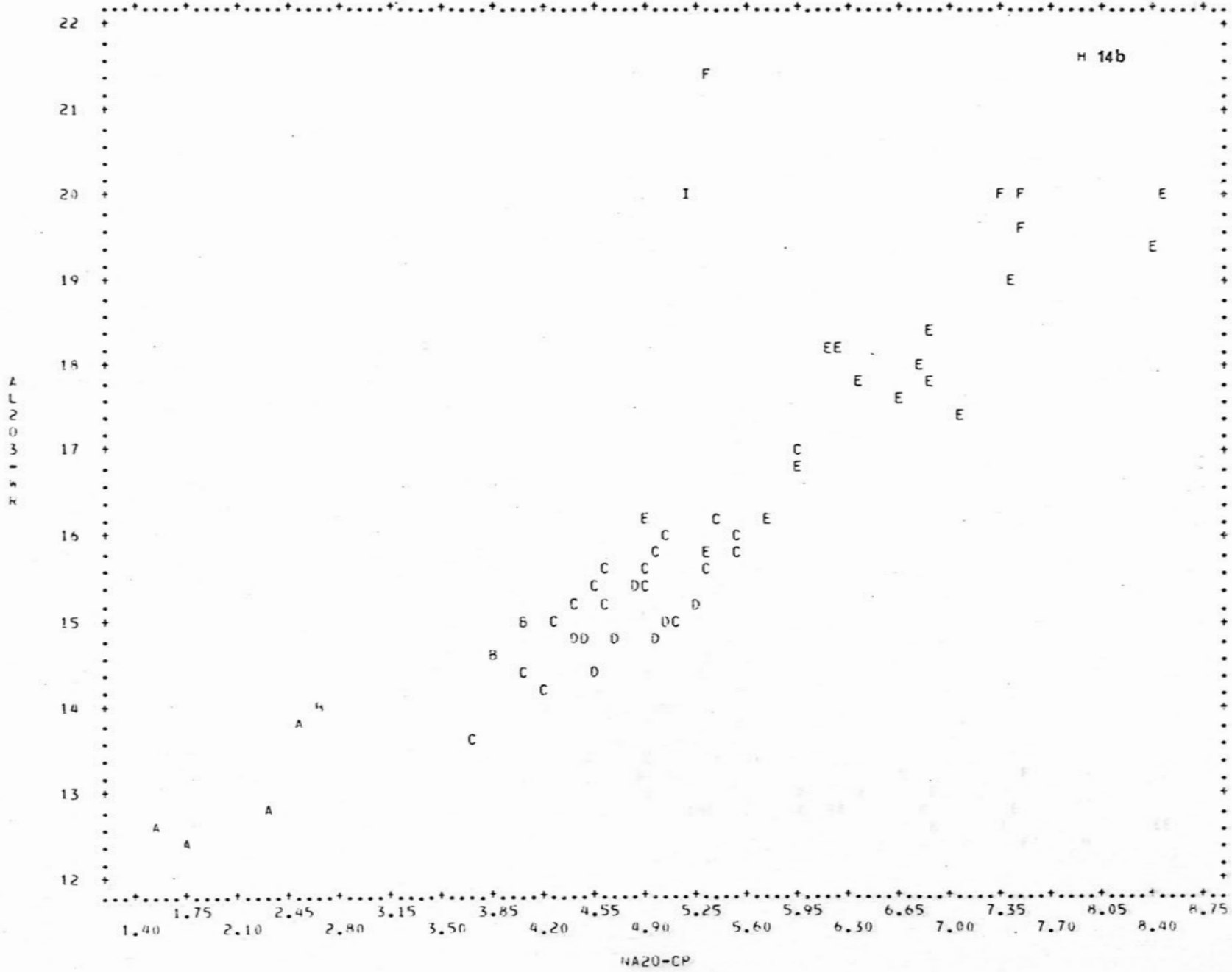

13f
.250
.225
.200
.175
.150
.125
.100
.075
.050
.025
0.00
MNO-CP
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
8.75
NA2O-CP

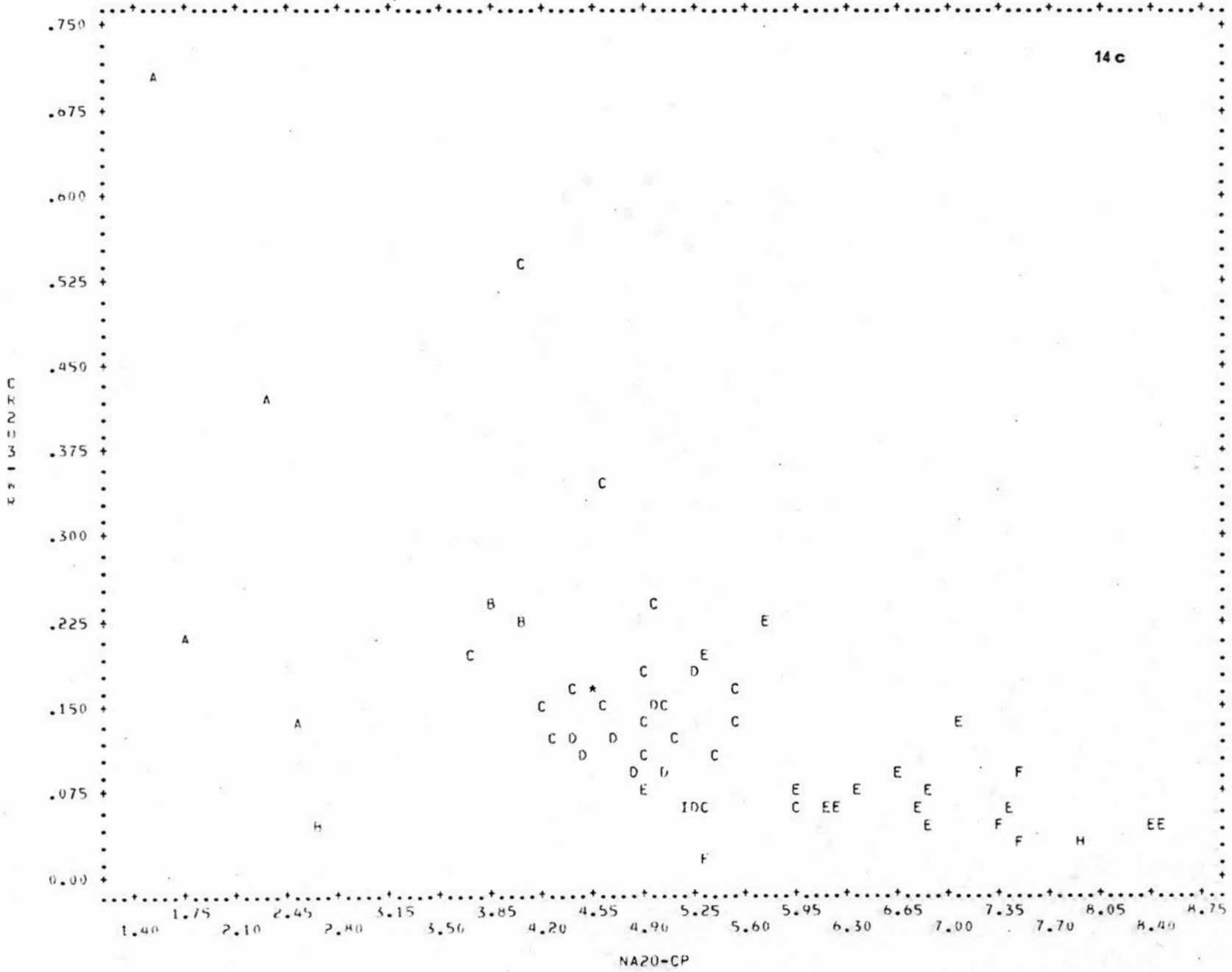

13g
MGO-CP
NA2O-CP
18.0
16.5
15.0
13.5
12.0
10.5
9.00
7.50
6.00
4.50
3.00
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40

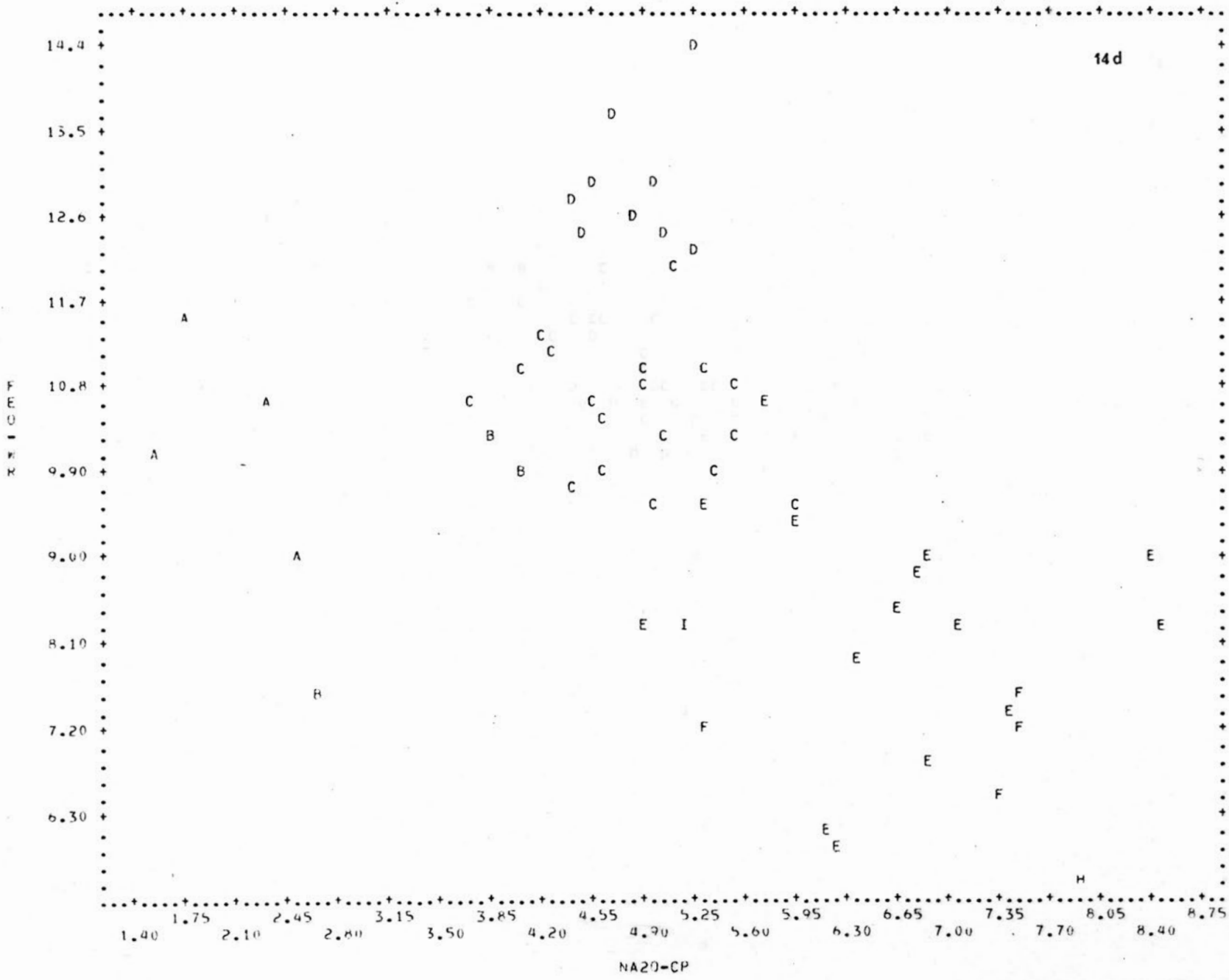

13h
CAO-CP
NA2O-CP
20.00
18.75
17.50
16.25
15.00
13.75
12.50
11.25
10.00
8.750
7.500
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
8.75

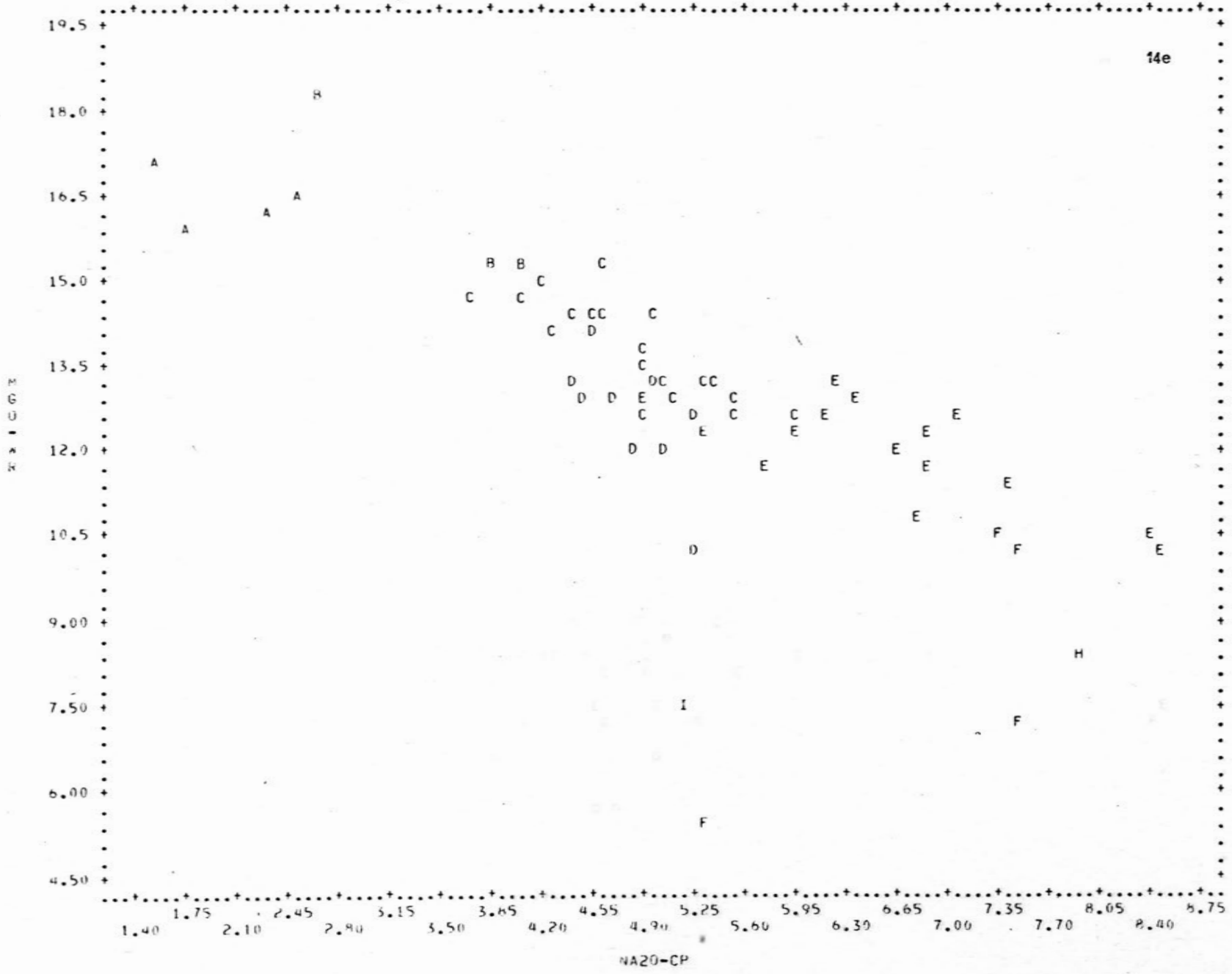

K2O-CP
.250
.225
.200
.175
.150
.125
.100
.075
.050
.025
0.00
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
8.75
NA2O-CP


14a
SIO2-CP
NA2O-CP
49.35
49.00
48.65
48.30
47.95
47.60
47.25
46.90
46.55
46.20
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
8.75


H 14b
AL2O3-CP
NA2O-CP
22
21
20
19
18
17
16
15
14
13
12
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
8.75


14 c
.750
.675
.600
.525
.450
.375
.300
.225
.150
.075
0.00
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
8.75
NA20-CP


14d
FEO-ER
14.4
13.5
12.6
11.7
10.8
9.90
9.00
8.10
7.20
6.30
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
8.75
NA2O-CP


14e
MGO-AK
NA2O-CP
19.5
18.0
16.5
15.0
13.5
12.0
10.5
9.00
7.50
6.00
4.50
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
8.75

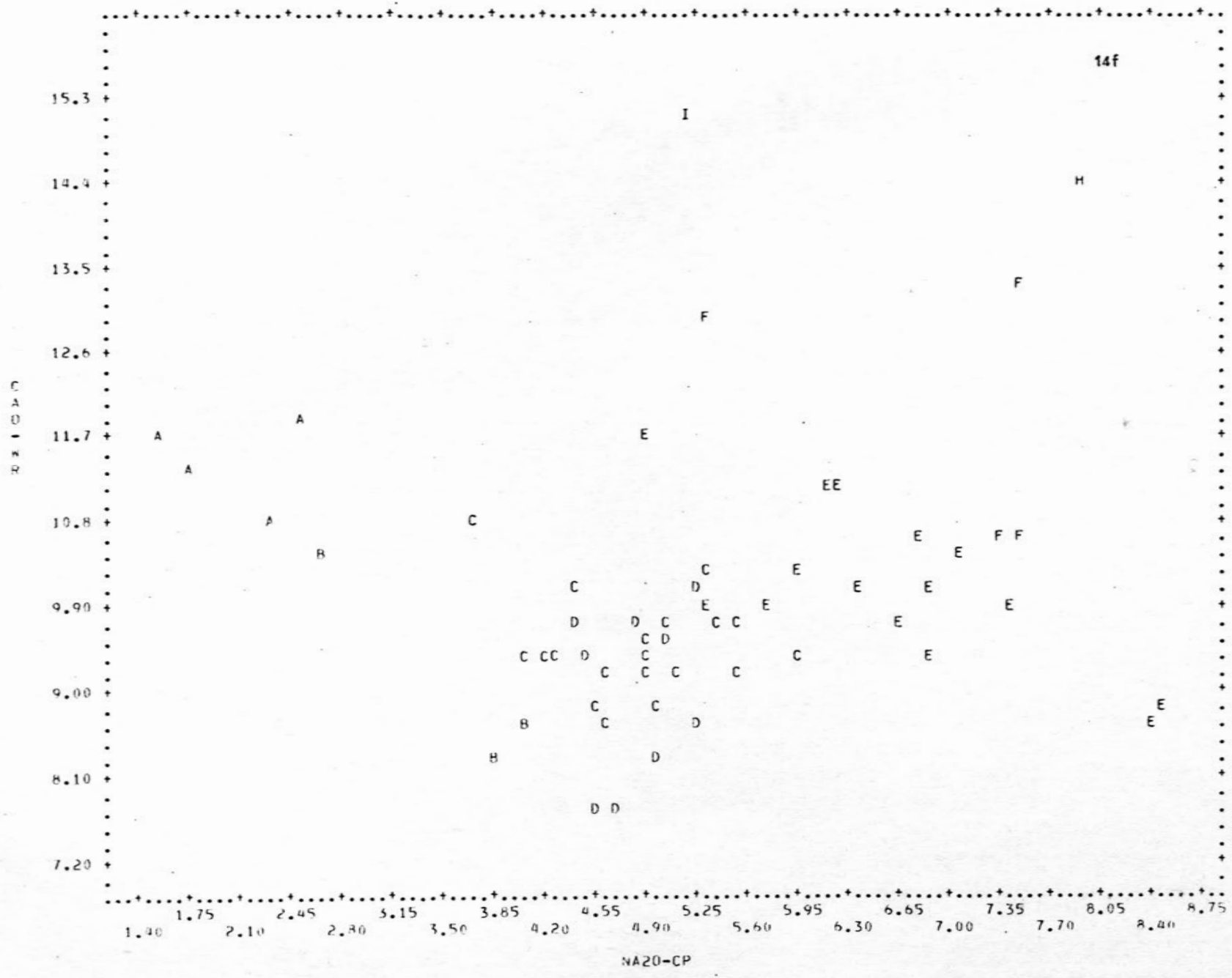

14f
15.3
14.4
13.5
12.6
11.7
10.8
9.90
9.00
8.10
7.20
CAO-WR
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
8.75
NA2O-CP

FIGURE 15. CMAS tetrahedron.

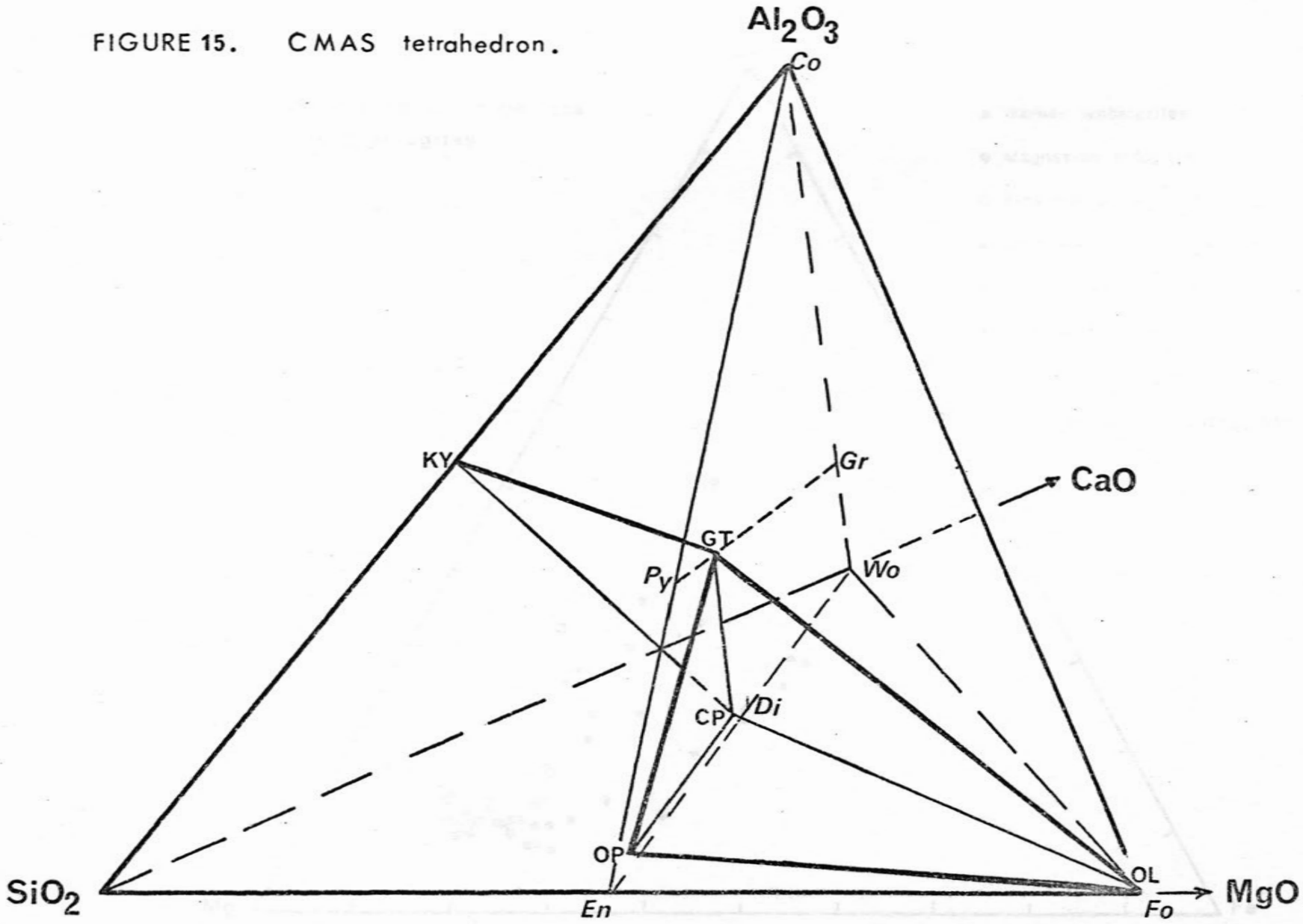
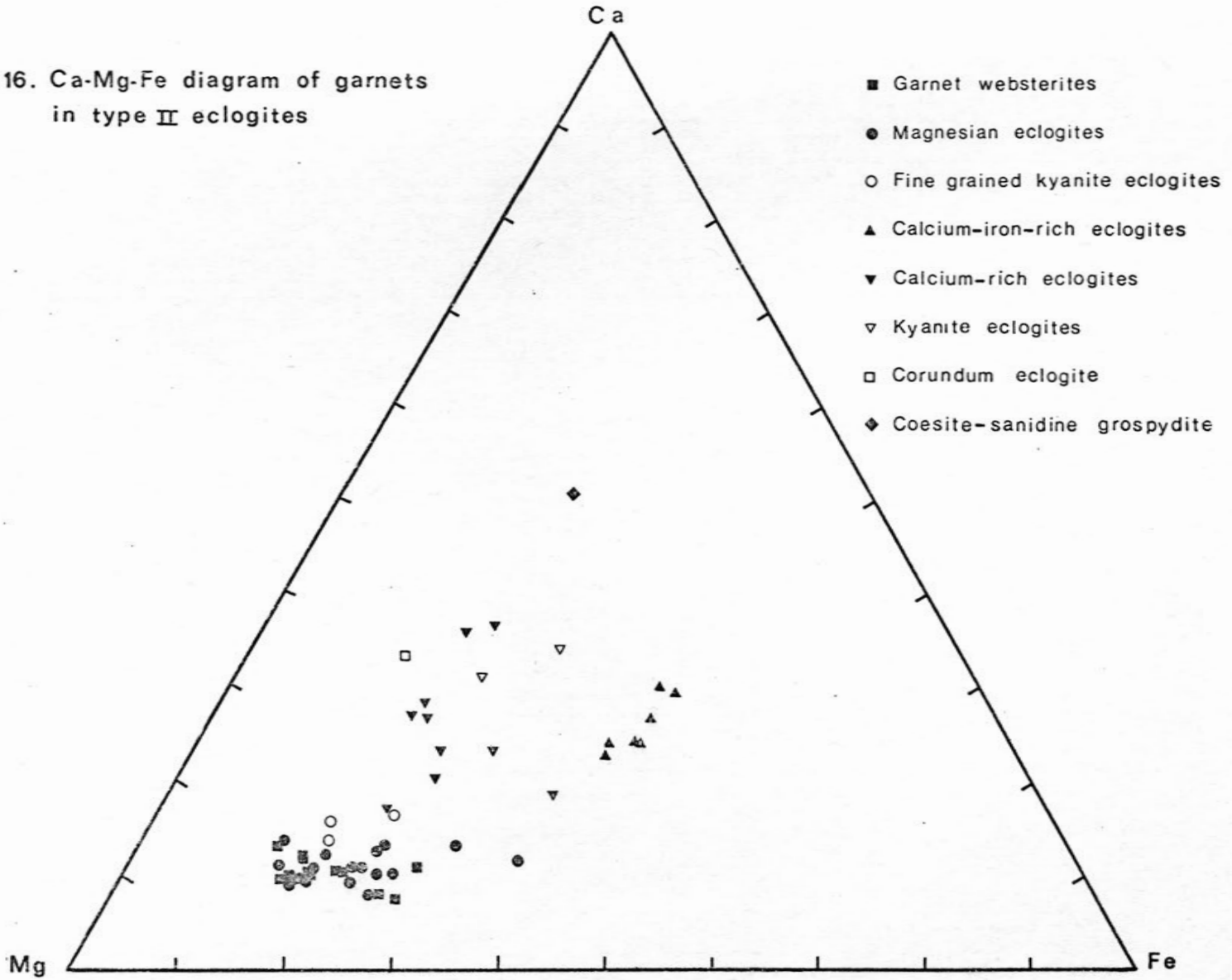


Figure 16. Ca-Mg-Fe diagram of garnets in type II eclogites



Preface to figures 17 to 19

The symbols in figures 17 to 19 refer to the following subgroups in the type II eclogites:

A Garnet websterites

B Magnesian eclogites

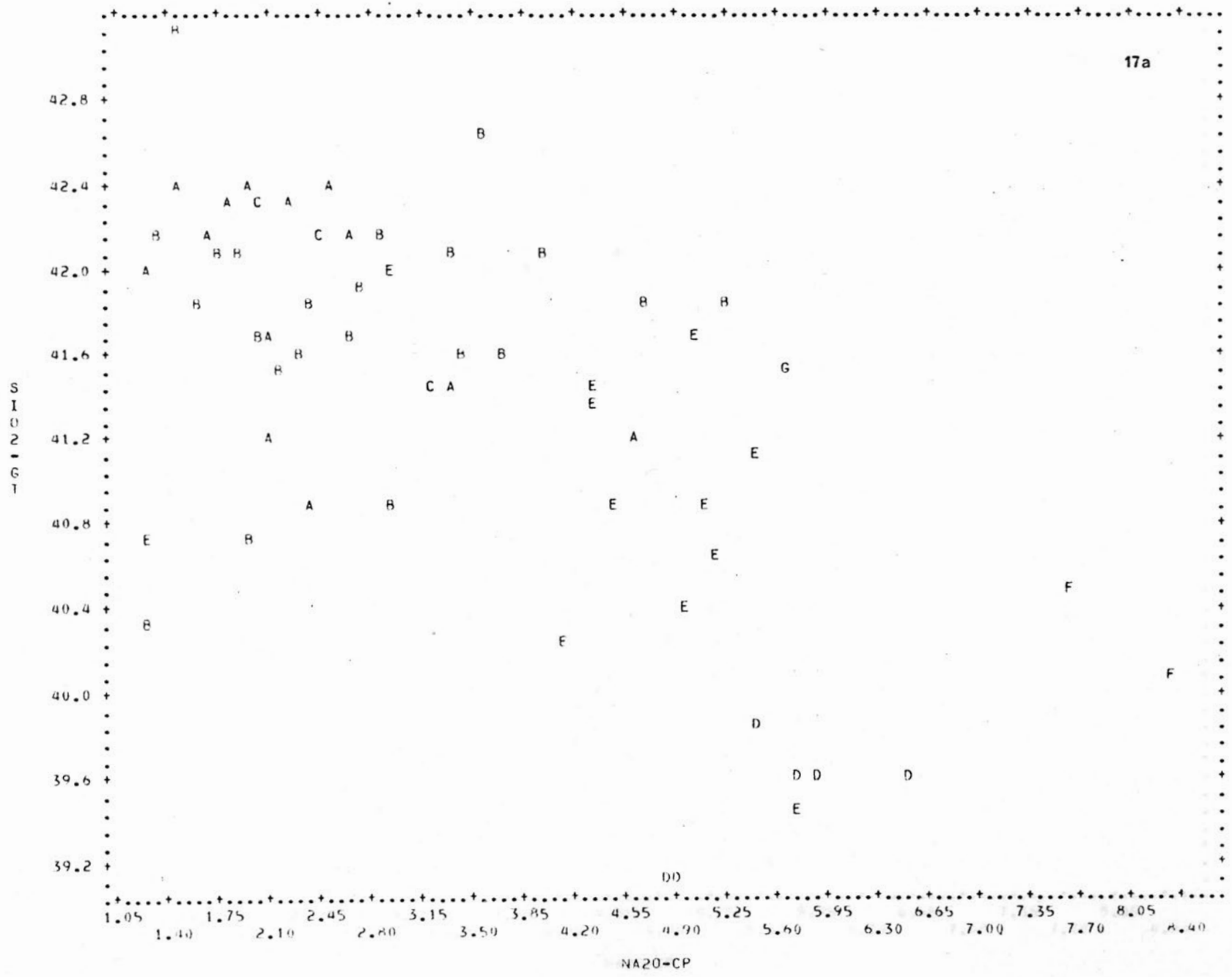
C Fine Grained Kyanite Corundum Eclogites

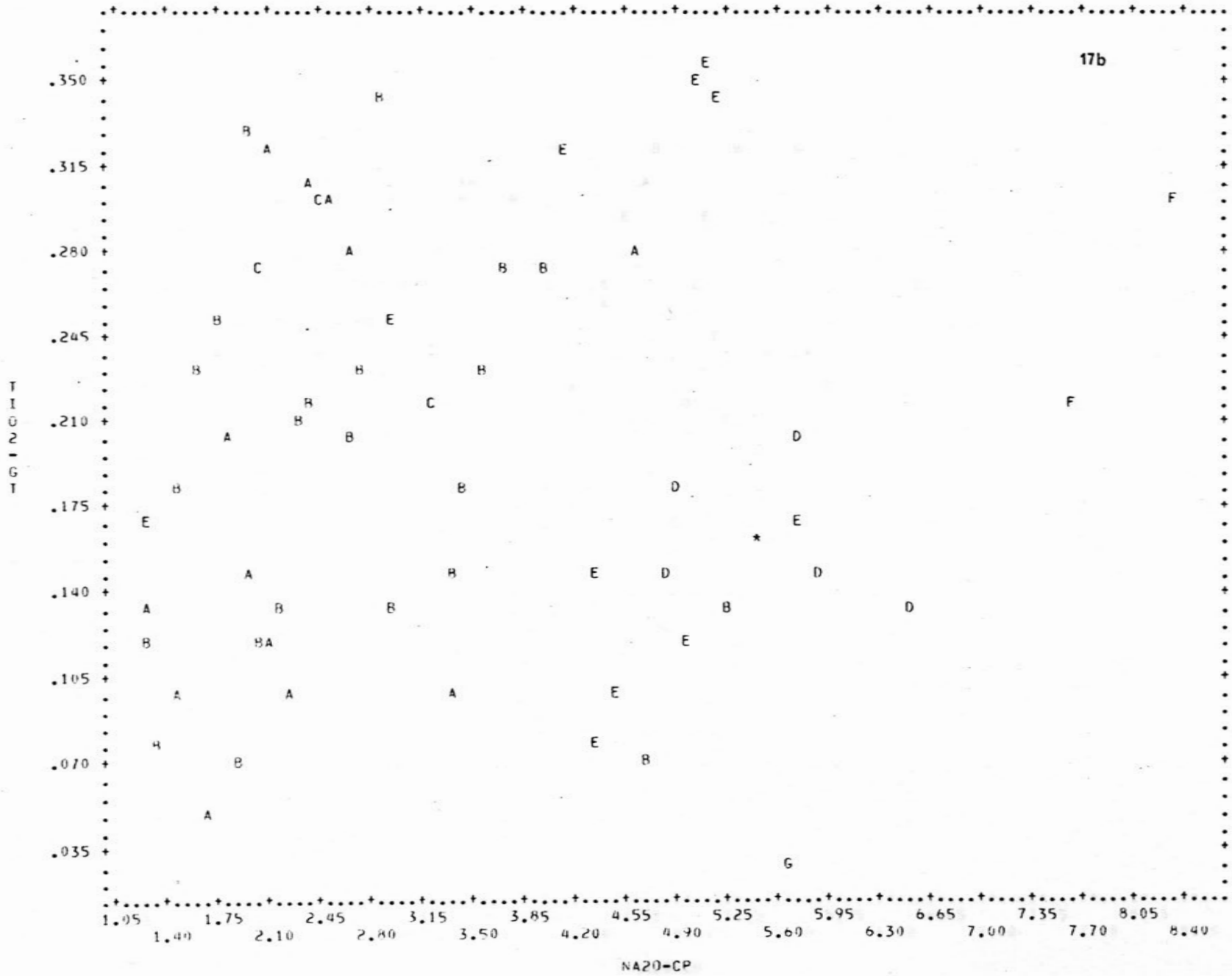
D Calcium-iron-rich eclogites

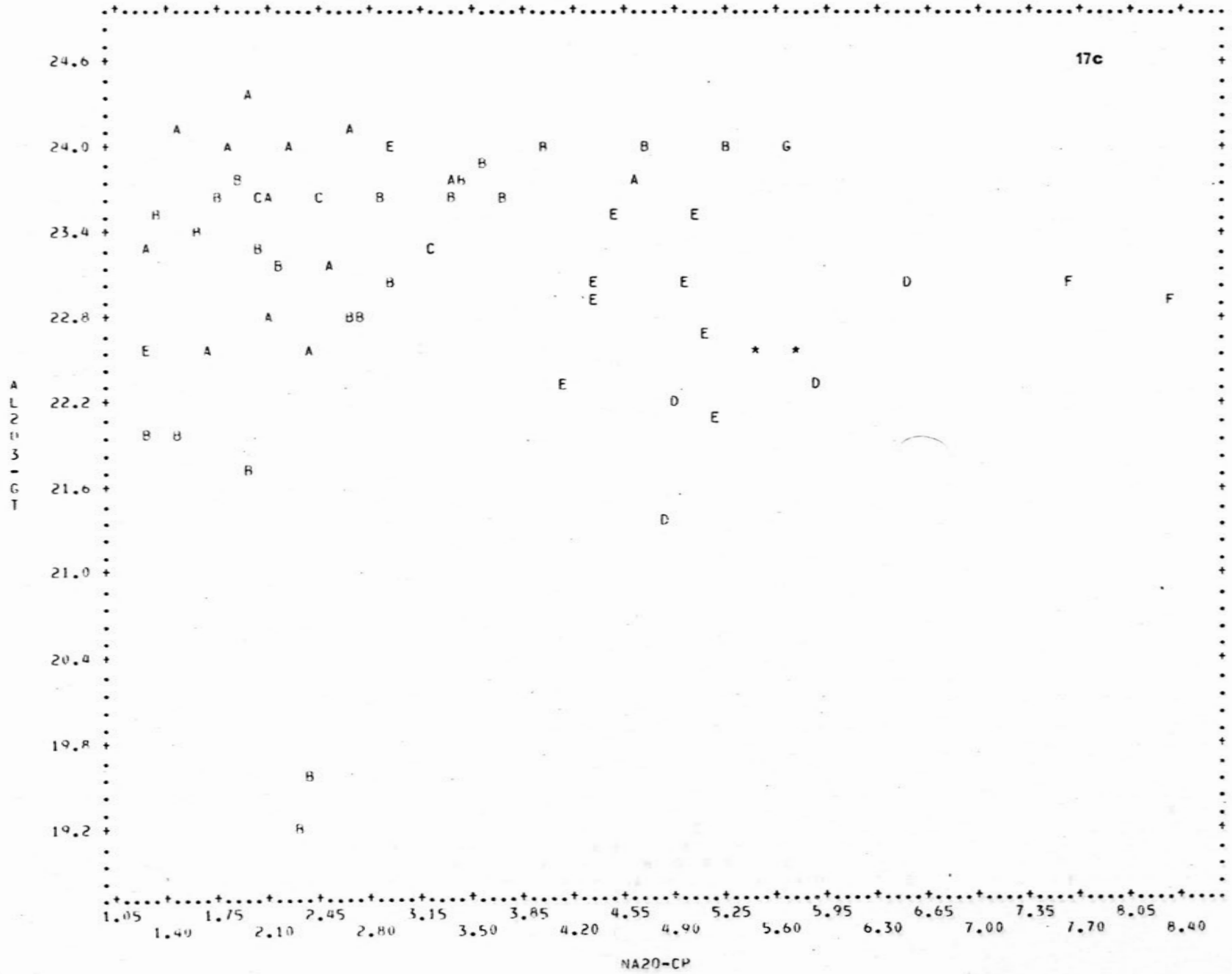
E Iron-rich eclogites

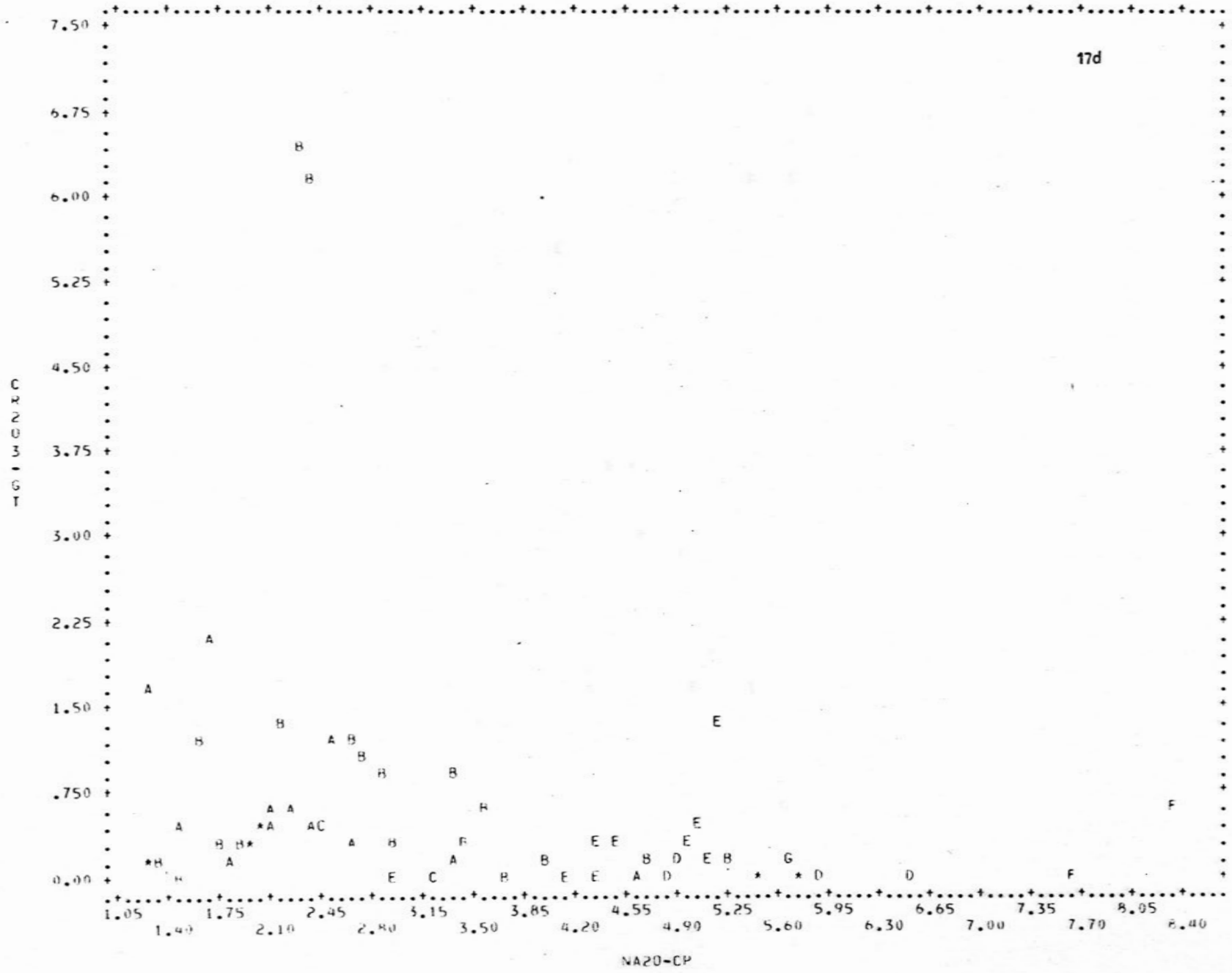
F Kyanite eclogites

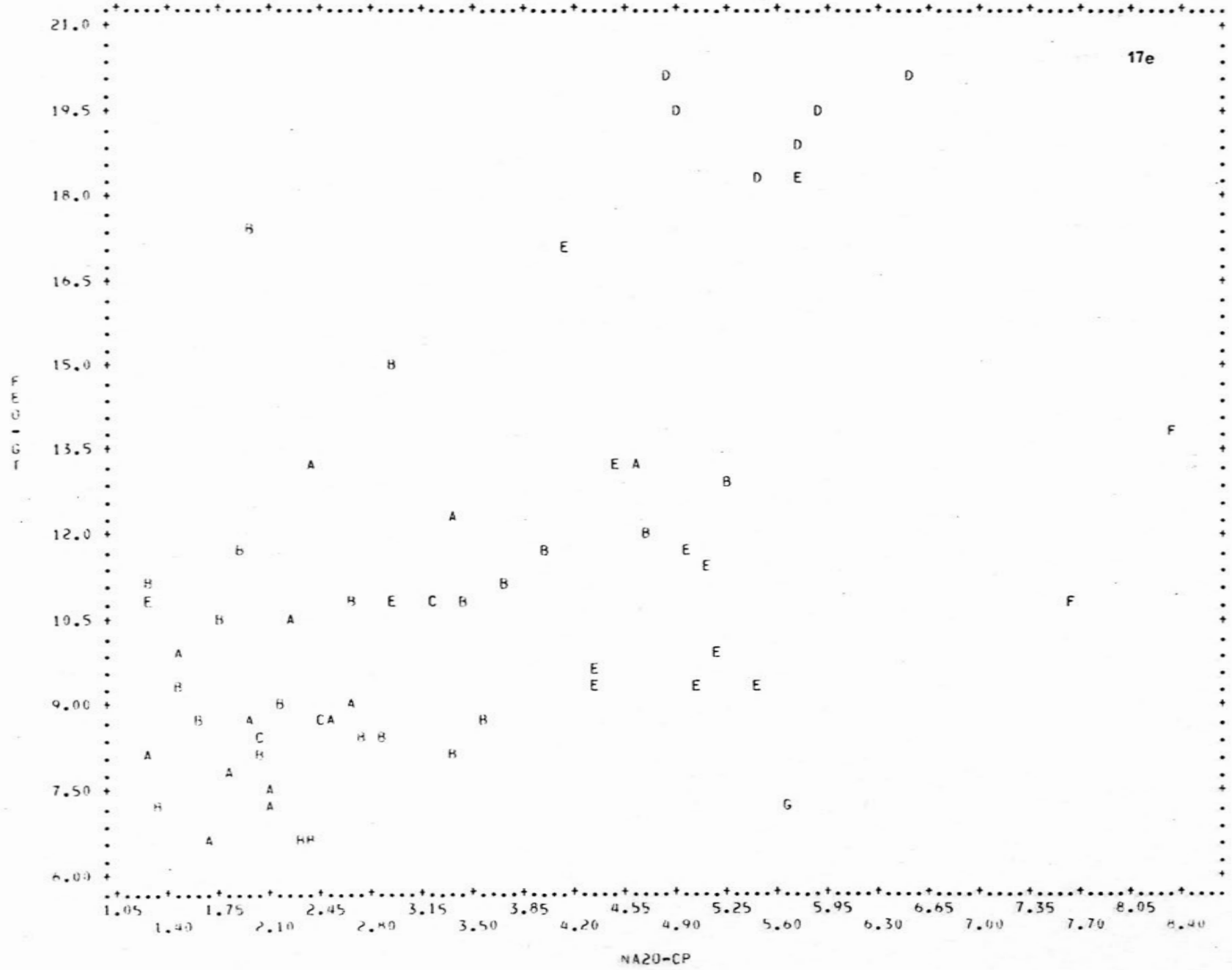
G Corundum eclogite

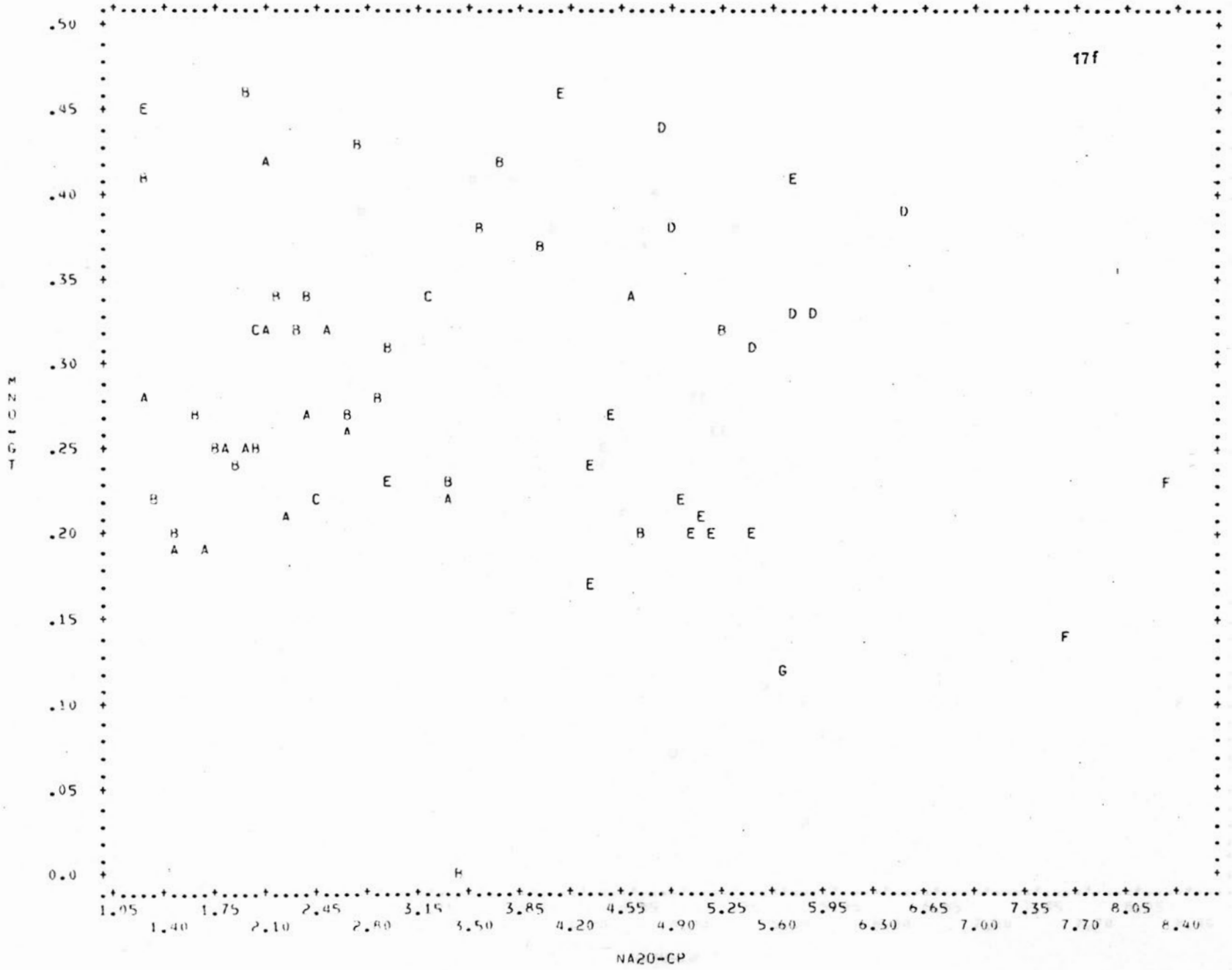

17a
SIO2-GT
42.8
42.4
42.0
41.6
41.2
40.8
40.4
40.0
39.6
39.2
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA2O-CP

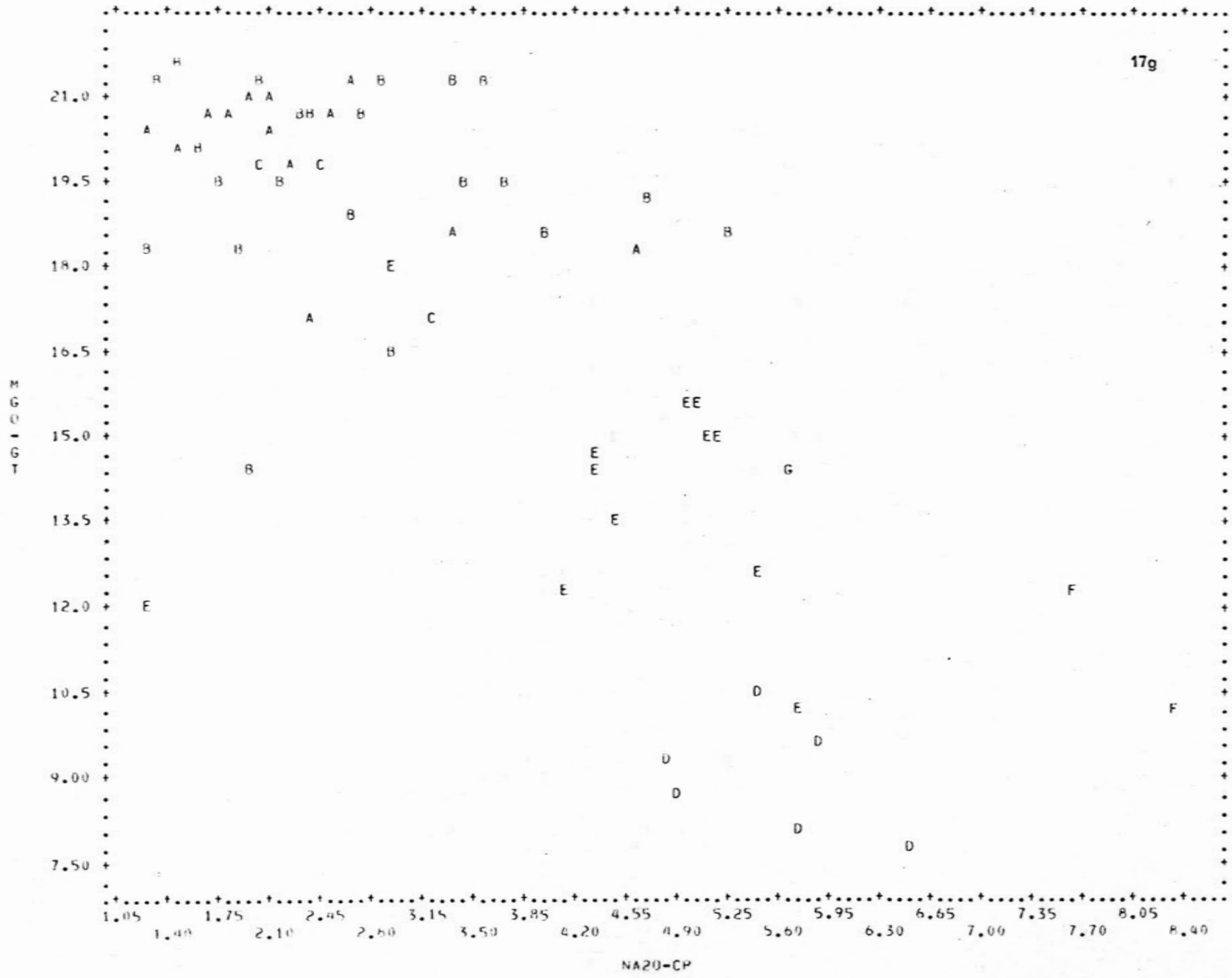

17b
TIO2-GT
.350
.315
.280
.245
.210
.175
.140
.105
.070
.035
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA2O-CP

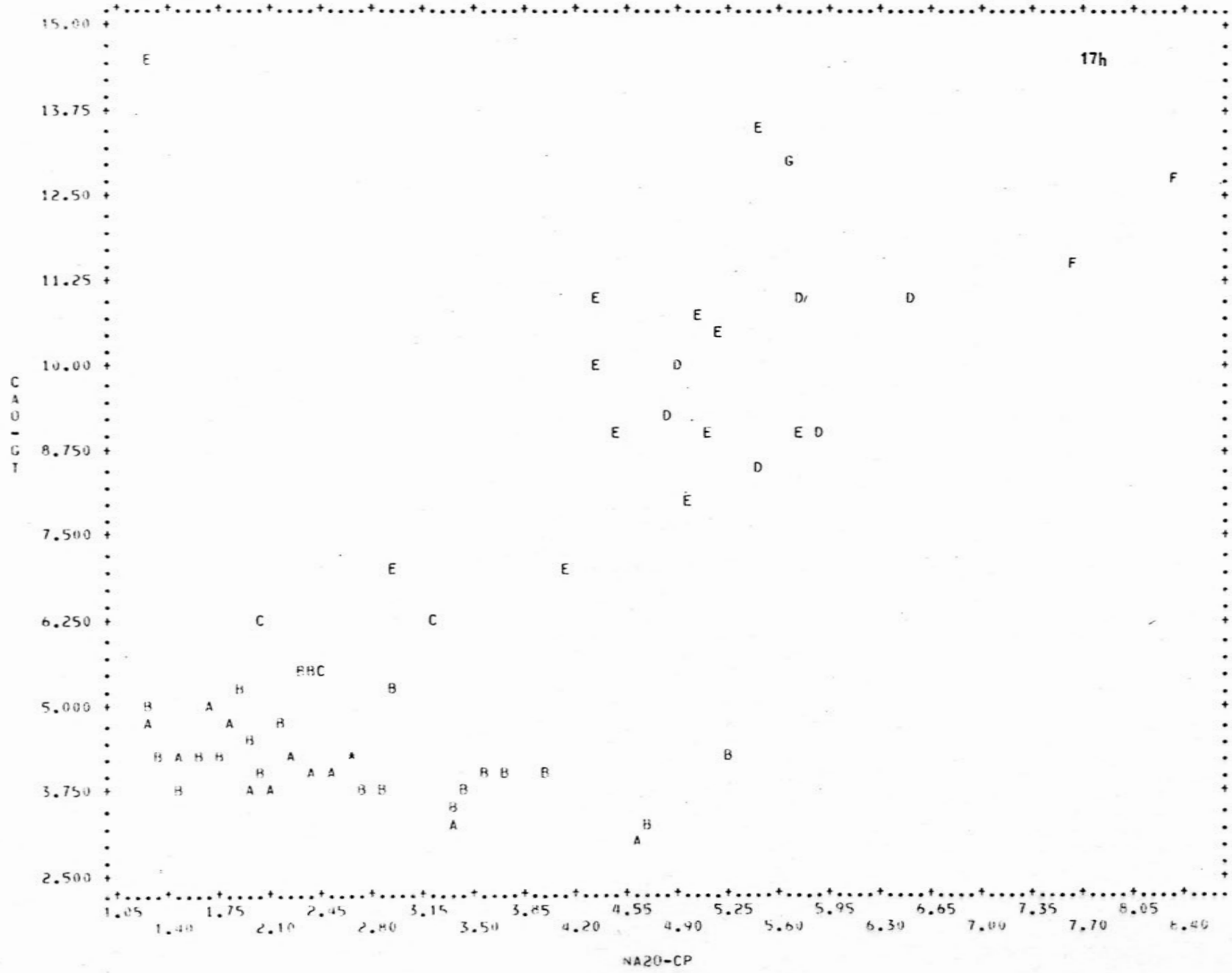

17c
AL2O3-GT
24.6
24.0
23.4
22.8
22.2
21.6
21.0
20.4
19.8
19.2
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA2O-CP

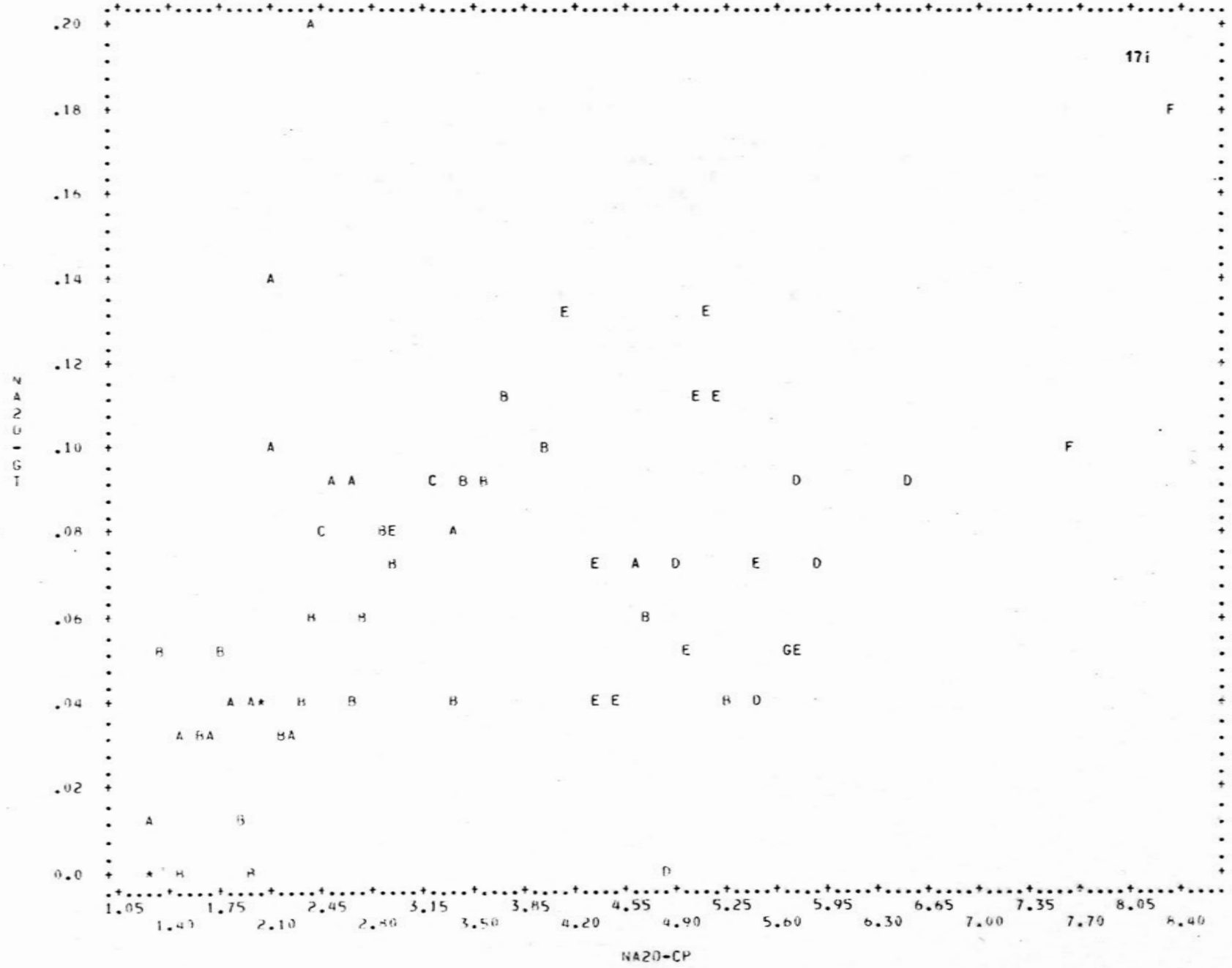

17d
CR203-GT
NA2O-CP
7.50
6.75
6.00
5.25
4.50
3.75
3.00
2.25
1.50
.750
0.00
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40

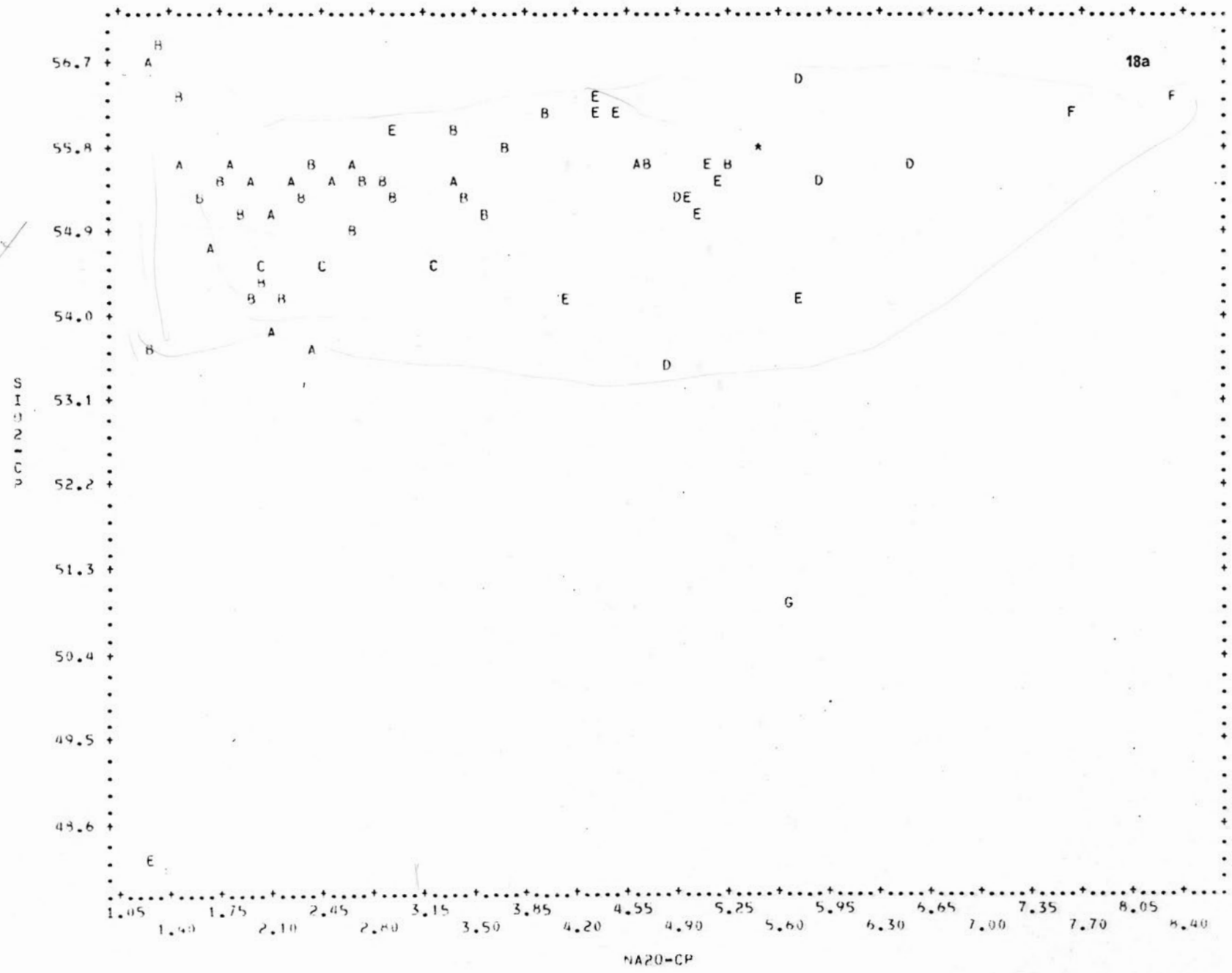

17e
FEG-GT
21.0
19.5
18.0
16.5
15.0
13.5
12.0
10.5
9.00
7.50
6.00
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA2O-CP


17f
MNOGT
.50
.45
.40
.35
.30
.25
.20
.15
.10
.05
0.0
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA2O-CP

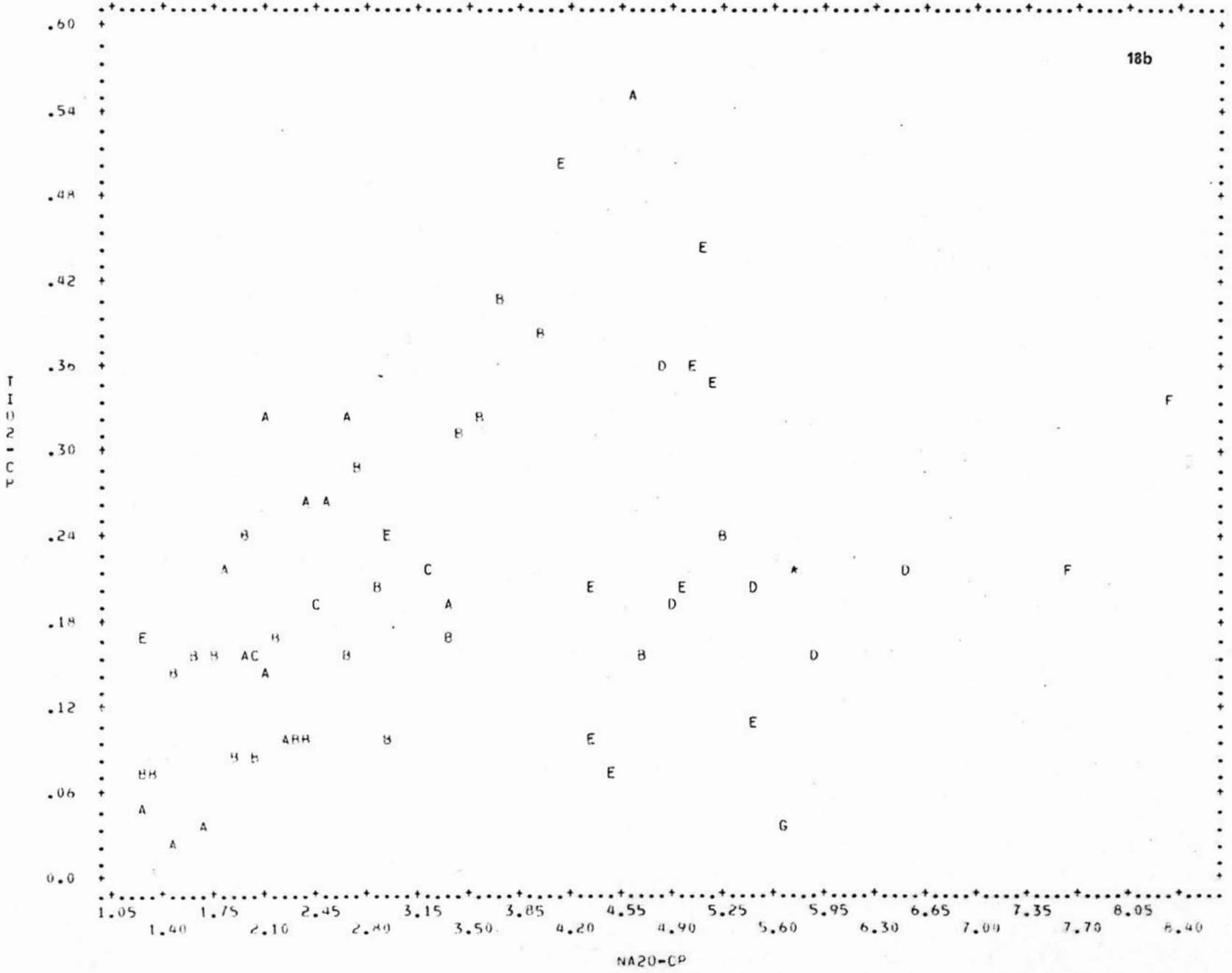

17g
MGO-GT
21.0
19.5
18.0
16.5
15.0
13.5
12.0
10.5
9.00
7.50
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA2O-CP

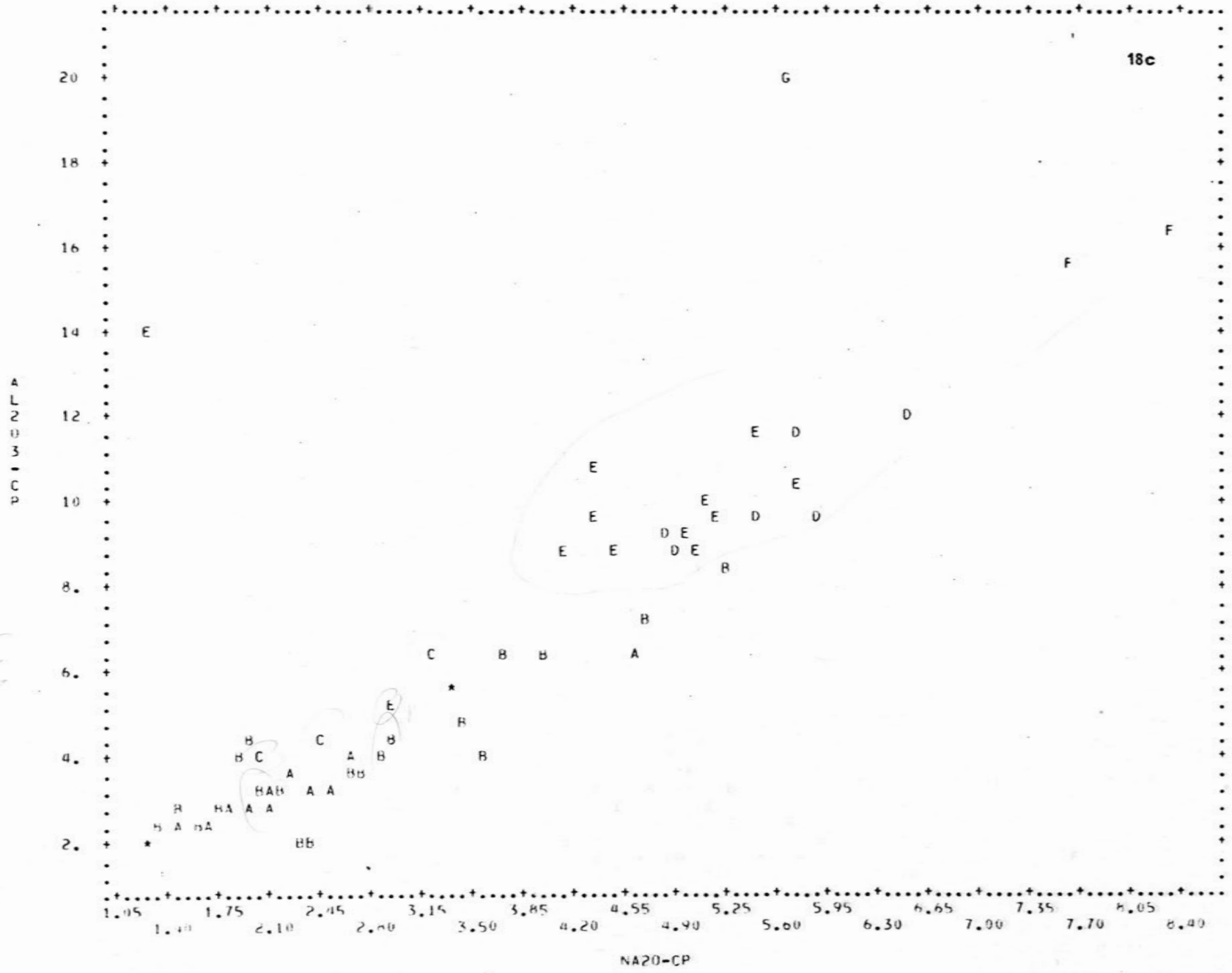

17h
CAO-GT
15.00
13.75
12.50
11.25
10.00
8.750
7.500
6.250
5.000
3.750
2.500
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA2O-CP

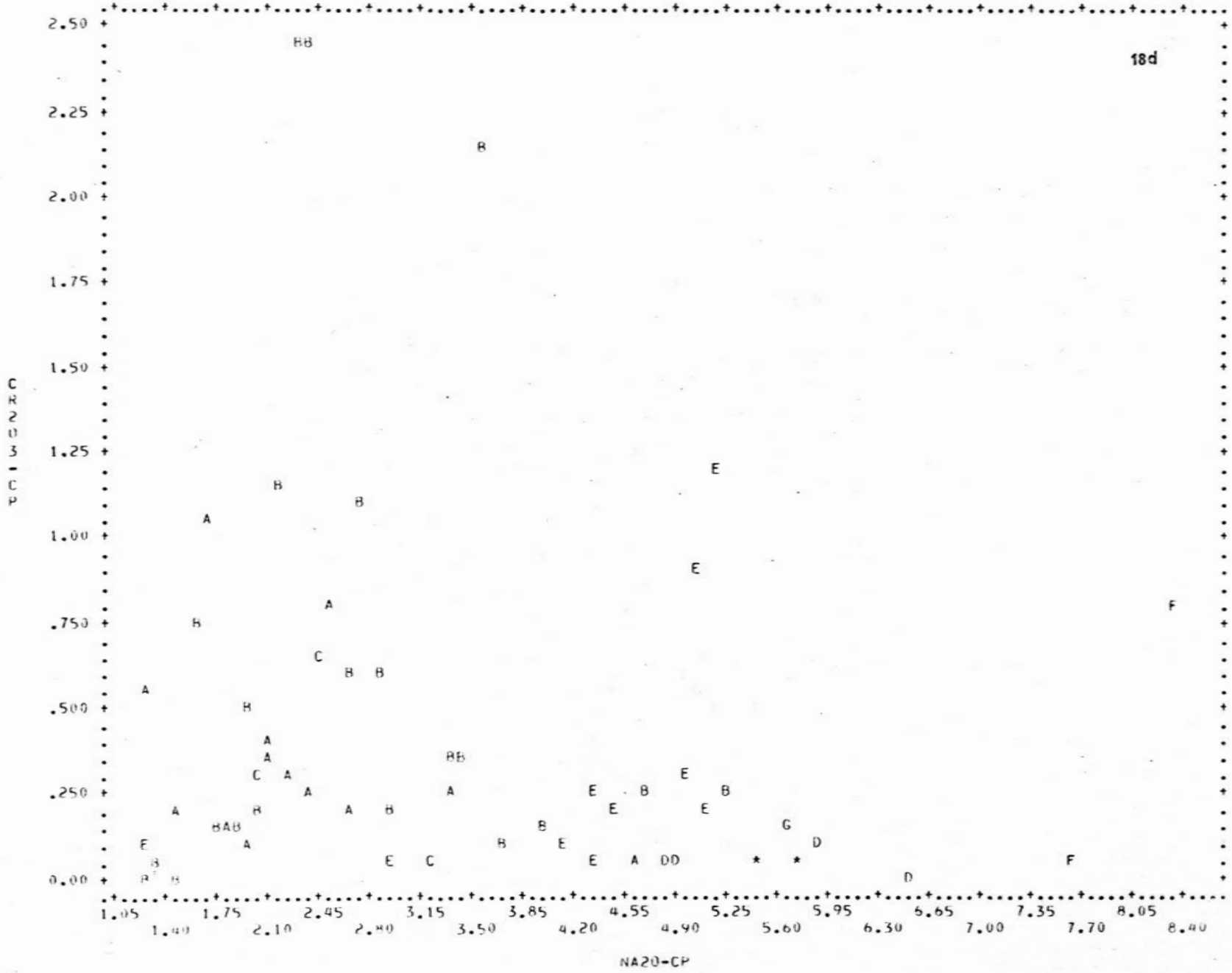

17i
NA2O-GT
NA2O-CP
.20
.18
.16
.14
.12
.10
.08
.06
.04
.02
0.0
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40

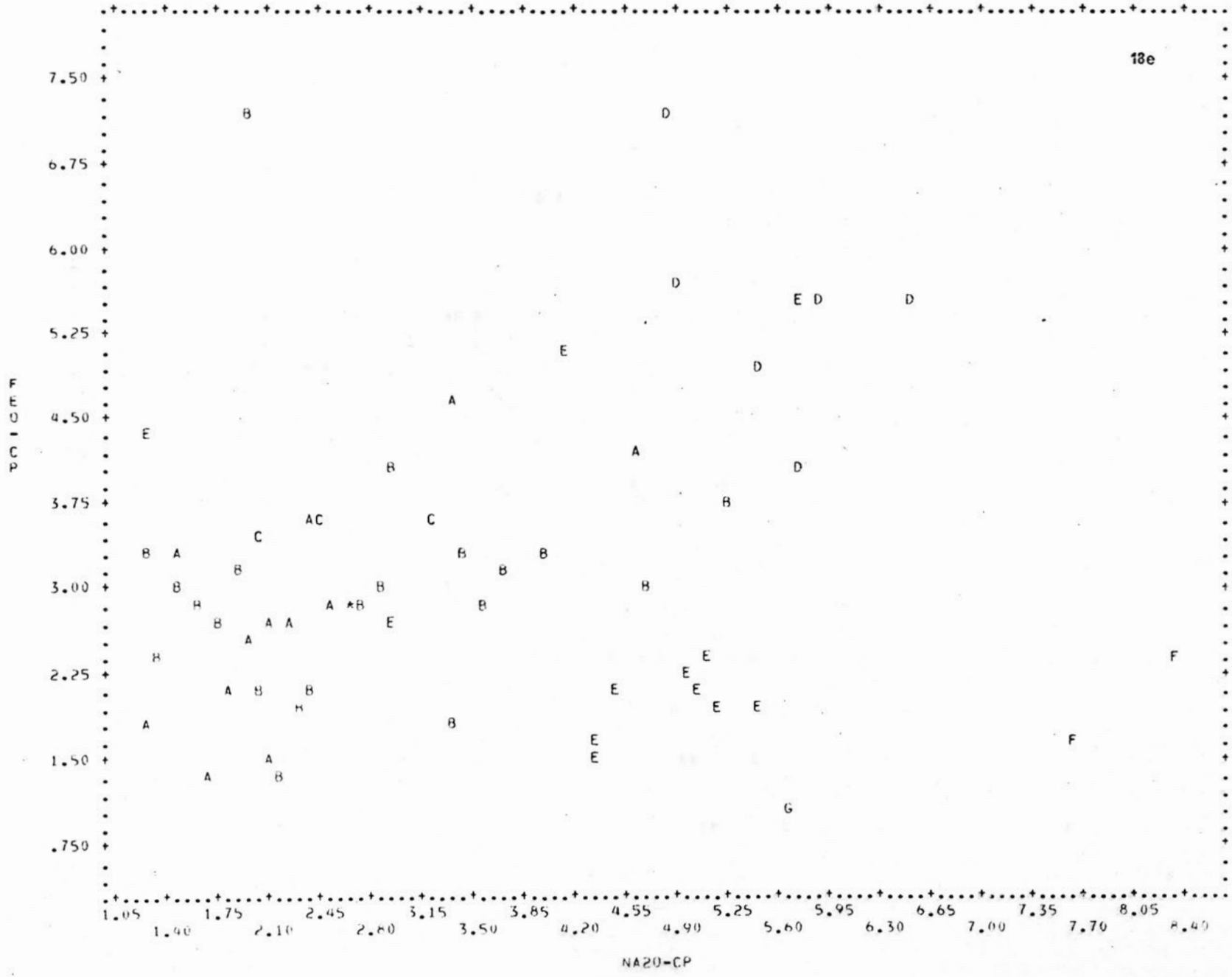

18a
SIO2-CP
56.7
55.8
54.9
54.0
53.1
52.2
51.3
50.4
49.5
48.6
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA2O-CP

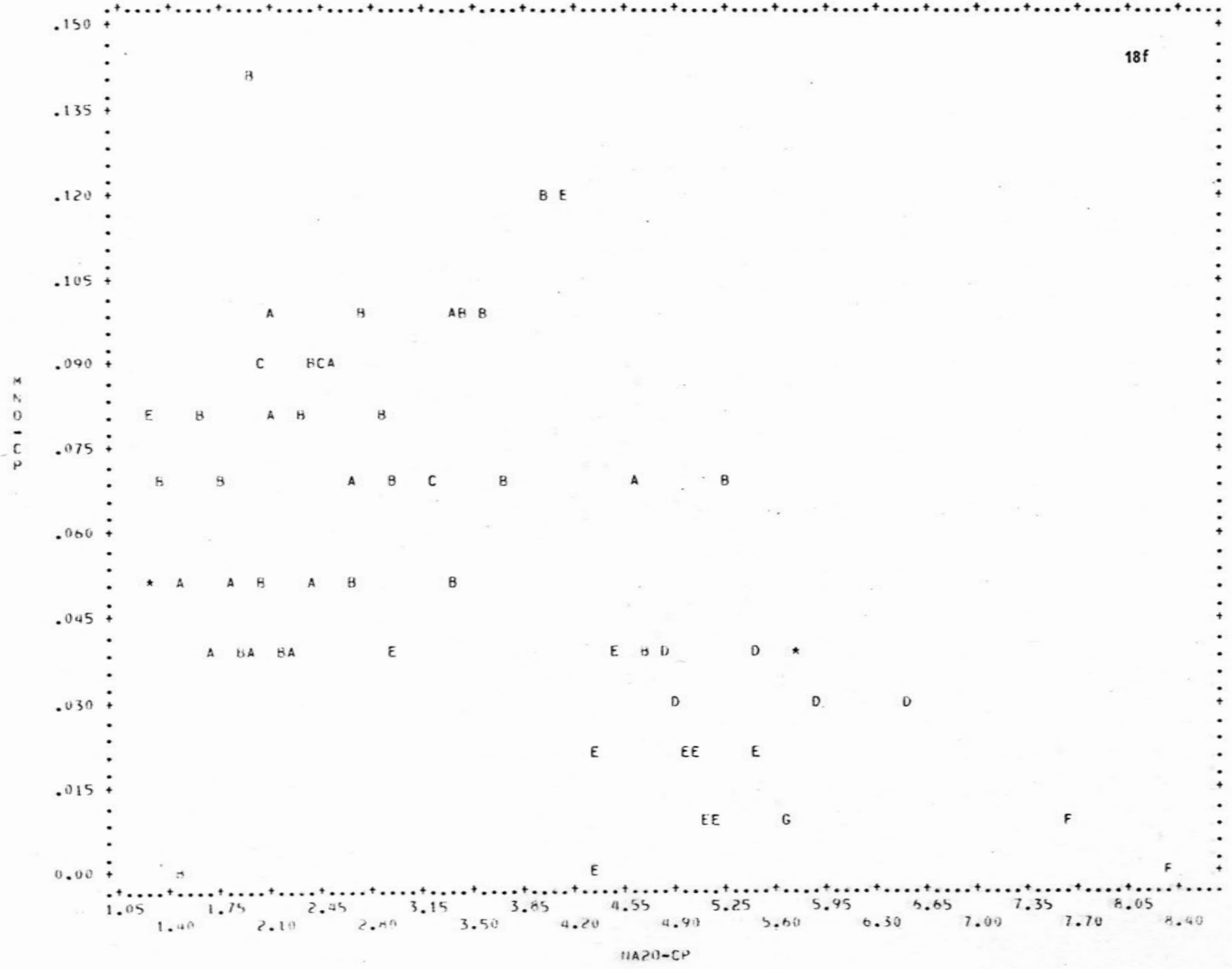
18b

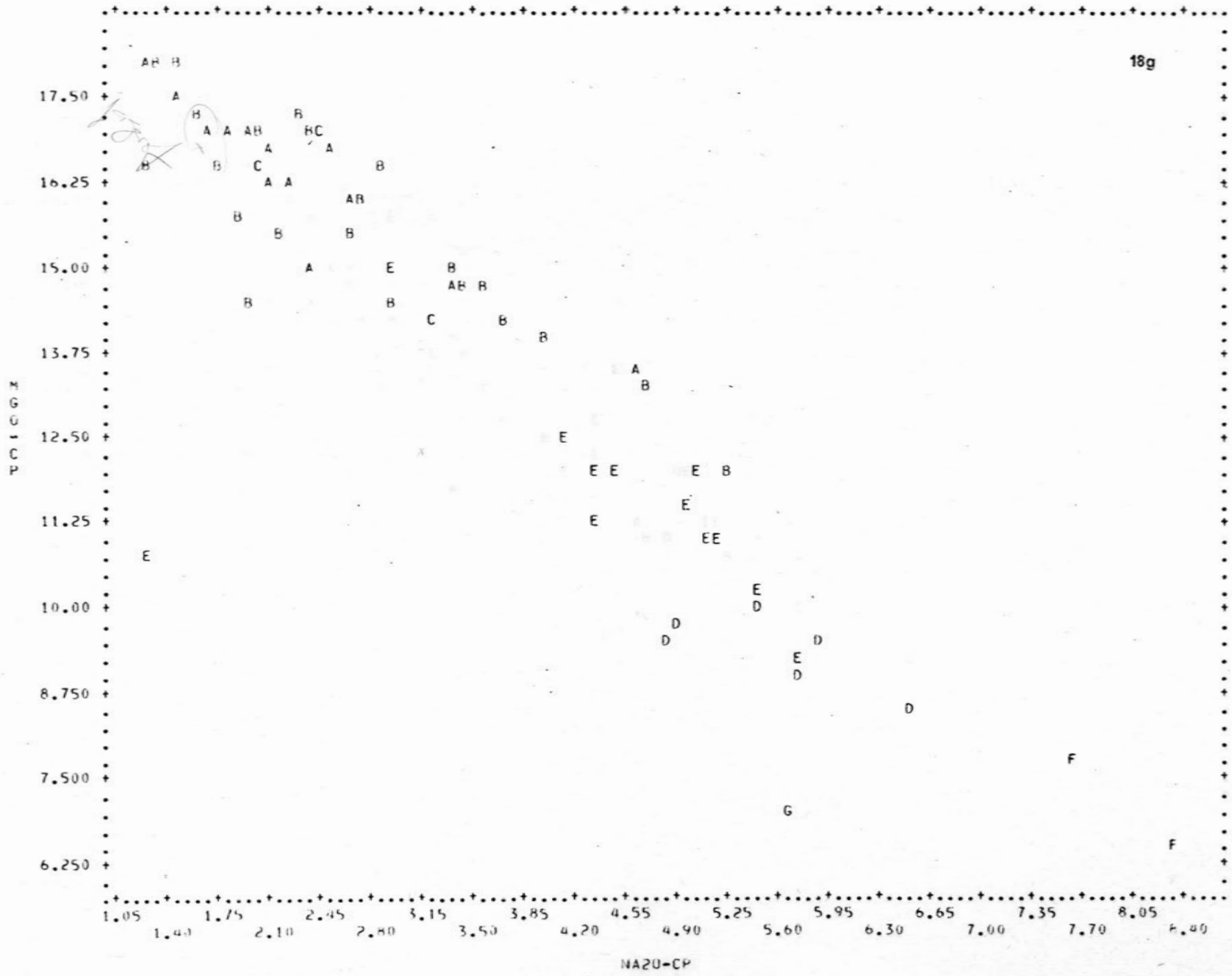

.60
.54
.48
.42
.36
.30
.24
.18
.12
.06
0.0
TIO2-CP
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA2O-CP

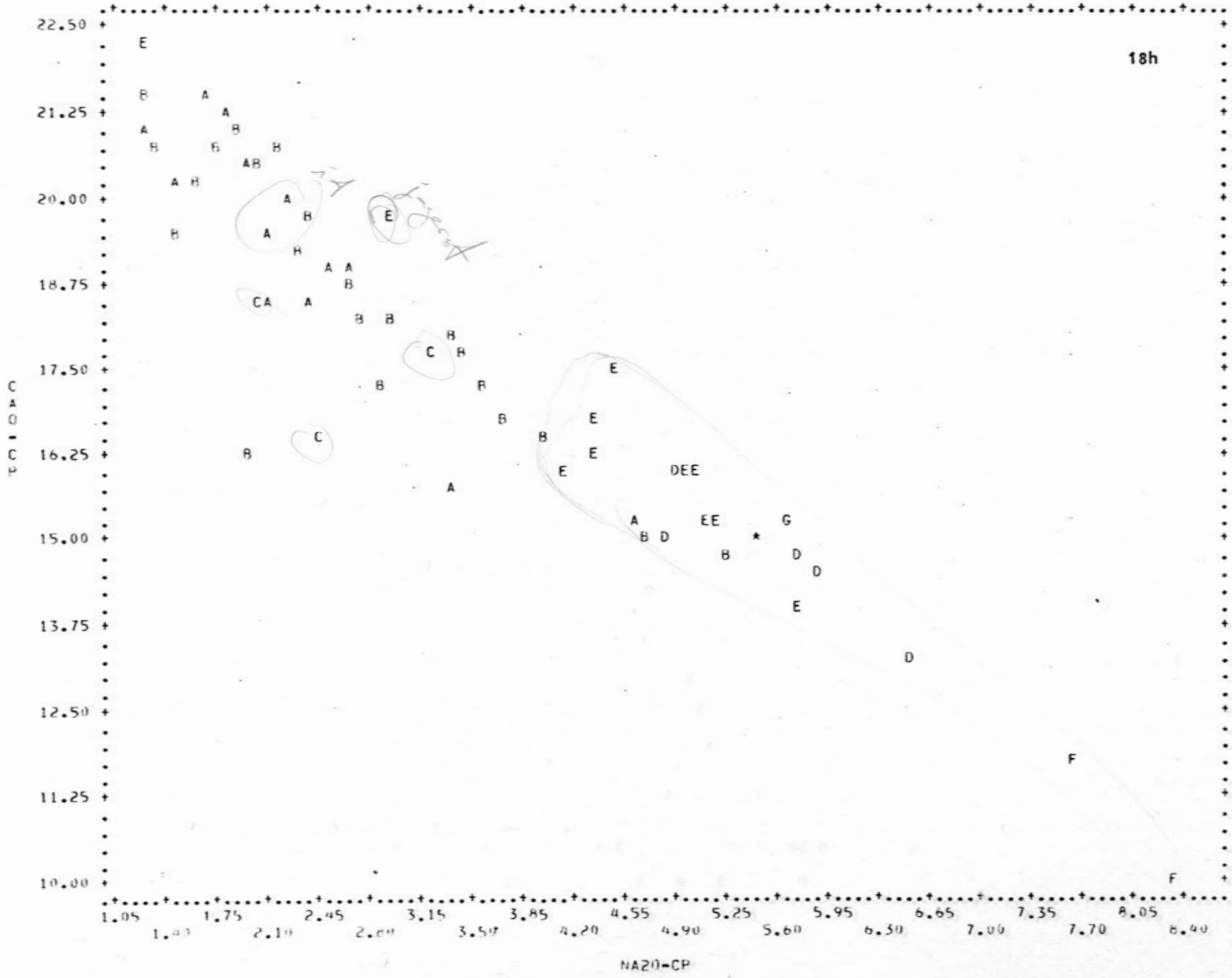

18c
AL2O3-CP
NA2O-CP
20
18
16
14
12
10
8.
6.
4.
2.
1.05
1.75
2.45
3.15
3.85
4.55
5.25
5.95
6.65
7.35
8.05
1.40
2.10
2.80
3.50
4.20
4.90
5.60
6.30
7.00
7.70
8.40

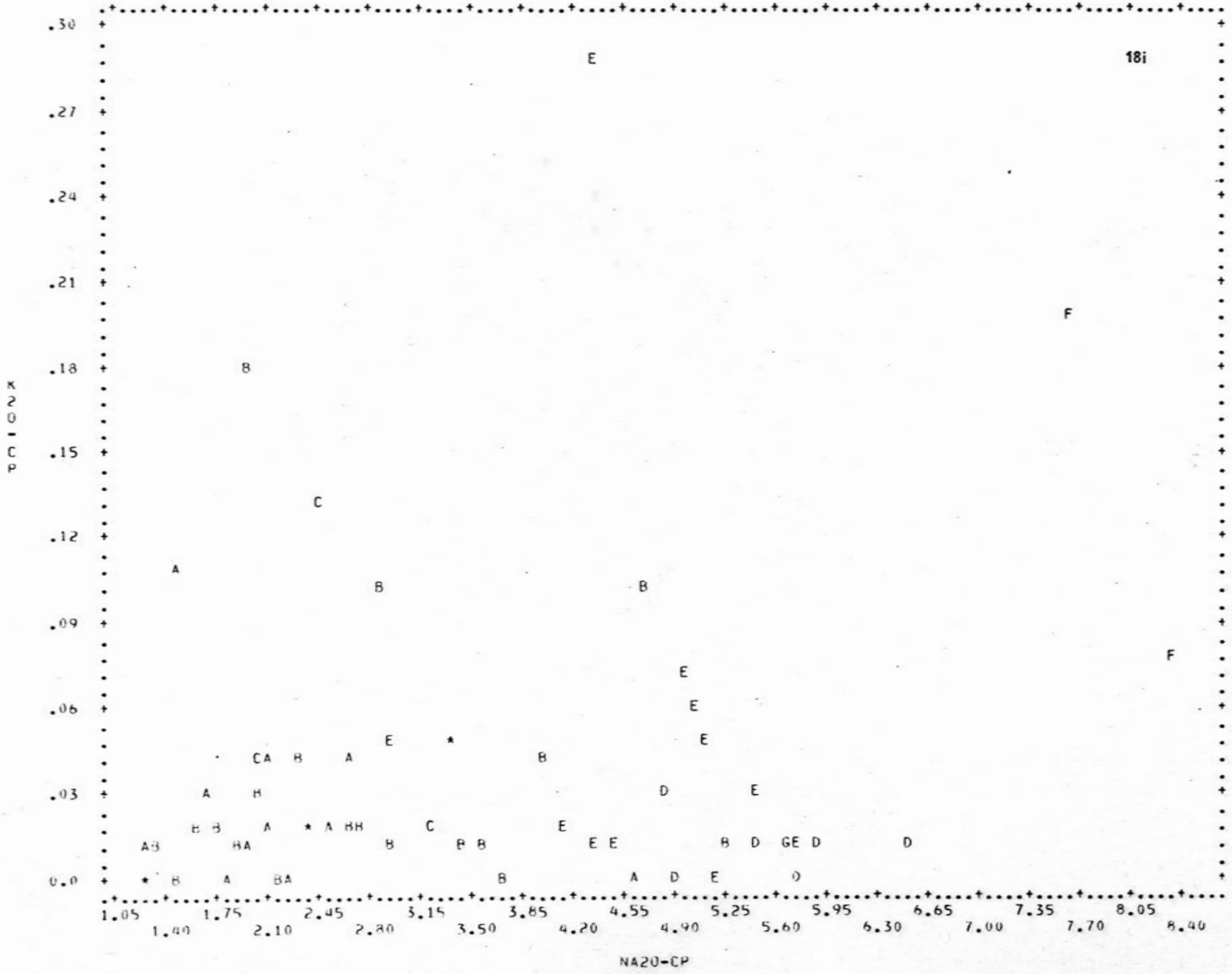

18d
CR2O3-CP
NA2O-CP
2.50
2.25
2.00
1.75
1.50
1.25
1.00
.750
.500
.250
0.00
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40

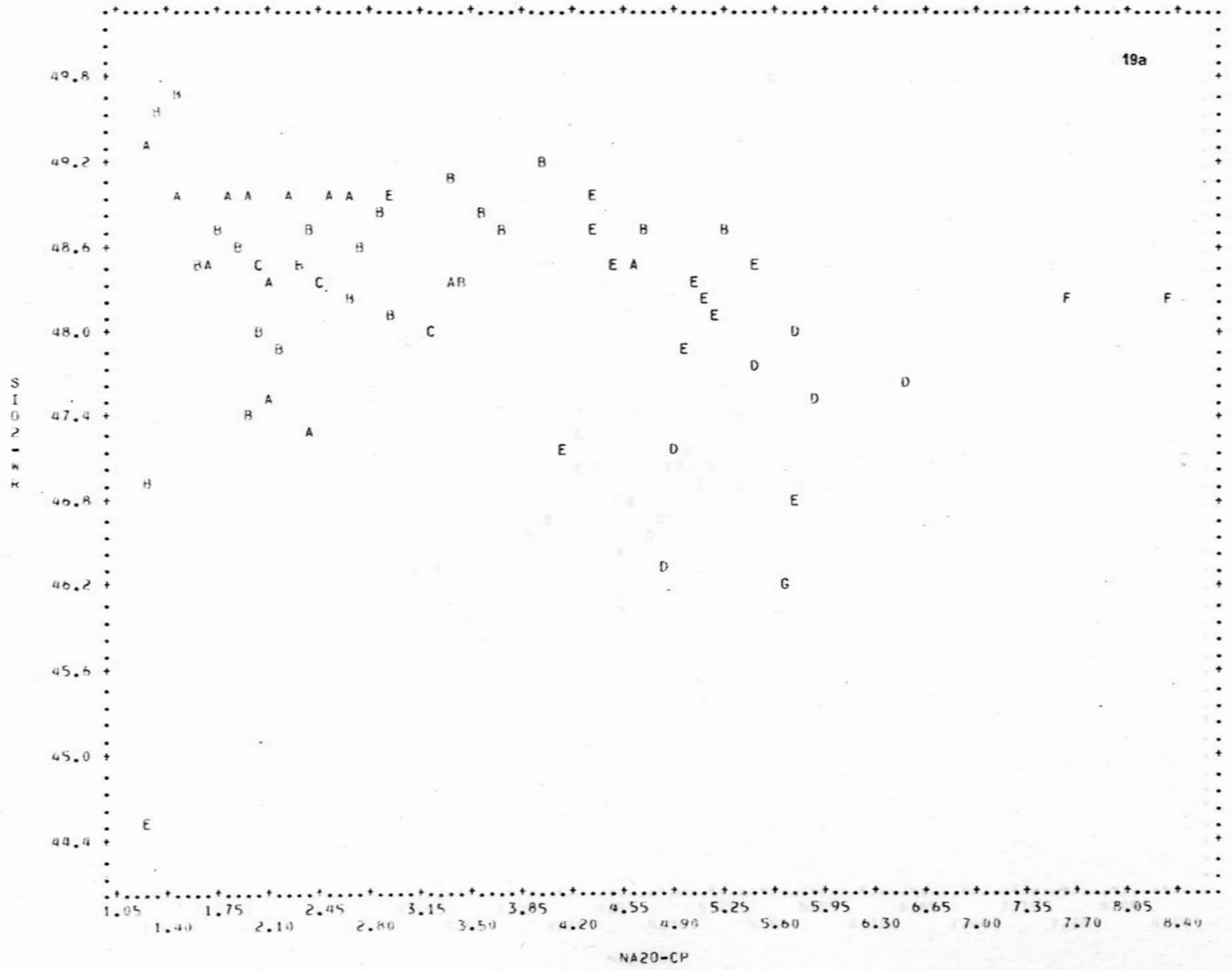

18e
FEO-CP
7.50
6.75
6.00
5.25
4.50
3.75
3.00
2.25
1.50
.750
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA2O-CP

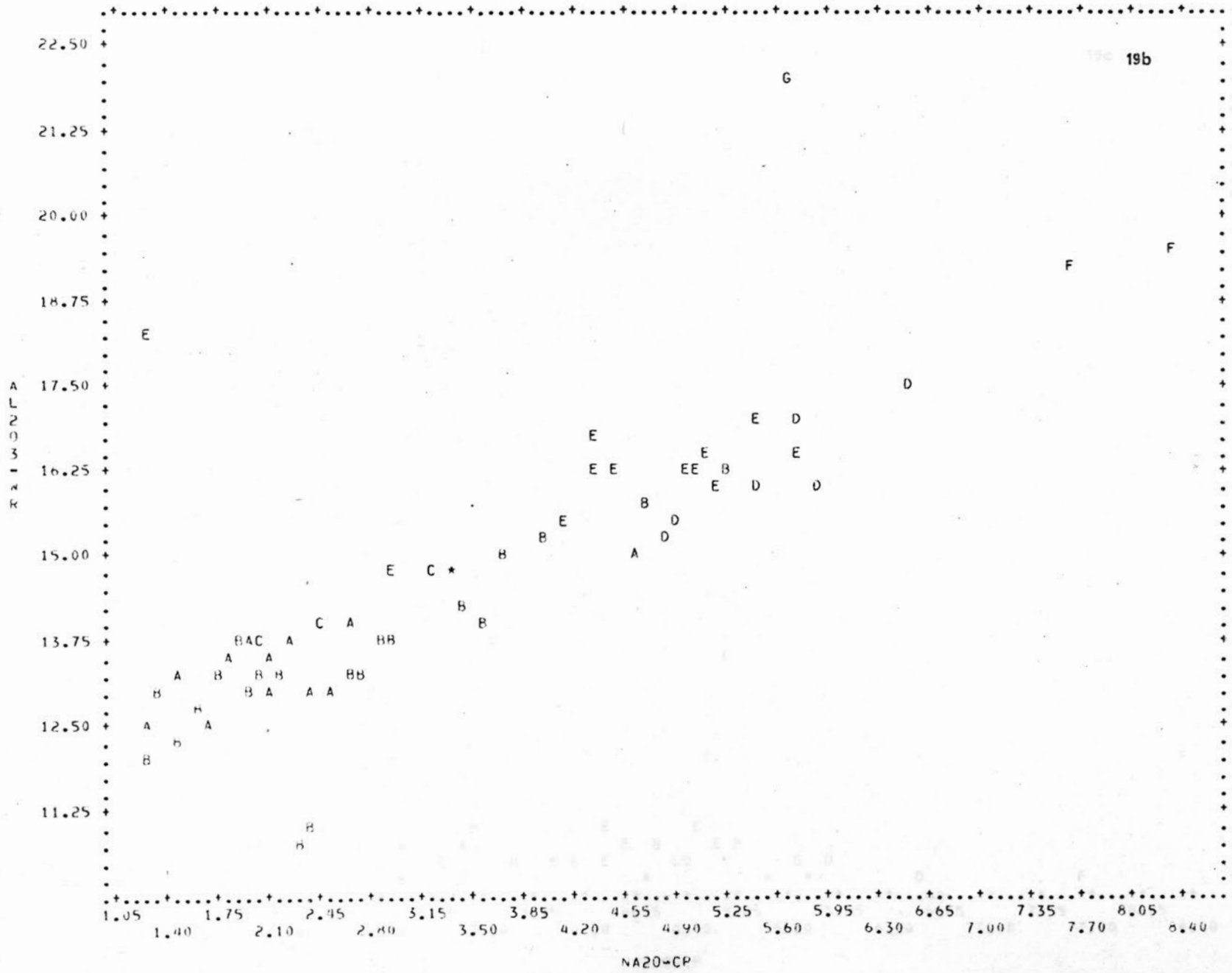

.150
.135
.120
.105
.090
.075
.060
.045
.030
.015
0.00
MNO-CP
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA2O-CP

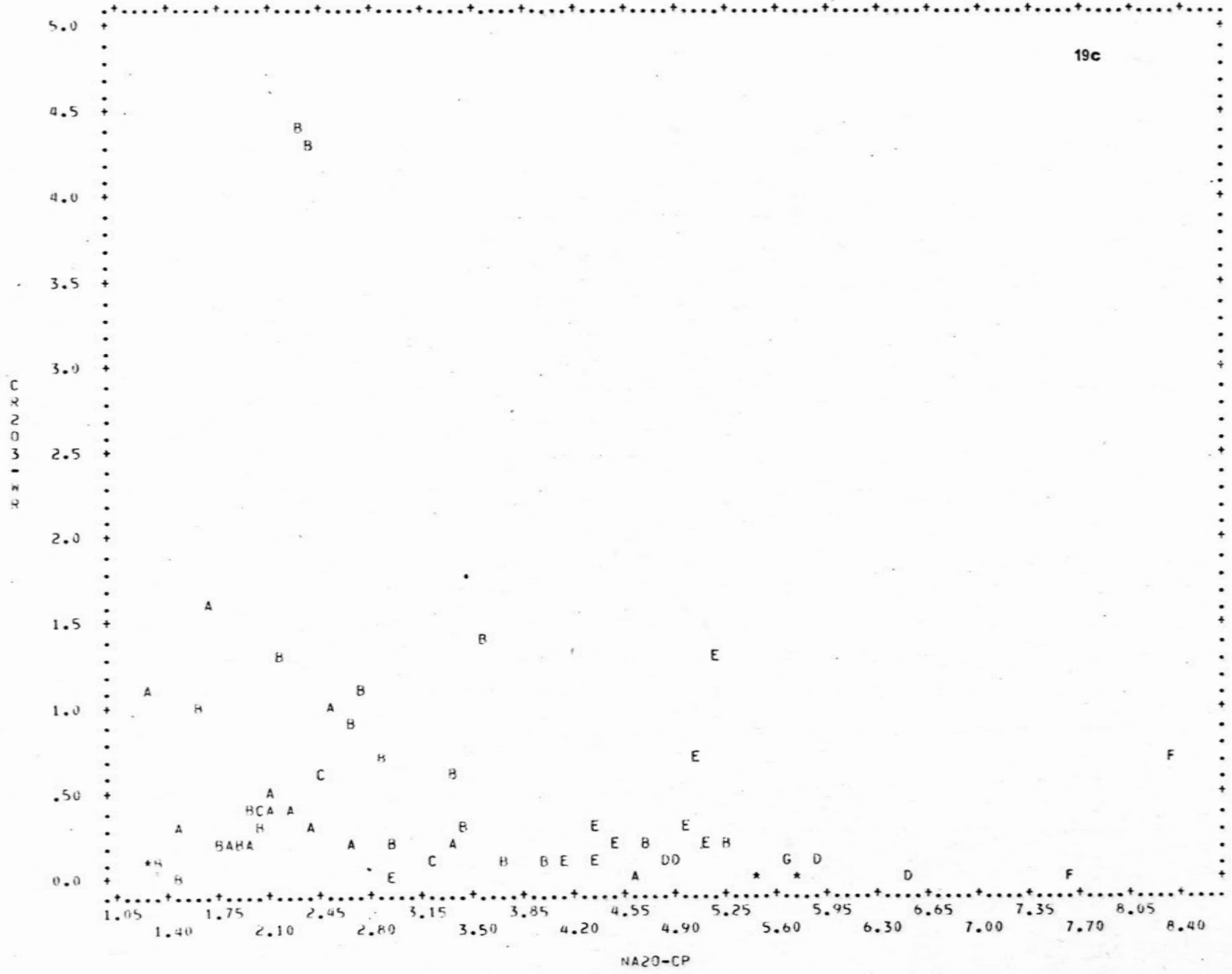

18g
MGO-CP
NA2O-CP
17.50
16.25
15.00
13.75
12.50
11.25
10.00
8.750
7.500
6.250
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40

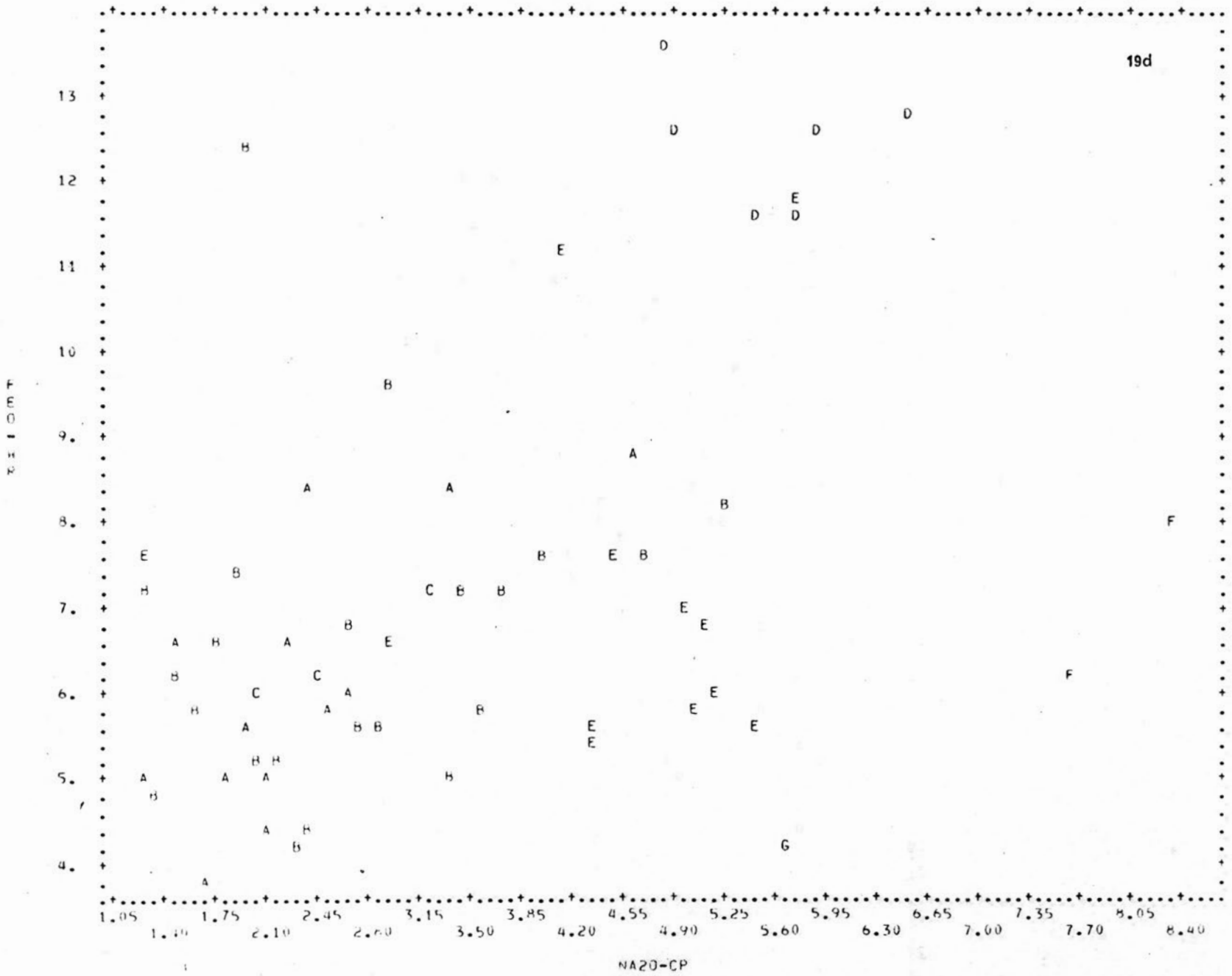

18h
CAO-CP
NA2O-CP
22.50
21.25
20.00
18.75
17.50
16.25
15.00
13.75
12.50
11.25
10.00
1.05
1.75
2.45
3.15
3.85
4.55
5.25
5.95
6.65
7.35
8.05
1.40
2.10
2.80
3.50
4.20
4.90
5.60
6.30
7.00
7.70
8.40

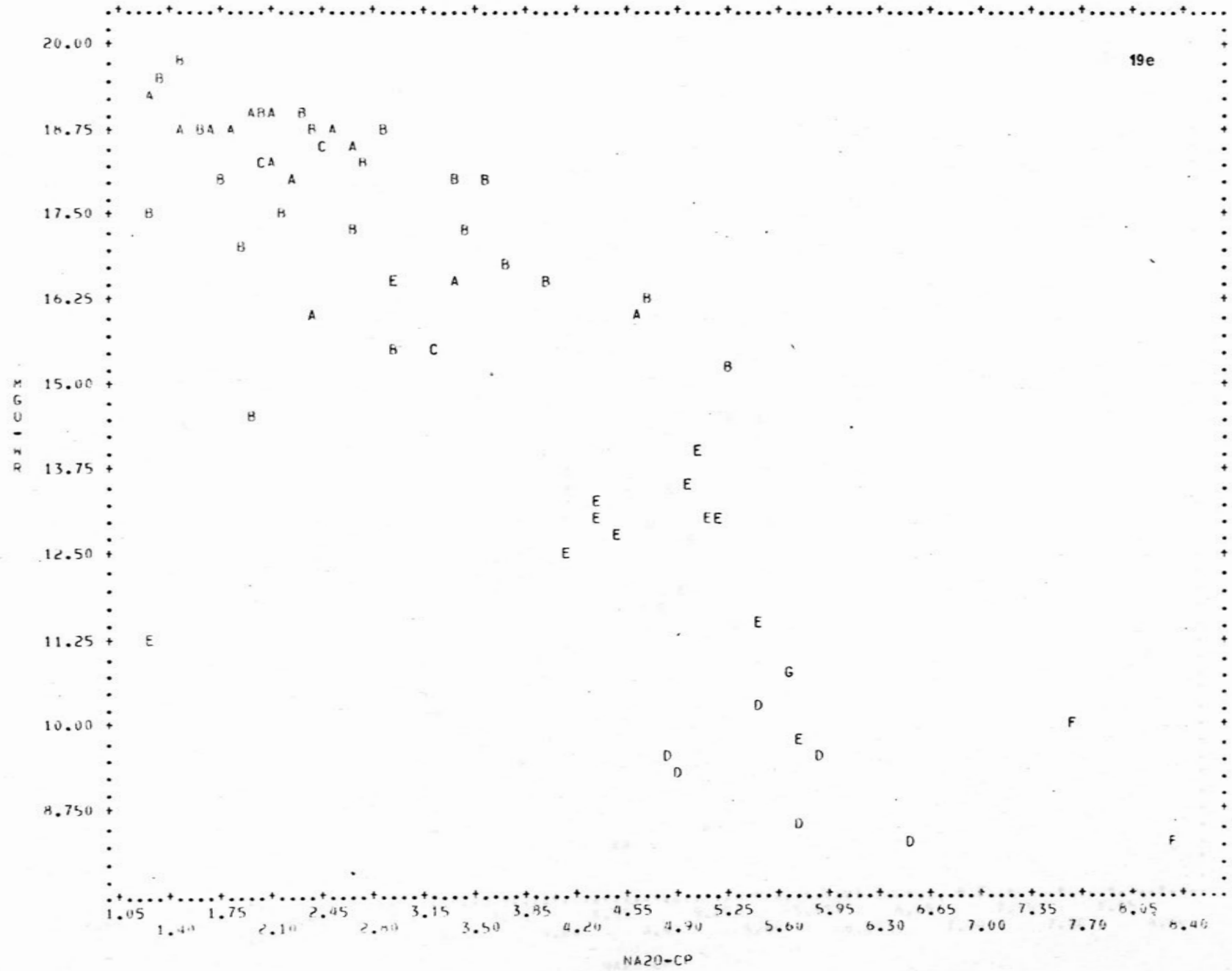

18i
K20-CP
.30
.27
.24
.21
.18
.15
.12
.09
.06
.03
0.0
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA20-CP


19a
SIO2-WR
49.8
49.2
48.6
48.0
47.4
46.8
46.2
45.6
45.0
44.4
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA2O-CP


19b
AL2O3-K2O
NA2O+CP
22.50
21.25
20.00
18.75
17.50
16.25
15.00
13.75
12.50
11.25
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40


19c
CR203-MX
NA2O-CP
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.50
0.0
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40


19d
FE203
13
12
11
10
9.
8.
7.
6.
5.
4.
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA20-CP


19e
MGO-HR
20.00
18.75
17.50
16.25
15.00
13.75
12.50
11.25
10.00
8.750
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA2O-CP

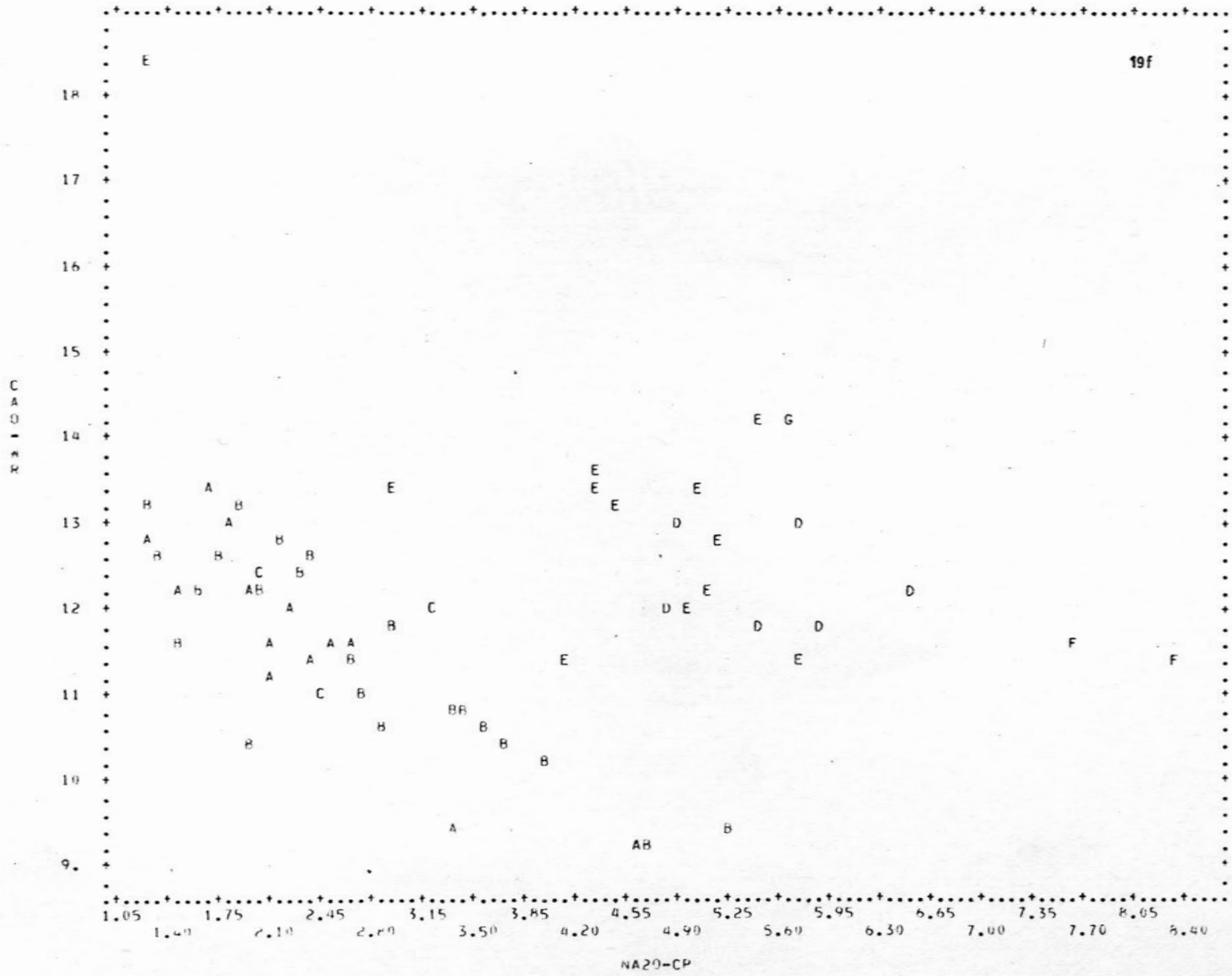

19f
CAO-AR
18
17
16
15
14
13
12
11
10
9.
1.05
1.40
1.75
2.10
2.45
2.80
3.15
3.50
3.85
4.20
4.55
4.90
5.25
5.60
5.95
6.30
6.65
7.00
7.35
7.70
8.05
8.40
NA2O-CP

Figure 20. Illustration of type I megacryst bearing eclogite nodule HRV 77.

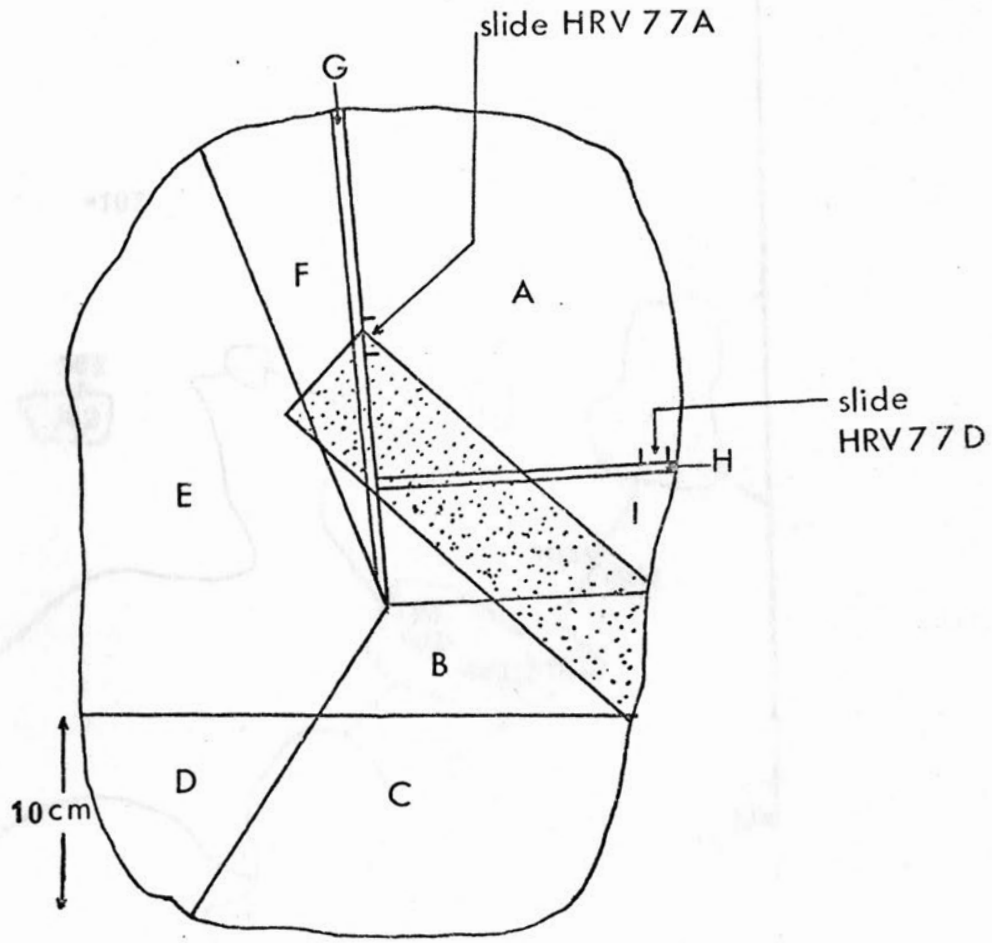
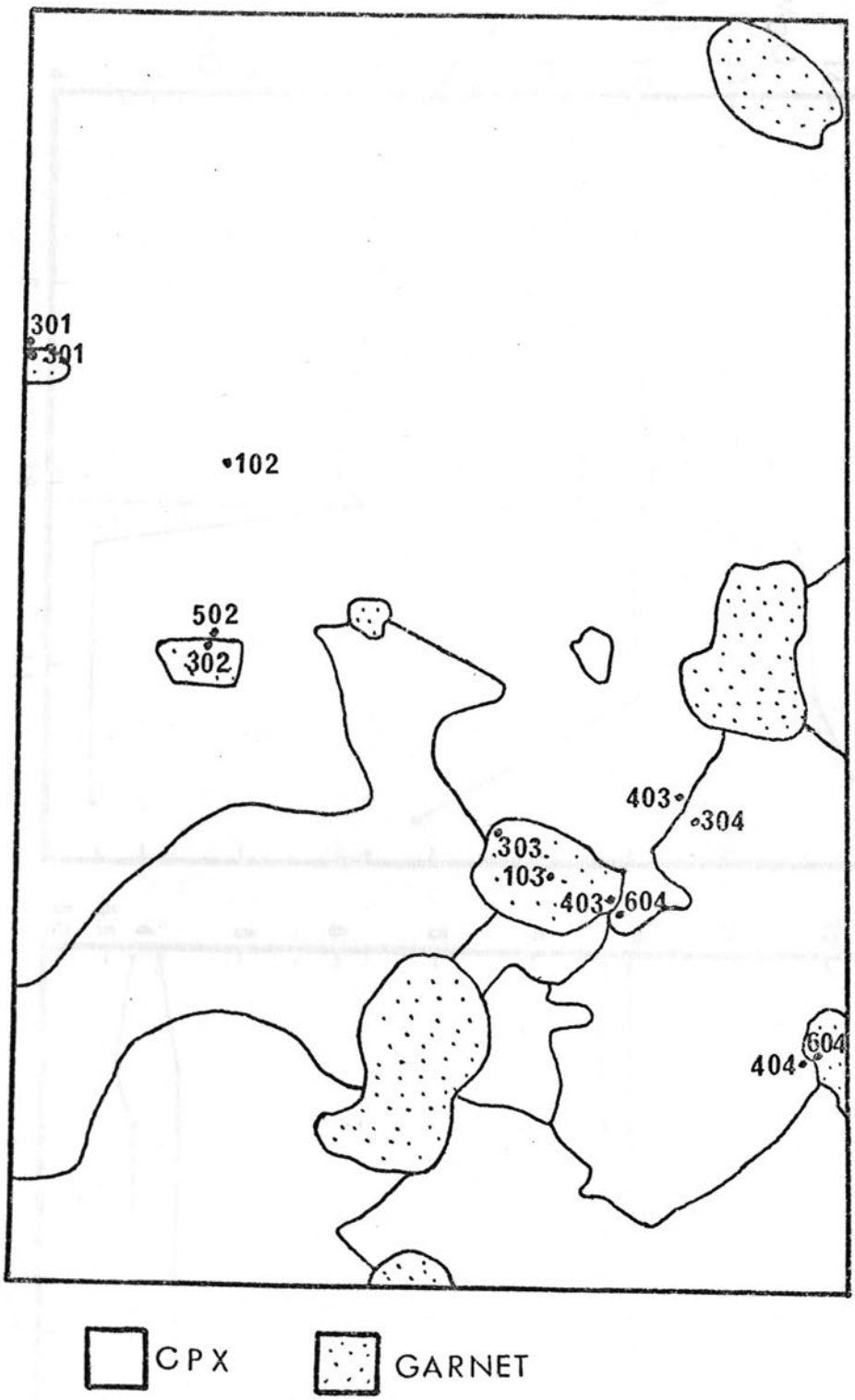


FIGURE 21. Drawing from slide HRV 77A indicating analysis localities



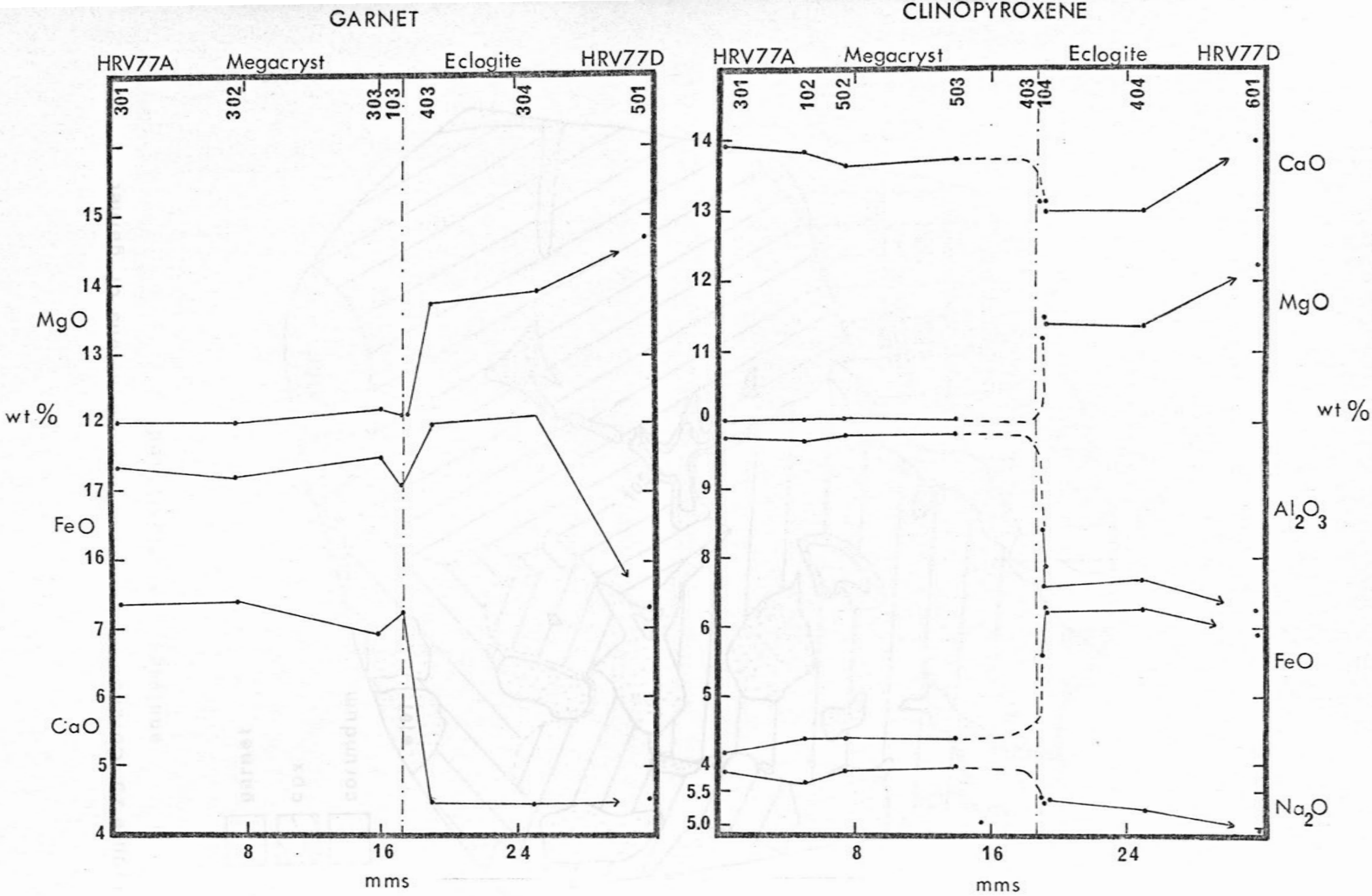
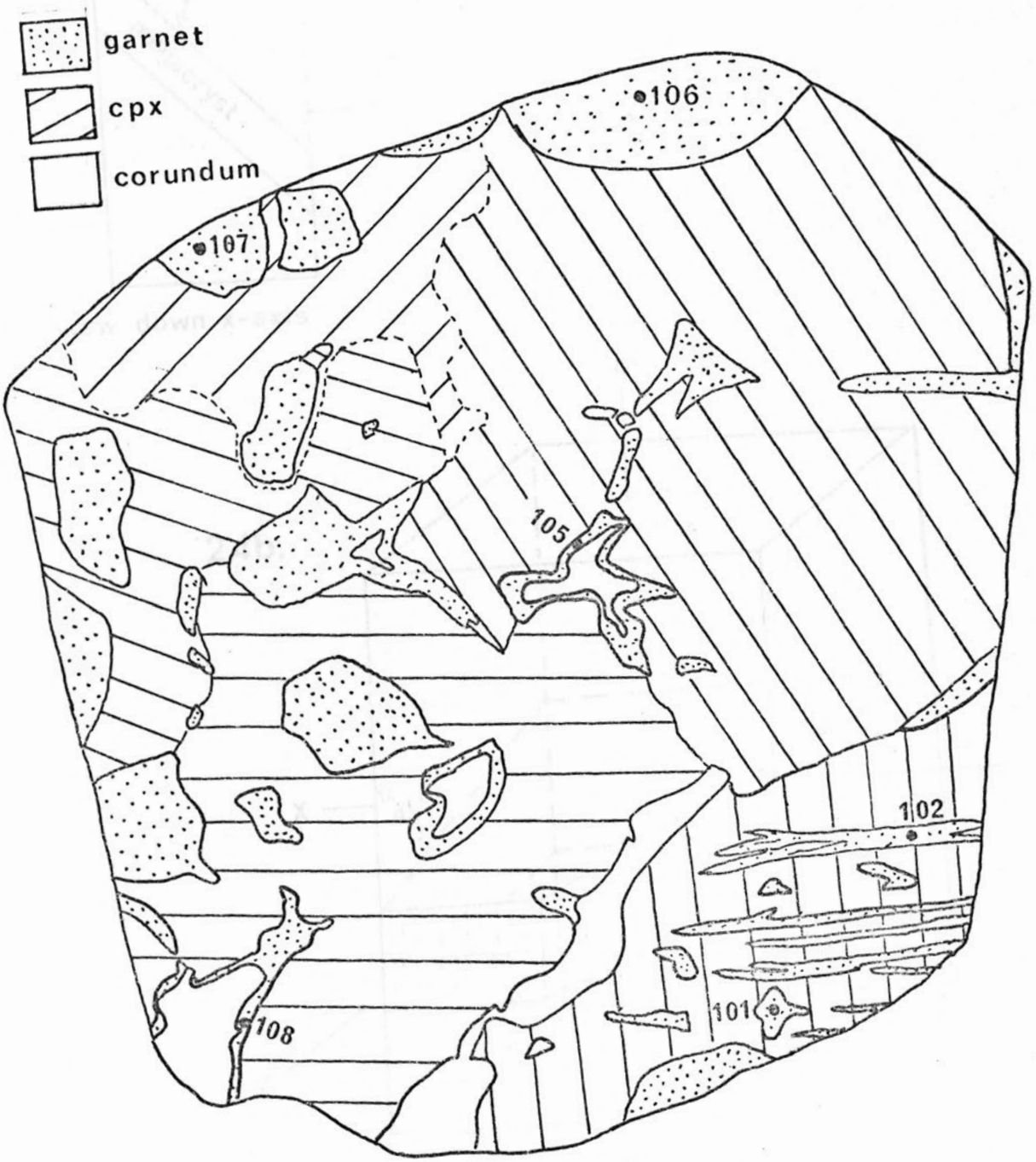
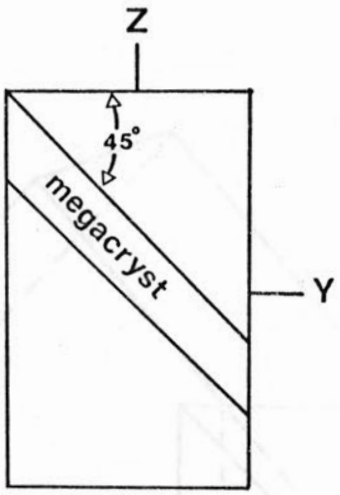


FIGURE 22. Compositional variation in HRV77

Figure 23. Corundum eclogite JJG 60. Locations of garnet analyses are illustrated.



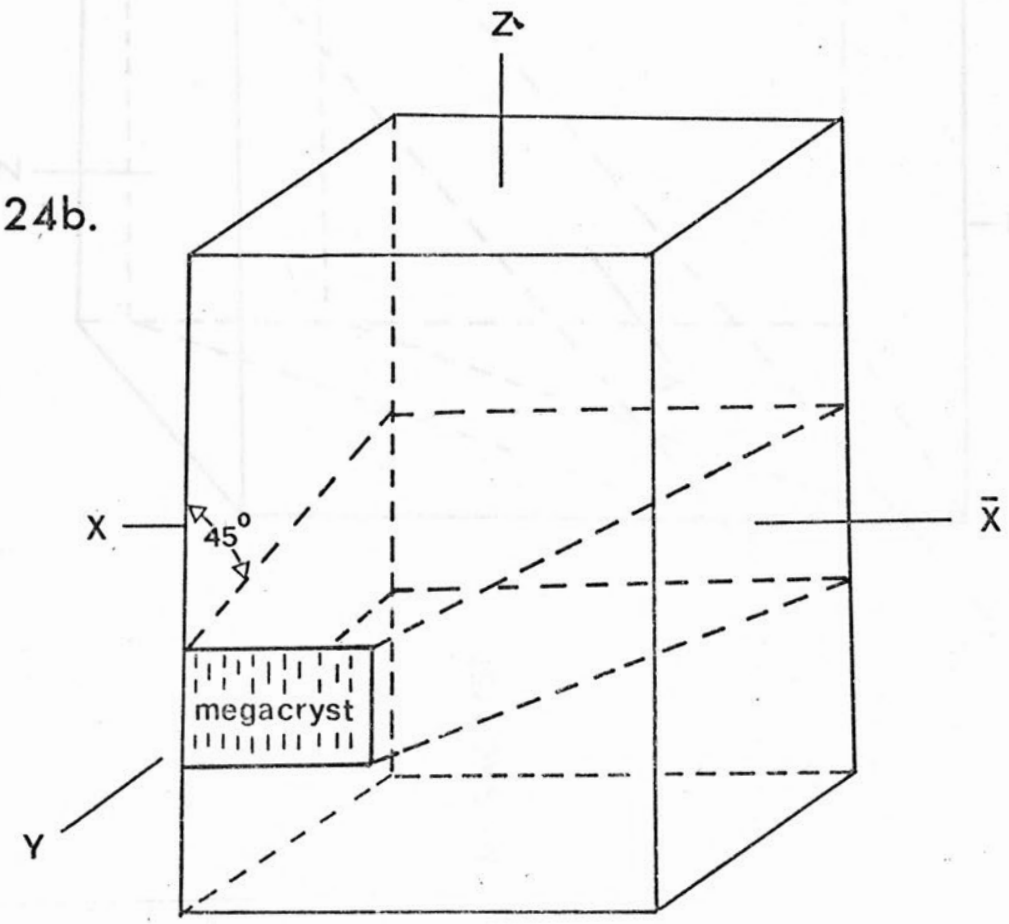
24a.



Plan view down x-axis

Figure 24. Orientation of megacryst in HRV 244.

24b.



View down y-axis

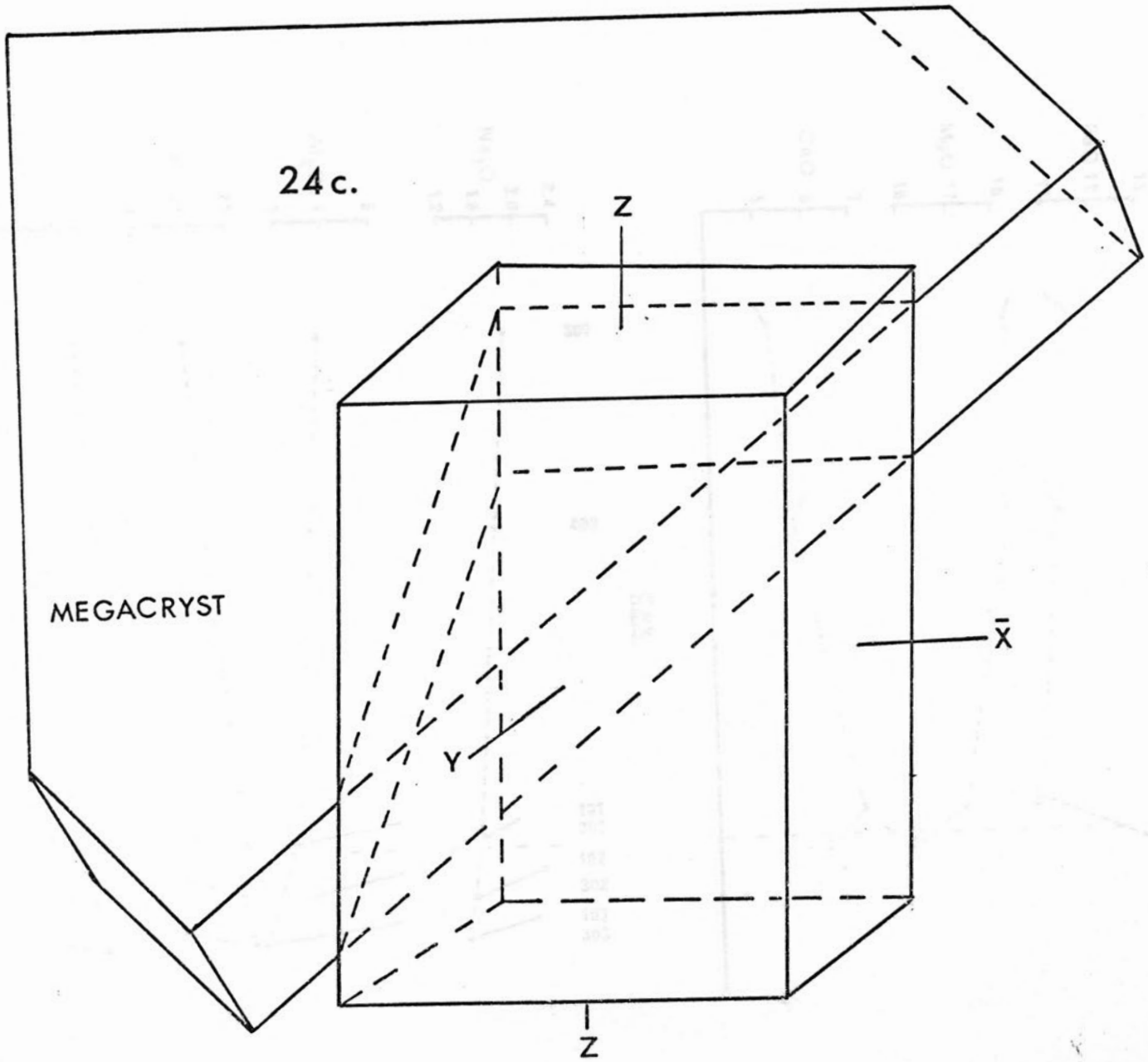

24 c.
Z
MEGACRYST
$\bar{X}$
Y
Z

Figure 25 Wt.% Oxides in Garnet and Cpx vs Distance across samples HRV 244 and HRV 244A

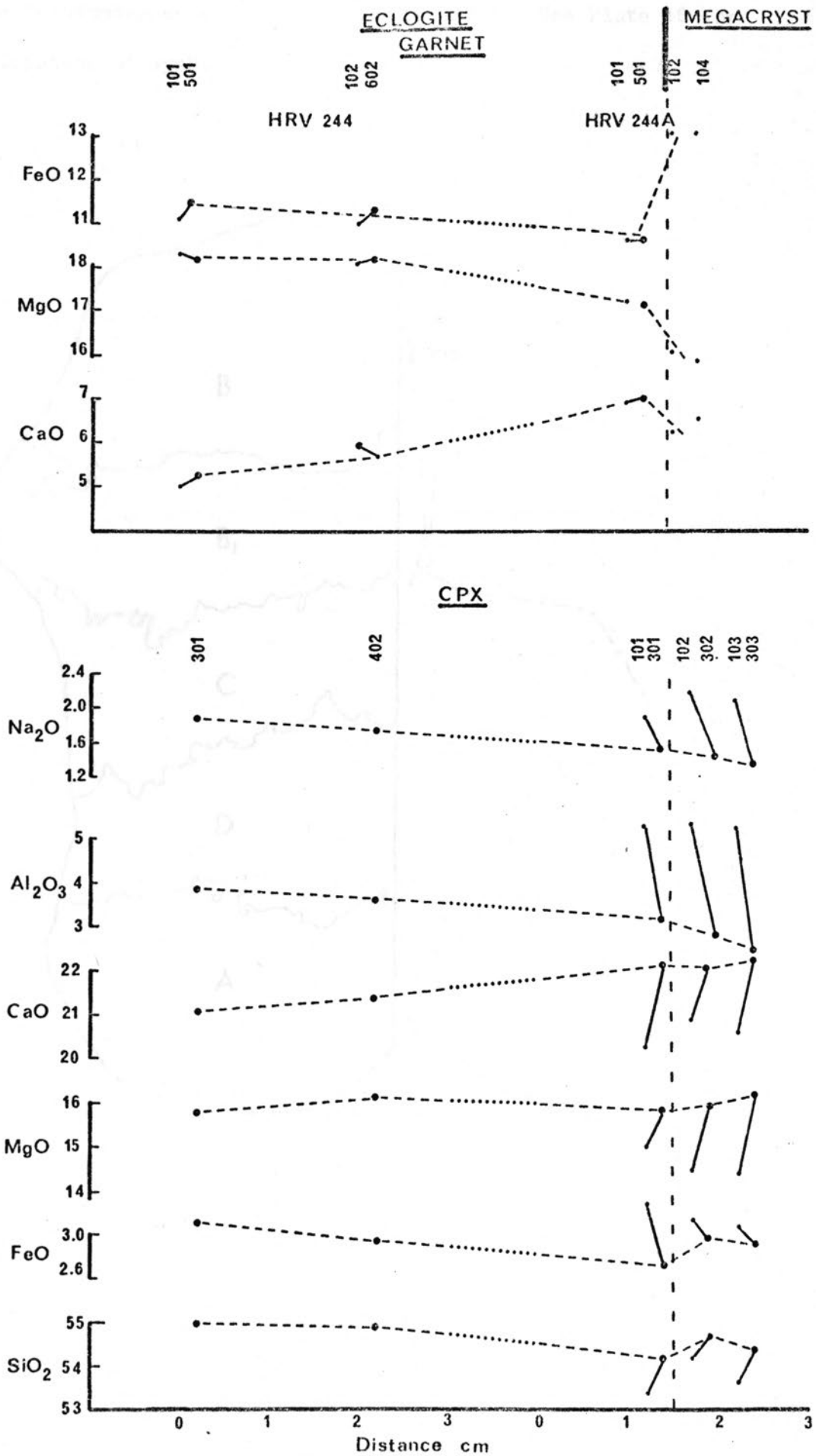


FIGURE 27

Type I inhomogeneous kyanite eclogite HRV17. See Plate 16 for explanation of symbols.

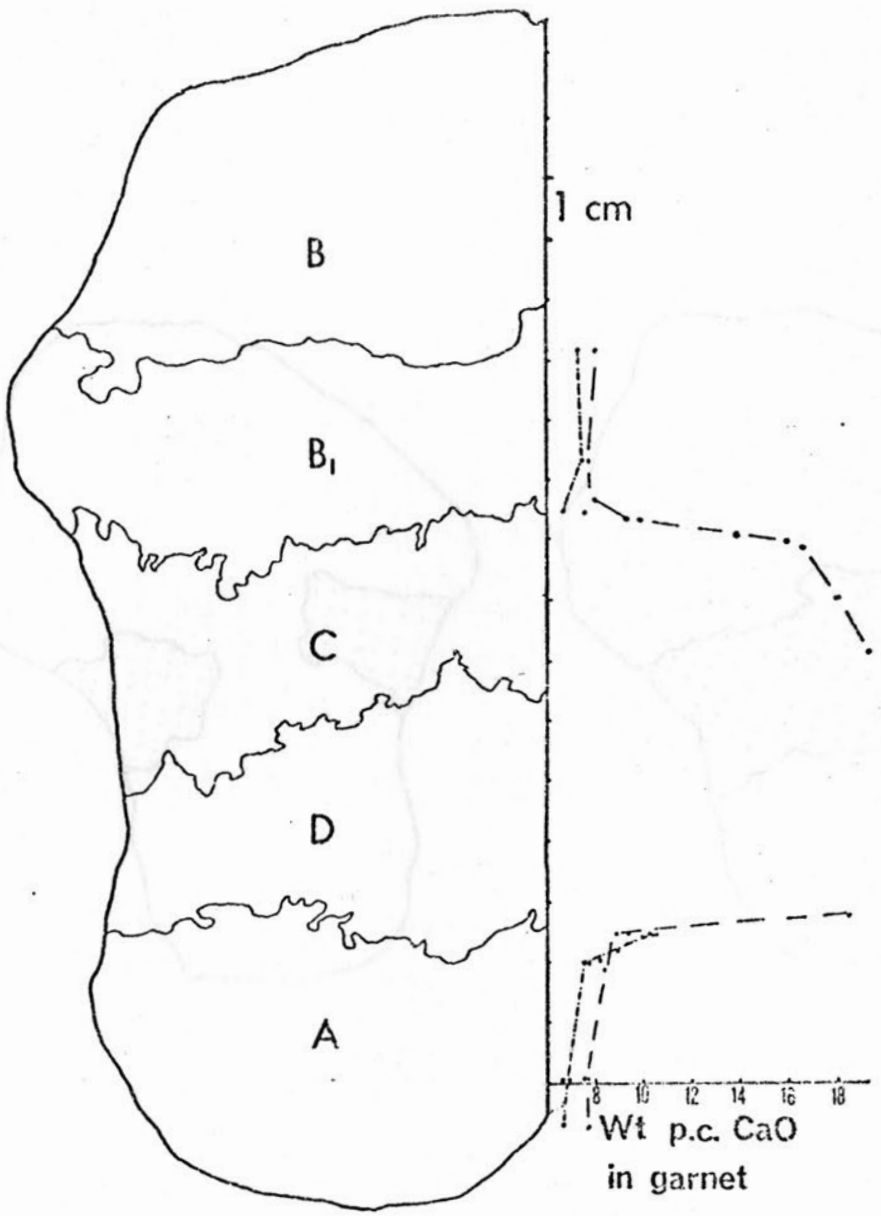


FIGURE 28

Type I inhomogeneous kyanite eclogite HRV30

clear = biminerallic eclogite

dotted = kyanite eclogite

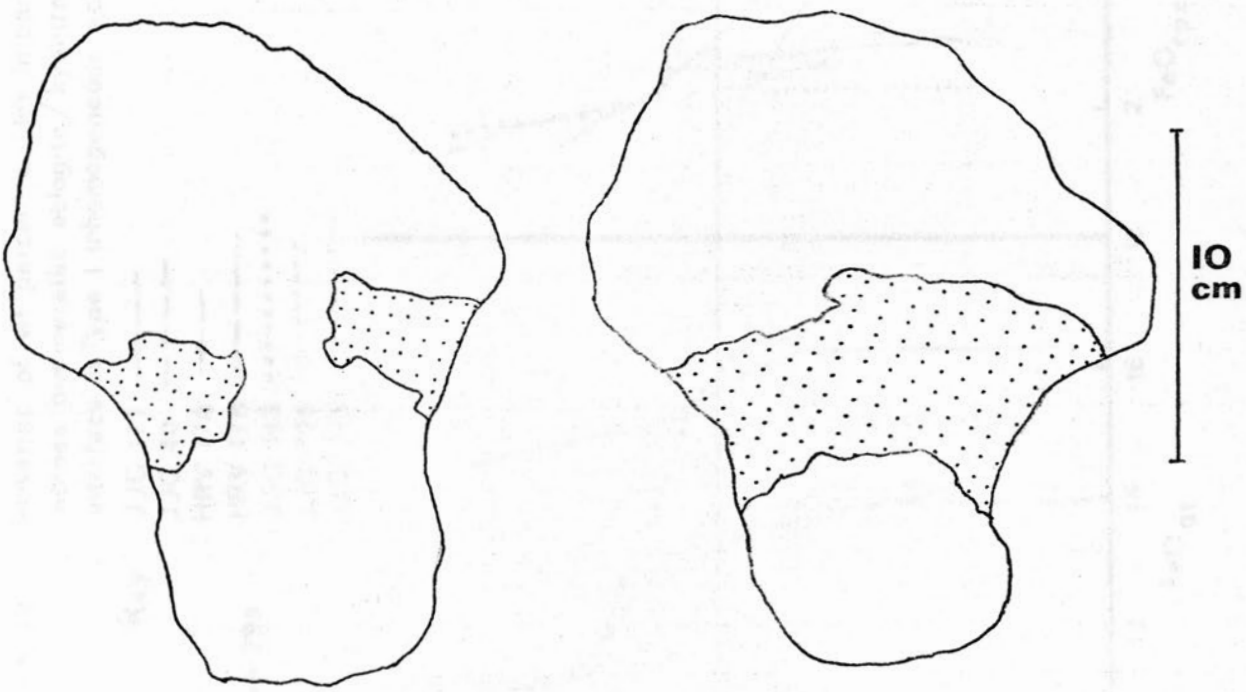
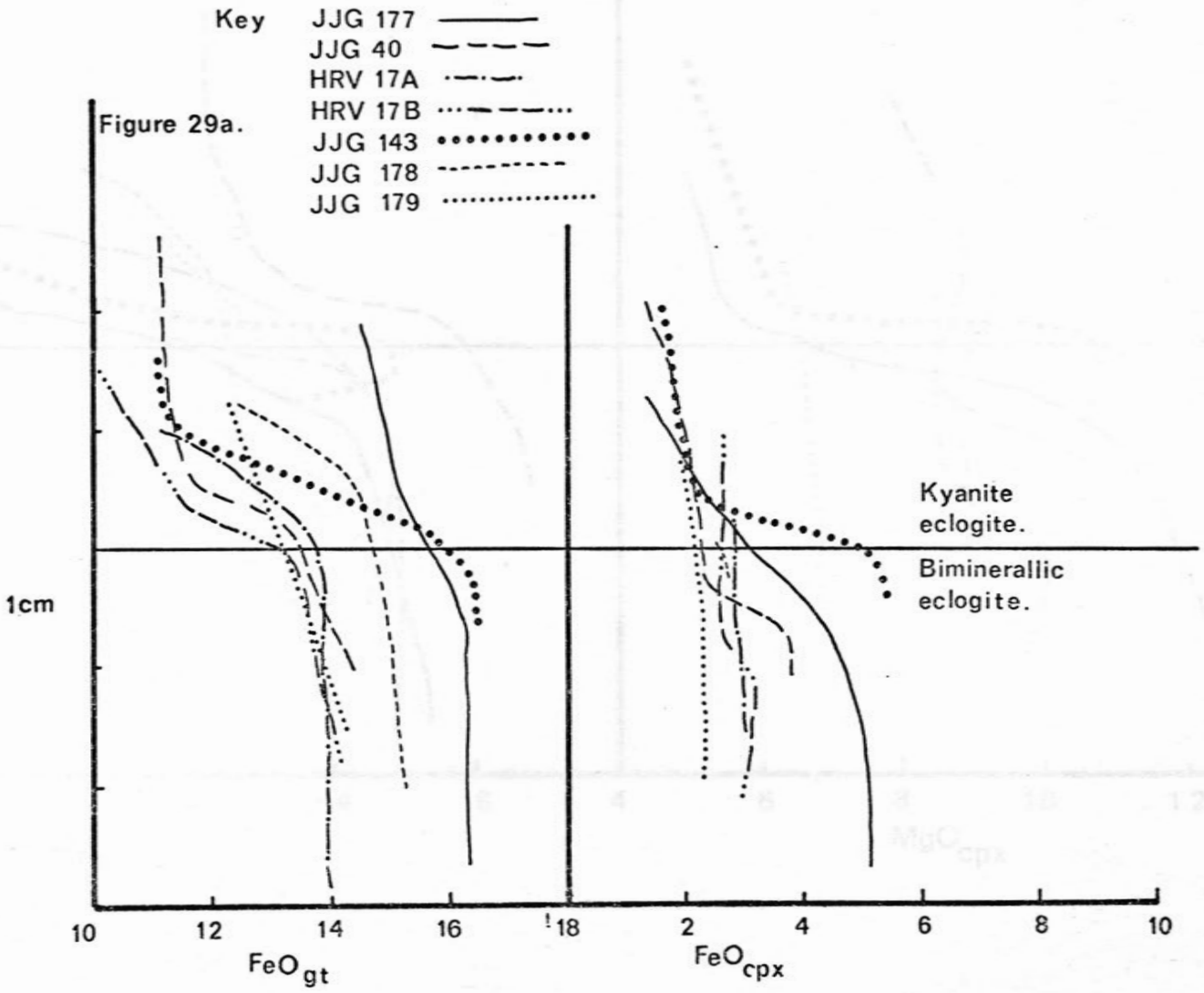


Figure 29. Variation of wt. percent oxides in garnet and cpx across bimineralic eclogite / kyanite eclogite interface in Type I inhomogeneous eclogites.



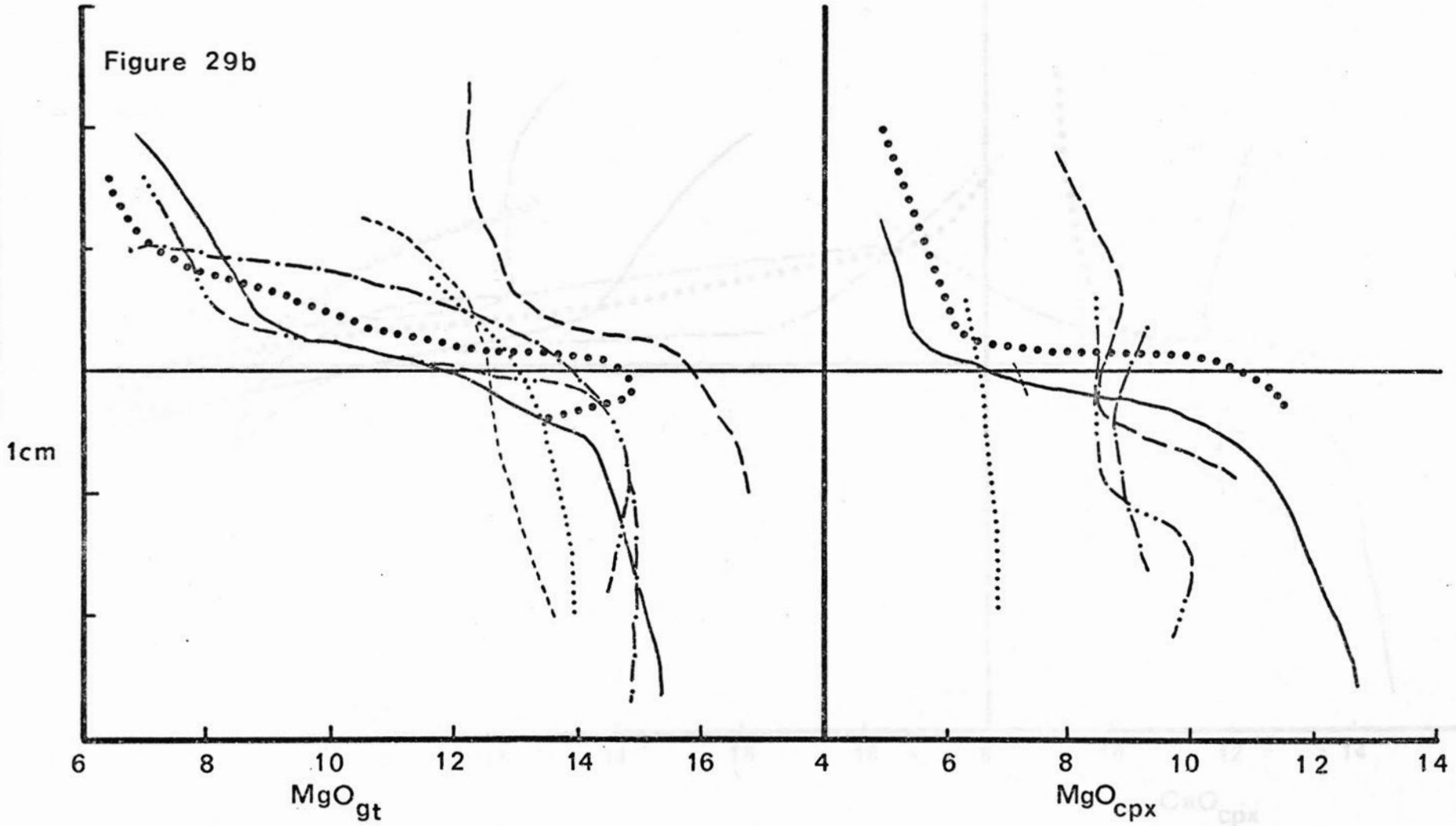


Figure 29b
1cm
6
8
10
12
14
16
MgO gt
4
6
8
10
12
14
MgO cpx

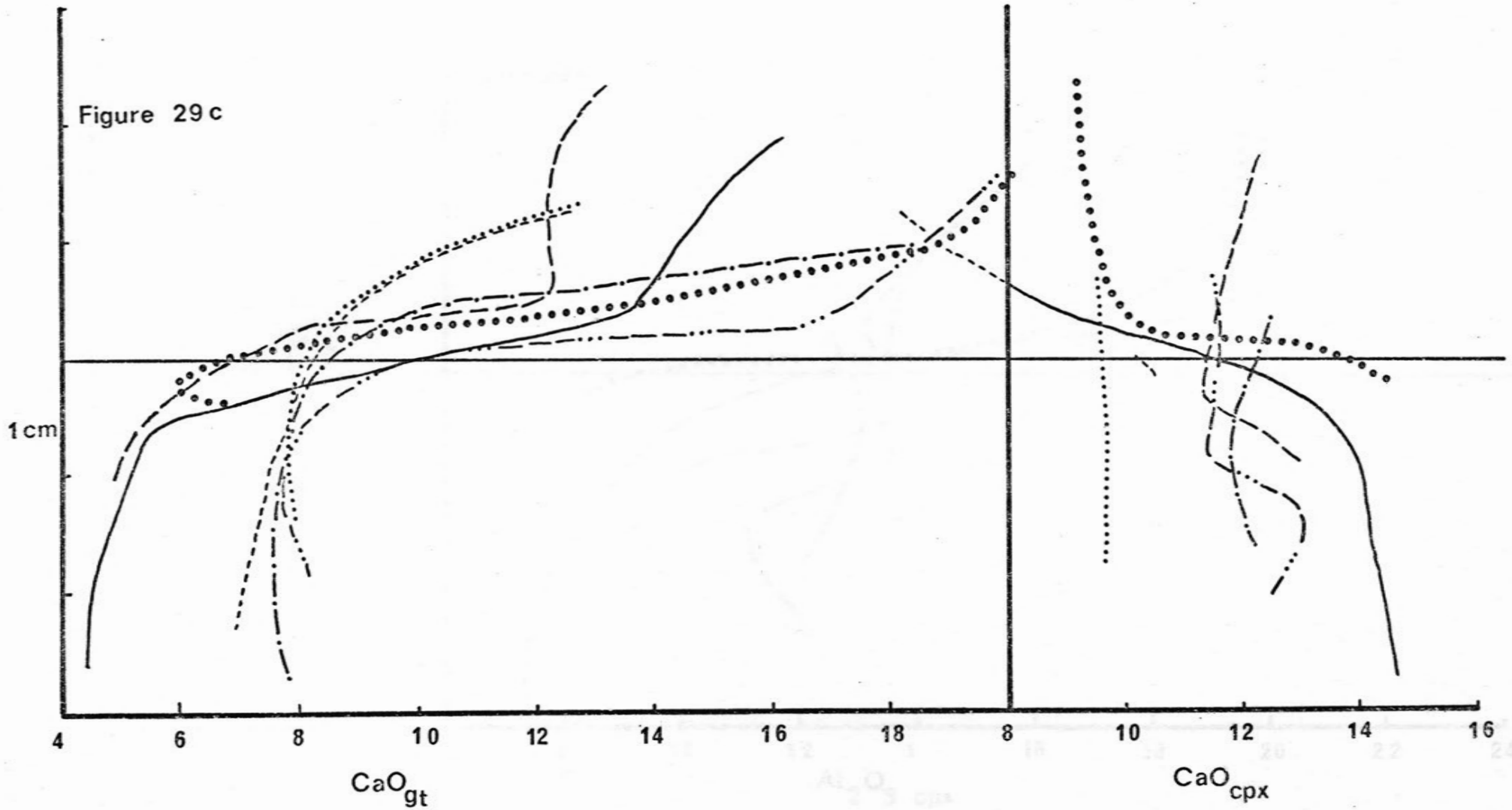


Figure 29c
1cm
4
6
8
10
12
14
16
18
8
10
12
14
16
CaO gt
CaO cpx

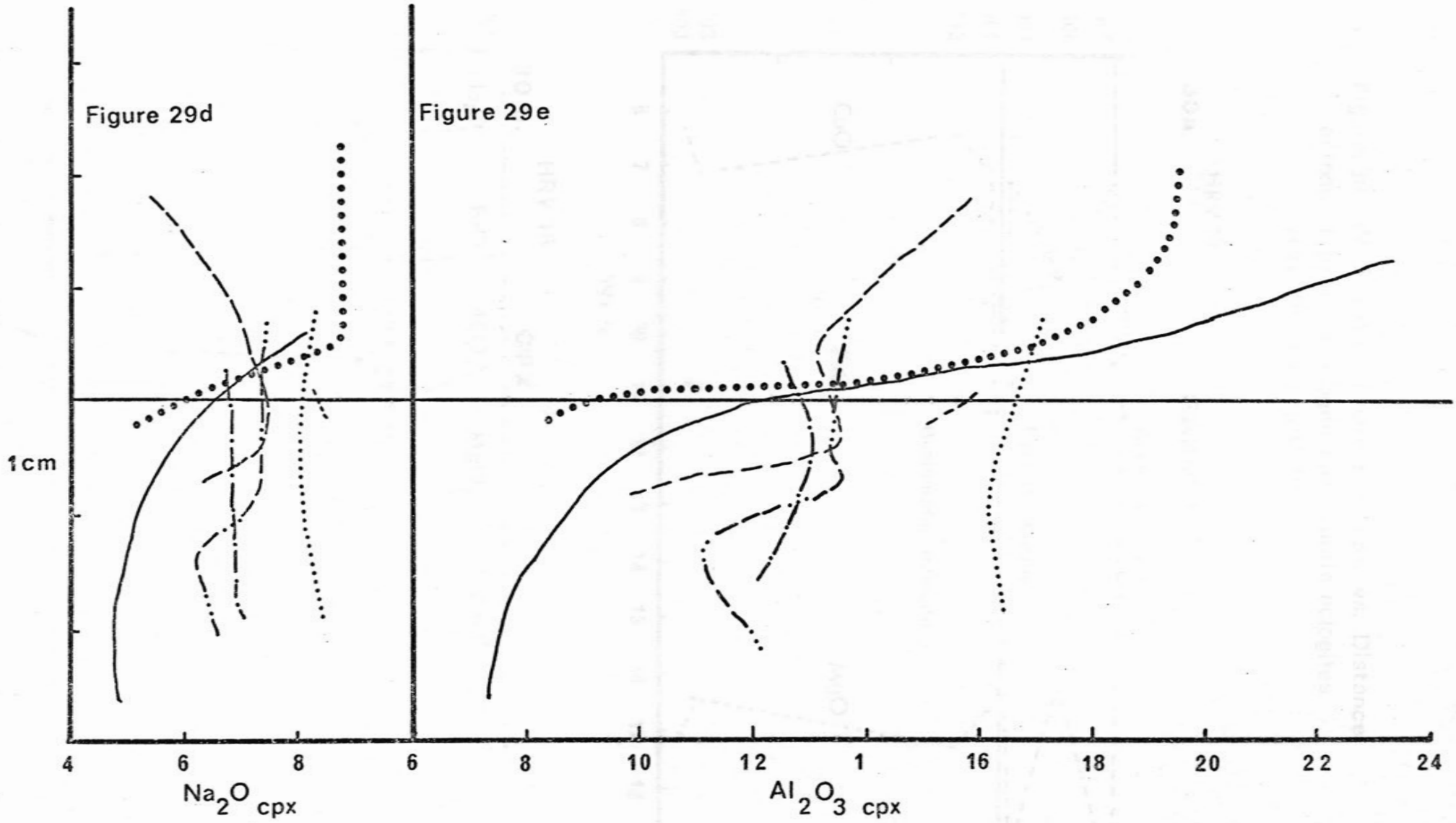
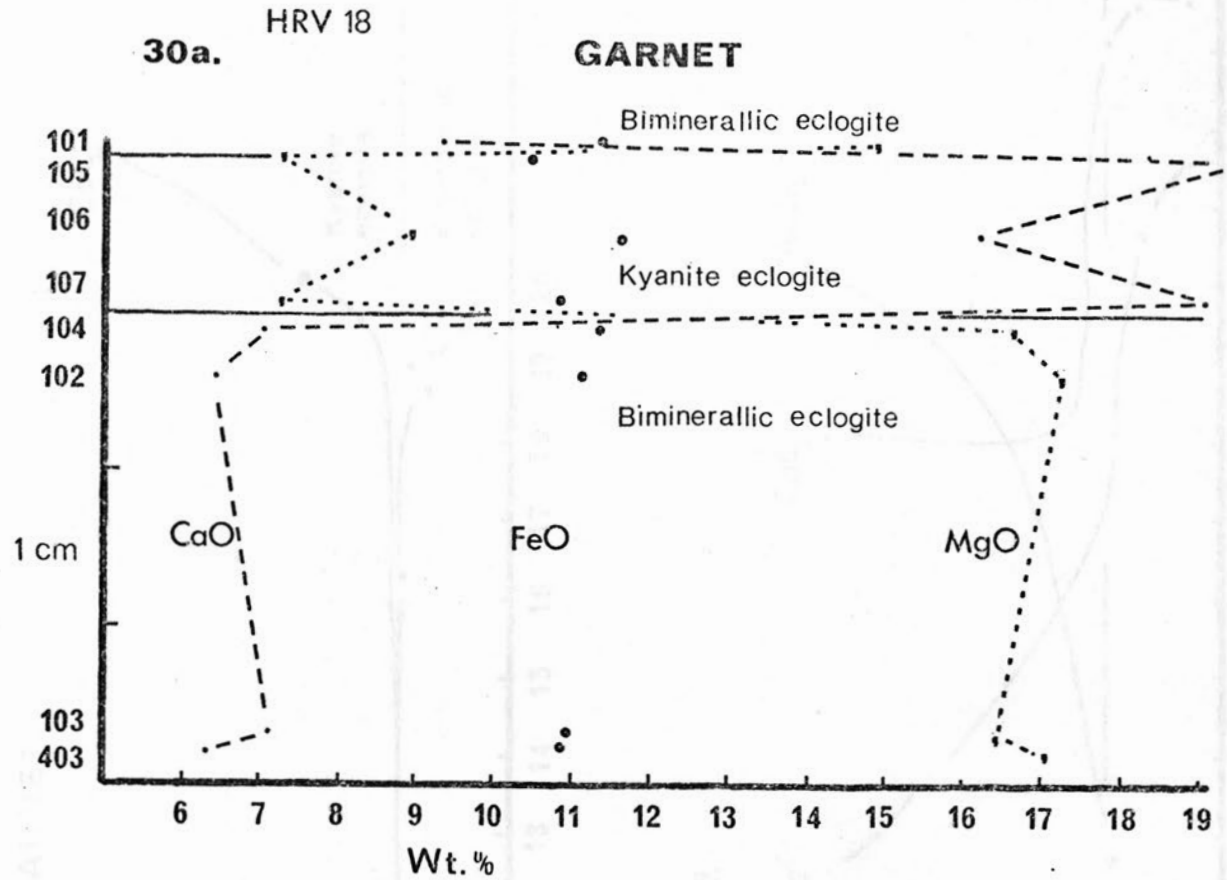
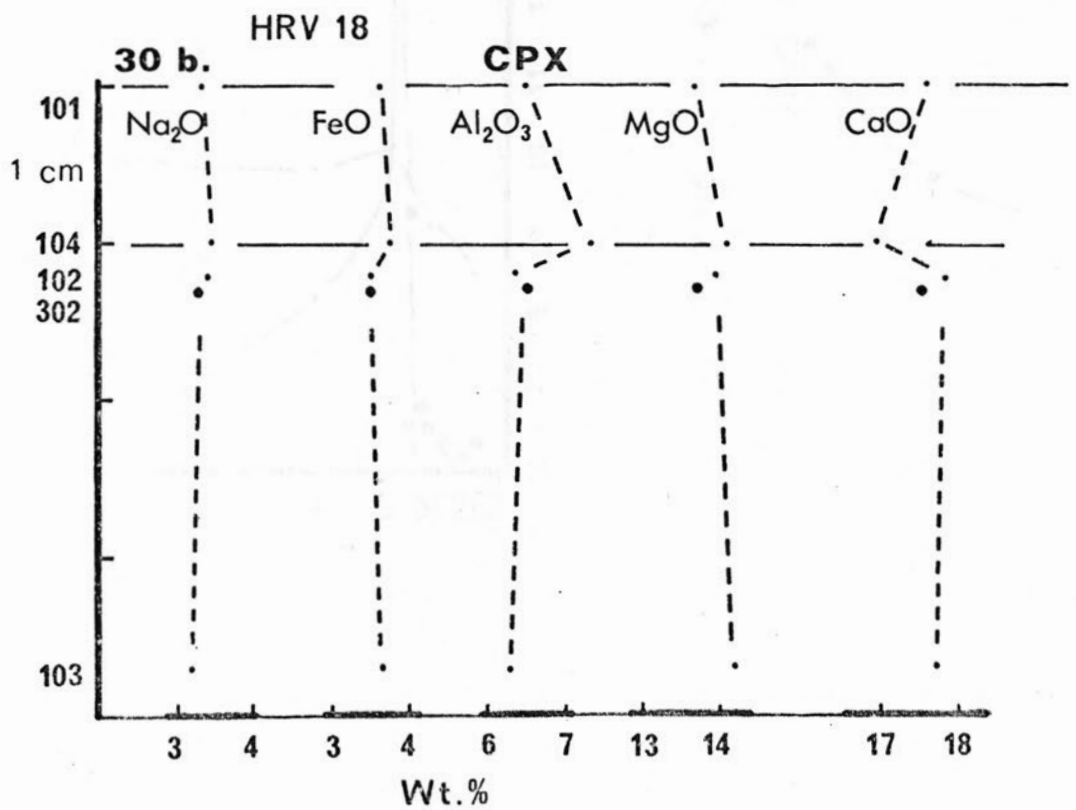
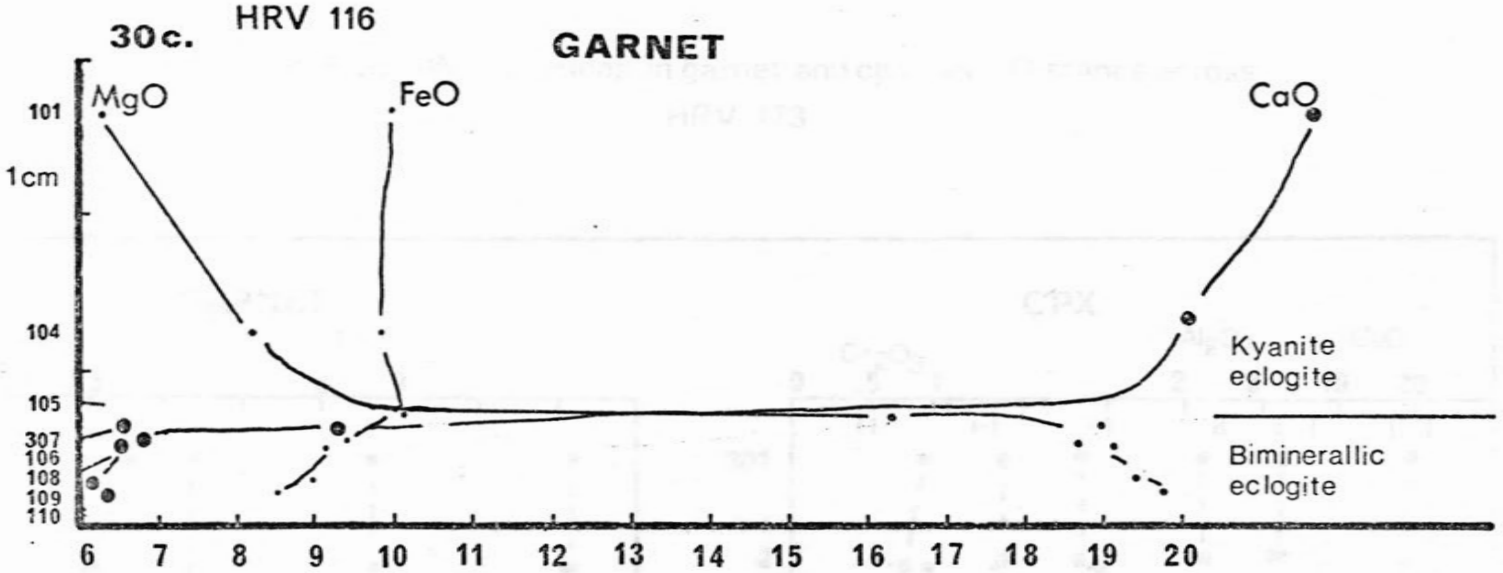


Figure 29d
Figure 29e
1cm
4
6
8
6
8
10
12
1
16
18
20
22
24
Na_2O cpx
Al_2O_3 cpx

Figure 30. Wt.% oxides in garnet and cpx vs. Distance across 'Type II' inhomogeneous kyanite eclogites HRV 18 and HRV 116.






30c. HRV 116
GARNET
MgO
FeO
CaO
1cm
101
104
105
307
106
108
109
110
Kyanite eclogite
Biminerallic eclogite
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

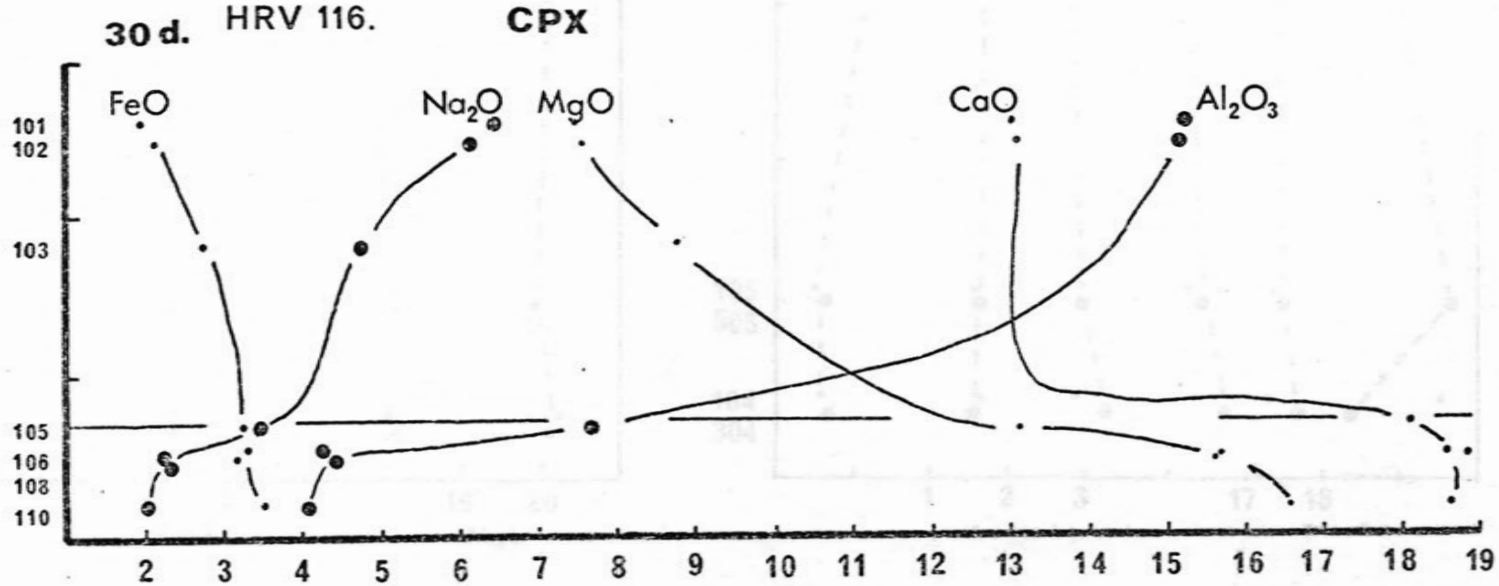

30d. HRV 116.
CPX
FeO
Na_2O
MgO
CaO
Al_2O_3
101
102
103
105
106
108
110
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

Figure 31. Wt. % oxides in garnet and cpx vs. Distance across HRV 173

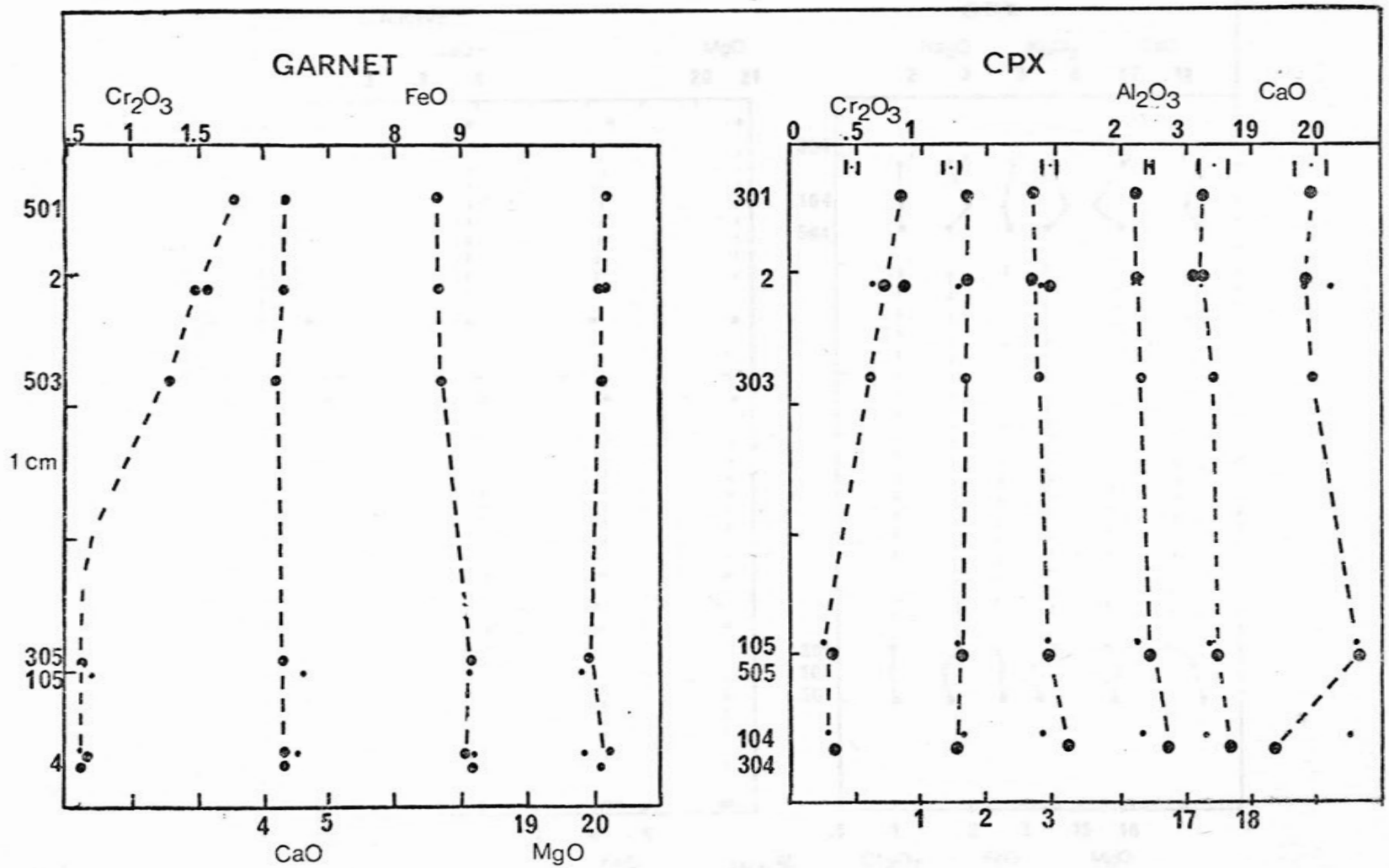


Figure 32. Wt. % oxides vs. Distance across sample HRV 132.

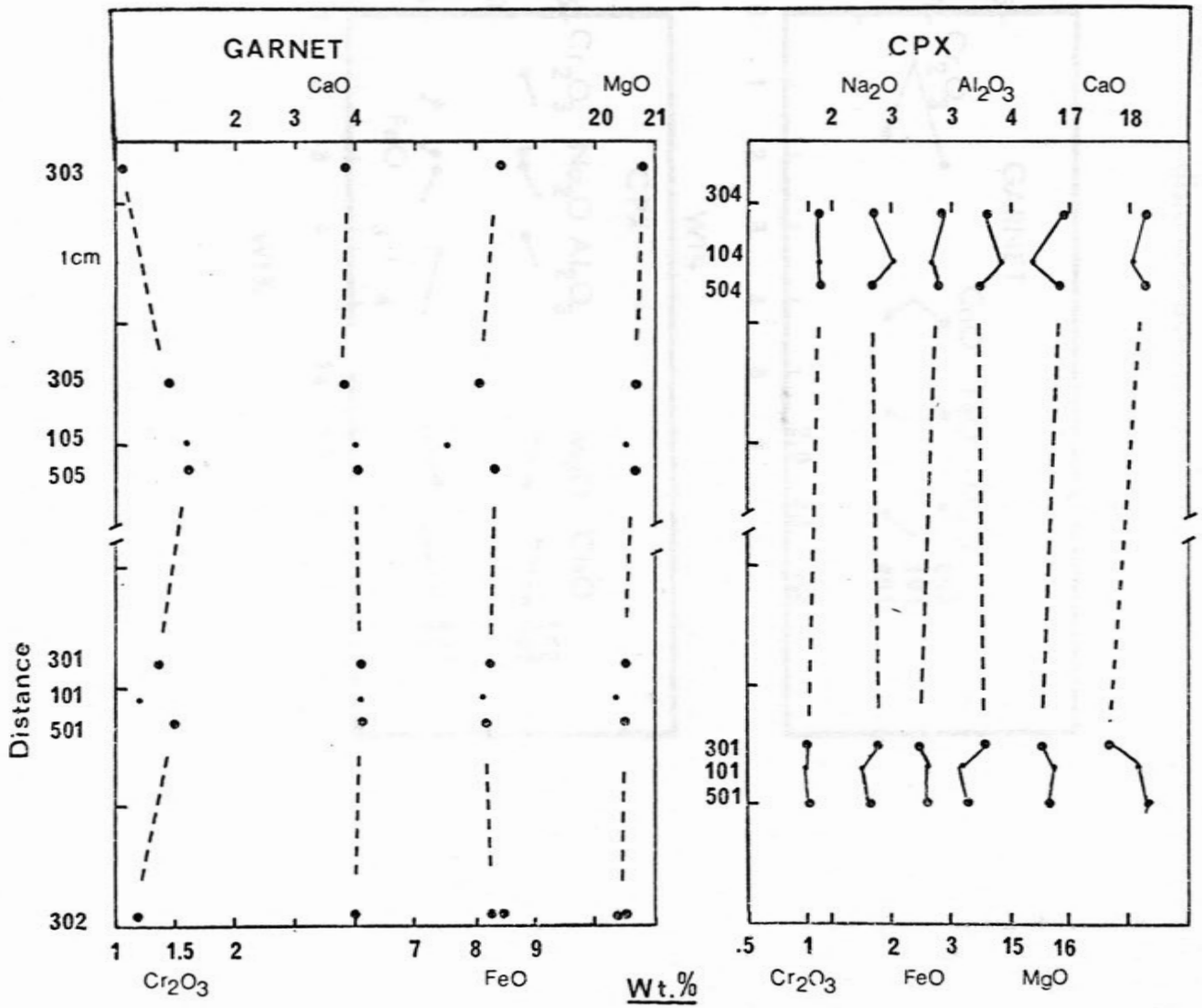


Figure 33. Wt% oxides in garnet and cpx vs distance across JJG 183

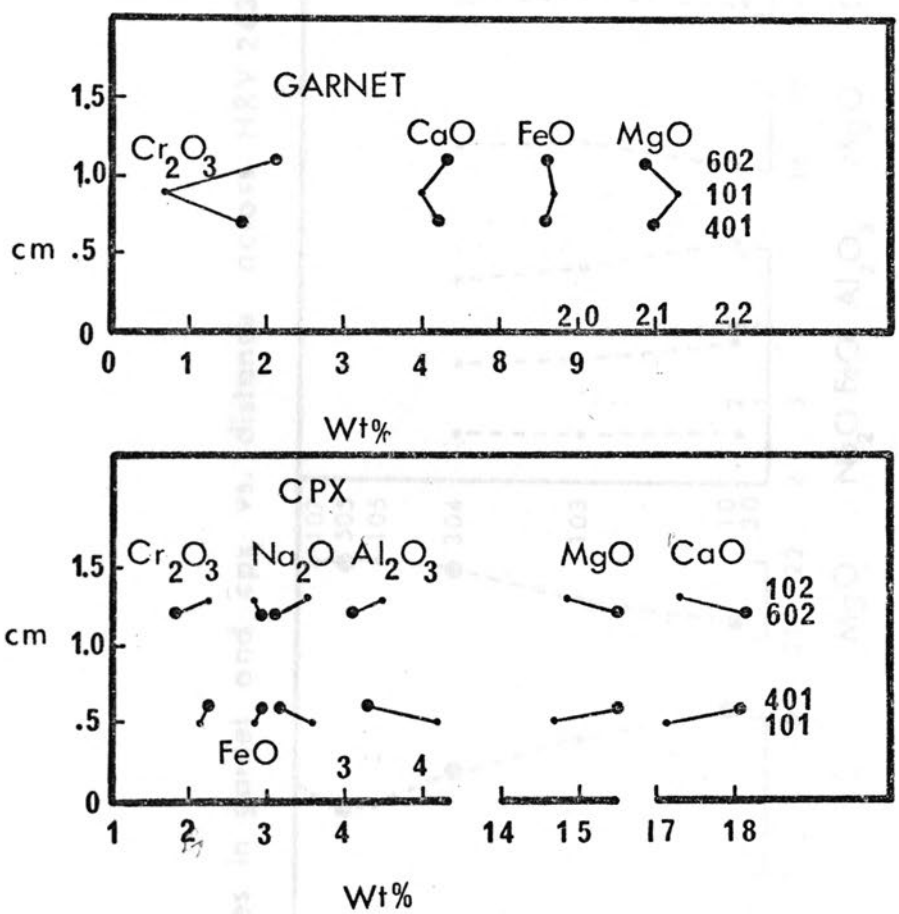


Figure 34. Wt.% oxides in garnet and cpx vs. distance across HRV 243

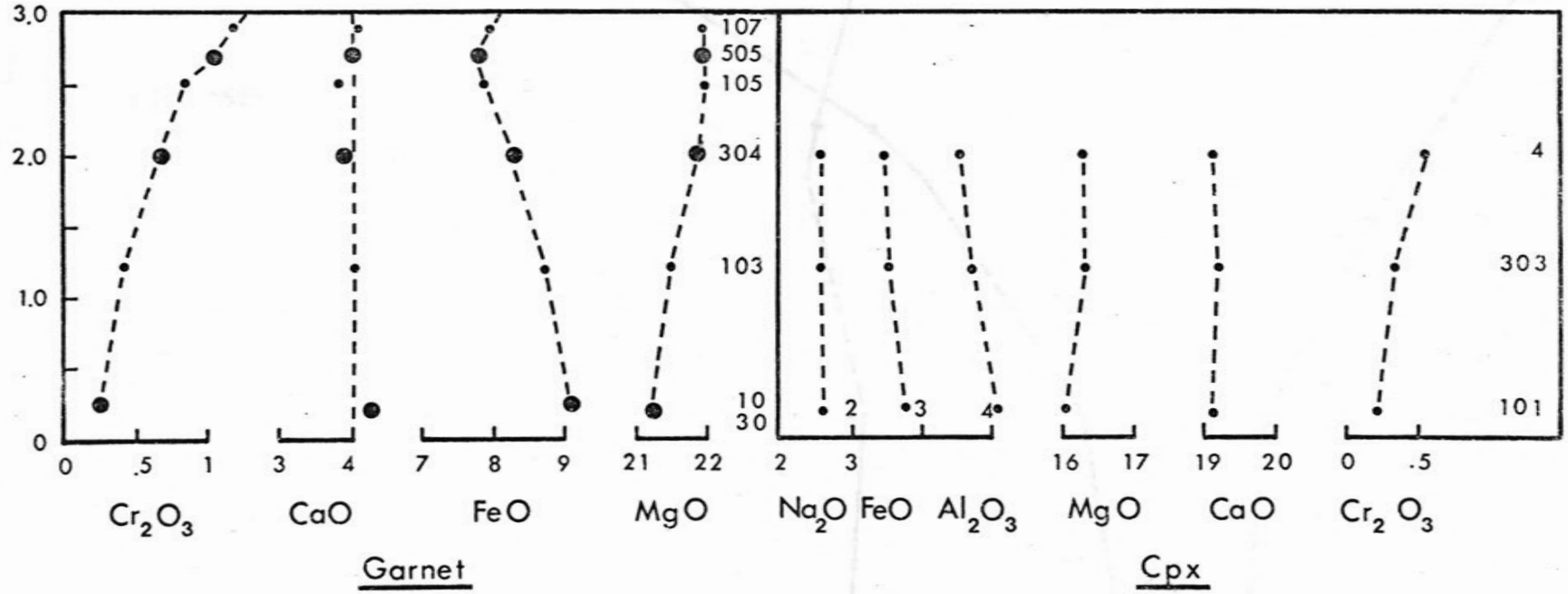


Figure 35a. Wt% of oxides in garnet vs. distance across sample HRV 15.

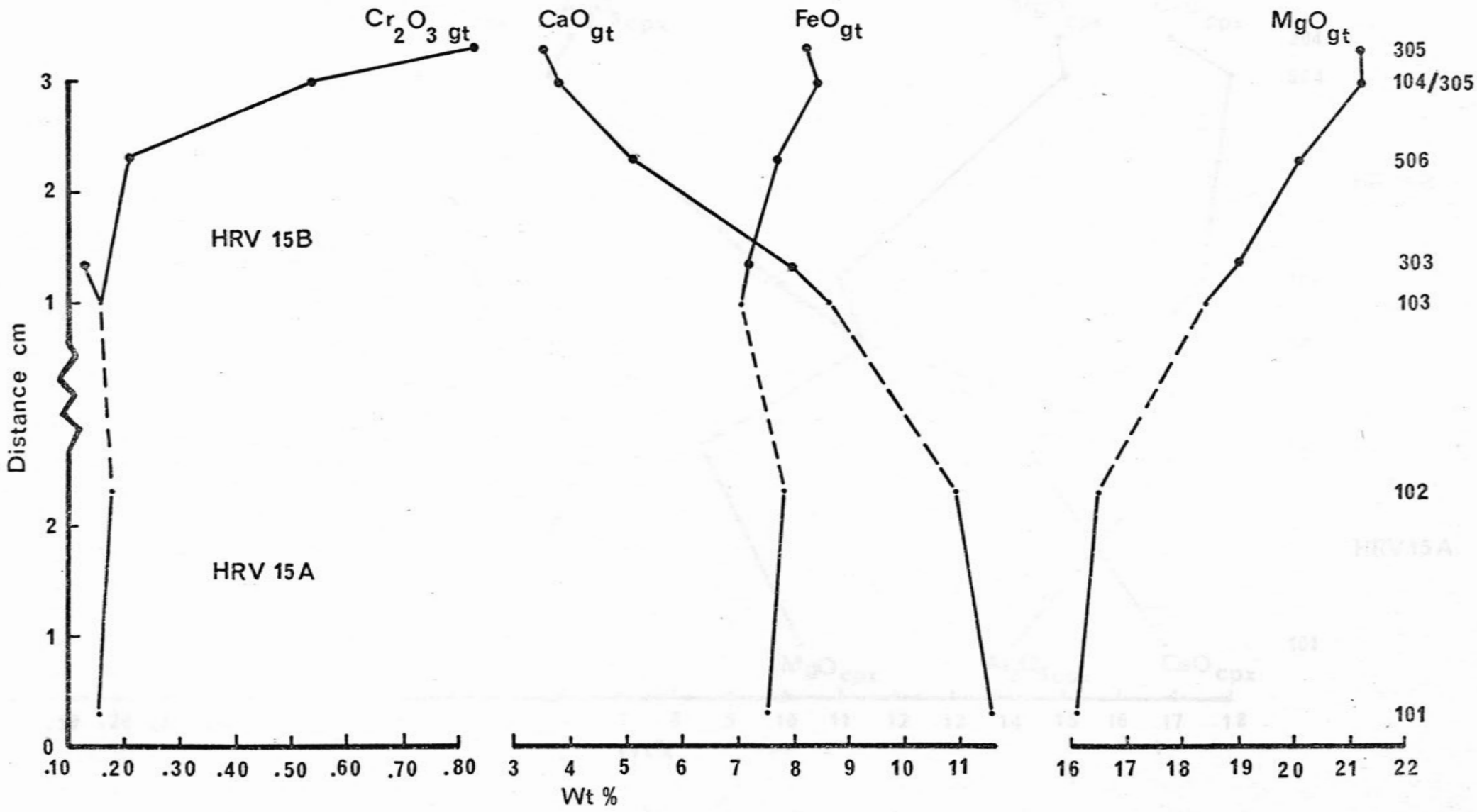


Figure 35b Wt% oxides in clinopyroxene vs distance across sample HRV 15.

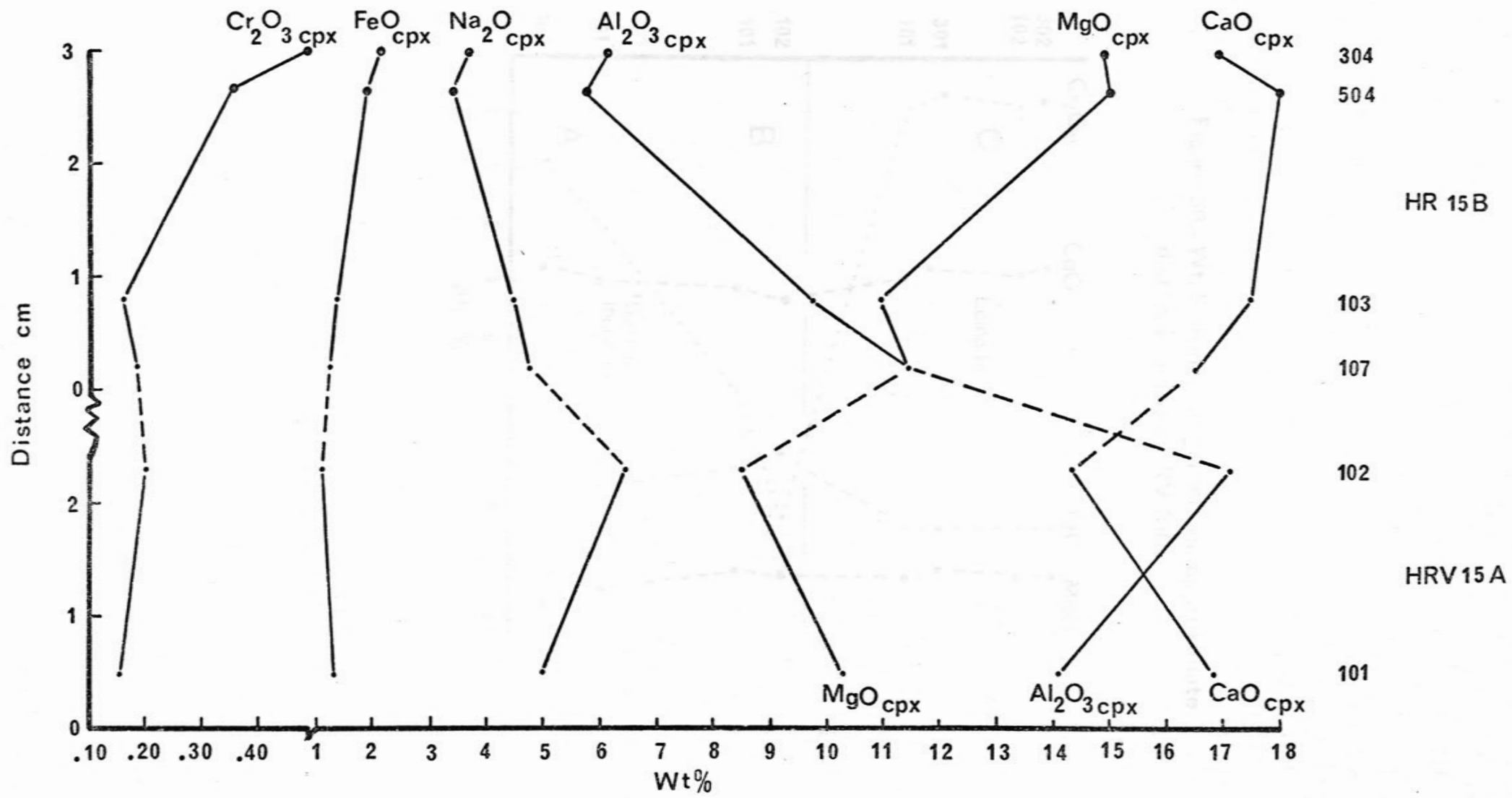


Figure 37. Wt.% oxides in garnet and cpx vs. Distance across HRV 180.

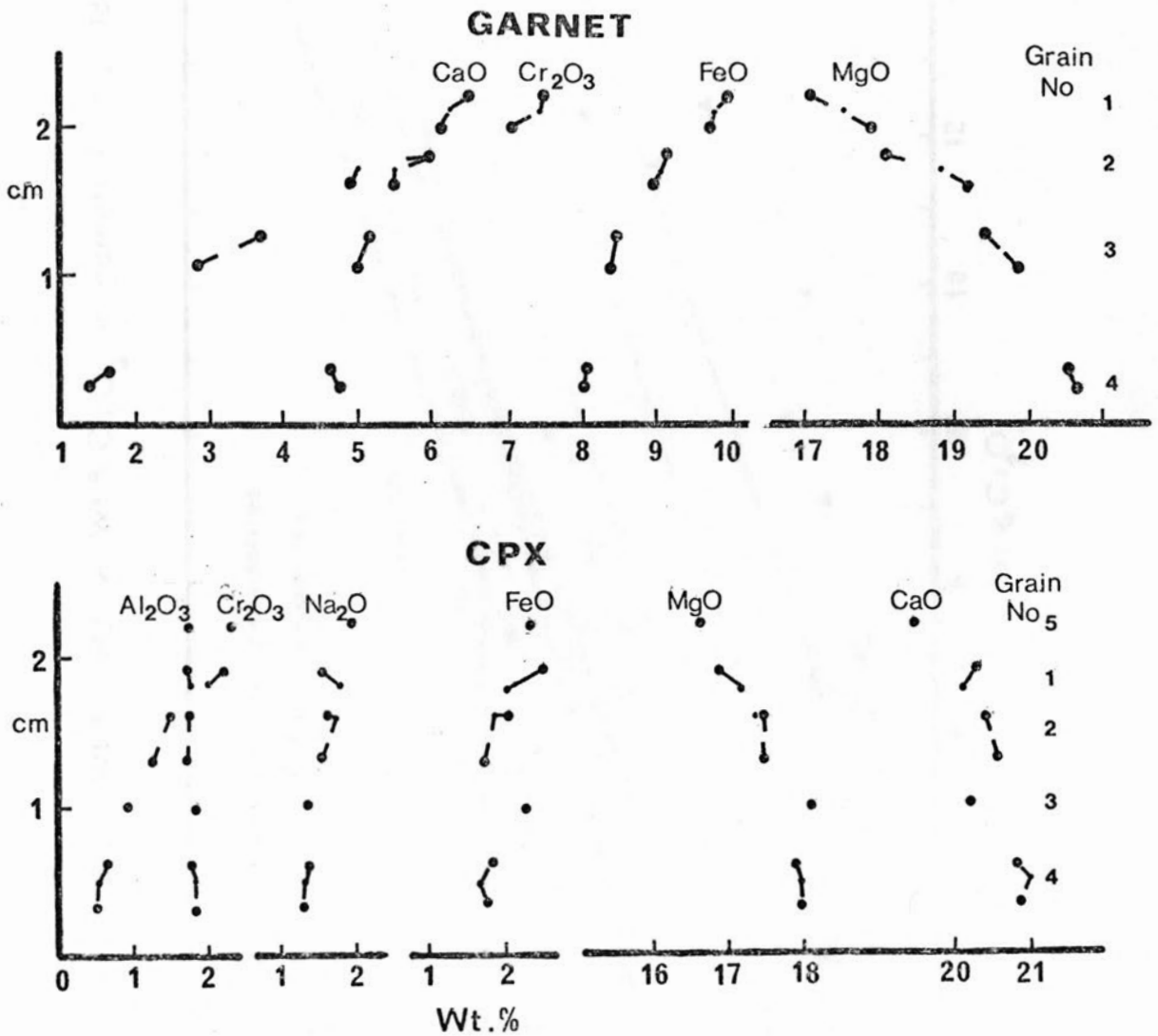


Figure 38. Wt % CaO vs Wt % Cr_2O_3 in garnets from peridotites.

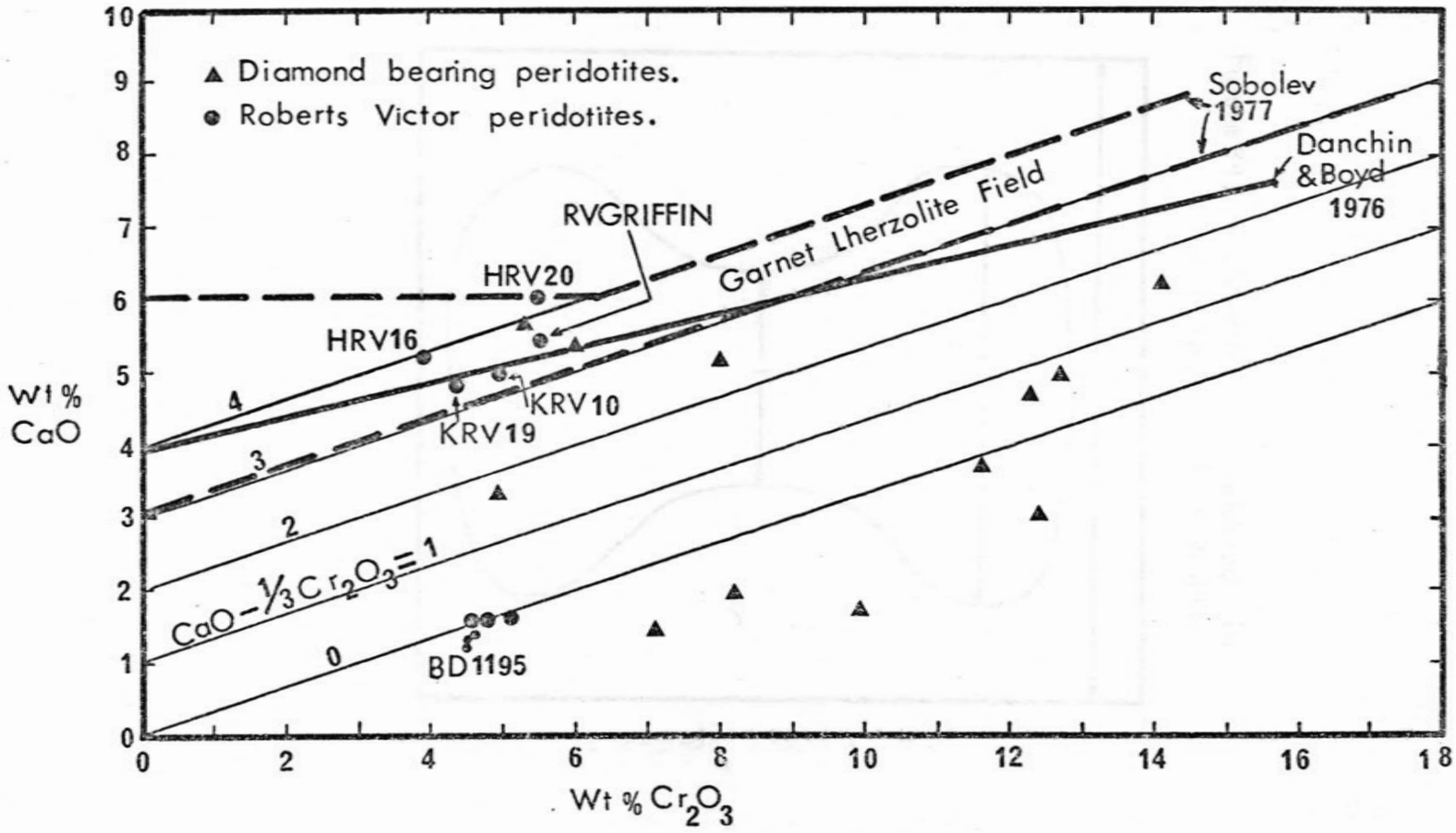


Figure 39. Paramaters considered in the abrasion of nodules.

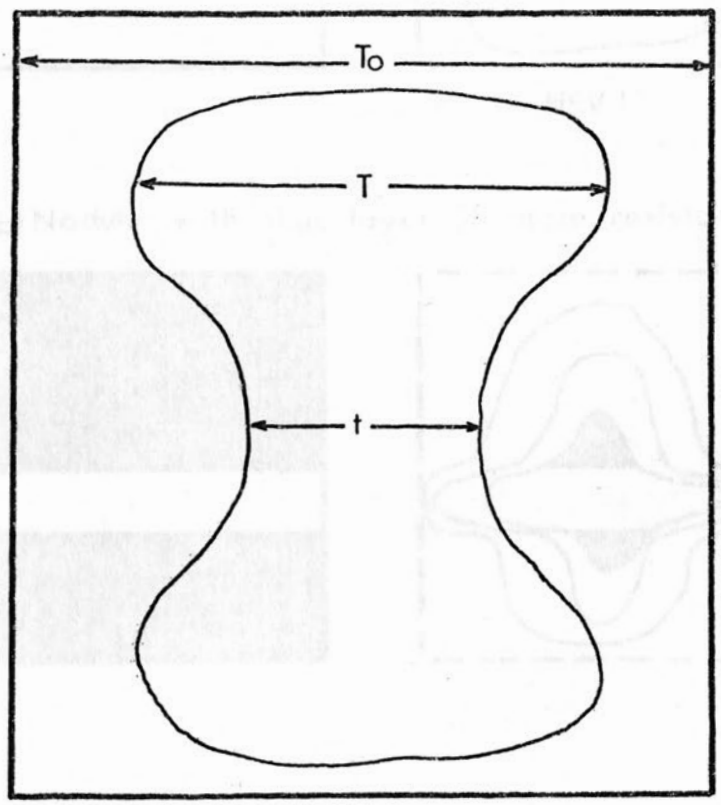
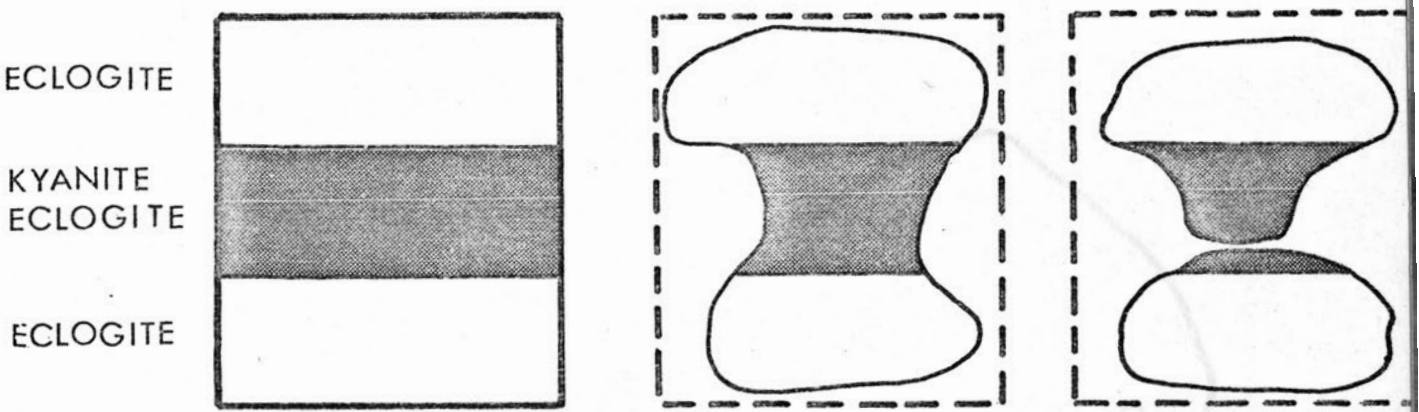


Figure 40. Abrasion patterns of nodules with layers of different hardness.

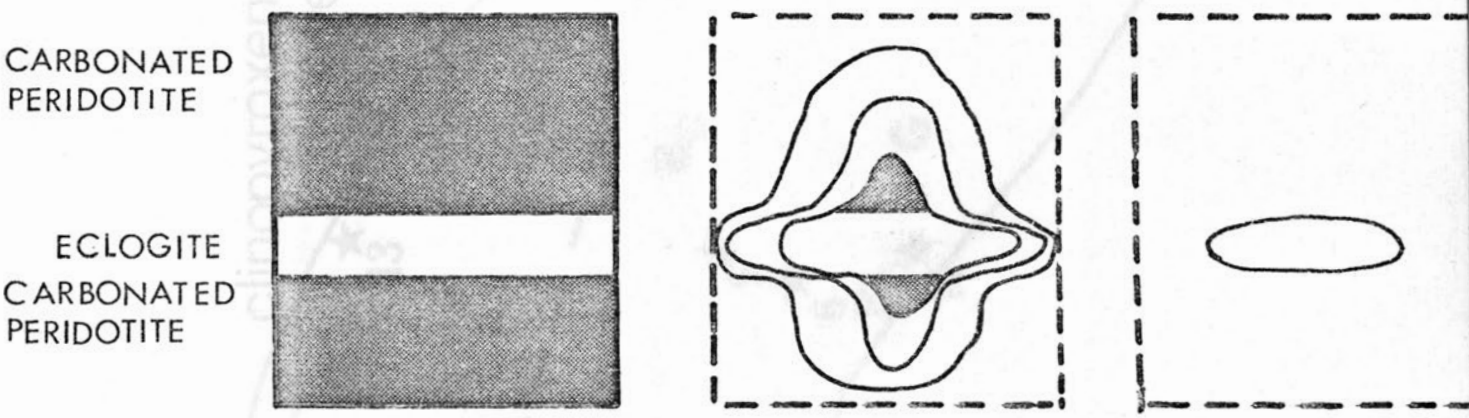
(a) Nodule with thin layer of less resistant material.



eg HRV 17

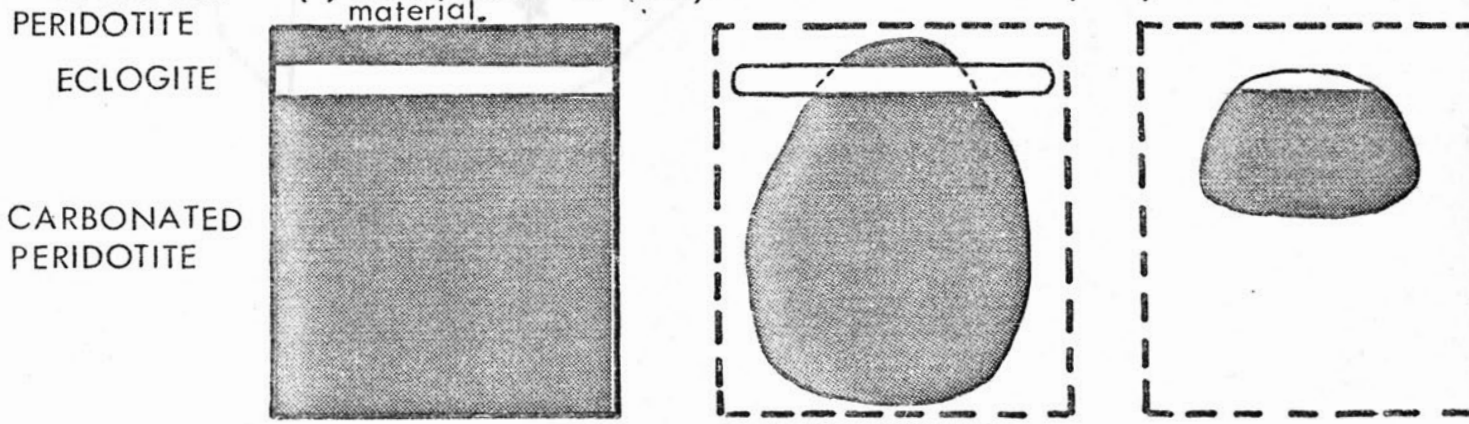
eg HRV 30
eg BD 1698

(b) Nodule with thin layer of more resistant material.



eg HRV 15

(c) Preservation of easily abraded material by layer of resistant material.



eg HRV 310

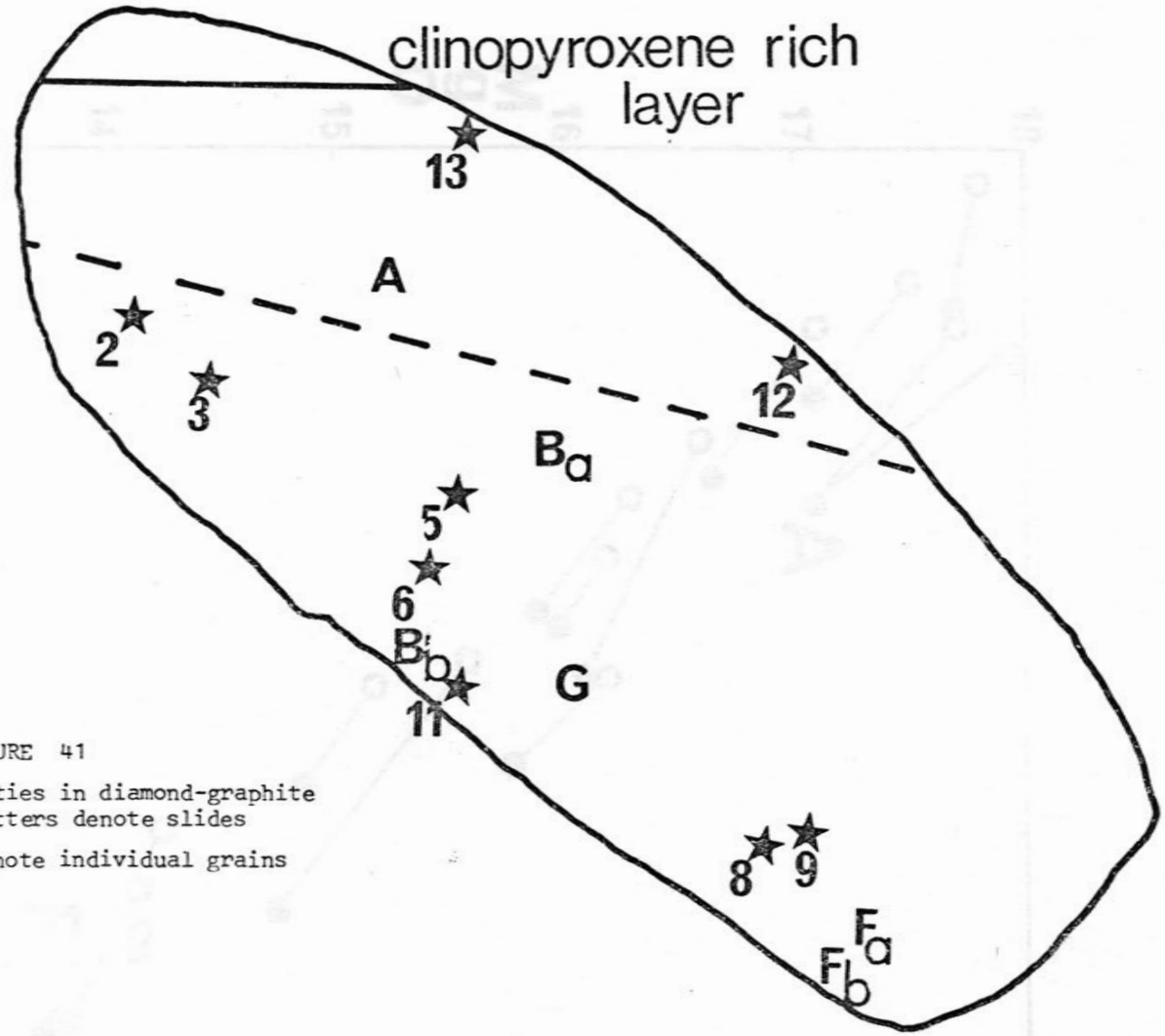
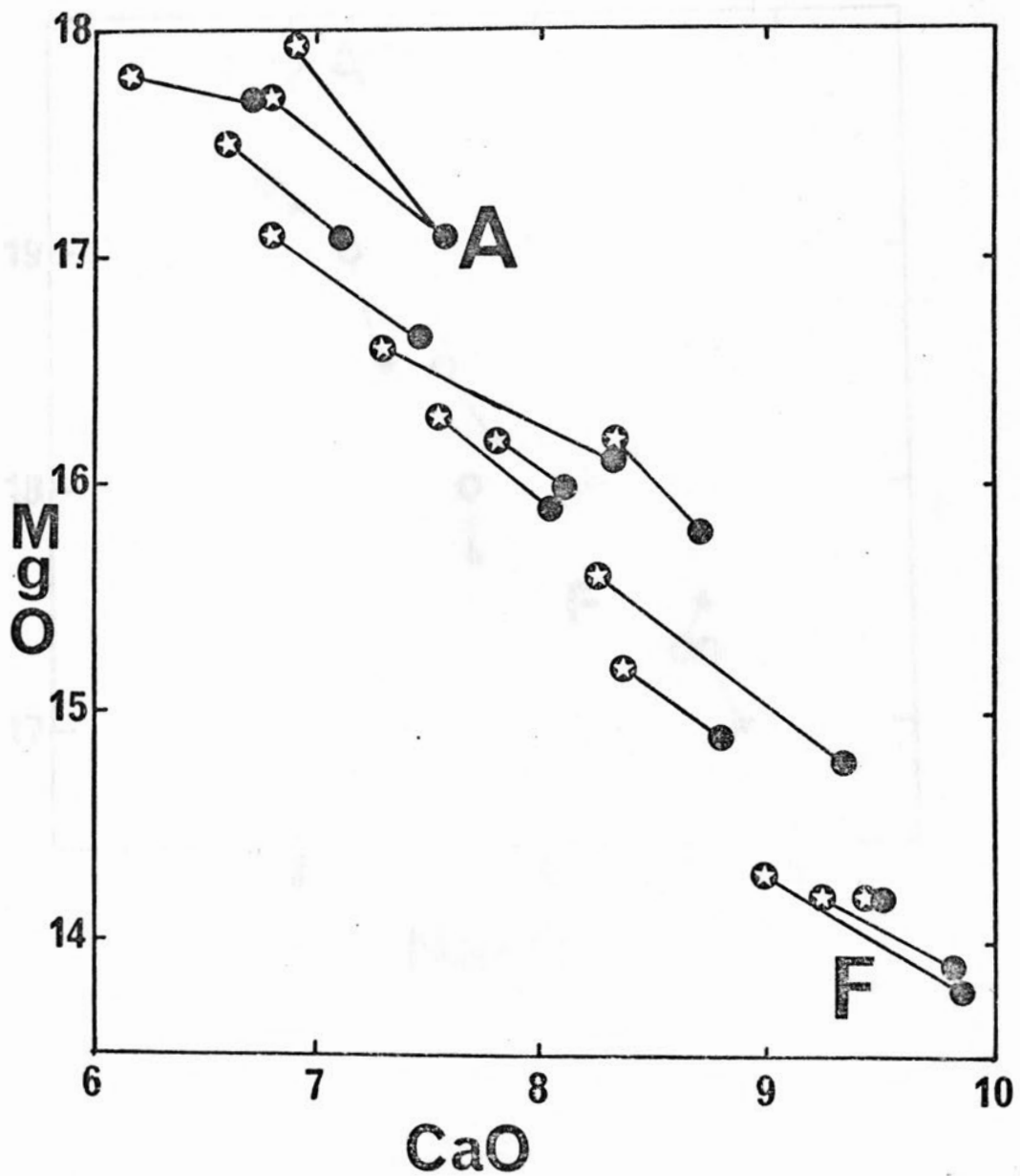


FIGURE 41

Analysis localities in diamond-graphite eclogite HRV247. Letters denote slides prepared, numbers denote individual grains removed.

FIGURE 42

Wt.% MgO vs wt.% CaO in garnets in HRV247. Solid circles denote cores; open symbols denote rims.



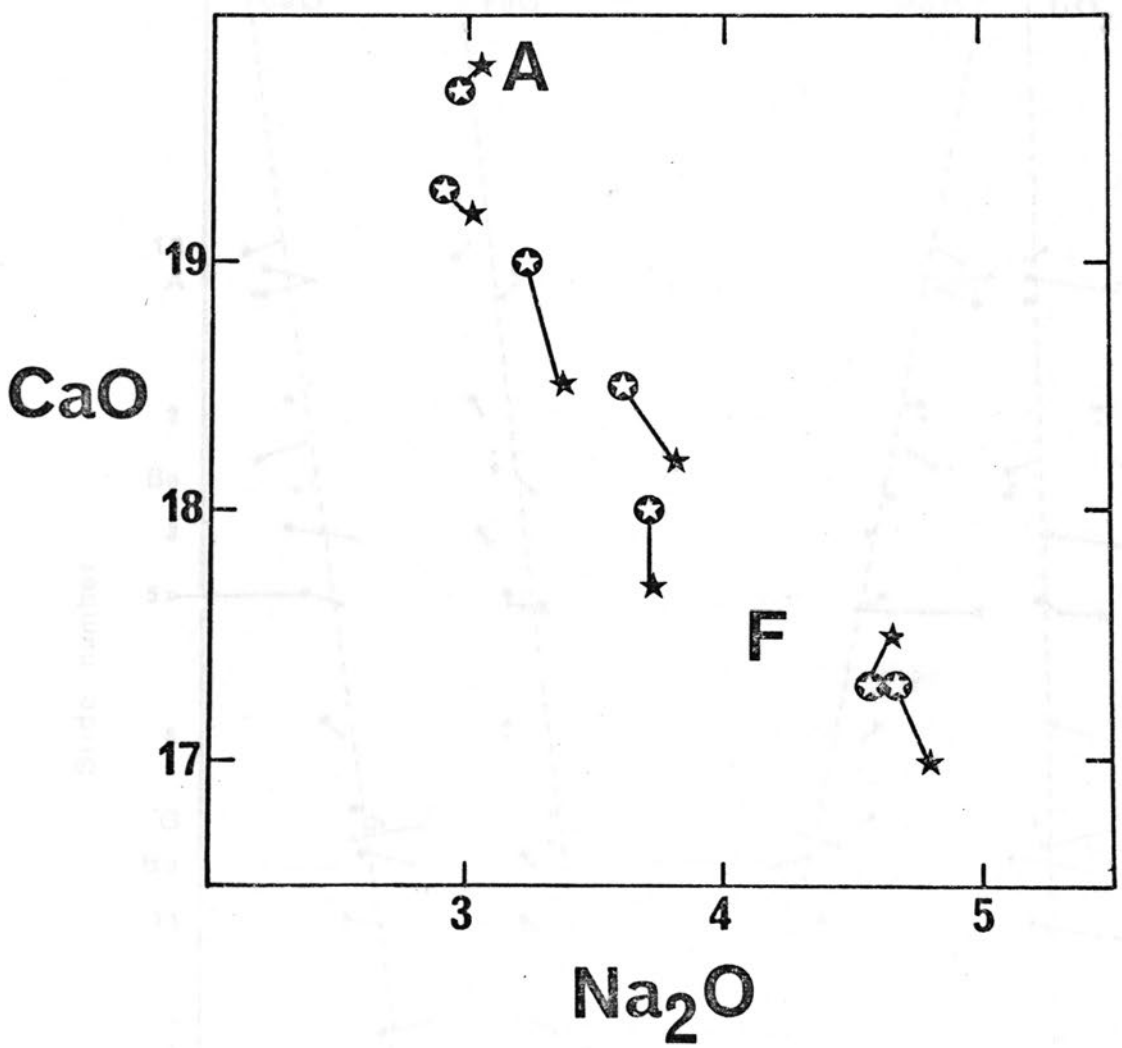


FIGURE 43. Wt.% CaO vs wt.% Na_2O in cpx in HRV247.
Solid stars denote cores.
Open stars denote rims.

Figure 44a. Wt% oxides in garnet vs. distance across HRV 247

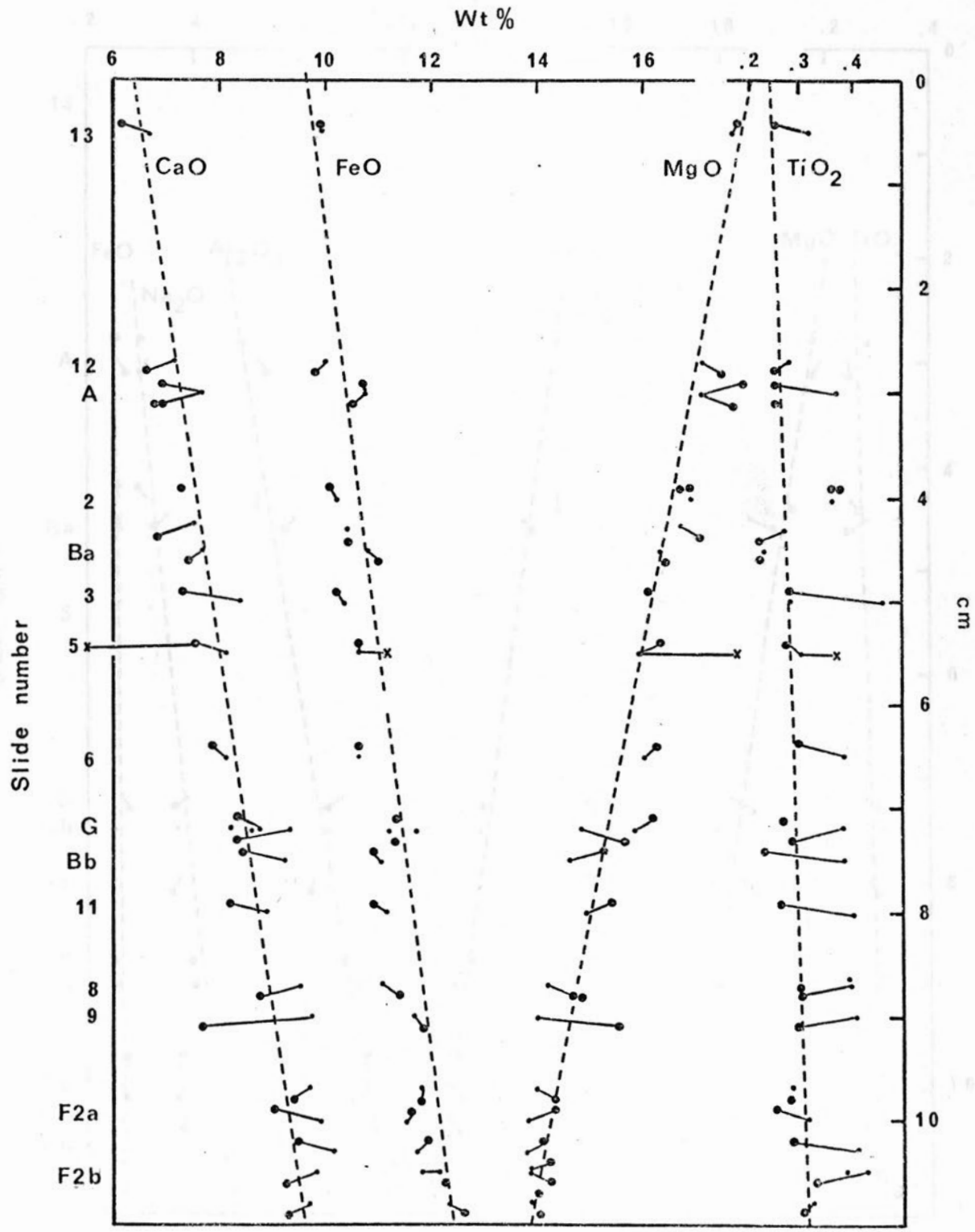


Figure 45. Wt % oxides in garnet and cpx vs distance across HRV 309

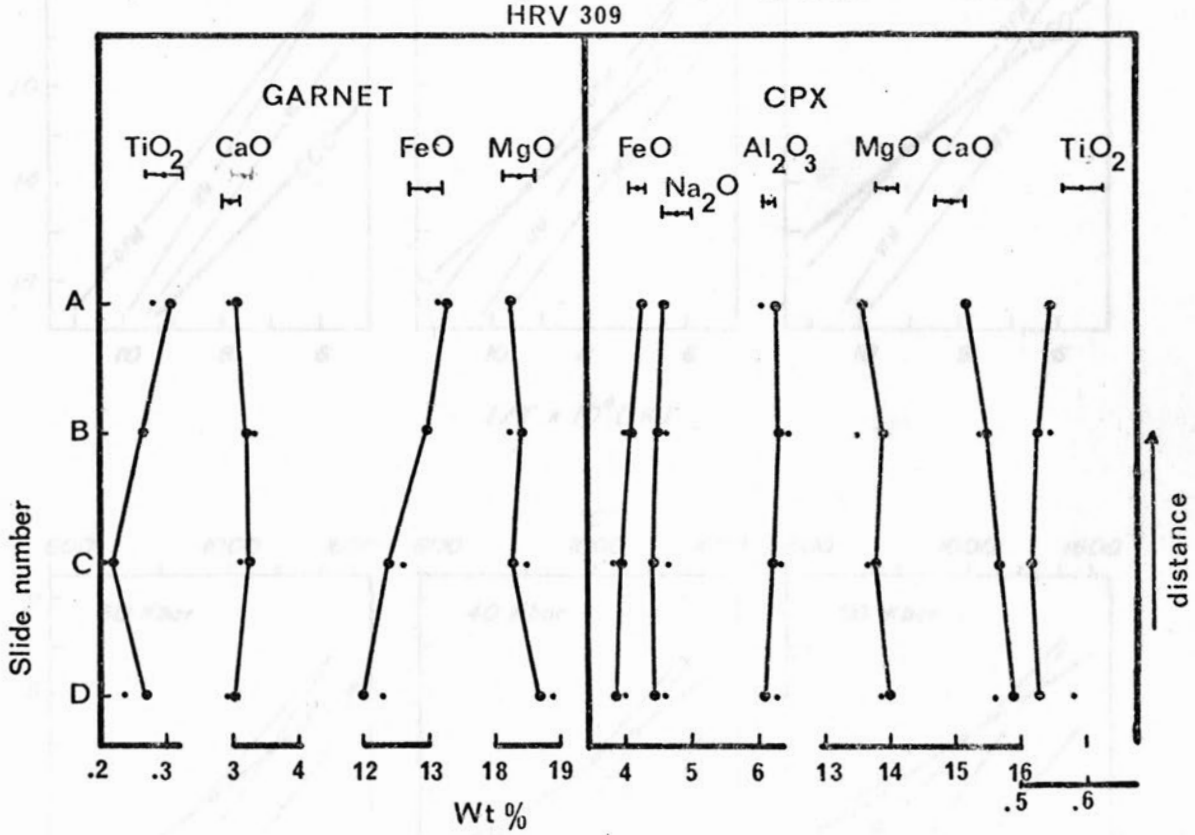


Figure 46

Calculated redox values for geophysically important mineralogic reactions. Only the CCO equilibrium has been experimentally verified.

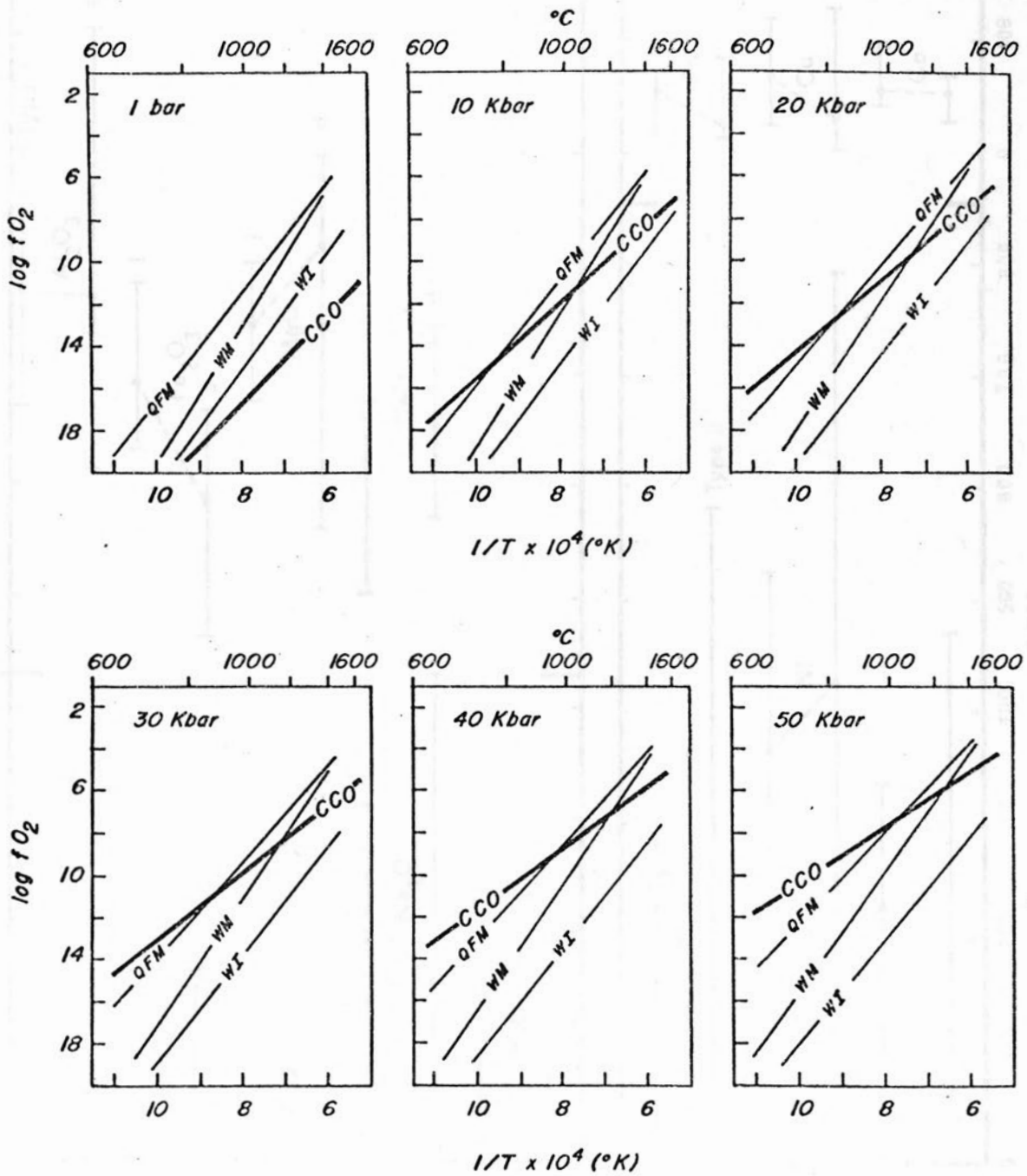
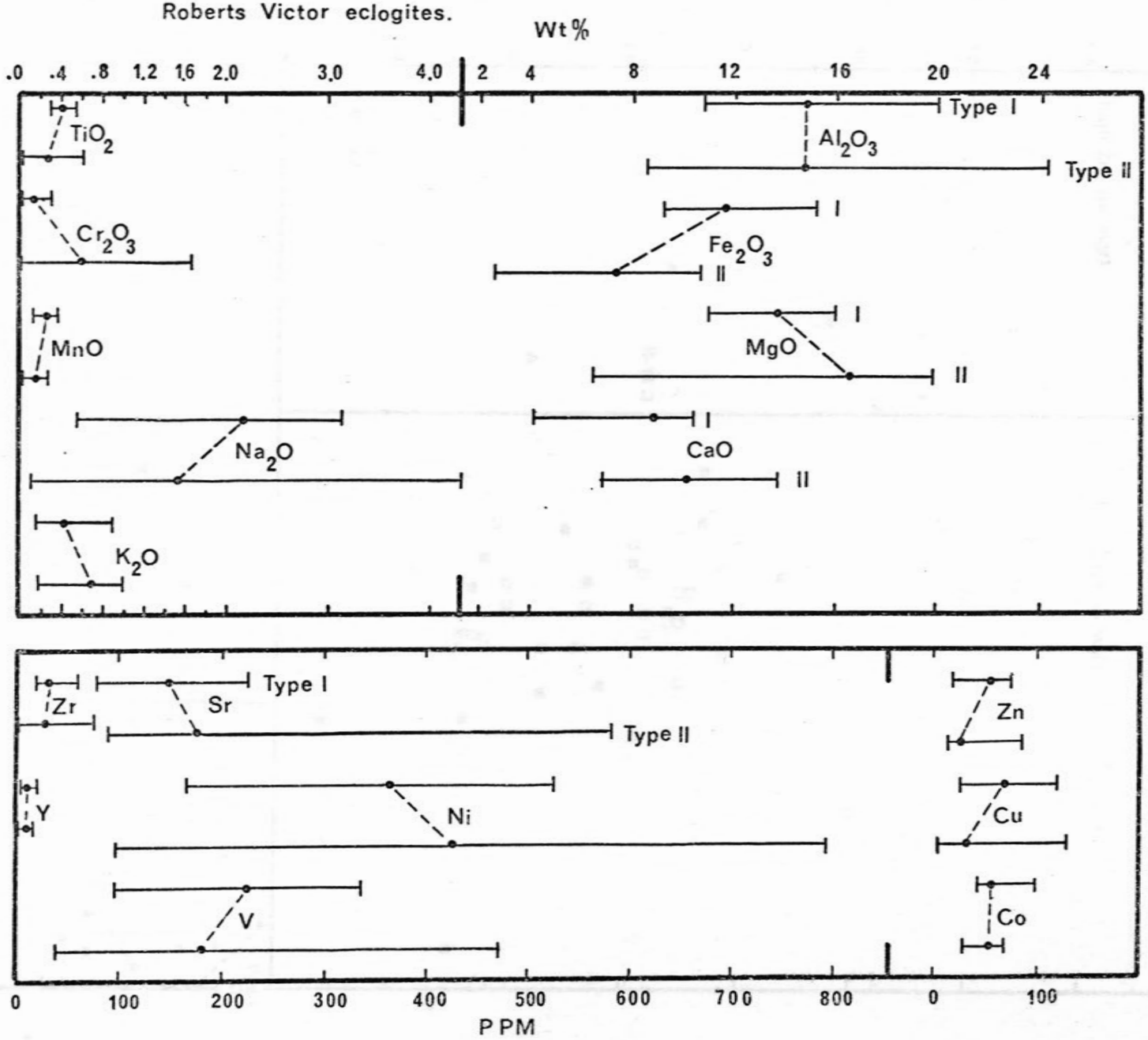


Figure 47. Ranges and mean values of oxides in whole rock analyses of Type I and Type II Roberts Victor eclogites.



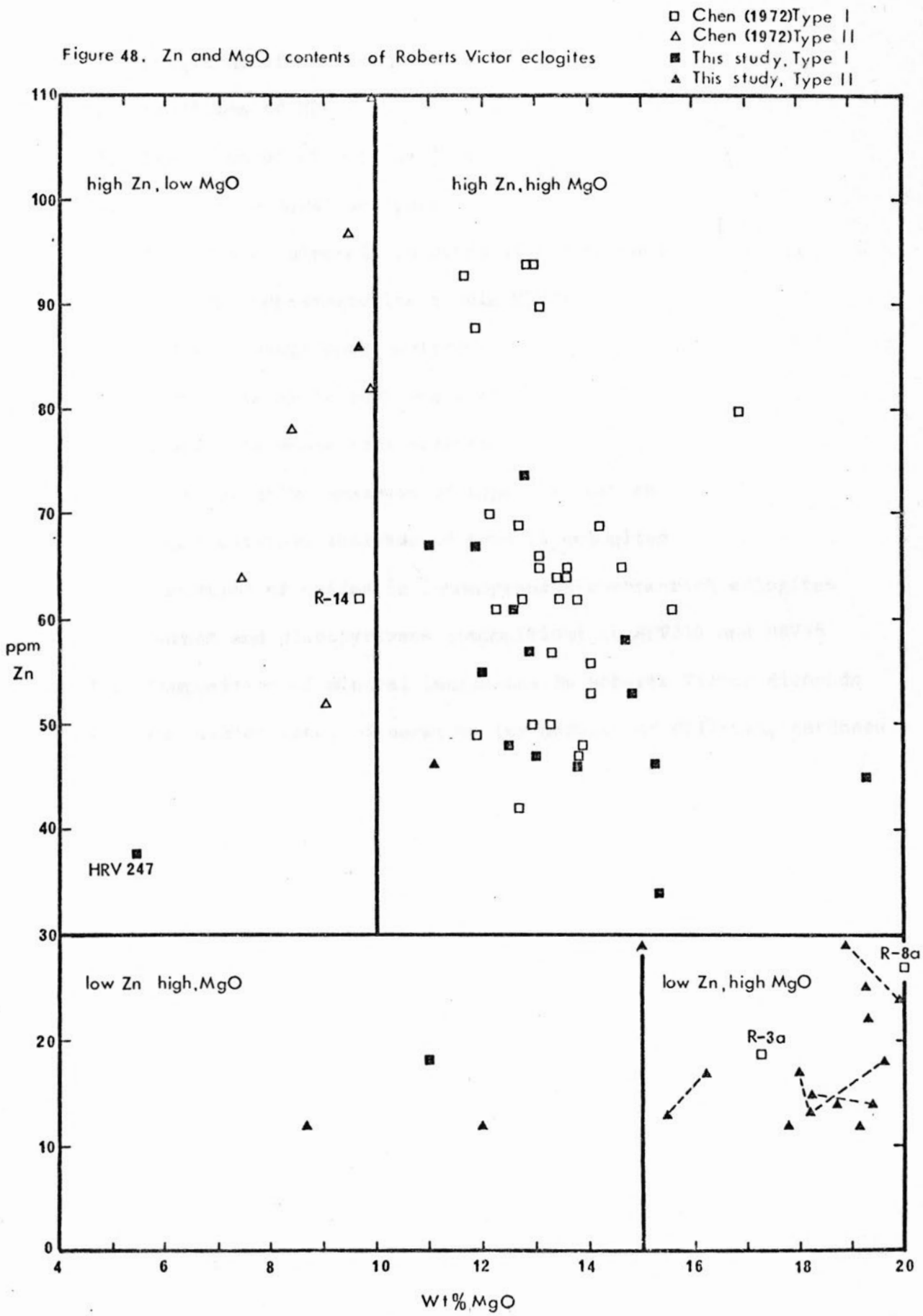


Figure 48. Zn and MgO contents of Roberts Victor eclogites

TABLES

1. Estimates of mantle composition
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8. Kimberlite whole rock analyses
9. Representative analyses of type I eclogites
10. Representative analyses of type II eclogites
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12. Garnet and clinopyroxene compositions in HRV310 and HRV15
13. Composition of mineral inclusions in Roberts Victor diamonds
14. Calculated rates of abrasion for nodules of differing hardness

TABLE 1

EXTRATERRESTRIAL

1. MASON (1966). Oxide fraction of olivine-bronzite chondrite.
2. RINGWOOD (1966a). Volatile free type I carbonaceous chondrite adjusted to FeO/FeO+MgO = .12 and silicate/metal = 69/31.

TERRESTRIAL

3. CARSWELL and DAWSON (1970). Mean of 9 garnet lherzolites from South Africa.
4. CARSWELL and DAWSON (1970). Mean of 6 previously analysed garnet lherzolites.
5. MAALOE and AOKI (1977). Average mineral compositions combined in the modal proportions 62.6% olivine, 30% orthopyroxene, 5% garnet, 2% clinopyroxene, .4% phlogopite.
6. MAALOE and AOKI (1977). Regression against MgO of 202 garnet lherzolite analyses. MgO specified = 43 wt.%.
7. MAALOE and AOKI (1977). Average composition of 301 continental spinel lherzolites.
8. MAALOE and AOKI (1977). Average composition of 83 oceanic spinel lherzolites.
9. MAALOE and AOKI (1977). Average composition of 384 oceanic and spinel lherzolites using Na_2O and TiO_2 contents of oceanic spinel lherzolites
10. GREEN (1964). Bulk composition of the Lizard intrusive, Cornwall.
11. GREEN (1963). Bulk composition of the Tinaquillo peridotite, Venezuela.
12. WHITE (1967). Mean concentrations of individual oxides in 168 ultramafic rocks.
13. HESS and OTALORA (1964). Suboceanic mantle exposed at mid oceanic ridge.
14. MELSON et al. (1967). Suboceanic mantle exposed at St. Peter and St. Pauls rocks.

HYPOTHETICAL

15. GREEN and RINGWOOD (1963). Pyrolite composition calculated by combination of 3 parts average dunite and 1 part average basalt to agree with chondrite model of Ringwood (1959).
16. RINGWOOD (1966b). Pyrolite composition calculated by combination of 3 parts hypothetical alpine peridotite and 1 part primitive Hawaiin tholeiite to agree with chondrite model of Ringwood (1966a).
17. RINGWOOD (1975). Pyrolite composition calculated by combination of 99% rare earth depleted Lizard peridotite (col.10) with 1% rare earth enriched nephelinite to yield chondrite rare earth abundances.
18. RINGWOOD (1975). Pyrolite composition calculated by combination of 83% olivine-orthopyroxene mix (2:1) and 17% least differentiated oceanic tholeiite to yield twice chondrite rare earth abundances.
19. HARRIS et al. (1967). Preferred oxide percentages in the range between White's (1967) estimates and the mean of 5 high Ca, Al "olivine nodules".
20. NICHOLLS (1967). Ocean tholeiite calculated to amphibole formula by addition of 7% Fe-Ti spinel, and combined with $3\frac{1}{2}$ parts oceanic serpentinite. Ratio determined by consideration of rate of degassing of earth.
21. CARTER (1970). Estimated composition of spinel lherzolite with olivine = Fa_{13}, considered to represent primitive material before partial melting to produce liquids ($Fa > 14$) and cumulates ($Fa \leq 14$).
22. MAALOE and AOKI (1977). Estimated composition of primitive spinel lherzolite with MgO = 41%.

TABLE 1. ESTIMATES OF MANTLE COMPOSITION . 1-2 METEORITIC. 3-14 TERRESTRIAL.

	MASON 1	C.C. 1 2	9 GT LH 3	6 GTLH 4	MIN MOD 5	43% MGO 6	CONT SL 7	OCEANIC 8	OC CONT 9	LIZARD 10
SIO2	48.1	43.3	46.5	45.5	45.0	46.1	44.2	44.4	44.2	44.8
TIO2	.13		.33	.16	.06	.10	.07	.13	.13	.19
AL2O3	3.02	3.90	1.84	2.65	1.40	1.20	1.96	2.38	2.05	4.16
CR2O3	.55		.38	.31	.32	.37	.44	.44	.44	.40
FEO	12.7	9.25	6.70	6.99	7.89	7.16	8.28	8.31	8.29	8.21
MNO	.43		.11	.12	.11	.12	.12	.17	.13	.11
MGO	31.2	38.1	42.0	41.9	42.6	43.0	42.3	42.1	42.2	39.2
CAO	2.32	3.72	1.47	1.89	.82	1.05	2.08	1.34	1.92	2.42
NA2O	1.13	1.78	.16	.19	.11	.18	.18	.27	.27	.22
K2O	.13		.15	.14	.04	.14	.05	.09	.06	.05
NIO			.32	.30	.26	.29	.27	.31	.28	.24
P2O5	.34		.02	.03		.02	.02	.06	.03	ND
TOTAL	100.0	100.0	100.0	100.2	98.6	99.7	100.0	100.0	100.0	100.0

IONIC PROPORTIONS

SI	3.514	3.174	3.329	3.264	3.286	3.318	3.210	3.216	3.208	3.236
TI	.007		.018	.009	.003	.005	.004	.007	.007	.010
AL	.260	.337	.155	.224	.121	.102	.168	.203	.175	.354
CR	.032		.022	.018	.018	.021	.025	.025	.025	.023
FE	.776	.567	.401	.419	.482	.431	.503	.503	.503	.496
MN	.027		.007	.007	.007	.007	.007	.010	.008	.007
MG	3.397	4.162	4.481	4.479	4.636	4.612	4.578	4.544	4.565	4.219
CA	.162	.292	.113	.145	.064	.081	.162	.104	.149	.187
NA	.160	.253	.022	.026	.016	.025	.025	.038	.038	.031
K	.012		.014	.013	.004	.013	.005	.008	.006	.005
NI			.018	.017	.015	.017	.016	.018	.016	.014
P	.021		.001	.002		.001	.001	.004	.002	
TOTAL	8.387	8.784	8.581	8.624	8.651	8.633	8.703	8.681	8.703	8.582
OXYGEN	12	12	12	12	12	12	12	12	12	12

M: 81.41	M: 88.01	M: 91.78	M: 91.44	M: 90.59	M: 91.45	M: 90.10	M: 90.03	M: 90.07	M: 89.48
CA 4.17	CA 5.82	CA 2.26	CA 2.88	CA 1.24	CA 1.58	CA 3.09	CA 2.02	CA 2.86	CA 3.82
MG 78.01	MG 82.89	MG 89.71	MG 88.81	MG 89.46	MG 90.01	MG 87.32	MG 88.21	MG 87.49	MG 86.06
FE 17.82	FE 11.29	FE 8.03	FE 8.31	FE 9.30	FE 8.41	FE 9.59	FE 9.77	FE 9.65	FE 10.12

TABLE 1. ESTIMATES OF MANTLE COMPOSITION . 3-14 TERRESTRIAL. 15-22 HYPOTHETICAL

	TINAQ' 11	WHITE 12	ST PAUL 13	C SERP 14	PYRO 1 15	PYRO 2 16	PYRO 3 17	PYRO 4 18	HARRIS 19	NICHLLS 20
SIO2	44.7	44.5	43.6	43.6	43.1	45.2	44.9	46.1	44.2	45.1
TIO2	.08	.15	.30	.04	.58	.71	.24	.20	.10	.50
AL2O3	3.19	2.55	3.70	2.36	3.99	3.54	4.30	4.30	2.70	4.10
CR2O3	.45		.50	.40	.42	.43	.40		.30	.30
FEO	7.62	8.65	8.00	8.67	8.15	8.45	8.20	8.20	8.29	9.70
MNO	.14	.14	.10	.10	.13	.14	.10		.15	.20
MGO	39.8	41.7	38.5	41.5	39.3	37.5	38.9	37.6	41.3	36.7
CAO	2.97	2.25	2.60	2.51	2.65	3.08	2.50	3.10	2.40	2.30
NA2O	.18	.25	.30	.32	.61	.57	.23	.40	.25	.60
K2O	ND	ND	.10		.22	.13	ND	.03	ND	ND
NIO	.26		.30	.34	.39	.20	.20		.20	.20
P2O5	.04		.10	.07	.08	.06	.02			.10
TOTAL	99.5	100.2	98.1	99.9	99.6	100.0	100.0	99.9	99.9	99.8

IONIC PROPORTIONS

SI	3.248	3.219	3.219	3.180	3.150	3.277	3.240	3.318	3.209	3.281
TI	.004	.008	.017	.002	.032	.039	.013	.011	.005	.027
AL	.273	.217	.322	.203	.344	.303	.366	.365	.231	.352
CR	.026		.029	.023	.024	.025	.023		.017	.017
FE	.463	.523	.494	.529	.498	.513	.495	.494	.503	.590
MN	.009	.009	.006	.006	.008	.009	.006		.009	.012
MG	4.309	4.495	4.236	4.511	4.281	4.051	4.184	4.033	4.469	3.979
CA	.231	.174	.206	.196	.208	.239	.193	.239	.187	.179
NA	.025	.035	.043	.045	.086	.080	.032	.056	.035	.085
K			.009		.021	.012		.003		
NI	.015		.018	.020	.023	.012	.012		.012	.012
P	.002		.006	.004	.005	.004	.001			.006
TOTAL	8.608	8.683	8.606	8.721	8.680	8.562	8.567	8.518	8.680	8.542
OXYGEN	12	12	12	12	12	12	12	12	12	12
	M: 90.30	M: 89.57	M: 89.56	M: 89.51	M: 89.57	M: 88.77	M: 89.42	M: 89.10	M: 89.88	M: 87.08
	CA 4.62	CA 3.36	CA 4.17	CA 3.75	CA 4.16	CA 4.98	CA 3.97	CA 5.02	CA 3.62	CA 3.78
	MG 86.12	MG 86.57	MG 85.83	MG 86.15	MG 85.84	MG 84.35	MG 85.87	MG 84.63	MG 86.62	MG 83.80
	FE 9.25	FE 10.08	FE 10.01	FE 10.10	FE 9.99	FE 10.67	FE 10.16	FE 10.36	FE 9.76	FE 12.43

TABLE 1. ESTIMATES OF MANTLE COMPOSITION . 15-22 HYPOTHETICAL.

	CARTER 21	41% MGO 22
SIO2	42.9	44.7
TIO2	.20	.16
AL2O3	5.80	2.46
CR2O3	.20	.42
FEO	9.17	8.15
MNO	.14	.18
MGO	37.2	41.0
CAO	3.70	2.42
NA2O	.40	.29
K2O		.09
NIO	.20	.26
P2O5		.06
TOTAL	99.9	100.2

IONIC PROPORTIONS

SI	3.133	3.235
TI	.011	.009
AL	.499	.210
CR	.012	.024
FE	.560	.493
MN	.009	.011
MG	4.048	4.422
CA	.289	.186
NA	.057	.041
K		.008
NI	.012	.015
P		.004
TOTAL	8.629	8.659
OXYGEN	12	12

M: 87.85	M: 89.96
CA 5.91	CA 3.68
MG 82.66	MG 86.66
FE 11.43	FE 9.67

TABLE 2

TABLE 2a

Estimated precision and detection limits for the major oxides. Precision is expressed as a percentage of the average concentration. Detection limits expressed as weight percent of oxide (from Reid, 1977).

Na on a pressed powder briquette; all other major elements on Norrish fusion discs.

OXIDE	AVERAGE	PRECISION	DETECTION LIMIT
Fe_2O_3	5	0.3	.04
MnO	0.20	2.5	.006
TiO_2	0.5	0.4	.004
CaO	5.0	0.3	.01
K_2O	2.5	0.8	.002
SiO_2	55	0.5	.05
Al_2O_3	15	0.5	.03
MgO	4.0	1.0	.05
Na_2O	3.0	1.3	.08

TABLE 2b

Counting errors and detection limits for trace elements analysed by XRF. All data are for basaltic rocks and are expressed in ppm (from Reid, 1977).

SD(100) = 2 error (95 percent confidence) at 100 ppm
SD(10) = 2 error at 10 ppm
DL = Detection limit at 99 percent confidence

ELEMENT	SD(100)	SD(10)	DL
Ba	6.2	4.0	7
Rb	0.6	0.5	1.0
Zr	1.4	1.2	2.6
Nb	1.6	1.4	2.9
Th	1.0	0.7	2.1
Pb	1.0	0.7	2.1
Y	1.2	1.1	2.2
Zn	1.0	0.7	1.0
Sr	0.6	0.5	0.9
Cu	1.2	1.0	2.0
Co	4.4	4.2	9
Ni	1.6	1.2	2.6
Cr	2.0	1.5	3.1
V	3.0	2.8	5.6

TABLE 3

TABLE 3 Statistical Error in Microprobe Analyses

Element	Standard	Nett peak counts	wt.% unknown	6
Si	kakanui pyrope	9000	42.00	.59
			40.00	.51
			38.00	.55
Sr	kakanui hornblende	13000	52.00	.62
			54.00	.64
			56.00	.66
			58.00	.68
		10000	54.00	.73
Ti	kakanui hornblende	500	.60	.073
			.40	.059
Al	kakanui pyrope	6300	24.00	.41
			20.00	.35
			16.00	.30
			12.00	.25
			8.00	.19
			4.00	.13
			2.00	.09
Cr	stillwater chromite	5000	6.00	.23
			2.00	.13
			1.00	.09
			.60	.07
			.40	.06
Fe	kakanui pyrope	1000	20.00	.74
			16.00	.62
			12.00	.49
			8.00	.37
			4.00	.23
			2.00	.14
			1.00	.10
Mn	kakanui pyrope	35	1.00	.18
			.80	.15
			.40	.08
Mg	kakanui pyrope	3000	20.00	.48
			16.00	.41
			12.00	.33
			8.00	.25
			4.00	.16
Ca	diopside	3000	20.00	.52
			16.00	.45
			12.00	.37
			8.00	.29
	kakanui pyrope	500	8.00	.44
			6.00	.35
			4.00	.26
Na	kakanui hornblende	100	8.00	.87
			4.00	.49
			2.00	.29
			0.40	.10
			.20	.07
			.10	.05
K	kakanui pyrope	240	.20	.04
			.10	.03
			.02	.01

PREFACE TO TABLE 4

DATA PRESENTATION

Mineral analyses are listed in tables produced by the program MINCALC. Sample headings in the tables consist of the sample number of the rock and below that the name of the mineral analysed and the number given to that grain. Mineral names in the tables are abbreviated according to the following convention:

GT - garnet
CP - clinopyroxene
OP - orthopyroxene
OL - olivine
RU - rutile
MI - mica
AM - amphibole
SP - spinel
CR - chromite spinel
KY - kyanite
CO - corundum
SD - sulphide
KF - potassium feldspar
NF - soda feldspar

Grains are numbered according to the convention XYY where YY is the grain number and X represents the location of the analysis point within the grain:

1 - centre
3 - top edge
4 - right edge
5 - bottom edge
6 - left edge

Thus GT104 refers to the centre of garnet grain no. 4. GT304 and CP504 refer to the top edge of garnet grain no. 4 and the bottom edge of clinopyroxene grain no. 4; GT304 and CP504 are therefore adjacent analysis points.

The prefix 2 is used to refer to clinopyroxene grains of secondary origin, usually having higher Ti and diopside contents than the primary clinopyroxenes. CP203 refers to a secondary clinopyroxene grain in the vicinity of primary clinopyroxene grain no. 3.

In the MINCALC tables FEO refers to total iron as FEO unless otherwise indicated.

At the foot of the tables ratios of ionic proportions are given. The symbols have the following meanings:

M - 100 (Mg/Mg+Fe)
CA - 100 (Ca/Ca+Mg+Fe)
MG - 100 (Mg/Ca+Mg+Fe)
FE - 100 (Fe/Ca+Mg+Fe)
C - 100 (Ca/Ca+Mg)

TABLE 4

BD1185 - TYPE II MAGNESIAN ECLOGITE (GARNET CUMULATE)

	BD1185 GT301	BD1185 GT101	BD1185 CP101	BD1185 CP102
SIO2	41.8	41.7	55.6	55.6
TIO2	.22	.22	.10	.10
AL2O3	19.6	19.6	2.18	2.22
CR2O3	6.13	6.11	2.46	2.44
FEO	6.60	6.73	2.06	2.00
MNO	.34	.35	.09	.08
MGO	20.6	20.6	17.0	17.0
CAO	5.44	5.46	19.8	19.7
NA2O	.06	ND	2.40	2.45
K2O			ND	ND
TOTAL	100.8	100.8	101.7	101.6

IONIC PROPORTIONS

SI	2.981	2.976	1.976	1.976
TI	.012	.012	.003	.003
AL	1.648	1.649	.091	.093
CR	.346	.345	.069	.069
FE	.394	.402	.061	.059
MN	.021	.021	.003	.002
MG	2.190	2.191	.900	.903
CA	.416	.418	.754	.750
NA	.008		.165	.169
K				
TOTAL	8.014	8.018	4.024	4.025
OXYGEN	12	12	6	6

M: 84.76	M: 84.51	M: 93.63	M: 93.82
CA 13.86	CA 13.87	CA 43.95	CA 43.80
MG 73.01	MG 72.79	MG 52.48	MG 52.73
FE 13.13	FE 13.34	FE 3.57	FE 3.47
		C: 45.58	C: 45.38

CSRV 3 - TYPE II CALCIUM-IRON-RICH ECLOGITE

	CSRV 3 GT301	CSRV 3 CP501	CSRV 3 GT402	CSRV 3 CP602
SIO2	39.6	55.7	39.5	55.9
TIO2	.13	.22	.10	.20
AL2O3	23.0	11.8	23.1	12.5
CR2O3	ND	ND	ND	ND
FEO	20.0	5.49	20.4	5.24
MNO	.39	ND	.42	ND
MGO	7.84	8.48	7.83	8.20
CAO	11.0	13.2	10.8	12.9
NA2O	.09	6.53	.10	6.60
K2O		ND		ND
TOTAL	102.1	101.5	102.3	101.6

IONIC PROPORTIONS

SI	2.957	1.962	2.948	1.961
TI	.007	.006	.006	.005
AL	2.025	.490	2.033	.517
CR				
FE	1.249	.162	1.273	.154
MN	.025		.027	
MG	.873	.445	.871	.429
CA	.880	.498	.864	.485
NA	.013	.446	.014	.449
K				
TOTAL	8.029	4.010	8.037	4.000
OXYGEN	12	6	12	6

M: 41.13	M: 73.35	M: 40.62	M: 73.61
CA 29.32	CA 45.08	CA 28.71	CA 45.43
MG 29.07	MG 40.28	MG 28.95	MG 40.17
FE 41.61	FE 14.63	FE 42.33	FE 14.40
	C: 52.81		C: 53.08

HRV 13 - TYPE I MAIN GROUP ECLOGITE

	HRV 13 GT101	HRV 13 GT601	HRV 13 CP101	HRV 13 CP501	HRV 13 CP502	HRV 13 GT103
SIO2	41.5	41.6	56.1	56.3	56.2	41.7
TIO2	.23	.23	.31	.29	.31	.23
AL2O3	23.3	23.5	7.13	7.07	7.30	23.5
CR2O3	.34	.26	.36	.36	.41	.36
FEO	14.8	14.9	4.92	5.00	5.05	14.9
MNO	.33	.33	.10	.09	.09	.32
MGO	16.9	16.9	13.4	13.2	13.4	17.1
CAO	3.94	3.94	14.5	14.6	14.1	3.63
NA2O	.11	.12	4.59	4.59	4.72	.07
K2O			.13		.16	
TOTAL	101.4	101.8	101.5	101.5	101.7	101.8

IONIC PROPORTIONS

SI	2.980	2.977	1.981	1.987	1.980	2.980
TI	.012	.012	.008	.008	.008	.012
AL	1.972	1.983	.297	.294	.303	1.980
CR	.019	.015	.010	.010	.011	.020
FE	.889	.892	.145	.148	.149	.891
MN	.020	.020	.003	.003	.003	.019
MG	1.808	1.803	.705	.694	.704	1.821
CA	.303	.302	.549	.552	.532	.278
NA	.015	.017	.314	.314	.322	.010
K			.006		.007	
TOTAL	8.020	8.020	4.018	4.010	4.019	8.012
OXYGEN	12	12	6	6	6	12

M: 67.05	M: 66.90	M: 82.92	M: 82.47	M: 82.54	M: 67.16
CA 10.10	CA 10.08	CA 39.21	CA 39.61	CA 38.44	CA 9.30
MG 60.28	MG 60.15	MG 50.40	MG 49.81	MG 50.81	MG 60.92
FE 29.62	FE 29.76	FE 10.38	FE 10.59	FE 10.75	FE 29.79
		C: 43.76	C: 44.30	C: 43.07	

HRV 15 - TYPE II MAGNESIAN ECLOGITE (SPINEL BEARING)

	HRV 15A GT101	HRV 15A GT102	HRV 15B GT103	HRV 15B GT303	HRV 15B GT104	HRV 15B GT305	HRV 15B GT505	HRV 15B GT506	HRV 15A CP101	HRV 15A CP102
SIO2	41.9	41.9	42.3	42.5	42.5	42.1	42.6	42.5	53.5	54.2
TIO2	.12	ND	.10	.10	.17	.15	.13	.17	.09	.03
AL2O3	24.0	24.2	24.1	24.1	23.9	23.6	24.0	24.1	14.1	17.1
CR2O3	.16	.18	.16	.13	.57	.83	.54	.21	.16	.20
FEO	7.55	7.82	7.05	7.17	8.29	8.21	8.41	7.62	1.33	1.08
MNO	.13	.13	.16	.16	.22	.23	.22	.19	ND	ND
MGO	16.1	16.5	18.4	19.0	21.1	21.2	21.2	20.1	10.3	8.46
CAO	11.6	10.9	8.67	7.96	4.01	3.56	3.80	6.02	16.8	14.3
NA2O	ND	ND	ND	.05	ND	ND	.06	.05	4.95	6.37
K2O									.05	.04
TOTAL	101.6	101.7	100.9	101.2	100.8	99.9	101.0	101.0	101.3	101.8

IONIC PROPORTIONS

SI	2.967	2.962	2.980	2.983	2.981	2.978	2.982	2.980	1.871	1.869
TI	.006		.005	.005	.009	.008	.007	.009	.002	.001
AL	2.003	2.017	2.002	1.994	1.976	1.968	1.981	1.993	.581	.696
CR	.009	.010	.009	.007	.032	.046	.030	.012	.004	.005
FE	.447	.462	.415	.421	.486	.486	.492	.447	.039	.031
MN	.008	.008	.010	.010	.013	.014	.013	.011		
MG	1.699	1.738	1.932	1.988	2.205	2.235	2.212	2.101	.537	.435
CA	.880	.826	.655	.599	.301	.270	.285	.452	.629	.528
NA				.007			.008	.007	.336	.426
K									.002	.002
TOTAL	8.023	8.025	8.010	8.014	8.009	8.010	8.010	8.012	4.003	3.993
OXYGEN	12	12	12	12	12	12	12	12	6	6
	M: 79.17	M: 78.99	M: 82.30	M: 82.52	M: 81.94	M: 82.15	M: 81.79	M: 82.46	M: 93.24	M: 93.32
	CA 29.08	CA 27.28	CA 21.80	CA 19.91	CA 10.07	CA 9.02	CA 9.54	CA 15.08	CA 52.23	CA 53.14
	MG 56.14	MG 57.44	MG 64.36	MG 66.09	MG 73.69	MG 74.74	MG 73.99	MG 70.02	MG 44.54	MG 43.73
	FE 14.77	FE 15.28	FE 13.84	FE 14.00	FE 16.25	FE 16.24	FE 16.47	FE 14.90	FE 3.23	FE 3.13
									C: 53.97	C: 54.86

HRV 15 - TYPE II MAGNESIAN ECLOGITE (SPINEL BEARING)

	HRV 15B CP103	HRV 15B CP304	HRV 15B CP504	HRV 15A CP107	HRV 15B SP101
SIO2	55.0	56.1	56.0	54.6	ND
TIO2	.03	.17	.17	.05	.03
AL2O3	9.72	6.09	5.74	11.5	68.3
CR2O3	.16	.48	.35	.18	1.20
FEO	1.35	2.12	1.87	1.25	7.98
MNO	ND	.04	.05	ND	.04
MGO	10.0	14.8	15.0	11.4	22.6
CAO	17.5	16.9	18.0	16.6	ND
NA2O	4.44	3.65	3.39	4.76	ND
K2O	.05	.05	.05	.06	ND
TOTAL	98.2	100.4	100.6	100.4	100.2

IONIC PROPORTIONS

SI	1.982	1.988	1.984	1.923	
TI	.001	.005	.005	.001	.001
AL	.413	.254	.240	.478	1.979
CR	.005	.013	.010	.005	.023
FE	.041	.063	.055	.037	.164
MN		.001	.002		.001
MG	.535	.781	.792	.598	.828
CA	.676	.641	.683	.627	
NA	.310	.251	.233	.325	
K	.002	.002	.002	.003	
TOTAL	3.965	4.000	4.005	3.998	2.999
OXYGEN	6	6	6	6	4

M: 92.94	M: 92.56	M: 93.46	M: 94.20	M: 83.46
CA 53.96	CA 43.18	CA 44.64	CA 49.65	
MG 42.77	MG 52.59	MG 51.74	MG 47.43	
FE 3.25	FE 4.23	FE 3.62	FE 2.92	
C: 55.79	C: 45.08	C: 46.32	C: 51.15	

HRV 17 - TYPE I CALCIUM-RICH ECLOGITE (INHOMOGENEOUS KYANITE ECLOGITE)

	HRV 17A GT101	HRV 17A GT101	HRV 17A GT101	HRV 17A GT301	HRV 17A GT601	HRV 17A GT601	HRV 17A GT102	HRV 17A GT102	HRV 17A GT302	HRV 17A GT502
SIO2	40.8	41.0	40.5	40.6	39.8	41.0	41.1	41.4	40.9	40.8
TIO2	.27	.28	.27	.27	.35	.23	.25	.25	.33	.27
AL2O3	23.3	23.4	23.3	23.4	22.8	23.3	23.8	23.6	23.4	23.7
CR2O3	ND	ND	ND	ND	.05	ND	.05	.05		.05
FEO	12.9	12.9	13.6	13.5	10.9	12.9	14.2	14.0	13.8	14.0
MNO	.23	.32	.27	.30	.18	.27	.32	.32	.10	.28
MGO	12.7	12.9	12.8	13.3	8.07	13.5	14.6	14.9	14.6	14.3
CAO	10.5	10.7	10.2	9.85	18.2	9.44	7.68	7.81	7.92	8.53
NA2O	.11	.12	.15	.12	.16	.13	.16	.15	.13	.12
K2O										
TOTAL	100.8	101.6	101.1	101.4	100.5	100.8	102.2	102.5	101.2	102.0

IONIC PROPORTIONS

SI	2.976	2.969	2.956	2.952	2.957	2.982	2.953	2.963	2.962	2.941
TI	.015	.015	.015	.015	.020	.013	.014	.013	.018	.015
AL	2.004	1.998	2.005	2.006	1.997	1.998	2.016	1.991	1.998	2.014
CR					.003		.003	.003		.003
FE	.787	.781	.830	.821	.677	.785	.853	.838	.836	.844
MN	.014	.020	.017	.018	.011	.017	.019	.019	.006	.017
MG	1.351	1.392	1.392	1.441	.894	1.464	1.563	1.589	1.576	1.536
CA	.821	.830	.798	.767	1.452	.736	.591	.599	.615	.659
NA	.016	.017	.021	.017	.023	.018	.022	.021	.018	.017
K										
TOTAL	8.014	8.024	8.036	8.038	8.035	8.014	8.035	8.037	8.030	8.045
OXYGEN	12	12	12	12	12	12	12	12	12	12

M: 63.69	M: 64.05	M: 62.65	M: 63.71	M: 56.88	M: 65.09	M: 64.69	M: 65.48	M: 65.34	M: 64.54
CA 27.46	CA 27.64	CA 26.41	CA 25.33	CA 48.04	CA 24.66	CA 19.66	CA 19.79	CA 20.31	CA 21.68
MG 46.20	MG 46.35	MG 46.10	MG 47.57	MG 29.56	MG 49.04	MG 51.98	MG 52.52	MG 52.07	MG 50.55
FE 26.34	FE 26.01	FE 27.49	FE 27.10	FE 22.40	FE 26.30	FE 28.37	FE 27.69	FE 27.62	FE 27.77

HRV 17 - TYPE I CALCIUM-RICH ECLOGITE (INHOMOGENEOUS KYANITE ECLOGITE)

	HRV 17A GT602	HRV 17A GT103	HRV 17A GT103	HRV 17A GT603	HRV 17A GT603	HRV 17A GT104	HRV 17A GT604	HRV 17D GT401	HRV 17D GT602	HRV 17D GT303
SIO2	40.6	41.3	41.1	40.9	41.3	40.7	41.2	39.7	40.5	40.7
TIO2	.25	.25	.25	.22	.25	.25	.23	.22	.25	.26
AL2O3	23.8	23.6	23.6	23.5	23.4	23.6	23.7	23.0	23.5	23.5
CR2O3	.05	ND	.05	ND	.05	ND	ND	.04	.04	.04
FEO	14.1	14.5	14.7	14.0	13.9	14.7	14.0	11.3	13.1	12.6
MNO	.30	.31	.33	.31	.32	.33	.32	.21	.25	.30
MGO	14.3	15.2	15.4	15.0	15.1	15.2	14.9	6.59	12.1	12.5
CAO	8.27	6.92	6.53	7.63	7.50	6.67	7.82	18.7	10.7	10.2
NA2O	.13	.11	.16	.16	.16	.14	.12	.12	.13	.10
K2O										
TOTAL	101.8	102.2	102.1	101.7	102.0	101.6	102.3	99.9	100.6	100.2

IONIC PROPORTIONS

SI	2.933	2.961	2.952	2.950	2.968	2.941	2.955	2.976	2.968	2.981
TI	.014	.013	.014	.012	.014	.014	.012	.012	.014	.014
AL	2.027	1.995	1.999	1.998	1.982	2.011	2.003	2.033	2.030	2.029
CR	.003		.003		.003			.002	.002	.002
FE	.852	.870	.883	.845	.835	.888	.839	.709	.803	.772
MN	.018	.019	.020	.019	.019	.020	.019	.013	.016	.019
MG	1.542	1.628	1.649	1.612	1.617	1.637	1.592	.736	1.321	1.364
CA	.640	.532	.503	.590	.577	.516	.601	1.502	.840	.800
NA	.018	.015	.022	.022	.022	.020	.017	.017	.018	.014
K										
TOTAL	8.047	8.034	8.044	8.049	8.038	8.049	8.039	8.002	8.012	7.996
OXYGEN	12	12	12	12	12	12	12	12	12	12
	M: 64.41	M: 65.18	M: 65.12	M: 65.63	M: 65.94	M: 64.82	M: 65.48	M: 50.96	M: 62.21	M: 63.87
	CA 21.10	CA 17.55	CA 16.56	CA 19.36	CA 19.06	CA 16.98	CA 19.81	CA 50.97	CA 28.34	CA 27.26
	MG 50.82	MG 53.74	MG 54.33	MG 52.92	MG 53.37	MG 53.82	MG 52.50	MG 24.98	MG 44.58	MG 46.46
	FE 28.08	FE 28.71	FE 29.10	FE 27.72	FE 27.57	FE 29.21	FE 27.68	FE 24.04	FE 27.08	FE 26.28

HRV 17 - TYPE I CALCIUM-RICH ECLOGITE (INHOMOGENEOUS KYANITE ECLOGITE)

	HRV 17B GT104	HRV 17B GT104	HRV 17B GT404	HRV 17B GT405	HRV 17B GT406	HRV 17B GT407	HRV 17B GT308	HRV 17B GT408	HRV 17B GT109	HRV 17B GT409
SIO2	40.7	41.0	41.1	40.1	40.3	40.7	40.8	40.9	41.2	40.9
TIO2	.22	.22	.23	.33	.32	.23	.25	.22	.25	.25
AL2O3	23.6	23.4	23.6	23.0	23.0	23.4	23.4	23.5	23.4	23.5
CR2O3	.05	.06	.05	.05	.05	.05	ND	.06	.08	.06
FEO	14.0	14.0	14.2	11.8	12.3	13.4	13.5	13.6	14.1	13.8
MNO	.33	.35	.33	.19	.21	.27	.30	.30	.32	.31
MGO	15.3	14.9	14.6	9.45	10.7	13.4	13.8	14.5	15.1	14.8
CAO	6.88	7.46	8.02	16.0	14.0	9.90	9.30	8.03	7.45	7.79
NA2O	.11	.13	.12	.14	.18	.17	.20	.16	.17	.15
K2O										
TOTAL	101.2	101.5	102.2	101.1	101.1	101.5	101.6	101.3	102.1	101.6

IONIC PROPORTIONS

SI	2.946	2.962	2.954	2.955	2.959	2.953	2.955	2.961	2.961	2.954
TI	.012	.012	.012	.018	.018	.013	.014	.012	.014	.014
AL	2.014	1.993	2.000	1.998	1.991	2.002	1.998	2.006	1.983	2.001
CR	.003	.003	.003	.003	.003	.003		.003	.005	.003
FE	.847	.846	.854	.727	.755	.813	.818	.823	.848	.834
MN	.020	.021	.020	.012	.013	.017	.018	.018	.019	.019
MG	1.650	1.604	1.564	1.038	1.171	1.449	1.490	1.564	1.617	1.593
CA	.534	.577	.618	1.264	1.104	.770	.722	.623	.574	.603
NA	.015	.018	.017	.020	.026	.024	.028	.022	.024	.021
K										
TOTAL	8.042	8.037	8.041	8.036	8.039	8.044	8.045	8.034	8.044	8.041
OXYGEN	12	12	12	12	12	12	12	12	12	12
	M: 66.07	M: 65.48	M: 64.69	M: 58.80	M: 60.79	M: 64.05	M: 64.56	M: 65.52	M: 65.62	M: 65.65
	CA 17.60	CA 19.07	CA 20.35	CA 41.72	CA 36.43	CA 25.39	CA 23.83	CA 20.69	CA 18.88	CA 19.90
	MG 54.44	MG 52.99	MG 51.53	MG 34.27	MG 38.64	MG 47.79	MG 49.18	MG 51.96	MG 53.23	MG 52.58
	FE 27.96	FE 27.94	FE 28.12	FE 24.01	FE 24.93	FE 26.82	FE 27.00	FE 27.35	FE 27.89	FE 27.52

HRV 17 - TYPE I CALCIUM-RICH ECLOGITE (INHOMOGENEOUS KYANITE ECLOGITE)

	HRV 17C GT101	HRV 17C GT502	HRV 17B GT101	HRV 17B GT401	HRV 17B GT601	HRV 17B GT502	HRV 17B GT103	HRV 17B GT103	HRV 17B GT403	HRV 17B GT104
SIO2	40.9	40.0	39.7	39.6	39.8	39.8	40.5	41.2	40.3	40.4
TIO2	.25	.34	.35	.37	.37	.32	.23	.23	.22	.25
AL2O3	23.1	22.4	22.6	22.7	22.7	22.8	23.5	23.4	23.3	23.3
CR2O3	.06	.06	ND	ND	.05	.05	ND	ND	.05	.06
FEO	13.6	9.60	10.1	10.2	10.7	11.7	14.4	13.9	14.0	14.4
MNO	.29	.14	.13	.15	.17	.18	.32	.42	.28	.33
MGO	14.1	6.98	7.32	7.28	8.10	9.04	15.5	15.5	14.8	15.6
CAO	7.87	19.9	20.2	19.9	18.1	16.7	6.73	6.55	7.64	6.77
NA2O	.10	.10	.13	.07	.18	.23	.15	.16	.09	.06
K2O										
TOTAL	100.3	99.5	100.8	100.3	100.2	100.8	101.4	101.4	100.7	101.2

IONIC PROPORTIONS

SI	2.987	2.998	2.951	2.954	2.965	2.948	2.933	2.971	2.940	2.932
TI	.014	.019	.020	.021	.021	.018	.013	.012	.012	.014
AL	1.989	1.979	1.996	1.996	1.994	1.991	2.006	1.989	2.004	1.994
CR	.003	.004			.003	.003			.003	.003
FE	.833	.602	.627	.638	.667	.725	.872	.838	.854	.874
MN	.018	.009	.008	.009	.011	.011	.020	.026	.017	.020
MG	1.535	.780	.810	.809	.899	.998	1.673	1.666	1.609	1.687
CA	.616	1.595	1.608	1.591	1.445	1.326	.522	.506	.597	.527
NA	.014	.015	.019	.010	.026	.033	.021	.022	.013	.008
K										
TOTAL	8.010	7.999	8.040	8.031	8.029	8.053	8.061	8.032	8.050	8.060
OXYGEN	12	12	12	12	12	12	12	12	12	12
	M: 64.81	M: 56.44	M: 56.36	M: 55.91	M: 57.43	M: 57.93	M: 65.73	M: 66.52	M: 65.32	M: 65.88
	CA 20.64	CA 53.60	CA 52.80	CA 52.35	CA 47.99	CA 43.48	CA 17.03	CA 16.81	CA 19.51	CA 17.05
	MG 51.44	MG 26.19	MG 26.60	MG 26.64	MG 29.87	MG 32.74	MG 54.54	MG 55.34	MG 52.58	MG 54.64
	FE 27.92	FE 20.21	FE 20.60	FE 21.01	FE 22.14	FE 23.78	FE 28.43	FE 27.85	FE 27.91	FE 28.31

HRV 17 - TYPE I CALCIUM-RICH ECLOGITE (INHOMOGENEOUS KYANITE ECLOGITE)

	HRV 17A CP101	HRV 17A CP102	HRV 17A CP302	HRV 17A CP103	HRV 17A CP303	HRV 17C CP101	HRV 17B CP101	HRV 17B CP302	HRV 17B CP103	HRV 17B CP404
SIO2	56.3	56.2	56.3	56.4	57.6	56.2	60.2	56.3	56.4	56.4
TIO2	.32	.32	.31	.31	.32	.31	.24	.32	.31	.34
AL2O3	12.6	13.1	13.6	12.1	14.0	13.6	14.8	13.4	13.6	11.2
CR2O3	.05	.05	.07	ND	.07	.05	.07	.05	.10	.08
FEO	2.84	2.84	2.73	3.12	2.75	2.65	2.29	2.64	2.69	3.19
MNO	ND	.04	ND	ND	ND	ND	.07	.04	.05	ND
MGO	9.12	8.77	8.54	9.30	8.57	8.45	6.56	8.52	8.48	10.1
CAO	12.5	11.9	11.8	12.2	11.6	11.5	10.9	11.7	11.4	13.1
NA2O	6.69	7.01	7.13	6.88	7.14	7.48	4.43	7.30	7.32	6.28
K2O	.09	.07	.10	.10	.11	.08	.49	.10	.10	.10
TOTAL	100.5	100.3	100.6	100.4	102.2	100.3	100.0	100.4	100.4	100.8

IONIC PROPORTIONS

SI	1.971	1.970	1.966	1.979	1.974	1.967	2.063	1.970	1.970	1.977
TI	.008	.008	.008	.008	.008	.008	.006	.008	.008	.009
AL	.521	.541	.560	.501	.566	.561	.598	.553	.560	.463
CR	.001	.001	.002		.002	.001	.002	.001	.003	.002
FE	.083	.083	.080	.092	.079	.078	.066	.077	.079	.094
MN		.001					.002	.001	.001	
MG	.476	.458	.444	.486	.438	.441	.335	.444	.442	.528
CA	.469	.447	.441	.459	.427	.431	.400	.439	.427	.492
NA	.454	.476	.483	.468	.475	.508	.294	.495	.496	.427
K	.004	.003	.004	.004	.005	.004	.021	.004	.004	.004
TOTAL	3.988	3.990	3.989	3.998	3.973	3.999	3.788	3.994	3.990	3.997
OXYGEN	6	6	6	6	6	6	6	6	6	6

M: 85.12	M: 84.62	M: 84.79	M: 84.16	M: 84.74	M: 85.03	M: 83.62	M: 85.19	M: 84.89	M: 84.94
CA 45.62	CA 45.22	CA 45.72	CA 44.25	CA 45.24	CA 45.42	CA 49.97	CA 45.68	CA 45.07	CA 44.20
MG 46.29	MG 46.35	MG 46.02	MG 46.92	MG 46.41	MG 46.42	MG 41.83	MG 46.27	MG 46.63	MG 47.40
FE 8.09	FE 8.42	FE 8.26	FE 8.83	FE 8.36	FE 8.17	FE 8.19	FE 8.05	FE 8.30	FE 8.40
C: 49.63	C: 49.38	C: 49.84	C: 48.54	C: 49.36	C: 49.46	C: 54.43	C: 49.68	C: 49.15	C: 48.25

HRV 17 - TYPE I CALCIUM-RICH ECLOGITE (INHOMOGENEOUS KYANITE ECLOGITE)

	HRV 17B CP505	HRV 17A KY101	HRV 17C KY 1	HRV 17D KY101	HRV 17B KY102	HRV 17C RU 1
SIO2	56.7	37.1	37.1	37.2	36.9	
TIO2	.52	.12	.08	.08	.10	102.0
AL2O3	12.1	62.5	63.9	64.0	61.9	.48
CR2O3	.08	.07	ND	.05	.05	
FEO	2.99	.30	.13	.15	.26	.21
MNO	.05					
MGO	9.69	.14	.06	.07	.13	.07
CAO	12.4					
NA2O	6.75					
K2O	.10					
TOTAL	101.2	100.2	101.3	101.5	99.3	102.8

IONIC PROPORTIONS

SI	1.975	1.000	.989	.989	1.003	
TI	.008	.002	.002	.002	.002	.993
AL	.497	1.987	2.008	2.007	1.984	.007
CR	.002	.001		.001	.001	
FE	.087	.007	.003	.003	.006	.002
MN	.001					
MG	.503	.006	.002	.003	.005	.001
CA	.463					
NA	.456					
K	.004					
TOTAL	3.997	3.003	3.005	3.005	3.002	1.004
OXYGEN	6	5	5	5	5	2

M: 85.24

CA 43.95
MG 47.77
FE 8.27

C: 47.92

HRV 18 - TYPE II FINE GRAINED KYANITE CORUNDUM ECLOGITE

	HRV 18 GT101	HRV 18 GT102	HRV 18 GT103	HRV 18 GT403	HRV 18 GT104	HRV 18 GT105	HRV 18 GT106	HRV 18 GT107	HRV 18 CP101	HRV 18 CP102
SIO2	41.3	41.8	41.5	41.4	41.7	39.5	39.9	39.7	54.3	54.3
TIO2	.23	.23	.20	.22	.22	.12	.18	.18	.22	.19
AL2O3	23.7	23.6	23.8	23.3	23.8	22.8	23.0	22.8	6.50	6.37
CR2O3	.06	.05	.08	.06	.05	.06	.06	.05	.05	ND
FEO	11.4	11.1	11.0	10.9	11.4	10.5	11.6	10.8	3.65	3.53
MNO	.24	.32	.30	.34	.31	.17	.24	.21	.04	.05
MGO	14.8	17.2	16.4	17.0	16.6	7.22	8.88	7.23	13.7	14.0
CAO	9.40	6.40	7.11	6.29	7.00	19.5	16.2	19.0	17.7	17.9
NA2O	.11	.08	.08	.09	.09	.11	.08	.08	3.36	3.41
K2O						ND			ND	ND
TOTAL	101.2	100.8	100.5	99.6	101.1	100.0	100.1	100.0	99.5	99.8

IONIC PROPORTIONS

SI	2.969	2.988	2.981	2.993	2.980	2.958	2.967	2.969	1.960	1.956
TI	.012	.012	.011	.012	.012	.007	.010	.010	.006	.005
AL	2.009	1.989	2.015	1.986	2.002	2.013	2.016	2.010	.277	.271
CR	.003	.003	.005	.003	.003	.004	.004	.003	.001	
FE	.685	.664	.661	.659	.681	.658	.721	.675	.110	.106
MN	.015	.019	.018	.021	.019	.011	.015	.013	.001	.002
MG	1.586	1.832	1.755	1.832	1.768	.806	.984	.806	.737	.752
CA	.724	.490	.547	.487	.536	1.564	1.291	1.522	.685	.691
NA	.015	.011	.011	.013	.012	.016	.012	.012	.235	.238
K										
TOTAL	8.020	8.009	8.004	8.006	8.012	8.036	8.019	8.020	4.013	4.022
OXYGEN	12	12	12	12	12	12	12	12	6	6

M: 69.82	M: 73.41	M: 72.65	M: 73.54	M: 72.18	M: 55.06	M: 57.70	M: 54.40	M: 86.99	M: 87.60
CA 24.18	CA 16.42	CA 18.46	CA 16.36	CA 17.95	CA 51.67	CA 43.08	CA 50.69	CA 44.69	CA 44.61
MG 52.94	MG 61.36	MG 59.24	MG 61.51	MG 59.22	MG 26.61	MG 32.84	MG 26.83	MG 48.11	MG 48.53
FE 22.88	FE 22.22	FE 22.30	FE 22.13	FE 22.82	FE 21.72	FE 24.08	FE 22.49	FE 7.19	FE 6.87
								C: 48.16	C: 47.90

HRV 18 - TYPE II FINE GRAINED KYANITE CORUNDUM ECLOGITE

	HRV 18 CP103	HRV 18 CP302	HRV 18 CP304	HRV 18 KY105	HRV 18 MI101	HRV 18 MI102	HRV 18 CO103	HRV 18 SP101	HRV 18 SP103	HRV 18 SP104
SIO2	54.5	54.4	54.5	37.4	38.3	37.9	.10	.20	.05	.05
TIO2	.21	.22	.19	.03	1.11	1.08	.08	.03	.03	.05
AL2O3	6.26	6.55	7.33	63.3	17.2	17.3	101.0	67.8	65.9	65.4
CR2O3	.05	.05	.07	.05	.06	.05	.11	.14	.14	.12
FEO	3.66	3.54	3.80	.25	5.58	5.87	.58	13.2	14.5	15.5
MNO	.07	.07	.07	ND	ND	ND	ND	.12	.13	.11
MGO	14.2	13.7	14.0	.08	21.2	21.0	.15	19.9	19.7	19.5
CAO	17.7	17.6	17.0		ND	ND				
NA2O	3.22	3.33	3.46		.28	.24				
K2O	ND	ND	.05		10.0	9.74				
TOTAL	99.9	99.5	100.5	101.1	93.7	93.2	102.0	101.4	100.4	100.7

IONIC PROPORTIONS

SI	1.960	1.963	1.946	.999	5.054	5.028	.002	.005	.001	.001
TI	.006	.006	.005	.001	.110	.108	.001	.001	.001	.001
AL	.265	.279	.309	1.993	2.670	2.706	1.987	1.982	1.961	1.951
CR	.001	.001	.002	.001	.006	.005	.001	.003	.003	.002
FE	.110	.107	.113	.006	.615	.651	.008	.274	.306	.328
MN	.002	.002	.002					.003	.003	.002
MG	.761	.737	.746	.003	4.165	4.152	.004	.735	.741	.735
CA	.682	.680	.650							
NA	.225	.233	.240		.072	.062				
K			.002		1.675	1.649				
TOTAL	4.014	4.008	4.015	3.003	14.371	14.364	2.003	3.002	3.016	3.021
OXYGEN	6	6	6	5	20	20	3	4	4	4

M: 87.36 M: 87.34 M: 86.80 M: 87.13 M: 86.44 M: 72.87 M: 70.77 M: 69.15

CA 43.91 CA 44.65 CA 43.08
MG 49.00 MG 48.34 MG 49.41
FE 7.09 FE 7.01 FE 7.52

C: 47.26 C: 48.02 C: 46.58

HRV 37 - - TYPE II MAGNESIAN ECLOGITE

	HRV 37 GT101	HRV 37 CP301	HRV 37 MI101	HRV 37 MI102	HRV 37 MI103
SIO2	41.7	54.9	41.0	39.1	39.7
TIO2	.20	.15	1.03	.86	1.11
AL2O3	22.8	3.53	14.6	14.0	14.5
CR2O3	1.14	.59	.65	.71	.69
FEO	10.8	2.82	5.55	4.94	5.48
MNO	.27	.05	.04	ND	.05
MGO	18.9	15.5	24.3	23.1	23.4
CAO	4.19	18.7	ND	ND	.06
NA2O	ND	2.63	.15	.19	.23
K2O		ND	9.85	9.72	9.12
TOTAL	100.0	98.9	97.2	92.6	94.3

IONIC PROPORTIONS

SI	2.991	1.996	5.209	5.211	5.185
TI	.011	.004	.098	.086	.109
AL	1.928	.151	2.185	2.200	2.233
CR	.065	.017	.065	.075	.071
FE	.648	.086	.589	.551	.599
MN	.016	.002	.004		.006
MG	2.020	.840	4.598	4.589	4.555
CA	.322	.728			.008
NA		.185	.037	.049	.058
K			1.595	1.653	1.520
TOTAL	8.005	4.009	14.383	14.416	14.343
OXYGEN	12	6	20	20	20

M: 75.72 M: 90.74 M: 88.64 M: 89.29 M: 88.38

CA 10.77 CA 44.04
MG 67.56 MG 50.77
FE 21.67 FE 5.18

C: 46.45

HRV 67 - TYPE II CALCIUM-RICH ECLOGITE

	HRV 67 GT101	HRV 67 GT601	HRV 67 CP401	HRV 67 CP101	HRV 67 GT102	HRV 67 GT302	HRV 67 CP202	HRV 67 CP102
SIO2	40.9	40.9	56.1	56.1	40.9	41.0	53.2	56.1
TIO2	.10	.07	.05	.07	.10	.08	.17	.07
AL2O3	23.5	23.5	8.19	8.94	23.5	23.6	8.02	9.13
CR2O3	.25	.19	.20	.18	.20	.14	.23	.18
FEO	13.2	13.1	2.21	2.16	12.8	12.9	3.97	2.25
MNO	.27	.27	ND	.04	.28	.26	.09	ND
MGO	13.6	13.7	12.5	12.0	13.9	13.9	13.9	12.0
CAO	8.91	8.77	17.9	17.4	8.44	8.40	18.9	16.8
NA2O	ND	ND	4.28	4.50	ND	.05	2.78	4.65
K2O			ND	ND			ND	ND
TOTAL	100.8	100.5	101.5	101.4	100.2	100.3	101.3	101.2

IONIC PROPORTIONS

SI	2.976	2.979	1.970	1.968	2.984	2.986	1.898	1.969
TI	.005	.004	.001	.002	.005	.004	.005	.002
AL	2.016	2.018	.339	.370	2.021	2.026	.337	.378
CR	.014	.011	.006	.005	.012	.008	.006	.005
FE	.803	.798	.065	.063	.781	.786	.118	.066
MN	.017	.017		.001	.017	.016	.003	
MG	1.475	1.487	.654	.627	1.511	1.508	.739	.628
CA	.695	.685	.674	.654	.660	.655	.723	.632
NA			.291	.306		.007	.192	.316
K								
TOTAL	8.006	8.005	4.002	3.996	7.997	7.997	4.022	3.996
OXYGEN	12	12	6	6	12	12	6	6
	M: 64.74	M: 65.08	M: 90.97	M: 90.83	M: 65.93	M: 65.75	M: 86.19	M: 90.48
	CA 23.37	CA 23.05	CA 48.36	CA 48.64	CA 22.35	CA 22.22	CA 45.73	CA 47.66
	MG 49.61	MG 50.08	MG 46.98	MG 46.65	MG 51.19	MG 51.14	MG 46.78	MG 47.35
	FE 27.02	FE 26.87	FE 4.66	FE 4.71	FE 26.46	FE 26.64	FE 7.50	FE 4.98
			C: 50.73	C: 51.04			C: 49.43	C: 50.16

HRV 77 - TYPE I IRON-RICH ECLOGITE (MEGACRYST BEARING)

	HRV 77A GT301	HRV 77A GT302	HRV 77A GT103	HRV 77A GT303	HRV 77A GT403	HRV 77A GT604	HRV 77D GT501	HRV 77A CP301	HRV 77A CP102	HRV 77A CP502
SIO2	40.2	39.8	39.6	39.8	39.9	40.0	40.9	54.7	55.0	54.9
TIO2	.28	.27	.30	.27	.26	.30	.24	.34	.32	.34
AL2O3	22.9	22.7	22.6	22.7	22.7	22.7	23.0	9.73	9.73	9.79
CR2O3	.22	.21	.22	.21	.17	.21	.16	.24	.24	.22
FEO	17.3	17.2	17.1	17.5	18.0	18.1	15.3	4.15	4.37	4.40
MNO	.33	.34	.33	.38	.43	.40	.43	.05	.04	ND
MGO	12.0	12.0	12.1	12.2	13.7	13.9	14.7	10.0	10.1	10.0
CAO	7.32	7.36	7.23	6.93	4.47	4.33	4.50	13.9	13.8	13.6
NA2O	ND						.06	5.77	5.66	5.83
K2O								.14	.15	.15
TOTAL	100.6	99.9	99.5	100.0	99.6	99.9	99.3	99.0	99.4	99.2

IONIC PROPORTIONS

SI	2.977	2.969	2.966	2.967	2.971	2.969	3.012	1.972	1.975	1.976
TI	.016	.015	.017	.015	.015	.017	.013	.009	.009	.009
AL	1.999	1.997	1.995	1.995	1.993	1.986	1.997	.414	.412	.415
CR	.013	.012	.013	.012	.010	.012	.009	.007	.007	.006
FE	1.071	1.073	1.071	1.091	1.121	1.124	.942	.125	.131	.132
MN	.021	.021	.021	.024	.027	.025	.027	.002	.001	
MG	1.324	1.334	1.350	1.355	1.520	1.538	1.613	.537	.541	.534
CA	.581	.588	.580	.554	.357	.344	.355	.537	.531	.524
NA							.009	.403	.394	.407
K								.006	.007	.007
TOTAL	8.003	8.011	8.013	8.014	8.013	8.015	7.976	4.013	4.007	4.011
OXYGEN	12	12	12	12	12	12	12	6	6	6
	M: 55.28	M: 55.42	M: 55.77	M: 55.40	M: 57.56	M: 57.78	M: 63.13	M: 81.11	M: 80.46	M: 80.12
	CA 19.51	CA 19.64	CA 19.33	CA 18.45	CA 11.90	CA 11.46	CA 12.20	CA 44.77	CA 44.15	CA 44.05
	MG 44.49	MG 44.54	MG 44.99	MG 45.18	MG 50.71	MG 51.16	MG 55.43	MG 44.80	MG 44.94	MG 44.83
	FE 35.99	FE 35.82	FE 35.68	FE 36.37	FE 37.39	FE 37.38	FE 32.37	FE 10.43	FE 10.91	FE 11.12
								C: 49.98	C: 49.56	C: 49.56

HRV 77 - TYPE I IRON-RICH ECLOGITE (MEGACRYST BEARING)

	HRV 77A CP403	HRV 77A CP503	HRV 77A CP304	HRV 77A CP404	HRV 77A CP604	HRV 77D CP601
SIO2	55.2	55.4	55.1	55.2	54.8	55.8
TIO2	.34	.33	.33	.33	.30	.32
AL2O3	8.44	9.86	7.91	7.77	7.60	7.25
CR2O3	.20	.19	.20	.14	.17	.16
FEO	5.61	4.41	6.27	6.28	6.29	5.92
MNO	.07	.04	.08	.10	.10	.09
MGO	11.2	10.2	11.4	11.4	11.5	12.2
CAO	13.1	13.7	13.0	13.0	13.1	14.0
NA2O	5.45	5.89	5.40	5.25	5.37	4.89
K2O	.10	.13	.11	.11	.11	.11
TOTAL	99.7	100.1	99.8	99.6	99.3	100.7

IONIC PROPORTIONS

SI	1.984	1.974	1.986	1.993	1.987	1.992
TI	.009	.009	.009	.009	.008	.009
AL	.358	.414	.336	.331	.325	.305
CR	.006	.005	.006	.004	.005	.005
FE	.169	.131	.189	.190	.191	.177
MN	.002	.001	.002	.003	.003	.003
MG	.600	.542	.612	.613	.621	.649
CA	.505	.523	.502	.503	.509	.535
NA	.380	.407	.377	.367	.378	.338
K	.005	.006	.005	.005	.005	.005
TOTAL	4.017	4.013	4.025	4.017	4.031	4.017
OXYGEN	6	6	6	6	6	6

M: 78.06	M: 80.47	M: 76.42	M: 76.39	M: 76.51	M: 78.60
CA 39.63	CA 43.73	CA 38.52	CA 38.51	CA 38.52	CA 39.34
MG 47.12	MG 45.28	MG 46.98	MG 46.97	MG 47.04	MG 47.68
FE 13.25	FE 10.99	FE 14.50	FE 14.52	FE 14.44	FE 12.98
C: 45.68	C: 49.13	C: 45.05	C: 45.05	C: 45.02	C: 45.21

HRV 98 - TYPE II GARNET WEBSTERITE

	HRV 98 GT101	HRV 98 GT501	HRV 98 CP101	HRV 98 CP501	HRV 98 GT102	HRV 98 GT302	HRV 98 CP102	HRV 98 CP302
SIO2	42.4	42.2	55.6	55.7	42.5	42.2	55.5	55.6
TIO2	.10	.12	ND	.05	.10	.12	.07	.05
AL2O3	24.1	24.0	2.48	2.48	24.2	24.1	2.50	2.52
CR2O3	.40	.38	.18	.16	.30	.35	.16	.15
FeO	10.0	10.0	3.27	3.35	9.86	9.90	3.26	3.32
MNO	.19	.19	.05	.05	.22	.19	ND	.05
MGO	20.1	20.0	17.6	17.5	20.3	20.1	17.5	17.6
CAO	4.17	4.11	20.2	20.2	4.11	4.07	19.9	19.9
NA2O	ND	ND	1.50	1.58	ND	ND	1.61	1.54
K2O			.11	.10			.13	.10
TOTAL	101.5	101.0	101.0	101.2	101.6	101.0	100.7	100.8

IONIC PROPORTIONS

SI	2.976	2.975	1.986	1.987	2.975	2.972	1.988	1.988
TI	.005	.006		.001	.005	.006	.002	.001
AL	1.994	1.995	.104	.104	1.997	2.001	.106	.106
CR	.022	.021	.005	.005	.017	.019	.005	.004
FE	.585	.590	.098	.100	.577	.583	.098	.099
MN	.011	.011	.002	.002	.013	.011		.002
MG	2.102	2.101	.937	.930	2.118	2.110	.934	.938
CA	.314	.310	.773	.772	.308	.307	.764	.762
NA			.104	.109			.112	.107
K			.005	.005			.006	.005
TOTAL	8.013	8.011	4.013	4.014	8.013	8.012	4.014	4.011
OXYGEN	12	12	6	6	12	12	6	6

	M: 78.23	M: 78.09	M: 90.56	M: 90.30	M: 78.58	M: 78.35	M: 90.54	M: 90.43
	CA 10.45	CA 10.34	CA 42.77	CA 42.84	CA 10.26	CA 10.24	CA 42.54	CA 42.37
	MG 70.05	MG 70.01	MG 51.83	MG 51.62	MG 70.52	MG 70.32	MG 52.03	MG 52.12
	FE 19.50	FE 19.64	FE 5.40	FE 5.54	FE 19.22	FE 19.44	FE 5.44	FE 5.52
			C: 45.21	C: 45.35			C: 44.98	C: 44.84

HRV110 - TYPE I GARNET WEBSTERITE

	HRV110 CP101	HRV110 CP301	HRV110 CP401	HRV110 GT102	HRV110 CP102	HRV110 CP402	HRV110 MI101	HRV110 MI201
SIO2	55.1	55.4	55.2	41.6	54.9	55.4	40.9	38.1
TIO2	.31	.32	.29	.18	.31	.31	3.78	3.70
AL2O3	6.70	7.08	7.08	23.6	6.21	6.21	11.9	14.9
CR2O3	.21	.21	.19	.22	.23	.24	.16	.21
FEO	5.27	5.14	5.09	14.6	5.04	5.17	6.83	8.32
MNO	.12	.08	.09	.38	.09	.10	ND	.05
MGO	12.6	13.3	13.2	16.6	14.1	13.8	19.5	18.2
CAO	14.1	13.6	13.8	3.63	13.6	13.7	ND	ND
NA2O	4.43	4.58	4.62	.11	4.03	4.21	.18	.46
K2O	.12	.11	.12		.12	.12	9.43	9.30
TOTAL	99.2	99.8	99.7	100.9	98.6	99.3	92.7	93.2

IONIC PROPORTIONS

SI	1.994	1.987	1.984	2.994	1.992	1.998	5.464	5.118
TI	.008	.009	.008	.010	.008	.008	.380	.374
AL	.286	.299	.300	2.002	.266	.264	1.874	2.360
CR	.006	.006	.005	.013	.007	.007	.017	.022
FE	.159	.154	.153	.879	.153	.156	.763	.935
MN	.004	.002	.003	.023	.003	.003		.006
MG	.690	.711	.707	1.781	.762	.742	3.882	3.644
CA	.547	.523	.531	.280	.529	.531		
NA	.311	.318	.322	.015	.283	.294	.047	.120
K	.006	.005	.006		.006	.006	1.607	1.594
TOTAL	4.010	4.014	4.019	7.996	4.008	4.008	14.038	14.174
OXYGEN	6	6	6	12	6	6	20	20

M: 81.23	M: 82.18	M: 82.21	M: 66.95	M: 83.29	M: 82.63	M: 83.57	M: 79.58
CA 39.15	CA 37.66	CA 38.19	CA 9.52	CA 36.61	CA 37.15		
MG 49.43	MG 51.23	MG 50.81	MG 60.58	MG 52.80	MG 51.93		
FE 11.42	FE 11.11	FE 11.00	FE 29.90	FE 10.59	FE 10.92		
C: 44.20	C: 42.37	C: 42.91		C: 40.95	C: 41.70		

HRV116 - TYPE II FINE GRAINED KYANITE CORUNDUM ECLOGITE

	HRV116D GT101	HRV116D CP101	HRV116D KY101	HRV116D NF101	HRV116D CP102	HRV116D CP103	HRV116D GT104	HRV116D GT105	HRV116D CP105	HRV116D GT307
SIO2	40.0	56.1	37.3	61.8	56.6	56.3	40.0	41.5	53.7	41.9
TIO2	.17	.12	ND		.12	.10	.17	.20	.22	.20
AL2O3	22.8	15.2	64.7	24.9	15.2	16.3	22.9	23.6	7.70	23.3
CR2O3	.05	ND	.08		.05	.05	.05	.06	ND	.73
FEO	10.0	1.95	.21	.04	2.16	2.78	9.84	10.1	3.23	9.26
MNO	.17	ND			ND	ND	.18	.31	.04	.34
MGO	6.24	7.53	.05		7.60	8.79	8.17	16.3	13.1	19.0
CAO	21.6	13.0	ND	4.42	13.1	10.7	19.1	8.96	18.1	6.54
NA2O	.07	6.44	ND	7.79	6.13	4.76	.08	.07	3.42	ND
K2O		.05		.77	.11	.35			ND	
TOTAL	101.1	100.4	102.4	99.7	101.1	100.1	100.5	101.1	99.6	101.3

IONIC PROPORTIONS

SI	2.969	1.953	.985	2.740	1.957	1.948	2.965	2.968	1.937	2.965
TI	.009	.003			.003	.003	.009	.011	.006	.011
AL	1.995	.624	2.014	1.301	.620	.665	2.001	1.990	.327	1.944
CR	.003		.002		.001	.001	.003	.005		.041
FE	.621	.057	.005	.001	.062	.080	.610	.604	.097	.548
MN	.011						.011	.019	.001	.020
MG	.690	.391	.002		.392	.453	.902	1.737	.704	2.004
CA	1.718	.465		.210	.485	.397	1.517	.687	.699	.496
NA	.010	.435		.670	.411	.319	.011	.010	.239	
K		.002		.044	.005	.015				
TOTAL	8.027	3.950	3.008	4.966	3.937	3.883	8.030	8.029	4.013	8.034
OXYGEN	12	6	5	8	6	6	12	12	6	12

	M: 52.65	M: 87.31			M: 86.24	M: 84.93	M: 59.67	M: 74.20	M: 87.85	M: 78.52
	CA 56.72	CA 52.01			CA 51.66	CA 42.64	CA 50.07	CA 22.68	CA 46.60	CA 16.27
	MG 22.79	MG 41.90			MG 41.69	MG 48.72	MG 29.79	MG 57.37	MG 46.91	MG 65.75
	FE 20.49	FE 6.09			FE 6.65	FE 8.65	FE 20.14	FE 19.95	FE 6.49	FE 17.98
		C: 55.38			C: 55.34	C: 46.67			C: 49.83	

HRV116 - TYPE II FINE GRAINED KYANITE CORUNDUM ECLOGITE

	HRV116D GT108	HRV116D CP108	HRV116D GT106	HRV116D CP106	HRV116D GT109	HRV116D GT110	HRV116D CP110	HRV116D MI 10
SIO2	42.2	54.8	42.1	54.9	42.2	42.3	54.6	41.1
TIO2	.23	.17	.22	.14	.17	.27	.15	1.14
AL2O3	23.3	4.39	23.8	4.29	23.5	23.6	4.02	15.8
CR2O3	.91	.46	.19	.49	.78	.43	.29	
FEO	9.13	3.19	9.40	3.27	8.98	8.54	3.49	4.44
MNO	.38	.07	.34	.09	.35	.32	.09	.04
MGO	19.2	15.6	18.7	15.7	19.4	19.8	16.6	24.1
CAO	6.53	18.8	6.78	18.6	6.20	6.32	18.6	ND
NA2O	.09	2.29	ND	2.35	ND	ND	2.05	.36
K2O		.05		ND			.04	9.45
TOTAL	102.0	99.8	101.6	99.8	101.6	101.6	99.9	96.4

IONIC PROPORTIONS

SI	2.967	1.974	2.969	1.977	2.969	2.969	1.967	5.206
TI	.012	.005	.012	.004	.009	.014	.004	.109
AL	1.931	.186	1.979	.182	1.949	1.953	.171	2.359
CR	.051	.013	.011	.014	.043	.024	.008	
FE	.537	.096	.554	.098	.528	.501	.105	.470
MN	.023	.002	.020	.003	.021	.019	.003	.004
MG	2.012	.838	1.965	.843	2.034	2.071	.891	4.549
CA	.492	.726	.512	.718	.467	.475	.718	
NA	.012	.160		.164			.143	.088
K		.002					.002	1.527
TOTAL	8.036	4.002	8.028	4.003	8.028	8.031	4.012	14.314
OXYGEN	12	6	12	6	12	12	6	20

M: 78.94	M: 89.71	M: 78.00	M: 89.54	M: 79.38	M: 80.51	M: 89.45	M: 90.63
CA 16.18	CA 43.73	CA 16.90	CA 43.27	CA 15.43	CA 15.60	CA 41.88	
MG 66.16	MG 50.47	MG 64.82	MG 50.80	MG 67.14	MG 67.96	MG 51.99	
FE 17.66	FE 5.79	FE 18.28	FE 5.94	FE 17.44	FE 16.45	FE 6.13	
	C: 46.42		C: 46.00			C: 44.62	

HRV132 - TYPE II MAGNESIAN ECLOGITE

	HRV132A GT301	HRV132A GT101	HRV132A GT501	HRV132A CP301	HRV132A CP101	HRV132A CP501	HRV132A GT302	HRV132A GT302	HRV132B GT303	HRV132B CP304
SIO2	41.0	41.0	41.2	53.4	53.8	52.8	42.3	40.8	41.9	55.4
TIO2	.25	.30	.23	.27	.29	.26	.18	.23	.23	.29
AL2O3	22.1	22.1	22.1	3.59	3.18	3.26	22.9	22.3	22.8	3.60
CR2O3	1.36	1.18	1.48	.97	.98	1.02	1.15	1.18	1.04	1.08
FEO	8.21	8.12	8.18	2.46	2.62	2.62	8.26	8.48	8.40	2.82
MNO	.39	.39	.38	.09	.09	.12	.39	.41	.43	.10
MGO	20.4	20.3	20.5	15.5	15.8	15.7	20.5	20.4	20.8	15.9
CAO	4.05	4.07	4.09	17.6	18.2	18.3	4.00	4.00	3.85	18.3
NA2O	.08	.06	ND	2.73	2.54	2.65	.06	.08	.06	2.70
K2O				ND	ND	ND				ND
TOTAL	97.8	97.5	98.2	96.6	97.5	96.7	99.7	97.9	99.5	100.2

IONIC PROPORTIONS

SI	2.980	2.987	2.982	1.985	1.985	1.970	3.006	2.967	2.988	1.987
TI	.014	.016	.013	.008	.008	.007	.010	.013	.012	.008
AL	1.894	1.898	1.889	.157	.138	.143	1.919	1.915	1.917	.152
CR	.078	.068	.085	.028	.029	.030	.065	.068	.059	.031
FE	.499	.495	.495	.076	.081	.082	.491	.516	.501	.085
MN	.024	.024	.023	.003	.003	.004	.023	.025	.026	.003
MG	2.210	2.204	2.211	.858	.869	.873	2.171	2.210	2.211	.850
CA	.315	.318	.317	.701	.720	.731	.305	.312	.294	.703
NA	.011	.008		.197	.182	.192	.008	.011	.008	.188
K										
TOTAL	8.026	8.018	8.021	4.014	4.014	4.032	7.997	8.035	8.016	4.008
OXYGEN	12	12	12	6	6	6	12	12	12	6

M: 81.58	M: 81.67	M: 81.70	M: 91.82	M: 91.49	M: 91.44	M: 81.56	M: 81.09	M: 81.52	M: 90.95
CA 10.43	CA 10.53	CA 10.49	CA 42.84	CA 43.11	CA 43.38	CA 10.27	CA 10.26	CA 9.79	CA 42.94
MG 73.07	MG 73.07	MG 73.13	MG 52.48	MG 52.05	MG 51.77	MG 73.19	MG 72.77	MG 73.55	MG 51.89
FE 16.50	FE 16.40	FE 16.38	FE 4.67	FE 4.84	FE 4.85	FE 16.55	FE 16.97	FE 16.67	FE 5.16
			C: 44.95	C: 45.30	C: 45.59				C: 45.28

HRV132 - TYPE II MAGNESIAN ECLOGITE

	HRV132B CP104	HRV132B CP504	HRV132B GT305	HRV132B GT105	HRV132B GT505
SIO2	53.8	53.9	40.5	41.1	41.6
TIO2	.27	.27	.25	.27	.27
AL2O3	3.89	3.40	22.1	22.1	22.3
CR2O3	1.10	1.11	1.40	1.58	1.61
FEO	2.65	2.79	8.08	7.54	8.30
MNO	.10	.09	.40	.40	.40
MGO	15.4	15.8	20.7	20.5	20.6
CAO	18.1	18.3	3.79	4.00	4.05
NA2O	3.01	2.67	.06	.05	.06
K2O	ND	ND			
TOTAL	98.3	98.3	97.3	97.5	99.2

IONIC PROPORTIONS

SI	1.971	1.976	2.960	2.987	2.983
TI	.007	.007	.014	.015	.015
AL	.168	.147	1.904	1.894	1.885
CR	.032	.032	.081	.091	.091
FE	.081	.086	.494	.458	.498
MN	.003	.003	.025	.025	.024
MG	.841	.863	2.255	2.221	2.202
CA	.711	.719	.297	.312	.311
NA	.214	.190	.009	.007	.008
K					
TOTAL	4.029	4.023	8.038	8.009	8.018
OXYGEN	6	6	12	12	12

M: 91.19	M: 90.98	M: 82.03	M: 82.89	M: 81.56
CA 43.52	CA 43.11	CA 9.75	CA 10.42	CA 10.34
MG 51.50	MG 51.76	MG 74.04	MG 74.26	MG 73.13
FE 4.97	FE 5.13	FE 16.22	FE 15.33	FE 16.53
C: 45.80	C: 45.44			

HRV147 - TYPE II CALCIUM-RICH ECLOGITE (KYANITE BEARING)

	HRV147 GT506	HRV147 GT101	HRV147 CP101
SIO2	41.1	40.5	56.1
TIO2	.22	.22	.21
AL2O3	23.6	23.0	15.6
CR2O3	ND	ND	ND
FEO	10.1	10.9	1.66
MNO		.14	ND
MGO	12.7	12.4	7.65
CAO	12.2	11.5	11.7
NA2O	.09	.10	7.64
K2O			.20
TOTAL	100.0	98.8	100.8

IONIC PROPORTIONS

SI	2.993	2.997	1.946
TI	.012	.012	.005
AL	2.026	2.006	.638
CR			
FE	.615	.675	.048
MN		.009	
MG	1.378	1.371	.395
CA	.952	.910	.435
NA	.013	.014	.514
K			.009
TOTAL	7.989	7.995	3.991
OXYGEN	12	12	6

M: 69.14	M: 67.02	M: 89.14
CA 32.32	CA 30.80	CA 49.50
MG 46.80	MG 46.38	MG 45.02
FE 20.88	FE 22.82	FE 5.48
		C: 52.37

HRV158 - TYPE II GARNET WEBSTERITE

	HRV158A GT101	HRV158A GT301	HRV158A CP101	HRV158A CP501	HRV158A GT102	HRV158A GT302	HRV158A CP102	HRV158A CP502
SIO2	42.4	42.5	55.5	55.4	42.5	42.2	55.6	55.5
TIO2	.15	.17	.15	.15	.15	.15	.15	.17
AL2O3	24.4	24.4	2.93	2.99	24.5	24.4	3.03	3.01
CR2O3	.24	.21	.11	.16	.21	.22	.16	.15
FEO	8.66	8.56	2.48	2.53	8.69	8.60	2.68	2.53
MNO	.25	.23	.04	.04	.23	.23	.04	.04
MGO	20.9	20.9	16.9	16.8	21.1	20.9	16.8	16.9
CAO	3.81	3.87	20.4	20.3	3.94	3.98	20.4	20.4
NA2O	ND	.05	1.93	1.96	ND	ND	2.00	2.05
K2O			ND	ND			ND	ND
TOTAL	100.8	100.9	100.4	100.3	101.4	100.7	100.9	100.8

IONIC PROPORTIONS

SI	2.972	2.976	1.987	1.986	2.966	2.964	1.985	1.983
TI	.008	.009	.004	.004	.008	.008	.004	.005
AL	2.017	2.015	.124	.126	2.016	2.020	.128	.127
CR	.013	.012	.003	.005	.012	.012	.005	.004
FE	.508	.501	.074	.076	.507	.505	.080	.076
MN	.015	.014	.001	.001	.014	.014	.001	.001
MG	2.183	2.181	.902	.898	2.194	2.188	.894	.900
CA	.286	.290	.783	.780	.295	.300	.780	.781
NA		.007	.134	.136			.138	.142
K								
TOTAL	8.008	8.005	4.013	4.013	8.016	8.014	4.015	4.018
OXYGEN	12	12	6	6	12	12	6	6

	M: 81.13	M: 81.31	M: 92.39	M: 92.21	M: 81.23	M: 81.24	M: 91.78	M: 92.25
	CA 9.61	CA 9.77	CA 44.50	CA 44.48	CA 9.83	CA 10.01	CA 44.48	CA 44.46
	MG 73.34	MG 73.37	MG 51.28	MG 51.20	MG 73.24	MG 73.11	MG 50.95	MG 51.23
	FE 17.05	FE 16.86	FE 4.22	FE 4.33	FE 16.93	FE 16.88	FE 4.56	FE 4.30
			C: 46.46	C: 46.49			C: 46.61	C: 46.46

HRV161 - TYPE II MAGNESIAN ECLOGITE (SULPHIDE BEARING)

	HRV161A GT101	HRV161A GT501	HRV161A CP101	HRV161A CP301
SIO2	41.5	41.8	55.8	55.6
TIO2	.11	.07	.14	.16
AL2O3	23.7	24.0	7.35	7.29
CR2O3	.25	.17	.25	.23
FEO	11.9	12.0	3.04	3.00
MNO	.19	.20	.05	.04
MGO	18.8	19.2	13.4	13.3
CAO	3.62	3.14	15.1	15.1
NA2O	.06	.06	4.74	4.69
K2O			.09	.10
TOTAL	100.1	100.6	100.0	99.5

IONIC PROPORTIONS

SI	2.974	2.975	1.987	1.989
TI	.006	.004	.004	.004
AL	2.002	2.014	.309	.307
CR	.014	.010	.007	.007
FE	.713	.714	.091	.090
MN	.012	.012	.002	.001
MG	2.008	2.037	.711	.709
CA	.278	.239	.576	.579
NA	.008	.008	.327	.325
K			.004	.005
TOTAL	8.016	8.013	4.017	4.015
OXYGEN	12	12	6	6
	M: 73.79	M: 74.03	M: 88.71	M: 88.76
	CA 9.27	CA 8.01	CA 41.82	CA 42.01
	MG 66.95	MG 68.11	MG 51.61	MG 51.47
	FE 23.78	FE 23.89	FE 6.57	FE 6.52
			C: 44.76	C: 44.94

HRV173 - TYPE II MAGNESIAN ECLOGITE

	HRV173A GT501	HRV173A GT102	HRV173A GT302	HRV173A GT502	HRV173A GT503	HRV173B GT104	HRV173B GT304	HRV173B GT504	HRV173B GT105	HRV173B GT305
SIO2	41.9	42.0	42.1	41.6	41.8	42.1	42.3	42.0	42.2	42.3
TIO2	.22	.20	.22	.20	.23	.27	.20	.23	.27	.22
AL2O3	23.1	22.6	23.2	22.6	23.4	24.0	24.2	24.1	23.8	24.3
CR2O3	1.78	1.53	1.56	1.48	1.27	.64	.59	.60	.67	.59
FEO	8.63	8.69	8.77	8.65	8.67	9.18	9.09	9.18	9.14	9.19
MNO	.27	.30	.32	.28	.27	.31	.31	.28	.28	.28
MGO	20.2	20.2	20.2	20.1	20.1	19.8	20.2	20.1	19.8	19.9
CAO	4.36	4.25	4.29	4.26	4.19	4.52	4.29	4.28	4.59	4.28
NA2O	.06	ND	.05	ND	ND	.05	.05	.06	.08	ND
K2O										
TOTAL	100.5	99.8	100.7	99.2	100.0	100.9	101.2	100.8	100.8	101.1

IONIC PROPORTIONS

SI	2.969	2.995	2.976	2.985	2.972	2.969	2.968	2.961	2.978	2.972
TI	.012	.011	.012	.011	.012	.014	.011	.012	.014	.012
AL	1.929	1.900	1.933	1.912	1.961	1.996	2.002	2.003	1.980	2.013
CR	.100	.086	.087	.084	.071	.036	.033	.033	.037	.033
FE	.511	.518	.518	.519	.516	.541	.533	.541	.539	.540
MN	.016	.018	.019	.017	.016	.019	.018	.017	.017	.017
MG	2.133	2.146	2.128	2.149	2.130	2.081	2.112	2.112	2.082	2.084
CA	.331	.325	.325	.328	.319	.342	.323	.323	.347	.322
NA	.008		.007			.007	.007	.008	.011	
K										
TOTAL	8.009	8.004	8.006	8.009	8.002	8.004	8.007	8.012	8.005	7.997
OXYGEN	12	12	12	12	12	12	12	12	12	12

M: 80.66	M: 80.55	M: 80.41	M: 80.55	M: 80.51	M: 79.35	M: 79.84	M: 79.60	M: 79.43	M: 79.42
CA 11.12	CA 10.86	CA 10.94	CA 10.93	CA 10.77	CA 11.52	CA 10.87	CA 10.86	CA 11.69	CA 10.94
MG 71.69	MG 71.80	MG 71.62	MG 71.74	MG 71.84	MG 70.21	MG 71.16	MG 70.95	MG 70.14	MG 70.73
FE 17.19	FE 17.33	FE 17.45	FE 17.33	FE 17.39	FE 18.27	FE 17.97	FE 18.18	FE 18.17	FE 18.33

HRV173 - TYPE II MAGNESIAN ECLOGITE

	HRV173A CP301	HRV173A CP102	HRV173A CP302	HRV173A CP102	HRV173A CP502	HRV173A CP303	HRV173B CP104	HRV173B CP304	HRV173B CP105	HRV173B CP505
SIO2	55.5	55.2	55.0	54.6	55.1	55.4	55.6	54.8	55.8	55.6
TIO2	.12	.15	.14	.10	.14	.12	.14	.12	.12	.14
AL2O3	2.29	2.24	2.31	2.31	2.24	2.38	2.35	2.74	2.31	2.46
CR2O3	.84	.75	.71	.62	.87	.62	.30	.33	.26	.31
FEO	2.70	2.83	2.70	2.70	2.95	2.79	2.82	3.26	2.91	2.88
MNO	.08	.08	.08	.09	.09	.08	.07	.05	.08	.08
MGO	17.3	17.3	17.2	17.3	17.4	17.4	17.4	17.7	17.4	17.5
CAO	20.0	20.2	19.9	20.3	20.3	20.0	20.6	19.4	20.6	20.7
NA2O	1.79	1.63	1.82	1.71	1.64	1.71	1.61	1.58	1.57	1.60
K2O	ND	ND	.04	ND	.05	ND	.04	.05	ND	ND
TOTAL	100.6	100.4	99.9	99.7	100.8	100.5	100.9	100.0	101.1	101.3

IONIC PROPORTIONS

SI	1.988	1.984	1.985	1.977	1.977	1.986	1.987	1.975	1.990	1.981
TI	.003	.004	.004	.003	.004	.003	.004	.003	.003	.004
AL	.097	.095	.098	.099	.095	.101	.099	.116	.097	.103
CR	.024	.021	.020	.018	.025	.018	.008	.009	.007	.009
FE	.081	.085	.082	.082	.089	.084	.084	.098	.087	.066
MN	.002	.002	.002	.003	.003	.002	.002	.002	.002	.002
MG	.923	.927	.925	.934	.930	.930	.927	.950	.925	.929
CA	.768	.778	.770	.788	.780	.768	.789	.749	.787	.790
NA	.124	.114	.127	.120	.114	.119	.112	.110	.109	.111
K			.002		.002		.002	.002		
TOTAL	4.011	4.011	4.016	4.023	4.018	4.011	4.013	4.016	4.009	4.015
OXYGEN	6	6	6	6	6	6	6	6	6	6
	M: 91.95	M: 91.59	M: 91.90	M: 91.95	M: 91.31	M: 91.74	M: 91.66	M: 90.63	M: 91.42	M: 91.55
	CA 43.32	CA 43.47	CA 43.33	CA 43.68	CA 43.37	CA 43.12	CA 43.83	CA 41.66	CA 43.76	CA 43.77
	MG 52.12	MG 51.78	MG 52.09	MG 51.78	MG 51.71	MG 52.18	MG 51.49	MG 52.87	MG 51.41	MG 51.47
	FE 4.56	FE 4.75	FE 4.59	FE 4.53	FE 4.92	FE 4.70	FE 4.68	FE 5.46	FE 4.83	FE 4.75
	C: 45.39	C: 45.64	C: 45.41	C: 45.76	C: 45.62	C: 45.25	C: 45.98	C: 44.07	C: 45.98	C: 45.96

HRV173 - TYPE II MAGNESIAN ECLOGITE

	HRV173B CP106
SIO2	55.5
TIO2	.12
AL2O3	2.25
CR2O3	.26
FEO	2.88
MNO	.05
MGO	17.4
CAO	20.4
NA2O	1.59
K2O	ND
TOTAL	100.5

IONIC PROPORTIONS

SI	1.991
TI	.003
AL	.095
CR	.007
FE	.086
MN	.002
MG	.930
CA	.784
NA	.111
K	
TOTAL	4.010
OXYGEN	6

M: 91.50

CA 43.54
MG 51.66
FE 4.80

C: 45.74

HRV180 - TYPE II GARNET WEBSTERITE

	HRV180 GT101	HRV180 GT401	HRV180 GT601	HRV180 CP105	HRV180 CP305	HRV180 CP401	HRV180 CP101	HRV180 CP102	HRV180 GT402	HRV180 GT102
SIO2	40.6	40.4	40.9	55.7	55.6	55.0	55.4	54.7	40.7	41.5
TIO2	.20	.16	.21	.07	.07	.10	.10	.15	.18	.18
AL2O3	18.4	18.2	18.9	1.73	1.75	1.71	1.77	3.06	19.5	20.4
CR2O3	7.44	7.45	7.03	2.31	2.41	2.21	2.02	2.24	5.94	5.00
FEO	9.80	10.0	9.68	2.35	2.32	2.47	2.03	3.53	9.19	9.06
MNO	.50	.53	.46	.10	.12	.08	.08	.16	.41	.40
MGO	17.5	17.0	17.9	16.6	16.8	16.9	16.9	16.3	18.0	18.9
CAO	6.23	6.45	6.14	19.5	19.7	20.3	20.2	18.4	5.94	5.47
NA2O	ND	ND	ND	1.93	1.97	1.55	1.79	2.13	ND	.05
K2O				ND	ND	ND	ND	ND		
TOTAL	100.7	100.2	101.2	100.3	100.8	100.3	100.3	100.7	99.9	101.0

IONIC PROPORTIONS

SI	2.966	2.972	2.963	2.003	1.993	1.983	1.992	1.967	2.970	2.977
TI	.011	.009	.011	.002	.002	.003	.003	.004	.010	.010
AL	1.585	1.578	1.614	.073	.074	.073	.075	.130	1.678	1.725
CR	.430	.433	.403	.066	.068	.063	.057	.064	.343	.284
FE	.599	.615	.587	.071	.070	.074	.061	.106	.561	.544
MN	.031	.033	.028	.003	.004	.002	.002	.005	.025	.024
MG	1.905	1.864	1.933	.890	.898	.908	.908	.874	1.957	2.021
CA	.488	.508	.477	.751	.757	.784	.778	.709	.464	.420
NA				.135	.137	.108	.125	.149		.007
K										
TOTAL	8.016	8.014	8.017	3.994	4.003	4.001	4.002	4.007	8.012	8.012
OXYGEN	12	12	12	6	6	6	6	6	12	12

M: 76.09	M: 75.18	M: 76.72	M: 92.64	M: 92.81	M: 92.42	M: 93.70	M: 89.16	M: 77.73	M: 78.80
CA 16.30	CA 17.02	CA 15.91	CA 43.90	CA 43.90	CA 44.39	CA 44.55	CA 41.98	CA 15.57	CA 14.09
MG 63.69	MG 62.39	MG 64.51	MG 51.97	MG 52.07	MG 51.40	MG 51.96	MG 51.73	MG 65.63	MG 67.70
FE 20.01	FE 20.59	FE 19.58	FE 4.13	FE 4.03	FE 4.22	FE 3.49	FE 6.29	FE 18.80	FE 18.21
			C: 45.79	C: 45.74	C: 46.34	C: 46.16	C: 44.80		

HRV180 - TYPE II GARNET WEBSTERITE

	HRV180 GT602	HRV180 CP602	HRV180 CP102	HRV180 CP302	HRV180 GT403	HRV180 GT603	HRV180 CP403	HRV180 CP404	HRV180 CP104	HRV180 CP604
SIO2	41.6	55.9	56.1	56.2	41.2	41.9	56.3	56.5	56.5	56.7
TIO2	.18	.09	.09	.10	.15	.13	.09	.07	.09	.05
AL2O3	20.8	1.77	1.82	1.75	21.6	22.4	1.84	1.78	1.84	1.80
CR2O3	4.89	1.45	1.50	1.22	3.68	2.80	.94	.64	.56	.53
FEO	8.99	2.00	1.85	1.77	8.50	8.39	2.26	1.81	1.68	1.77
MNO	.36	.08	.05	.07	.35	.31	.08	.07	.07	.05
MGO	19.2	17.5	17.4	17.4	19.4	19.9	18.1	17.9	18.0	17.9
CAO	5.48	20.4	20.5	20.6	5.14	4.99	20.2	20.8	21.0	20.9
NA2O	ND	1.61	1.70	1.56	ND	ND	1.35	1.35	1.36	1.26
K2O		.04	ND	ND			ND	ND	ND	ND
TOTAL	101.5	100.8	101.0	100.7	100.0	100.8	101.2	100.9	101.1	101.0

IONIC PROPORTIONS

SI	2.965	1.996	1.998	2.005	2.960	2.971	1.999	2.008	2.004	2.012
TI	.010	.002	.002	.003	.008	.007	.002	.002	.002	.001
AL	1.747	.075	.076	.074	1.830	1.873	.077	.075	.077	.075
CR	.275	.041	.042	.034	.209	.157	.026	.018	.016	.015
FE	.536	.060	.055	.053	.511	.498	.067	.054	.050	.053
MN	.022	.002	.002	.002	.021	.019	.002	.002	.002	.002
MG	2.039	.931	.923	.925	2.077	2.103	.958	.948	.951	.946
CA	.418	.780	.782	.788	.396	.379	.768	.792	.798	.795
NA		.111	.117	.108			.093	.093	.094	.087
K		.002								
TOTAL	8.016	4.001	4.000	3.992	8.013	8.008	3.994	3.991	3.994	3.985
OXYGEN	12	6	6	6	12	12	6	6	6	6
	M: 79.19	M: 93.97	M: 94.37	M: 94.60	M: 80.26	M: 80.87	M: 93.45	M: 94.63	M: 95.02	M: 94.74
	CA 13.98	CA 44.06	CA 44.43	CA 44.61	CA 13.26	CA 12.72	CA 42.85	CA 44.15	CA 44.35	CA 44.30
	MG 68.12	MG 52.57	MG 52.45	MG 52.40	MG 69.62	MG 70.58	MG 53.41	MG 52.85	MG 52.88	MG 52.77
	FE 17.90	FE 3.37	FE 3.13	FE 2.99	FE 17.12	FE 16.70	FE 3.74	FE 3.00	FE 2.77	FE 2.93
		C: 45.60	C: 45.86	C: 45.98			C: 44.52	C: 45.52	C: 45.62	C: 45.64

HRV180 - TYPE II GARNET WEBSTERITE

	HRV180 GT404	HRV180 GT104
SIO2	42.0	42.2
TIO2	.13	.17
AL2O3	23.3	23.4
CR2O3	1.61	1.39
FEO	8.07	8.05
MNO	.28	.29
MGO	20.5	20.6
CAO	4.64	4.76
NA2O	ND	ND
K2O		
TOTAL	100.5	100.9

IONIC PROPORTIONS

SI	2.968	2.970
TI	.007	.009
AL	1.941	1.942
CR	.090	.077
FE	.477	.474
MN	.017	.017
MG	2.159	2.161
CA	.351	.359
NA		
K		
TOTAL	8.011	8.013
OXYGEN	12	12

M: 81.91	M: 82.01
CA 11.76	CA 11.99
MG 72.27	MG 72.18
FE 15.97	FE 15.83

HRV207 - TYPE I PHLOGOPITISED ECLOGITE

	HRV207 GT101	HRV207 CP101	HRV207 MI 1
SIO2	41.4	55.4	41.3
TIO2	.18	.17	1.42
AL2O3	23.3	4.21	14.4
CR2O3	.13	.13	.10
FEO	13.1	4.75	6.77
MNO	.40	.16	.04
MGO	17.0	15.8	23.3
CAO	5.16	18.5	ND
NA2O	.07	2.50	.17
K2O		.04	10.5
TOTAL	100.7	101.7	98.0

IONIC PROPORTIONS

SI	2.981	1.972	5.241
TI	.010	.005	.136
AL	1.978	.177	2.154
CR	.007	.004	.010
FE	.789	.141	.718
MN	.024	.005	.004
MG	1.824	.838	4.406
CA	.398	.706	
NA	.010	.173	.042
K		.002	1.700
TOTAL	8.021	4.021	14.413
OXYGEN	12	6	20

M: 69.81	M: 85.56	M: 85.98
CA 13.22	CA 41.87	
MG 60.58	MG 49.74	
FE 26.20	FE 8.39	
	C: 45.71	

HRV243 - TYPE II GARNET WEBSTERITE

	HRV243B GT101	HRV243B GT301	HRV243B GT103	HRV243B GT304	HRV243B GT105	HRV243B GT505	HRV243B GT107	HRV243B CP101	HRV243B CP303	HRV243B CP104
SIO2	42.2	42.5	42.6	42.1	42.1	41.8	42.0	55.7	55.5	55.5
TIO2	.28	.28	.33	.28	.28	.28	.32	.33	.33	.31
AL2O3	24.1	24.2	24.0	24.0	23.9	23.7	23.6	4.06	3.77	3.58
CR2O3	.25	.25	.40	.69	.85	1.04	1.20	.21	.33	.56
FEO	9.07	9.10	8.75	8.30	7.88	7.80	8.00	2.78	2.56	2.52
MNO	.26	.23	.26	.27	.27	.27	.25	.07	.08	.08
MGO	21.2	21.1	21.5	21.9	22.0	21.9	21.9	16.0	16.3	16.3
CAO	4.14	4.26	4.04	3.93	3.89	4.00	4.10	19.1	19.2	19.1
NA2O	.09	.08	.09	.08	.08	.08	.10	2.63	2.59	2.58
K2O								.04	ND	ND
TOTAL	101.6	102.0	102.0	101.5	101.2	100.9	101.5	100.9	100.7	100.5

IONIC PROPORTIONS

SI	2.950	2.958	2.962	2.938	2.942	2.935	2.936	1.982	1.980	1.983
TI	.015	.015	.017	.015	.015	.015	.017	.009	.009	.008
AL	1.986	1.986	1.967	1.974	1.969	1.962	1.945	.170	.159	.151
CR	.014	.014	.022	.038	.047	.058	.066	.006	.009	.016
FE	.530	.530	.509	.484	.460	.458	.468	.083	.076	.075
MN	.015	.014	.015	.016	.016	.016	.015	.002	.002	.002
MG	2.209	2.189	2.228	2.277	2.291	2.291	2.281	.849	.867	.868
CA	.310	.318	.301	.294	.291	.301	.307	.728	.734	.731
NA	.012	.011	.012	.011	.011	.011	.014	.181	.179	.179
K								.002		
TOTAL	8.041	8.033	8.033	8.047	8.041	8.046	8.048	4.012	4.017	4.015
OXYGEN	12	12	12	12	12	12	12	6	6	6

	M: 80.64	M: 80.51	M: 81.41	M: 82.46	M: 83.26	M: 83.34	M: 82.99	M: 91.12	M: 91.90	M: 92.02
	CA 10.17	CA 10.46	CA 9.91	CA 9.62	CA 9.57	CA 9.86	CA 10.05	CA 43.88	CA 43.77	CA 43.67
	MG 72.44	MG 72.09	MG 73.34	MG 74.53	MG 75.29	MG 75.12	MG 74.65	MG 51.13	MG 51.68	MG 51.83
	FE 17.39	FE 17.45	FE 16.75	FE 15.85	FE 15.13	FE 15.01	FE 15.30	FE 4.99	FE 4.55	FE 4.50
								C: 46.19	C: 45.85	C: 45.73

HRV243 - TYPE II GARNET WEBSTERITE

	HRV243B OP106	HRV243B CP201	HRV243B CP204	HRV243B CP205	HRV243B CP206	HRV243B SP 1	HRV243B SP 6	HRV243B KF 2	HRV243B KF 5
SIO2	55.3	53.9	53.5	54.7	49.7	.41	.24	63.4	67.7
TIO2	.10	.12	.24	.21	.31	.18	.15	.03	ND
AL2O3	4.70	3.39	4.02	3.17	7.98	58.1	61.1	19.0	20.7
CR2O3	.32	.24	.69	.65	.34	4.51	3.97	ND	ND
FEO	7.20	4.13	3.84	3.58	5.48	18.5	15.3	.08	.13
MNO	.33	.13	.10	.13	.38	.32	.30	ND	ND
MGO	31.8	16.8	14.7	16.9	16.8	20.0	21.3	ND	.03
CAO	1.69	20.7	19.4	19.5	18.9	.10	.04	.06	.07
NA2O	ND	1.40	1.59	1.69	.32	ND		.43	1.40
K2O	ND	ND	ND	ND	ND			15.7	14.3
TOTAL	101.5	100.8	98.1	100.5	100.2	102.1	102.4	98.7	104.4

IONIC PROPORTIONS

SI	1.896	1.943	1.971	1.966	1.808	.011	.006	2.965	2.963
TI	.003	.003	.007	.006	.008	.003	.003	.001	
AL	.190	.144	.175	.134	.342	1.769	1.820	1.048	1.068
CR	.009	.007	.020	.018	.010	.092	.079		
FE	.206	.125	.118	.108	.167	.400	.323	.003	.005
MN	.010	.004	.003	.004	.012	.007	.006		
MG	1.625	.903	.807	.905	.911	.770	.802		.002
CA	.062	.800	.766	.751	.737	.003	.001	.003	.003
NA		.098	.114	.118	.023			.039	.119
K								.937	.799
TOTAL	4.003	4.027	3.982	4.011	4.019	3.055	3.041	4.998	4.961
OXYGEN	6	6	6	6	6	4	4	8	8

M: 88.73	M: 87.88	M: 87.22	M: 89.38	M: 84.53	M: 65.83	M: 71.27
CA 3.28	CA 43.77	CA 45.28	CA 42.58	CA 40.61		
MG 85.82	MG 49.41	MG 47.72	MG 51.32	MG 50.20		
FE 10.90	FE 6.82	FE 7.00	FE 6.10	FE 9.19		
C: 3.68	C: 46.97	C: 48.69	C: 45.34	C: 44.72		

HRV244 - TYPE II MAGNESIAN ECLOGITE (MEGACRYST BEARING)

	HRV244 GT101	HRV244 GT501	HRV244 CP301	HRV244 GT102	HRV244 GT602	HRV244 CP402
SIO2	42.1	42.1	55.0	42.0	42.2	54.9
TIO2	.07	.07	.09	.05	.07	.09
AL2O3	23.9	23.8	3.85	23.8	23.9	3.57
CR2O3	.30	.30	.16	.32	.32	.20
FEO	11.1	11.6	3.14	11.0	11.2	2.91
MNO	.26	.24	.04	.28	.26	.04
MGO	18.3	18.2	15.8	18.1	18.2	16.1
CAO	5.01	5.24	21.1	5.89	5.71	21.4
NA2O	ND	ND	1.89	ND	ND	1.75
K2O			ND			ND
TOTAL	101.1	101.6	101.1	101.4	101.9	101.0

IONIC PROPORTIONS

SI	2.988	2.982	1.967	2.977	2.979	1.966
TI	.004	.004	.002	.003	.004	.002
AL	2.000	1.988	.162	1.989	1.989	.151
CR	.017	.017	.005	.018	.018	.006
FE	.659	.687	.094	.652	.661	.087
MN	.016	.014	.001	.017	.016	.001
MG	1.935	1.921	.842	1.912	1.915	.859
CA	.381	.398	.808	.447	.432	.821
NA			.131			.121
K						
TOTAL	8.003	8.013	4.013	8.017	8.016	4.015
OXYGEN	12	12	6	12	12	6

M: 74.61	M: 73.66	M: 89.97	M: 74.57	M: 74.33	M: 90.79
CA 12.80	CA 13.23	CA 46.35	CA 14.85	CA 14.36	CA 46.46
MG 65.05	MG 63.91	MG 48.27	MG 63.49	MG 63.66	MG 48.61
FE 22.14	FE 22.86	FE 5.38	FE 21.65	FE 21.98	FE 4.93
		C: 48.98			C: 48.87

HRV244 : TYPE II MAGNESIAN ECLOGITE (MEGACRYST BEARING)

	HRV244A GT101	HRV244A GT501	HRV244A CP101	HRV244A CP301	HRV244A GT102	HRV244A CP102	HRV244A CP302	HRV244A CP103	HRV244A CP303	HRV244A GT104
SIO2	41.3	41.4	53.4	54.2	40.7	54.2	54.7	53.6	54.4	41.0
TIO2	.08	.08	.10	.12	.05	.12	.05	.14	.03	.03
AL2O3	23.8	23.8	5.23	3.13	23.9	5.34	2.74	5.25	2.39	23.8
CR2O3	.32	.28	.18	.16	.27	.21	.18	.20	.15	.27
FEO	10.6	10.6	3.35	2.61	13.1	3.17	2.95	3.09	2.88	13.1
MNO	.23	.23	.05	ND	.32	ND	.04	.05	.05	.30
MGO	17.2	17.1	15.0	15.8	16.1	14.4	15.9	14.4	16.2	15.9
CAO	6.89	6.98	20.3	22.2	6.18	20.9	22.1	20.6	22.3	6.48
NA2O	ND	ND	1.78	1.50	ND	2.19	1.42	2.08	1.33	ND
K2O			ND	ND		ND	ND	ND	ND	
TOTAL	100.4	100.5	99.4	99.8	100.6	100.6	100.1	99.4	99.8	100.8

IONIC PROPORTIONS

SI	2.962	2.968	1.941	1.967	2.944	1.948	1.980	1.948	1.978	2.960
TI	.004	.004	.003	.003	.002	.003	.001	.004	.001	.002
AL	2.013	2.012	.224	.134	2.038	.226	.117	.225	.102	2.022
CR	.018	.016	.005	.005	.015	.006	.005	.006	.004	.015
FE	.636	.636	.102	.079	.792	.095	.089	.094	.088	.791
MN	.014	.014	.002		.020		.001	.002	.002	.018
MG	1.839	1.827	.812	.856	1.736	.771	.858	.780	.878	1.710
CA	.530	.536	.791	.863	.479	.805	.857	.802	.869	.501
NA			.125	.106		.153	.100	.147	.094	
K										
TOTAL	8.020	8.014	4.005	4.014	8.030	4.009	4.008	4.007	4.015	8.021
OXYGEN	12	12	6	6	12	6	6	6	6	12
	M: 74.30	M: 74.19	M: 88.86	M: 91.53	M: 68.65	M: 89.00	M: 90.57	M: 89.25	M: 90.93	M: 68.38
	CA 17.63	CA 17.88	CA 46.37	CA 48.00	CA 15.93	CA 48.15	CA 47.51	CA 47.86	CA 47.37	CA 16.69
	MG 61.21	MG 60.93	MG 47.66	MG 47.60	MG 57.72	MG 46.15	MG 47.54	MG 46.53	MG 47.86	MG 56.97
	FE 21.17	FE 21.19	FE 5.97	FE 4.40	FE 26.35	FE 5.70	FE 4.95	FE 5.60	FE 4.77	FE 26.34
			C: 49.32	C: 50.21		C: 51.06	C: 49.98	C: 50.70	C: 49.74	

MRV 247 - TYPE II DIAMOND GRAPHITE ECLOGITE - GARNETS

	A GT101	A GT501	A GT501	B(A) GT101	B(A) GT601	B(A) GT102	B(A) GT502	G GT 5	G GT 3	G GT 1
SIO2	42.1	42.0	42.1	41.3	41.4	41.6	41.6	41.3	41.4	41.4
TIO2	.37	.25	.25	.23	.22	.27	.22	.25	.35	.25
AL2O3	23.8	24.0	24.0	23.6	23.5	23.6	23.6	23.8	23.5	23.6
CR2O3	ND	.05	.05	.06	.08	.06	.06	.08	.09	.05
FEO	10.7	10.7	10.5	10.8	11.0	10.4	10.4	11.3	11.7	11.3
MNO	.22	.23	.27	.25	.27	.26	.26	.23	.24	.26
MGO	17.1	17.9	17.7	16.3	16.4	16.7	17.1	16.1	15.8	16.0
CAO	7.57	6.92	6.79	7.64	7.36	7.45	6.80	8.17	8.61	8.18
NA2O	.13	.06	.13	.09	.12	.09	.10	.08	.12	.11
K2O										
TOTAL	102.0	102.1	101.8	100.3	100.3	100.4	100.1	101.3	101.8	101.1

IONIC PROPORTIONS

SI	2.977	2.961	2.974	2.975	2.981	2.984	2.987	2.957	2.959	2.969
TI	.020	.013	.013	.012	.012	.015	.012	.013	.019	.013
AL	1.984	1.995	1.999	2.005	1.995	1.996	1.998	2.009	1.980	1.995
CR		.003	.003	.003	.005	.003	.003	.005	.005	.003
FE	.633	.631	.620	.651	.662	.624	.625	.677	.699	.678
MN	.013	.014	.016	.015	.016	.016	.016	.014	.015	.016
MG	1.802	1.881	1.863	1.750	1.760	1.785	1.830	1.718	1.683	1.710
CA	.574	.523	.514	.590	.568	.573	.523	.627	.659	.628
NA	.018	.011	.018	.013	.017	.013	.014	.011	.017	.015
K										
TOTAL	8.020	8.032	8.021	8.014	8.016	8.008	8.007	8.029	8.037	8.027
OXYGEN	12	12	12	12	12	12	12	12	12	12
	M: 74.01	M: 74.88	M: 75.02	M: 72.90	M: 72.65	M: 74.10	M: 74.55	M: 71.74	M: 70.64	M: 71.62
	CA 19.07	CA 17.23	CA 17.14	CA 19.72	CA 18.99	CA 19.20	CA 17.57	CA 20.75	CA 21.68	CA 20.84
	MG 59.90	MG 61.98	MG 62.16	MG 58.52	MG 58.86	MG 59.87	MG 61.46	MG 56.86	MG 55.33	MG 56.69
	FE 21.03	FE 20.79	FE 20.69	FE 21.76	FE 22.15	FE 20.92	FE 20.97	FE 22.40	FE 22.99	FE 22.47

HRV 247 - TYPE 11 DIAMOND GRAPHITE ECLOGITE - GARNETS

	G GT102	G GT502	B(B) GT101	B(B) GT301	B(B) GT102	B(B) GT502	F2(A) GT101	F2(A) GT301	F2(A) GT102	F2(A) GT602
SIO2	41.1	41.4	41.0	41.1	41.0	41.2	40.1	40.2	40.3	40.8
TIO2	.28	.27	.38	.23	.38	.28	.33	.25	.28	.28
AL2O3	23.7	23.8	23.2	23.4	23.4	23.6	23.1	23.2	23.2	23.2
CR2O3	.09	.06	.06	.06	.08	.06	.08	.08	.09	.11
FEO	11.3	11.3	11.2	11.1	11.2	11.3	11.5	11.6	11.8	11.8
MNO	.24	.25	.26	.25	.26	.27	.23	.23	.22	.24
MGO	15.8	16.2	14.6	15.2	14.8	15.6	13.8	14.3	14.0	14.3
CAO	8.70	8.34	9.24	8.38	9.34	8.26	9.85	9.00	9.58	9.39
NA2O	.11	.09	.13	.12	.12	.13	.13	.12	.11	.16
K2O										
TOTAL	101.3	101.7	100.1	99.8	100.6	100.7	99.1	99.0	99.6	100.3

IONIC PROPORTIONS

SI	2.949	2.954	2.981	2.985	2.967	2.969	2.958	2.962	2.959	2.971
TI	.015	.014	.021	.013	.021	.015	.018	.014	.015	.015
AL	2.004	2.002	1.989	2.003	1.996	2.005	2.009	2.015	2.008	1.992
CR	.005	.003	.003	.003	.005	.003	.005	.005	.005	.006
FE	.678	.674	.681	.674	.678	.681	.709	.715	.725	.719
MN	.015	.014	.016	.015	.016	.016	.014	.014	.014	.015
MG	1.689	1.723	1.582	1.645	1.596	1.675	1.517	1.570	1.532	1.552
CA	.669	.638	.720	.652	.724	.638	.778	.711	.754	.735
NA	.015	.012	.018	.017	.017	.018	.019	.017	.016	.023
K										
TOTAL	8.039	8.035	8.011	8.008	8.020	8.021	8.027	8.023	8.027	8.026
OXYGEN	12	12	12	12	12	12	12	12	12	12

M: 71.56	M: 71.87	M: 69.91	M: 70.93	M: 70.19	M: 71.10	M: 68.14	M: 68.72	M: 67.89	M: 68.35
CA 22.03	CA 21.01	CA 24.13	CA 21.95	CA 24.16	CA 21.30	CA 25.91	CA 23.72	CA 25.04	CA 24.40
MG 55.64	MG 56.77	MG 53.04	MG 55.37	MG 53.24	MG 55.95	MG 50.48	MG 52.42	MG 50.89	MG 51.68
FE 22.33	FE 22.22	FE 22.83	FE 22.69	FE 22.61	FE 22.74	FE 23.61	FE 23.86	FE 24.07	FE 23.93

HKV 247 - TYPE 11 DIAMOND GRAPHITE ECLOGITE - GARNETS

	F2(A) GT103	F2(A) GT403	F2(B) GT102	F2(B) GT502	F2(B) GT101	F2(B) GT101	F2(B) GT501
SIO2	40.1	40.2	40.9	41.1	40.9	40.6	40.6
TIO2	.40	.28	.32	.30	.42	.38	.32
AL2O3	23.1	23.3	23.4	23.5	23.3	23.0	23.2
CR2O3	.09	.09	.05	.08	.08	.05	.09
FEO	11.7	11.9	12.3	12.6	12.1	11.8	12.2
MNO	.21	.21	.24	.24	.23	.22	.23
MGO	13.8	14.1	13.9	14.0	13.9	13.9	14.2
CAO	10.1	9.44	9.71	9.28	9.85	9.80	9.25
NA2O	.17	.12	.09	.11	.12	.11	.12
K2O							
TOTAL	99.7	99.6	100.9	101.2	100.9	99.9	100.2

IONIC PROPORTIONS

SI	2.947	2.950	2.967	2.972	2.967	2.973	2.963
TI	.022	.015	.017	.016	.023	.021	.018
AL	2.002	2.016	2.001	2.003	1.993	1.985	1.996
CR	.005	.005	.003	.005	.005	.003	.005
FE	.719	.730	.746	.762	.734	.723	.745
MN	.013	.013	.015	.015	.014	.014	.014
MG	1.512	1.542	1.503	1.509	1.503	1.517	1.545
CA	.795	.742	.755	.719	.766	.769	.723
NA	.024	.017	.013	.015	.017	.016	.017
K							
TOTAL	8.039	8.032	8.020	8.016	8.020	8.020	8.027
OXYGEN	12	12	12	12	12	12	12
	M: 67.76	M: 67.86	M: 66.82	M: 66.44	M: 67.18	M: 67.73	M: 67.47
	CA 26.28	CA 24.62	CA 25.13	CA 24.05	CA 25.50	CA 25.56	CA 24.01
	MG 49.95	MG 51.15	MG 50.03	MG 50.46	MG 50.05	MG 50.42	MG 51.27
	FE 23.77	FE 24.23	FE 24.84	FE 25.49	FE 24.45	FE 24.02	FE 24.72

ORV 247 - TYPE II DIAMOND GRAPHITE ECLOGITE - GARNETS FROM CHIPS

	C1 12. GT501	E3 5. GT301	E3 5. GT101	E3 5. GT101	F1 6. GT301	F1 6. GT101	F3 8. GT101	CA DIOP	F3 8. GT601	F3 8. GT601
SiO2	41.4	41.4	41.5	41.3	41.2	41.4	40.3	40.3	40.6	40.9
TiO2	.25	.27	.36	.30	.30	.38	.39	.39	.30	.30
Al2O3	23.5	23.4	23.3	23.3	23.2	23.1	22.8	22.8	23.1	23.3
Cr2O3	.08	.05	.10	.05	.07	.06	.06	.06	.07	.10
FeO	9.79	10.6	11.1	10.6	10.6	10.6	11.1	11.1	11.1	11.4
MnO	.25	.24	.33	.22	.23	.23	.23	.23	.22	.22
MgO	17.5	16.3	17.8	15.9	16.2	16.0	14.2	14.2	14.8	14.7
CaO	6.60	7.55	5.34	8.04	7.82	8.11	9.50	9.43	8.77	8.73
Na2O	.06	.08	.06	.09	.10	.09	ND	ND	ND	.10
K2O	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOTAL	99.4	99.9	99.9	99.8	99.7	100.0	98.6	98.5	99.0	99.8

IONIC PROPORTIONS

SI	2.985	2.990	2.987	2.990	2.985	2.993	2.978	2.979	2.979	2.981
TI	.014	.015	.019	.016	.016	.021	.022	.022	.017	.016
AL	1.997	1.992	1.977	1.988	1.981	1.969	1.986	1.987	1.998	2.002
CR	.005	.003	.006	.003	.004	.003	.004	.004	.004	.006
FE	.590	.640	.668	.642	.642	.641	.686	.686	.681	.695
MN	.015	.015	.020	.013	.014	.014	.014	.014	.014	.014
MG	1.880	1.754	1.909	1.715	1.749	1.724	1.564	1.564	1.619	1.597
CA	.510	.584	.412	.624	.607	.628	.752	.747	.690	.682
NA	.008	.011	.008	.015	.014	.013				.014
K										
TOTAL	8.005	8.004	8.007	8.005	8.014	8.007	8.007	8.005	8.004	8.007
OXYGEN	12	12	12	12	12	12	12	12	12	12

N: 76.11	M: 73.26	M: 74.08	M: 72.77	M: 73.14	M: 72.90	M: 69.51	M: 69.51	M: 70.38	M: 69.68
CA 17.11	CA 19.61	CA 13.78	CA 20.92	CA 20.25	CA 20.99	CA 25.06	CA 24.92	CA 23.07	CA 22.93
MG 63.09	MG 58.89	MG 63.87	MG 57.55	MG 58.33	MG 57.60	MG 52.09	MG 52.19	MG 54.14	MG 53.70
FE 19.81	FE 21.49	FE 22.35	FE 21.53	FE 21.42	FE 21.41	FE 22.85	FE 22.89	FE 22.79	FE 23.37

HRV 247 - TYPE 11 DIAMOND GRAPHITE ECLOGITE - GARNETS FROM CHIPS

	D2 2. GT501	D2 2. GT501	D2 2. GT101	C2 3. GT601	C2 3. GT101	D4 13. GT401	D4 13. GT101	B 11. GT101	B 11. GT301	C1 12. GT101
SIO2	40.9	41.3	41.5	41.3	41.3	41.5	41.5	40.9	40.9	41.2
TIO2	.36	.37	.36	.28	.45	.25	.31	.40	.26	.28
AL2O3	23.1	23.0	23.3	23.2	23.1	23.5	23.5	22.9	23.3	23.4
CR2O3	.07	.08	.07	.06	.06	.10	.11	.08	.08	.08
FEO	10.1	10.2	10.2	10.2	10.3	9.90	9.94	11.1	10.9	10.0
MNO	.23	.23	.22	.22	.22	.24	.21	.22	.24	.23
MGO	16.7	16.9	16.9	16.6	16.1	17.8	17.7	14.9	15.4	17.1
CAO	7.24	7.24	7.21	7.29	8.33	6.16	6.70	8.80	8.16	7.12
NA2O	.07	.07	.09	.09	.10	.07	.07	.11	.08	.09
K2O	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOTAL	98.8	99.4	99.9	99.2	100.0	99.5	100.0	99.4	99.3	99.5

IONIC PROPORTIONS

SI	2.981	2.992	2.990	2.995	2.985	2.987	2.977	2.989	2.982	2.977
TI	.020	.020	.020	.015	.024	.014	.017	.022	.014	.015
AL	1.985	1.964	1.979	1.983	1.968	1.994	1.987	1.973	2.003	1.993
CR	.004	.005	.004	.003	.003	.006	.006	.005	.005	.005
FE	.616	.618	.615	.619	.623	.596	.596	.678	.665	.604
MN	.014	.014	.013	.014	.013	.015	.013	.014	.015	.014
MG	1.814	1.824	1.815	1.794	1.734	1.909	1.892	1.623	1.673	1.842
CA	.565	.562	.557	.566	.645	.475	.515	.689	.637	.551
NA	.010	.010	.013	.013	.014	.010	.010	.016	.011	.013
K										
TOTAL	8.010	8.009	8.006	8.003	8.012	8.005	8.015	8.009	8.006	8.015
OXYGEN	12	12	12	12	12	12	12	12	12	12
	M: 74.66	M: 74.70	M: 74.70	M: 74.36	M: 73.58	M: 76.21	M: 76.04	M: 70.52	M: 71.57	M: 75.29
	CA 18.88	CA 18.70	CA 18.64	CA 19.01	CA 21.49	CA 15.94	CA 17.15	CA 23.04	CA 21.42	CA 18.39
	MG 60.57	MG 60.73	MG 60.77	MG 60.22	MG 57.77	MG 64.06	MG 63.00	MG 54.27	MG 56.24	MG 61.44
	FE 20.56	FE 20.57	FE 20.58	FE 20.77	FE 20.74	FE 20.00	FE 19.85	FE 22.69	FE 22.34	FE 20.16

HRV 247 - TYPE 11 DIAMOND GRAPHITE ECLOGITE - GARNETS FROM CHIPS

	FS 9. GT101	FS 9. GT601
SIO2	40.7	40.9
TIO2	.40	.29
AL2O3	23.1	23.3
CR2O3	.10	.12
FEO	11.7	11.8
MNO	.23	.26
MGO	14.0	15.5
CAO	9.74	7.60
NA2O	.10	.08
K2O	ND	ND
TOTAL	100.1	99.9

IONIC PROPORTIONS

SI	2.972	2.975
TI	.022	.016
AL	1.988	1.998
CR	.006	.007
FE	.714	.718
MN	.014	.016
MG	1.523	1.680
CA	.762	.592
NA	.014	.011
K		
TOTAL	8.017	8.013
OXYGEN	12	12
	M: 68.07	M: 70.07
	CA 25.40	CA 19.81
	MG 50.78	MG 56.19
	FE 23.82	FE 24.00

MRV 247 - TYPE II DIAMOND GRAPHITE ECLOGITE - CLINOPYROXENES

	A CP101	A CP501	B(A) CP101	B(A) CP501	B(A) CP102	B(A) CP402	G CP105	G CP 5	G CP 2	B(B) CP102
SIO2	56.0	55.9	54.6	54.8	55.0	55.4	55.5	55.5	55.7	55.5
TIO2	.24	.24	.27	.24	.24	.26	.29	.29	.27	.31
AL2O3	5.16	5.26	5.81	5.72	5.13	5.15	6.73	6.52	6.58	6.49
CR2O3	.05	ND	.06	ND	.07	.08	.07	.07	.05	.07
FEO	2.46	2.65	2.55	2.53	2.51	2.49	2.62	2.68	2.62	2.49
MNO	.04	.04	.04	.04	ND	.04	ND	.04	.04	.04
MGO	14.9	14.9	14.2	14.3	14.8	14.8	13.4	13.4	13.6	13.4
CAO	19.8	19.7	18.5	19.0	19.2	19.3	18.2	18.5	18.4	17.9
NA2O	3.04	2.97	3.37	3.23	3.01	2.91	3.81	3.61	3.61	3.70
K2O	.06	.05	.07	.07	.05	.06	.05	.04	.05	.06
TOTAL	101.8	101.7	99.5	99.9	100.0	100.5	100.7	100.6	100.9	100.0

IONIC PROPORTIONS

SI	1.976	1.974	1.968	1.968	1.974	1.977	1.973	1.975	1.975	1.983
TI	.006	.006	.007	.006	.006	.007	.008	.008	.007	.008
AL	.215	.219	.247	.242	.217	.217	.282	.273	.275	.273
CR	.001		.002		.002	.002	.002	.002	.001	.002
FE	.073	.078	.077	.076	.075	.074	.078	.080	.076	.074
MN	.001	.001	.001	.001		.001		.001	.001	.001
MG	.783	.784	.763	.765	.791	.787	.710	.711	.719	.714
CA	.749	.745	.715	.731	.738	.738	.693	.705	.699	.685
NA	.208	.203	.236	.225	.209	.201	.263	.249	.248	.256
K	.003	.002	.003	.003	.002	.003	.002	.002	.002	.003
TOTAL	4.015	4.013	4.019	4.018	4.016	4.008	4.010	4.005	4.005	4.000
OXYGEN	6	6	6	6	6	6	6	6	6	6
	M: 91.46	M: 90.93	M: 90.85	M: 90.97	M: 91.31	M: 91.37	M: 90.11	M: 89.91	M: 90.24	M: 90.56
	CA 46.63	CA 46.36	CA 45.97	CA 46.50	CA 45.99	CA 46.14	CA 46.81	CA 47.16	CA 46.75	CA 46.52
	MG 48.81	MG 48.77	MG 49.08	MG 48.67	MG 49.31	MG 49.21	MG 47.93	MG 47.51	MG 48.06	MG 48.43
	FE 4.56	FE 4.87	FE 4.95	FE 4.83	FE 4.69	FE 4.65	FE 5.26	FE 5.33	FE 5.20	FE 5.05
	C: 48.66	C: 48.73	C: 48.37	C: 48.86	C: 48.26	C: 48.39	C: 49.41	C: 49.81	C: 49.31	C: 48.99

BRV 247 - TYPE II DIAMOND GRAPHITE ECLOGITE - CLINOPYROXENES

	F1(A) CP101	F2(A) CP501	F2(A) CP102	F2(A) CP402	F2(A) CP103	F2(A) CP603	F2(B) CP101	F2(B) CP501	F2(B) CP102	F2(B) CP302
SIO2	55.7	55.7	55.5	55.8	55.8	55.7	55.2	55.5	55.8	55.7
TIO2	.33	.29	.29	.27	.29	.27	.31	.29	.36	.31
AL2O3	7.29	6.99	7.23	7.26	7.33	7.33	7.80	7.76	8.01	7.65
CR2O3	.08	.08	.08	.07	.07	.10	.07	.07	.07	.10
FEO	2.61	2.69	2.69	2.69	2.65	2.69	2.61	2.62	2.71	2.71
MNO	.04	ND	.05	ND	.04	ND	.05	ND	ND	ND
MGO	12.9	13.0	13.0	13.0	12.8	12.9	12.6	12.6	12.4	12.7
CAO	17.7	18.0	18.0	17.8	17.8	17.8	17.5	17.3	17.0	17.3
NA2O	3.73	3.69	3.71	3.73	3.86	3.85	4.65	4.57	4.79	4.66
K2O	.07	.08	.08	.06	.07	.07	.06	.06	.05	.06
TOTAL	100.4	100.5	100.6	100.7	100.7	100.7	100.8	100.8	101.2	101.2

IONIC PROPORTIONS

SI	1.978	1.979	1.971	1.978	1.978	1.975	1.959	1.968	1.969	1.968
TI	.009	.008	.008	.007	.008	.007	.008	.008	.010	.008
AL	.305	.293	.303	.303	.306	.306	.326	.324	.333	.319
CR	.002	.002	.002	.002	.002	.003	.002	.002	.002	.003
FE	.078	.080	.080	.080	.079	.080	.077	.078	.080	.080
MN	.001		.002		.001		.002			
MG	.683	.688	.688	.687	.676	.682	.667	.666	.652	.669
CA	.674	.685	.685	.676	.676	.676	.666	.657	.643	.655
NA	.257	.254	.256	.256	.265	.265	.320	.314	.328	.319
K	.003	.004	.004	.003	.003	.003	.003	.003	.002	.003
TOTAL	3.989	3.994	3.998	3.992	3.994	3.997	4.030	4.020	4.019	4.024
OXYGEN	6	6	6	6	6	6	6	6	6	6
	M: 89.60	M: 89.60	M: 89.60	M: 89.60	M: 89.59	M: 89.52	M: 89.59	M: 89.55	M: 89.08	M: 89.31
	CA 46.98	CA 47.14	CA 47.14	CA 46.87	CA 47.25	CA 47.04	CA 47.22	CA 46.92	CA 46.75	CA 46.66
	MG 47.62	MG 47.36	MG 47.36	MG 47.61	MG 47.26	MG 47.41	MG 47.29	MG 47.53	MG 47.43	MG 47.64
	FE 5.41	FE 5.50	FE 5.50	FE 5.53	FE 5.49	FE 5.55	FE 5.50	FE 5.55	FE 5.82	FE 5.70
	C: 49.66	C: 49.89	C: 49.89	C: 49.61	C: 50.00	C: 49.80	C: 49.96	C: 49.68	C: 49.64	C: 49.48

MRV 247 - TYPE 11 DIAMOND GRAPHITE ECLOGITE - CPX FROM CHIPS

	B 11. CP501	B 11. CP101	C2 12. CP301	F3 8. CP401	F5 9. CP401	E3 5. CP201	C2 3. CP201
SIO2	55.5	55.5	55.3	55.8	55.6	47.1	54.6
TIO2	.29	.28	.27	.29	.29	.62	ND
AL2O3	6.18	6.20	4.80	6.78	7.04	9.87	3.44
CR2O3	.05	.05	.07	.07	.18	ND	ND
FEO	2.43	2.47	2.51	2.53	2.57	7.14	3.61
MNO	ND	ND	ND	ND	ND	.25	.08
MGO	13.8	13.7	14.8	13.2	12.9	13.4	16.1
CAO	18.0	18.4	19.6	18.1	17.9	19.8	21.8
NA2O	3.58	3.66	2.90	3.93	4.00	.52	1.29
K2O	.05	.05	.04	.08	.06	ND	ND
TOTAL	100.5	100.3	100.3	100.8	100.5	98.7	100.9

IONIC PROPORTIONS

SI	1.977	1.979	1.980	1.979	1.977	1.761	1.962
TI	.008	.008	.007	.008	.008	.017	
AL	.259	.261	.203	.284	.295	.435	.146
CR	.001	.001	.002	.002	.005		
FE	.072	.074	.075	.075	.076	.223	.108
MN						.008	.002
MG	.732	.728	.790	.698	.683	.747	.862
CA	.710	.703	.752	.688	.682	.793	.839
NA	.247	.253	.201	.270	.276	.038	.090
K	.002	.002	.002	.004	.003		
TOTAL	4.010	4.010	4.012	4.007	4.005	4.023	4.010
OXYGEN	6	6	6	6	6	6	6

M: 91.01	M: 90.81	M: 91.31	M: 90.29	M: 89.94	M: 76.98	M: 88.82
CA 46.86	CA 46.72	CA 46.51	CA 47.09	CA 47.29	CA 44.99	CA 46.37
MG 48.36	MG 48.38	MG 48.84	MG 47.77	MG 47.41	MG 42.35	MG 47.63
FE 4.78	FE 4.90	FE 4.65	FE 5.14	FE 5.30	FE 12.66	FE 5.99
C: 49.21	C: 49.13	C: 48.77	C: 49.64	C: 49.94	C: 51.51	C: 49.33

HRV 247 - TYPE II DIAMOND GRAPHITE ECLOGITE - OTHER MINERALS

	G CP202	G CP204	G CP205	G AM 5	G MI 5	G MI 4
SIO2	48.3	51.5	52.0	41.3	40.7	39.8
TIO2	.70	1.95	.55	1.06	3.36	4.85
AL2O3	11.7	4.98	5.90	17.5	17.2	17.2
CR2O3	.07	.05	.08	ND	.10	.08
FEO	4.68	3.77	4.20	8.18	6.84	6.55
MNO	.07	.09	.09	.14	.05	ND
MGO	12.6	15.0	14.8	15.1	20.5	19.5
CAO	21.1	21.7	21.0	10.8	.03	ND
NA2O	1.38	1.33	1.32	3.03	.17	.23
K2O	ND	ND	ND	1.16	9.58	9.81
TOTAL	100.6	100.2	99.9	98.3	98.5	98.0

IONIC PROPORTIONS

SI	1.755	1.871	1.893	5.683	5.100	5.024
TI	.019	.053	.015	.110	.317	.460
AL	.501	.214	.253	2.839	2.541	2.560
CR	.002	.001	.002		.010	.008
FE	.142	.115	.128	.941	.717	.691
MN	.002	.003	.003	.016	.005	
MG	.682	.815	.803	3.097	3.828	3.668
CA	.821	.846	.819	1.593	.004	
NA	.097	.094	.093	.809	.041	.056
K				.204	1.531	1.580
TOTAL	4.025	4.015	4.011	15.293	14.094	14.050
OXYGEN	6	6	6	22	20	20

	M: 82.75	M: 87.64	M: 86.26	M: 76.69	M: 84.23	M: 84.14
	CA 49.91	CA 47.69	CA 46.81			
	MG 41.45	MG 45.85	MG 45.88			
	FE 8.64	FE 6.47	FE 7.31			
	C: 54.63	C: 50.98	C: 50.50			

HRV267 - TYPE II GARNET WEBSTERITE

	HRV267 GT101	HRV267 CP101	HRV267 OP101	HRV267 OP102	HRV267 OP103	HRV267 OP102	HRV267 OP102	HRV267 OP101	HRV267 OP102
SIO2	42.2	54.8	45.8	46.1	45.5	46.9	47.3	45.7	46.2
TIO2	.05	.04	ND	.03	.03	ND	.03	ND	ND
AL2O3	22.6	2.38	5.98	5.80	6.09	5.61	5.66	5.46	5.62
CR2O3	2.11	1.04	.29	.34	.30	.34	.32	.32	.40
FEO	6.47	1.30	7.16	7.54	8.71	6.97	7.12	6.95	7.29
MNO	.19	.04				.07	.08	.08	.05
MGO	20.7	16.9	22.6	21.7	21.0	22.8	23.2	21.9	22.1
CAO	5.10	21.5	1.40	2.59	1.80	3.27	2.66	1.25	2.65
NA2O	ND	1.66	3.36	2.41	3.52	1.19	1.07	5.75	3.11
K2O		.03				.15	.10	.14	.05
TOTAL	99.4	99.7	86.6	86.5	86.9	87.3	87.6	87.6	87.5

IONIC PROPORTIONS

SI	2.999	1.980	1.870	1.886	1.869	1.891	1.898	1.866	1.876
TI	.003	.001		.001	.001		.001		
AL	1.893	.101	.288	.280	.295	.267	.268	.263	.269
CR	.119	.030	.009	.011	.010	.011	.010	.010	.013
FE	.385	.039	.244	.258	.299	.235	.239	.237	.248
MN	.011	.001				.002	.003	.003	.002
MG	2.192	.910	1.375	1.323	1.285	1.370	1.387	1.332	1.337
CA	.388	.832	.061	.114	.079	.141	.114	.055	.115
NA		.116	.266	.191	.280	.093	.083	.455	.245
K		.001				.008	.005	.007	.003
TOTAL	7.994	4.012	4.114	4.063	4.118	4.020	4.007	4.228	4.107
OXYGEN	12	6	6	6	6	6	6	6	6

M: 85.08	M: 95.86	M: 84.91	M: 83.68	M: 81.12	M: 85.36	M: 85.31	M: 84.88	M: 84.38
CA 13.10	CA 46.72	CA 3.64	CA 6.70	CA 4.76	CA 8.09	CA 6.57	CA 3.37	CA 6.78
MG 73.94	MG 51.08	MG 81.81	MG 78.08	MG 77.26	MG 78.45	MG 79.70	MG 82.03	MG 78.66
FE 12.97	FE 2.20	FE 14.54	FE 15.22	FE 17.98	FE 13.46	FE 13.73	FE 14.61	FE 14.56
	C: 47.77	C: 4.26	C: 7.90	C: 5.80	C: 9.35	C: 7.62	C: 3.94	C: 7.94

HRV272 - TYPE II CALCIUM-RICH ECLOGITE (KYANITE CORUNDUM BEARING)

	HRV272A GT602	HRV272A CP102	HRV272A KY102	HRV272A CO102	HRV272B GT101	HRV272B CP101	HRV272B KY101
SIO2	40.3	56.0	37.2		40.1	56.4	37.2
TIO2	.32	.30	.12		.30	.34	.13
AL2O3	22.9	18.3	62.8	98.9	22.9	16.3	61.9
CR2O3	.52	.74	1.03	2.19	.60	.82	1.17
FEO	13.1	1.87	.23		13.7	2.34	.23
MNO	.20				.23		
MGO	10.2	5.46	.08		10.3	6.41	.07
CAO	13.2	8.94			12.7	9.91	
NA2O	.14	9.05			.18	8.35	
K2O		.06				.08	
TOTAL	100.9	100.7	101.5	101.1	101.0	100.9	100.7

IONIC PROPORTIONS

SI	2.971	1.933	.994		2.959	1.952	1.001
TI	.018	.008	.002		.017	.009	.003
AL	1.990	.745	1.978	1.971	1.992	.665	1.964
CR	.030	.020	.022	.029	.035	.022	.025
FE	.808	.054	.005		.845	.068	.005
MN	.012				.014		
MG	1.120	.281	.003		1.133	.331	.003
CA	1.043	.331			1.004	.367	
NA	.020	.606			.026	.560	
K		.003				.004	
TOTAL	8.012	3.980	3.004	2.000	8.024	3.978	3.001
OXYGEN	12	6	5	3	12	6	5

M: 58.12 M: 83.88

CA 35.10 CA 49.68
MG 37.72 MG 42.20
FE 27.19 FE 8.11

C: 54.07

M: 57.26 M: 83.00

CA 33.67 CA 47.99
MG 37.98 MG 43.17
FE 28.35 FE 8.84

C: 52.64

HRV274 - TYPE II MAGNESIAN ECLOGITE (MICA BEARING)

	HRV274 GT501	HRV274 CP301	HRV274 MI101	HRV274 MI102
SIO2	41.6	55.2	41.5	40.5
TIO2	.18	.31	.86	1.14
AL203	23.8	4.73	13.1	14.5
CR203	.35	.33	.39	.25
FEO	10.9	3.37	4.27	5.27
MNO		.10	.04	.04
MGO	19.6	14.7	24.5	23.4
CAO	3.72	17.8	ND	ND
NA2O	.09	3.44	.36	.10
K2O		ND	10.0	9.77
TOTAL	100.2	99.9	95.0	95.0

IONIC PROPORTIONS

SI	2.965	1.986	5.363	5.247
TI	.010	.008	.084	.111
AL	2.000	.201	1.996	2.215
CR	.020	.009	.040	.026
FE	.650	.101	.462	.571
MN		.003	.004	.004
MG	2.082	.786	4.719	4.526
CA	.264	.686		
NA	.012	.240	.090	.025
K			1.642	1.615
TOTAL	8.022	4.021	14.401	14.342
OXYGEN	12	6	20	20

M: 76.21	M: 88.57	M: 91.09	M: 88.80
CA 9.42	CA 43.61		
MG 69.04	MG 49.95		
FE 21.54	FE 6.44		
	C: 46.61		

HRV309 - TYPE II GARNET WEBSTERITE (GRAPHITE BEARING)

	HRV309A GT101	HRV309A GT501	HRV309B GT101	HRV309B GT401	HRV309C GT101	HRV309C GT501	HRV309D GT101	HRV309D GT301	HRV309A CP301	HRV309B CP101
SIO2	41.2	41.4	41.6	41.6	41.5	41.5	41.4	41.3	55.7	55.3
TIO2	.28	.31	.27	.27	.21	.22	.24	.27	.55	.55
AL2O3	23.8	23.9	23.6	23.7	23.6	23.6	23.9	24.0	6.33	6.47
CR2O3	.04	ND	.05	.05	.04	.04	.06	.08	.05	.08
FEO	13.2	13.3	13.0	13.0	12.6	12.4	12.3	11.9	4.26	4.02
MNO	.34	.32	.34	.34	.34	.32	.33	.31	.07	.07
MGO	18.3	18.3	18.3	18.4	18.5	18.3	18.9	18.7	13.6	13.5
CAO	3.01	3.07	3.33	3.23	3.14	3.25	2.99	3.01	15.2	15.4
NA2O	.07	.07	.08	.08	.09	.09	.07	.05	4.59	4.61
K2O										
TOTAL	100.2	100.7	100.6	100.7	100.0	99.7	100.2	99.6	100.3	100.0

IONIC PROPORTIONS

SI	2.963	2.965	2.981	2.977	2.983	2.989	2.966	2.969	1.988	1.981
TI	.015	.017	.015	.015	.011	.012	.013	.015	.015	.015
AL	2.018	2.018	1.994	1.999	2.000	2.004	2.019	2.034	.266	.273
CR	.002		.003	.003	.002	.002	.003	.005	.001	.002
FE	.794	.797	.779	.778	.757	.747	.737	.716	.127	.120
MN	.021	.019	.021	.021	.021	.020	.020	.019	.002	.002
MG	1.961	1.953	1.954	1.962	1.982	1.964	2.018	2.004	.723	.721
CA	.232	.236	.256	.248	.242	.251	.230	.232	.581	.591
NA	.010	.010	.011	.011	.013	.013	.010	.007	.318	.320
K										
TOTAL	8.016	8.014	8.012	8.013	8.011	8.002	8.015	8.000	4.022	4.026
OXYGEN	12	12	12	12	12	12	12	12	6	6

	M: 71.19	M: 71.03	M: 71.50	M: 71.61	M: 72.35	M: 72.45	M: 73.25	M: 73.69	M: 85.05	M: 85.68
	CA 7.76	CA 7.89	CA 8.55	CA 8.29	CA 8.11	CA 8.47	CA 7.69	CA 7.86	CA 40.60	CA 41.27
	MG 65.66	MG 65.43	MG 65.38	MG 65.67	MG 66.48	MG 66.32	MG 67.62	MG 67.90	MG 50.52	MG 50.32
	FE 26.58	FE 26.68	FE 26.06	FE 26.04	FE 25.41	FE 25.22	FE 24.69	FE 24.25	FE 8.88	FE 8.41
									C: 44.55	C: 45.06

HRV309 - TYPE II GARNET WEBSTERITE (GRAPHITE BEARING)

	HRV309B CP601	HRV309C CP101	HRV309C CP301	HRV309D CP101	HRV309D CP501
SIO2	55.4	55.3	55.3	55.5	55.5
TIO2	.53	.52	.52	.58	.53
AL2O3	6.34	6.33	6.22	6.29	6.08
CR2O3	.07	.05	.06	.05	.08
FEO	4.08	3.83	3.94	3.99	3.89
MNO	.07	.06	.06	.06	.06
MGO	13.9	13.7	13.8	13.9	14.0
CAO	15.5	15.7	15.7	15.6	15.9
NA2O	4.52	4.67	4.43	4.58	4.49
K2O	ND				ND
TOTAL	100.4	100.2	100.0	100.5	100.5

IONIC PROPORTIONS

SI	1.978	1.979	1.981	1.978	1.980
TI	.014	.014	.014	.016	.014
AL	.267	.267	.263	.264	.256
CR	.002	.001	.002	.001	.002
FE	.122	.115	.118	.119	.116
MN	.002	.002	.002	.002	.002
MG	.740	.731	.737	.738	.744
CA	.593	.602	.603	.596	.608
NA	.313	.324	.308	.317	.311
K					
TOTAL	4.030	4.035	4.027	4.031	4.033
OXYGEN	6	6	6	6	6

M: 85.86	M: 86.44	M: 86.19	M: 86.13	M: 86.51
CA 40.77	CA 41.60	CA 41.35	CA 41.00	CA 41.40
MG 50.85	MG 50.48	MG 50.55	MG 50.81	MG 50.70
FE 8.38	FE 7.92	FE 8.10	FE 8.19	FE 7.91
C: 44.50	C: 45.17	C: 44.99	C: 44.66	C: 44.95

HRV310 - TYPE II MAGNESIAN ECLOGITE(IN CONTACT WITH PERIDOTITE)

	HRV310A GT101	HRV310A GT102	HRV310A CP101	HRV310B GT101	HRV310B GT102	HRV310C GT301	HRV310C GT101	HRV310C GT502	HRV310C GT102	HRV310C CP501
SIO2	42.0	42.2	55.0	41.4	41.0	42.3	42.2	42.3	42.5	55.5
TIO2	.39	.27	.23	.37	.46	.31	.34	.24	.30	.20
AL2O3	21.5	22.8	3.59	19.4	17.7	23.6	23.6	23.7	23.6	3.97
CR2O3	3.10	1.91	1.18	6.00	8.17	.65	.83	.76	.81	.58
FEO	7.65	7.72	2.74	7.29	7.01	8.32	8.27	8.26	8.32	2.93
MNO	.33	.31	.10	.37	.42	.27	.28	.27	.26	.08
MGO	21.4	21.7	16.6	21.0	21.2	21.0	21.2	21.2	21.2	16.4
CAO	3.99	3.76	17.4	4.11	4.28	3.74	3.85	3.72	3.80	17.3
NA2O	.12	.12	2.70	.13	.13	.10	.08	.08	.10	2.86
K2O			.09							.10
TOTAL	100.5	100.7	99.6	100.1	100.3	100.3	100.7	100.5	100.9	99.9

IONIC PROPORTIONS

SI	2.977	2.970	1.982	2.974	2.961	2.983	2.968	2.976	2.981	1.990
TI	.021	.014	.006	.020	.025	.016	.018	.013	.016	.005
AL	1.797	1.888	.152	1.643	1.505	1.962	1.960	1.966	1.951	.168
CR	.174	.106	.034	.341	.466	.036	.046	.042	.045	.016
FE	.453	.454	.083	.438	.423	.491	.486	.486	.488	.088
MN	.020	.018	.003	.023	.026	.016	.017	.016	.015	.002
MG	2.265	2.276	.891	2.250	2.282	2.207	2.219	2.223	2.216	.876
CA	.303	.284	.672	.316	.331	.263	.290	.280	.286	.665
NA	.016	.016	.189	.018	.018	.014	.011	.011	.014	.199
K			.004							.005
TOTAL	8.025	8.027	4.015	8.023	8.037	8.008	8.016	8.013	8.012	4.014
OXYGEN	12	12	6	12	12	12	12	12	12	6

M: 83.32	M: 83.36	M: 91.52	M: 83.71	M: 84.35	M: 81.81	M: 82.02	M: 82.06	M: 81.95	M: 90.89
CA 10.03	CA 9.41	CA 40.82	CA 10.53	CA 10.91	CA 9.48	CA 9.69	CA 9.38	CA 9.55	CA 40.80
MG 74.96	MG 75.52	MG 54.16	MG 74.90	MG 75.15	MG 74.05	MG 74.08	MG 74.36	MG 74.12	MG 53.80
FE 15.01	FE 15.08	FE 5.02	FE 14.58	FE 13.94	FE 16.46	FE 16.24	FE 16.26	FE 16.32	FE 5.39
		C: 42.98							C: 43.13

HRV310 - TYPE II MAGNESIAN ECLOGITE(IN CONTACT WITH PERIDOTITE)

	HRV310C MI101
SIO2	42.5
TIO2	2.69
AL2O3	15.9
CR2O3	.34
FEO	4.28
MNO	.04
MGO	22.1
CAO	.16
NA2O	
K2O	9.76
TOTAL	95.8

IONIC PROPORTIONS

SI	5.412
TI	.258
AL	2.087
CR	.034
FE	.456
MN	.004
MG	4.202
CA	.022
NA	
K	1.589
TOTAL	14.064
OXYGEN	20

M: 90.21

HRV313 - TYPE I CALCIUM-RICH ECLOGITE (DIAMONDIFEROUS)

	HRV313 GT101	HRV313 GT301	HRV313 CP501	HRV313 CP101
SIO2	40.7	40.9	55.9	56.3
TIO2	.25	.25	.34	.29
AL2O3	23.5	23.3	12.0	13.8
CR2O3	.07	.07	.11	.10
FEO	14.1	13.9	3.05	2.71
MNO	.27	.27	ND	.04
MGO	14.8	14.8	9.32	8.32
CAO	7.15	7.00	12.6	11.8
NA2O	.14	.07	6.68	7.27
K2O			.10	.09
TOTAL	100.8	100.6	100.1	100.7

IONIC PROPORTIONS

SI	2.961	2.976	1.971	1.964
TI	.014	.014	.009	.008
AL	1.999	1.998	.499	.568
CR	.004	.004	.003	.003
FE	.858	.846	.090	.079
MN	.017	.017		.001
MG	1.605	1.605	.490	.433
CA	.557	.546	.476	.441
NA	.020	.010	.457	.492
K			.004	.004
TOTAL	8.034	8.014	4.000	3.991
OXYGEN	12	12	6	6

M: 65.16	M: 65.49	M: 84.48	M: 84.55
CA 18.46	CA 18.21	CA 45.09	CA 46.30
MG 53.14	MG 53.56	MG 46.39	MG 45.40
FE 28.41	FE 28.23	FE 8.52	FE 8.30
		C: 49.29	C: 50.49

HRV335 - ALUMINOUS ECLOGITE WITH GARNET EXSOLUTION (TYPE I)

	HRV335 GT601	HRV335 CP401	HRV335 GT102	HRV335 CP102	HRV335 CP403
SIO2	39.5	57.1	39.5	52.9	54.3
TIO2	.20	.20	.16	.22	.21
AL2O3	22.4	15.6	22.5	17.4	14.9
CR2O3	.08	ND	.07	.04	.05
FEO	10.2	2.06	14.3	2.16	2.51
MNO	.14	ND	.25	ND	ND
MGO	5.73	7.63	8.06	6.65	7.50
CAO	21.3	13.8	15.1	15.3	14.0
NA2O	ND	5.20	ND	5.16	5.60
K2O		ND			ND
TOTAL	99.6	101.6	100.0	99.8	99.1

IONIC PROPORTIONS

SI	2.980	1.957	2.972	1.866	1.927
TI	.011	.005	.009	.006	.006
AL	1.992	.630	1.996	.724	.623
CR	.005		.004	.001	.001
FE	.644	.059	.900	.064	.075
MN	.009		.016		
MG	.644	.390	.904	.350	.397
CA	1.722	.507	1.217	.578	.532
NA		.346		.353	.385
K					
TOTAL	8.013	3.896	8.021	3.942	3.948
OXYGEN	12	6	12	6	6

M: 50.03	M: 86.84	M: 50.11	M: 84.58	M: 84.19
CA 57.21	CA 53.04	CA 40.30	CA 58.32	CA 53.05
MG 21.41	MG 40.79	MG 29.92	MG 35.26	MG 39.53
FE 21.38	FE 6.18	FE 29.79	FE 6.43	FE 7.42
	C: 56.53		C: 62.32	C: 57.30

JJG 2 - TYPE I MAIN GROUP ECLOGITE

	JJG 2 GT101	JJG 2 CP101	JJG 2 GT102	JJG 2 GT302	JJG 2 CP102	JJG 2 MI 1	JJG 2 MI 2	JJG 2 MI 3	JJG 2 AM 1	JJG 2 BROWN
SIO2	41.0	56.0	41.2	41.1	56.0	38.2	41.2	40.7	41.6	55.5
TIO2										
AL2O3	23.2	7.87	23.2	23.3	7.94	17.5	14.3	14.8	16.4	19.6
CR2O3	.14	.16	.12	.12	.15	ND	.26	.14	ND	ND
FEO	15.6	5.26	15.8	16.0	5.22	10.5	5.90	9.00	12.3	3.73
MNO	.37	.12	.35	.38	.09	.06	ND	.08	.26	ND
MGO	16.0	12.5	16.1	16.0	12.5	19.3	23.1	19.0	14.2	.66
CAO	3.73	13.4	3.83	3.73	13.4	.03	ND	ND	9.44	.28
NA2O	.12	4.65	.11	.12	4.66	.41	.22	.18	3.41	6.46
K2O		.12			.15	9.54	10.0	10.1	.64	1.76
TOTAL	100.2	100.1	100.7	100.7	100.1	95.6	95.0	94.0	98.3	88.0

IONIC PROPORTIONS

SI	2.991	1.998	2.991	2.985	1.997	5.043	5.352	5.417	5.802	1.410
TI										
AL	1.995	.331	1.986	1.995	.334	2.724	2.190	2.322	2.697	.587
CR	.008	.005	.007	.007	.004		.027	.015		
FE	.952	.157	.959	.972	.156	1.159	.641	1.002	1.435	.079
MN	.023	.004	.022	.023	.003	.007		.009	.031	
MG	1.739	.665	1.742	1.732	.664	3.797	4.472	3.769	2.952	.025
CA	.292	.512	.298	.290	.512	.004			1.411	.008
NA	.017	.322	.015	.017	.322	.105	.055	.046	.922	.318
K		.005			.007	1.607	1.651	1.715	.114	.057
TOTAL	8.016	3.998	8.020	8.022	3.999	14.449	14.393	14.296	15.366	2.484
OXYGEN	12	6	12	12	6	20	20	20	22	4

	M: 64.64	M: 80.90	M: 64.49	M: 64.05	M: 81.01	M: 76.61	M: 87.46	M: 79.00	M: 67.29	M: 23.97
	CA 9.77	CA 38.40	CA 9.93	CA 9.70	CA 38.44					
	MG 58.32	MG 49.83	MG 58.08	MG 57.84	MG 49.87					
	FE 31.91	FE 11.77	FE 31.99	FE 32.46	FE 11.69					
		C: 43.53			C: 43.53					

JJG 4 - TYPE I KYANITE ECLOGITE

	JJG 4 GT101	JJG 4 CP101	JJG 4 KY101	JJG 4 GT102	JJG 4 CP202	JJG 4 KY102	JJG 4 GT103	JJG 4 CP103	JJG 4 RU 1	JJG 4 RU 2
SIO2	40.9	56.8	37.6	40.9	56.6	37.6	40.8	56.5	.19	.38
TIO2	.25	.32	.10	.25	.32	.15	.23	.17	84.5	81.3
AL2O3	23.4	15.9	62.7	23.5	15.7	62.3	23.4	16.5	2.12	5.11
CR2O3	.08	.11	.16	.08	.10	.15	.08	.08	.22	.35
FEO	12.3	1.98	.16	12.7	1.95	.14	12.1	1.78	1.24	1.04
MNO	.22	ND	ND	.21	.04	ND	.21	ND	ND	ND
MGO	13.4	7.26	.12	13.6	7.14	.12	13.3	6.95	.15	1.74
CAO	10.1	11.0	ND	9.94	10.6	ND	10.3	10.8	.80	.08
NA2O	.11	7.48	ND	.12	7.74	ND	.11	7.51	.05	.06
K2O		.07	ND		.06	ND		.06	ND	ND
TOTAL	100.8	100.9	100.9	101.3	100.2	100.5	100.5	100.4	89.3	90.1

IONIC PROPORTIONS

SI	2.974	1.960	1.007	2.963	1.966	1.010	2.973	1.956	.003	.006
TI	.014	.008	.002	.014	.008	.003	.013	.004	.951	.898
AL	2.006	.647	1.979	2.007	.643	1.973	2.010	.674	.037	.089
CR	.005	.003	.003	.005	.003	.003	.005	.002	.003	.004
FE	.748	.057	.004	.769	.057	.003	.737	.052	.016	.013
MN	.014			.013	.001		.013			
MG	1.452	.373	.005	1.468	.370	.005	1.444	.359	.003	.038
CA	.787	.407		.772	.394		.804	.401	.013	.001
NA	.016	.500		.017	.521		.016	.504	.001	.002
K		.003			.003			.003		
TOTAL	8.015	3.959	3.001	8.026	3.965	2.999	8.015	3.955	1.027	1.051
OXYGEN	12	6	5	12	6	5	12	6	2	2

M: 66.00	M: 86.73		M: 65.62	M: 86.71		M: 66.20	M: 87.43	M: 17.73	M: 74.88
CA 26.34	CA 48.58		CA 25.64	CA 48.07		CA 26.93	CA 49.41		
MG 48.61	MG 44.60		MG 48.79	MG 45.03		MG 48.37	MG 44.23		
FE 25.04	FE 6.83		FE 25.57	FE 6.90		FE 24.70	FE 6.36		
	C: 52.14			C: 51.63			C: 52.77		

JJG 4 - TYPE I KYANITE ECLOGITE

	JJG 4 ROSEI	JJG 4 MI 1	JJG 4 CP206	JJG 4 CP206	JJG 4 CP201
SIO2	42.9	36.0	58.8	57.5	58.2
TIO2	2.24	5.94	.26	.32	.51
AL2O3	19.5	17.5	17.5	16.5	15.9
CR2O3	ND	ND	.11	.05	.08
FEO	3.55	9.74	1.55	2.08	1.94
MNO	ND	.04	ND	.05	ND
MGO	7.30	15.9	6.41	7.15	7.32
CAO	.38	.03	10.8	10.4	11.7
NA2O	15.7	.45	6.65	7.29	5.51
K2O	2.93	8.78	.21	.16	.10
TOTAL	94.5	94.4	102.3	101.5	101.1

IONIC PROPORTIONS

SI	1.107	4.805	1.981	1.966	1.989
TI	.043	.596	.007	.008	.008
AL	.593	2.754	.695	.665	.641
CR			.003	.001	.002
FE	.077	1.087	.044	.059	.055
MN		.005		.001	
MG	.281	3.163	.322	.364	.373
CA	.011	.004	.390	.381	.428
NA	.786	.116	.434	.483	.365
K	.096	1.495	.009	.007	.004
TOTAL	2.994	14.027	3.885	3.938	3.867
OXYGEN	4	20	6	6	6
	M: 78.56	M: 74.42	M: 88.05	M: 85.97	M: 87.05
			CA 51.61	CA 47.34	CA 50.01
			MG 42.61	MG 45.27	MG 43.52
			FE 5.78	FE 7.39	FE 6.47
			C: 54.78	C: 51.12	C: 53.47

JJG 5 - TYPE II MAGNESIAN ECLOGITE

	JJG 5 GT101	JJG 5 GT301	JJG 5 CP101	JJG 5 CP301	JJG 5 GT102	JJG 5 GT302	JJG 5 CP102	JJG 5 CP302
SIO2	41.0	41.1	55.6	55.3	40.8	40.9	55.3	55.3
TIO2	.12	.08	.09	.07	.13	.13	.10	.10
AL2O3	23.2	23.3	5.35	4.50	23.1	23.1	5.97	4.59
CR2O3	.26	.26	.20	.23	.26	.26	.18	.21
FEO	15.5	15.4	3.92	4.17	14.8	15.1	4.19	4.03
MNO	.32	.29	.04	.05	.27	.31	.07	.07
MGO	15.7	16.3	13.6	14.3	16.4	16.5	13.6	14.5
CAO	6.28	5.66	18.4	18.9	5.40	5.25	17.0	18.2
NA2O	.08	ND	3.21	2.89	ND	.07	3.59	2.96
K2O			ND	ND			ND	ND
TOTAL	102.5	102.4	100.4	100.4	101.2	101.6	100.0	100.0

IONIC PROPORTIONS

SI	2.947	2.947	1.992	1.989	2.952	2.951	1.986	1.992
TI	.006	.004	.002	.002	.007	.007	.003	.003
AL	1.966	1.970	.226	.191	1.971	1.965	.253	.195
CR	.015	.015	.006	.007	.015	.015	.005	.006
FE	.932	.924	.117	.125	.896	.911	.126	.121
MN	.019	.018	.001	.002	.017	.019	.002	.002
MG	1.682	1.742	.726	.766	1.769	1.774	.728	.779
CA	.484	.435	.706	.728	.419	.406	.654	.703
NA	.011		.223	.202		.010	.250	.207
K								
TOTAL	8.062	8.058	4.001	4.012	8.050	8.057	4.007	4.008
OXYGEN	12	12	6	6	12	12	6	6

	M: 64.35	M: 65.35	M: 86.08	M: 85.94	M: 66.38	M: 66.07	M: 85.26	M: 86.51
	CA 15.62	CA 14.03	CA 45.57	CA 44.95	CA 13.58	CA 13.13	CA 43.38	CA 43.84
	MG 54.30	MG 56.18	MG 46.85	MG 47.31	MG 57.37	MG 57.39	MG 48.27	MG 48.58
	FE 30.08	FE 29.79	FE 7.58	FE 7.74	FE 29.05	FE 29.48	FE 8.35	FE 7.58
			C: 49.31	C: 48.72			C: 47.33	C: 47.44

JJG 6 - TYPE II CALCIUM-IRON-RICH ECLOGITE

	JJG 6 GT101	JJG 6 GT301	JJG 6 GT102	JJG 6 CP101
SIO2	39.6	39.6	39.7	55.5
TIO2	.15	.13	.13	.15
AL2O3	22.3	22.3	22.4	9.56
CR2O3	.05	.08	.09	.10
FEO	19.5	19.2	19.1	5.58
MNO	.33	.34	.34	ND
MGO	9.55	9.68	9.54	9.47
CAO	9.11	9.16	9.06	14.4
NA2O	.07	.08	.07	5.86
K2O				ND
TOTAL	100.7	100.6	100.4	100.7

IONIC PROPORTIONS

SI	2.978	2.978	2.986	1.980
TI	.008	.007	.007	.004
AL	1.977	1.977	1.986	.402
CR	.003	.005	.005	.003
FE	1.226	1.207	1.201	.166
MN	.021	.022	.022	
MG	1.070	1.085	1.069	.504
CA	.734	.738	.730	.550
NA	.010	.012	.010	.405
K				
TOTAL	8.029	8.030	8.017	4.016
OXYGEN	12	12	12	6
	M: 46.60	M: 47.32	M: 47.09	M: 75.15
	CA 24.22	CA 24.36	CA 24.33	CA 45.10
	MG 35.31	MG 35.80	MG 35.63	MG 41.26
	FE 40.46	FE 39.85	FE 40.04	FE 13.64
				C: 52.23

JJG 11 - TYPE I IRON-RICH ECLOGITE

	JJG 11 GT101	JJG 11 GT401	JJG 11 CP101	JJG 11 CP101	JJG 11 CP101	JJG 11 GT302	JJG 11 CP502	JJG 11 CP102	JJG 11 BLACK	JJG 11 AM 1
SIO2	40.2	40.1	55.6	55.3	55.2	40.4	55.9	56.0	17.1	41.1
TIO2										
AL2O3	22.7	22.7	7.07	7.02	7.04	22.9	7.78	7.69	7.44	16.2
CR2O3	.12	.12	.13	.13	.11	.11	.15	.16	.10	.19
FEO	19.6	19.6	7.79	7.81	7.86	19.2	6.91	7.02	35.0	13.1
MNO	.65	.66	.17	.19	.19	.60	.17	.13	.07	.37
MGO	13.8	13.8	12.4	12.2	12.2	13.8	11.7	11.8	10.7	14.6
CAO	3.36	3.32	12.1	12.0	12.1	3.60	12.5	12.6	.19	8.05
NA2O	.14	.15	4.97	4.68	4.67	.15	5.00	4.93	.40	3.30
K2O			.11	.13	.13		.12	.13	.04	.61
TOTAL	100.6	100.4	100.2	99.5	99.5	100.8	100.2	100.5	71.0	97.5

IONIC PROPORTIONS

SI	2.979	2.976	2.000	2.005	2.002	2.982	2.003	2.003	.733	5.784
TI										
AL	1.983	1.986	.300	.300	.301	1.993	.329	.324	.376	2.688
CR	.007	.007	.004	.004	.003	.006	.004	.005	.003	.021
FE	1.215	1.216	.232	.237	.238	1.185	.207	.210	1.254	1.542
MN	.041	.041	.005	.006	.006	.038	.005	.004	.003	.044
MG	1.524	1.526	.665	.659	.659	1.518	.625	.629	.683	3.062
CA	.267	.264	.466	.466	.470	.285	.480	.483	.009	1.214
NA	.020	.022	.347	.329	.328	.021	.347	.342	.033	.901
K			.005	.006	.006		.005	.006	.002	.110
TOTAL	8.036	8.039	4.024	4.011	4.014	8.029	4.007	4.006	3.096	15.366
OXYGEN	12	12	6	6	6	12	6	6	4	22

	M: 55.65	M: 55.65	M: 74.16	M: 73.57	M: 73.45	M: 56.16	M: 75.11	M: 74.97	M: 35.27	M: 66.51
	CA 8.88	CA 8.78	CA 34.22	CA 34.22	CA 34.37	CA 9.53	CA 36.59	CA 36.53		
	MG 50.71	MG 50.76	MG 48.78	MG 48.39	MG 48.20	MG 50.80	MG 47.63	MG 47.58		
	FE 40.42	FE 40.46	FE 17.00	FE 17.38	FE 17.43	FE 39.67	FE 15.79	FE 15.89		
			C: 41.23	C: 41.42	C: 41.63		C: 43.44	C: 43.43		

JJG 11 - TYPE I IRON-RICH ECLOGITE

	JJG 11 AM 2	JJG 11 MI 1
SIO2	42.0	39.3
TIO2		
AL2O3	15.4	15.2
CR2O3	.16	.11
FEO	13.6	10.2
MNO	.39	.08
MGO	14.6	19.2
CAO	8.10	.04
NA2O	3.69	.47
K2O	.52	9.27
TOTAL	98.5	93.9

IONIC PROPORTIONS

SI	5.868	5.267
TI		
AL	2.536	2.402
CR	.018	.012
FE	1.589	1.143
MN	.046	.009
MG	3.040	3.835
CA	1.213	.006
NA	1.000	.122
K	.093	1.585
TOTAL	15.401	14.380
OXYGEN	22	20

M: 65.67 M: 77.03

JJG 14 - TYPE I CALCIUM-RICH ECLOGITE

	JJG 14 GT101	JJG 14 GT301	JJG 14 CP101	JJG 14 CP301	JJG 14 GT102	JJG 14 GT302	JJG 14 CP102	JJG 14 CP302
SIO2	41.5	41.5	56.9	55.9	41.5	41.3	56.4	56.5
TIO2	.25	.23	.29	.29	.23	.22	.29	.29
AL2O3	23.6	23.7	12.1	12.0	23.6	23.8	11.8	11.8
CR2O3	.06	.06	.10	.07	.05	.08	.07	.08
FEO	13.1	12.4	2.56	2.40	12.6	12.4	2.52	2.53
MNO	.23	.22	ND	ND	.22	.23	ND	.04
MGO	16.1	16.4	9.91	9.71	16.2	16.0	9.93	10.0
CAO	6.94	7.07	13.1	12.8	7.21	7.40	13.0	13.1
NA2O	.12	.12	6.37	6.33	.13	.16	6.21	6.18
K2O			.11	.11			.12	.11
TOTAL	101.9	101.7	101.5	99.6	101.7	101.6	100.4	100.6

IONIC PROPORTIONS

SI	2.966	2.964	1.974	1.973	2.967	2.957	1.977	1.977
TI	.013	.012	.008	.008	.012	.012	.008	.008
AL	1.989	1.996	.495	.499	1.989	2.009	.488	.487
CR	.003	.003	.003	.002	.003	.005	.002	.002
FE	.783	.741	.074	.071	.753	.742	.074	.074
MN	.014	.013			.013	.014		.001
MG	1.715	1.746	.512	.511	1.726	1.707	.519	.519
CA	.532	.541	.487	.484	.552	.568	.488	.491
NA	.017	.017	.428	.433	.018	.022	.422	.419
K			.005	.005			.005	.005
TOTAL	8.032	8.033	3.987	3.987	8.034	8.036	3.984	3.983
OXYGEN	12	12	6	6	12	12	6	6

	M: 68.65	M: 70.21	M: 87.34	M: 87.82	M: 69.62	M: 69.69	M: 87.53	M: 87.52
	CA 17.54	CA 17.87	CA 45.36	CA 45.42	CA 18.22	CA 18.81	CA 45.17	CA 45.29
	MG 56.61	MG 57.66	MG 47.72	MG 47.93	MG 56.93	MG 56.58	MG 47.99	MG 47.89
	FE 25.85	FE 24.47	FE 6.92	FE 6.65	FE 24.85	FE 24.61	FE 6.83	FE 6.83
			C: 48.73	C: 48.66			C: 48.49	C: 48.60

JJG 17 - TYPE I MAIN GROUP ECLOGITE

	JJG 17 GT101	JJG 17 GT102	JJG 17 GT502	JJG 17 CP101	JJG 17 CP502
SIO2	40.7	40.7	40.7	55.5	55.4
TIO2	.18	ND	.07	.08	.05
AL2O3	23.3	23.3	23.4	7.40	7.36
CR2O3	.15	.15	.15	.19	.18
FEO	15.6	15.6	15.5	5.80	5.72
MNO	.37	.37	.35	.04	.09
MGO	15.9	16.1	16.2	12.9	12.9
CAO	3.80	3.91	3.87	13.9	14.0
NA2O	.10	.11	.11	4.53	4.40
K2O			ND	.15	.16
TOTAL	100.1	100.3	100.4	100.5	100.3

IONIC PROPORTIONS

SI	2.973	2.970	2.965	1.983	1.984
TI	.010		.004	.002	.001
AL	2.007	2.004	2.010	.312	.311
CR	.009	.009	.009	.005	.005
FE	.953	.952	.944	.173	.171
MN	.023	.023	.022	.001	.003
MG	1.731	1.751	1.759	.687	.688
CA	.297	.306	.302	.532	.537
NA	.014	.016	.016	.314	.306
K				.007	.007
TOTAL	8.017	8.031	8.030	4.017	4.013
OXYGEN	12	12	12	6	6
	M: 64.49	M: 64.78	M: 65.07	M: 79.85	M: 80.08
	CA 9.98	CA 10.16	CA 10.05	CA 38.22	CA 38.45
	MG 58.06	MG 58.20	MG 58.52	MG 49.33	MG 49.28
	FE 31.97	FE 31.64	FE 31.42	FE 12.45	FE 12.26
				C: 43.65	C: 43.83

JJG 30 - TYPE I KYANITE ECLOGITE

	JJG 30 GT101	JJG 30 GT301	JJG 30 GT102	JJG 30 GT302	JJG 30 CP103	JJG 30 CP104	JJG 30 CP105	JJG 30 CP204
SIO2	41.0	40.8	41.0	40.7	58.6	56.9	57.4	55.5
TIO2	.25	.25	.25	.25	.29	.27	.31	.36
AL2O3	23.4	23.4	23.6	23.3	17.2	16.7	17.5	7.05
CR2O3	.08	.09	.09	.08				
FEO	11.1	11.0	11.1	11.4	1.51	1.63	1.63	6.72
MNO	.19	.21	.18	.21				
MGO	14.3	14.4	14.4	14.2	7.29	6.91	6.79	13.7
CAO	10.8	10.7	10.8	10.5	11.1	10.9	10.3	13.2
NA2O	.09	.11	.13	.09	4.24	7.32	7.10	4.17
K2O					.37	.10	.10	.04
TOTAL	101.2	101.0	101.5	100.7	100.6	100.7	101.1	100.7

IONIC PROPORTIONS

SI	2.959	2.952	2.949	2.955	1.993	1.959	1.960	1.979
TI	.014	.014	.014	.014	.007	.007	.008	.010
AL	1.991	1.996	2.001	1.994	.690	.678	.705	.296
CR	.005	.005	.005	.005				
FE	.670	.666	.668	.692	.043	.047	.047	.200
MN	.012	.013	.011	.013				
MG	1.538	1.553	1.544	1.536	.369	.355	.346	.728
CA	.835	.829	.832	.817	.405	.403	.377	.504
NA	.013	.015	.018	.013	.280	.489	.470	.288
K					.016	.004	.004	.002
TOTAL	8.036	8.042	8.043	8.038	3.803	3.941	3.917	4.008
OXYGEN	12	12	12	12	6	6	6	6

	M: 69.66	M: 70.00	M: 69.80	M: 68.94	M: 89.59	M: 88.31	M: 88.13	M: 78.42
	CA 27.44	CA 27.22	CA 27.35	CA 26.82	CA 49.51	CA 50.06	CA 49.01	CA 35.20
	MG 50.54	MG 50.94	MG 50.72	MG 50.45	MG 45.23	MG 44.10	MG 44.94	MG 50.81
	FE 22.02	FE 21.84	FE 21.94	FE 22.73	FE 5.26	FE 5.84	FE 6.05	FE 13.99
					C: 52.26	C: 53.17	C: 52.17	C: 40.92

JJG 31 - TYPE I CALCIUM-RICH ECLOGITE

	JJG 31 GT101	JJG 31 GT301	JJG 31 GT501	JJG 31 CP101	JJG 31 CP301	JJG 31 CP103	JJG 31 GT102	JJG 31 CP303
SIO2	41.4	41.6	41.0	55.0	55.1	57.1	41.2	56.3
TIO2	.17	.17	.13	.14	.19	.19	.15	.15
AL2O3	23.6	23.6	23.4	13.3	12.8	13.1	23.5	12.7
CR2O3	.08	.06	.08	.10	.10	.10	.06	.05
FEO	9.78	10.1	10.1	1.73	1.83	2.21	10.3	1.98
MNO	.17	.16	.17	ND	ND	ND	.16	ND
MGO	15.2	15.2	15.3	9.00	9.09	9.75	15.4	9.50
CAO	9.61	9.50	9.18	12.6	12.8	12.6	9.18	13.0
NA2O	.13	.08	.09	6.43	6.31	6.24	.08	6.19
K2O				.13	.12	.12		.13
TOTAL	100.1	100.5	99.4	98.4	98.3	101.4	100.0	100.0

IONIC PROPORTIONS

SI	2.988	2.994	2.982	1.958	1.965	1.971	2.981	1.973
TI	.009	.009	.007	.004	.005	.005	.008	.004
AL	2.008	2.002	2.006	.558	.538	.533	2.004	.525
CR	.005	.003	.005	.003	.003	.003	.003	.001
FE	.590	.608	.614	.052	.055	.064	.623	.058
MN	.010	.010	.010				.010	
MG	1.635	1.630	1.658	.478	.483	.502	1.660	.496
CA	.743	.733	.715	.481	.489	.466	.712	.488
NA	.018	.011	.013	.444	.436	.418	.011	.421
K				.006	.005	.005		.006
TOTAL	8.006	8.000	8.012	3.983	3.980	3.967	8.013	3.973
OXYGEN	12	12	12	6	6	6	12	6
	M: 73.47	M: 72.84	M: 72.97	M: 90.26	M: 89.85	M: 88.72	M: 72.71	M: 89.53
	CA 25.04	CA 24.66	CA 23.94	CA 47.60	CA 47.63	CA 45.18	CA 23.76	CA 46.83
	MG 55.08	MG 54.88	MG 55.50	MG 47.29	MG 47.05	MG 48.63	MG 55.44	MG 47.60
	FE 19.89	FE 20.46	FE 20.56	FE 5.10	FE 5.32	FE 6.19	FE 20.81	FE 5.57
				C: 50.16	C: 50.31	C: 48.16		C: 49.59

JJG 40 - TYPE I MAIN GROUP ECLOGITE (INHOMOGENEOUS KYANITE ECLOGITE)

	JJG 40B GT101	JJG 40B GT301	JJG 40B CP101	JJG 40B GT102	JJG 40B GT302	JJG 40B GT502	JJG 40B CP103	JJG 40B CP104	JJG 40B CP105	JJG 40B GT303
SIO2	40.3	40.5	54.5	40.9	40.8	41.3	54.4	53.8	54.0	41.0
TIO2	.23	.25	.32	.23	.23	.28	.31	.34	.34	.26
AL2O3	23.4	23.4	13.2	23.4	23.5	23.6	13.7	10.1	10.2	23.4
CR2O3	ND	ND	.08	.08	.08	.08	.08	.11	.11	.08
FEO	11.7	11.8	2.43	13.1	13.3	13.7	2.46	3.80	3.80	14.5
MNO	.23	.23	.04	.31	.36	.36	ND	.09	.08	.38
MGO	12.8	13.0	8.95	15.2	15.5	17.1	8.54	10.8	10.8	16.6
CAO	12.7	12.2	11.7	8.27	7.59	5.44	11.3	13.4	13.2	5.23
NA2O	.11	.13	7.23	.13	.13	.20	7.43	5.96	6.11	.13
K2O			.09				.10	.11	.11	
TOTAL	101.5	101.5	98.5	101.6	101.5	102.1	98.3	98.5	98.7	101.6

IONIC PROPORTIONS

SI	2.928	2.938	1.947	2.948	2.943	2.948	1.945	1.949	1.950	2.950
TI	.013	.014	.009	.012	.012	.015	.008	.009	.009	.014
AL	2.005	2.001	.556	1.988	1.998	1.986	.578	.431	.434	1.985
CR			.002	.005	.005	.005	.002	.003	.003	.005
FE	.713	.716	.073	.790	.802	.818	.074	.115	.115	.873
MN	.014	.014	.001	.019	.022	.022		.003	.002	.023
MG	1.386	1.405	.477	1.633	1.666	1.819	.455	.583	.581	1.760
CA	.989	.948	.448	.639	.587	.416	.433	.520	.511	.403
NA	.015	.018	.501	.018	.018	.028	.515	.419	.428	.018
K			.004				.005	.005	.005	
TOTAL	8.064	8.056	4.017	8.052	8.053	8.056	4.016	4.037	4.039	8.050
OXYGEN	12	12	6	12	12	12	6	6	6	12
	M: 66.02	M: 66.25	M: 86.78	M: 67.40	M: 67.50	M: 68.98	M: 86.08	M: 83.51	M: 83.51	M: 67.11
	CA 32.02	CA 30.89	CA 44.92	CA 20.86	CA 19.20	CA 13.63	CA 45.02	CA 42.69	CA 42.32	CA 13.20
	MG 44.88	MG 45.79	MG 47.80	MG 53.34	MG 54.54	MG 59.58	MG 47.33	MG 47.86	MG 48.17	MG 58.25
	FE 23.10	FE 23.32	FE 7.28	FE 25.80	FE 26.26	FE 26.79	FE 7.65	FE 9.45	FE 9.51	FE 28.55
			C: 48.45				C: 48.75	C: 47.15	C: 46.77	

JJG 40 - TYPE I MAIN GROUP ECLOGITE (INHOMOGENEOUS KYANITE ECLOGITE)

	JJG 40B GT503	JJG 40C GT101	JJG 40C GT301	JJG 40C KY101	JJG 40C CP102	JJG 40C GT102	JJG 40C GT302	JJG 40C KY102
SIO2	41.0	40.6	40.6	37.3	57.6	40.8	40.6	37.6
TIO2	.30	.25	.23	.10	.26	.27	.23	.10
AL2O3	23.3	23.3	23.3	63.8	15.9	23.3	23.2	64.0
CR2O3	.06	ND	ND	.05		ND	ND	ND
FEO	14.6	11.4	11.1	.13	1.64	11.3	11.1	.13
MNO	.37	.19	.23			.22	.21	
MGO	16.6	12.2	12.3	.12	7.91	12.1	12.3	.12
CAO	5.14	13.1	13.2		12.2	13.2	13.1	
NA2O	.15	.11	.12		5.35	.11	.08	
K2O					.20			
TOTAL	101.5	101.2	101.1	101.5	101.1	101.3	100.8	102.0

IONIC PROPORTIONS

SI	2.952	2.956	2.955	.992	1.972	2.964	2.962	.995
TI	.016	.014	.013	.002	.007	.015	.013	.002
AL	1.978	2.000	2.000	2.001	.642	1.996	1.995	1.998
CR	.003			.001				
FE	.879	.694	.676	.003	.047	.687	.677	.003
MN	.023	.012	.014			.014	.013	
MG	1.782	1.324	1.334	.005	.404	1.310	1.337	.005
CA	.397	1.022	1.030		.448	1.028	1.024	
NA	.021	.016	.017		.355	.015	.011	
K					.009			
TOTAL	8.051	8.038	8.040	3.004	3.882	8.030	8.033	3.003
OXYGEN	12	12	12	5	6	12	12	5

M: 66.95	M: 65.60	M: 66.38	M: 89.58	M: 65.61	M: 66.38
CA 12.97	CA 33.62	CA 33.87	CA 49.83	CA 33.98	CA 33.70
MG 58.27	MG 43.55	MG 43.90	MG 44.94	MG 43.32	MG 44.01
FE 28.76	FE 22.83	FE 22.23	FE 5.23	FE 22.70	FE 22.29
			C: 52.58		

JJG 41 - TYPE II CALCIUM-RICH ECLOGITE (MEGACRYST BEARING)

	JJG 41 GT 1	JJG 41 CP 1	JJG 41 GT 2	JJG 41 CP 2	JJG 41 GT 3	JJG 41 CP 3	JJG 41 GT 4	JJG 41 CP 4	JJG 41 GT 5	JJG 41 CP 5
SIO2	40.7	48.3	40.8	49.0	40.2	51.4	40.8	53.8	41.3	52.2
TIO2	.17	.17	.15	.17	.12	.18	.12	.13	.14	.15
AL2O3	22.5	13.8	22.4	11.5	22.5	7.48	22.0	5.56	21.7	7.29
CR2O3	.12	.10	.12	.10	.12	.09	.10	.10	.11	.05
FEO	10.8	4.36	9.10	4.08	9.24	3.06	9.06	3.00	8.12	2.93
MNO	.45	.08	.40	.08	.36	.05	.39	.09	.19	ND
MGO	12.0	10.7	11.4	12.2	9.90	13.8	9.30	13.8	7.68	13.2
CAO	14.4	22.3	15.2	23.5	17.2	22.5	18.2	22.7	21.0	21.7
NA2O		1.27		1.11		1.59		1.19		1.71
K2O										
TOTAL	101.1	101.1	99.6	101.7	99.6	100.1	100.0	100.4	100.2	99.2

IONIC PROPORTIONS

SI	2.972	1.744	3.007	1.764	2.983	1.867	3.021	1.940	3.055	1.903
TI	.009	.005	.008	.005	.007	.005	.007	.004	.008	.004
AL	1.937	.587	1.946	.488	1.968	.320	1.920	.236	1.893	.313
CR	.007	.003	.007	.003	.007	.003	.006	.003	.006	.001
FE	.660	.132	.561	.123	.573	.093	.561	.090	.502	.089
MN	.028	.002	.025	.002	.023	.002	.024	.003	.012	
MG	1.306	.576	1.252	.655	1.095	.747	1.026	.742	.847	.717
CA	1.127	.863	1.200	.907	1.367	.876	1.444	.877	1.665	.847
NA		.089		.078		.112		.083		.121
K										
TOTAL	8.046	4.001	8.008	4.024	8.023	4.023	8.009	3.978	7.988	3.996
OXYGEN	12	6	12	6	12	6	12	6	12	6
	M: 66.44	M: 81.39	M: 69.06	M: 84.20	M: 65.63	M: 88.93	M: 64.65	M: 89.13	M: 62.76	M: 88.92
	CA 36.44	CA 54.95	CA 39.83	CA 53.83	CA 45.05	CA 51.04	CA 47.64	CA 51.32	CA 55.23	CA 51.24
	MG 42.23	MG 36.67	MG 41.55	MG 38.87	MG 36.06	MG 43.54	MG 33.86	MG 43.39	MG 28.10	MG 43.36
	FE 21.33	FE 8.38	FE 18.61	FE 7.30	FE 18.89	FE 5.42	FE 18.51	FE 5.29	FE 16.67	FE 5.40
		C: 59.97		C: 58.07		C: 53.96		C: 54.18		C: 54.17

JJG 60 - CORUNDUM ECLOGITE (TYPE I)

	JJG 60 GT101	JJG 60 GT102	JJG 60 GT105	JJG 60 GT106	JJG 60 GT107	JJG 60 GT108	JJG 60 CP201	JJG 60 CP201	JJG 60 CP201	JJG 60 CP102
SIO2	40.6	40.4	40.7	40.6	40.6	40.5	55.0	54.9	56.7	53.5
TIO2	.12	.12	.12	.07	.12	.12	.14	.14	.12	.14
AL2O3	23.3	23.1	23.4	23.3	23.5	23.3	20.7	20.6	19.1	20.5
CR2O3	ND	ND	ND	ND	.05	ND	.05	ND	ND	ND
FEO	8.78	7.51	9.82	10.9	10.4	9.30	.92	.94	1.14	1.04
MNO	.10	.06	.09	.13	.14	.10	ND	ND	ND	ND
MGO	9.73	8.55	10.6	12.4	12.1	10.6	5.94	5.49	6.88	5.73
CAO	18.7	20.9	16.7	13.2	14.2	16.8	10.7	10.9	11.3	12.4
NA2O	.05	.16	ND	ND	ND	.07	6.19	8.58	7.46	7.82
K2O							.28	.26	.06	ND
TOTAL	101.4	100.8	101.5	100.7	101.1	100.8	99.9	101.8	102.8	101.2

IONIC PROPORTIONS

SI	2.960	2.966	2.960	2.963	2.951	2.961	1.895	1.876	1.911	1.847
TI	.007	.007	.007	.004	.007	.007	.004	.004	.003	.004
AL	2.002	1.999	2.006	2.005	2.014	2.008	.841	.830	.759	.834
CR					.003		.001			
FE	.535	.461	.597	.665	.632	.569	.027	.027	.032	.030
MN	.006	.004	.006	.008	.009	.006				
MG	1.057	.935	1.149	1.349	1.311	1.155	.305	.280	.346	.295
CA	1.461	1.644	1.301	1.032	1.106	1.316	.395	.399	.408	.459
NA	.007	.023				.010	.414	.568	.468	.524
K							.012	.011	.003	
TOTAL	8.036	8.039	8.033	8.033	8.037	8.033	3.893	3.995	3.951	3.994
OXYGEN	12	12	12	12	12	12	6	6	6	6

M: 66.38	M: 66.98	M: 65.79	M: 66.97	M: 67.46	M: 67.01	M: 92.00	M: 91.23	M: 91.49	M: 90.76
CA 47.84	CA 54.07	CA 42.70	CA 33.89	CA 36.27	CA 43.30	CA 54.37	CA 56.57	CA 51.93	CA 58.54
MG 34.62	MG 30.77	MG 37.70	MG 44.27	MG 42.99	MG 38.00	MG 41.98	MG 39.63	MG 43.98	MG 37.63
FE 17.53	FE 15.16	FE 19.60	FE 21.84	FE 20.74	FE 18.71	FE 3.65	FE 3.81	FE 4.09	FE 3.83
						C: 56.43	C: 58.80	C: 54.15	C: 60.87

JJG 60 - CORUNDUM ECLOGITE (TYPE I)

	JJG 60 CP203	JJG 60 CP104	JJG 60 CP105	JJG 60 CP206	JJG 60 CP207	JJG 60 CP309	JJG 60 CP109	JJG 60 SP 5	JJG 60 SP 7	JJG 60 SP 8
SIO2	54.8	54.0	54.2	49.0	50.4	52.3	51.3	ND	ND	.05
TIO2	.12	.15	.14	.29	.19	.14	.12	.05	.03	.03
AL2O3	19.0	19.6	20.4	16.3	11.2	20.5	21.0	65.8	66.4	64.4
CR2O3	ND	ND	ND	ND	ND	ND	ND	.05	.12	ND
FEO	1.16	1.24	1.21	5.43	6.15	1.30	1.57	16.9	15.0	20.2
MNO	ND	ND	ND	.07	.08	ND	ND	.08	.06	.06
MGO	6.47	5.94	6.34	9.35	11.5	6.16	6.29	19.2	20.1	17.8
CAO	11.4	12.0	11.9	16.7	17.9	13.9	14.7	.05	ND	.05
NA2O	8.13	7.93	7.39	3.65	3.09	7.05	6.58	ND	ND	ND
K2O	.06	ND	.05	ND	ND	.04	.04			
TOTAL	101.2	100.9	101.7	100.8	100.5	101.4	101.6	102.2	101.7	102.6

IONIC PROPORTIONS

SI	1.888	1.869	1.857	1.758	1.828	1.813	1.781			.001
TI	.003	.004	.004	.008	.005	.004	.003	.001	.001	.001
AL	.772	.800	.824	.689	.479	.838	.860	1.946	1.955	1.927
CR								.001	.002	
FE	.033	.036	.035	.163	.187	.038	.046	.355	.313	.429
MN				.002	.002			.002	.001	.001
MG	.332	.306	.324	.500	.622	.318	.325	.718	.748	.673
CA	.421	.445	.437	.642	.696	.516	.547	.001		.001
NA	.543	.532	.491	.254	.217	.474	.443			
K	.003		.002			.002	.002			
TOTAL	3.996	3.994	3.974	4.017	4.036	4.002	4.008	3.025	3.021	3.035
OXYGEN	6	6	6	6	6	6	6	4	4	4

M: 90.86	M: 89.51	M: 90.33	M: 75.42	M: 76.92	M: 89.41	M: 87.71	M: 66.94	M: 70.48	M: 61.09
CA 53.51	CA 56.52	CA 54.93	CA 49.20	CA 46.26	CA 59.19	CA 59.58			
MG 42.24	MG 38.92	MG 40.71	MG 38.31	MG 41.34	MG 36.49	MG 35.46			
FE 4.25	FE 4.56	FE 4.36	FE 12.49	FE 12.41	FE 4.32	FE 4.97			
C: 55.89	C: 59.22	C: 57.44	C: 56.22	C: 52.81	C: 61.87	C: 62.69			

JJG 60 - CORUNDUM ECLOGITE (TYPE I)

	JJG 60 GL 7	JJG 60 GL 8	JJG 60 RR 9	JJG 60 XK 6
SIO2	46.8	39.8	36.8	52.9
TIO2	.07	.07	.10	ND
AL2O3	23.5	18.1	21.8	27.9
CR2O3	ND	ND	ND	ND
FEO	1.08	8.52	9.70	.22
MNO	ND	.09	.13	ND
MGO	.85	9.37	13.9	.03
CAO	3.71	7.68	10.2	.69
NA2O	11.2	1.52	2.40	9.35
K2O	.54	.82	.79	.11
TOTAL	87.8	86.0	95.8	91.2

IONIC PROPORTIONS

SI	1.226	1.112	.949	1.280
TI	.001	.001	.002	
AL	.726	.596	.663	.796
CR				
FE	.024	.199	.209	.004
MN		.002	.003	
MG	.033	.390	.534	.001
CA	.104	.230	.282	.018
NA	.569	.082	.120	.439
K	.018	.029	.026	.003
TOTAL	2.703	2.644	2.790	2.542
OXYGEN	4	4	4	4

M: 58.38 M: 66.21 M: 71.86

JJG 88 - TYPE I KYANITE ECLOGITE

	JJG 88 GT101	JJG 88 GT301	JJG 88 KY101	JJG 88 GT102	JJG 88 KY102
SIO2	39.7	39.7	37.6	39.6	37.6
TIO2	.38	.37	.09	.37	.10
AL2O3	22.8	22.8	63.5	22.9	63.8
CR2O3	ND	ND	ND	.05	ND
FEO	13.4	13.3	.18	13.4	.20
MNO	.21	.19			
MGO	7.46	7.49	.12	7.60	.11
CAO	17.0	17.0		16.9	
NA2O	.16	.19		.18	
K2O					
TOTAL	101.1	101.1	101.5	101.0	101.8

IONIC PROPORTIONS

SI	2.955	2.956	1.000	2.949	.997
TI	.021	.021	.002	.021	.002
AL	2.001	2.002	1.991	2.011	1.995
CR				.003	
FE	.834	.828	.004	.835	.004
MN	.013	.012			
MG	.828	.831	.005	.844	.004
CA	1.356	1.356		1.349	
NA	.023	.027		.026	
K					
TOTAL	8.034	8.035	3.002	8.036	3.003
OXYGEN	12	12	5	12	5

M: 49.80	M: 50.09	M: 50.27
CA 44.93	CA 44.98	CA 44.56
MG 27.42	MG 27.56	MG 27.87
FE 27.64	FE 27.46	FE 27.57

JJG139 - TYPE II GARNET WEBSTERITE

	JJG139 GT101	JJG139 CP101	JJG139 CP301	JJG139 CP403	JJG139 OP101	JJG139 OP102
SIO2	41.5	54.2	53.4	53.9	47.1	51.0
TIO2	.13	.17	.19	.14	.03	ND
AL2O3	23.2	3.33	3.26	5.33	1.72	1.28
CR2O3	1.37	1.14	1.10	.20	.05	.05
FEO	8.87	1.34	1.31	3.27	5.74	5.75
MNO	.34	.04	ND	.04	.12	.09
MGO	19.6	15.5	15.4	14.4	25.0	24.2
CAO	4.75	20.7	20.2	20.8	.65	.56
NA2O	ND	2.18	2.18	1.98	ND	.58
K2O					.15	.03
TOTAL	99.8	98.6	97.0	100.1	80.6	83.5

IONIC PROPORTIONS

SI	2.966	1.978	1.978	1.947	2.014	2.089
TI	.007	.005	.005	.004	.001	
AL	1.955	.143	.142	.227	.087	.062
CR	.077	.033	.032	.006	.002	.002
FE	.530	.041	.041	.099	.205	.197
MN	.021	.001		.001	.004	.003
MG	2.088	.840	.850	.775	1.593	1.477
CA	.364	.811	.802	.805	.030	.025
NA		.154	.157	.139		.046
K					.008	.002
TOTAL	8.013	4.006	4.008	4.002	3.945	3.903
OXYGEN	12	6	6	6	6	6

M: 79.75	M: 95.36	M: 95.44	M: 88.70	M: 88.59	M: 88.24
CA 12.20	CA 47.91	CA 47.37	CA 47.95	CA 1.63	CA 1.45
MG 70.02	MG 49.67	MG 50.23	MG 46.17	MG 87.14	MG 86.96
FE 17.78	FE 2.42	FE 2.40	FE 5.88	FE 11.23	FE 11.59
	C: 49.10	C: 48.54	C: 50.94	C: 1.84	C: 1.64

JJG143 - TYPE I MAIN GROUP ECLOGITE (INHOMOGENEOUS KYANITE ECLOGITE)

	JJG143 CP207	JJG143 SP 2	JJG143 SP 2	JJG143 KY 6	JJG143 MI 1	JJG143 KF 8	JJG143 GL 2	JJG143 AM 1	JJG143 SP 6
SIO2	56.9	.26	.14	37.3	37.6	64.3	44.2	38.4	.65
TIO2	.20	.03	.09	.09	1.40	.03	.52	.72	.09
AL2O3	19.5	57.6	57.0	63.6	18.1	18.9	10.8	18.9	58.7
CR2O3	ND	.23	.22	ND	.08	ND	ND	ND	.09
FEO	1.70	29.1	29.9	.17	12.0	.10	10.4	13.3	31.1
MNO	ND	.37	.33	ND	.08	ND	.32	.21	.26
MGO	4.99	13.4	13.6	.08	13.9	.03	10.4	11.6	10.2
CAO	9.37	.07	.04	ND	.31	.46	19.8	10.7	.31
NA2O	8.77	ND	ND		.51	2.25	.83	2.73	.06
K2O	.11				9.20	13.1	.04	1.73	ND
TOTAL	101.6	101.1	101.3	101.3	93.2	99.2	97.3	98.3	101.5

IONIC PROPORTIONS

SI	1.939	.007	.004	.995	5.118	2.969	1.142	5.445	.018
TI	.005	.001	.002	.002	.143	.001	.010	.077	.002
AL	.783	1.842	1.828	1.999	2.905	1.029	.329	3.160	1.881
CR		.005	.005		.009				.002
FE	.048	.660	.680	.004	1.366	.004	.225	1.577	.707
MN		.009	.008		.009		.007	.025	.006
MG	.253	.542	.551	.003	2.820	.002	.400	2.451	.413
CA	.342	.002	.001		.045	.023	.548	1.626	.009
NA	.579				.135	.201	.042	.751	.003
K	.005				1.598	.772	.001	.313	
TOTAL	3.956	3.069	3.078	3.004	14.148	5.002	2.705	15.428	3.041
OXYGEN	6	4	4	5	20	8	4	22	4

M: 83.95 M: 45.07 M: 44.77 M: 67.36 M: 64.05 M: 60.85 M: 36.89

CA 53.13
MG 39.35
FE 7.52

C: 57.45

JJG143 - TYPE I MAIN GROUP ECLOGITE (INHOMOGENEOUS KYANITE ECLOGITE)

	JJG143 GT101	JJG143 GT102	JJG143 GT103	JJG143 GT104	JJG143 GT105	JJG143 GT106	JJG143 CP201	JJG143 CP103	JJG143 CP105	JJG143 CP205
SIO2	40.8	40.5	40.9	40.6	40.1	39.6	55.6	55.8	56.6	57.1
TIO2	.28	.31	.25	.26	.35	.40	.29	.32	.24	.24
AL2O3	22.9	23.1	23.2	23.1	23.1	22.7	8.36	9.20	17.5	17.4
CR2O3	.06	ND	ND	ND	ND	.06	.05	ND	ND	.05
FEO	16.5	15.6	15.9	16.5	13.3	11.1	5.38	5.05	2.18	1.94
MNO	.43	.40	.47	.47	.27	.19	.10	.09	.04	ND
MGO	14.9	12.3	14.6	13.5	9.26	6.50	11.4	10.8	6.00	5.95
CAO	5.96	9.57	6.50	7.36	15.2	20.1	14.4	13.5	9.80	10.4
NA2O	.12	.14	.12	.10	.15	.18	5.34	5.85	8.99	5.23
K2O							.15	.13	.10	.43
TOTAL	101.9	101.9	102.0	101.9	101.7	100.8	101.1	100.8	101.5	98.7

IONIC PROPORTIONS

SI	2.959	2.955	2.961	2.957	2.949	2.954	1.977	1.981	1.945	1.988
TI	.015	.017	.014	.014	.019	.022	.008	.009	.006	.006
AL	1.958	1.987	1.980	1.984	2.003	1.996	.350	.385	.709	.714
CR	.003					.004	.001			.001
FE	1.001	.952	.963	1.005	.818	.693	.160	.150	.063	.056
MN	.026	.025	.029	.029	.017	.012	.003	.003	.001	
MG	1.610	1.338	1.575	1.465	1.015	.723	.604	.571	.307	.309
CA	.463	.748	.504	.574	1.198	1.607	.549	.514	.361	.388
NA	.017	.020	.017	.014	.021	.026	.368	.403	.599	.353
K							.007	.006	.004	.019
TOTAL	8.053	8.043	8.043	8.044	8.041	8.036	4.027	4.022	3.996	3.835
OXYGEN	12	12	12	12	12	12	6	6	6	6

M: 61.67	M: 58.42	M: 62.07	M: 59.32	M: 55.37	M: 51.06	M: 79.06	M: 79.21	M: 83.06	M: 84.53
CA 15.06	CA 24.63	CA 16.57	CA 18.86	CA 39.52	CA 53.17	CA 41.79	CA 41.59	CA 49.38	CA 51.51
MG 52.38	MG 44.03	MG 51.78	MG 48.13	MG 33.49	MG 23.91	MG 46.02	MG 46.27	MG 42.05	MG 40.99
FE 32.55	FE 31.34	FE 31.64	FE 33.01	FE 26.99	FE 22.92	FE 12.19	FE 12.14	FE 8.57	FE 7.50
						C: 47.59	C: 47.33	C: 54.01	C: 55.69

JJG177 - TYPE I MAIN GROUP ECLOGITE (INHOMOGENEOUS KYANITE ECLOGITE)

	JJG177 GT301	JJG177 GT301	JJG177 CP501	JJG177 CP101	JJG177 GT302	JJG177 GT102	JJG177 CP502	JJG177 CP102	JJG177 GT103	JJG177 GT503
SIO2	41.3	41.1	55.7	55.5	40.8	41.2	55.7	55.5	41.2	41.1
TIO2	.28	.31	.36	.36	.28	.31	.34	.34	.26	.36
AL2O3	23.2	23.3	7.70	6.02	23.0	23.2	7.66	7.19	23.1	23.0
CR2O3	.19	.19	.18	.21	.15	.15	.19	.15	.11	.15
FEO	16.4	16.4	5.15	5.59	16.4	16.3	5.08	5.17	16.6	16.5
MNO	.47	.47	.08	.09	.49	.50	.09	.09	.55	.51
MGO	15.5	15.4	12.3	13.1	15.3	15.5	12.2	12.5	14.4	14.3
CAO	4.42	4.40	14.2	15.3	4.41	4.38	14.2	14.4	5.47	5.65
NA2O	.10	.11	4.92	4.02	.12	.11	4.93	4.68	.15	.16
K2O			.12	.13			.13	.13		
TOTAL	101.9	101.7	100.7	100.3	100.9	101.6	100.5	100.1	101.8	101.7

IONIC PROPORTIONS

SI	2.980	2.971	1.983	1.993	2.974	2.978	1.986	1.988	2.986	2.983
TI	.015	.017	.010	.010	.015	.017	.009	.009	.014	.020
AL	1.973	1.986	.323	.255	1.976	1.977	.322	.304	1.974	1.968
CR	.011	.011	.005	.006	.009	.009	.005	.004	.006	.009
FE	.990	.992	.153	.168	1.000	.985	.151	.155	1.006	1.001
MN	.029	.029	.002	.003	.030	.031	.003	.003	.034	.031
MG	1.667	1.659	.653	.701	1.662	1.670	.648	.667	1.555	1.547
CA	.342	.341	.542	.589	.344	.339	.543	.553	.425	.439
NA	.014	.015	.340	.280	.017	.015	.341	.325	.021	.023
K			.005	.006			.006	.006		
TOTAL	8.020	8.021	4.016	4.010	8.027	8.020	4.014	4.014	8.021	8.020
OXYGEN	12	12	6	6	12	12	6	6	12	12
	M: 62.74	M: 62.59	M: 80.97	M: 80.68	M: 62.44	M: 62.89	M: 81.06	M: 81.16	M: 60.72	M: 60.70
	CA 11.40	CA 11.39	CA 40.20	CA 40.39	CA 11.46	CA 11.33	CA 40.42	CA 40.20	CA 14.22	CA 14.71
	MG 55.59	MG 55.46	MG 48.43	MG 48.10	MG 55.29	MG 55.76	MG 48.30	MG 48.54	MG 52.08	MG 51.77
	FE 33.01	FE 33.14	FE 11.38	FE 11.52	FE 33.26	FE 32.91	FE 11.29	FE 11.27	FE 33.69	FE 33.52
			C: 45.36	C: 45.64			C: 45.56	C: 45.30		

JJG177 - TYPE I MAIN GROUP ECLOGITE (INHOMOGENEOUS KYANITE ECLOGITE)

	JJG177 CP303	JJG177 CP103	JJG177 GT104	JJG177 GT504	JJG177 CP304	JJG177 GT305	JJG177 CP106	JJG177 CP206	JJG177 CP206	JJG177 GT108
SIO2	56.2	55.9	40.9	41.0	56.0	40.1	56.7	51.5	61.9	39.4
TIO2	.36	.34	.28	.28	.34	.33	.29	.46	.22	.30
AL2O3	9.54	8.37	23.0	23.3	8.92	23.2	17.7	15.5	21.8	22.8
CR2O3	.16	.15	.09	.14	.18	ND	ND	.05	ND	.05
FEO	4.25	4.72	16.4	16.3	4.47	15.3	2.58	3.47	1.85	15.9
MNO	.08	.08	.57	.50	.08	.28	ND	.05	.05	.37
MGO	10.6	11.4	14.6	14.6	11.1	8.95	5.44	9.24	3.53	7.40
CAO	13.7	14.0	5.49	5.40	13.8	13.7	9.15	15.1	4.92	14.8
NA2O	5.86	5.27	.14	.12	5.58	.18	8.86	3.55	7.95	.17
K2O	.13	.12			.12		.07	.22	.09	
TOTAL	100.9	100.3	101.5	101.6	100.6	102.1	100.8	99.1	102.3	101.2

IONIC PROPORTIONS

SI	1.985	1.991	2.975	2.973	1.987	2.952	1.956	1.843	2.034	2.950
TI	.010	.009	.015	.015	.009	.018	.008	.012	.005	.017
AL	.397	.351	1.972	1.992	.373	2.014	.720	.654	.845	2.012
CR	.004	.004	.005	.008	.005			.001		.003
FE	.126	.141	.998	.988	.133	.942	.074	.104	.051	.995
MN	.002	.002	.035	.031	.002	.017		.002	.001	.023
MG	.558	.605	1.583	1.578	.587	.982	.280	.493	.173	.826
CA	.519	.534	.428	.420	.525	1.081	.338	.579	.173	1.187
NA	.401	.364	.020	.017	.384	.026	.593	.246	.507	.025
K	.006	.005			.005		.003	.010	.004	
TOTAL	4.008	4.007	8.031	8.021	4.010	8.034	3.974	3.945	3.793	8.038
OXYGEN	6	6	12	12	6	12	6	6	6	12
	M: 81.63	M: 81.15	M: 61.34	M: 61.48	M: 81.57	M: 51.04	M: 78.98	M: 82.59	M: 77.27	M: 45.34
	CA 43.14	CA 41.74	CA 14.22	CA 14.05	CA 42.17	CA 35.97	CA 48.85	CA 49.25	CA 43.64	CA 39.46
	MG 46.42	MG 47.27	MG 52.61	MG 52.84	MG 47.17	MG 32.68	MG 40.40	MG 41.92	MG 43.55	MG 27.44
	FE 10.44	FE 10.98	FE 33.16	FE 33.11	FE 10.66	FE 31.35	FE 10.75	FE 8.83	FE 12.81	FE 33.09
	C: 48.17	C: 46.89			C: 47.20		C: 54.74	C: 54.02	C: 50.05	

JJG177 - TYPE I MAIN GROUP ECLOGITE (INHOMOGENEOUS KYANITE ECLOGITE)

	JJG177 GT308	JJG177 CP109	JJG177 GT510	JJG177 GT310
SIO2	40.1	52.9	39.7	39.5
TIO2	.35	.29	.35	.35
AL2O3	22.9	23.7	22.6	22.6
CR2O3	ND	ND	.05	.05
FEO	14.6	1.37	14.3	14.8
MNO	.40	ND	.31	.31
MGO	7.67	4.90	7.30	6.98
CAO	15.2	6.23	15.9	16.2
NA2O	.15	7.32	.12	.17
K2O		.42		
TOTAL	101.4	97.2	100.6	100.9

IONIC PROPORTIONS

SI	2.976	1.860	2.974	2.961
TI	.020	.008	.020	.020
AL	2.004	.982	1.996	1.997
CR			.003	.003
FE	.906	.040	.896	.928
MN	.025		.020	.020
MG	.848	.257	.815	.780
CA	1.209	.235	1.276	1.299
NA	.022	.499	.017	.025
K		.019		
TOTAL	8.012	3.900	8.016	8.032
OXYGEN	12	6	12	12

M: 48.35	M: 86.44	M: 47.64	M: 45.66
CA 40.79	CA 44.14	CA 42.73	CA 43.22
MG 28.63	MG 48.29	MG 27.28	MG 25.93
FE 30.58	FE 7.58	FE 29.99	FE 30.85
	C: 47.76		

JJG178 - TYPE I CALCIUM-RICH ECLOGITE (INHOMOGENEOUS KYANITE ECLOGITE)

	JJG178 GT501	JJG178 GT402	JJG178 CP102	JJG178 CP203	JJG178 CP103	JJG178 GT104	JJG178 GT504	JJG178 GT305
SIO2	39.9	40.2	57.4	59.8	57.0	40.1	40.2	40.5
TIO2	.33	.30	.32	.27	.32	.23	.23	.20
AL2O3	23.0	23.2	16.0	15.8	15.2	23.1	23.3	23.5
CR2O3	ND	ND	.05	ND	ND	.05	ND	.05
FEO	12.6	14.5	2.51	1.76	2.68	15.2	15.1	15.3
MNO	.24	.33	ND	.04	.07	.40	.38	.40
MGO	10.8	12.3	7.07	6.09	7.31	12.9	12.9	13.6
CAO	12.9	8.97	10.2	10.9	10.4	7.47	7.53	7.00
NA2O	.15	.14	8.31	6.89	8.43	.12	.12	.15
K2O			.07	.28	.09			
TOTAL	99.9	100.0	101.9	101.8	101.5	99.6	99.8	100.7

IONIC PROPORTIONS

SI	2.960	2.971	1.965	2.026	1.966	2.973	2.971	2.964
TI	.018	.017	.008	.007	.008	.013	.013	.011
AL	2.012	2.021	.646	.631	.618	2.019	2.030	2.028
CR			.001			.003		.003
FE	.780	.896	.072	.050	.077	.943	.933	.936
MN	.015	.021		.001	.002	.025	.024	.025
MG	1.194	1.355	.361	.308	.376	1.425	1.421	1.483
CA	1.025	.710	.374	.396	.384	.593	.596	.549
NA	.022	.020	.551	.453	.564	.017	.017	.021
K			.003	.012	.004			
TOTAL	8.026	8.011	3.981	3.884	4.000	8.012	8.008	8.020
OXYGEN	12	12	6	6	6	12	12	12

M: 60.49	M: 60.19	M: 83.39	M: 86.05	M: 82.94	M: 60.20	M: 60.35	M: 61.30
CA 34.19	CA 23.99	CA 46.38	CA 52.55	CA 45.90	CA 20.04	CA 20.21	CA 18.49
MG 39.81	MG 45.75	MG 44.71	MG 40.83	MG 44.87	MG 48.13	MG 48.16	MG 49.97
FE 26.00	FE 30.26	FE 8.91	FE 6.62	FE 9.23	FE 31.83	FE 31.63	FE 31.54
		C: 50.91	C: 56.27	C: 50.57			

JJG179 - TYPE I CALCIUM-RICH ECLOGITE (INHOMOGENEOUS KYANITE ECLOGITE)

	JJG179 GT501	JJG179 CP101	JJG179 GT302	JJG179 CP502	JJG179 GT503	JJG179 CP403	JJG179 CP603
SIO2	41.1	57.4	41.2	57.8	40.9	57.1	55.7
TIO2	.27	.34	.27	.29	.30	.29	.27
AL2O3	23.4	16.4	23.5	16.1	23.2	17.1	17.4
CR2O3	ND	.07	.05	.05	ND	ND	ND
FEO	14.3	2.39	13.8	2.37	12.3	2.12	1.94
MNO	.37	.04	.35	.04	.23	ND	ND
MGO	13.4	6.88	13.8	6.82	11.7	6.34	5.91
CAO	7.98	9.63	7.89	9.78	12.7	9.78	9.41
NA2O	.14	8.44	.15	8.06	.15	8.54	8.09
K2O		.07		.06		.09	.21
TOTAL	101.0	101.7	101.0	101.4	101.5	101.4	99.0

IONIC PROPORTIONS

SI	2.990	1.965	2.989	1.981	2.975	1.958	1.953
TI	.015	.009	.015	.007	.016	.007	.007
AL	2.007	.662	2.010	.650	1.990	.691	.719
CR		.002	.003	.001			
FE	.870	.068	.837	.068	.748	.061	.057
MN	.023	.001	.022	.001	.014		
MG	1.453	.351	1.492	.348	1.268	.324	.309
CA	.622	.353	.613	.359	.990	.359	.354
NA	.020	.560	.021	.536	.021	.568	.550
K		.003		.003		.004	.009
TOTAL	8.001	3.976	8.001	3.955	8.024	3.974	3.959
OXYGEN	12	6	12	6	12	6	6

M: 62.54	M: 83.69	M: 64.05	M: 83.68	M: 62.90	M: 84.20	M: 84.44
CA 21.12	CA 45.72	CA 20.84	CA 46.32	CA 32.92	CA 48.29	CA 49.15
MG 49.33	MG 45.43	MG 50.70	MG 44.92	MG 42.19	MG 43.54	MG 42.94
FE 29.54	FE 8.86	FE 28.45	FE 8.76	FE 24.89	FE 8.17	FE 7.91
	C: 50.16		C: 50.76		C: 52.59	C: 53.37

JJG181 - TYPE I PHLOGOPITISED ECLOGITE

	JJG181 GT101	JJG181 GT501	JJG181 GT101	JJG181 GT501	JJG181 CP102	JJG181 CP302	JJG181 CP502	JJG181 GT105	JJG181 GT505	JJG181 GT106
SIO2	40.7	41.1	41.0	41.3	51.8	55.1	54.8	41.1	41.5	40.9
TIO2	.25	.28	.26	.26	.22	.20	.19	.26	.28	.26
AL2O3	22.6	22.8	23.0	23.5	3.11	3.16	2.68	23.3	23.4	23.1
CR2O3	.19	.25	.23	.26	.57	.49	.58	.21	.20	.25
FEO	17.4	15.4	18.3	15.4	5.90	6.14	6.03	17.4	15.7	17.6
MNO	.39	.47	.46	.56	.13	.14	.14	.52	.55	.54
MGO	15.4	16.8	15.5	16.5	14.7	15.4	15.8	15.6	16.7	15.5
CAO	3.44	3.60	3.35	4.15	16.3	17.4	17.9	3.77	3.76	3.85
NA2O	.12	.07	.10	.16	2.30	2.58	2.33	.10	.07	.06
K2O					.12	.11	.08			
TOTAL	100.5	100.7	102.2	102.1	95.1	100.7	100.5	102.3	102.2	102.1

IONIC PROPORTIONS

SI	2.965	2.981	2.967	2.961	1.982	1.990	1.987	2.964	2.971	2.960
TI	.014	.015	.014	.014	.006	.005	.005	.014	.015	.014
AL	1.954	1.951	1.962	1.986	.140	.135	.115	1.981	1.975	1.971
CR	.011	.014	.013	.015	.017	.014	.017	.012	.011	.014
FE	1.067	.933	1.108	.923	.189	.186	.183	1.049	.940	1.065
MN	.024	.029	.028	.034	.004	.004	.004	.032	.033	.033
MG	1.683	1.813	1.672	1.763	.838	.829	.854	1.676	1.782	1.672
CA	.270	.280	.260	.319	.668	.674	.695	.291	.288	.299
NA	.017	.010	.014	.022	.171	.181	.164	.014	.010	.008
K					.006	.005	.004			
TOTAL	8.027	8.026	8.038	8.036	4.021	4.023	4.026	8.033	8.026	8.037
OXYGEN	12	12	12	12	6	6	6	12	12	12

M: 61.20	M: 66.02	M: 60.15	M: 65.63	M: 81.62	M: 81.72	M: 82.36	M: 61.50	M: 65.46	M: 61.08
CA 8.95	CA 9.25	CA 8.55	CA 10.61	CA 39.42	CA 39.90	CA 40.15	CA 9.65	CA 9.58	CA 9.84
MG 55.72	MG 59.91	MG 55.01	MG 58.67	MG 49.44	MG 49.11	MG 49.29	MG 55.57	MG 59.19	MG 55.07
FE 35.33	FE 30.83	FE 36.44	FE 30.73	FE 11.14	FE 10.99	FE 10.56	FE 34.78	FE 31.23	FE 35.09
				C: 44.36	C: 44.82	C: 44.89			

JJG181 - TYPE I PHLOGOPITISED ECLOGITE

	JJG181 GT406
SIO2	41.4
TIO2	.26
AL2O3	23.2
CR2O3	.31
FEO	16.0
MNO	.60
MGO	16.3
CAO	4.16
NA2O	.08
K2O	
TOTAL	102.3

IONIC PROPORTIONS

SI	2.969
TI	.014
AL	1.962
CR	.018
FE	.960
MN	.036
MG	1.742
CA	.320
NA	.011
K	
TOTAL	8.032
OXYGEN	12

M: 64.48

CA 10.58
MG 57.66
FE 31.76

JJG183 - TYPE II MAGNESIAN ECLOGITE

	JJG183 GT101	JJG183 GT601	JJG183 CP401	JJG183 CP101	JJG183 GT401	JJG183 CP602	JJG183 CP102
SIO2	42.6	42.2	55.4	55.1	42.0	55.0	54.2
TIO2	.23	.18	.27	.32	.23	.29	.31
AL2O3	23.9	23.1	3.29	4.18	22.4	3.11	3.50
CR2O3	.64	1.74	2.22	2.17	2.18	1.85	2.29
FEO	8.73	8.60	2.93	2.83	8.60	2.93	2.83
MNO	.38	.36	.08	.10		.09	.09
MGO	21.3	21.0	15.5	14.7	20.9	15.5	14.9
CAO	3.99	4.15	18.1	17.2	4.37	18.1	17.3
NA2O	.09	.10	3.17	3.60	.06	3.05	3.53
K2O			ND	ND		ND	ND
TOTAL	101.9	101.4	101.0	100.2	100.7	99.9	99.0

IONIC PROPORTIONS

SI	2.967	2.963	1.981	1.980	2.971	1.987	1.978
TI	.012	.010	.007	.009	.012	.008	.009
AL	1.962	1.912	.139	.177	1.868	.132	.151
CR	.035	.097	.063	.062	.122	.053	.066
FE	.508	.505	.088	.085	.509	.089	.086
MN	.022	.021	.002	.003		.003	.003
MG	2.211	2.197	.826	.787	2.204	.834	.810
CA	.298	.312	.694	.662	.331	.700	.677
NA	.012	.014	.220	.251	.008	.214	.250
K							
TOTAL	8.028	8.030	4.021	4.017	8.026	4.020	4.030
OXYGEN	12	12	6	6	12	6	6

M: 81.30	M: 81.31	M: 90.41	M: 90.25	M: 81.24	M: 90.41	M: 90.37
CA 9.87	CA 10.36	CA 43.15	CA 43.16	CA 10.88	CA 43.15	CA 43.00
MG 73.28	MG 72.89	MG 51.40	MG 51.30	MG 72.40	MG 51.40	MG 51.51
FE 16.85	FE 16.75	FE 5.45	FE 5.54	FE 16.72	FE 5.45	FE 5.49
		C: 45.64	C: 45.69		C: 45.64	C: 45.50

JJG246 - TYPE I MAIN GROUP ECLOGITE

	JJG246 GT101	JJG246 CP102	JJG246 GT102	JJG246 GT103	JJG246 CP103	JJG246 CP104	JJG246 SP 1	JJG246 GUNGU	JJG246 GUNGU	JJG246 GUNGU
SIO2	41.2	55.7	41.2	41.0	55.9	56.7	.08	33.4	34.8	35.2
TIO2	.25	.29	.25	.23	.31	.31	.11	.23	.21	.31
AL2O3	23.3	7.18	23.2	23.2	7.66	7.98	59.7	21.8	17.2	16.8
CR2O3	.14	.15	.19	.14	.15	.15	.32	.28	.15	.22
FEO	14.9	4.57	14.8	14.9	4.33	4.12	25.5	14.4	14.3	15.0
MNO	.35	.07	.35	.33	.05	.08	.28	.29	.32	.29
MGO	15.9	12.8	15.9	15.8	12.3	12.1	16.2	20.0	21.2	21.1
CAO	5.06	15.3	5.02	5.07	15.0	14.9	.03	.66	.51	.61
NA2O	.12	4.38	.05	.09	4.50	4.85	ND	.15	.12	.15
K2O		.16			.16	.12	ND	1.44	.69	.14
TOTAL	101.2	100.6	101.0	100.8	100.4	101.3	102.2	92.6	89.5	89.8

IONIC PROPORTIONS

SI	2.976	1.984	2.981	2.976	1.990	1.996	.002	.891	.957	.965
TI	.014	.008	.014	.013	.008	.008	.002	.005	.004	.006
AL	1.984	.302	1.979	1.985	.322	.331	1.852	.686	.558	.543
CR	.008	.004	.011	.008	.004	.004	.007	.006	.003	.005
FE	.900	.136	.896	.904	.129	.121	.561	.321	.329	.344
MN	.021	.002	.021	.020	.002	.002	.006	.007	.007	.007
MG	1.712	.680	1.715	1.709	.653	.635	.635	.795	.869	.862
CA	.392	.584	.389	.394	.572	.562	.001	.019	.015	.018
NA	.017	.303	.007	.013	.311	.331		.008	.006	.008
K		.007			.007	.005		.049	.024	.005
TOTAL	8.023	4.010	8.013	8.022	3.998	3.996	3.067	2.787	2.773	2.762
OXYGEN	12	6	12	12	6	6	4	4	4	4

M: 65.54	M: 83.31	M: 65.69	M: 65.39	M: 83.50	M: 83.96	M: 53.10	M: 71.22	M: 72.54	M: 71.48
CA 13.04	CA 41.72	CA 12.98	CA 13.11	CA 42.27	CA 42.64				
MG 56.99	MG 48.55	MG 57.16	MG 56.82	MG 48.21	MG 48.16				
FE 29.97	FE 9.73	FE 29.86	FE 30.07	FE 9.52	FE 9.20				
	C: 46.22			C: 46.72	C: 46.96				

JJG246 - TYPE I MAIN GROUP ECLOGITE

	JJG246 MI 2	HRV246 MI 1	JJG246 SP 2
SIO2	38.9	40.4	3.00
TIO2	2.65	2.81	.18
AL2O3	15.6	16.4	59.0
CR2O3	.09	.09	.30
FEO	11.0	10.7	21.2
MNO	.15	.12	.24
MGO	18.2	16.3	14.7
CAO	.20	.29	.11
NA2O	.82	.94	ND
K2O	8.06	8.20	.23
TOTAL	95.7	96.2	99.0

IONIC PROPORTIONS

SI	5.116	5.249	.079
TI	.262	.275	.004
AL	2.419	2.512	1.842
CR	.009	.009	.006
FE	1.210	1.163	.469
MN	.017	.013	.005
MG	3.567	3.156	.580
CA	.028	.040	.003
NA	.209	.237	
K	1.352	1.359	.008
TOTAL	14.189	14.014	2.997
OXYGEN	20	20	4

M: 74.67 M: 73.08 M: 55.27

JJG307 - TYPE II GARNET WEBSTERITE

	JJG307 GT101	JJG307 GT601	JJG307 GT102	JJG307 GT602	JJG307 CP102	JJG307 CP402
SIO2	42.4	42.5	42.4	42.4	55.5	55.4
TIO2	.30	.30	.30	.28	.27	.29
AL2O3	23.2	23.3	23.2	23.2	3.04	3.09
CR2O3	1.19	1.23	1.18	1.27	.79	.72
FEO	8.63	8.55	8.60	8.56	2.91	2.84
MNO	.51	.34	.32	.34	.09	.08
MGO	20.7	20.6	20.6	20.7	16.7	16.7
CAO	4.21	4.14	4.10	4.12	19.1	19.2
NA2O	.08	.10	.09	.05	2.49	2.47
K2O					ND	ND
TOTAL	101.0	101.1	100.8	100.9	100.9	100.8

IONIC PROPORTIONS

SI	2.982	2.986	2.987	2.984	1.982	1.980
TI	.016	.016	.016	.015	.007	.008
AL	1.924	1.930	1.927	1.925	.128	.130
CR	.066	.068	.066	.071	.022	.020
FE	.508	.502	.507	.504	.087	.085
MN	.018	.020	.019	.020	.003	.002
MG	2.170	2.157	2.163	2.171	.889	.890
CA	.317	.312	.310	.311	.731	.735
NA	.011	.014	.012	.007	.172	.171
K						
TOTAL	8.012	8.006	8.007	8.007	4.022	4.023
OXYGEN	12	12	12	12	6	6

M: 81.04	M: 81.11	M: 81.02	M: 81.16	M: 91.09	M: 91.29
CA 10.59	CA 10.49	CA 10.39	CA 10.41	CA 42.83	CA 43.01
MG 72.45	MG 72.60	MG 72.60	MG 72.72	MG 52.08	MG 52.03
FE 16.95	FE 16.91	FE 17.01	FE 16.88	FE 5.09	FE 4.97
				C: 45.12	C: 45.25

JJG309 - TYPE I PHLOGOPITISED ECLOGITE

	JJG309 GT101	JJG309 GT301	JJG309 CP501	JJG309 GT102	JJG309 GT302	JJG309 CP502	JJG309 MI 2
SIO2	41.6	41.8	54.8	42.9	43.0	55.4	42.3
TIO2	.26	.28	.10	.18	.25	.12	1.08
AL2O3	22.3	22.4	1.74	23.6	23.6	1.70	12.6
CR2O3	.84	1.38	.57	.12	.34	.57	.18
FEO	14.6	14.8	5.51	15.3	15.0	5.92	7.64
MNO	.60	.60	.21	.74	.61	.20	.05
MGO	17.3	17.4	16.9	16.9	17.5	16.6	22.7
CAO	4.56	4.62	18.8	4.30	4.33	18.9	ND
NA2O	.08	.08	1.56	.09	.08	1.56	.08
K2O			.06			.06	10.4
TOTAL	102.1	103.4	100.2	104.2	104.7	101.0	97.0

IONIC PROPORTIONS

SI	2.981	2.966	1.991	3.005	2.994	1.999	5.433
TI	.014	.015	.003	.009	.013	.003	.104
AL	1.884	1.874	.075	1.952	1.937	.072	1.908
CR	.048	.077	.016	.007	.019	.016	.018
FE	.875	.878	.167	.896	.873	.179	.821
MN	.036	.036	.006	.044	.036	.006	.005
MG	1.847	1.840	.915	1.764	1.816	.892	4.345
CA	.350	.351	.732	.323	.323	.731	
NA	.011	.011	.110	.012	.011	.109	.020
K			.003			.003	1.704
TOTAL	8.045	8.049	4.017	8.012	8.021	4.010	14.361
OXYGEN	12	12	6	12	12	6	20

M: 67.86	M: 67.69	M: 84.53	M: 66.31	M: 67.52	M: 83.32	M: 84.11
CA 11.39	CA 11.44	CA 40.34	CA 10.82	CA 10.72	CA 40.55	
MG 60.13	MG 59.94	MG 50.43	MG 59.14	MG 60.28	MG 49.54	
FE 28.48	FE 28.61	FE 9.23	FE 30.04	FE 29.00	FE 9.91	
		C: 44.44			C: 45.01	

JJG316 - TYPE I CALCIUM-RICH ECLOGITE

	JJG316 GT101	JJG316 GT301	JJG316 AM 1	JJG316 CP301	JJG316 CP101	JJG316 GT102	JJG316 CP102	JJG316 CP203	JJG316 CP204	JJG316 WHAT
SIO2	40.7	40.6	40.9	56.2	56.0	40.7	56.1	53.2	53.6	51.2
TIO2	.26	.30	.70	.34	.32	.28	.32	.44	.37	.20
AL2O3	23.2	23.2	18.7	10.4	10.5	23.1	10.3	8.96	8.00	20.9
CR2O3	.06	.09	.05	.07	.07	.08	.08	.08	.10	.10
FEO	15.0	15.0	11.4	3.66	3.74	15.0	3.57	5.95	5.43	7.30
MNO	.36	.37	.17	.08	.05	.35	.05	.12	.09	.10
MGO	14.4	14.2	12.0	10.3	10.3	14.3	10.4	12.6	12.6	9.36
CAO	6.82	6.88	8.80	13.6	13.5	6.30	13.6	16.0	16.2	.58
NA2O	.15	.10	3.45	5.95	6.01	.15	5.90	3.62	3.80	.57
K2O			1.58	.15	.15		.13	ND	ND	.85
TOTAL	100.9	100.7	97.7	100.7	100.6	100.3	100.4	101.0	100.2	91.2

IONIC PROPORTIONS

SI	2.966	2.966	5.719	1.980	1.976	2.981	1.981	1.905	1.932	1.267
TI	.014	.016	.074	.009	.008	.015	.008	.012	.010	.004
AL	1.993	1.998	3.083	.432	.437	1.995	.429	.378	.340	.610
CR	.003	.005	.006	.002	.002	.005	.002	.002	.003	.002
FE	.914	.916	1.333	.108	.110	.919	.105	.178	.164	.151
MN	.022	.023	.020	.002	.001	.022	.001	.004	.003	.002
MG	1.564	1.546	2.501	.541	.542	1.561	.547	.673	.677	.345
CA	.533	.539	1.319	.513	.510	.494	.515	.614	.626	.015
NA	.021	.014	.935	.406	.411	.021	.404	.251	.266	.027
K			.282	.007	.007		.006			.027
TOTAL	8.032	8.023	15.271	4.001	4.005	8.014	4.000	4.019	4.020	2.450
OXYGEN	12	12	22	6	6	12	6	6	6	4

M: 63.11	M: 62.78	M: 65.23	M: 83.37	M: 83.07	M: 62.95	M: 83.85	M: 79.05	M: 80.53	M: 69.56
CA 17.69	CA 17.95		CA 44.18	CA 43.91	CA 16.62	CA 44.08	CA 41.92	CA 42.67	
MG 51.95	MG 51.52		MG 46.54	MG 46.60	MG 52.48	MG 46.89	MG 45.91	MG 46.16	
FE 30.37	FE 30.54		FE 9.28	FE 9.49	FE 30.89	FE 9.03	FE 12.17	FE 11.16	
			C: 48.70	C: 48.52		C: 48.46	C: 47.73	C: 48.04	

JJG318 - TYPE I CALCIUM-RICH ECLOGITE

	JJG318 GT101	JJG318 CP102	JJG318 CP103
SIO2	41.5	57.5	57.2
TIO2	.17	.17	.27
AL2O3	23.8	14.3	12.7
CR2O3	.05	.08	.08
FEO	9.73	1.55	2.27
MNO	.19	ND	ND
MGO	16.2	9.15	10.0
CAO	9.02	11.4	13.3
NA2O	.08	6.75	6.22
K2O		.11	.12
TOTAL	100.7	101.0	102.2

IONIC PROPORTIONS

SI	2.972	1.978	1.967
TI	.009	.004	.007
AL	2.009	.580	.515
CR	.003	.002	.002
FE	.583	.045	.065
MN	.012		
MG	1.729	.469	.511
CA	.692	.420	.490
NA	.011	.450	.415
K		.005	.005
TOTAL	8.019	3.954	3.978
OXYGEN	12	6	6
	M: 74.79	M: 91.32	M: 88.67
	CA 23.04	CA 44.99	CA 45.96
	MG 57.56	MG 50.23	MG 47.92
	FE 19.40	FE 4.77	FE 6.12
		C: 47.25	C: 48.96

JJG339 - TYPE I PHLOGOPITISED ECLOGITE

	JJG339 GT101	JJG339 GT301	JJG339 CP501	JJG339 GT102	JJG339 GT402	JJG339 CP103	JJG339 CP602	JJG339 RR 1	JJG339 MI 1	JJG339 MI 2
SIO2	40.6	40.4	53.6	40.8	40.7	55.0	55.1	37.5	42.8	42.1
TIO2	.15	.15	.07	.15	.16	.07	.08	.07	1.19	1.29
AL2O3	22.8	22.6	2.21	22.5	22.5	2.21	2.23	13.1	16.4	11.8
CR2O3	.08	.17	.21	.17	.31	.26	.24	1.97	.14	.16
FEO	16.7	16.5	6.54	16.4	16.5	6.55	6.59	17.3	8.93	9.16
MNO	.69	.66	.18	.64	.65	.20	.17	.13	ND	.05
MGO	15.5	15.2	15.7	15.5	15.4	16.2	16.1	19.6	21.5	22.4
CAO	3.89	4.26	18.3	4.31	4.41	18.5	18.6	.73	.04	.04
NA2O	.05	.05	1.78	.05	.07	1.76	1.78	.39	ND	.32
K2O			.13			.13	.12	.63	10.2	10.8
TOTAL	100.5	100.0	98.7	100.5	100.7	100.9	101.0	91.4	101.3	98.1

IONIC PROPORTIONS

SI	2.976	2.978	1.986	2.988	2.980	1.991	1.992	1.028	5.262	5.414
TI	.008	.008	.002	.008	.009	.002	.002	.001	.110	.125
AL	1.970	1.964	.097	1.943	1.942	.094	.095	.423	2.377	1.789
CR	.005	.010	.006	.010	.018	.007	.007	.043	.014	.016
FE	1.024	1.017	.203	1.005	1.010	.198	.199	.397	.918	.985
MN	.043	.041	.006	.040	.040	.006	.005	.003		.005
MG	1.693	1.670	.867	1.692	1.680	.874	.868	.801	3.939	4.293
CA	.306	.336	.727	.338	.346	.718	.721	.021	.005	.006
NA	.007	.007	.128	.007	.010	.124	.125	.021		.080
K			.006			.006	.006	.022	1.600	1.772
TOTAL	8.032	8.031	4.027	8.031	8.036	4.021	4.020	2.759	14.236	14.485
OXYGEN	12	12	6	12	12	6	6	4	20	20

	M: 62.32	M: 62.14	M: 81.05	M: 62.74	M: 62.45	M: 81.51	M: 81.32	M: 66.88	M: 81.10	M: 81.34
	CA 10.11	CA 11.13	CA 40.45	CA 11.15	CA 11.39	CA 40.09	CA 40.32			
	MG 56.02	MG 55.23	MG 48.27	MG 55.75	MG 55.34	MG 48.83	MG 48.54			
	FE 33.87	FE 33.64	FE 11.28	FE 33.10	FE 33.27	FE 11.08	FE 11.15			
			C: 45.59			C: 45.09	C: 45.37			

JJG339 - TYPE I PHLOGOPITISED ECLOGITE

	JJG339 MI 3	JJG339 MI 4	JJG339 GT105	JJG339 GT105	JJG339 GT305	JJG339 GT305	JJG339 CP505	JJG339 CP505	JJG339 GT306	JJG339 GT306
SIO2	41.7	41.3	41.9	41.9	41.9	41.9	54.9	54.9	42.2	42.2
TIO2	1.17	1.26	.13	.13	.12	.12	.07	.07	.13	.13
AL2O3	11.0	11.4	23.1	23.1	23.1	23.1	2.21	2.20	23.3	23.3
CR2O3	.18	.14	.09	.09	.09	.09	.29	.29	.09	.09
FEO	9.35	9.02	16.0	16.0	16.1	16.1	6.50	9.50	16.3	16.3
MNO	.04	.05	.66	.66	.72	.72	.20	.20	.68	.68
MGO	22.3	22.7	15.5	15.5	15.5	15.5	16.0	19.0	15.6	15.6
CAO	.37	.04	4.39	4.39	4.39	4.39	18.5	18.5	4.23	4.23
NA2O	.35	.09	.10	.10	.07	.07	1.78	1.78	.10	.10
K2O	9.79	10.2					.11	ND		
TOTAL	96.2	96.2	101.9	101.9	102.0	102.0	100.6	106.4	102.6	102.6

IONIC PROPORTIONS

SI	5.455	5.403	3.015	3.015	3.013	3.013	1.994	1.914	3.014	3.014
TI	.115	.124	.007	.007	.006	.006	.002	.002	.007	.007
AL	1.696	1.758	1.959	1.959	1.958	1.958	.095	.090	1.962	1.962
CR	.019	.014	.005	.005	.005	.005	.008	.008	.005	.005
FE	1.023	.987	.963	.963	.968	.968	.197	.277	.974	.974
MN	.004	.006	.040	.040	.044	.044	.006	.006	.041	.041
MG	4.347	4.426	1.662	1.662	1.661	1.661	.866	.987	1.661	1.661
CA	.052	.006	.338	.338	.338	.338	.720	.691	.324	.324
NA	.089	.023	.014	.014	.010	.010	.125	.120	.014	.014
K	1.634	1.702					.005			
TOTAL	14.434	14.449	8.003	8.003	8.004	8.004	4.018	4.096	8.002	8.002
OXYGEN	20	20	12	12	12	12	6	6	12	12

M: 80.95	M: 81.77	M: 63.32	M: 63.32	M: 63.18	M: 63.18	M: 81.43	M: 78.09	M: 63.04	M: 63.04
		CA 11.42	CA 11.42	CA 11.40	CA 11.40	CA 40.37	CA 35.34	CA 10.94	CA 10.94
		MG 56.09	MG 56.09	MG 55.97	MG 55.97	MG 48.56	MG 50.49	MG 56.14	MG 56.14
		FE 32.49	FE 32.49	FE 32.63	FE 32.63	FE 11.07	FE 14.17	FE 32.92	FE 32.92
						C: 45.39	C: 41.18		

JJG339 - TYPE I PHLOGOPITISED ECLOGITE

	JJG339 CP506	JJG339 CP506	JJG339 MI 6	JJG339 MI 6
SIO2	54.6	54.6	39.4	39.4
TIO2	.05	.05	1.12	1.12
AL2O3	2.14	2.14	14.4	14.4
CR2O3	.26	.26	.27	.27
FEO	6.58	6.58	10.8	10.8
MNO	.17	.17	.13	.13
MGO	16.1	16.1	21.0	21.0
CAO	18.7	18.7	.03	.03
NA2O	1.63	1.60	.07	.07
K2O	.11	.11	9.72	9.72
TOTAL	100.3	100.3	96.9	96.9

IONIC PROPORTIONS

SI	1.989	1.989	5.150	5.150
TI	.001	.001	.110	.110
AL	.092	.092	2.219	2.219
CR	.007	.007	.028	.028
FE	.200	.201	1.181	1.181
MN	.005	.005	.014	.014
MG	.874	.874	4.091	4.091
CA	.730	.730	.004	.004
NA	.115	.113	.018	.018
K	.005	.005	1.621	1.621
TOTAL	4.020	4.019	14.436	14.436
OXYGEN	6	6	20	20

M: 81.34	M: 81.34	M: 77.60	M: 77.60
CA 40.45	CA 40.45		
MG 48.44	MG 48.44		
FE 11.11	FE 11.11		
C: 45.51	C: 45.51		

JJG520 - TYPE II FINE GRAINED KYANITE CORUNDUM ECLOGITE

	JJG520 GT101	JJG520 GT102	JJG520 GT103	JJG520 GT104	JJG520 CP101	JJG520 CP301	JJG520 CP103	JJG520 KY101	JJG520 CO101
SIO2	42.0	42.6	42.2	42.1	54.6	54.6	54.6	37.6	.30
TIO2	.22	.32	.30	.28	.10	.12	.19	.14	.12
AL2O3	24.2	23.1	23.6	23.1	3.13	2.37	4.42	64.0	101.0
CR2O3	.22	1.10	.48	.97	.57	1.05	.65	.23	.39
FEO	8.98	7.84	8.83	8.17	3.61	3.50	3.57	.22	.63
MNO	.21	.23	.22	.23	.08	.10	.09		
MGO	18.3	21.0	19.9	20.3	17.9	18.8	17.1	.05	.22
CAO	6.84	5.35	5.50	5.57	18.1	17.7	16.6		
NA2O	.09	ND	.08	.06	1.81	1.46	2.45		
K2O					.11	.10	.13		
TOTAL	101.1	101.6	101.1	100.8	100.0	99.8	99.8	102.2	102.7

IONIC PROPORTIONS

SI	2.968	2.978	2.973	2.973	1.967	1.970	1.963	.994	.005
TI	.012	.017	.016	.015	.003	.003	.005	.003	.001
AL	2.016	1.904	1.960	1.923	.133	.101	.187	1.995	1.977
CR	.012	.061	.027	.054	.016	.030	.018	.005	.005
FE	.531	.458	.520	.483	.109	.106	.107	.005	.009
MN	.013	.014	.013	.014	.002	.003	.003		
MG	1.931	2.188	2.089	2.136	.961	1.011	.917	.002	.005
CA	.518	.401	.415	.421	.699	.685	.639		
NA	.012		.011	.008	.126	.102	.171		
K					.005	.005	.006		
TOTAL	8.013	8.026	8.024	8.028	4.021	4.015	4.017	3.003	2.003
OXYGEN	12	12	12	12	6	6	6	5	3

	M: 78.45	M: 82.68	M: 80.06	M: 81.58	M: 89.83	M: 90.54	M: 89.52
	CA 17.38	CA 13.15	CA 13.73	CA 13.86	CA 39.51	CA 38.01	CA 38.43
	MG 64.81	MG 71.80	MG 69.07	MG 70.27	MG 54.34	MG 56.12	MG 55.12
	FE 17.81	FE 15.04	FE 17.20	FE 15.87	FE 6.15	FE 5.86	FE 6.45
					C: 42.10	C: 40.38	C: 41.08

JJG522 - TYPE II MAGNESIAN ECLOGITE

	JJG522 GT101	JJG522 GT301	JJG522 CP501	JJG522 GT102	JJG522 GT302	JJG522 CP104	JJG522 CP105	JJG522 CP202	JJG522 CP203	JJG522 CP206
SIO2	42.3	42.2	56.9	41.3	41.7	54.8	55.1	57.2	55.9	56.3
TIO2	.08	.08	.07	.10	.07	.09	.07	.03	.03	.03
AL2O3	24.3	23.5	2.38	23.6	23.8	2.48	2.40	1.85	2.06	1.82
CR2O3	.19	.21	.07	.21	.21	.08	.08	.07	ND	.07
FEO	7.22	7.09	2.33	6.92	6.87	2.51	2.56	1.48	1.56	1.38
MNO	.21	.22	.07	.18	.21	.05	.08	ND	.07	.04
MGO	21.3	21.3	17.9	21.2	21.4	18.0	17.8	18.1	17.7	18.0
CAO	4.35	4.28	20.8	4.31	4.24	20.2	20.1	22.1	21.5	21.9
NA2O	.06	.05	1.31	.08	.05	1.36	1.29	1.10	1.07	1.04
K2O			ND			ND	ND	ND	.05	ND
TOTAL	100.0	98.9	101.8	97.9	98.5	99.6	99.5	102.0	99.9	100.6

IONIC PROPORTIONS

SI	2.975	3.000	2.003	2.968	2.974	1.979	1.989	2.009	2.004	2.005
TI	.004	.004	.002	.005	.004	.002	.002	.001	.001	.001
AL	2.015	1.969	.099	2.000	2.001	.106	.102	.077	.087	.076
CR	.011	.012	.002	.012	.012	.002	.002	.002		.002
FE	.425	.421	.069	.416	.410	.076	.077	.043	.047	.041
MN	.013	.013	.002	.011	.013	.002	.002		.002	.001
MG	2.233	2.256	.939	2.271	2.275	.969	.958	.948	.946	.956
CA	.328	.326	.785	.332	.324	.782	.778	.832	.826	.836
NA	.008	.007	.089	.011	.007	.095	.090	.075	.074	.072
K									.002	
TOTAL	8.012	8.009	3.990	8.026	8.019	4.013	4.002	3.988	3.990	3.991
OXYGEN	12	12	6	12	12	6	6	6	6	6

M: 84.02	M: 84.26	M: 93.19	M: 84.52	M: 84.73	M: 92.74	M: 92.53	M: 95.61	M: 95.29	M: 95.88
CA 10.98	CA 10.85	CA 43.78	CA 11.00	CA 10.77	CA 42.80	CA 42.90	CA 45.63	CA 45.42	CA 45.61
MG 74.79	MG 75.12	MG 52.40	MG 75.23	MG 75.61	MG 53.05	MG 52.84	MG 51.98	MG 52.01	MG 52.14
FE 14.23	FE 14.03	FE 3.83	FE 13.78	FE 13.62	FE 4.15	FE 4.26	FE 2.39	FE 2.57	FE 2.24
		C: 45.52			C: 44.65	C: 44.81	C: 46.75	C: 46.62	C: 46.66

JJG522 - TYPE II MAGNESIAN ECLOGITE

	JJG522 MI 1	JJG522 MI 2
SIO2	41.1	43.1
TIO2	1.08	1.17
AL2O3	14.1	13.4
CR2O3	.11	.16
FEO	4.55	4.03
MNO	ND	ND
MGO	24.6	24.3
CAO	.06	ND
NA2O	.14	.12
K2O	9.47	9.70
TOTAL	95.2	96.0

IONIC PROPORTIONS

SI	5.283	5.464
TI	.104	.112
AL	2.137	2.003
CR	.011	.016
FE	.489	.427
MN		
MG	4.712	4.591
CA	.008	
NA	.035	.029
K	1.553	1.569
TOTAL	14.333	14.215
OXYGEN	20	20

M: 90.60 M: 91.49

KRV 1 - TYPE I IRON-RICH ECLOGITE

	KRV 1 GT401	KRV 1 CP601
SIO2	40.2	54.7
TIO2	.29	.34
AL2O3	22.8	6.84
CR2O3	.12	.09
FEO	18.4	6.47
MNO	.60	.15
MGO	13.4	12.2
CAO	4.58	14.2
NA2O	.05	4.50
K2O		.16
TOTAL	100.4	99.6

IONIC PROPORTIONS

SI	2.976	1.983
TI	.016	.009
AL	1.990	.292
CR	.007	.003
FE	1.139	.196
MN	.038	.005
MG	1.478	.659
CA	.363	.552
NA	.007	.316
K		.007
TOTAL	8.014	4.022
OXYGEN	12	6

M: 56.48	M: 77.07
CA 12.19	CA 39.21
MG 49.60	MG 46.85
FE 38.22	FE 13.94
	C: 45.56

KRV 2 - TYPE I IRON-RICH ECLOGITE

	KRV 2B GT101	KRV 2B GT501	KRV 2B GT102	KRV 2B GT502	KRV 2B CP101	KRV 2B CP301	KRV 2B CP401	KRV 2B CP501
SIO2	39.9	40.1	39.9	40.0	55.3	55.2	55.1	55.4
TIO2	.31	.29	.35	.27	.31	.29	.31	.31
AL2O3	22.6	22.7	22.4	22.7	8.55	7.53	8.55	8.46
CR2O3	.14	.13	.14	.15	.12	.13	.12	.13
FEO	17.9	18.3	18.6	18.6	4.05	5.88	4.02	4.45
MNO	.46	.44	.43	.47	.04	.09	.06	.04
MGO	13.9	13.7	13.6	13.9	11.2	11.8	11.2	11.3
CAO	4.14	4.33	4.43	4.22	14.8	13.9	15.0	14.5
NA2O					4.90	4.96	5.03	5.12
K2O					.21	.15	.19	.16
TOTAL	99.3	100.0	99.8	100.3	99.5	99.9	99.6	99.9

IONIC PROPORTIONS

SI	2.976	2.976	2.973	2.964	1.985	1.987	1.978	1.984
TI	.017	.016	.020	.015	.008	.008	.008	.008
AL	1.987	1.986	1.968	1.983	.362	.320	.362	.357
CR	.008	.008	.008	.009	.003	.004	.003	.004
FE	1.116	1.136	1.159	1.153	.122	.177	.121	.133
MN	.029	.028	.027	.030	.001	.003	.002	.001
MG	1.545	1.516	1.510	1.535	.599	.633	.599	.603
CA	.331	.344	.354	.335	.569	.536	.577	.556
NA					.341	.346	.350	.355
K					.010	.007	.009	.007
TOTAL	8.009	8.010	8.019	8.024	4.000	4.020	4.010	4.009
OXYGEN	12	12	12	12	6	6	6	6

	M: 58.05	M: 57.16	M: 56.58	M: 57.11	M: 83.13	M: 78.15	M: 83.23	M: 81.90
	CA 11.06	CA 11.50	CA 11.70	CA 11.08	CA 44.13	CA 39.83	CA 44.49	CA 43.04
	MG 51.63	MG 50.59	MG 49.96	MG 50.78	MG 46.45	MG 47.02	MG 46.20	MG 46.65
	FE 37.31	FE 37.92	FE 38.34	FE 38.13	FE 9.43	FE 13.15	FE 9.31	FE 10.31
					C: 48.72	C: 45.86	C: 49.06	C: 47.99

KRV 3 - TYPE I MAIN GROUP ECLOGITE

	KRV 3 GT101	KRV 3 GT601	KRV 3 CP401	KRV 3 MI 1	KRV 3 MI 2
SIO2	40.6	40.7	54.9	42.8	40.3
TIO2		.34	.25	2.64	2.61
AL2O3	22.6	22.7	4.55	11.6	12.0
CR2O3	.19	.22	.18	.07	.08
FEO	15.5	15.6	5.81	8.11	8.92
MNO	.53	.54	.12	.05	.05
MGO	15.4	15.3	13.9	20.3	20.8
CAO	5.06	5.08	16.6	ND	ND
NA2O		.07	3.68	.11	.20
K2O			.11	10.0	9.75
TOTAL	99.9	100.5	100.1	95.7	94.7

IONIC PROPORTIONS

SI	2.986	2.976	1.990	5.567	5.346
TI		.019	.007	.258	.260
AL	1.959	1.957	.194	1.780	1.877
CR	.011	.013	.005	.007	.008
FE	.953	.954	.176	.882	.990
MN	.033	.033	.004	.006	.006
MG	1.688	1.667	.751	3.935	4.112
CA	.399	.398	.645		
NA		.010	.259	.028	.051
K			.005	1.659	1.650
TOTAL	8.029	8.026	4.035	14.124	14.302
OXYGEN	12	12	6	20	20

M: 63.91	M: 63.61	M: 81.00	M: 81.69	M: 80.60
CA 13.12	CA 13.18	CA 41.02		
MG 55.52	MG 55.22	MG 47.77		
FE 31.36	FE 31.60	FE 11.21		
		C: 46.20		

KRV 4 - TYPE I IRON-RICH ECLOGITE

	KRV 4 GT101	KRV 4 GT301	KRV 4 GT102	KRV 4 CP101	KRV 4 CP501
SIO2	40.3	40.2	40.2	54.9	55.2
TIO2	.31	.27	.28	.35	.33
AL2O3	22.5	22.6	22.6	6.99	6.96
CR2O3	.15	.13	.15	.15	.16
FEO	18.6	18.7	18.5	7.36	7.42
MNO	.61	.58	.59	.16	.17
MGO	13.9	14.0	14.0	12.3	12.1
CAO	3.71	3.60	3.66	12.7	12.7
NA2O	.09	.13	.12	5.00	5.03
K2O				.09	.09
TOTAL	100.2	100.2	100.1	100.0	100.2

IONIC PROPORTIONS

SI	2.987	2.980	2.981	1.984	1.991
TI	.017	.015	.016	.010	.009
AL	1.966	1.975	1.976	.298	.296
CR	.009	.008	.009	.004	.005
FE	1.153	1.159	1.147	.222	.224
MN	.038	.036	.037	.005	.005
MG	1.536	1.546	1.547	.663	.651
CA	.295	.286	.291	.492	.491
NA	.013	.019	.017	.350	.352
K				.004	.004
TOTAL	8.014	8.024	8.020	4.032	4.027
OXYGEN	12	12	12	6	6

M: 57.11	M: 57.16	M: 57.42	M: 74.86	M: 74.40
CA 9.86	CA 9.56	CA 9.74	CA 35.72	CA 35.96
MG 51.47	MG 51.69	MG 51.83	MG 48.12	MG 47.65
FE 38.65	FE 38.75	FE 38.43	FE 16.16	FE 16.40
			C: 42.61	C: 43.01

KRV 5 - TYPE I IRON-RICH ECLOGITE

	KRV 5 GT601	KRV 5 GT102	KRV 5 CP101	KRV 5 CP401	KRV 5 CP102
SIO2	40.3	40.1	55.2	55.1	55.3
TIO2	.29	.31	.32	.32	.29
AL2O3	22.5	22.3	6.24	6.40	6.36
CR2O3	.17	.18	.19	.16	.18
FEO	18.1	18.4	7.64	7.78	7.52
MNO	.59	.61	.21	.21	.21
MGO	14.9	14.8	13.3	13.0	13.1
CAO	3.14	3.17	12.3	12.2	12.3
NA2O	.17	.15	4.57	4.54	4.56
K2O			.09	.10	.10
TOTAL	100.2	100.0	100.1	99.8	99.9

IONIC PROPORTIONS

SI	2.978	2.974	1.993	1.994	1.997
TI	.016	.017	.009	.009	.008
AL	1.960	1.950	.266	.273	.271
CR	.010	.011	.005	.005	.005
FE	1.119	1.141	.231	.235	.227
MN	.037	.038	.006	.006	.006
MG	1.641	1.636	.716	.701	.705
CA	.249	.252	.476	.473	.476
NA	.024	.022	.320	.319	.319
K			.004	.005	.005
TOTAL	8.033	8.040	4.025	4.020	4.019
OXYGEN	12	12	6	6	6

M: 59.46	M: 58.90	M: 75.62	M: 74.86	M: 75.64
CA 8.27	CA 8.32	CA 33.46	CA 33.56	CA 33.80
MG 54.55	MG 54.01	MG 50.32	MG 49.74	MG 50.07
FE 37.19	FE 37.68	FE 16.22	FE 16.70	FE 16.13
		C: 39.94	C: 40.29	C: 40.30

KRV 6 - TYPE I MAIN GROUP ECLOGITE

	KRV 6 GT101	KRV 6 GT601	KRV 6 CP401	KRV 6 SD
SIO2	40.7	40.7	55.5	
TIO2	.35	.34	.29	.06
AL2O3	22.7	22.8	5.55	.49
CR2O3	.18	.12	.17	
FEO	16.4	16.4	6.37	48.0
MNO	.39	.41	.12	
MGO	15.8	15.8	13.9	2.00
CAO	3.98	3.93	14.8	
NA2O	.11	.05	4.17	
K2O			.10	
TOTAL	100.6	100.5	101.0	50.6

IONIC PROPORTIONS

SI	2.974	2.974	1.987	
TI	.019	.019	.008	.001
AL	1.955	1.964	.234	.013
CR	.010	.007	.005	
FE	1.002	1.002	.191	.911
MN	.024	.025	.004	
MG	1.720	1.720	.742	.068
CA	.312	.308	.568	
NA	.016	.007	.290	
K			.005	
TOTAL	8.032	8.026	4.032	.992
OXYGEN	12	12	6	1

M: 63.19	M: 63.19	M: 79.54	M: 6.91
CA 10.27	CA 10.15	CA 37.85	
MG 56.70	MG 56.78	MG 49.44	
FE 33.03	FE 33.07	FE 12.71	
		C: 43.36	

KRV 7 - TYPE I CALCIUM-RICH ECLOGITE

	KRV 7 GT501	KRV 7 GT101	KRV 7 GT301	KRV 7 CP501	KRV 7 CP301	KRV 7 GT102	KRV 7 GT502	KRV 7 CP302
SIO2	40.1	40.5	40.5	55.6	56.0	40.8	40.6	55.9
TIO2								
AL2O3	23.0	22.4	22.8	9.73	9.78	22.8	22.8	9.77
CR2O3	.20	.25	.22	.23	.23	.25	.20	.28
FEO	16.7	17.3	16.9	4.47	4.54	16.4	16.5	4.34
MNO	.54	.62	.57	.09	.07	.57	.52	.05
MGO	12.9	13.6	13.1	10.3	10.3	13.7	13.3	10.2
CAO	6.82	5.50	6.32	13.5	13.5	5.86	6.11	13.3
NA2O	.19	.18	.15	5.76	5.82	.19	.18	5.79
K2O				.13	.15			.15
TOTAL	100.4	100.3	100.6	99.8	100.4	100.6	100.2	99.8

IONIC PROPORTIONS

SI	2.966	2.996	2.988	1.986	1.988	2.998	2.997	1.993
TI								
AL	2.005	1.953	1.983	.410	.409	1.975	1.984	.411
CR	.012	.015	.013	.006	.006	.015	.012	.008
FE	1.033	1.070	1.043	.134	.135	1.008	1.019	.129
MN	.034	.039	.036	.003	.002	.035	.033	.002
MG	1.422	1.499	1.441	.548	.545	1.500	1.463	.542
CA	.540	.436	.500	.517	.514	.461	.483	.510
NA	.027	.026	.021	.399	.401	.027	.026	.400
K				.006	.007			.007
TOTAL	8.039	8.033	8.024	4.008	4.007	8.020	8.017	4.001
OXYGEN	12	12	12	6	6	12	12	6

M: 57.92	M: 58.35	M: 58.01	M: 80.42	M: 80.17	M: 59.82	M: 58.96	M: 80.73
CA 18.04	CA 14.50	CA 16.75	CA 43.11	CA 43.04	CA 15.54	CA 16.30	CA 43.15
MG 47.47	MG 49.89	MG 48.29	MG 45.75	MG 45.67	MG 50.52	MG 49.35	MG 45.89
FE 34.49	FE 35.61	FE 34.96	FE 11.14	FE 11.30	FE 33.94	FE 34.35	FE 10.96
			C: 48.52	C: 48.52			C: 48.46

PCR 1 - TYPE I IRON-RICH ECLOGITE

	PCR 1 GT101	PCR 1 GT501	PCR 1 CP501	PCR 1 CP301	PCR 1 CP101
SIO2	39.6	39.7	55.3	55.4	55.6
TIO2	.39	.39	.46	.47	.46
AL2O3	22.4	22.5	7.49	7.35	7.48
CR2O3	.09	.09	.10	.10	.10
FEO	18.6	18.9	6.15	6.24	6.24
MNO	.34	.36	.07	.07	.08
MGO	12.8	12.8	11.2	11.4	11.2
CAO	4.97	5.05	14.1	14.4	14.2
NA2O	.15	.17	4.97	5.20	5.06
K2O			.12	.15	.11
TOTAL	99.3	100.0	100.0	100.8	100.5

IONIC PROPORTIONS

SI	2.972	2.966	1.992	1.985	1.993
TI	.022	.022	.012	.013	.012
AL	1.982	1.981	.318	.310	.316
CR	.005	.005	.003	.003	.003
FE	1.167	1.181	.185	.187	.187
MN	.022	.023	.002	.002	.002
MG	1.432	1.425	.601	.609	.598
CA	.400	.404	.544	.553	.545
NA	.022	.025	.347	.361	.352
K			.006	.007	.005
TOTAL	8.023	8.031	4.011	4.030	4.014
OXYGEN	12	12	6	6	6

M: 55.08	M: 54.69	M: 76.44	M: 76.50	M: 76.18
CA 13.33	CA 13.43	CA 40.90	CA 40.99	CA 40.98
MG 47.74	MG 47.34	MG 45.18	MG 45.14	MG 44.96
FE 38.93	FE 39.23	FE 13.92	FE 13.87	FE 14.06
		C: 47.51	C: 47.59	C: 47.69

PJL 17 - TYPE I KYANITE ECLOGITE

	PJL 17 GT101	PJL 17 CP101	PJL 17 KY101	PJL 17 GT302	PJL 17 CP302	PJL 17 KY103	PJL 17 CP103	PJL 17 AM 4	PJL 17 GT104	PJL 17 SP 4
SIO2	39.7	56.8	38.0	39.5	56.9	37.7	56.8	37.5	39.6	.10
TIO2	.35	.29	.10	.33	.31	.12	.29	.95	.33	.16
AL2O3	22.7	17.4	63.2	22.7	17.4	63.3	17.5	20.5	22.7	59.0
CR2O3	ND	ND	ND	ND	ND	ND	ND	ND	ND	.06
FEO	13.0	2.03	.23	13.0	2.13	.22	2.09	13.0	13.2	28.0
MNO	.23	ND	ND	.21	ND	ND	ND	.18	.23	.25
MGO	8.29	6.06	.09	7.94	6.03	.09	6.01	10.9	8.27	14.6
CAO	16.0	10.7	ND	16.1	10.8	ND	10.7	10.9	15.7	.15
NA2O	.11	7.51	ND	.12	7.52	ND	7.67	2.86	.12	
K2O		.16	ND		.14	ND	.12	1.41		
TOTAL	100.4	101.0	101.7	99.9	101.3	101.5	101.2	98.2	100.2	102.3

IONIC PROPORTIONS

SI	2.963	1.954	1.009	2.964	1.953	1.003	1.951	5.312	2.964	.003
TI	.020	.008	.002	.019	.008	.002	.007	.101	.019	.003
AL	1.997	.706	1.978	2.008	.704	1.986	.709	3.423	2.003	1.850
CR										.001
FE	.811	.058	.005	.816	.061	.005	.060	1.540	.826	.623
MN	.015			.013				.022	.015	.006
MG	.922	.311	.004	.888	.308	.004	.308	2.301	.922	.579
CA	1.280	.394		1.295	.397		.394	1.654	1.259	.004
NA	.016	.501		.017	.501		.511	.786	.017	
K		.007			.006		.005	.255		
TOTAL	8.026	3.939	3.000	8.021	3.940	3.002	3.945	15.395	8.025	3.069
OXYGEN	12	6	5	12	6	5	6	22	12	4

M: 53.19	M: 84.18		M: 52.12	M: 83.46		M: 83.67	M: 59.91	M: 52.75	M: 48.16
CA 42.47	CA 51.66		CA 43.17	CA 51.80		CA 51.71		CA 41.86	
MG 30.60	MG 40.69		MG 29.62	MG 40.23		MG 40.40		MG 30.67	
FE 26.93	FE 7.65		FE 27.21	FE 7.97		FE 7.88		FE 27.47	
	C: 55.94			C: 56.29		C: 56.14			

PJL 17 - TYPE I KYANITE ECLOGITE

	PJL 17 GUNGU	PJL 17 GUNGU	PJL 17 KY 5	PJL 17 CO 5
SIO2	40.7	33.9	37.9	.16
TIO2	.63	.13	.12	.32
AL2O3	18.2	19.1	63.3	100.0
CR2O3	.05	ND	.05	.05
FEO	12.4	18.5	.21	.66
MNO	.13	.17	ND	ND
MGO	13.2	15.7	.09	.20
CAO	7.31	1.94	ND	ND
NA2O	.80	.27		ND
K2O	3.16	.13		ND
TOTAL	96.6	89.8	101.7	101.4

IONIC PROPORTIONS

SI	1.048	.947	1.006	.003
TI	.012	.003	.002	.004
AL	.552	.629	1.981	1.980
CR	.001		.001	.001
FE	.267	.432	.005	.009
MN	.003	.004		
MG	.506	.653	.004	.005
CA	.202	.058		
NA	.040	.015		
K	.104	.005		
TOTAL	2.735	2.746	3.000	2.003
OXYGEN	4	4	5	3

M: 65.48 M: 60.20

PJL 18 - TYPE I CALCIUM-RICH ECLOGITE (DIAMONDIFEROUS)

	PJL 18 GT102	PJL 18 GT502	PJL 18 GT103	PJL 18 GT503	PJL 18 GT104	PJL 18 GT504	PJL 18 GT305	PJL 18 CP104	PJL 18 CP103	PJL 18 CP105
SIO2	41.1	41.0	41.0	40.9	40.8	40.7	40.5	56.9	56.9	58.7
TIO2	.23	.22	.23	.20	.23	.22	.20	.24	.22	.26
AL2O3	23.7	23.7	23.6	23.5	23.5	23.3	23.2	14.8	14.7	14.7
CR2O3	.08	.05	.05	.06	.06	.05	.05	.08	.08	.11
FEO	12.0	12.2	12.0	12.2	12.0	12.8	12.6	2.11	2.13	1.89
MNO	.19	.21	.21	.23	.22	.24	.19	.04	.04	ND
MGO	14.1	14.3	14.1	14.1	13.9	14.2	13.9	8.35	8.32	9.16
CAO	9.11	8.90	9.00	8.87	9.03	8.22	8.58	11.7	11.7	12.3
NA2O	.12	.09	.09	.12	.13	.12	.05	7.40	7.30	5.34
K2O								.12	.10	.21
TOTAL	100.6	100.7	100.3	100.2	99.9	99.8	99.3	101.7	101.5	102.7

IONIC PROPORTIONS

SI	2.978	2.971	2.980	2.979	2.980	2.978	2.981	1.957	1.961	1.983
TI	.013	.012	.013	.011	.013	.012	.011	.006	.006	.007
AL	2.024	2.024	2.022	2.018	2.023	2.010	2.013	.600	.597	.585
CR	.005	.003	.003	.003	.003	.003	.003	.002	.002	.003
FE	.727	.739	.729	.743	.733	.783	.776	.061	.061	.053
MN	.012	.013	.013	.014	.014	.015	.012	.001	.001	
MG	1.522	1.544	1.527	1.530	1.513	1.549	1.525	.428	.427	.461
CA	.707	.691	.701	.692	.707	.645	.677	.431	.432	.445
NA	.017	.013	.013	.017	.018	.017	.007	.493	.488	.350
K								.005	.004	.009
TOTAL	8.004	8.010	8.001	8.008	8.004	8.012	8.004	3.985	3.980	3.896
OXYGEN	12	12	12	12	12	12	12	6	6	6

	M: 67.68	M: 67.62	M: 67.68	M: 67.32	M: 67.36	M: 66.41	M: 66.28	M: 87.58	M: 87.44	M: 89.62
	CA 23.92	CA 23.23	CA 23.70	CA 23.34	CA 23.93	CA 21.65	CA 22.73	CA 46.87	CA 46.92	CA 46.39
	MG 51.49	MG 51.91	MG 51.64	MG 51.60	MG 51.24	MG 52.03	MG 51.22	MG 46.53	MG 46.41	MG 48.05
	FE 24.59	FE 24.85	FE 24.66	FE 25.06	FE 24.82	FE 26.32	FE 26.05	FE 6.60	FE 6.67	FE 5.56
								C: 50.18	C: 50.27	C: 49.12

PJL 18 - TYPE I CALCIUM-RICH ECLOGITE (DIAMONDIFEROUS)

	PJL 18 GT106	PJL 18 GT306	PJL 18 CP106
SIO2	41.9	42.1	56.2
TIO2	.23	.20	.31
AL2O3	23.9	24.1	15.2
CR2O3	.06		.07
FEO	11.9	12.0	1.77
MNO	.18		ND
MGO	14.3	14.4	8.15
CAO	9.26	9.49	11.4
NA2O	.15	.15	6.58
K2O	ND		.22
TOTAL	101.9	102.4	99.9

IONIC PROPORTIONS

SI	2.993	2.991	1.958
TI	.012	.011	.008
AL	2.013	2.019	.624
CR	.003		.002
FE	.711	.711	.052
MN	.011		
MG	1.523	1.525	.423
CA	.709	.722	.426
NA	.021	.021	.445
K			.010
TOTAL	7.997	7.999	3.948
OXYGEN	12	12	6

M: 68.17	M: 68.21	M: 89.14
CA 24.09	CA 24.43	CA 47.27
MG 51.74	MG 51.55	MG 47.00
FE 24.16	FE 24.03	FE 5.73
		C: 50.14

RV 372 - TYPE II CORUNDUM ECLOGITE

	RV 372 GT101	RV 372 GT601	RV 372 CP101	RV 372 CP401	RV 372 GT102	RV 372 GT502	RV 372 CP102	RV 372 CP302
SIO2	41.5	41.1	50.9	51.0	41.3	41.0	50.7	53.0
TIO2	.03	ND	.03	ND	ND	.03	ND	.03
AL2O3	24.0	23.7	20.1	20.5	23.6	23.4	20.1	18.7
CR2O3	.11	.10	.13	.13	.11	.10	.13	.13
FEO	7.21	6.52	1.01	.94	6.70	6.20	.91	.75
MNO	.12	.14	ND	ND	.13	.10	ND	ND
MGO	14.5	12.5	7.09	6.94	14.3	12.4	6.98	7.04
CAO	12.9	16.0	15.3	15.0	12.9	15.8	15.4	13.3
NA2O	.05	ND	5.68	6.11	ND	ND	5.72	6.96
K2O			ND	ND			ND	ND
TOTAL	100.4	100.1	100.3	100.7	99.1	99.1	100.0	99.9

IONIC PROPORTIONS

SI	2.978	2.977	1.787	1.783	2.997	2.995	1.786	1.855
TI	.002		.001			.002		.001
AL	2.030	2.024	.832	.845	2.019	2.018	.835	.772
CR	.006	.006	.004	.004	.006	.006	.004	.004
FE	.433	.395	.030	.027	.407	.379	.027	.022
MN	.007	.009			.008	.006		
MG	1.551	1.349	.371	.362	1.547	1.350	.366	.367
CA	.992	1.245	.577	.562	1.003	1.237	.581	.499
NA	.007		.387	.414			.391	.472
K								
TOTAL	8.006	8.008	3.988	4.000	7.990	7.993	3.991	3.993
OXYGEN	12	12	6	6	12	12	6	6

	M: 78.18	M: 77.36	M: 92.60	M: 92.94	M: 79.18	M: 78.09	M: 93.18	M: 94.36
	CA 33.34	CA 41.65	CA 59.02	CA 59.09	CA 33.93	CA 41.70	CA 59.65	CA 56.17
	MG 52.12	MG 45.14	MG 37.94	MG 38.02	MG 52.31	MG 45.52	MG 37.60	MG 41.36
	FE 14.54	FE 13.21	FE 3.03	FE 2.89	FE 13.75	FE 12.77	FE 2.75	FE 2.47
			C: 60.87	C: 60.85			C: 61.33	C: 57.60

WM 7 - TYPE II MAGNESIAN ECLOGITE (SULPHIDE BEARING)

	WM 7 GT101	WM 7 GT101	WM 7 CP102	WM 7 GT103	WM 7 CP103	WM 7 GT304	WM 7 CP106	WM 7 CP201	WM 7 CP203	WM 7 CP206
SIO2	41.5	41.8	55.6	41.8	56.0	41.9	55.2	54.2	54.1	52.2
TIO2	.13	.13	.24	.10	.24	.12	.24	.26	.31	.48
AL2O3	24.0	24.0	8.30	24.0	8.24	23.9	8.23	5.28	6.02	8.42
CR2O3	.15	.17	.23	.14	.23	.14	.23	.26	.23	.18
FEO	12.7	12.9	3.68	12.8	3.74	12.9	3.77	4.28	4.03	4.46
MNO	.31	.32	.07	.32	.08	.36	.07	.05	.08	.09
MGO	17.9	18.7	12.0	18.7	12.1	18.7	12.1	14.6	14.8	14.1
CAO	4.19	4.16	14.8	4.03	14.9	4.15	15.0	18.4	18.0	17.1
NA2O	.05	ND	5.28	.05	5.40	.08	5.38	2.79	2.83	2.91
K2O			ND		ND		ND	ND	ND	ND
TOTAL	100.9	102.2	100.2	101.9	100.9	102.2	100.2	100.1	100.4	99.9

IONIC PROPORTIONS

SI	2.966	2.953	1.980	2.958	1.981	2.959	1.970	1.956	1.942	1.885
TI	.007	.007	.006	.005	.006	.006	.006	.007	.008	.013
AL	2.022	1.999	.348	2.002	.344	1.990	.346	.225	.255	.358
CR	.008	.009	.006	.008	.006	.008	.006	.007	.007	.005
FE	.759	.762	.110	.758	.111	.762	.113	.129	.121	.135
MN	.019	.019	.002	.019	.002	.022	.002	.002	.002	.003
MG	1.906	1.969	.637	1.972	.638	1.968	.644	.785	.792	.759
CA	.321	.315	.565	.306	.565	.314	.574	.712	.692	.661
NA	.007		.365	.007	.370	.011	.372	.195	.197	.204
K										
TOTAL	8.015	8.039	4.019	8.035	4.023	8.041	4.034	4.019	4.017	4.023
OXYGEN	12	12	6	12	6	12	6	6	6	6
	M: 71.52	M: 72.09	M: 85.32	M: 72.25	M: 85.22	M: 72.09	M: 85.12	M: 85.87	M: 86.74	M: 84.93
	CA 10.74	CA 10.34	CA 43.07	CA 10.07	CA 43.00	CA 10.32	CA 43.14	CA 43.76	CA 43.13	CA 42.55
	MG 63.84	MG 64.64	MG 48.57	MG 64.97	MG 48.57	MG 64.65	MG 48.40	MG 48.29	MG 49.33	MG 48.79
	FE 25.42	FE 25.02	FE 8.36	FE 24.96	FE 8.42	FE 25.03	FE 8.46	FE 7.94	FE 7.54	FE 8.66
			C: 47.00		C: 46.96		C: 47.13	C: 47.54	C: 46.65	C: 46.58

WM 7 - TYPE II MAGNESIAN ECLOGITE (SULPHIDE BEARING)

	WM 7 CC 1	WM 7 CC 5	WM 7 SP 1	WM 7 SP 3	WM 7 SP 3	WM 7 SP 4	WM 7 SP 7	WM 7 GUNGU	WM 7 GUNGU	WM 7 GU(11
SIO2	.15	ND	.12	.17	.17	.15	.26	51.0	45.5	50.8
TIO2	ND	ND	.13	.06	.05	.08	.06	.36	.12	.19
AL203	.09	ND	64.6	63.0	63.3	64.9	61.0	7.14	15.0	8.34
CR203	ND	ND	.75	.63	.60	.36	.57	.24	.14	ND
FEO	.30	.10	15.4	18.5	18.7	17.5	21.8	6.46	13.4	8.11
MNO	.57	1.20	.14	.20	.18	.19	.24	.17	.33	.36
MGO	.39	.22	21.2	20.0	20.0	18.9	18.3	15.6	25.4	16.7
CAO	60.4	60.5	.03	ND	.05	.03	.05	18.5	1.86	14.3
NA2O	ND	ND	ND	ND	ND	ND		1.12	.13	.96
K2O	ND							ND	ND	.10
TOTAL	61.9	62.1	102.4	102.6	103.1	102.1	102.3	100.6	101.9	99.9

IONIC PROPORTIONS

SI	.002		.003	.004	.004	.004	.007	1.235	1.075	1.232
TI			.002	.001	.001	.002	.001	.007	.002	.003
AL	.002		1.902	1.880	1.881	1.929	1.857	.204	.418	.238
CR			.015	.013	.012	.007	.012	.005	.003	
FE	.004	.001	.322	.392	.394	.369	.471	.131	.265	.164
MN	.007	.015	.003	.004	.004	.004	.005	.003	.007	.007
MG	.009	.005	.789	.754	.751	.710	.704	.563	.894	.603
CA	.973	.977	.001		.001	.001	.001	.480	.047	.372
NA								.053	.006	.045
K										.003
TOTAL	.997	1.000	3.037	3.049	3.049	3.027	3.058	2.681	2.716	2.669
OXYGEN	1	1	4	4	4	4	4	4	4	4
			M: 71.04	M: 65.83	M: 65.59	M: 65.81	M: 59.93	M: 81.14	M: 77.16	M: 78.58

WRV 4 - TYPE I CALCIUM-RICH ECLOGITE (DIAMONDIFEROUS)

	WRV 4 GT101	WRV 4 GT102	WRV 4 GT103	WRV 4 GT104	WRV 4 CP101	WRV 4 CP102	WRV 4 CP103	WRV 4 CP104
SIO2	40.5	40.5	40.6	40.5	56.9	56.3	56.7	56.6
TIO2	.25	.25	.25	.27	.34	.34	.34	.34
AL2O3	22.6	22.7	22.9	22.9	14.0	13.5	13.7	13.7
CR2O3	.05	.08	.06	.06	.10	.11	.10	.10
FEO	11.8	11.8	11.7	11.8	1.81	1.92	1.88	1.95
MNO	.17	.15	.15	.17	ND	ND	.04	.04
MGO	14.9	14.8	14.8	14.7	8.44	8.43	8.45	8.42
CAO	8.31	8.27	8.42	8.37	11.8	11.8	11.8	11.7
NA2O	.16	.11	.12	.12	6.84	6.83	6.73	6.71
K2O	ND	ND	ND	ND	.15	.16	.15	.12
TOTAL	98.7	98.7	99.0	98.9	100.4	99.4	99.9	99.7

IONIC PROPORTIONS

SI	2.987	2.988	2.984	2.982	1.977	1.979	1.981	1.981
TI	.014	.014	.014	.015	.009	.009	.009	.009
AL	1.965	1.975	1.984	1.988	.574	.560	.564	.565
CR	.003	.005	.003	.003	.003	.003	.003	.003
FE	.728	.728	.719	.727	.053	.056	.055	.057
MN	.011	.009	.009	.011			.001	.001
MG	1.638	1.627	1.621	1.613	.437	.442	.440	.439
CA	.657	.654	.663	.660	.439	.445	.442	.439
NA	.023	.016	.017	.017	.461	.466	.456	.455
K					.007	.007	.007	.005
TOTAL	8.027	8.017	8.017	8.017	3.960	3.967	3.958	3.956
OXYGEN	12	12	12	12	6	6	6	6
	M: 69.23	M: 69.09	M: 69.27	M: 68.94	M: 89.26	M: 88.67	M: 88.90	M: 88.50
	CA 21.73	CA 21.73	CA 22.08	CA 22.01	CA 47.29	CA 47.16	CA 47.16	CA 46.93
	MG 54.19	MG 54.08	MG 53.98	MG 53.77	MG 47.05	MG 46.86	MG 46.97	MG 46.97
	FE 24.08	FE 24.20	FE 23.95	FE 24.22	FE 5.66	FE 5.99	FE 5.86	FE 6.10
					C: 50.13	C: 50.16	C: 50.10	C: 49.98

XRV 5 - TYPE I IRON-RICH ECLOGITE

	XRV 5 GT101	XRV 5 GT102	XRV 5 CP101
SIO2	39.6	39.7	54.9
TIO2	.31	.31	.37
AL2O3	22.2	21.9	8.38
CR2O3		.09	.11
FEO	21.7	21.7	6.99
MNO	.37	.39	.09
MGO	9.90	10.5	10.2
CAO	6.10	6.22	13.9
NA2O	.16	.17	5.22
K2O			.17
TOTAL	100.3	101.0	100.3

IONIC PROPORTIONS

SI	2.992	2.984	1.978
TI	.018	.018	.010
AL	1.977	1.941	.356
CR		.005	.003
FE	1.371	1.364	.211
MN	.024	.025	.003
MG	1.115	1.176	.548
CA	.494	.501	.537
NA	.023	.025	.365
K			.008
TOTAL	8.014	8.038	4.018
OXYGEN	12	12	6
	M: 44.84	M: 46.30	M: 72.22
	CA 16.57	CA 16.47	CA 41.44
	MG 37.41	MG 38.67	MG 42.30
	FE 46.02	FE 44.85	FE 16.27
			C: 49.49

XRV 6 - TYPE I MAIN GROUP ECLOGITE

	XRV 6 GT101	XRV 6 GT501	XRV 6 CP301	XRV 6 GT303	XRV 6 CP503	XRV 6 GT102	XRV 6 CP102	XRV 6 GT503
SIO2	40.6	40.5	56.0	40.0	56.6	40.5	56.3	40.1
TIO2								
AL2O3	23.0	22.8	7.13	22.8	12.5	23.2	8.96	23.1
CR2O3	.11	.12	.11	ND	ND	.06	.11	ND
FEO	17.9	17.6	6.46	18.0	4.78	18.1	5.94	17.7
MNO	.57	.52	.13	.45	.08	.54	.10	.46
MGO	14.3	13.9	11.9	10.9	8.23	13.7	10.6	10.8
CAO	4.54	4.51	14.0	8.80	11.3	5.10	12.9	8.86
NA2O	.15	.19	5.12	.18	7.93	.19	6.36	.14
K2O			.11		.10		.13	
TOTAL	101.2	100.1	101.0	101.2	101.5	101.4	101.4	101.2

IONIC PROPORTIONS

SI	2.975	2.993	2.000	2.970	1.980	2.968	1.993	2.970
TI								
AL	1.987	1.987	.300	1.996	.515	2.004	.374	2.017
CR	.006	.007	.003			.003	.003	
FE	1.097	1.088	.193	1.118	.140	1.109	.176	1.096
MN	.035	.033	.004	.028	.002	.034	.003	.029
MG	1.562	1.531	.633	1.206	.429	1.496	.559	1.192
CA	.356	.357	.536	.700	.424	.400	.489	.703
NA	.021	.027	.355	.026	.538	.027	.437	.020
K			.005		.004		.006	
TOTAL	8.039	8.023	4.028	8.045	4.033	8.042	4.040	8.030
OXYGEN	12	12	6	12	6	12	6	12

M: 58.74	M: 58.46	M: 76.65	M: 51.90	M: 75.42	M: 57.43	M: 76.08	M: 52.09
CA 11.82	CA 12.00	CA 39.33	CA 23.15	CA 42.68	CA 13.32	CA 39.96	CA 23.50
MG 51.79	MG 51.45	MG 46.50	MG 39.89	MG 43.23	MG 49.77	MG 45.67	MG 39.85
FE 36.38	FE 36.55	FE 14.17	FE 36.96	FE 14.09	FE 36.90	FE 14.36	FE 36.65
		C: 45.82		C: 49.68		C: 46.67	

XRV 8 - TYPE I MAIN GROUP ECLOGITE

	XRV 8 GT101	XRV 8 GT501	XRV 8 CP301	XRV 8 GT102	XRV 8 GT302	XRV 8 CP502	XRV 8 AM 1	XRV 8 MI 1	XRV 8 MI 2	XRV 8 SP 1
SIO2	41.0	41.1	55.9	41.1	41.3	56.0	40.3	38.9	40.2	.13
TIO2										
AL2O3	23.0	23.0	6.99	23.3	23.4	6.88	17.6	16.6	15.4	62.4
CR2O3	.05	.12	.11	.06	.06	.11	.06	.09	.19	.12
FEO	16.7	16.7	5.62	16.6	16.9	5.54	12.6	11.9	10.2	23.7
MNO	.49	.50	.10	.45	.49	.10	.34	.10	ND	.25
MGO	15.5	15.4	12.9	15.7	15.5	12.9	14.1	18.0	19.3	16.0
CAO	4.19	4.12	14.7	4.06	4.05	15.0	8.63	ND	.03	.04
NA2O	.16	.12	4.30	.12	.12	4.30	3.43	.24	.16	ND
K2O			.17			.16	.69	9.44	9.46	ND
TOTAL	101.1	101.1	100.8	101.4	101.8	101.0	97.7	95.3	94.9	102.7

IONIC PROPORTIONS

SI	2.984	2.991	1.993	2.978	2.983	1.993	5.660	5.173	5.311	.003
TI										
AL	1.974	1.973	.294	1.990	1.992	.289	2.914	2.603	2.399	1.902
CR	.003	.007	.003	.003	.003	.003	.007	.009	.020	.002
FE	1.017	1.016	.168	1.006	1.021	.165	1.480	1.324	1.127	.512
MN	.030	.031	.003	.028	.030	.003	.040	.011		.005
MG	1.681	1.670	.685	1.695	1.668	.684	2.951	3.568	3.800	.616
CA	.327	.321	.561	.315	.313	.572	1.299		.004	.001
NA	.023	.017	.297	.017	.017	.297	.934	.062	.041	
K			.008			.007	.124	1.602	1.595	
TOTAL	8.039	8.027	4.012	8.033	8.028	4.013	15.409	14.353	14.297	3.046
OXYGEN	12	12	6	12	12	6	22	20	20	4

	M: 62.32	M: 62.17	M: 80.35	M: 62.76	M: 62.04	M: 80.58	M: 66.60	M: 72.94	M: 77.13	M: 54.61
	CA 10.80	CA 10.68	CA 39.70	CA 10.45	CA 10.44	CA 40.25				
	MG 55.59	MG 55.53	MG 48.45	MG 56.20	MG 55.56	MG 48.15				
	FE 33.61	FE 33.79	FE 11.85	FE 33.35	FE 34.00	FE 11.60				
			C: 45.03			C: 45.53				

XRV 8 - TYPE I MAIN GROUP ECLOGITE

	XRV 8 SP 2
SIO2	.18
TIO2	
AL2O3	59.5
CR2O3	.44
FEO	26.1
MNO	.34
MGO	15.9
CAO	ND
NA2O	ND
K2O	ND
TOTAL	102.5

IONIC PROPORTIONS

SI	.005
TI	
AL	1.847
CR	.009
FE	.575
MN	.008
MG	.624
CA	
NA	
K	
TOTAL	3.068
OXYGEN	4

M: 52.05

XRV 10 - TYPE I MAIN GROUP ECLOGITE

	XRV 10 G1101	XRV 10 CP101
SIO2	41.9	55.7
TIO2	.26	.31
AL2O3	23.6	8.26
CR2O3	.14	.15
FEO	15.8	4.75
MNO	.41	.10
MGO	15.0	11.6
CAO	5.27	14.1
NA2O	.15	5.02
K2O	ND	.16
TOTAL	102.5	100.1

IONIC PROPORTIONS

SI	2.996	1.988
TI	.014	.008
AL	1.990	.348
CR	.008	.004
FE	.945	.142
MN	.025	.003
MG	1.599	.617
CA	.404	.539
NA	.021	.347
K		.007
TOTAL	8.002	4.005
OXYGEN	12	6

M: 62.85	M: 81.31
CA 13.70	CA 41.54
MG 51.24	MG 47.54
FE 32.06	FE 10.92
	C: 46.64

XRV 22 - TYPE II MAGNESIAN ECLOGITE (DIAMOND & GRAPHITE PRESENT)

	2 ROVIC	2 ROVIC	XRV 22 GT101	XRV 22 GT302	XRV 22 GT102	XRV 22 GT103	XRV 22 CP101	XRV 22 CP102	XRV 22 CP103	XRV 22 CP103
SIO2	41.6	55.7	42.1	42.1	42.2	42.2	56.2	56.2	56.1	56.0
TIO2	.27	.41	.27	.25	.23	.23	.38	.38	.38	.39
AL2O3	23.6	6.39	24.0	23.9	24.0	23.7	6.32	6.26	6.13	6.14
CR2O3	.06	.09	.11	.11	.09	.13	.13	.13	.15	.15
FEO	11.2	3.13	11.8	11.8	11.6	11.6	3.37	3.40	3.40	3.26
MNO	.42	.07	.37	.39	.37	.40	.12	.10	.09	.07
MGO	19.3	14.3	18.7	18.6	18.8	18.6	14.1	14.2	13.9	13.9
CAO	3.91	16.7	3.99	3.95	3.80	3.84	16.5	16.6	16.3	16.2
NA2O	.11	3.68	.10	.10	.12	.07	3.97	3.93	3.80	3.75
K2O			ND	ND	ND	ND	.04	.04	.04	.04
TOTAL	100.6	100.5	101.5	101.2	101.2	100.8	101.1	101.2	100.3	99.9

IONIC PROPORTIONS

SI	2.967	1.980	2.979	2.985	2.987	3.001	1.986	1.985	1.996	1.998
TI	.014	.011	.014	.013	.012	.012	.010	.010	.010	.010
AL	1.982	.268	2.002	1.998	2.003	1.987	.263	.261	.257	.258
CR	.003	.003	.006	.006	.005	.007	.004	.004	.004	.004
FE	.670	.093	.698	.700	.687	.690	.100	.100	.101	.097
MN	.025	.002	.022	.023	.022	.024	.004	.003	.003	.002
MG	2.056	.755	1.972	1.966	1.983	1.971	.743	.747	.737	.739
CA	.299	.637	.302	.300	.288	.293	.625	.628	.622	.619
NA	.015	.253	.014	.014	.016	.010	.272	.269	.262	.259
K							.002	.002	.002	.002
TOTAL	8.033	4.001	8.011	8.007	8.005	7.995	4.007	4.009	3.995	3.991
OXYGEN	12	6	12	12	12	12	6	6	6	6
	M: 75.42	M: 89.03	M: 73.85	M: 73.75	M: 74.28	M: 74.08	M: 88.17	M: 88.16	M: 87.93	M: 88.37
	CA 9.87	CA 42.92	CA 10.18	CA 10.12	CA 9.74	CA 9.91	CA 42.59	CA 42.56	CA 42.57	CA 42.54
	MG 67.97	MG 50.82	MG 66.33	MG 66.28	MG 67.04	MG 66.74	MG 50.62	MG 50.64	MG 50.50	MG 50.77
	FE 22.16	FE 6.26	FE 23.49	FE 23.60	FE 23.21	FE 23.36	FE 6.79	FE 6.80	FE 6.93	FE 6.68
		C: 45.79					C: 45.69	C: 45.67	C: 45.74	C: 45.59

XRV 22 - TYPE II MAGNESIAN ECLOGITE (DIAMOND & GRAPHITE PRESENT)

	XRV 22 MI 1	XRV 22 RU 1
SIO2	40.7	ND
TIO2	2.85	85.2
AL2O3	15.2	.22
CR2O3	ND	
FEO	5.54	.56
MNO	ND	ND
MGO	21.6	.05
CAO	ND	.06
NA2O	.42	ND
K2O	9.35	ND
TOTAL	95.7	86.1

IONIC PROPORTIONS

SI	5.224	
TI	.275	.992
AL	2.300	.004
CR		
FE	.595	.007
MN		
MG	4.132	.001
CA		.001
NA	.105	
K	1.531	
TOTAL	14.168	1.006
OXYGEN	20	2

M: 87.42

10A - TYPE I IRON-RICH ECLOGITE

	10A GT101	10A GT301	10A CP501	10A GT302	10A CP502	10A GT303	10A CP503	10A AM 1	10A AM 2	10A MI 2
SIO2	40.1	40.4	55.3	40.4	55.4	40.5	54.8	40.6	39.4	40.8
TIO2	.16	.21	.47	.34	.49	.34	.32	.78	.66	3.18
AL2O3	23.3	23.3	7.68	23.2	7.60	23.1	7.52	17.1	17.9	14.8
CR2O3	.08	.09	.08	.09	.08	.08	.10	.08	.08	.11
FEO	20.9	20.7	6.80	20.0	6.49	19.0	6.21	14.7	15.3	10.6
MNO	.42	.37	.08	.38	.07	.37	.07	.22	.29	.04
MGO	12.8	12.5	11.8	12.1	12.0	12.0	12.0	12.7	12.2	18.6
CAO	4.98	5.00	14.0	5.02	14.1	5.04	14.3	8.70	9.20	.03
NA2O	.18	.17	4.87	.17	4.82	.17	4.86	3.71	3.66	.13
K2O			.13		.13		.12	.86	.68	9.07
TOTAL	102.9	102.7	101.2	101.7	101.2	100.6	100.3	99.4	99.4	97.4

IONIC PROPORTIONS

SI	2.931	2.952	1.973	2.973	1.975	2.998	1.972	5.668	5.535	5.256
TI	.009	.012	.013	.019	.013	.019	.009	.082	.070	.308
AL	2.008	2.007	.323	2.013	.319	2.016	.319	2.814	2.965	2.248
CR	.005	.005	.002	.005	.002	.005	.003	.009	.009	.011
FE	1.278	1.265	.203	1.231	.193	1.176	.187	1.716	1.798	1.142
MN	.026	.023	.002	.024	.002	.023	.002	.026	.035	.004
MG	1.394	1.361	.628	1.327	.638	1.324	.644	2.642	2.554	3.571
CA	.390	.392	.535	.396	.539	.400	.551	1.301	1.385	.004
NA	.026	.024	.337	.024	.333	.024	.339	1.004	.997	.032
K			.006		.006		.006	.153	.122	1.491
TOTAL	8.066	8.042	4.023	8.011	4.021	7.985	4.031	15.417	15.468	14.068
OXYGEN	12	12	6	12	6	12	6	22	22	20

	M: 52.18	M: 51.83	M: 75.56	M: 51.88	M: 76.72	M: 52.95	M: 77.50	M: 60.62	M: 58.69	M: 75.77
	CA 12.74	CA 12.97	CA 39.19	CA 13.40	CA 39.32	CA 13.79	CA 39.90			
	MG 45.54	MG 45.11	MG 45.95	MG 44.93	MG 46.55	MG 45.65	MG 46.57			
	FE 41.72	FE 41.92	FE 14.86	FE 41.67	FE 14.13	FE 40.56	FE 13.52			
			C: 46.03		C: 45.79		C: 46.14			

390/4 - TYPE I KYANITE ECLOGITE

	390/4 GT501	390/4 GT302	390/4 CP 1	390/4 CP 2
SIO2	39.2	39.9	58.1	57.2
TIO2	.49	.48	.15	.24
AL2O3	22.7	22.7	18.6	20.2
CR2O3	.04	.05		
FEO	12.7	12.4	.88	1.72
MNO	.28	.27		
MGO	6.67	6.87	2.06	4.28
CAO	17.5	17.7	10.7	8.58
NA2O	.06	.08	6.67	5.29
K2O			.50	.14
TOTAL	99.7	100.5	97.7	97.6

IONIC PROPORTIONS

SI	2.958	2.982	2.034	1.987
TI	.028	.027	.004	.006
AL	2.024	1.997	.768	.827
CR	.002	.003		
FE	.801	.777	.026	.050
MN	.018	.017		
MG	.750	.765	.107	.222
CA	1.415	1.417	.401	.319
NA	.009	.012	.453	.356
K			.022	.006
TOTAL	8.005	7.997	3.816	3.774
OXYGEN	12	12	6	6

M: 48.34	M: 49.60	M: 80.66	M: 81.60
CA 47.70	CA 47.88	CA 75.08	CA 54.05
MG 25.29	MG 25.85	MG 20.10	MG 37.50
FE 27.02	FE 26.27	FE 4.82	FE 8.46
		C: 78.88	C: 59.04

*** SINGLE GRAIN MOUNTS OF ROBERTS VICTOR ECLOGITES ***

	HRV 10 CP101	HRV 19 GT101	HRV 19 OP101	HRV 26 GT101	HRV 26 CP101	HRV 26 CP101	HRV 31 GT101	HRV 31 OP101	HRV144 GT101	HRV144 CP201
SIO2	54.7	40.9	57.9	40.6	54.8	54.9	40.4	45.4	40.6	53.2
TIO2	.44	.31	.05	.31	.37	.36	.36	ND	.27	.51
AL2O3	7.45	22.6	1.38	22.9	8.81	9.45	22.3	5.50	23.3	4.86
CR2O3	.08	.41	ND	.20	.20	.18	.14	ND	ND	.08
FEO	7.41	13.1	3.07	15.0	3.98	3.85	17.0	8.54	12.2	3.44
MNO	.09	.27	.04	.49	.05	.08	.65	.04	.23	.05
MGO	11.1	17.0	28.0	13.7	11.0	10.9	14.0	22.2	13.0	15.2
CAO	12.3	4.08	.43	6.03	13.9	13.5	5.27	1.89	10.4	20.9
NA2O	4.99	.20	.46	.14	5.31	5.43	.14	1.34	.13	1.70
K2O	.12		.03		.16	.15		.04		.05
TOTAL	98.7	98.9	91.4	99.4	98.6	98.8	100.3	85.0	100.2	100.0

IONIC PROPORTIONS

SI	1.998	2.996	2.124	3.000	1.982	1.977	2.986	1.889	2.973	1.929
TI	.012	.017	.001	.017	.010	.010	.020		.015	.014
AL	.321	1.952	.060	1.995	.376	.401	1.943	.270	2.011	.208
CR	.002	.024		.012	.006	.005	.008			.002
FE	.226	.803	.094	.927	.120	.116	1.051	.297	.747	.104
MN	.003	.017	.001	.031	.002	.002	.041	.001	.014	.002
MG	.604	1.856	1.530	1.509	.593	.585	1.542	1.377	1.419	.821
CA	.481	.320	.017	.478	.539	.521	.417	.084	.816	.812
NA	.353	.028	.033	.020	.372	.379	.020	.108	.018	.120
K	.006		.001		.007	.007		.002		.002
TOTAL	4.008	8.013	3.862	7.989	4.007	4.003	8.028	4.030	8.015	4.013
OXYGEN	6	12	6	12	6	6	12	6	12	6

M: 72.75	M: 69.81	M: 94.20	M: 61.94	M: 83.12	M: 83.46	M: 59.47	M: 82.25	M: 65.50	M: 88.73
CA 36.69	CA 10.75	CA 1.03	CA 16.39	CA 43.03	CA 42.63	CA 13.86	CA 4.79	CA 27.37	CA 46.73
MG 46.05	MG 62.31	MG 93.23	MG 51.79	MG 47.36	MG 47.88	MG 51.23	MG 78.30	MG 47.58	MG 47.27
FE 17.25	FE 26.94	FE 5.74	FE 31.82	FE 9.62	FE 9.49	FE 34.91	FE 16.90	FE 25.06	FE 6.00
C: 44.34		C: 1.09		C: 47.60	C: 47.10		C: 5.77		C: 49.71

*** SINGLE GRAIN MOUNTS OF ROBERTS VICTOR ECLOGITES ***

	HRV145 GT101	HRV145 CP101	HRV146 GT101	HRV146 CP101	HRV154 GT101	HRV154 CP101	HRV155 GT101	HRV155 CP101	HRV172 GT101	HRV172 CP101
SIO2	41.4	55.4	40.0	56.0	39.8	55.8	41.0	57.1	40.3	55.9
TIO2	.10	.19	.24	.37	.16	.20	.28	.36	.25	.29
AL2O3	23.7	5.68	22.7	8.36	22.6	9.40	23.2	10.6	23.2	9.02
CR2O3	.16	.26	.14	.18	ND	.05	.05	.07	.08	.07
FEO	12.2	4.60	19.0	6.04	18.4	4.97	15.1	3.90	13.3	3.24
MNO	.22	.10	.45	.12	.31	.04	.35	.07	.19	.05
MGO	18.5	14.7	13.6	11.2	10.4	9.89	14.8	10.4	14.3	11.5
CAO	3.13	15.7	3.84	12.8	8.50	14.9	5.69	12.9	7.65	15.7
NA2O	.08	3.34	.14	5.33	ND	5.44	.14	5.97	.11	4.90
K2O		.05		.13		ND		.12		.13
TOTAL	99.5	100.0	100.1	100.5	100.2	100.7	100.6	101.5	99.4	100.8

IONIC PROPORTIONS

SI	2.985	1.986	2.973	1.996	2.982	1.984	2.987	1.991	2.967	1.975
TI	.005	.005	.013	.010	.009	.005	.015	.009	.014	.008
AL	2.014	.240	1.989	.351	1.997	.394	1.993	.436	2.014	.376
CR	.009	.007	.008	.005		.001	.003	.002	.005	.002
FE	.736	.138	1.181	.180	1.153	.146	.920	.114	.819	.096
MN	.013	.003	.028	.004	.020	.001	.022	.002	.012	.001
MG	1.968	.785	1.506	.595	1.161	.524	1.607	.540	1.569	.606
CA	.242	.603	.306	.489	.682	.569	.444	.482	.603	.594
NA	.011	.232	.020	.368		.375	.020	.404	.016	.336
K		.002		.006				.005		.006
TOTAL	8.004	4.002	8.025	4.003	8.012	4.001	8.010	3.985	8.018	3.999
OXYGEN	12	6	12	6	12	6	12	6	12	6

	M: 72.99	M: 85.06	M: 56.05	M: 76.77	M: 50.18	M: 78.00	M: 63.59	M: 82.61	M: 65.71	M: 86.35
	CA 8.15	CA 39.51	CA 10.22	CA 38.68	CA 22.77	CA 45.85	CA 14.95	CA 42.42	CA 20.17	CA 45.87
	MG 67.04	MG 51.45	MG 50.33	MG 47.07	MG 38.75	MG 42.24	MG 54.08	MG 47.57	MG 52.45	MG 46.74
	FE 24.81	FE 9.04	FE 39.46	FE 14.25	FE 38.48	FE 11.91	FE 30.97	FE 10.01	FE 27.38	FE 7.39
		C: 43.44		C: 45.11		C: 52.05		C: 47.14		C: 49.53

*** SINGLE GRAIN MOUNTS OF ROBERTS VICTOR ECLOGITES ***

	HRV174 GT101	HRV174 CP101	HRV175 GT101	HRV175 CP101	HRV177 GT101	HRV177 CP101	HRV182 GT101	HRV182 CP101	HRV186 GT101	HRV186 CP101
SIO2	40.5	56.1	39.1	55.3	40.2	56.1	40.4	56.5	40.7	55.7
TIO2	.26	.36	.18	.19	.39	.41	.26	.34	.31	.32
AL2O3	23.0	8.09	22.2	8.71	22.5	9.04	23.0	8.54	22.9	5.87
CR2O3	.11	.11	.12	.06	.15	.13	.25	.23	.39	.68
FEO	16.2	5.22	19.4	5.64	16.1	4.50	14.5	4.45	16.1	5.77
MNO	.32	.10	.38	ND	.50	.08	.40	.07	.47	.12
MGO	15.0	11.9	8.82	9.71	14.4	10.9	16.4	12.2	15.8	13.6
CAO	4.59	13.9	9.92	16.0	5.54	13.9	4.08	13.5	3.88	14.9
NA2O	.10	4.89	.07	4.92	.15	5.51	ND	4.98	.10	4.06
K2O		.15				.12		.13		.13
TOTAL	100.1	100.8	100.2	100.6	99.9	100.7	99.3	100.9	100.6	101.1

IONIC PROPORTIONS

SI	2.975	1.991	2.965	1.981	2.971	1.988	2.966	1.991	2.969	1.986
TI	.014	.010	.010	.005	.022	.011	.014	.009	.017	.009
AL	1.992	.338	1.984	.368	1.960	.378	1.990	.355	1.970	.247
CR	.006	.003	.007	.002	.009	.004	.015	.006	.022	.019
FE	.995	.155	1.230	.169	.995	.133	.890	.131	.982	.172
MN	.020	.003	.024		.031	.002	.025	.002	.029	.004
MG	1.642	.629	.997	.518	1.586	.576	1.794	.641	1.718	.723
CA	.361	.528	.806	.614	.439	.528	.321	.510	.303	.569
NA	.014	.336	.010	.342	.021	.379		.340	.014	.281
K		.007				.005		.006		.006
TOTAL	8.019	4.001	8.034	4.000	8.034	4.003	8.021	3.992	8.025	4.015
OXYGEN	12	6	12	6	12	6	12	6	12	6

	M: 62.26	M: 80.25	M: 44.76	M: 75.42	M: 61.45	M: 81.19	M: 66.84	M: 83.01	M: 63.62	M: 80.77
	CA 12.05	CA 40.26	CA 26.57	CA 47.19	CA 14.53	CA 42.67	CA 10.68	CA 39.77	CA 10.10	CA 38.88
	MG 54.76	MG 47.94	MG 32.86	MG 39.83	MG 52.52	MG 46.54	MG 59.70	MG 49.99	MG 57.20	MG 49.36
	FE 33.19	FE 11.80	FE 40.56	FE 12.98	FE 32.95	FE 10.78	FE 29.62	FE 10.23	FE 32.71	FE 11.75
		C: 45.65		C: 54.23		C: 47.83		C: 44.31		C: 44.06

*** SINGLE GRAIN MOUNTS OF ROBERTS VICTOR ECLOGITES ***

	HRV187 GT101	HRV187 CP101	HRV190 GT101	HRV190 CP101	HRV195 GT101	HRV195 CP101	HRV197 GT101	HRV197 CP101	HRV206 GT101	HRV206 CP101
SIO2	42.3	55.7	41.2	56.1	42.1	55.4	41.4	56.8	40.8	56.7
TIO2	.20	.21	.28	.36	.25	.15	.23	.34	.26	.32
AL203	24.0	2.97	23.2	9.30	23.6	2.69	23.5	11.2	23.1	8.94
CR203	.21	.13	.09	.11	.32	.16	.08	.20	.15	.18
FEO	7.94	2.17	15.5	4.25	10.6	2.66	13.5	3.15	16.5	5.00
MNO	.25	.05	.46	.09	.25	.07	.31	.07	.42	.09
MGO	20.6	17.0	15.0	11.2	19.5	16.6	14.9	10.1	14.7	11.1
CAO	4.85	21.3	5.58	13.8	4.31	20.7	7.69	13.1	4.84	13.6
NA2O	ND	1.79	.12	5.42	.05	1.74	.13	7.09	.14	5.51
K2O				.15		ND		.12		.15
TOTAL	100.4	101.3	101.4	100.8	101.0	100.2	101.7	102.2	100.9	101.6

IONIC PROPORTIONS

SI	2.979	1.979	2.983	1.983	2.981	1.992	2.976	1.971	2.978	1.993
TI	.011	.006	.015	.010	.013	.004	.012	.009	.014	.008
AL	1.993	.124	1.980	.387	1.970	.114	1.992	.458	1.988	.370
CR	.012	.004	.005	.003	.018	.005	.005	.005	.009	.005
FE	.468	.064	.938	.126	.628	.080	.812	.091	1.007	.147
MN	.015	.002	.028	.003	.015	.002	.019	.002	.026	.003
MG	2.162	.900	1.618	.590	2.058	.890	1.596	.522	1.599	.581
CA	.366	.811	.433	.523	.327	.797	.592	.487	.379	.512
NA		.123	.017	.371	.007	.121	.018	.477	.020	.376
K				.007				.005		.007
TOTAL	8.011	4.013	8.018	4.002	8.016	4.006	8.022	4.029	8.019	4.002
OXYGEN	12	6	12	6	12	6	12	6	12	6

	M: 82.22	M: 93.32	M: 63.30	M: 82.44	M: 76.63	M: 91.75	M: 66.29	M: 85.11	M: 61.35	M: 79.82
	CA 12.22	CA 45.67	CA 14.48	CA 42.21	CA 10.85	CA 45.13	CA 19.74	CA 44.25	CA 12.68	CA 41.29
	MG 72.17	MG 50.70	MG 54.13	MG 47.65	MG 68.31	MG 50.34	MG 53.21	MG 47.45	MG 53.57	MG 46.87
	FE 15.61	FE 3.63	FE 31.39	FE 10.15	FE 20.84	FE 4.53	FE 27.05	FE 8.30	FE 33.74	FE 11.85
		C: 47.39		C: 46.97		C: 47.27		C: 48.25		C: 46.83

*** SINGLE GRAIN MOUNTS OF ROBERTS VICTOR ECLOGITES ***

	HRV207 CP201	HRV211 GT101	HRV219 GT101	HRV219 CP101	HRV246 GT101	HRV248 CP101	HRV249 GT101	HRV249 CP101	HRV249 MI 1	HRV246 CP101
SIO2	53.1	41.6	39.6	56.5	40.9	56.2	42.4	56.0	41.9	56.0
TIO2	.19	.20	.20	.22	.32	.17	.42	.39	2.34	.32
AL2O3	3.52	23.5	22.6	11.6	23.4	6.01	23.8	4.16	12.7	12.7
CR2O3	.11	.08	.05	ND	.05	.23	ND	.05	.48	.08
FEO	4.54	11.2	19.0	4.08	14.3	3.61	11.0	4.03	6.04	3.26
MNO	.12	.18	.33	.04	.24	.07	.27	.08	ND	.05
MGO	15.6	15.7	8.04	9.04	12.7	14.4	19.7	16.7	22.8	8.83
CAO	19.1	7.55	11.1	14.8	9.20	16.9	3.74	17.2	ND	11.9
NA2O	1.85	.13	.09	5.76	.12	3.60	.12	2.68	.15	6.81
K2O	ND					.10		.11	10.5	.13
TOTAL	98.1	100.1	101.0	102.1	101.2	101.3	101.5	101.4	96.9	100.1

IONIC PROPORTIONS

SI	1.964	3.002	2.976	1.968	2.978	1.986	2.985	1.983	5.364	1.972
TI	.005	.011	.011	.006	.018	.005	.022	.010	.225	.008
AL	.153	1.999	2.003	.476	2.009	.250	1.975	.174	1.917	.527
CR	.003	.005	.003		.003	.006		.001	.049	.002
FE	.140	.676	1.194	.119	.871	.107	.648	.119	.647	.096
MN	.004	.011	.021	.001	.015	.002	.016	.002		.001
MG	.860	1.689	.901	.469	1.378	.759	2.067	.881	4.350	.463
CA	.757	.584	.894	.552	.718	.640	.282	.653		.449
NA	.133	.018	.013	.389	.017	.247	.016	.184	.037	.465
K						.005		.005	1.715	.006
TOTAL	4.019	7.994	8.016	3.982	8.007	4.006	8.013	4.013	14.305	3.990
OXYGEN	6	12	12	6	12	6	12	6	20	6

M: 85.96	M: 71.41	M: 42.99	M: 79.79	M: 61.28	M: 87.67	M: 76.14	M: 88.07	M: 87.06	M: 82.84
CA 43.08	CA 19.80	CA 29.91	CA 48.43	CA 24.19	CA 42.52	CA 9.41	CA 39.47		CA 44.53
MG 48.93	MG 57.27	MG 30.13	MG 41.15	MG 46.45	MG 50.39	MG 68.97	MG 53.31		MG 45.95
FE 7.99	FE 22.93	FE 39.96	FE 10.42	FE 29.35	FE 7.09	FE 21.61	FE 7.22		FE 9.52
C: 46.82			C: 54.07		C: 45.76		C: 42.55		C: 49.21

*** SINGLE GRAIN MOUNTS OF ROBERTS VICTOR ECLOGITES ***

	HRV252M GT101	HRV252M CP101	HRV252A GT101	HRV260 GT101	HRV261 GT101	HRV261 CP101	HRV261 OP101	HRV266 GT101	HRV266 CP101	HRV268 CP101
SIO2	39.1	52.8	40.3	40.6	40.6	52.6	44.7	40.7	56.0	55.3
TIO2	.29	.39	.33	.36	.36	.20	.03	.28	.34	.17
AL203	22.2	8.65	22.6	23.0	22.5	2.63	5.42	22.9	6.58	6.30
CR203	.09	.11	.18	.11	.73	.34	.06	.14	.11	.20
FEO	20.7	6.59	19.0	16.2	15.9	4.24	8.10	19.6	5.78	4.10
MNO	.90	.16	.78	.42	.37	.09	.04	.66	.09	.05
MGO	10.1	7.26	13.6	14.6	15.3	11.6	19.4	13.8	12.6	13.2
CAO	5.63	13.4	4.30	5.10	4.48	20.5	2.08	4.08	15.4	15.8
NA2O	.13	8.09	.07	.15	.10	2.80	2.21	.10	4.40	4.02
K2O		.20				ND			.13	.05
TOTAL	99.1	97.6	101.2	100.5	100.3	95.0	82.0	102.3	101.4	99.2

IONIC PROPORTIONS

SI	2.983	1.975	2.971	2.974	2.976	2.021	1.927	2.970	1.990	1.996
TI	.017	.011	.018	.020	.020	.006	.001	.015	.009	.005
AL	1.997	.381	1.964	1.986	1.944	.119	.275	1.970	.276	.268
CR	.005	.003	.010	.006	.042	.010	.002	.008	.003	.006
FE	1.321	.206	1.171	.992	.975	.136	.292	1.196	.172	.124
MN	.058	.005	.049	.026	.023	.003	.001	.041	.003	.002
MG	1.146	.405	1.494	1.594	1.671	.664	1.246	1.501	.667	.710
CA	.460	.537	.340	.400	.352	.844	.096	.319	.586	.611
NA	.019	.587	.010	.021	.014	.209	.185	.014	.303	.281
K		.010							.006	.002
TOTAL	8.009	4.120	8.028	8.020	8.018	4.013	4.026	8.033	4.016	4.004
OXYGEN	12	6	12	12	12	6	6	12	6	6

	M: 46.51	M: 66.25	M: 56.05	M: 61.63	M: 63.16	M: 82.98	M: 81.02	M: 55.65	M: 79.53	M: 85.16
	CA 15.71	CA 46.79	CA 11.30	CA 13.40	CA 11.74	CA 51.32	CA 5.88	CA 10.58	CA 41.14	CA 42.29
	MG 39.20	MG 35.26	MG 49.72	MG 53.37	MG 55.75	MG 40.39	MG 76.26	MG 49.76	MG 46.81	MG 49.14
	FE 45.09	FE 17.96	FE 38.98	FE 33.23	FE 32.51	FE 8.29	FE 17.87	FE 39.66	FE 12.05	FE 8.57
		C: 57.03				C: 55.96	C: 7.16		C: 46.77	C: 46.25

*** SINGLE GRAIN MOUNTS OF ROBERTS VICTOR ECLOGITES ***

	HRV269 GT101	HRV269 CP101	HRV274 GT101	HRV274 CP101	JJG306 GT101	JJG306 CP101	JJG306 OP101	JJG306 OP501	JJG312 GT101	JJG312 CP101
SIO2	42.3	55.5	42.3	55.8	40.9	54.9	50.1	48.0	41.7	55.1
TIO2	.10	.10	.18	.32	.25	.29	.03	.03	.12	.14
AL2O3	24.0	3.41	23.9	4.84	23.0	6.19	5.55	4.32	23.6	3.17
CR2O3	.54	.30	.27	.36	.26	.23	.08	.06	.43	.36
FEO	10.4	2.64	11.2	3.43	14.8	5.77	7.54	7.40	7.32	1.52
MNO	.21	.04	.37	.09	.45	.17	.09	.09	.42	.10
MGO	19.9	16.3	19.4	15.1	16.9	13.4	24.0	23.1	21.1	16.8
CAO	4.15	20.0	3.51	17.7	3.23	13.2	.93	.93	3.74	19.5
NA2O	ND	2.25	.12	3.49	.11	3.83	1.17	.93	.10	2.10
K2O				ND		.13	.18	.16		ND
TOTAL	101.6	100.5	101.2	101.1	99.9	98.1	89.7	85.0	98.5	98.8

IONIC PROPORTIONS

SI	2.971	1.986	2.987	1.982	2.981	2.004	1.945	1.967	2.981	1.994
TI	.005	.003	.010	.009	.014	.008	.001	.001	.006	.004
AL	1.987	.144	1.990	.203	1.976	.266	.254	.209	1.989	.135
CR	.030	.008	.015	.010	.015	.007	.002	.002	.024	.010
FE	.611	.079	.661	.102	.902	.176	.245	.254	.438	.046
MN	.012	.001	.022	.003	.028	.005	.003	.003	.025	.003
MG	2.083	.869	2.042	.800	1.835	.729	1.389	1.410	2.248	.906
CA	.312	.767	.266	.674	.252	.516	.039	.041	.286	.756
NA		.156	.016	.240	.016	.271	.088	.074	.014	.147
K						.006	.009	.008		
TOTAL	8.017	4.013	8.009	4.023	8.018	3.990	3.974	3.968	8.013	4.003
OXYGEN	12	6	12	6	12	6	6	6	12	6

M: 77.32	M: 91.67	M: 75.53	M: 88.69	M: 67.05	M: 80.54	M: 85.01	M: 84.76	M: 83.70	M: 95.17
CA 10.39	CA 44.71	CA 8.95	CA 42.77	CA 8.44	CA 36.32	CA 2.31	CA 2.39	CA 9.64	CA 44.26
MG 69.29	MG 50.68	MG 68.77	MG 50.76	MG 61.39	MG 51.29	MG 83.05	MG 82.73	MG 75.64	MG 53.04
FE 20.32	FE 4.61	FE 22.28	FE 6.47	FE 30.17	FE 12.39	FE 14.64	FE 14.87	FE 14.72	FE 2.69
	C: 46.87		C: 45.73		C: 41.46	C: 2.71	C: 2.81		C: 45.49

TABLE 5

ROBERTS VICTOR - ALTERED GARNET DUNITE; POTENTIAL DIAMOND SOURCE ROCK - BD1192

	BD1192 GT101	BD1192 GT301	BD1192 GT102	BD1192 GT602	BD1192 GT402	BD1192 GT103	BD1192 GT104	BD1192 GT504
SIO2	42.6	42.6	42.5	42.5	42.4	42.4	42.7	42.3
TIO2	ND	.03	ND	.03	.03	ND	ND	.03
AL2O3	21.5	21.1	21.4	21.3	21.2	21.2	21.5	20.9
CR2O3	4.50	4.80	4.58	4.55	4.66	4.69	4.48	5.13
FEO	6.41	6.49	6.46	6.38	6.45	6.35	6.49	6.36
MNO	.30	.31	.32	.31	.31	.29	.31	.34
MGO	23.9	23.6	23.8	23.7	23.6	23.5	23.9	23.5
CAO	1.22	1.60	1.39	1.57	1.53	1.53	1.26	1.63
NA2O	ND	ND	ND	ND	ND	ND	ND	ND
K2O								
TOTAL	100.5	100.6	100.5	100.4	100.2	100.0	100.7	100.2

IONIC PROPORTIONS

SI	2.987	2.992	2.984	2.987	2.987	2.991	2.989	2.985
TI		.002		.002	.002			.002
AL	1.777	1.747	1.771	1.765	1.761	1.763	1.774	1.739
CR	.249	.267	.254	.253	.259	.262	.248	.286
FE	.376	.381	.379	.375	.380	.375	.380	.375
MN	.018	.018	.019	.018	.018	.017	.018	.020
MG	2.497	2.470	2.490	2.482	2.477	2.471	2.493	2.471
CA	.092	.120	.105	.118	.115	.116	.095	.123
NA								
K								
TOTAL	8.001	8.002	8.004	8.005	8.004	7.996	8.000	8.002
OXYGEN	12	12	12	12	12	12	12	12

M: 86.92	M: 86.63	M: 86.78	M: 86.88	M: 86.70	M: 86.83	M: 86.78	M: 86.82
CA 3.09	CA 4.05	CA 3.52	CA 3.97	CA 3.88	CA 3.91	CA 3.18	CA 4.15
MG 84.23	MG 83.12	MG 83.73	MG 83.42	MG 83.33	MG 83.44	MG 84.01	MG 83.21
FE 12.68	FE 12.83	FE 12.75	FE 12.60	FE 12.78	FE 12.65	FE 12.80	FE 12.64

ROBERTS VICTOR - ALTERD GARNET LHERZOLITE - HRV 20

	HRV 20 GT101	HRV 20 CP101	HRV 20 CC101	HRV 20 ??102	HRV 20 ??103
SIO2	41.1	54.9	.92	10.0	47.1
TIO2	.25	.09	ND	ND	.05
AL2O3	19.6	1.33	.09	1.38	6.13
CR2O3	5.43	1.29	.10	.46	1.83
FEO	10.4	3.28	.34	3.15	12.8
MNO	.37	.09	.38	.55	.17
MGO	17.8	17.6	.84	5.27	20.5
CAO	6.00	20.7	58.8	53.1	1.97
NA2O	ND	1.36	ND	.10	.10
K2O		ND	ND	ND	ND
TOTAL	101.0	100.6	61.5	74.0	90.7

IONIC PROPORTIONS

SI	2.977	1.980	.014	1.099	3.121
TI	.014	.002			.002
AL	1.674	.057	.002	.179	.479
CR	.311	.037	.001	.040	.096
FE	.630	.099	.004	.290	.709
MN	.023	.003	.005	.051	.010
MG	1.922	.946	.019	.864	2.025
CA	.466	.800	.940	6.255	.140
NA		.095		.021	.013
K					
TOTAL	8.017	4.019	.985	8.802	6.596
OXYGEN	12	6	1	10	10

M: 75.31 M: 90.53 M: 74.88 M: 74.05

CA 15.43 CA 43.36
MG 63.69 MG 51.28
FE 20.88 FE 5.36

C: 45.82

ROBERTS VICTOR - CLINOPYROXENE-MAGNETITE INTERGROWTH - HRV21

	HRV 21 CP101	HRV 21 CP102	HRV 21 CP103	HRV 21 MT101
SIO2	49.6	49.6	50.0	2.92
TIO2	.42	.37	.34	ND
AL2O3	4.42	4.12	4.21	.14
CR2O3	.16	.14	.14	ND
FEO	9.68	10.6	10.5	82.5
MNO	.18	.18	.21	.07
MGO	11.7	11.4	11.8	.13
CAO	21.4	20.6	21.0	
NA2O	.86	1.10	.89	
K2O	ND	ND	ND	
TOTAL	98.4	98.1	99.1	85.8

IONIC PROPORTIONS

SI	1.892	1.903	1.898	.155
TI	.012	.011	.010	
AL	.199	.186	.188	.009
CR	.005	.004	.004	
FE	.309	.340	.333	3.661
MN	.006	.006	.007	.003
MG	.665	.652	.668	.010
CA	.875	.847	.854	
NA	.064	.082	.066	
K				
TOTAL	4.026	4.032	4.029	3.840
OXYGEN	6	6	6	4

M: 68.29	M: 65.71	M: 66.70	M: .28
CA 47.32	CA 46.05	CA 46.04	
MG 35.98	MG 35.45	MG 35.99	
FE 16.70	FE 18.50	FE 17.97	
C: 56.80	C: 56.51	C: 56.13	

ROBERTS VICTOR - CPx-CHROMITE DUNITE : POTENTIAL DIAMOND SOURCE ROCK - JJG503

	JJG503 CP101	JJG503 CP101	JJG503 CP102	JJG503 OL101	JJG503 OL102	JJG503 MI101	JJG503 MI102	JJG503 MI103	JJG503 MI104	JJG503 MI105
SIO2	55.0	55.1	55.3	40.9	41.0	42.0	41.8	43.0	42.4	42.4
TIO2	.03	.03	.03			.58	.73	1.46	1.00	.53
AL2O3	1.90	1.95	1.92	ND		12.3	13.1	12.6	12.5	12.7
CR2O3	3.20	3.06	3.06	ND		.65	.50	.54	.70	.47
FEO	1.29	1.26	1.26	5.53	5.44	3.25	4.40	4.09	3.98	3.44
MNO	.05	.07	.08	.08	.07	ND	.04	.04	.04	ND
MGO	16.7	16.7	16.8	52.4	52.5	24.7	23.8	25.0	24.5	25.0
CAO	20.0	19.7	19.8	ND		ND	ND	.04	ND	.03
NA2O	2.27	2.26	2.26			.15	.35	.12	.14	.21
K2O	ND	.04	ND			10.2	9.46	10.2	10.4	9.93
TOTAL	100.5	100.2	100.5	98.9	99.0	93.8	94.2	97.1	95.7	94.7

IONIC PROPORTIONS

SI	1.978	1.984	1.984	.994	.995	5.469	5.425	5.425	5.440	5.459
TI	.001	.001	.001			.057	.071	.139	.096	.051
AL	.081	.083	.081			1.888	2.012	1.877	1.891	1.928
CR	.091	.087	.087			.067	.051	.054	.071	.048
FE	.039	.038	.038	.112	.110	.354	.478	.432	.427	.370
MN	.002	.002	.002	.002	.001		.004	.004	.004	
MG	.895	.896	.898	1.897	1.898	4.793	4.603	4.700	4.684	4.797
CA	.770	.760	.761					.005		.004
NA	.158	.158	.157			.038	.088	.029	.035	.052
K		.002				1.694	1.566	1.642	1.702	1.631
TOTAL	4.015	4.010	4.010	3.006	3.005	14.363	14.300	14.307	14.352	14.343
OXYGEN	6	6	6	4	4	20	20	20	20	20
	M: 95.85	M: 95.94	M: 95.96	M: 94.41	M: 94.50	M: 93.12	M: 90.60	M: 91.59	M: 91.65	M: 92.83
	CA 45.21	CA 44.86	CA 44.85							
	MG 52.51	MG 52.90	MG 52.93							
	FE 2.28	FE 2.24	FE 2.23							
	C: 46.27	C: 45.89	C: 45.87							

ROBERTS VICTOR - CPX-CHROMITE DUNITE : POTENTIAL DIAMOND SOURCE ROCK - JJG503

	JJG503 CR101	JJG503 CR102
SIO2	.04	ND
TIO2	.25	.28
AL2O3	7.75	7.75
CR2O3	63.2	63.1
FEO	14.5	14.6
MNO	.77	.81
MGO	14.0	13.9
CAO		
NA2O		
K2O		
TOTAL	100.5	100.4

IONIC PROPORTIONS

SI	.001	
TI	.006	.007
AL	.298	.298
CR	1.628	1.628
FE	.395	.398
MN	.021	.022
MG	.680	.676
CA		
NA		
K		
TOTAL	3.030	3.030
OXYGEN	4	4

M: 63.24 M: 62.92

ROBERTS VICTOR - SLIGHTLY PORPHYROCLASTIC METASOMATISED? LHERZOLITE - KRV 10

	KRV 10 OL 1	KRV 10 OL 1	KRV 10 OL 2	KRV 10 OL 3	KRV 10 OP 1	KRV 10 OP 2	KRV 10 CP 1	KRV 10 CR 1	KRV 10 CR 2	KRV 10 MI 1
SIO2	41.7	40.7	40.9	40.8	57.4	57.5	54.9	.07	.20	40.1
TIO2	ND	ND			.08	.09	.18	1.55	.64	1.89
AL2O3	ND	ND			.49	.53	1.83	5.43	23.6	11.3
CR2O3	ND	ND			.46	.44	3.43	59.8	42.2	.98
FEO	7.78	7.83	7.77	7.68	4.72	4.69	2.32	20.0	14.9	2.87
MNO	.08	.08	.09	.11	.09	.09	.10			.05
MGO	50.1	50.1	50.6	50.5	35.4	23.4	16.4	13.0	17.1	24.7
CAO					.49	.49	18.4			.07
NA2O	ND	ND			.22	.15	2.70			.51
K2O							.03			10.0
TOTAL	99.7	98.8	99.4	99.1	99.3	87.4	100.3	99.9	98.6	92.4

IONIC PROPORTIONS

SI	1.012	1.000	.999	.999	1.981	2.210	1.982	.002	.006	5.334
TI					.002	.003	.005	.039	.015	.189
AL					.020	.024	.078	.215	.849	1.772
CR					.013	.013	.098	1.588	1.018	.103
FE	.158	.161	.159	.157	.136	.151	.070	.562	.380	.319
MN	.002	.002	.002	.002	.003	.003	.003			.006
MG	1.813	1.835	1.842	1.843	1.821	1.340	.882	.651	.778	4.896
CA					.018	.020	.712			.010
NA					.015	.011	.189			.132
K							.001			1.689
TOTAL	2.988	3.000	3.001	3.001	4.008	3.775	4.020	3.057	3.046	14.449
OXYGEN	4	4	4	4	6	6	6	4	4	20

M: 91.98 M: 91.94 M: 92.07 M: 92.14 M: 93.04 M: 89.89 M: 92.65 M: 53.69 M: 67.16 M: 93.88

CA .92 CA 1.34 CA 42.77
MG 92.19 MG 88.69 MG 53.02
FE 6.90 FE 9.98 FE 4.21

C: .99 C: 1.48 C: 44.65

ROBERTS VICTOR - GARNET HARZBURGITE - KRV 19

	KRV 19 GT401	KRV 19 KL201	KRV 19 OL601	KRV 19 MI201	KRV 19 OP101	KRV 19 OP301
SIO2	42.1	41.8	40.9	40.1	57.7	57.7
TIO2	.05	.25		2.73	.03	ND
AL2O3	21.2	14.2		15.8	.75	.81
CR2O3	4.40	1.94		2.25	.34	.36
FEO	6.33	5.48	6.60	3.73	4.05	3.98
MNO	.33	.22	.07	ND	.08	.07
MGO	21.2	18.9	51.4	23.3	35.7	36.1
CAO	4.86	10.0		ND	.34	.42
NA2O	ND	.64		.44	.07	.09
K2O		.18		9.73		
TOTAL	100.5	93.6	99.0	98.2	99.1	99.5

IONIC PROPORTIONS

SI	2.983	3.220	.998	5.027	1.987	1.978
TI	.003	.014		.257	.001	
AL	1.771	1.290		2.338	.030	.033
CR	.246	.118		.223	.009	.010
FE	.375	.353	.135	.391	.117	.114
MN	.020	.014	.001		.002	.002
MG	2.238	2.170	1.869	4.361	1.832	1.844
CA	.369	.825			.013	.015
NA		.096		.107	.005	.006
K		.018		1.556		
TOTAL	8.008	8.118	3.002	14.266	3.995	4.003
OXYGEN	12	12	4	20	6	6
	M: 85.65	M: 86.01	M: 93.28	M: 91.77	M: 94.01	M: 94.17
	CA 12.37	CA 24.65			CA .64	CA .78
	MG 75.05	MG 64.80			MG 93.41	MG 93.44
	FE 12.58	FE 10.54			FE 5.95	FE 5.78
					C: .68	C: .83

ROBERTS VICTOR - CHROMITE BEARING HARZBURGITE - RV12, DEREK WHITFIELD

	RV12 DW OP101	RV12 DW OP102	RV12 DW OL101	RV12 DW CR101	RV12 DW CR102
SIO2	58.1	57.9	41.1	.12	.15
TIO2	.05	.05		1.49	2.00
AL2O3	.10	.08		1.78	3.41
CR2O3	.23	.20	ND	62.5	60.0
FEO	3.86	3.85	6.33	20.1	20.0
MNO	.11	.11	.07	.95	.90
MGO	36.6	36.5	51.8	13.0	13.4
CAO	.29	.26			
NA2O	.13	.11			
K2O					
TOTAL	99.5	99.1	99.3	100.0	99.9

IONIC PROPORTIONS

SI	1.992	1.993	.998	.004	.005
TI	.001	.001		.038	.051
AL	.004	.003		.072	.136
CR	.006	.005		1.692	1.609
FE	.111	.111	.129	.576	.567
MN	.003	.003	.001	.028	.026
MG	1.870	1.872	1.874	.665	.677
CA	.011	.010			
NA	.009	.007			
K					
TOTAL	4.006	4.005	3.002	3.075	3.071
OXYGEN	6	6	4	4	4

M: 94.41 M: 94.41 M: 93.58 M: 53.60 M: 54.42

CA .53 CA .48
MG 93.91 MG 93.96
FE 5.56 FE 5.56

C: .57 C: .51

ROBERTS VICTOR - ALTERED GARNET LHERZOLITE - RVGRIFFIN

	RVG GT101	RVG GT301	RVG GT102	RVG GT302	RVG CP101	RVG MI001	RVG SD	RVG CR001
SIO2	41.4	41.4	41.6	41.4	55.6	41.1	.36	.13
TIO2	.07	.07	.05	.08	.05	.57	.09	1.58
AL2O3	20.3	20.1	20.1	20.1	1.96	13.5	.13	8.02
CR2O3	5.47	5.29	5.28	5.40	2.14	1.55	.16	58.4
FEO	6.88	6.91	6.89	6.97	2.16	3.14	93.1	2.23
MNO	.35	.34	.35	.34	.06	ND		
MGO	20.1	20.3	20.2	20.4	17.2	24.8	.17	15.8
CAO	5.40	5.26	5.39	5.11	19.7	ND		
NA2O	ND	ND	ND	ND	1.99	ND		
K2O					ND	10.3		
TOTAL	100.0	99.7	99.9	99.8	100.8	95.0	94.0	86.2

IONIC PROPORTIONS

SI	2.972	2.980	2.988	2.977	1.989	5.303	.005	.005
TI	.004	.004	.003	.004	.001	.055	.001	.043
AL	1.718	1.706	1.702	1.704	.083	2.054	.002	.339
CR	.310	.301	.300	.307	.061	.158	.002	1.656
FE	.413	.416	.414	.419	.065	.339	.981	.067
MN	.021	.021	.021	.021	.002			
MG	2.154	2.177	2.162	2.186	.915	4.773	.003	.846
CA	.415	.406	.415	.394	.755			
NA					.138			
K						1.696		
TOTAL	8.013	8.015	8.011	8.017	4.008	14.384	.993	2.955
OXYGEN	12	12	12	12	6	20	1	4

	M: 83.91	M: 83.96	M: 83.93	M: 83.91	M: 93.40	M: 93.37	M: .32	M: 92.67
	CA 13.92	CA 13.53	CA 13.87	CA 13.13	CA 43.53			
	MG 72.23	MG 72.61	MG 72.29	MG 72.90	MG 52.74			
	FE 13.85	FE 13.87	FE 13.84	FE 13.98	FE 3.73			
					C: 45.22			

TABLE 6

TYPE I ECLOGITES - WHOLE ROCK ANALYSES

	HRV 17A	HRV 17B	HRV 17C	HRV 17D	HRV 77OE	HRV 77M	HRV1100E	HRV110M	HRV127	JJG 2
SIO2	44.00	44.20	44.70	45.00	48.70	53.70	46.10	48.90	45.70	47.30
TIO2	.51	.51	.33	.28	.35	.37	.33	.38	.30	.35
AL2O3	18.80	18.20	19.60	26.10	11.30	9.65	14.90	11.70	17.30	14.70
FE2O3	10.70	11.10	7.60	5.62	10.10	5.36	11.10	9.20	9.43	11.50
FEO	-	-	-	-	-	-	-	-	-	-
MNO	.24	.26	.12	.08	.21	.06	.24	.17	.18	.24
MGO	12.00	12.70	6.77	5.55	12.50	10.40	15.30	16.00	13.00	14.80
CAO	8.42	8.10	14.50	11.70	10.40	13.20	7.51	6.47	9.01	8.54
NA2O	3.02	2.84	3.47	3.60	3.21	4.39	1.98	1.98	2.96	1.96
K2O	.81	.71	.81	.64	.36	.30	.53	.73	.30	.26
P2O5	.03	.04	.02	.02	.02	.01	.02	.03	.02	.03
H2O+	1.09	1.00	1.01	.90	1.11	.76	.52	1.31	1.35	.16
H2O-	.57	.19	.13	.09	.43	.29	.33	1.15	.40	.47
CO2	.38	.31	.26	.21	.26	.20	-	-	-	-
TOTAL	100.17	99.96	99.32	99.79	98.95	98.69	98.86	100.02	99.95	100.31
				* * * TRACE ELEMENTS * * *						
ZR	30.0	29.0	19.0	14.0	28.0	14.0	27.0	25.0	22.0	25.0
NB	-	-	-	-	-	-	-	-	-	-
Y	12.0	11.0	5.0	3.0	8.0	3.0	7.0	5.0	9.0	8.0
RB	12.0	10.0	12.0	12.0	5.0	-	7.0	12.0	7.0	4.0
BA	-	-	-	-	-	-	-	-	-	-
SR	127.	120.	365.	269.	166.	186.	134.	171.	107.	126.
CO	52.0	56.0	41.0	34.0	55.0	59.0	63.0	63.0	56.0	65.0
CR	257.	372.	234.	209.	1049.	1404.	1316.	1282.	504.	940.
NI	165.	161.	179.	165.	274.	609.	310.	437.	222.	405.
V	142.	147.	83.0	79.0	269.	263.	191.	134.	141.	179.
ZN	55.0	54.0	50.0	39.0	48.0	68.0	46.0	69.0	47.0	53.0
CU	8.0	7.0	7.0	5.0	38.0	211.	47.0	29.0	25.0	59.0
SC	-	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-	-
PB	-	-	-	-	-	-	-	-	-	-
GA	11.0	10.0	15.0	16.0	12.0	19.0	10.0	10.0	-	-
				* * * ELEMENT RATIOS * * *						
ZR/NB	-	-	-	-	-	-	-	-	-	-
ZR/BA	-	-	-	-	-	-	-	-	-	-
ZR/Y	2.50	2.64	3.80	4.67	3.50	4.67	3.86	5.00	2.44	3.13
K/RB	560.	589.	560.	443.	598.	-	629.	505.	356.	540.
K/BA	-	-	-	-	-	-	-	-	-	-
K/ZR	224.	203.	354.	380.	107.	176.	163.	242.	113.	86.3
RB/SR	9.449-002	8.333-002	3.288-002	4.461-002	3.012-002	-	5.224-002	7.018-002	6.542-002	3.175-002
CA/Y	5.015+003	5.263+003	2.073+004	2.787+004	9.291+003	3.145+004	7.668+003	1.211+004	7.155+003	7.629+003
ZR/NI	.182	.180	.106	8.485-002	.102	2.299-002	8.710-002	5.721-002	9.910-002	6.173-002
CR/NI	1.55	2.31	1.31	1.27	3.83	2.31	4.25	2.93	2.27	2.32
NI/CO	3.17	2.87	4.37	4.85	4.98	10.3	4.92	6.94	3.96	6.43
CR/V	1.81	2.53	2.82	2.65	3.90	5.34	6.89	9.57	3.57	5.25
K/U*1000	-	-	-	-	-	-	-	-	-	-
TI/P	14.2	10.6	22.7	19.2	24.0	59.8	22.7	17.4	20.6	16.0
GA*10000/AL	1.11	1.09	1.45	1.30	2.01	3.72	1.27	1.61	-	-
M.I.	47.1	46.6	52.9	50.3	44.7	34.0	42.0	36.5	42.0	43.7
O.I.	-	-	-	-	-	-	-	-	-	-

TYPE I ECLOGITES - WHOLE ROCK ANALYSES

	JJG 4	JJG 5	JJG181	KRV 1	KRV 2	KRV 3	KRV 4	KRV 5	KRV 6	KRV 7
SIO2	45.70	46.20	44.40	47.00	46.90	46.00	48.80	46.40	46.90	44.90
TIO2	.37	.13	1.37	.34	.36	.38	.35	.35	.51	.55
AL2O3	20.00	14.40	10.80	14.10	14.50	13.20	12.50	14.50	12.70	17.40
FE2O3	9.00	10.70	9.42	13.20	13.60	12.40	12.30	15.20	11.70	12.80
FEO	-	-	-	-	-	-	-	-	-	-
MNO	.15	.20	.13	.30	.38	.33	.32	.34	.36	.25
MGO	11.00	15.00	19.30	12.60	12.80	15.30	12.90	13.80	14.70	11.00
CAO	9.90	11.30	4.17	9.50	8.94	10.30	9.90	7.58	9.20	10.20
NA2O	3.25	1.49	.57	2.29	2.99	1.51	2.56	1.78	1.61	2.42
K2O	.18	.21	6.79	.22	.36	.49	.25	.14	.92	.26
P2O5	.05	.03	.04	.04	.04	.04	.04	.04	.06	.05
H2O+	.50	.28	1.77	.13	.24	.26	.27	.04	.51	.18
H2O-	.27	.30	.85	.18	.22	.24	.30	.27	.19	.12
CO2	-	-	-	-	-	-	-	-	-	-
TOTAL	100.35	100.24	99.61	99.90	101.33	100.45	100.49	100.44	99.36	100.13
				* * * TRACE ELEMENTS * * *						
ZR	20.0	14.0	29.0	24.0	28.0	59.0	23.0	27.0	54.0	50.0
NB	-	-	4.0	-	-	-	-	-	-	4.0
Y	7.0	5.0	6.0	11.0	14.0	12.0	9.0	12.0	21.0	17.0
RB	3.0	3.0	314.	5.0	8.0	18.0	6.0	3.0	26.0	6.0
BA	-	-	-	-	-	-	-	-	-	-
SR	78.0	99.0	147.	156.	225.	208.	164.	119.	161.	105.
CU	55.0	69.0	82.0	59.0	73.0	98.0	62.0	77.0	62.0	57.0
CR	493.	1280.	1668.	598.	735.	1015.	875.	990.	1201.	3018.
NI	309.	356.	730.	302.	476.	526.	349.	456.	327.	240.
V	97.0	221.	206.	271.	224.	308.	322.	271.	335.	209.
ZN	18.0	29.0	45.0	61.0	74.0	34.0	57.0	46.0	58.0	67.0
CU	30.0	104.	120.	68.0	109.	181.	80.0	139.	87.0	37.0
SC	-	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-	-
PB	-	-	-	-	-	-	-	-	-	-
GA	-	-	-	-	-	-	-	-	-	-
				* * * ELEMENT RATIOS * * *						
ZR/NB	-	-	7.25	-	-	-	-	-	-	12.5
ZR/BA	-	-	-	-	-	-	-	-	-	-
ZR/Y	2.86	2.80	4.83	2.18	2.00	4.92	2.56	2.25	2.57	2.94
K/RB	498.	581.	180.	365.	374.	226.	346.	387.	294.	360.
K/BA	-	-	-	-	-	-	-	-	-	-
K/ZR	74.7	125.	1.944+003	76.1	107.	68.9	90.2	43.0	141.	43.2
RB/SR	3.846-002	3.030-002	2.14	3.205-002	3.556-002	8.654-002	3.659-002	2.521-002	.161	5.714-002
CA/K	1.811+004	1.615+004	4.967+003	6.172+003	4.564+003	6.135+003	7.862+003	4.515+003	3.131+003	4.288+003
ZR/NI	6.472-002	3.933-002	3.973-002	7.947-002	5.882-002	.112	6.590-002	5.921-002	.165	.208
CR/NI	1.60	3.60	2.28	1.98	1.54	1.93	2.51	2.17	3.67	12.6
NI/CO	5.62	5.16	8.90	5.12	6.52	5.37	5.63	5.92	5.27	4.21
CR/V	5.08	5.79	8.10	2.21	3.28	3.30	2.72	3.65	3.59	14.4
K/BA*1000	-	-	-	-	-	-	-	-	-	-
TI/P	15.4	5.45	47.1	11.7	12.4	13.1	12.0	12.0	11.7	15.1
GA*10000/AL	-	-	-	-	-	-	-	-	-	-
N.I.	45.0	41.6	32.8	51.2	51.5	44.8	48.8	52.4	44.3	53.8
N.I.	-	-	-	-	-	-	-	-	-	-

TYPE I ECLOGITES - WHOLE ROCK ANALYSES

	KRV 8	KV 390/4
SIO2	47.70	44.30
TIO2	.40	.35
AL2O3	12.50	16.00
FE2O3	13.90	1.96
FEO	-	10.90
MNO	.38	.21
MGO	11.90	11.00
CAO	9.75	10.80
NA2O	2.51	1.58
K2O	.34	.50
P2O5	.04	.05
H2O+	.09	2.34
H2O-	.18	.37
CO2	-	-
TOTAL	99.69	100.36

* * * TRACE ELEMENTS * * *

ZR	29.0	15.0
NB	-	3.0
Y	12.0	15.0
RB	5.0	8.0
BA	-	-
SR	170.	95.0
CO	59.0	73.0
CR	548.	362.
NI	305.	266.
V	294.	276.
ZN	87.0	78.0
CU	54.0	23.0
SC	-	-
U	-	-
PB	-	-
GA	-	-

* * * ELEMENT RATIOS * * *

ZR/NB	-	5.00
ZR/BA	-	-
ZR/Y	2.42	1.00
K/RB	565.	519.
K/BA	-	-
K/ZR	97.3	277.
RB/SR	2.941-002	8.421-002
CA/Y	5.897+003	5.146+003
ZR/NI	9.508-002	5.639-002
CR/NI	1.80	1.36
NI/CO	5.17	3.64
CR/V	1.86	1.31
K/U*1000	-	-
TI/P	13.7	9.62
GA*10000/AL	-	-
M.I.	53.9	53.9
D.I.	-	-

TYPE II ECLOGITES - WHOLE ROCK ANALYSES

	HRV116	HRV132GT	HRV132CP	HRV147	HRV158	HRV173GT	HRV173CP	HRV243OE	HRV243M	HRV243CR
SIO2	41.10	43.60	48.20	46.20	47.20	41.20	48.70	46.00	48.60	43.10
TIO2	.41	.28	.27	.29	.22	.30	.26	.41	.38	.39
AL2O3	16.70	17.50	10.10	18.10	12.60	18.10	8.49	14.80	11.80	18.70
FE2O3	6.50	7.73	5.87	8.07	5.88	8.39	5.48	7.74	6.43	8.16
FEO	-	-	-	-	-	-	-	-	-	-
MNO	.16	.29	.18	.13	.14	.25	.14	.16	.15	.23
MGO	16.70	19.20	17.80	11.10	19.30	19.40	18.20	18.00	18.20	19.60
CAO	6.75	6.82	11.60	11.00	11.10	6.00	13.60	9.72	11.70	5.86
NA2O	.47	.88	1.33	3.34	.94	1.84	2.61	1.13	1.24	.87
K2O	3.21	.64	.38	.29	.79	.91	.81	.75	.64	.68
P2O5	.05	.08	.05	.03	.07	.04	.04	.04	.04	.07
H2O+	1.78	1.37	1.37	1.03	1.08	1.61	.88	.60	.63	.94
H2O-	.32	.86	.30	.17	.62	1.27	.54	.37	.40	.40
CO2	.11	-	.54	.17	-	-	-	-	-	-
TOTAL	98.26	99.05	97.99	99.92	99.94	99.31	99.75	99.72	100.21	99.00
				* * * TRACE ELEMENTS * * *						
ZR	45.0	49.0	48.0	34.0	30.0	53.0	39.0	28.0	29.0	31.0
NB	3.0	-	-	-	3.0	4.0	3.0	-	-	3.0
Y	16.0	14.0	9.0	7.0	5.0	22.0	12.0	8.0	7.0	12.0
RB	106.	23.0	13.0	3.0	14.0	24.0	21.0	17.0	13.0	15.0
BA	-	-	-	-	-	-	-	-	-	-
SR	132.	106.	177.	133.	217.	98.0	202.	143.	188.	89.0
CO	53.0	50.0	51.0	50.0	45.0	55.0	45.0	62.0	56.0	54.
CR	3479.	6959.	6311.	507.	983.	5946.	2585.	782.	2326.	*****
NI	469.	325.	468.	350.	329.	287.	479.	623.	795.	139.
V	138.	123.	170.	83.0	126.	230.	293.	161.	222.	172.
ZN	14.0	12.0	12.0	46.0	22.0	14.0	15.0	17.0	13.0	18.0
CU	-	11.0	17.0	5.0	26.0	19.0	13.0	49.0	70.0	2.0
SC	-	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-	-
PB	-	-	-	-	-	-	-	-	-	-
GA	7.0	8.0	6.0	15.0	-	8.0	6.0	12.0	10.0	11.0
				* * * ELEMENT RATIOS * * *						
ZR/NB	15.0	-	-	-	10.0	13.2	13.0	-	-	10.3
ZR/BA	-	-	-	-	-	-	-	-	-	-
ZR/Y	2.81	3.50	5.33	4.86	6.00	2.41	3.25	3.50	4.14	2.58
K/RB	251.	231.	243.	803.	468.	315.	320.	366.	409.	376.
K/BA	-	-	-	-	-	-	-	-	-	-
K/ZR	592.	108.	65.7	70.8	219.	143.	172.	222.	183.	182.
RB/SR	.803	.217	7.345-002	2.256-002	6.452-002	.245	.104	.119	6.915-002	.169
CA/Y	5.015+003	3.482+003	9.212+003	1.123+004	1.537+004	1.949+003	8.100+003	8.684+003	1.195+004	3.490+003
ZR/NI	9.202-002	.152	.103	9.714-002	9.119-002	.185	8.142-002	4.494-002	3.648-002	.223
CR/NI	7.11	21.5	13.5	1.45	2.99	20.7	5.40	1.26	2.93	74.5
NI/CO	9.23	6.46	9.18	7.00	7.31	5.22	10.6	10.0	14.2	2.57
CR/V	25.2	56.4	37.1	6.11	7.68	25.9	8.82	4.86	10.5	60.2
K/U*1000	-	-	-	-	-	-	-	-	-	-
TI/P	11.3	4.81	7.42	13.3	4.32	10.3	8.93	14.1	13.1	7.65
GA*10000/AL	.707	.873	1.12	1.57	-	.885	1.35	1.53	1.60	1.11
M.I.	25.6	26.7	24.8	42.1	23.4	30.2	23.1	30.1	26.1	29.4
O.I.	-	-	-	-	-	-	-	-	-	-

TYPE II ECLOGITES - WHOLE ROCK ANALYSES

	HRV180	HRV267GT	HRV267CP	HRV272	HRV277	HRV309OE	HRV309G	JJG 41	RV 372
SIO2	42.50	44.80	46.20	43.50	49.90	47.30	47.00	42.90	45.30
TIO2	.20	.13	.13	.63	.09	.49	.51	.17	.02
AL2O3	17.50	12.70	8.80	19.80	24.30	12.70	11.10	14.90	24.20
FE2O3	8.90	6.11	5.72	10.10	4.97	8.15	7.93	9.81	.44
FEO	-	-	-	-	-	-	-	-	2.24
MNO	.20	.15	.12	.15	.09	.20	.17	.18	.05
MGO	14.30	19.90	18.90	9.67	5.43	16.20	15.50	12.10	8.66
CAO	7.08	8.46	11.00	10.30	11.00	9.79	10.30	17.30	13.80
NA2O	.52	.81	1.03	2.79	2.99	1.68	1.70	.21	4.32
K2O	.64	.92	.77	.64	.48	.92	1.00	-	.18
P2O5	.04	.05	.04	.06	.03	.06	.04	.11	.03
H2O+	1.58	2.22	2.47	1.09	.31	1.14	1.65	1.22	1.55
H2O-	1.00	2.12	.84	.55	.06	.58	.74	.55	.07
CO2	-	-	1.60	-	-	-	-	-	-
TOTAL	99.46	98.37	97.62	99.28	99.65	99.21	97.84	99.45	100.86
				* * * TRACE ELEMENTS * * *					
ZR	17.0	22.0	23.0	48.0	15.0	76.0	75.0	14.0	-
NB	3.0	4.0	5.0	8.0	-	6.0	2.0	-	-
Y	3.0	12.0	7.0	14.0	2.0	16.0	13.0	7.0	-
RB	15.0	21.0	16.0	10.0	5.0	16.0	17.0	4.0	4.0
BA	-	-	-	-	-	-	-	-	-
SR	98.0	157.	232.	133.	106.	229.	276.	52.0	582.
CU	53.0	53.0	61.0	51.0	29.0	49.0	65.0	42.0	35.0
CR	7066.	7239.	5986.	4285.	236.	660.	339.	540.	741.
NI	256.	523.	754.	281.	171.	404.	627.	97.0	546.
V	137.	138.	128.	150.	40.0	200.	207.	473.	75.0
ZN	25.0	24.0	29.0	86.0	38.0	17.0	13.0	12.0	12.0
CO	8.0	7.0	11.0	22.0	53.0	62.0	128.	3.0	2.0
SC	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
PB	-	-	-	-	-	-	-	-	-
GA	-	4.0	5.0	-	15.0	13.0	13.0	-	-
				* * * ELEMENT RATIOS * * *					
ZR/NB	5.67	5.50	4.60	6.00	-	12.7	37.5	-	-
ZR/BA	-	-	-	-	-	-	-	-	-
ZR/Y	5.67	1.83	3.29	3.43	7.50	4.75	5.77	2.00	-
K/RB	465.	364.	400.	531.	797.	477.	488.	-	374.
K/BA	-	-	-	-	-	-	-	-	-
K/ZR	410.	347.	278.	111.	266.	100.	111.	-	-
RB/SR	.153	.134	6.897-002	7.519-002	4.717-002	6.987-002	6.159-002	7.692-002	6.873-003
CA/Y	1.687+004	5.039+003	1.123+004	5.258+003	3.931+004	4.373+003	5.663+003	1.766+004	-
ZR/NI	6.641-002	4.207-002	3.050-002	.171	8.772-002	.188	.120	.144	-
CR/NI	27.6	13.8	7.94	15.2	1.38	1.63	.541	5.57	1.36
NI/CO	4.83	9.87	12.4	5.51	5.90	8.24	9.65	2.31	15.6
CR/V	51.6	52.5	46.8	28.6	5.90	3.30	1.64	1.14	9.88
K/U*1000	-	-	-	-	-	-	-	-	-
TI/P	5.87	5.57	4.86	14.4	4.12	11.2	17.5	2.12	.916
CA*10000/AL	-	.595	1.07	-	1.17	1.93	2.21	-	-
A.I.	31.6	23.5	23.2	51.1	47.8	33.5	33.8	44.8	23.6
P.I.	-	-	-	-	-	-	-	-	-

TABLE 7

WHOLE ROCK ANALYSES OF THE ROBERTS VICTOR PERIDOTITES

	44x 20
SIO2	25.40
TIO2	.14
AL2O3	3.38
FE2O3	3.85
FEO	-
MNO	.10
MGO	6.52
CAO	50.60
NA2O	.09
K2O	.15
P2O5	.04
H2O+	25.30
H2O-	1.79
CO2	-
TOTAL	98.47

* * * TRACE ELEMENTS * * *

ZR	12.0
NB	-
Y	9.0
RB	8.0
BA	-
SR	1353.
CU	115.
CR	5691.
NI	1278.
V	64.0
ZN	64.0
CU	60.0
SC	-
U	-
PB	-
GA	-

* * * ELEMENT RATIOS * * *

ZR/NB	-
ZR/BA	-
ZR/Y	1.33
K/RB	166.
K/BA	-
K/ZR	111.
RB/SR	5.913-003
CA/Y	2.450+004
ZR/NI	9.390-003
CR/NI	4.45
NI/CU	11.1
CR/V	88.9
K/BA1000	-
TI/P	4.81
BA1000/AL	-
M.I.	37.1
C.I.	-

TABLE 8

WHOLE ROCK ANALYSES OF THE ROBERTS VICTOR KIMBERLITES

	JJG 1	JJG 28	JJG 29
SIO2	35.20	35.70	35.60
TIO2	1.23	1.32	1.29
AL2O3	4.45	4.45	4.69
FE2O3	8.24	8.50	7.63
FEO	-	-	-
MNO	.22	.24	.32
MGO	23.60	22.40	22.50
CAO	8.60	8.34	9.01
NA2O	.13	.29	.36
K2O	4.44	4.82	4.84
P2O5	1.10	1.52	.69
H2O+	12.20	10.80	12.20
H2O-	-	-	-
CO2	-	-	-
TOTAL	99.41	98.36	99.13

* * * TRACE ELEMENTS * * *

ZR	486.	511.	503.
NB	126.	126.	150.
Y	23.0	27.0	20.0
RB	162.	168.	161.
BA	-	-	-
SR	1183.	1414.	844.
CU	69.0	74.0	78.0
CR	1169.	1169.	1252.
NI	961.	996.	1033.
V	80.0	87.0	62.0
ZN	75.0	76.0	74.0
CU	26.0	30.0	24.0
SC	-	-	-
U	-	-	-
PB	-	-	-
GA	-	-	-

* * * ELEMENT RATIOS * * *

ZR/NB	3.86	4.06	3.35
ZR/BA	-	-	-
ZR/Y	21.1	18.9	25.1
K/RB	228.	238.	250.
K/BA	-	-	-
K/ZR	75.8	78.3	79.9
RB/SR	.137	.119	.191
CA/Y	2.672+003	2.208+003	3.220+003
ZR/NI	.506	.513	.487
CR/NI	1.15	1.17	1.21
NI/CO	13.9	13.5	13.2
CR/V	13.9	13.4	20.2
P/0*1000	-	-	-
TI/P	1.54	1.19	2.57
GA*10000/AL	-	-	-
M.I.	25.9	27.5	25.5
C.I.	-	-	-

PREFACE TO TABLES 9 AND 10

In tables 9 and 10 analyses of Roberts Victor eclogites by other workers are included. In many cases these eclogites could not be examined in hand specimen by the writer, and their assignment to type I or type II is based on the description of the rock and on chemical features defined by the eclogites examined in hand specimen by the writer. The chemical criteria are the K_2O contents of clinopyroxene and the relationship of CaO in garnet to Na_2O in cpx. In cases where there was ambiguity in assigning an eclogite to a particular type that sample was not included.

The data sources are listed below:

Sample prefix	Reference
OH	O'Hara, M.J., Saunders, M.J., Mercy, E.L.P.(1975) Phys. Chem. Earth 9, 571-604.
KA	Kushiro, I., Aoki, K. (1968) Amer. Mineral. 53, 1347-1367
Numbers 1 through 9	Reid, A.M., Brown, R.W., Dawson, J.B., Whitfield, G.G., Siebert, J.C. (1976) Contr. Mineral. Petrol. 58, 203-220.
BD	Bishop, F.C., Smith, J.V., Dawson, J.B.
(Some analysed by writer)	In press.

PREFACE TO TABLES 9 and 10

Symbols and abbreviations in the following tables have the same meaning as in Table 4 (q.v.). However the following additional observations are used in Tables 9 and 10:

$$F: \; - \; 100 \; (Fe^{3+}/Fe^{2+} + Fe^{3+})$$

PY	Pyrope
AL	Almandine
GR	Grossular
UV	Uvarovite
DH	Diopside-Hedenbergite
EF	Enstatite-Ferrosilite
JD	Jadeite
UR	Ureyite
CT	Ca Tschermak's molecule
AC	Acmite
PS	Pseudojadeite

TABLE 9

TYPE I : CALCIUM-RICH ECLOGITES

	HRV 26 GT101	HRV 26 CP101	JJG 14 GT101	JJG 14 CP101	JJG 31 GT102	JJG 31 CP303	JJG318 GT101	JJG318 CP103	HRV 17A GT103	HRV 17A CP103
SIO2	40.6	54.8	41.5	56.9	41.2	56.3	41.5	57.2	41.1	56.4
TIO2	.31	.37	.25	.29	.15	.15	.17	.27	.25	.31
AL2O3	22.9	8.81	23.6	12.1	23.5	12.7	23.8	12.7	23.6	12.1
CR2O3	.20	.20	.06	.10	.06	.05	.05	.08	.05	ND
FE2O3		.77	1.81		.71		1.05		2.46	
FEO	15.0	3.29	11.5	2.56	9.66	1.98	8.79	2.27	12.5	3.12
MNO	.49	.05	.23	ND	.16	ND	.19	ND	.33	ND
MGO	13.7	11.0	16.1	9.91	15.4	9.50	16.2	10.0	15.4	9.30
CAO	6.03	13.9	6.94	13.1	9.18	13.0	9.02	13.3	6.53	12.2
NA2O	.14	5.31	.12	6.37	.08	6.19	.08	6.22	.16	6.88
K2O		.16		.11		.13		.12		.10
TOTAL	99.4	98.7	102.1	101.5	100.1	100.0	100.8	102.2	102.4	100.4

IONIC PROPORTIONS

SI	3.000	1.979	2.954	1.974	2.976	1.973	2.965	1.967	2.936	1.979
TI	.017	.010	.013	.008	.008	.004	.009	.007	.013	.008
AL	1.995	.375	1.981	.495	2.001	.525	2.004	.515	1.988	.501
CR	.012	.006	.003	.003	.003	.001	.003	.002	.003	
FE3		.021	.097		.039		.056		.132	
FE2	.927	.099	.683	.074	.584	.058	.525	.065	.746	.092
MN	.031	.002	.014		.010		.011		.020	
MG	1.509	.592	1.708	.512	1.658	.496	1.725	.511	1.640	.486
CA	.478	.538	.529	.487	.710	.488	.690	.490	.500	.459
NA	.020	.372	.017	.428	.011	.421	.011	.415	.022	.468
K		.007		.005		.006		.005		.004
TOTAL	7.989	4.000	8.000	3.987	8.000	3.973	8.000	3.978	8.000	3.998
OXYGEN	12	6	12	6	12	6	12	6	12	6

	M: 61.9	M: 85.6	M: 71.4	M: 87.3	M: 74.0	M: 89.5	M: 76.7	M: 88.7	M: 68.7	M: 84.2
	CA 16.4	CA 43.8	CA 18.1	CA 45.4	CA 24.1	CA 46.8	CA 23.5	CA 46.0	CA 17.3	CA 44.3
	MG 51.8	MG 48.2	MG 58.5	MG 47.7	MG 56.2	MG 47.6	MG 58.7	MG 47.9	MG 56.8	MG 46.9
	FE 31.8	FE 8.1	FE 23.4	FE 6.9	FE 19.8	FE 5.6	FE 17.9	FE 6.1	FE 25.8	FE 8.8
		C: 47.6		C: 48.7		C: 49.6		C: 49.0		C: 48.5
	HRV 26 GT101	HRV 26 CP101	JJG 14 GT101	JJG 14 CP101	JJG 31 GT102	JJG 31 CP303	JJG318 GT101	JJG318 CP103	HRV 17A GT103	HRV 17A CP103
	PY 50.9	DH 52.8	PY 56.0	DH 45.5	PY 55.0	DH 43.8	PY 57.1	DH 44.1	PY 53.6	DH 44.5
	AL 32.3	EF 8.2	AL 26.0	EF 6.6	AL 21.0	EF 5.8	AL 19.6	EF 6.7	AL 29.4	EF 6.7
	GR 16.2	JD 35.2	GR 17.7	JD 43.1	GR 23.8	JD 42.5	GR 23.1	JD 41.8	GR 16.9	JD 47.3
	UV .6	UR .6	UV .2	UR .3	UV .2	UR .1	UV .1	UR .2	UV .1	UR .0
		CT 1.1		CT 1.9		CT 2.3		CT 2.6		CT 1.3
		AC 2.1		PS 2.7		PS 5.4		PS 4.5		PS .3
		100.0		100.0		100.0		100.0		99.9
		F: 17.4		F: .0		F: .0		F: .0		F: .0
	GR 16.3	WO 43.2	GR 17.8	WO 43.7	GR 23.8	WO 44.2	GR 23.1	WO 43.4	GR 16.9	WO 43.5
	PY 51.2	EN 48.6	PY 56.1	EN 49.2	PY 55.1	EN 50.0	PY 57.2	EN 50.2	PY 53.7	EN 47.6
	AL 32.5	FS 8.1	AL 26.1	FS 7.1	AL 21.0	FS 5.8	AL 19.7	FS 6.4	AL 29.4	FS 9.0

KD FROM TOTAL FE, T AT 40 KM FROM RAHEIM & GREEN

ERROR:	1.11	1129.	1.15	1113.	1.17	1106.	.97	1188.	1.05	1155.

TYPE I : CALCIUM-RICH ECLOGITES

	HRV246 GT101	HRV246 CP101	HRV197 GT101	HRV197 CP101	HRV172 GT101	HRV172 CP101	JJG316 GT301	JJG316 CP301	KRV 7 GT301	KRV 7 CP501
SIO2	40.9	56.0	41.4	56.8	40.3	55.9	40.6	56.2	40.5	55.6
TIO2	.32	.32	.23	.34	.25	.29	.30	.34		
AL203	23.4	12.7	23.5	11.2	23.2	9.02	23.2	10.4	22.8	9.73
CR203	.05	.08	.08	.20	.08	.07	.09	.07	.22	.23
FE203	.36		1.24	3.36	.97		1.27	.07	1.32	.93
FEO	14.0	5.26	12.4	.13	12.4	3.24	13.9	3.60	15.7	5.63
MNO	.24	.05	.31	.07	.19	.05	.37	.08	.57	.09
MGO	12.7	8.83	14.9	10.1	14.3	11.5	14.2	10.3	13.1	10.3
CAO	9.20	11.9	7.69	13.1	7.65	15.7	6.88	13.6	6.32	13.5
NA20	.12	6.81	.13	7.09	.11	4.90	.10	5.95	.15	5.76
K20		.13		.12		.13		.15		.13
TOTAL	101.3	100.1	101.9	102.5	99.5	100.8	100.9	100.8	100.7	99.9

IONIC PROPORTIONS

SI	2.976	1.972	2.968	1.957	2.960	1.975	2.957	1.980	2.979	1.982
TI	.018	.008	.012	.009	.014	.008	.016	.009		
AL	2.007	.527	1.986	.455	2.009	.376	1.992	.432	1.977	.409
CR	.003	.002	.005	.005	.005	.002	.005	.002	.013	.006
FE3	.020		.067	.087	.054		.070	.002	.073	.025
FE2	.850	.096	.743	.004	.763	.096	.844	.106	.967	.108
MN	.015	.001	.019	.002	.012	.001	.023	.002	.036	.003
MG	1.377	.463	1.592	.519	1.565	.606	1.541	.541	1.436	.547
CA	.717	.449	.591	.484	.602	.594	.537	.513	.498	.516
NA	.017	.465	.018	.474	.016	.336	.014	.406	.021	.398
K		.006		.005		.006		.007		.006
TOTAL	8.000	3.990	8.000	4.000	8.000	3.999	8.000	4.000	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6	12	6

	M: 61.8	M: 82.8	M: 68.2	M: 99.3	M: 67.2	M: 86.3	M: 64.6	M: 83.6	M: 59.8	M: 83.5
	CA 24.4	CA 44.5	CA 20.2	CA 48.1	CA 20.5	CA 45.9	CA 18.4	CA 44.3	CA 17.2	CA 44.0
	MG 46.8	MG 46.0	MG 54.4	MG 51.6	MG 53.4	MG 46.7	MG 52.7	MG 46.6	MG 49.5	MG 46.7
	FE 28.9	FE 9.5	FE 25.4	FE .4	FE 26.0	FE 7.4	FE 28.9	FE 9.1	FE 33.3	FE 9.2
		C: 49.2		C: 48.3		C: 49.5		C: 48.7		C: 48.5
	HRV246 GT101	HRV246 CP101	HRV197 GT101	HRV197 CP101	HRV172 GT101	HRV172 CP101	JJG316 GT301	JJG316 CP301	KRV 7 GT301	KRV 7 CP501
	PY 46.0	DI 42.1	PY 52.6	DI 45.1	PY 52.0	DI 57.8	PY 50.9	DI 50.4	PY 47.4	DI 50.0
	AL 29.5	EF 6.9	AL 27.3	EF 3.5	AL 27.5	EF 6.2	AL 30.9	EF 7.1	AL 35.5	EF 7.8
	GR 24.4	JD 46.9	GR 19.9	JD 36.6	GR 20.3	JD 34.0	GR 17.9	JD 40.9	GR 16.5	JD 37.3
	UV .1	UR .2	UV .2	UR .5	UV .2	UR .2	UV .3	UR .2	UV .6	UR .6
		CI 2.0		CT 3.4		CI 1.7		CI 1.1		CI 1.8
		PS 1.9		AC 8.7		PS .2		AC .2		AC 2.5
		100.0		100.0		100.0		100.0		100.0
		F: .0		F: 96.0		F: .0		F: 1.7		F: 18.7
	GR 24.4	AD 42.9	GR 19.9	AD 46.2	GR 20.3	AD 45.1	GR 18.0	AD 43.7	GR 16.6	AD 43.1
	PY 46.0	EN 47.5	PY 52.7	EN 53.4	PY 52.1	EN 47.4	PY 51.0	EN 47.1	PY 47.7	EN 47.5
	AL 29.6	FS 9.8	AL 27.4	FS .4	AL 27.6	FS 7.5	AL 31.0	FS 9.2	AL 35.7	FS 9.4

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:T	1.12	1126.	1.07	1146.	1.19	1095.	1.09	1137.	1.09	1137.

TYPE 1 : CORUNDUM ECLOGITE

	JJG 60 GT105	JJG 60 CP104
SIO2	40.7	54.0
TIO2	.12	.15
AL2O3	23.4	19.6
CR2O3	ND	ND
FE2O3	1.79	
FEO	8.21	1.24
MNO	.09	ND
MGO	10.6	5.94
CAO	16.7	12.0
NA2O	ND	7.93
K2O		ND
TOTAL	101.7	100.9

IONIC PROPORTIONS

SI	2.948	1.869
TI	.007	.004
AL	1.998	.800
CR		
FE3	.097	
FE2	.497	.036
MN	.006	
MG	1.144	.306
CA	1.296	.445
NA		.532
K		
TOTAL	8.000	3.994
OXYGEN	12	6

M: 69.7 M: 89.5

CA 44.1	CA 56.5
MG 38.9	MG 38.9
FE 16.9	FE 4.6

C: 59.2

JJG 60 GT105	JJG 60 CP104
PY 37.6	DI 31.1
AL 19.7	EF 1.6
GR 42.6	JD 53.2
UV .0	UR .0
	CT 12.7
	PS 1.3
	99.9
	F: .0
GR 42.6	HD 47.6
PY 37.6	EN 46.9
AL 19.7	FS 5.5

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:T 1.49 989.

TYPE I : GARNET WEBSTERITES

	HRV249 GT101	HRV249 CP101	HRV110 GT102	HRV110 CP102	JJG306 GT101	JJG306 CP101
SIO2	42.4	56.0	41.6	54.9	40.9	54.9
TIO2	.42	.39	.18	.31	.25	.29
AL2O3	23.5	4.16	23.6	6.21	23.0	6.19
CR2O3	ND	.05	.22	.23	.26	.23
FE2O3	.72	1.51		.90	.99	
FEO	10.3	2.67	14.6	4.23	13.9	5.77
MNO	.27	.08	.38	.09	.45	.17
MGO	19.7	16.7	16.6	14.1	16.9	13.4
CAO	3.74	17.2	3.63	13.6	3.23	13.2
NA2O	.12	2.68	.11	4.03	.11	3.83
K2O		.11		.12		.13
TOTAL	101.6	101.6	100.9	98.7	100.0	98.1

IONIC PROPORTIONS

SI	2.980	1.977	2.994	1.988	2.974	2.004
TI	.022	.010	.010	.008	.014	.008
AL	1.972	.173	2.002	.265	1.972	.266
CR		.001	.013	.007	.015	.007
FE3	.038	.040		.025	.054	
FE2	.608	.079	.879	.128	.846	.176
MN	.016	.002	.023	.003	.028	.005
MG	2.063	.878	1.781	.761	1.831	.729
CA	.282	.650	.280	.528	.252	.516
NA	.016	.183	.015	.283	.016	.271
K		.005		.006		.006
TOTAL	8.000	4.000	7.996	4.000	8.000	3.990
OXYGEN	12	6	12	6	12	6

	M: 77.2	M: 91.8	M: 67.0	M: 85.6	M: 68.4	M: 80.5
	CA 9.5	CA 40.5	CA 9.5	CA 37.2	CA 8.6	CA 36.3
	MG 69.9	MG 54.6	MG 60.6	MG 53.7	MG 62.5	MG 51.3
	FE 20.6	FE 4.9	FE 29.9	FE 9.0	FE 28.9	FE 12.4
		C: 42.5		C: 40.9		C: 41.5
	HRV249 GT101	HRV249 CP101	HRV110 GT102	HRV110 CP102	JJG306 GT101	JJG306 CP101
	PY 68.2	DI 64.0	PY 59.8	DI 52.6	PY 60.5	DI 52.2
	AL 21.9	EF 15.9	AL 30.3	EF 18.1	AL 30.7	EF 19.0
	GR 9.9	JD 14.7	GR 9.3	JD 25.7	GR 8.1	JD 26.6
	UV .0	UR .1	UV .6	UR .7	UV .8	UR .7
		CT 1.3		CT .4		CT .0
		AC 4.0		AC 2.5		AC .4
		100.0		100.0		98.9
		F: 35.7		F: 16.1		F: 2.3
	GR 9.9	WO 40.0	GR 9.4	WO 37.1	GR 8.1	WO 36.4
	PY 68.2	EN 55.1	PY 60.2	EN 53.9	PY 61.0	EN 51.4
	AL 21.9	FS 4.9	AL 30.5	FS 9.1	AL 30.9	FS 12.1

KD FROM TOTAL FE, T AT 40 KM FROM RAHEIM & GREEN

LNKD:T	.84	1248.	.90	1219.	.71	1513.

TYPE I : HOMOGENEOUS KYANITE ECLOGITES

	JJG 30 GT302	JJG 30 CP104	JJG 4 GT101	JJG 4 CP101	PJL 17 GT101	PJL 17 CP101	390/4 GT501	390/4 CP 2
SIO2	40.7	56.9	40.9	56.8	39.7	56.8	39.2	57.2
TIO2	.25	.27	.25	.32	.35	.29	.49	.24
AL2O3	23.3	16.7	23.4	15.9	22.7	17.4	22.7	20.2
CR2O3	.08		.08	.11	ND	ND	.04	
FE2O3	2.11		.80		1.37		.29	
FEO	9.50	1.63	11.6	1.98	11.8	2.03	12.4	1.72
MNO	.21		.22	ND	.23	ND	.28	
MGO	14.2	6.91	13.4	7.26	8.29	6.06	6.67	4.28
CAO	10.5	10.9	10.1	11.0	16.0	10.7	11.5	8.58
NA2O	.09	7.32	.11	7.48	.11	7.51	.06	5.29
K2O		.10		.07		.16		.14
TOTAL	100.9	100.7	100.8	100.9	100.5	101.0	99.7	97.6

IONIC PROPORTIONS

SI	2.941	1.959	2.969	1.960	2.954	1.954	2.956	1.987
TI	.014	.007	.014	.008	.020	.008	.028	.006
AL	1.985	.678	2.002	.647	1.991	.706	2.023	.827
CR	.005		.005	.003			.002	
FE3	.115		.044		.077		.016	
FE2	.574	.047	.703	.057	.732	.058	.785	.050
MN	.013		.014		.014		.018	
MG	1.529	.355	1.450	.373	.919	.311	.750	.222
CA	.813	.403	.786	.407	1.276	.394	1.414	.319
NA	.013	.489	.015	.500	.016	.501	.009	.356
K		.004		.003		.007		.006
TOTAL	8.000	3.941	8.000	3.959	8.000	3.939	8.000	3.774
OXYGEN	12	6	12	6	12	6	12	6

	M: 72.7	M: 88.3	M: 67.3	M: 86.7	M: 55.7	M: 84.2	M: 48.9	M: 81.6
	CA 27.9	CA 50.1	CA 26.7	CA 48.6	CA 43.6	CA 51.7	CA 48.0	CA 54.0
	MG 52.4	MG 44.1	MG 49.3	MG 44.6	MG 31.4	MG 40.7	MG 25.4	MG 37.5
	FE 19.7	FE 5.8	FE 23.9	FE 6.8	FE 25.0	FE 7.6	FE 26.6	FE 8.5
		C: 53.2		C: 52.1		C: 55.9		C: 59.0
	JJG 30 GT302	JJG 30 CP104	JJG 4 GT101	JJG 4 CP101	PJL 17 GT101	PJL 17 CP101	390/4 GT501	390/4 CP 2
	PY 50.0	DI 31.0	PY 48.1	DI 33.4	PY 30.3	DI 29.6	PY 25.1	DI 8.7
	AL 23.6	EF 4.6	AL 25.2	EF 4.8	AL 27.1	EF 5.7	AL 27.4	EF 9.2
	GR 26.8	JD 49.3	GR 26.4	JD 50.0	GR 42.6	JD 50.8	GR 47.4	JD 36.3
	UV .2	UR .0	UV .2	UR .3	UV .0	UR .0	UV .1	UR .0
		CT 5.4		CT 3.2		CT 3.9		CT .7
		PS 11.7		PS 8.2		PS 12.1		PS 45.2
		100.0		100.0		99.9		100.0
		F: .0		F: .0		F: .0		F: .0
	GR 26.8	WO 43.6	GR 26.4	WO 43.7	GR 42.6	WO 44.5	GR 47.5	WO 24.3
	PY 50.1	EN 49.8	PY 48.3	EN 48.9	PY 30.3	EN 46.7	PY 25.1	EN 61.8
	AL 23.0	FS 6.6	AL 25.3	FS 7.5	AL 27.1	FS 8.8	AL 27.4	FS 13.9

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:T	1.22	1083.	1.21	1087.	1.54	971.	1.56	967.

TYPE I : HRV 335 = ECLOGITE WITH GARNET EXSOLUTION

	HRV335 GI102	HRV335 CP102
SIO2	39.5	52.9
TIO2	.16	.22
AL2O3	22.5	17.4
CR2O3	.07	.04
FE2O3	1.09	
FEO	13.3	2.16
MNO	.25	ND
MGO	8.06	6.65
CAO	15.1	15.3
NA2O	ND	5.16
K2O		
TOTAL	100.1	99.8

IONIC PROPORTIONS

SI	2.964	1.866
TI	.009	.006
AL	1.991	.724
CR	.004	.001
FE3	.062	
FE2	.836	.064
MN	.016	
MG	.901	.350
CA	1.214	.578
NA		.353
K		
TOTAL	8.000	3.942
OXYGEN	12	6

M: 51.9 M: 84.6

CA 41.1	CA 58.3
MG 30.5	MG 35.3
FE 28.3	FE 6.4

C: 62.3

HRV335 GI102	HRV335 CP102
PY 29.8	DI 39.2
AL 30.2	EF 1.0
GR 39.9	JD 35.2
UV .2	OR .1
	CT 12.6
	PS 11.6
	100.0

F: .0

GR 40.0	AD 48.7
PY 29.8	EN 43.4
AL 30.2	FS 7.9

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:T	1.70	924.

TYPE I : IRON-RICH ECLOGITES

	HRV266 GT101	HRV266 CP101	KRV 5 GT601	KRV 5 CP401	JJG 11 GT101	JJG 11 CP101	HRV 77A GT604	HRV 77A CP404	KRV 1 GT401	KRV 1 CP601
SIO2	40.7	56.0	40.3	55.1	40.2	55.3	40.0	55.2	40.2	54.7
TIO2	.25	.58	.29	.32			.30	.33	.29	.34
AL2O3	22.9	6.58	22.5	6.40	22.7	7.02	22.7	7.77	22.8	6.84
CR2O3	.14	.11	.17	.16	.12	.13	.21	.14	.12	.09
FE2O3	1.82	1.77	1.79	2.19	1.93	1.21	.81	1.92	.73	2.44
FEO	18.0	4.19	16.5	5.80	17.9	6.72	17.8	4.55	17.7	4.27
MNO	.06	.09	.59	.21	.65	.19	.40	.10	.60	.15
MGO	13.8	12.6	14.9	13.0	13.8	12.2	13.9	11.4	13.4	12.2
CAO	4.06	15.4	3.14	12.2	3.36	12.0	4.33	13.0	4.58	14.2
NA2O	.10	4.40	.17	4.54	.14	4.68		5.25	.05	4.50
K2O		.13		.10		.13		.11		.16
TOTAL	102.4	101.6	100.3	100.0	100.8	99.6	100.0	99.8	100.5	99.9

IONIC PROPORTIONS

SI	2.957	1.983	2.966	1.984	2.966	1.999	2.963	1.984	2.971	1.972
TI	.015	.009	.016	.009			.017	.009	.016	.009
AL	1.962	.275	1.952	.272	1.974	.299	1.983	.329	1.986	.291
CR	.008	.003	.010	.005	.007	.004	.012	.004	.007	.003
FE3	.099	.047	.099	.059	.107	.033	.045	.052	.041	.066
FE2	1.092	.124	1.015	.175	1.102	.203	1.077	.137	1.096	.129
MN	.041	.003	.037	.006	.041	.006	.025	.003	.038	.005
MG	1.494	.665	1.634	.698	1.517	.657	1.535	.611	1.476	.655
CA	.318	.584	.248	.471	.266	.465	.344	.501	.363	.549
NA	.014	.302	.024	.317	.020	.328		.366	.007	.315
K		.006		.005		.006		.005		.007
TOTAL	8.000	4.000	8.000	4.000	8.000	4.000	8.000	4.000	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6	12	6

	M: 57.8	M: 84.3	M: 61.7	M: 80.0	M: 57.9	M: 76.4	M: 58.8	M: 81.7	M: 57.4	M: 83.6
	CA 10.9	CA 42.5	CA 8.5	CA 35.0	CA 9.2	CA 35.1	CA 11.6	CA 40.1	CA 12.4	CA 41.2
	MG 51.5	MG 48.4	MG 56.4	MG 51.9	MG 52.6	MG 49.6	MG 51.9	MG 48.9	MG 50.3	MG 49.2
	FE 37.6	FE 9.0	FE 35.0	FE 13.0	FE 38.2	FE 15.3	FE 36.4	FE 11.0	FE 37.4	FE 9.7
		C: 46.8		C: 40.3		C: 41.4		C: 45.1		C: 45.6
	HRV266 GT101	HRV266 CP101	KRV 5 GT601	KRV 5 CP401	JJG 11 GT101	JJG 11 CP101	HRV 77A GT604	HRV 77A CP404	KRV 1 GT401	KRV 1 CP601
	PY 48.9	DH 57.8	PY 53.5	DH 47.0	PY 49.7	DH 47.0	PY 50.7	DH 49.7	PY 48.9	DH 53.4
	AL 40.3	EF 10.5	AL 37.6	EF 20.1	AL 40.9	EF 19.5	AL 37.9	EF 12.5	AL 38.9	EF 12.5
	GR 10.4	JD 25.8	GR 8.4	JD 25.8	GR 9.0	JD 29.7	GR 10.7	JD 31.5	GR 11.9	JD 25.3
	UV .4	UR .3	UV .5	UR .5	UV .4	UR .4	UV .6	UR .4	UV .4	UR .3
		CT .8		CT .7		CT .1		CT .7		CT 1.9
		AC 4.7		AC 5.9		AC 3.3		AC 5.2		AC 6.6
		100.0		100.0		100.0		100.0		100.0
		F: 27.5		F: 25.4		F: 14.0		F: 27.6		F: 34.0
	GR 10.5	WO 42.2	GR 8.4	WO 34.7	GR 9.0	WO 35.0	GR 10.8	WO 39.8	GR 11.9	WO 40.3
	PY 49.1	EN 48.7	PY 53.7	EN 52.2	PY 49.9	EN 49.6	PY 51.1	EN 49.2	PY 49.0	EN 49.9
	AL 40.4	FS 9.1	AL 37.8	FS 13.1	AL 41.1	FS 15.3	AL 38.1	FS 11.0	AL 39.0	FS 9.8

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:T	1.13	1120.	.71	1314.	.80	1268.	.86	1238.	.95	1196.

TYPE I : IRON-RICH ECLOGITES

	KRV 4 GT101	KRV 4 CP101	PCR 1 GT101	PCR 1 CP101	10A GT303	10A CP503	XRV 5 GT101	XRV 5 CP101
SIO2	40.3	54.9	39.6	55.6	40.5	54.8	39.6	54.9
TIO2	.51	.35	.39	.46	.34	.32	.31	.37
AL2O3	22.5	6.99	22.4	7.48	23.1	7.52	22.2	8.38
CR2O3	.15	.15	.09	.10	.08	.10		.11
FE2O3	.77	3.57	1.24	1.53		3.42	.72	2.01
FEO	17.9	4.15	17.5	4.86	19.0	3.13	21.1	5.18
MNO	.61	.16	.34	.08	.37	.07	.37	.09
MGO	13.9	12.3	12.8	11.2	12.0	12.0	9.90	10.2
CAO	3.71	12.7	4.97	14.2	5.04	14.3	6.10	13.9
NA2O	.09	5.00	.15	5.06	.17	4.86	.16	5.22
K2O		.09		.11		.12		.17
TOTAL	100.2	100.4	99.5	100.7	100.6	100.6	100.4	100.5

IONIC PROPORTIONS

SI	2.982	1.968	2.963	1.986	2.998	1.957	2.987	1.969
TI	.017	.009	.022	.012	.019	.009	.018	.010
AL	1.963	.295	1.976	.315	2.016	.317	1.974	.354
CR	.009	.004	.005	.003	.005	.003		.003
FE3	.043	.096	.070	.041		.092	.041	.054
FE2	1.108	.124	1.094	.145	1.176	.094	1.328	.155
MN	.038	.005	.022	.002	.023	.002	.024	.003
MG	1.533	.657	1.427	.596	1.324	.639	1.113	.545
CA	.294	.488	.398	.543	.400	.547	.493	.534
NA	.013	.348	.022	.350	.024	.336	.023	.363
K		.004		.005		.005		.008
TOTAL	8.000	4.000	8.000	4.000	7.985	4.000	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6

	M: 58.0	M: 84.1	M: 56.6	M: 80.4	M: 53.0	M: 87.2	M: 45.6	M: 77.8
	CA 10.0	CA 38.4	CA 13.6	CA 42.3	CA 13.8	CA 42.8	CA 16.8	CA 43.3
	MG 52.2	MG 51.8	MG 48.9	MG 46.4	MG 45.7	MG 49.9	MG 37.9	MG 44.2
	FE 37.8	FE 9.8	FE 37.5	FE 11.3	FE 40.6	FE 7.3	FE 45.3	FE 12.6
		C: 42.6		C: 47.7		C: 46.1		C: 49.5
	KRV 4 GT101	KRV 4 CP101	PCR 1 GT101	PCR 1 CP101	10A GT303	10A CP503	XRV 5 GT101	XRV 5 CP101
	PY 50.6	DH 47.1	PY 47.1	DH 54.4	PY 44.9	DH 51.5	PY 36.8	DH 51.7
	AL 39.3	EF 15.6	AL 39.1	EF 9.9	AL 40.7	EF 10.9	AL 46.1	EF 9.2
	GR 9.7	JD 25.1	GR 13.6	JD 31.2	GR 14.2	JD 24.7	GR 17.1	JD 31.3
	UV .4	UR .4	UV .5	UR .5	UV .2	UR .5	UV .0	UR .3
		CT 2.2		CT .2		CT 3.5		CT 2.1
		AC 9.6		AC 4.1		AC 9.2		AC 5.4
		100.0		100.0		100.0		100.0
		F: 43.6		F: 22.1		F: 49.5		F: 25.9
	GR 9.7	WO 37.5	GR 13.6	WO 42.2	GR 14.2	WO 41.2	GR 17.1	WO 42.3
	PY 50.6	EN 52.7	PY 47.2	EN 46.5	PY 45.0	EN 51.3	PY 36.8	EN 44.9
	AL 39.4	FS 10.0	AL 39.2	FS 11.3	AL 40.8	FS 7.5	AL 46.1	FS 12.8

	KD FROM TOTAL FE. T AT 40 KB FROM RAHEIM & GREEN							
LNKD:T	.40	1265.	.96	1193.	1.12	1125.	1.16	1107.

TYPE 1 : MAIN GROUP

	HRV186 GT101	HRV186 CP101	KRV 6 GT601	KRV 6 CP401	HRV 13 GT101	HRV 13 CP101	HRV182 GT101	HRV182 CP101	JJG246 GT102	JJG246 CP102
SIO2	40.7	55.7	40.7	55.5	41.5	56.1	40.4	56.5	41.2	55.7
TIO2	.51	.32	.34	.29	.23	.31	.26	.34	.25	.29
AL2O3	22.9	5.87	22.8	5.55	23.3	7.13	23.0	8.54	23.2	7.18
CR2O3	.39	.68	.12	.17	.34	.36	.25	.23	.19	.15
FE2O3	1.36	1.72	1.41	3.60	1.09	2.00	1.11		.74	1.10
FEO	14.9	4.22	15.1	3.13	13.8	3.12	13.5	4.45	14.1	3.58
MNO	.47	.12	.41	.12	.33	.10	.40	.07	.35	.07
MGO	15.8	13.6	15.8	13.9	16.9	13.4	16.4	12.2	15.9	12.8
CAO	3.88	14.9	3.93	14.8	3.94	14.5	4.08	13.5	5.02	15.3
NA2O	.10	4.06	.05	4.17	.11	4.59	ND	4.98	.05	4.38
K2O		.13		.10		.13		.13		.16
TOTAL	100.8	101.3	100.7	101.3	101.6	101.7	99.4	100.9	101.0	100.7

IONIC PROPORTIONS

SI	2.960	1.979	2.964	1.971	2.973	1.972	2.958	1.991	2.976	1.980
TI	.017	.009	.019	.008	.012	.008	.014	.009	.014	.008
AL	1.963	.246	1.958	.232	1.968	.295	1.985	.355	1.976	.301
CR	.022	.019	.007	.005	.019	.010	.014	.006	.011	.004
FE3	.074	.046	.077	.096	.059	.053	.061		.040	.029
FE2	.905	.125	.922	.093	.828	.092	.827	.131	.854	.106
MN	.029	.004	.025	.004	.020	.003	.025	.002	.021	.002
MG	1.713	.720	1.715	.736	1.804	.702	1.790	.641	1.712	.678
CA	.302	.567	.307	.563	.302	.546	.320	.510	.389	.583
NA	.014	.280	.007	.287	.015	.313		.340	.007	.302
K		.006		.005		.006		.006		.007
TOTAL	8.000	4.000	8.000	4.000	8.000	4.000	8.000	3.992	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6	12	6

	M: 65.4	M: 85.2	M: 65.0	M: 88.8	M: 68.5	M: 88.4	M: 68.4	M: 83.0	M: 66.7	M: 86.4
	CA 10.4	CA 40.2	CA 10.4	CA 40.5	CA 10.3	CA 40.8	CA 10.9	CA 39.8	CA 13.2	CA 42.6
	MG 58.7	MG 51.0	MG 58.3	MG 52.9	MG 61.5	MG 52.4	MG 60.9	MG 50.0	MG 57.9	MG 49.6
	FE 31.0	FE 8.9	FE 31.3	FE 6.7	FE 28.2	FE 6.8	FE 28.1	FE 10.2	FE 28.9	FE 7.8
		C: 44.1		C: 43.4		C: 43.8		C: 44.3		C: 46.2
	HRV186 GT101	HRV186 CP101	KRV 6 GT601	KRV 6 CP401	HRV 13 GT101	HRV 13 CP101	HRV182 GT101	HRV182 CP101	JJG246 GT102	JJG246 CP102
	PY 56.4	DH 55.8	PY 56.2	DH 54.6	PY 59.6	DH 52.9	PY 59.2	DH 50.4	PY 56.6	DH 57.2
	AL 33.2	EF 14.4	AL 33.5	EF 14.1	AL 29.9	EF 13.2	AL 30.2	EF 13.4	AL 30.3	EF 10.6
	GR 9.3	JD 22.0	GR 9.9	JD 19.1	GR 9.5	JD 25.6	GR 9.9	JD 34.0	GR 12.5	JD 27.5
	UV 1.1	UR 1.9	UV .4	UR .5	UV 1.0	UR 1.0	UV .7	UR .6	UV .5	UR .4
		CT 1.3		CT 2.1		CT 2.0		CT .0		CT 1.3
		AC 4.6		AC 9.6		AC 5.3		PS 1.5		AC 2.9
		100.0		100.0		100.0		100.0		100.0
		F: 26.9		F: 50.9		F: 36.6		F: .0		F: 21.6
	GR 9.4	WO 39.6	GR 10.0	WO 39.6	GR 9.6	WO 39.9	GR 9.9	WO 39.4	GR 12.6	WO 42.1
	PY 57.0	EN 51.4	PY 56.4	EN 53.7	PY 60.2	EN 53.2	PY 59.6	EN 50.3	PY 56.9	EN 50.1
	AL 33.6	FS 9.0	AL 33.7	FS 6.8	AL 30.2	FS 6.9	AL 30.4	FS 10.3	AL 30.5	FS 7.9

KD FROM TOTAL FE. T AT 40 KB FROM RAHEIM & GREEN

LNKD:T	.88	1230.	.82	1258.	.87	1234.	.89	1226.	.96	1193.

TYPE I : MAIN GROUP

	KRV 2B GT101	KRV 2B CP101	XRV 6 GT501	XRV 6 CP301	JJG177 GT301	JJG177 CP501	JJG143 GT101	JJG143 CP201
SIO2	39.9	55.3	40.5	56.0	41.3	55.7	40.8	55.6
TIO2	.31	.31			.28	.30	.28	.29
AL2O3	22.6	8.55	22.8	7.13	23.2	7.70	22.9	8.36
CR2O3	.14	.12	.12	.11	.19	.18	.06	.05
FE2O3	.50		1.26	3.17	1.10	1.78	2.94	3.03
FEO	17.4	4.05	16.5	3.61	15.4	3.55	13.9	2.66
MNO	.46	.04	.52	.13	.47	.08	.43	.10
MGO	13.9	11.2	13.9	11.9	15.5	12.3	14.9	11.4
CAO	4.14	14.8	4.51	14.0	4.42	14.2	5.96	14.4
NA2O		4.90	.19	5.12	.10	4.92	.12	5.34
K2O		.21		.11		.12		.15
TOTAL	99.4	99.5	100.3	101.3	102.0	100.9	102.2	101.4

IONIC PROPORTIONS

SI	2.972	1.985	2.985	1.986	2.972	1.975	2.939	1.964
TI	.017	.008			.015	.010	.015	.008
AL	1.985	.362	1.981	.298	1.968	.322	1.945	.348
CR	.008	.003	.007	.003	.011	.005	.003	.001
FE3	.028		.070	.085	.060	.047	.159	.080
FE2	1.087	.122	1.015	.107	.928	.105	.835	.078
MN	.029	.001	.032	.004	.029	.002	.026	.003
MG	1.543	.599	1.527	.629	1.663	.650	1.600	.600
CA	.330	.569	.356	.532	.341	.540	.460	.545
NA		.341	.027	.352	.014	.338	.017	.366
K		.010		.005		.005		.007
TOTAL	8.000	4.000	8.000	4.000	8.000	4.000	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6

	M: 58.7	M: 83.1	M: 60.1	M: 85.5	M: 64.2	M: 86.1	M: 65.7	M: 88.4
	CA 11.2	CA 44.1	CA 12.3	CA 42.0	CA 11.6	CA 41.7	CA 15.9	CA 44.5
	MG 52.1	MG 46.4	MG 52.7	MG 49.6	MG 56.7	MG 50.2	MG 55.3	MG 49.0
	FE 36.7	FE 9.4	FE 35.0	FE 8.4	FE 31.6	FE 8.1	FE 28.8	FE 6.4
		C: 46.7		C: 45.8		C: 45.4		C: 47.6
	KRV 2B GT101	KRV 2B CP101	XRV 6 GT501	XRV 6 CP301	JJG177 GT301	JJG177 CP501	JJG143 GT101	JJG143 CP201
	PY 51.1	DH 56.3	PY 50.4	DH 52.1	PY 54.8	DH 52.7	PY 51.7	DH 51.9
	AL 37.9	EF 7.9	AL 36.9	EF 10.7	AL 33.5	EF 11.4	AL 32.9	EF 8.0
	GR 10.5	JD 34.7	GR 12.3	JD 26.9	GR 11.2	JD 29.1	GR 15.2	JD 29.1
	UV .4	UR .3	UV .4	UR .3	UV .5	UR .5	UV .2	UR .1
		CT .7		CT 1.4		CT 1.5		CT 2.9
		PS .1		AC 8.5		AC 4.7		AC 8.0
		100.0		100.0		100.9		100.0
		F: .0		F: 44.1		F: 31.0		F: 50.6
	GR 10.6	MO 43.8	GR 12.4	MO 41.3	GR 11.2	MO 41.0	GR 15.2	MO 43.2
	PY 51.3	EN 46.7	PY 50.6	EN 50.2	PY 55.1	EN 50.8	PY 51.7	EN 50.2
	AL 38.1	FS 9.5	AL 37.0	FS 8.5	AL 33.7	FS 8.2	AL 33.0	FS 6.6

KD FROM TOTAL FE, I AT 40 KB FROM RAHEIM & GREEN

LNKD:I	1.27	1066.	.85	1244.	.93	1207.	.85	1241.

TYPE I : MAIN GROUP

	KRV 3 GT601	KRV 3 CP401	XRV 10 GT101	XRV 10 CP101	HRV155 GT101	HRV155 CP101	HRV177 GT101	HRV177 CP101	HRV190 GT101	HRV190 CP101
SIO2	40.7	54.9	41.9	55.7	41.0	57.1	40.2	56.1	41.2	56.1
TIO2	.34	.25	.26	.31	.28	.36	.39	.41	.28	.36
AL2O3	22.7	4.55	23.6	8.26	23.2	10.6	22.5	9.04	23.2	9.30
CR2O3	.22	.18	.14	.15	.05	.07	.15	.13	.09	.11
FE2O3	1.42	3.89	.10	.53	.55		1.83	.31	.99	.39
FEO	14.3	2.31	15.7	4.28	14.6	3.90	14.5	4.22	14.6	4.08
MNO	.54	.12	.41	.10	.35	.07	.50	.08	.46	.09
MGO	15.3	13.9	15.0	11.6	14.8	10.4	14.4	10.9	15.0	11.2
CAO	5.08	16.6	5.27	14.1	5.69	12.9	5.54	13.9	5.58	13.8
NA2O	.07	3.68	.15	5.02	.14	5.97	.15	5.51	.12	5.42
K2O		.11	ND	.16		.12		.12		.15
TOTAL	100.7	100.5	102.5	100.2	100.7	101.5	100.1	100.7	101.5	100.8

IONIC PROPORTIONS

SI	2.966	1.972	2.996	1.986	2.983	1.991	2.958	1.986	2.976	1.982
TI	.019	.007	.014	.008	.015	.009	.022	.011	.015	.010
AL	1.950	.193	1.989	.347	1.990	.436	1.952	.377	1.976	.387
CR	.013	.005	.008	.004	.003	.002	.009	.004	.005	.003
FE3	.078	.105	.005	.014	.030		.101	.008	.054	.005
FE2	.873	.069	.939	.128	.889	.114	.890	.125	.883	.121
MN	.033	.004	.025	.003	.022	.002	.031	.002	.028	.003
MG	1.662	.744	1.598	.616	1.605	.540	1.579	.575	1.615	.590
CA	.397	.639	.404	.539	.444	.482	.437	.527	.432	.522
NA	.010	.256	.021	.347	.020	.404	.021	.378	.017	.371
K		.005		.007		.005		.005		.007
TOTAL	8.000	4.000	8.000	4.000	8.000	3.985	8.000	4.000	8.000	4.009
OXYGEN	12	6	12	6	12	6	12	6	12	6

	M: 65.6	M: 91.5	M: 63.0	M: 82.9	M: 64.4	M: 82.6	M: 64.0	M: 82.2	M: 64.7	M: 83.0
	CA 13.5	CA 44.0	CA 13.7	CA 42.0	CA 15.1	CA 42.4	CA 15.0	CA 43.0	CA 14.7	CA 42.4
	MG 56.7	MG 51.2	MG 54.3	MG 48.1	MG 54.6	MG 47.6	MG 54.3	MG 46.9	MG 55.1	MG 47.8
	FE 29.8	FE 4.8	FE 31.9	FE 9.9	FE 30.3	FE 10.0	FE 30.6	FE 10.2	FE 30.1	FE 9.8
		C: 46.2		C: 46.6		C: 47.1		C: 47.8		C: 47.0

	KRV 3 GT601	KRV 3 CP401	XRV 10 GT101	XRV 10 CP101	HRV155 GT101	HRV155 CP101	HRV177 GT101	HRV177 CP101	HRV190 GT101	HRV190 CP101
	PY 54.4	OH 62.2	PY 53.4	OH 53.6	PY 53.3	OH 47.0	PY 51.6	OH 52.7	PY 53.3	OH 51.6
	AL 32.2	EF 9.6	AL 32.4	EF 10.4	AL 31.3	EF 9.2	AL 33.4	EF 8.7	AL 31.9	EF 9.7
	GR 12.7	JD 15.1	GR 13.8	JD 33.6	GR 15.3	JD 40.7	GR 14.5	JD 37.2	GR 14.6	JD 37.3
	OV .6	UR .5	OV .4	UR .4	OV .1	UR .2	OV .4	UR .4	OV .3	UR .3
		CT 2.1		CT .6		CT .0		CT .3		CT .9
		AC 10.5		AC 1.4		PS 2.9		AC .8		AC .5
		100.0		100.0		100.0		100.0		100.0
		F: 60.2		F: 10.0		F: .0		F: 6.3		F: 3.9
	GR 12.8	AD 45.2	GR 13.8	AD 41.7	GR 15.3	AD 41.7	GR 14.6	AD 42.8	GR 14.6	AD 42.8
	PY 54.8	EN 52.0	PY 53.6	EN 48.3	PY 53.4	EN 48.2	PY 51.8	EN 47.0	PY 53.5	EN 48.2
	AL 32.5	FS 4.8	AL 32.5	FS 10.0	AL 31.3	FS 10.1	AL 33.6	FS 10.2	AL 31.9	FS 9.9

KD FROM TOTAL FE, 1 AT 40 KB FROM KAHEIM & GREEN

LNKD:1	.89	1223.	.94	1199.	1.00	1174.	1.00	1176.	1.00	1174.

TYPE I : MAIN GROUP

	JJG 2 GT101	JJG 2 CP101	JJG 17 GT101	JJG 17 CP101	XRV 8 GT501	XRV 8 CP301	HRV206 GT101	HRV206 CP101	HRV174 GT101	HRV174 CP101
SIO2	41.0	56.0	40.7	55.5	41.1	55.9	40.8	56.7	40.5	56.1
TIO2			.18	.08			.26	.32	.26	.36
AL2O3	23.2	7.87	23.3	7.40	23.0	6.99	23.1	8.94	23.0	8.09
CR2O3	.14	.16	.15	.19	.12	.11	.15	.18	.11	.11
FE2O3	.89		.90	1.85	1.49	1.29	1.06	.24	1.04	.07
FEO	14.8	5.26	14.8	4.13	15.4	4.46	15.5	4.78	15.3	5.15
MNO	.37	.12	.37	.04	.50	.10	.42	.09	.32	.10
MGO	16.0	12.5	15.9	12.9	15.4	12.9	14.7	11.1	15.0	11.9
CAO	3.75	13.4	3.80	13.9	4.12	14.7	4.84	13.6	4.59	13.9
NA2O	.12	4.65	.10	4.53	.12	4.30	.14	5.51	.10	4.89
K2O		.12		.15		.17		.15		.15
TOTAL	100.2	100.1	100.2	100.7	101.2	100.9	101.0	101.6	100.2	100.8

IONIC PROPORTIONS

SI	2.985	1.998	2.967	1.975	2.981	1.987	2.971	1.992	2.967	1.990
TI			.010	.002			.014	.008	.014	.010
AL	1.991	.331	2.002	.310	1.967	.293	1.983	.370	1.987	.338
CR	.008	.005	.009	.005	.007	.003	.009	.005	.006	.003
FE3	.049		.050	.050	.081	.034	.058	.006	.058	.002
FE2	.901	.157	.901	.123	.932	.133	.947	.140	.935	.153
MN	.023	.004	.023	.001	.031	.003	.026	.003	.020	.003
MG	1.736	.665	1.727	.684	1.665	.683	1.595	.581	1.638	.629
CA	.291	.512	.297	.530	.320	.560	.378	.512	.360	.528
NA	.017	.322	.014	.313	.017	.296	.029	.375	.014	.336
K		.005		.007		.008		.007		.007
TOTAL	8.000	3.998	8.000	4.000	8.000	4.000	8.000	4.000	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6	12	6
	M: 65.8	M: 80.9	M: 65.7	M: 84.8	M: 64.1	M: 83.8	M: 62.8	M: 80.5	M: 63.7	M: 80.4
	CA 9.9	CA 38.4	CA 10.1	CA 39.6	CA 11.0	CA 40.7	CA 12.9	CA 41.5	CA 12.3	CA 40.3
	MG 59.3	MG 49.8	MG 59.0	MG 51.2	MG 57.1	MG 49.7	MG 54.6	MG 47.1	MG 55.8	MG 48.0
	FE 30.8	FE 11.8	FE 30.8	FE 9.2	FE 31.9	FE 9.6	FE 32.4	FE 11.4	FE 31.9	FE 11.7
		C: 43.5		C: 43.7		C: 45.0		C: 46.8		C: 45.6
	JJG 2 GT101	JJG 2 CP101	JJG 17 GT101	JJG 17 CP101	XRV 8 GT501	XRV 8 CP301	HRV206 GT101	HRV206 CP101	HRV174 GT101	HRV174 CP101
	PY 57.5	DH 51.2	PY 57.3	DH 50.8	PY 54.7	DH 55.0	PY 52.8	DH 51.5	PY 54.1	DH 53.1
	AL 32.2	EF 15.5	AL 32.3	EF 14.9	AL 34.3	EF 13.3	AL 34.1	EF 10.3	AL 33.5	EF 12.5
	GR 9.8	JD 32.3	GR 9.9	JD 26.4	GR 10.7	JD 26.6	GR 12.7	JD 37.0	GR 12.1	JD 33.8
	UV .4	UR .5	UV .4	UR .5	UV .3	UR .3	UV .4	UR .5	UV .3	UR .3
		CT .2		CT 2.3		CT 1.3		CT .0		CT .0
		PS .4		AC 5.0		AC 3.4		AC .7		AC .2
		100.0		100.0		100.0		100.0		100.0
		F: .0		F: 28.7		F: 20.6		F: 4.6		F: 1.3
	GR 9.8	WO 38.2	GR 9.9	WO 38.6	GR 10.8	WO 40.1	GR 12.8	WO 41.5	GR 12.1	WO 40.3
	PY 57.8	EN 50.0	PY 57.6	EN 52.1	PY 54.9	EN 50.2	PY 53.0	EN 47.1	PY 54.3	EN 48.0
	AL 32.4	FS 11.8	AL 32.5	FS 9.4	AL 34.4	FS 9.7	AL 34.2	FS 11.4	AL 33.6	FS 11.7

KD FROM TOTAL FE, T AT 40 KM FROM RAHEIM & GREEN

LNKD:T	.84	1247.	.78	1277.	.91	1214.	.91	1213.	.90	1219.

TYPE I : PALEOPILLISED ECLOGITES

	HRV207 GT101	HRV207 CP101	JJG181 GT501	JJG181 CP502	JJG309 GT101	JJG309 CP501	JJG339 GT102	JJG339 CP103
SIO2	41.4	55.4	41.1	54.8	41.6	54.8	40.8	55.0
TIO2	.18	.17	.28	.19	.26	.10	.15	.07
AL2O3	23.3	4.21	22.8	2.68	23.3	1.74	22.5	2.21
CR2O3	.13	.13	.25	.58	.84	.57	.17	.26
FE2O3	1.19	2.32	1.43	2.90	2.53	1.92	1.67	2.28
FEO	12.0	2.66	14.1	3.42	12.3	5.78	14.9	4.50
MNO	.40	.16	.47	.14	.60	.21	.64	.20
MGO	17.0	15.8	16.8	15.8	17.3	16.9	15.5	16.2
CAO	5.16	18.5	3.60	17.9	4.56	18.8	4.31	18.5
NA2O	.07	2.50	.07	2.33	.08	1.56	.05	1.76
K2O		.04		.08		.06		.13
TOTAL	100.9	101.9	100.8	100.8	103.4	100.4	100.7	101.1

IONIC PROPORTIONS

SI	2.973	1.962	2.971	1.974	2.933	1.982	2.977	1.981
TI	.010	.005	.015	.005	.014	.003	.008	.002
AL	1.973	.176	1.945	.114	1.937	.074	1.935	.094
CR	.007	.004	.014	.017	.047	.016	.010	.007
FE3	.064	.062	.078	.079	.134	.052	.092	.062
FE2	.722	.079	.852	.103	.727	.114	.909	.135
MN	.024	.005	.029	.004	.036	.006	.040	.006
MG	1.819	.834	1.807	.848	1.818	.911	1.685	.870
CA	.397	.702	.279	.691	.344	.729	.357	.714
NA	.010	.172	.010	.163	.011	.109	.007	.123
K		.002		.004		.003		.006
TOTAL	8.000	4.000	8.000	4.000	8.000	4.000	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6

	M: 71.6	M: 91.4	M: 68.0	M: 89.2	M: 71.4	M: 88.8	M: 65.0	M: 86.5
	CA 13.5	CA 43.5	CA 9.5	CA 42.1	CA 11.9	CA 41.5	CA 11.5	CA 41.5
	MG 61.9	MG 51.8	MG 61.5	MG 51.7	MG 62.9	MG 51.9	MG 57.5	MG 50.6
	FE 24.6	FE 4.9	FE 29.0	FE 6.3	FE 25.2	FE 6.5	FE 31.0	FE 7.9
		C: 45.7		C: 44.9		C: 44.4		C: 45.1
	HRV207 GT101	HRV207 CP101	JJG181 GT501	JJG181 CP502	JJG309 GT101	JJG309 CP501	JJG339 GT102	JJG339 CP103
	PY 59.9	DI 67.3	PY 59.2	DI 67.4	PY 59.2	DI 72.0	PY 54.9	DI 70.3
	AL 26.7	EF 12.0	AL 31.4	EF 13.9	AL 29.2	EF 15.3	AL 33.9	EF 15.1
	GR 13.0	JD 10.8	GR 8.7	JD 7.1	GR 9.2	JD 4.4	GR 10.7	JD 6.0
	UV .4	UR .4	UV .7	UR 1.7	UV 2.4	UR 1.6	UV .5	UR .7
		CT 3.4		CT 2.1		CT 1.5		CT 1.7
		AC 6.2		AC 7.9		AC 5.2		AC 6.2
		100.0		100.0		100.0		100.0
		F: 44.0		F: 43.3		F: 31.3		F: 31.4
	GR 13.1	MG 42.3	GR 8.8	MG 41.3	GR 9.4	MG 41.0	GR 10.8	MG 40.9
	PY 60.1	FM 52.8	PY 59.6	FM 52.3	PY 60.7	FM 52.4	PY 55.2	FM 51.1
	AL 26.8	FS 5.0	AL 31.6	FS 6.4	AL 29.9	FS 6.6	AL 34.1	FS 8.0

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:T	.94	1280.	.88	1230.	.95	1196.	.96	1191.

TABLE 10

TYPE II : CALCIUM-RICH ECLOGITES

	JJG 41 GT 1	JJG 41 CP 1	HRV 67 GT101	HRV 67 CP101	A GT301	A CP501	3 ROVIC	3A ROVIC	4 ROVIC	4A ROVIC
SIO2	40.7	48.3	40.9	56.1	42.0	55.9	41.3	56.2	40.2	54.1
TIO2	.17	.17	.10	.07	.25	.24	.15	.20	.32	.51
AL2O3	22.5	13.8	23.5	8.94	24.0	5.26	23.0	10.7	22.3	8.86
CR2O3	.12	.10	.25	.18	.05	ND	.05	.05	ND	.08
FE2O3	2.52	.07	.35		1.80	1.50	.71		.98	2.43
FEO	8.53	4.30	12.9	2.16	9.08	1.30	8.63	1.56	16.3	2.99
MNO	.45	.08	.27	.04	.23	.04	.17	ND	.46	.12
MGO	12.0	10.7	13.6	12.0	17.9	14.9	14.8	11.3	12.4	12.5
CAO	14.4	22.3	8.91	17.4	6.92	19.7	11.0	16.3	6.95	16.0
NA2O		1.27	ND	4.50	.08	2.97	.07	4.34	.13	4.14
K2O				ND		.05		.29		ND
TOTAL	101.4	101.1	100.8	101.4	102.3	101.9	99.9	100.9	100.1	101.8

IONIC PROPORTIONS

SI	2.955	1.744	2.973	1.968	2.950	1.967	2.995	1.964	2.987	1.911
TI	.009	.005	.005	.002	.013	.006	.008	.005	.018	.014
AL	1.926	.587	2.014	.370	1.987	.218	1.962	.441	1.952	.369
CR	.007	.003	.014	.005	.003		.003	.001		.002
FE3	.138	.002	.019		.095	.040	.039		.055	.064
FE2	.518	.130	.783	.063	.533	.038	.523	.046	1.011	.088
MN	.028	.002	.017	.001	.014	.001	.010		.029	.004
MG	1.299	.576	1.474	.627	1.874	.781	1.598	.590	1.374	.659
CA	1.120	.863	.694	.654	.521	.743	.852	.609	.553	.605
NA		.089		.306	.011	.203	.010	.294	.019	.283
K						.002		.013		
TOTAL	8.000	4.000	8.000	3.996	8.000	4.000	8.000	3.964	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6	12	6
	M: 71.5	M: 81.6	M: 65.3	M: 90.8	M: 77.8	M: 95.3	M: 75.4	M: 92.8	M: 57.6	M: 88.2
	CA 38.1	CA 55.0	CA 23.5	CA 48.6	CA 17.8	CA 47.5	CA 28.7	CA 48.9	CA 18.8	CA 44.7
	MG 44.2	MG 36.7	MG 49.9	MG 46.7	MG 64.0	MG 50.0	MG 53.7	MG 47.4	MG 46.8	MG 48.7
	FE 17.6	FE 8.3	FE 26.5	FE 4.7	FE 18.2	FE 2.4	FE 17.6	FE 3.7	FE 34.4	FE 6.5
		C: 60.0		C: 51.0		C: 48.7		C: 50.8		C: 47.9

	JJG 41 GT 1	JJG 41 CP 1	HRV 67 GT101	HRV 67 CP101	A GT301	A CP501	3 ROVIC	3A ROVIC	4 ROVIC	4A ROVIC
	PY 41.9	DH 61.4	PY 49.3	DH 62.1	PY 61.5	DH 71.7	PY 52.7	DH 54.2	PY 45.2	DH 53.5
	AL 22.0	EF 4.6	AL 27.4	EF 3.5	AL 21.1	EF 5.1	AL 18.9	EF 4.7	AL 36.0	EF 10.8
	GR 35.8	JD 8.4	GR 22.5	JD 30.1	GR 17.3	JD 16.4	GR 28.3	JD 30.6	GR 18.8	JD 21.8
	UV .4	UR .3	UV .7	UR .5	UV .1	UR .0	UV .1	UR .1	UV .0	UR .2
		CT 25.2		CT 3.0		CT 2.7		CT 3.1		CT 7.6
		AC .2		PS .8		AC 4.1		PS 7.3		AC 6.4
		100.0		100.0		100.0		100.0		100.0
		F: 1.4		F: .0		F: 52.0		F: .0		F: 41.6
	GR 35.9	AD 46.4	GR 22.7	AD 47.3	GR 17.3	AD 46.6	GR 28.3	AD 46.0	GR 18.8	AD 41.4
	PY 42.0	EN 43.7	PY 49.7	EN 47.9	PY 61.6	EN 50.9	PY 52.8	EN 50.1	PY 45.2	EN 51.6
	AL 22.1	FS 9.9	AL 27.6	FS 4.8	AL 21.1	FS 2.4	AL 18.9	FS 3.9	AL 36.0	FS 7.0

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:T	.79	1271.	1.68	928.	1.21	1088.	1.51	981.	1.21	1089.

TYPE II : CALCIUM-RICH ECLOGITES

	6 ROVIC	6 ROVIC	7 ROVIC	7 ROVIC	BD1190 GT	BD1190 CP	9 ROVIC	9 ROVIC	BD1175 GT	BD1175 CP
SIO2	41.1	55.9	40.8	55.6	41.7	55.1	40.6	55.5	40.4	55.3
TIO2	.16	.11	.36	.45	.35	.36	.34	.35	.12	.20
AL2O3	22.6	11.5	22.7	10.1	23.5	8.92	22.1	9.69	23.1	9.26
CR2O3	ND	ND	.17	.19	.49	.89	1.31	1.22	.25	.32
FE2O3	.09		1.32		1.66	1.71	1.76		1.52	.15
FEO	9.08	1.91	10.2	2.37	7.92	.58	8.27	1.96	10.3	2.19
MNO	.20	ND	.21	ND	.20	ND	.20	ND	.22	ND
MGO	12.5	10.3	15.0	11.0	15.7	12.1	14.9	11.0	15.5	11.5
CAO	13.6	14.9	8.95	15.3	10.7	16.0	10.4	15.2	7.88	16.0
NA2O	.07	5.49	.13	5.14	.11	5.03	.11	5.17	.05	4.95
K2O		.03		.05		.06				.07
TOTAL	99.4	100.1	99.9	100.3	102.4	100.9	100.1	100.1	99.4	100.0

IONIC PROPORTIONS

SI	3.016	1.966	2.973	1.965	2.946	1.942	2.955	1.965	2.949	1.965
TI	.009	.003	.020	.012	.019	.010	.019	.009	.007	.005
AL	1.954	.475	1.950	.421	1.957	.371	1.896	.404	1.988	.388
CR			.010	.005	.027	.025	.075	.034	.014	.009
FE3	.005		.072		.088	.045	.096		.083	.004
FE2	.558	.056	.619	.070	.468	.017	.503	.058	.631	.065
MN	.012		.013		.012		.012		.014	
MG	1.367	.542	1.626	.581	1.653	.636	1.616	.583	1.686	.609
CA	1.068	.561	.698	.578	.810	.604	.812	.575	.616	.609
NA	.010	.375	.018	.352	.015	.344	.016	.355	.007	.341
K		.001		.002		.003				.003
TOTAL	8.000	3.981	8.000	3.987	8.000	4.000	8.000	3.984	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6	12	6

	M: 71.0	M: 90.6	M: 72.4	M: 89.3	M: 77.9	M: 97.4	M: 76.3	M: 90.9	M: 72.8	M: 90.4
	CA 35.7	CA 48.4	CA 23.7	CA 47.0	CA 27.6	CA 48.1	CA 27.7	CA 47.3	CA 21.0	CA 47.5
	MG 45.7	MG 46.7	MG 55.3	MG 47.3	MG 56.4	MG 50.6	MG 55.1	MG 47.9	MG 57.5	MG 47.5
	FE 18.6	FE 4.8	FE 21.0	FE 5.7	FE 16.0	FE 1.4	FE 17.2	FE 4.8	FE 21.5	FE 5.1
		C: 50.9		C: 49.9		C: 48.7		C: 49.7		C: 50.0

	6 ROVIC	6 ROVIC	7 ROVIC	7 ROVIC	BD1190 GT	BD1190 CP	9 ROVIC	9 ROVIC	BD1175 GT	BD1175 CP
	PY 45.3	DH 51.2	PY 53.4	DH 54.2	PY 54.3	DH 55.6	PY 52.9	DH 53.4	PY 55.5	DH 57.9
	AL 19.0	EF 4.3	AL 23.1	EF 5.5	AL 18.6	EF 4.9	AL 20.0	EF 5.4	AL 24.0	EF 4.6
	GR 35.7	JD 37.6	GR 23.0	JD 34.9	GR 25.7	JD 27.5	GR 23.3	JD 32.1	GR 19.8	JD 32.8
	UV .0	UR .0	UV .5	UR .5	UV 1.4	UR 2.5	UV 3.8	UR 3.4	UV .7	UR .9
		CT 3.1		CT 2.4		CT 4.8		CT 2.6		CT 3.0
		PS 3.7		PS 2.5		AC 4.7		PS 3.1		AC .8
		99.9		100.0		99.9		100.0		99.9
		F: .0		F: .0		F: 75.4		F: .0		F: 11.1
	GR 35.7	MO 45.1	GR 23.1	MO 45.4	GR 26.1	MO 46.1	GR 24.2	MO 45.4	GR 19.9	MO 46.3
	PY 45.3	EN 48.8	PY 53.6	EN 48.7	PY 55.0	EN 52.7	PY 55.0	EN 49.6	PY 55.9	EN 48.7
	AL 19.0	FS 5.1	AL 23.2	FS 5.9	AL 18.9	FS 1.3	AL 20.8	FS 4.9	AL 24.1	FS 4.9

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:T	1.38	1027.	1.26	1069.	1.23	1081.	1.31	1049.	1.32	1048.

TYPE II : CALCIUM-IRON-RICH ECLOGITES

	RV 32 GT	RV 32 CP	HRV154 GT101	HRV154 CP101	HRV219 GT101	HRV219 CP101	HRV175 GT101	HRV175 CP101	CSRV 3 GT301	CSRV 3 CP501
SIO2	39.1	55.5	39.8	55.8	39.6	56.5	39.1	55.3	39.6	55.7
TIO2	.15	.36	.16	.20	.20	.22	.18	.19	.13	.22
AL2O3	21.4	9.25	22.6	9.40	22.6	11.6	22.2	8.71	23.0	11.8
CR2O3	.07	.04	ND	.05	.05	ND	.12	.06	ND	ND
FE2O3	2.35	1.42	.66	.13	.86		1.80		1.57	1.17
FEO	10.0	5.98	17.8	4.85	18.2	4.98	17.8	5.64	18.6	4.44
MNO	.44	.04	.31	.04	.33	.04	.38	ND	.39	ND
MGO	9.40	9.40	10.8	9.89	8.04	9.04	8.82	9.71	7.84	8.48
CAO	9.17	15.0	8.50	14.9	11.1	14.8	9.92	16.0	11.0	13.2
NA2O		4.80	ND	5.44	.09	5.76	.07	4.92	.09	6.53
K2O	ND	.05		ND						ND
TOTAL	100.1	99.9	100.3	100.7	101.1	102.1	100.4	100.6	102.2	101.6

IONIC PROPORTIONS

SI	2.963	1.940	2.978	1.983	2.970	1.968	2.952	1.981	2.946	1.957
TI	.009	.010	.009	.005	.011	.006	.010	.005	.007	.006
AL	1.912	.395	1.993	.394	1.999	.476	1.976	.368	2.017	.489
CR	.004	.001		.001	.003		.007	.002		
FE3	.134	.039	.037	.004	.048		.102		.088	.031
FE2	1.139	.181	1.114	.144	1.144	.119	1.123	.169	1.157	.130
MN	.028	.001	.020	.001	.021	.001	.024		.025	
MG	1.062	.508	1.160	.524	.899	.469	.992	.518	.869	.444
CA	.745	.583	.681	.568	.892	.552	.803	.614	.877	.497
NA		.338		.375	.013	.389	.010	.342	.013	.445
K		.001								
TOTAL	8.000	4.000	8.000	4.000	8.000	3.982	8.000	4.000	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6	12	6

	M: 48.3	M: 73.7	M: 51.0	M: 78.4	M: 44.0	M: 79.8	M: 46.9	M: 75.4	M: 42.9	M: 77.3
	CA 25.3	CA 45.6	CA 23.1	CA 46.0	CA 30.4	CA 48.4	CA 27.5	CA 47.2	CA 30.2	CA 46.4
	MG 36.1	MG 39.9	MG 39.2	MG 42.4	MG 30.6	MG 41.1	MG 34.0	MG 39.8	MG 29.9	MG 41.4
	FE 38.7	FE 14.3	FE 37.7	FE 11.7	FE 39.0	FE 10.4	FE 38.5	FE 13.0	FE 39.8	FE 12.2
	RV 32 G1	RV 32 CP	HRV154 GT101	HRV154 CP101	HRV219 GT101	HRV219 CP101	HRV175 GT101	HRV175 CP101	CSRV 3 GT301	CSRV 3 CP501
	PY 34.2	DI 53.4	PY 38.5	DI 55.8	PY 29.8	DI 51.0	PY 32.5	DI 60.0	PY 28.7	DI 46.0
	AL 41.9	EF 7.6	AL 38.9	EF 5.5	AL 40.2	EF 3.9	AL 40.9	EF 4.4	AL 41.9	EF 5.7
	GR 23.8	JD 29.5	GR 22.6	JD 37.0	GR 29.9	JD 38.9	GR 26.2	JD 34.0	GR 29.4	JD 41.4
	UV .2	UR .1	UV .0	UR .1	UV .1	UR .0	UV .4	UR .2	UV .0	UR .0
		CT 5.0		CT 1.2		CT 2.6		CT 1.4		CT 5.7
		AC 4.3		AC .3		PS 3.5		PS .0		AC 3.1
		99.9		100.0		99.9		100.0		99.9
		F: 19.3		F: 2.1		F: .0		F: .0		F: 19.1
	GR 23.8	AD 43.7	GR 22.6	AD 45.4	GR 29.9	AD 46.4	GR 26.3	AD 46.6	GR 29.4	AD 44.4
	PY 34.2	EN 41.7	PY 38.5	EN 42.8	PY 29.8	EN 42.8	PY 32.6	EN 40.3	PY 28.7	EN 42.9
	AL 41.9	FS 14.6	AL 38.9	FS 11.8	AL 40.3	FS 10.8	AL 41.0	FS 13.1	AL 41.9	FS 12.6

	KD FROM TOTAL FE, T AT 40 KB		KB FROM RAHEIM & GREEN							
LOG10:I	1.02	1167.	1.26	1070.	1.66	936.	1.33	1043.	1.37	1029.

TYPE II : CALCIUM-RICH ECLOGITES

	BD1188 GT	BD1188 CP	BD1191 GT	BD1191 CP
SIO2	41.4	56.4	39.4	54.2
TIO2	.08	.19	.17	.21
AL2O3	23.1	9.40	22.5	10.5
CR2O3	.27	.24	.04	.05
FE2O3			1.43	1.86
FEO	9.60	1.60	16.9	3.88
MNO	.24		.41	.04
MGO	14.5	11.9	10.3	9.14
CAO	10.0	16.7	8.89	14.1
NA2O	ND	4.37	.05	5.76
K2O		ND		ND
TOTAL	99.2	100.7	100.1	99.8

IONIC PROPORTIONS

SI	3.016	1.978	2.956	1.946
TI	.004	.003	.010	.006
AL	1.984	.389	1.990	.444
CR	.016	.007	.002	.001
FE3			.081	.050
FE2	.585	.047	1.061	.116
MN	.015		.026	.001
MG	1.574	.622	1.152	.489
CA	.781	.627	.715	.542
NA		.297	.007	.401
K				
TOTAL	7.981	3.970	8.000	4.000
OXYGEN	12	6	12	6

M: 72.9	M: 93.0	M: 52.0	M: 80.8
CA 26.6	CA 48.4	CA 24.4	CA 47.3
MG 53.6	MG 46.0	MG 39.3	MG 42.6
FE 19.9	FE 3.6	FE 36.2	FE 10.1
	C: 50.2		C: 52.6

BD1188 GT	BD1188 CP	BD1191 GT	BD1191 CP
PY 53.3	DI 57.8	PY 37.9	DI 49.5
AL 20.3	EF 4.5	AL 38.4	EF 5.5
GR 25.7	JD 29.0	GR 23.6	JD 34.8
UV .8	UR .7	UV .1	UR .1
	CT 2.0		CT 4.8
	PS 5.9		AC 5.2
	99.9		99.9
	F: .0		F: 31.0
GR 25.9	HD 46.4	GR 23.6	HD 45.0
PY 53.7	EN 49.9	PY 37.9	EN 44.5
AL 20.5	FS 3.8	AL 38.4	FS 10.5

	KD FROM TOTAL FE, T AT 40 KB		KB FROM RAHEIM & GREEN	
LNKD:T	1.59	955.	1.07	1145.

TYPE II : CALCIUM-IRON-RICH ECLOGITES

	JJG 6 GT101	JJG 6 CP101
SIO2	39.6	55.5
TIO2	.15	.15
AL2O3	22.3	9.56
CR2O3	.05	.10
FE2O3	1.52	1.82
FEO	18.1	5.94
MNO	.33	ND
MGO	9.55	9.47
CAO	9.11	14.4
NA2O	.07	5.86
K2O		ND
TOTAL	100.8	100.8

IONIC PROPORTIONS

SI	2.967	1.972
TI	.008	.004
AL	1.970	.400
CR	.003	.003
FE3	.085	.049
FE2	1.157	.117
MN	.021	
MG	1.067	.501
CA	.731	.548
NA	.010	.404
K		
TOTAL	8.000	4.000
OXYGEN	12	6

	M: 48.4	M: 81.1
	CA 24.9	CA 47.0
	MG 36.3	MG 43.0
	FE 38.7	FE 10.0
		C: 52.2
	JJG 6 GT101	JJG 6 CP101
	PY 35.0	DM 52.4
	AL 40.7	EF 4.7
	GR 24.2	JD 35.3
	UV .2	UR .5
		CT 2.4
		AC 4.8
		99.9
		F: 29.2
	GR 24.2	WO 45.9
	PY 35.0	EN 43.9
	AL 40.8	FS 10.3

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:T	1.24	1076.

TYPE II : COESITE-SANIDINE GROSPYDITE

	HRV277 GT101	HRV277 CP101
SIO2	40.5	56.6
TIO2	.17	.07
AL2O3	22.0	17.0
CR2O3	.14	.04
FE2O3	.51	
FEO	10.0	1.56
MNO	.29	
MGO	7.57	6.24
CAO	18.9	11.6
NA2O	.07	7.23
K2O		.20
TOTAL	99.8	100.5

IONIC PROPORTIONS

SI	3.013	1.956
TI	.010	.002
AL	1.939	.693
CR	.008	.001
FE3	.018	
FE2	.626	.045
MN	.018	
MG	.843	.321
CA	1.514	.430
NA	.010	.485
K		.009
TOTAL	8.000	3.942
OXYGEN	12	6

M: 57.4 M: 87.7

CA 50.7	CA 54.0
MG 28.3	MG 40.4
FE 21.0	FE 5.7

C: 57.2

HRV277 GT101	HRV277 CP101
PY 27.8	DI 32.9
AL 21.9	EF 1.9
GR 49.9	JD 49.2
UV .4	UR .1
	CT 4.2
	PS 11.7
	100.0
	F: .0
GR 50.1	AN 47.3
PY 28.0	EN 46.2
AL 22.0	FS 6.5

KD FROM TOTAL FE, T AT 40 KB FROM KAMEIM & GREEN

LAB01	1.69	925.

TYPE II : CORUNDUM ECLOGITE

	RV 372 GT101	RV 372 CP101
SIO2	41.5	50.9
TIO2	.03	.03
AL2O3	24.0	20.1
CR2O3	.11	.13
FE2O3	.51	
FEO	6.95	1.01
MNO	.12	ND
MGO	14.5	7.09
CAO	12.9	15.3
NA2O	.05	5.68
K2O		ND
TOTAL	100.5	100.3

IONIC PROPORTIONS

SI	2.976	1.787
TI	.002	.001
AL	2.029	.832
CR	.006	.004
FE3	.017	
FE2	.416	.030
MN	.007	
MG	1.550	.371
CA	.991	.577
NA	.007	.387
K		
TOTAL	8.000	3.988
OXYGEN	12	6

M: 78.9	M: 92.6
CA 33.5	CA 59.0
MG 52.4	MG 37.9
FE 14.1	FE 3.0
	C: 60.9

RV 372 GT101	RV 372 CP101
PY 51.9	DM 35.3
AL 14.7	EF 2.8
GR 33.1	JD 38.3
UV .3	UR .4
	CT 21.2
	PS 2.4
	100.0
	F: .0
GR 33.2	KO 46.8
PY 52.0	EN 49.2
AL 14.8	FS 3.9

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

ENKD:1 1.25 1073.

TYPE II : FINE GRAINED KYANITE CORUNDUM ECLOGITES

	HRV 18 GT403	HRV 18 CP103	HRV116D GT110	HRV116D CP110	JJG520 GT105	JJG520 CP103
SIO2	41.4	54.5	42.3	54.6	42.2	54.6
TIO2	.22	.21	.27	.15	.30	.19
AL2O3	23.5	6.26	23.6	4.02	23.6	4.42
CR2O3	.06	.05	.03	.29	.08	.65
FE2O3	.35	1.50	1.79	1.33	1.34	1.93
FEO	10.6	2.31	6.93	2.29	7.65	1.83
MNO	.34	.07	.32	.09	.22	.09
MGO	17.0	14.2	19.8	16.6	19.9	17.1
CAO	6.29	17.7	6.32	18.6	5.50	16.6
NA2O	.09	3.22	ND	2.05	.08	2.45
K2O		ND		.04		.13
TOTAL	99.6	100.0	101.8	100.1	101.2	100.0

IONIC PROPORTIONS

SI	2.991	1.953	2.957	1.961	2.964	1.954
TI	.012	.006	.014	.004	.016	.005
AL	1.984	.265	1.945	.170	1.954	.187
CR	.003	.001	.024	.008	.027	.018
FE3	.019	.040	.094	.036	.071	.052
FE2	.640	.069	.405	.069	.448	.055
MN	.021	.002	.019	.003	.013	.003
MG	1.830	.759	2.063	.889	2.086	.913
CA	.487	.680	.473	.716	.414	.637
NA	.013	.224		.143	.011	.170
K				.002		.006
TOTAL	8.000	4.000	8.000	4.000	8.000	4.000
OXYGEN	12	6	12	6	12	6

M: 78.1	M: 91.6	M: 83.6	M: 92.8	M: 82.3	M: 94.3
CA 16.5	CA 45.1	CA 16.1	CA 42.8	CA 14.1	CA 39.7
MG 61.9	MG 50.3	MG 70.1	MG 53.1	MG 70.7	MG 56.9
FE 21.6	FE 4.6	FE 13.8	FE 4.1	FE 15.2	FE 3.4
	C: 47.3		C: 44.6		C: 41.1

HRV 18 GT403	HRV 18 CP103	HRV116D GT110	HRV116D CP110	JJG520 GT105	JJG520 CP103
PY 60.8	DI 64.1	PY 67.5	DI 68.4	PY 66.5	DI 59.9
AL 22.6	EF 9.4	AL 17.0	EF 13.7	AL 17.5	EF 18.5
GR 16.4	JD 18.3	GR 14.3	JD 10.0	GR 12.6	JD 10.6
UV .2	UR .1	UV 1.2	UR .8	UV 1.4	UR 1.8
	CT 4.1		CT 3.5		CT 4.0
	AC 4.0		AC 3.6		AC 5.2
	100.0		100.0		100.0
	F: 36.0		F: 34.4		F: 48.7
GR 16.5	WO 43.5	GR 14.5	WO 41.6	GR 12.8	WO 38.1
PY 60.9	EN 51.7	PY 68.4	EN 54.2	PY 69.5	EN 58.4
AL 22.6	FS 4.8	AL 17.2	FS 4.2	AL 17.7	FS 3.5

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:T	.91	1214.	.72	1308.	.76	1289.

TYPE II : GARNET PERIDOTITES

	HRV180 GT404	HRV180 CP604	HRV243B GT101	HRV243B CP101	JJG307 GT102	JJG307 CP102	HRV267 GT101	HRV267 CP101	JJG312 GT101	JJG312 CP101
SIO2	42.0	56.7	42.2	55.7	42.4	55.5	42.2	54.8	41.7	55.1
TIO2	.13	.05	.28	.33	.30	.27	.05	.04	.12	.14
AL2O3	23.3	1.80	20.1	4.06	23.2	3.08	22.6	2.38	23.6	3.17
CR2O3	1.61	.53	.25	.21	1.18	.79	2.11	1.04	.45	.56
FE2O3	.60		2.36	1.39	.32	2.48		1.37	.70	.32
FEO	7.53	1.77	6.95	1.55	8.26	.68	6.47	.07	6.69	1.19
MNO	.28	.05	.26	.07	.32	.09	.19	.04	.42	.10
MGO	20.5	17.9	21.2	16.0	20.6	16.7	20.7	16.9	21.1	16.8
CAO	8.64	20.9	4.14	19.1	4.10	19.1	5.10	21.5	3.74	19.5
NA2O	ND	1.26	.09	2.63	.09	2.49	ND	1.66	.10	2.10
K2O		ND		.04		ND		.03		ND
TOTAL	100.6	101.0	101.8	101.1	100.8	101.2	99.4	99.8	98.6	98.8

IONIC PROPORTIONS

SI	2.964	2.012	2.935	1.976	2.985	1.971	2.999	1.974	2.977	1.995
TI	.007	.001	.015	.009	.016	.007	.003	.001	.006	.004
AL	1.938	.075	1.976	.170	1.925	.127	1.893	.101	1.986	.135
CR	.090	.015	.014	.006	.066	.022	.119	.030	.024	.010
FE3	.032		.123	.037	.020	.066		.037	.038	.010
FE2	.444	.053	.404	.045	.487	.020	.385	.002	.399	.056
MN	.017	.002	.015	.002	.019	.003	.011	.001	.025	.003
MG	2.156	.946	2.197	.886	2.161	.884	2.192	.967	2.245	.945
CA	.351	.795	.309	.726	.309	.727	.388	.830	.286	.799
NA		.087	.012	.181	.012	.171		.116	.014	.147
K				.002				.001		
TOTAL	8.000	3.985	8.000	4.000	8.000	4.000	7.994	4.000	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6	12	6

	M: 82.9	M: 94.7	M: 84.5	M: 94.9	M: 81.6	M: 97.8	M: 85.1	M: 99.8	M: 84.9	M: 96.2
	CA 11.9	CA 44.3	CA 10.6	CA 44.9	CA 10.5	CA 44.6	CA 13.1	CA 47.7	CA 9.8	CA 44.5
	MG 73.1	MG 52.8	MG 75.5	MG 52.3	MG 73.1	MG 54.2	MG 73.9	MG 52.2	MG 76.6	MG 53.4
	FE 15.1	FE 2.9	FE 13.9	FE 2.8	FE 16.5	FE 1.2	FE 13.0	FE .1	FE 13.6	FE 2.1
		C: 45.6		C: 46.2		C: 45.1		C: 47.8		C: 45.5

	HRV180 GT404	HRV180 CP604	HRV243B GT101	HRV243B CP101	JJG307 GT102	JJG307 CP102	HRV267 GT101	HRV267 CP101	JJG312 GT101	JJG312 CP101
	PY 71.9	OH 79.8	PY 71.8	OH 71.3	PY 71.8	OH 70.8	PY 73.7	OH 80.6	PY 74.6	OH 75.5
	AL 16.4	EF 10.2	AL 17.7	EF 8.9	AL 17.5	EF 9.9	AL 13.3	EF 5.2	AL 15.4	EF 9.4
	GR 7.2	JD 7.2	GR 9.8	JD 14.0	GR 7.4	JD 8.4	GR 7.2	JD 5.1	GR 8.8	JD 12.8
	UV 4.5	UR 1.5	UV .7	UR .6	UV 3.3	UR 2.2	UV 5.9	UR 3.0	UV 1.2	UR 1.9
		CT .0		CT 1.5		CT 2.2		CT 2.5		CT .4
		PS .3		AC 3.7		AC 6.5		AC 3.7		AC .9
		98.7		100.0		100.0		100.0		100.0
		F: .0		F: 45.1		F: 75.7		F: 94.6		F: 19.8
	GR 7.5	WO 44.2	GR 9.8	WO 44.4	GR 7.6	WO 43.8	GR 7.6	WO 46.9	GR 8.9	WO 44.4
	PY 75.2	EN 52.8	PY 72.3	EN 52.8	PY 74.3	EN 54.9	PY 78.3	EN 52.9	PY 75.6	EN 53.4
	AL 17.2	FS 2.9	AL 17.9	FS 2.8	AL 18.1	FS 1.3	AL 14.1	FS .1	AL 15.6	FS 2.2

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:1	1.58	1026.	.90	1219.	.87	1232.	1.40	1019.	1.34	1059.

TYPE II : GARNET HERSTERITES

	JJG323 GT101	JJG323 CP101	HRV269 GT101	HRV269 CP101	HRV158A GT101	HRV158A CP101	HRV187 GT101	HRV187 CP101	HRV 98 GT101	HRV 98 CP101
SIO2	41.2	53.8	42.3	55.5	42.4	55.5	42.3	55.7	42.4	55.6
TIO2	.32	.35	.10	.10	.15	.15	.20	.21	.10	ND
AL2O3	22.8	2.98	24.0	3.41	24.4	2.93	24.0	2.97	24.1	2.48
CR2O3	.56	.38	.54	.30	.24	.11	.21	.13	.40	.18
FE2O3	.18	.74	.96	1.48	.43	1.40	.60	1.46	.75	1.51
FEO	7.29	2.06	9.54	1.31	8.27	1.22	7.40	.86	9.30	1.91
MNO	.32	.08	.21	.04	.25	.04	.25	.05	.19	.05
MGO	20.4	16.3	19.9	16.3	20.9	16.9	20.6	17.0	20.1	17.6
CAO	3.65	18.4	4.15	20.0	3.81	20.4	4.85	21.3	4.17	20.2
NA2O	.14	2.10	ND	2.25	ND	1.93	ND	1.79	ND	1.50
K2O		.04				ND				.11
TOTAL	97.1	97.2	101.7	100.7	100.9	100.6	100.5	101.5	101.5	101.2

IONIC PROPORTIONS

SI	2.995	1.986	2.965	1.979	2.969	1.981	2.975	1.973	2.971	1.979
TI	.017	.009	.005	.003	.008	.004	.011	.006	.005	
AL	1.954	.130	1.983	.143	2.015	.123	1.990	.124	1.991	.104
CR	.032	.011	.030	.008	.013	.003	.012	.004	.022	.005
FE3	.010	.021	.051	.040	.023	.037	.032	.039	.040	.040
FE2	.443	.064	.559	.039	.484	.037	.435	.025	.545	.057
MN	.020	.003	.012	.001	.015	.001	.015	.001	.011	.002
MG	2.210	.897	2.079	.866	2.181	.899	2.159	.897	2.099	.934
CA	.300	.728	.312	.764	.286	.780	.366	.808	.313	.770
NA	.020	.150		.156		.134		.123		.104
K		.002								.005
TOTAL	8.000	4.000	8.000	4.000	8.000	4.000	8.000	4.000	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6	12	6
	M: 83.3	M: 93.4	M: 78.8	M: 95.7	M: 81.8	M: 96.1	M: 83.2	M: 97.3	M: 79.4	M: 94.2
	CA 10.2	CA 43.1	CA 10.6	CA 45.8	CA 9.7	CA 45.5	CA 12.3	CA 46.7	CA 10.6	CA 45.7
	MG 74.8	MG 53.1	MG 70.5	MG 51.9	MG 73.9	MG 52.4	MG 73.0	MG 51.8	MG 71.0	MG 53.0
	FE 15.0	FE 3.8	FE 19.0	FE 2.3	FE 16.4	FE 2.1	FE 14.7	FE 1.5	FE 18.4	FE 3.2
		C: 44.8		C: 46.9		C: 46.5		C: 47.4		C: 45.2
	JJG323 GT101	JJG323 CP101	HRV269 GT101	HRV269 CP101	HRV158A GT101	HRV158A CP101	HRV187 GT101	HRV187 CP101	HRV 98 GT101	HRV 98 CP101
	PY 73.6	DH 72.6	PY 69.0	DH 74.7	PY 73.0	DH 76.7	PY 71.8	DH 78.8	PY 69.8	DH 75.1
	AL 15.7	EF 11.7	AL 20.7	EF 7.9	AL 17.5	EF 8.5	AL 16.0	EF 6.7	AL 19.8	EF 11.9
	GR 9.0	JD 12.1	GR 8.8	JD 10.7	GR 8.9	JD 9.3	GR 11.6	JD 8.0	GR 9.3	JD 6.2
	UV 1.6	UR 1.1	UV 1.5	UR .8	UV .7	UR .3	UV .6	UR .4	UV 1.1	UR .5
		CT .5		CT 1.8		CT 1.5		CT 2.2		CT 2.1
		AC 2.1		AC 4.0		AC 3.7		AC 3.9		AC 4.1
		100.0		100.0		100.0		100.0		100.0
		F: 24.4		F: 50.5		F: 50.0		F: 60.6		F: 42.6
	GR 9.2	MO 43.0	GR 9.0	MO 45.2	GR 9.0	MO 45.0	GR 11.6	MO 46.0	GR 9.4	MO 43.1
	PY 74.8	EN 53.3	PY 70.1	EN 52.5	PY 73.5	EN 52.8	PY 72.2	EN 52.5	PY 70.6	EN 53.7
	AL 16.0	FS 3.8	AL 21.0	FS 2.4	AL 17.6	FS 2.2	AL 16.1	FS 1.5	AL 20.0	FS 3.2

KD FROM TOTAL FE, T AT 40 KM FROM RAHEIM & GREEN

LNKD:T	.78	1277.	1.17	1104.	1.04	1158.	1.11	1130.	.98	1182.

TYPE II : GARNET MEGSTERITES

	HRV309A GT101	HRV309A CP301	HRV145 GT101	HRV145 CP101	HRV 19 GT101	HRV 19 CP101
SIO2	41.2	55.7	41.4	55.4	40.9	53.6
TIO2	.28	.55	.10	.19	.31	.27
AL2O3	23.8	6.33	23.7	5.68	22.6	3.25
CR2O3	.04	.05	.16	.26	.41	.25
FE2O3	.91	2.48	.20	.27	.71	1.32
FEO	12.4	2.03	12.0	4.36	12.5	2.35
MNO	.34	.07	.22	.10	.27	.05
MGO	18.3	13.6	18.5	14.7	17.0	15.1
CAO	3.01	15.2	3.13	15.7	4.08	18.6
NA2O	.07	4.59	.08	3.34	.20	2.40
K2O				.05		ND
TOTAL	100.3	100.6	99.5	100.0	98.9	97.2

IONIC PROPORTIONS

SI	2.957	1.977	2.983	1.985	2.991	1.986
TI	.015	.015	.005	.005	.017	.008
AL	2.014	.265	2.014	.240	1.949	.142
CR	.002	.001	.009	.007	.024	.007
FE3	.049	.066	.011	.007	.039	.037
FE2	.743	.060	.725	.131	.762	.073
MN	.021	.002	.013	.003	.017	.002
MG	1.957	.719	1.987	.785	1.853	.834
CA	.231	.578	.242	.603	.320	.739
NA	.010	.316	.011	.232	.028	.172
K				.002		
TOTAL	8.000	4.000	8.000	4.000	8.000	4.000
OXYGEN	12	6	12	6	12	6

	M: 72.5	M: 92.3	M: 73.3	M: 85.7	M: 70.9	M: 92.0
	CA 7.9	CA 42.6	CA 8.2	CA 39.7	CA 10.9	CA 44.9
	MG 66.8	MG 53.0	MG 67.3	MG 51.7	MG 63.1	MG 50.7
	FE 25.3	FE 4.4	FE 24.5	FE 8.6	FE 26.0	FE 4.4
		C: 44.6		C: 43.4		C: 47.0
	HRV309A GT101	HRV309A CP301	HRV145 GT101	HRV145 CP101	HRV 19 GT101	HRV 19 CP101
	PY 65.0	DH 57.2	PY 66.5	DH 59.6	PY 61.4	DH 73.4
	AL 27.0	EF 10.4	AL 25.1	EF 16.0	AL 27.1	EF 8.7
	GR 7.9	JD 24.8	GR 8.0	JD 22.0	GR 10.3	JD 12.9
	UV .1	UR .1	UV .5	UR .7	UV 1.2	UR .7
		CT .8		CT 1.0		CT .6
		AC 6.6		AC .7		AC 3.6
		100.0		100.0		100.0
		F: 52.3		F: 5.2		F: 32.6
	GR 7.9	AD 42.2	GR 8.0	AD 39.3	GR 10.5	AD 44.5
	PY 65.1	EN 53.3	PY 66.8	EN 52.0	PY 62.1	EN 50.8
	AL 27.0	FS 4.5	AL 25.2	FS 8.7	AL 27.4	FS 4.5

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:T	.83	1250.	.75	1294.	1.19	1096.

TYPE II : KYANITE ECLOGITES

	HRV147 GT101	HRV147 CP101	HRV272B GT101	HRV272B CP101
SIO2	40.5	56.1	40.1	56.4
TIO2	.22	.21	.30	.34
AL2O3	23.0	15.6	22.9	16.3
CR2O3	ND	ND	.60	.82
FE2O3			1.31	
FEO	10.9	1.66	12.5	2.34
MNO	.14	ND	.23	
MGO	12.4	7.65	10.3	6.41
CAO	11.5	11.7	12.7	9.91
NA2O	.10	7.64	.18	8.35
K2O		.20		.08
TOTAL	98.8	100.8	101.1	100.9

IONIC PROPORTIONS

SI	2.997	1.946	2.950	1.952
TI	.012	.005	.017	.009
AL	2.006	.638	1.986	.665
CR			.035	.022
FE3			.072	
FE2	.675	.048	.770	.068
MN	.009		.014	
MG	1.371	.395	1.129	.331
CA	.910	.435	1.001	.367
NA	.014	.514	.026	.560
K		.009		.004
TOTAL	7.995	3.991	8.000	3.978
OXYGEN	12	6	12	6

M: 67.0	M: 89.1	M: 59.4	M: 83.0
CA 30.8	CA 49.5	CA 34.5	CA 48.0
MG 46.4	MG 45.0	MG 38.9	MG 43.2
FE 22.8	FE 5.5	FE 26.6	FE 8.8
	C: 52.4		C: 52.6

HRV147 GT101	HRV147 CP101	HRV272B GT101	HRV272B CP101
PY 46.0	DI 37.7	PY 37.5	DI 30.6
AL 22.9	EF 3.3	AL 28.4	EF 4.6
GR 31.0	JD 52.3	GR 32.3	JD 54.1
UV .0	UR .0	UV 1.8	UR 2.2
	CT 4.9		CT 3.9
	PS 1.7		PS 4.5
	99.9		100.0
	F: .0		F: .0
GR 31.0	AD 46.0	GR 32.9	AD 43.4
PY 46.0	EN 48.2	PY 38.1	EN 47.0
AL 22.9	FS 5.9	AL 29.0	FS 9.6

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:T	1.40	1020.	1.29	1057.

TYPE II : MAGNESIAN ECLOGITES

	BD1185 GT301	BD1185 CP101	BD1185 GT	BD1185 CP	JJG522 GT301	JJG522 CP501	HRV 37 GT101	HRV 37 CP301	HRV195 GT101	HRV195 CP101
SIO2	41.6	55.6	41.6	55.3	42.2	56.9	41.7	54.9	42.1	55.4
TIO2	.22	.10	.21	.10	.08	.07	.20	.15	.25	.15
AL2O3	19.6	2.18	19.2	2.12	23.5	2.38	22.8	3.53	23.6	2.69
CR2O3	6.15	2.46	6.40	2.45	.21	.07	1.14	.59	.32	.16
FE2O3	.80	2.70	1.18	2.03	.50		.30	1.03	.88	.65
FEO	5.88		5.54	.05	6.64	2.33	10.5	1.89	9.81	2.07
MNO	.34	.09	.32	.08	.22	.07	.27	.05	.25	.07
MGO	20.6	17.0	20.8	17.2	21.3	17.9	18.9	15.5	19.5	16.6
CAO	5.44	19.8	5.40	19.2	4.28	20.8	4.19	18.7	4.31	20.7
NA2O	.06	2.40	ND	2.31	.05	1.31	ND	2.63	.05	1.74
K2O		ND		.04		ND		ND		ND
TOTAL	100.9	102.0	100.7	101.0	99.0	101.8	100.1	99.0	101.1	100.3

IONIC PROPORTIONS

SI	2.976	1.964	2.967	1.970	2.996	2.003	2.989	1.991	2.975	1.989
TI	.012	.003	.011	.003	.004	.002	.011	.004	.013	.004
AL	1.645	.091	1.615	.089	1.967	.099	1.926	.151	1.966	.114
CR	.345	.069	.361	.069	.012	.002	.065	.017	.018	.005
FE3	.043	.072	.063	.054	.027		.016	.028	.047	.018
FE2	.350		.330	.002	.394	.069	.631	.057	.580	.062
MN	.021	.003	.019	.002	.013	.002	.016	.002	.015	.002
MG	2.186	.895	2.211	.913	2.254	.939	2.019	.838	2.053	.868
CA	.415	.750	.413	.733	.326	.785	.322	.727	.326	.796
NA	.008	.164		.160	.007	.089		.165	.007	.121
K				.002						
TOTAL	8.000	4.000	8.000	4.000	8.000	3.990	8.000	4.000	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6	12	6

	M: 86.2	M:100.0	M: 87.0	M: 99.8	M: 85.1	M: 93.2	M: 76.2	M: 93.6	M: 78.0	M: 95.4
	CA 14.1	CA 45.6	CA 14.0	CA 44.5	CA 11.0	CA 43.8	CA 10.8	CA 44.8	CA 11.0	CA 45.6
	MG 74.1	MG 54.4	MG 74.8	MG 55.4	MG 75.8	MG 52.4	MG 67.9	MG 51.7	MG 69.4	MG 50.8
	FE 11.9	FE .0	FE 11.2	FE .1	FE 13.3	FE 3.8	FE 21.2	FE 3.5	FE 19.6	FE 3.6
		C: 45.6		C: 44.5		C: 45.5		C: 46.4		C: 47.3
	BD1185 GT301	BD1185 CP101	BD1185 GT	BD1185 CP	JJG522 GT301	JJG522 CP501	HRV 37 GT101	HRV 37 CP301	HRV195 GT101	HRV195 CP101
	PY 54.9	DH 71.9	PY 54.5	DH 70.8	PY 74.6	DH 78.1	PY 67.2	DH 72.3	PY 67.8	DH 79.1
	AL 13.7	EF 8.8	AL 13.6	EF 10.3	AL 14.4	EF 11.3	AL 22.1	EF 8.6	AL 21.2	EF 8.0
	GR 14.0	JD 2.5	GR 13.6	JD 3.4	GR 10.4	JD 8.7	GR 7.5	JD 14.1	GR 10.1	JD 10.0
	KN 17.4	UR 6.9	KN 18.3	UR 6.9	UV .6	UR .2	UV 3.2	UR 1.7	UV .9	UR .5
		CT 3.3		CT 2.7		CT .0		CT .5		CT .7
		AC 7.1		AC 5.8		PS 1.1		AC 2.7		AC 1.7
		100.5		99.9		99.5		100.0		100.0
		F: 98.7		F:103.7		F: .0		F: 31.8		F: 20.9
	GR 16.9	WO 44.4	GR 16.6	WO 43.6	GR 10.5	WO 43.6	GR 7.7	WO 44.6	GR 10.2	WO 45.3
	PY 66.5	EN 55.5	PY 66.7	EN 56.4	PY 75.1	EN 52.6	PY 69.4	EN 51.8	PY 68.4	EN 51.0
	AL 16.6	FS .1	AL 16.6	FS .0	AL 14.5	FS 3.8	AL 22.8	FS 3.6	AL 21.4	FS 3.6

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:T	.81	1264.	1.07	1146.	.94	1201.	1.14	1114.	1.22	1084.

TYPE II : MAGNESIAN ECLOGITES

	HRV 15B GT305	HRV 15B CP504	HRV132B GT303	HRV132B CP304	HRV173A GT503	HRV173A CP102	JJG183 GT101	JJG183 CP101	HRV310C GT101	HRV310C CP501
SIO2	42.1	56.0	41.9	55.4	41.8	55.2	42.6	55.1	42.2	55.5
TIO2	.15	.17	.25	.29	.23	.15	.23	.52	.34	.20
AL2O3	23.6	5.74	22.8	3.60	23.4	2.24	23.9	4.18	23.6	3.97
CR2O3	.83	.35	1.04	1.08	1.27	.75	.64	2.17	.83	.58
FE2O3	.55	.52	.89	.87	.09	1.22	1.62	1.93	.91	1.58
FEO	7.72	1.40	7.60	2.04	6.59	1.73	7.27	1.10	7.45	1.50
MNO	.23	.05	.23	.10	.27	.08	.38	.10	.28	.08
MGO	21.2	15.0	20.8	15.9	20.1	17.3	21.3	14.7	21.2	16.8
CAO	3.56	18.0	3.85	18.3	4.19	20.2	3.99	17.2	3.85	17.3
NA2O	ND	3.39	.06	2.70	ND	1.63	.09	3.60	.08	2.86
K2O		.05		ND		ND		ND		.10
TOTAL	100.0	100.7	99.6	100.3	100.0	100.5	102.0	100.4	100.8	100.1

IONIC PROPORTIONS

SI	2.974	1.981	2.982	1.983	2.971	1.979	2.956	1.972	2.962	1.983
TI	.008	.005	.012	.008	.012	.004	.012	.009	.018	.005
AL	1.966	.239	1.913	.152	1.961	.095	1.955	.176	1.956	.167
CR	.046	.010	.059	.031	.071	.021	.035	.061	.046	.016
FE3	.029	.014	.048	.023	.005	.033	.085	.052	.048	.043
FE2	.456	.041	.452	.061	.511	.052	.422	.033	.438	.045
MN	.014	.001	.026	.003	.016	.002	.022	.003	.017	.002
MG	2.232	.791	2.206	.848	2.129	.924	2.203	.784	2.215	.873
CA	.269	.682	.294	.702	.319	.776	.297	.659	.290	.662
NA		.233	.008	.187		.113	.012	.250	.011	.198
K		.002								.005
TOTAL	8.000	4.000	8.000	4.000	8.000	4.000	8.000	4.000	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6	12	6

	M: 83.0	M: 95.0	M: 83.0	M: 93.3	M: 80.7	M: 94.7	M: 83.9	M: 96.0	M: 83.5	M: 95.1
	CA 9.1	CA 45.1	CA 9.9	CA 43.6	CA 10.8	CA 44.3	CA 10.2	CA 44.7	CA 9.8	CA 41.9
	MG 75.5	MG 52.2	MG 74.7	MG 52.6	MG 72.0	MG 52.8	MG 75.4	MG 53.1	MG 75.3	MG 55.3
	FE 15.4	FE 2.7	FE 15.3	FE 3.8	FE 17.3	FE 3.0	FE 14.4	FE 2.2	FE 14.9	FE 2.8
		C: 46.3		C: 45.3		C: 45.6		C: 45.7		C: 45.1

	HRV 15B GT305	HRV 15B CP504	HRV132B GT303	HRV132B CP304	HRV173A GT503	HRV173A CP102	JJG183 GT101	JJG183 CP101	HRV310C GT101	HRV310C CP501
	PY 74.4	DH 67.0	PY 72.7	DH 69.6	PY 71.5	DH 76.1	PY 72.4	DH 64.3	PY 73.4	DH 65.3
	AL 16.6	EF 8.1	AL 17.5	EF 10.7	AL 17.8	EF 10.8	AL 17.4	EF 8.7	AL 16.6	EF 13.3
	GR 6.7	JD 21.1	GR 7.0	JD 13.4	GR 7.2	JD 6.0	GR 8.4	JD 15.7	GR 7.6	JD 14.4
	UV 2.3	UR 1.0	UV 3.0	UR 3.1	UV 3.5	UR 2.1	UV 1.8	UR 6.1	UV 2.3	UR 1.6
		CT 1.4		CT .9		CT 1.7		CT 2.0		CT 1.2
		AC 1.4		AC 2.2		AC 3.2		AC 5.1		AC 4.3
		100.0		100.0		100.0		100.0		100.0
		F: 25.2		F: 26.5		F: 37.8		F: 60.7		F: 48.7
	GR 6.8	WO 44.5	GR 7.2	WO 43.2	GR 7.4	WO 43.7	GR 8.5	WO 43.9	GR 7.8	WO 41.5
	PY 76.2	EN 52.7	PY 74.9	EN 52.9	PY 74.1	EN 53.3	PY 73.8	EN 53.8	PY 75.1	EN 55.7
	AL 17.0	FS 2.8	AL 17.9	FS 3.9	AL 18.5	FS 3.0	AL 17.7	FS 2.3	AL 17.0	FS 2.9

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LOG:T	1.13	1119.	.82	1256.	.97	1138.	.76	1289.	.78	1276.

TYPE II : MAGNESIAN ECLOGITES

	HRV244 GT501	HRV244 CP301	JJG139 GT101	JJG139 CP101	HRV274 GT501	HRV274 CP301	XRV 22 GT101	XRV 22 CP101	2 ROVIC	2 ROVIC
SIO2	42.1	55.0	41.5	54.2	41.6	55.2	42.1	56.2	41.6	55.7
TIO2	.07	.09	.13	.17	.18	.31	.27	.38	.27	.41
AL2O3	23.8	5.85	23.2	3.33	23.8	4.73	24.0	6.32	23.6	6.59
CR2O3	.30	.16	1.37	1.14	.35	.33	.11	.13	.06	.09
FE2O3	.70	1.47	.70	.69	1.23	2.33	.61	.83	1.83	.12
FEO	11.0	1.82	8.24	.72	9.79	1.27	11.2	2.62	9.59	3.02
MNO	.24	.04	.34	.04		.10	.37	.12	.22	.07
MGO	18.2	15.8	19.6	15.5	19.6	14.7	18.7	14.1	19.3	14.3
CAO	5.24	21.1	4.75	20.7	3.72	17.8	3.99	16.5	3.91	16.7
NA2O	ND	1.89	ND	2.18	.09	3.44	.10	3.97	.11	3.68
K2O		ND				ND	ND	.04		
TOTAL	101.6	101.2	99.9	98.6	100.4	100.2	101.5	101.2	100.8	100.5

IONIC PROPORTIONS

SI	2.978	1.960	2.962	1.975	2.957	1.975	2.974	1.982	2.955	1.979
TI	.004	.002	.007	.005	.010	.008	.014	.010	.014	.011
AL	1.984	.162	1.952	.143	1.994	.200	1.999	.263	1.974	.267
CR	.017	.005	.077	.033	.020	.009	.006	.004	.003	.003
FE3	.037	.039	.037	.019	.066	.063	.033	.022	.098	.003
FE2	.649	.054	.492	.022	.582	.038	.665	.077	.570	.040
MN	.014	.001	.021	.001		.003	.022	.004	.025	.002
MG	1.918	.839	2.085	.839	2.076	.782	1.969	.741	2.047	.754
CA	.397	.806	.363	.809	.283	.683	.302	.624	.297	.657
NA		.131		.154	.012	.239	.014	.272	.015	.253
K								.002		
TOTAL	8.000	4.000	8.000	4.000	8.000	4.000	8.000	4.000	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6	12	6

	M: 74.7	M: 93.9	M: 80.9	M: 97.5	M: 78.1	M: 95.4	M: 74.8	M: 90.6	M: 78.2	M: 89.4
	CA 13.4	CA 47.4	CA 12.4	CA 48.5	CA 9.6	CA 45.4	CA 10.3	CA 43.2	CA 10.2	CA 43.0
	MG 64.7	MG 49.4	MG 70.9	MG 50.2	MG 70.6	MG 52.0	MG 67.1	MG 51.4	MG 70.2	MG 50.9
	FE 21.9	FE 3.2	FE 16.7	FE 1.3	FE 19.8	FE 2.5	FE 22.6	FE 5.4	FE 19.5	FE 6.1
		C: 49.0		C: 49.1		C: 46.6		C: 45.7		C: 45.8
	HRV244 GT501	HRV244 CP301	JJG139 GT101	JJG139 CP101	HRV274 GT501	HRV274 CP301	XRV 22 GT101	XRV 22 CP101	2 ROVIC	2 ROVIC
	PY 63.6	DH 77.0	PY 69.5	DH 79.0	PY 68.8	DH 66.9	PY 65.5	DH 62.0	PY 67.1	DH 62.9
	AL 23.2	EF 6.2	AL 18.3	EF 3.5	AL 21.5	EF 7.6	AL 23.9	EF 9.9	AL 22.7	EF 10.7
	GR 12.3	JD 8.7	GR 8.3	JD 10.2	GR 8.8	JD 16.7	GR 10.2	JD 24.8	GR 10.1	JD 24.8
	UV .8	UR .5	UV 3.9	UR 3.3	UV 1.0	UR .9	UV .3	UR .4	UV .2	UR .3
		CT 3.7		CT 2.0		CT 1.6		CT .8		CT 1.0
		AC 3.9		AC 1.9		AC 6.2		AC 2.2		AC .3
		100.0		100.0		100.0		100.0		100.0
		F: 41.5		F: 46.3		F: 61.9		F: 22.2		F: 3.4
	GR 12.4	WO 46.2	GR 8.6	WO 47.8	GR 8.9	WO 44.8	GR 10.2	WO 42.9	GR 10.1	WO 42.6
	PY 64.1	EN 50.5	PY 72.3	EN 50.9	PY 69.4	EN 52.6	PY 65.7	EN 51.7	PY 67.2	EN 51.3
	AL 23.4	FS 5.3	AL 19.1	FS 1.3	AL 21.7	FS 2.6	AL 24.0	FS 5.4	AL 22.7	FS 6.1

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:T	1.17	1106.	1.65	937.	.88	1227.	.97	1187.	.97	1186.

TYPE II : MAGNESIAN ECLOGITES

	KM 7 GT101	KM 7 CP102	HRV161A GT501	HRV161A CP301	JJG 5 GT302	JJG 5 CP302	OH 4 GT	OH 4 CP	BD1698 GT	BD1698 CP
SIO2	41.8	55.6	41.8	55.6	40.9	55.3	40.7	54.1	41.7	54.5
TIO2	.15	.24	.07	.16	.13	.10	.33	.24	.12	.09
AL2O3	24.0	8.30	24.0	7.29	23.1	4.59	21.7	4.36	23.3	3.04
CR2O3	.17	.23	.17	.23	.26	.21	.34	.48	.42	.22
FE2O3	2.18	2.13	.75	1.68	3.16	.89	.28		1.62	3.46
FEO	10.9	1.77	11.3	1.49	12.3	3.23	17.3	7.26	6.63	
MNO	.32	.07	.20	.04	.31	.07	.46	.14	.25	.05
MGO	18.7	12.0	19.2	13.3	16.5	14.5	14.4	14.6	21.2	17.0
CAO	4.16	14.8	3.14	15.1	5.25	18.2	4.39	16.3	4.02	20.4
NA2O	ND	5.28	.06	4.69	.07	2.96		1.98	ND	2.04
K2O		ND		.10		ND		.18		.03
TOTAL	102.4	100.4	100.7	99.7	101.9	100.1	99.9	99.7	99.3	99.7

IONIC PROPORTIONS

SI	2.939	1.970	2.970	1.981	2.930	1.988	3.014	1.975	2.963	1.953
TI	.007	.006	.004	.004	.007	.003	.018	.007	.006	.002
AL	1.989	.347	2.011	.306	1.951	.195	1.894	.188	1.952	.129
CR	.009	.006	.010	.006	.015	.006	.020	.014	.024	.006
FE3	.116	.057	.040	.045	.171	.024	.016		.087	.094
FE2	.643	.052	.673	.044	.734	.097	1.069	.222	.394	
MN	.019	.002	.012	.001	.019	.002	.029	.004	.015	.002
MG	1.959	.634	2.033	.706	1.762	.777	1.589	.794	2.245	.911
CA	.313	.562	.239	.576	.403	.701	.348	.638	.306	.786
NA		.363	.008	.324	.010	.206		.140		.142
K				.005				.008		.001
TOTAL	8.000	4.000	8.000	4.000	8.000	4.000	8.000	3.991	8.000	4.000
OXYGEN	12	6	12	6	12	6	12	6	12	6

	M: 75.3	M: 92.4	M: 75.1	M: 94.1	M: 70.6	M: 88.9	M: 59.8	M: 78.2	M: 85.1	M:100.0
	CA 10.7	CA 45.0	CA 8.1	CA 43.4	CA 13.9	CA 44.5	CA 11.6	CA 38.6	CA 10.4	CA 46.3
	MG 67.2	MG 50.8	MG 69.0	MG 53.2	MG 60.8	MG 49.3	MG 52.9	MG 48.0	MG 76.2	MG 53.7
	FE 22.1	FE 4.2	FE 22.9	FE 3.3	FE 25.3	FE 6.2	FE 35.6	FE 13.4	FE 13.4	FE .0
		C: 47.0		C: 44.9		C: 47.4		C: 44.5		C: 46.3
	KM 7 GT101	KM 7 CP102	HRV161A GT501	HRV161A CP301	JJG 5 GT302	JJG 5 CP302	OH 4 GT	OH 4 CP	BD1698 GT	BD1698 CP
	PY 64.2	OH 54.1	PY 67.6	OH 56.3	PY 56.9	OH 69.4	PY 52.1	OH 61.5	PY 73.7	OH 74.3
	AL 25.5	EF 7.3	AL 24.1	EF 9.4	AL 29.8	EF 9.0	AL 36.5	EF 20.1	AL 16.3	EF 8.3
	GR 9.8	JD 30.0	GR 7.8	JD 27.7	GR 12.6	JD 17.7	GR 10.4	JD 13.5	GR 8.8	JD 4.0
	UV .5	UR .6	UV .5	UR .6	UV .8	UR .6	UV 1.0	UR 1.4	UV 1.2	UR .6
		CT 2.3		CT 1.5		CT .9		CT 1.9		CT 4.4
		AC 5.6		AC 4.5		AC 2.4		PS 1.6		AC 9.7
		100.0		100.0		100.0		99.9		101.4
		F: 51.6		F: 50.5		F: 19.5		F: .0		F:103.9
	GR 9.8	WO 44.0	GR 7.8	WO 42.8	GR 12.7	WO 44.2	GR 10.5	WO 37.6	GR 9.0	WO 44.9
	PY 64.5	EN 51.7	PY 68.0	EN 53.8	PY 57.3	EN 49.6	PY 52.6	EN 48.8	PY 74.6	EN 55.1
	AL 25.6	FS 4.3	AL 24.2	FS 3.4	AL 30.0	FS 6.2	AL 36.9	FS 13.6	AL 16.5	FS .0

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

ENKD:T	.81	1262.	1.62	1166.	1.19	1096.	.90	1222.	.73	1300.

TYPE II : MAGNESIAN ECLOGITES

	OFS-7 GT	OFS-7 CP	OFS-8 GT	OFS-8 CP
SIO2	43.1	56.3	40.3	53.6
TIO2	.18	.14	.12	.07
AL2O3	21.9	2.62	22.0	1.81
CR2O3	ND		.21	
FE2O3	.99		2.34	2.23
FEO	8.31	3.06	8.99	1.30
MNO	.20		.41	.05
MGO	21.5	17.9	18.3	16.5
CAO	5.80	19.6	4.90	21.4
NA2O		1.48		1.29
K2O				
TOTAL	100.0	101.1	97.6	98.3

IONIC PROPORTIONS

SI	3.050	1.997	2.967	1.974
TI	.010	.004	.007	.002
AL	1.827	.110	1.910	.079
CR			.012	
FE3	.053		.130	.062
FE2	.492	.091	.554	.040
MN	.012		.026	.002
MG	2.267	.946	2.008	.906
CA	.288	.745	.387	.844
NA		.102		.092
K				
TOTAL	8.000	3.995	8.000	4.000
OXYGEN	12	6	12	6

M: 82.2	M: 91.2	M: 78.4	M: 95.8
CA 9.5	CA 41.8	CA 13.1	CA 47.2
MG 74.4	MG 53.1	MG 68.1	MG 50.6
FE 16.1	FE 5.1	FE 18.8	FE 2.2
	C: 44.0		C: 48.3

OFS-7 GT	OFS-7 CP	OFS-8 GT	OFS-8 CP
PY 72.9	OR 74.1	PY 64.7	OR 82.2
AL 17.9	EF 14.8	AL 22.8	EF 6.2
GR 9.3	JD 10.2	GR 11.8	JD 3.0
UV .9	UR .0	UV .6	UR .0
	CT .0		CT 2.4
	PS .8		AC 6.2
	99.9		100.0
	F: .0		F: 60.7
GR 9.3	WO 41.7	GR 11.9	WO 46.5
PY 72.9	EN 53.2	PY 65.1	EN 51.3
AL 17.9	FS 5.1	AL 23.0	FS 2.3

KD FROM TOTAL FE, T AT 40 KB FROM RAHEIM & GREEN

LNKD:T	.92	1211.	1.11	1130.

TABLE 11

TABLE 11

Magnitude and nature of variation of concentrations of oxides in inhomogeneous chrome-rich eclogites. Variations are considered as the concentration of the oxide in the mineral with highest chrome relative to the mineral with lowest chrome.

				Garnet			
x	Sample	Cr_2O_3	CaO	FeO	MgO	Na_2O	Al_2O_3
501/304	HRV173	3.0	1.0	.95	1.0		
501/101	HRV132A	1.2	1.0	1.0	1.0		
401/101	JJG183	3.4	1.1	.99	.98		
107/101	HRV243	4.7	.99	.88	1.03		
305/101	HRV15	5.2	.31	1.09	1.3		
B102/A301	HRV310	12.6	1.14	.84	1.0		
401/404	HRV180	5.4	1.4	1.24	.83		
				Cpx			
301/104	HRV173	2.8	.97	.96	1.0	1.1	.97
301/101	HRV132A	1.0	.97	.94	.98	1.1	1.1
602/102	JJG183	.80	1.05	1.04	1.04	.86	.89
104/107	HRV243	2.6	1.0	.91	1.01	.98	.88
304/101	HRV15	3.0	1.0	1.6	1.4	.73	.43
A101/C501	HRV310	2.0	1.0	.94	1.02	.94	.90
305/604	HRV180	4.5	.94	1.3	.94	1.6	.97

$$x = \frac{\text{Grain no. with highest } Cr_2O_3}{\text{Grain no. with lowest } Cr_2O_3}$$

TABLE 12

TABLE 12

Garnet and clinopyroxene compositions in HRV310 and HRV15

	HRV15B GT305	HRV310C GT502	HRV15B CP504	HRV310C CP501
SiO_2	42.10	42.3	56.00	55.50
TiO_2	.15	.24	.17	.20
Al_2O_3	23.60	23.70	5.74	3.97
Cr_2O_3	.83	.76	.35	.58
MgO	8.21	8.26	1.87	2.93
MnO	.23	.27	.05	.08
FeO	21.20	21.20	15.00	16.40
CaO	3.56	3.72	18.00	17.30
Na_2O	N.D.	.08	3.39	2.86
K_2O	N.D.	N.D.	.05	.10
Total	99.90	100.50	100.60	99.9

TABLE 13

TABLE 13. ROBERTS VICTOR DIAMOND INCLUSIONS

	OPX RV2	OPX RV5	OPX RV6	OPX RV8 A	OPX RV8 B	OPX RV9 A	OPX RV1 1A	OL RV3	OL RV4	OL RV7
SIO2	58.2	57.6	57.4	57.5	57.8	57.8	57.4	40.8	41.0	41.1
TIO2	ND	ND	ND	.03	.04	.04	ND		ND	
AL2O3	.97	1.20	1.15	1.18	1.15	.39	1.02	ND	ND	
CR2O3	.71	.73	.74	.57	.58	.31	.71	ND	ND	.04
FEO	3.19	3.26	3.31	3.28	3.37	3.40	3.36	6.48	5.27	5.33
MNO	.07	.06	.06	.06	.06	.07	.08	.04	.07	.06
MGO	37.6	36.6	36.5	36.3	36.2	37.2	35.2	51.2	52.0	53.3
CAO	.11	.17	.14	.30	.32	.26	.26	.04	.04	.03
NA2O	ND	ND	ND	.07	.10	.14		ND	ND	ND
K2O	ND	ND		ND	.04	.06	ND		ND	
TOTAL	100.9	99.7	99.3	99.3	99.7	99.7	98.0	98.6	98.5	99.9

IONIC PROPORTIONS

SI	1.963	1.966	1.967	1.970	1.974	1.976	1.990	.998	.999	.989
TI				.001	.001	.001				
AL	.039	.048	.046	.048	.046	.016	.042			
CR	.019	.020	.020	.015	.016	.008	.019			.001
FE	.090	.093	.095	.094	.096	.097	.097	.133	.107	.107
MN	.002	.002	.002	.002	.002	.002	.002	.001	.001	.001
MG	1.890	1.862	1.864	1.855	1.843	1.895	1.819	1.867	1.889	1.911
CA	.004	.006	.005	.011	.012	.010	.010	.001	.001	.001
NA				.005	.007	.009				
K					.002	.003				
TOTAL	4.010	4.000	4.000	4.001	3.998	4.017	3.980	3.002	3.001	3.012
OXYGEN	6	6	6	6	6	6	6	4	4	4
	M: 95.46	M: 95.24	M: 95.16	M: 95.18	M: 95.04	M: 95.12	M: 94.92	M: 93.37	M: 94.62	M: 94.69
	CA .20	CA .32	CA .26	CA .56	CA .60	CA .48	CA .50			
	MG 95.26	MG 94.94	MG 94.91	MG 94.64	MG 94.46	MG 94.67	MG 94.44			
	FE 4.54	FE 4.75	FE 4.83	FE 4.79	FE 4.93	FE 4.86	FE 5.06			
	C: .21	C: .33	C: .28	C: .59	C: .63	C: .50	C: .53			

TABLE 14

TABLE 14

Rate x by which soft layer of present thickness t must be more rapidly abraded than hard layer of present thickness T, in order to produce observed values of t/T. Values of x are calculated for various factors (To/T) by which initial thickness of the hard layer (To) exceeds the present thickness of hard layer (T).

$$x = \frac{To/T - t/T}{To/T - 1}$$

		T^o/T							
		1.05	1.10	1.20	1.23	1.4	1.6	1.8	2.0
	.33	14.3	7.7	4.4	3.9	2.7	2.1	1.8	1.7
	.5	11	6	3.5	3.2	2.3	1.8	1.6	1.5
Soft layer = kyanite eclogite	.66	7.7	4.3	2.8	2.5	1.8	1.6	1.4	1.3
Soft layer = cpx rich band	.77	5.6	3.3	2.2	2.0	1.6	1.4	1.3	1.2

$$t/T = \frac{\text{thickness of soft layer}}{\text{thickness of hard layer}}$$