

THE SURFACE TEXTURES ON PYROPE, MICROILMENITE AND
CHROME DIOPSIDE FROM KIMBERLITE

by

O.G. GARVIE BSc. (Hons.).

Thesis submitted in fulfilment of the requirements
for the degree of Master of Science
in the Department of
Geology of the University of Cape Town.

The University of Cape Town has been given
the right to reproduce this thesis in whole
or in part. If you wish to reproduce it,
please apply to the author.

Department of Geology,
University of Capetown.

July, 1981.

The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.

VOLUME 2 (2)

University of Cape Town

VOLUME 1	Abstract
	Contents
	Chapters 1.0 - 12.0
	Acknowledgements
	References
VOLUME 2	Tables I - XVIII
	Figures 1 - 21
	Plates 1 - 160

LIST OF TABLES

- No.
- I Classification scheme of surface textures on pyrope, microilmenite and chrome diopside from kimberlite.
- II Surface characteristics of kimberlitic minerals from jumper drill hole No. 15/4 Jwaneng kimberlite pipe, Botswana.
- III Surface characteristics of kimberlitic minerals from jumper drill hole No. 15/5 Jwaneng kimberlite pipe, Botswana.
- IV Surface characteristics of kimberlitic minerals from jumper drill hole No. 15/11 Jwaneng kimberlite pipe, Botswana.
- V Surface characteristics of kimberlitic minerals from jumper drill hole No. 15/13 Jwaneng kimberlite pipe, Botswana.
- VI Surface characteristics of kimberlitic minerals from jumper drill hole No. 15/15 Jwaneng kimberlite pipe, Botswana.
- VII Surface characteristics of kimberlitic minerals from jumper drill hole No. 15/25 Jwaneng kimberlite pipe, Botswana.
- VIII Relationship between surface features and colour from garnets from the Jwaneng kimberlite pipe.
- IX Proportion of sculptured ilmenite and chrome diopside from Jwaneng.
- X Proportion of garnet, ilmenite and chrome diopside exhibiting diagenetic etch features from Jwaneng.
- XI Surface characteristics of mineral grains from the Montrose No. 3 kimberlite pipe.
- XII Surface characteristics of mineral grains from the Dullstroom kimberlite fissure.
- XIII Amount of ilmenite recovered from Montrose samples.
- XIV Number of kelyphite-encrusted garnets examined from thirty kimberlite occurrences having a global distribution.
- XV Microprobe analysis of nodular garnet from Muza, U.S.S.R.
- XVI Proportion of sculptured garnet grains from kimberlite.
- XVII Proportion of sculptured ilmenites from kimberlite.
- XVIII Proportion of sculptured chrome diopside grains from kimberlite.

LIST OF FIGURES

No.

1. Showing position of jumper drill holes and diamond drill holes forming a cross-section (A-B) across the Jwaneng kimberlite pipe.
2. Diagram showing trilobate shape of Jwaneng kimberlite pipe.
3. Jwaneng kimberlite pipe - borehole cross section of upper weathered portion of pipe.
4. Log for Shaft No.1 (Based on logging by P.J.Bartlett - Mine Geologist, 1977).
5. Plot of number of mineral grains and important surface textural changes in weathered profile of Jwaneng kimberlite pipe.
6. Graphs showing the proportional distribution of surface textures displayed by different coloured garnet as well as ilmenite and chrome diopside grains from the weathered profile of the Jwaneng kimberlite.
7. The distribution of the combined percentage of sculptured garnet from the four colour groups recovered from the six boreholes, through the weathered profile at Jwaneng.
8. Diagram showing position and dimensions of samples in soil profile overlying the Montrose No. 3 kimberlite pipe.
9. Diagram showing position of samples in soil profile overlying the Dullstroom kimberlite fissure.
10. Graph showing intensity of diagenetic etching on kimberlitic mineral grains in soil profile overlying the Montrose No. 3 kimberlite pipe.
11. Distribution trends of honeycomb surfaces on garnets and variation in garnet content of samples with depth.
12. Schematic diagram showing structure of kelyphite shell surrounding a pyrope grain.
13. Locality map of kimberlites from which euhedral garnets have been found.
14. Stereographic projection, showing the shape and position of etch pits (after Mendelssohn, 1971).
15. Stability of an etch pit on a slow etching surface when $R_d > R_a > R_s$.
16. Instability of an etch pit on a fast etching surface when $R_s > R_a > R_d$.

17. Schematic representation of etch pit formation.
18. Instability of a hillock on a slow etching surface.
19. Stability of hillock on a fast etching surface.
20. Possible relationship between older and younger generations of kelyphite formation (as suggested by Klein and Padera, 1972).
21. Pressure/Temperature diagram showing a generalized field for the proposed conditions of kelyphitization of pyrope in peridotite nodules during the ascent of kimberlite magma within the upper mantle.

TABLES

University of Cape Town

TABLE I

CLASSIFICATION SCHEME OF SURFACE TEXTURES ON
PYROPE, PICOILMENITE AND CHROME DIOPSIDE FROM KIMBERLITE

SURFACE FEATURES	GEOLOGICAL SITUATION	SURFACE CHARACTERISTICS AND MINERAL TYPE		
		PYROPE	PICOILMENITE	CHROME DIOPSIDE
SECONDARY SURFACE FEATURES	LATERITIC SOILS (FERRICRETE)	Destruction of sculptured surfaces. Formation of Honeycomb textures and enlarged solution cavities. Partial elimination of pyrope and change in colour from vivid red to pale pink.	Formation of small oval-shaped etch pits and sub-parallel sinuous grooves. Stable.	Formation of rectangular-shaped solution pits and cavernous hollows causing widespread surface disintegration. Complete elimination of chrome diopside.
	IN-SITU WEATHERING OF KIMBERLITE PIPE	Decomposition of kelyphite. Formation of oriented solution pits, chattermark trails and trichitic cavities. Stable.	Slight tarnishing and fine stippling. Stable.	Development of solution cavities along cracks and cleavage planes. Modification of sculptured features forming fluted surfaces. Progressive decomposition with change in colour from emerald green to pale whitish green.
PRIMARY SURFACE FEATURES	KIMBERLITE EMPLACEMENT	Sculpturing of pyrope with hillocks formed on cubic surfaces and etch pits formed on octahedral and dodecahedral surfaces Kelyphitisation of pyrope and formation of sub-kelyphitic surface	Reaction mantles formed around ilmenite composed of perovskite, spinel, ilmenite and ferromagnesian silicates. Development of rough blocky sculptured surfaces	Production of cockscomb or hacksaw terminations on pyramidal surfaces and lens-like etch pits on prism surfaces. Occasional development of hummocky features on basal pinacoidal surfaces

TABLE II

Rehole No. 15/4 Depth of sample	Type of mineral	No. of grains	No. of grains examined in SEM	Shape			Surface textures				Colour of garnet
				Ang	Sub rounded	Well rounded	ROK	SKS	SS	Diagenetic features	
30 m	G	1	1	1				1	1	1?	mauve red orange pink
	G	2		2					2		
	G	1	1	1					1	1	
	G	1		1					1		
	I	2	1	2					1?		
40 m	G	34	4	30	3	1		7	12	1	mauve red orange pink
	G	5		5					5		
	G	5	1	5					4	1	
	G	5	1	5					5		
	I	100	2	99	1				21	1	
50 m	G	32	2	32				17	9	1	mauve red orange pink
	G	23	2	18	3	2		9	16		
	G	35	1	35					29	1	
	G	14	2	14				2?	12	1	
	I	100	1	100					37		
60 m	G	27	2	23	2	2		20	5	1	mauve red orange pink
	G	26		24				7	16		
	G	31		31	2			5	18		
	G	25	1	25				12	3	2	
	I	100		90	10				51		
	CD	2	1	2					2	1?	
70 m	G	30	2	28	1	1	1	16	6	6	mauve red orange pink
	G	24		22	2			4	22	1	
	G	35		35				2	30		
	G	22	1	22				4	18	1	
	I	100	1	98	2				59		
	CD	2		2					2	1	
80 m	G	30	1	22	3	5	8	14	7	3	mauve red orange pink
	G	27		27				4	23		
	G	29	1	26	2	1	1	3	20		
	G	22		20	2			13	8	1	
	I	100	1	92	7	1			76		
	CD	100	2	100					61	14	
90 m	G	34		29	2	3	14	34	3	1	mauve red orange pink
	G	32		32			2	4	26		
	G	27		23	4				15		
	G	12		12				2	10		
	I	100	1	87	3	10			26		
	CD	100	1	100					19	17	
100 m	G	25	1	17	2	6	11	10	4		mauve red orange pink
	G	24		21	3		2	4	18		
	G	25	1	22	3			5	14		
	G	5		4	1		1		2		
	I	100		65	22	13			35		
	CD	100		96	4				20	19	
10 m	G	34	3	24	3	7	11	17	6		mauve red orange pink
	G	28	1	28				5	20		
	G	28	1	28			6		22		
	G	13	1	13			1	3	10		
	I	100		71	20	9			61		
	CD	100	3	100					23	15	

TABLE III

Rehole No. 15/5 Depth of sample	Type of mineral	No. of grains	No. of grains examined in SEM	Shape			Surface textures				Colour of garnet
				Ang	Sub rounded	Well rounded	ROK	SKS	SS	Diagenetic features	
30 m	G G I	4 2 7		2 2 6	1			1	4 1 1	2 1	mauve orange
40 m	G G G I	7 3 2 28		5 3 2 25	2 3			2	5 3 27 8	2 2	mauve red pink
50 m	G G G G I CD	46 22 20 19 100 1		46 22 20 19 94 1	2	4		42 7 4 7	10 15 20 12 41 17	1	mauve red orange pink
60 m	G G G G I CD	49 27 22 10 100 1	1	45 25 22 10 90 1	2 4	4 6		24 10 2	25 18 22 8 30 17	5 1 3 2 17	mauve red orange pink
70 m	G G G G I	51 46 24 7 100		43 44 24 7 92	2 2 3	6 5		24 18 7 3	27 28 17 3 21	6 2 1	mauve red orange pink
80 m	G G G G I CD	62 22 23 4 100 21	1 1	56 32 23 4 95 21	2 5	4	9 1	18 11 11 1	35 20 6 2 30 3	3 1 17 3	mauve red orange pink
90 m	G G G G I CD	47 34 15 9 100 98	2 1	40 29 15 9 94 78	3 2	4 3	10 3 37 2	17 10 4 4	10 24 8 3 27 64	107	mauve red orange pink
00 m	G G G G I CD	52 34 15 4 100 94		47 31 15 3 92 81	2 1 3 4	3 2 1 5 9	14 7 2 2	17 11 6 1	21 16 7 1 35 76	2 26	mauve red orange pink
10 m	G G G G I CD	64 22 14 7 100 100	1	40 19 11 2 91 90	9 1 1 1 3 3	15 2 2 4 6 7	34 4 7 3	23 3 7 2	15 16 2 28 82	2 14	mauve red orange pink

TABLE II (CONTD.)

Orehole No. 15/5 Depth of Sample	Type of mineral	No. of grains	No. of grains examined in SEM	Shape			Surface textures				Colour of garnet
				Ang	Sub rounded	Well rounded	ROK	SKS	SS	Diagenetic features	
120 m	G	55		42	3	10	17	18	20		mauve red orange pink
	G	21		20	1		1	4	16		
	G	28	1	28		10	6	15	2		
	G	10	1	9	1		1	4	5		
	I	100		96	2	2			18		
	CD	100		97	2	1			85	9	
130 m	G	49		44	1	4	17	20	12		mauve red orange pink
	G	30		27	2	1	4	5	21		
	G	20		20			6	5	9		
	G	9		6	3		3	6			
	I	100		94	4	2			38		
	CD	100		95	3	2			88	12	
140 m	G	61	1	57	3	1	23	34	4	1	mauve red orange pink
	G	30		28	2		3	23	3		
	G	26		26			6	10	14		
	G	10		10				7	3		
	I	100		96	1	3			33		
	CD	100		93	4	3			90	5	
150 m	G	58	1	52	2	4	28	19	11	1	mauve red orange pink
	G	35	1	30	2	3	1	7	27	1	
	G	33		31	2		8	7	18		
	G	26		26			3	11	12		
	I	100		91	2	7			34		
	CD	100		97	3				87	5	
TOTALS	G	605	5	521	29	55	152	259	199	23	mauve red orange pink black green
	G	336	3	310	15	11	24	109	207	3	
	G	242	2	237	3	12	38	76	124	7	
	G	117	1	107	5	5	14	48	53	3	
	I	1135		1056	35	44			344		
	CD	694	5	633	33	28			595	85	

Abbreviations as for Table II

TABLE IV

Corehole No. 15/11 Depth of sample	Type of mineral	No. of grains	No. of grains examined in SEM	Shape			Surface textures				Colour of garnet
				Ang	Sub rounded	Well rounded	ROK	SKS	SS	Diagenetic features	
10 m	G G G I	4 2 1 13	1	4 2 1 3	9	1		2	2 2 1 2		mauve red pink
20 m	G G I	1 2 5		1 2 5					1 1	1	mauve pink
30 m	G G I	5 2 4		5 2 4					5 2		mauve orange
40 m	G G G G I	41 35 23 16 100		38 34 23 16 97	3 1			14 8 2 3	27 26 21 13 12	5 1	mauve red orange pink
50 m	G G G G I	66 17 16 8 100	1	50 14 16 7 95	12 3 1 5	4		23 2 1	46 16 16 7 44	4 1	mauve red orange pink
60 m	G G G G I	28 27 30 11 100		22 27 30 11 83	4	2		16 5 4	12 23 26 11 62	3	mauve red orange pink
70 m	G G G G I CD	49 18 49 19 100 21	1	32 16 40 19 76 21	5 2 3 14	12 10	8	26 3 2 8	15 15 41 11 70 21	2 1 6	mauve red orange pink
80 m	G G G G I CD	42 34 26 14 100 67		35 28 26 14 81 61	4 6	3	13	15 6 2	14 28 24 14 44 37	2 1 13	mauve red orange pink
90 m	G G G G I CD	35 30 30 16 100 23		21 26 30 14 80 23	14 4 2 14	6	14	14 7 1 2	7 23 29 12 53 18	2 3	mauve red orange pink
100 m	G G G G I CD	34 33 43 17 100 31		24 33 39 17 96 31	6 4 4	4	13	9 6 4 5	27 39 10 27 21	2 11	mauve red orange pink

TABLE IV (Cont)

Corehole No. 15/11 Depth of Sample	Type of mineral	No. of grains	No. of grains examined in SEM	Shape			Surface textures				Colour of garnet
				Ang	Sub rounded	Well rounded	ROK	SKS	SS	Diagenetic features	
110 m	G G G G I CD	48 21 29 10 100 73	1	38 20 29 10 77 69	4 1 13 4	6 10	14	27 1	7 21 29 9 56 51	1 10	mauve red orange pink
120 m	G G G G I CD	45 26 24 20 100 60		33 26 24 20 89 60	5 7	7 4	11	33 4 5	1 22 24 15 52 38	1 20	mauve red orange pink
130 m	G G G G I CD	38 29 23 25 100 100	1	20 24 21 25 97 82	10 5 2 3 10	8 8	13 5	18 7 3 4	7 22 15 21 28 73	23	mauve red orange pink
140 m	G G G G I CD	39 23 21 8 100 78		31 23 21 8 84 70	4 10 6	4 6 2	11	24 5 5 5	6 18 16 3 62 25	9	mauve red orange pink
150 m	G G G G I CD	50 39 31 15 100 100		29 39 31 15 80 92	10 14 8	11 6	20 8	18 3 3 6	12 36 20 9 65 81	3	mauve red orange pink
TOTALS	G G G G I CD	525 334 341 182 1222 553	2 2 1 1	383 312 332 179 1049 509	81 22 9 3 116 34	61 59 10	117 13	249 56 26 40	162 280 302 137 549 365	14 3 4 5 98	mauve red orange pink black green

ations as for Table II

TABLE V

Borehole No. 15/13 Depth of Sample	Type of mineral	No. of grains	No. of grains examined in SEM	Shape			Surface textures				Colour of garnet
				Ang	Sub rounded	Well rounded	ROK	SKS	SS	Diagenetic features	
10 m	G G I	5 2 30	1	4 2 22	1 8		1	4 1	9		mauve red
20 m	G G G I	6 1 1 21	1	5 1 1 14	1 4	3		4	1 1 4	1	mauve red orange
30 m	G G I	4 2 21		4 2 13	5	3		2	2 2 5		mauve orange
40 m	G G G I CD	48 23 28 100 12	1	38 23 28 85 12	6 10	4 5	15	17 1	16 23 28 59 6	1 1 2	mauve red orange
50 m	G G G G I	27 29 39 1 100	1	24 29 39 1 92	1 8	2		6 2	17 27 32 1 53	2 1	mauve red orange pink
60 m	G G G G I	27 33 27 12 100		23 28 24 12 88	2 4 3 8	2 1 4	5	15 2	7 33 25 12 29	2 3 2	mauve red orange pink
70 m	G G G G I CD	27 28 37 7 100 100		22 28 30 7 85 92	2 4 10 6	3 3 5 2		12 4 12 3	15 24 25 4 69 28	2 15	mauve red orange pink
80 m	G G G G I CD	29 27 30 13 100 100		20 24 26 13 60 68	6 2 4 28 24	3 1	4 5 9	16 2 1 4	9 20 20 9 38 70	1 1 38	mauve red orange pink
90 m	G G G G I CD	33 26 38 5 100 100		24 23 34 5 71 87	6 2 3 21 8	3 1 1 8 5	11 3 8 1	13 1	9 19 30 3 31 88	2 24	mauve red orange pink
100 m	G G G G I CD	25 25 38 12 100 100	1	17 23 28 11 84 88	6 1 6 1 12 8	2 1 4 4 4	10 2 2 1	11 1 3 3	4 22 33 8 32 84		mauve red orange pink

TABLE V (Cont)

Borehole No. 15/13	Type of mineral	No. of grains	No. of grains examined in SEM	Shape			Surface textures				Colour of garnet
				Ang	Sub rounded	Well rounded	ROK	SKS	SS	Diagenetic features	
110 m	G	42		30	9	3	9	23	10	1	mauve red orange pink
	G	27		27			1	1	25		
	G	30		26	4		1	2	27		
	G	7		3	2	1	1	3	3		
	I	100		88	9	3			22		
CD	100		95	4	1			91	34		
120 m	G	34		24	6	4	6	24	3	1	mauve red orange pink
	G	26		24	2		2	2	22		
	G	31		28	3		3		28		
	G	11		10	1		1	6	4		
	I	100	1	90	8	2			14		
CD	100		92	6	2			80	27		
130 m	G	43		35	5	3	10	18	15		mauve red orange pink
	G	20		18	2			9	11		
	G	28		26	2			3	25		
	G	13		13				5	8		
	I	100		92	7	1			32		
CD	100		92	8				80	23		
140 m	G	44		35	5	4	13	13	8		mauve red orange pink
	G	29		24	4	1	7	4	18		
	G	28		23	3	2	7	1	20		
	G	10		10			1	4	5		
	I	100		80	12	8			55		
CD	100		90	10				74	19		
150 m	G	31		24	4	3	10	11	10		mauve red orange pink
	G	26		20	4	2		9	17		
	G	44		39	5			10	34		
	G	10		10				4	6		
	I	100		81	14	5			38		
CD	100		88	7	5		88	17			
TOTALS	G	425	1	329	60	36	94	189	125	11	mauve red orange pink black green
	G	322	1	294	21	7	20	36	263	1	
	G	401	1	354	37	10	30	34	330	9	
	G	101		95	4	2	5	33	63	2	
	I	1272	3	1045	164	63			485		
CD	912		804	81	27			689	233		

Deviations as for Table II

TABLE VI

Borehole No. 15/15	Type of mineral	No. of grains	No. of grains examined in SEM	Shape			Surface textures				Colour of garnet
				Ang	Sub rounded	Well rounded	ROK	SKS	SS	Diagenetic features	
20m	G	1			1			1			mauve
	I	4		1	3						
30m	G	59		52	4	3		11	41	7	mauve red pink
	G	15		13	2			15			
	G	2		2				2			
	I	21		18	2	1		6			
	CD	1		1				1			
40m	G	24		20	3	1		3	21	4	mauve red orange pink
	G	29		26	3			22			
	G	32		30	2			27			
	G	10		8	2			10		1	
	I	50		38	8	4		29			
50m	G	74		59	11	4		22	42	4	mauve red orange pink
	G	22		18	4			22			
	G	22		21	1			22			
	G	13		13				13			
	I	100		88	7	5		43			
60m	G	71		56	9	6		12	45	10	mauve red orange pink
	G	15		15				15		1	
	G	22		18	3	1		22		3	
	G	16		13	3			15		1	
	I	100		89	9	2		27			
70m	G	48	1	38	7	3	14	13	17	8	mauve red orange pink
	G	20		17	2	1		1	10		
	G	37		31	6				28	2	
	G	7		7				6		1	
	I	100		87	11	2		60			
80m	G	43		37	3	3	12	6	21	4	mauve red orange pink
	G	25		19	6			25		1	
	G	28		21	5	2		28		1	
	G	9		9				9			
	I	100		80	13	7		48			
	CD	5		5				5		3	
90m	G	37		28	5	4	11	4	22	3	mauve red orange pink
	G	29		24	5		7	1	21		
	G	40		32	8			1	33		
	G	12		12					11	1	
	I	100		88	8	4			37		
	CD	11		11					7	2	
100m	G	33		25	6	2	11	5	17		mauve red orange pink
	G	33		28	3	2	7		25	1	
	G	37		29	6	2	2	4	31		
	G	7		7				1	6		
	I	100		89	6	5			51		
	CD	16		12	4				8	6	
110m	G	44	1	36	6	2	16	6	22		mauve red orange pink
	G	28		20	5	3	6	1	20		
	G	25		23	2		4	1	20		
	G	10		10					10		
	I	100		38	9	3			44		
	CD	9		7	2				6	4	

TABLE VI (Contd.)

Borehole No. 15/15 Depth of Sample	Type of mineral	No. of grains	No. of grains examined in SEM	Shape			Surface textures				Colour of garnet	
				Ang	Sub rounded	Well rounded	ROK	SKS	SS	Diagenetic features		
120m	G	31		20	8	3	8	10	13		mauve red orange pink	
	G	28		25	3	28						
	G	32		29	3	32						
	G	12		12		12						
	I	100		91	9	24						
130m	G	43		39	4		20	7	16		mauve red orange pink	
	G	28		26	2	7		4	23			
	G	33		30	3	4	4	25				
	G	9		9				8	1			
	I	100		83	10	7		63				
	CD	91		73	14	4		63	35			
140m	G	32		24	5	3	7	15	10		mauve red orange pink	
	G	33		22	7	4		1	32			
	G	29		25	4			2	27			
	G	7		7					7			
	I	100		87	10	3			27			
	CD	4		4					4			1
150m	G	29		21	6	2	10	8	11		mauve red orange pink	
	G	27		19	5	3			2			25
	G	48		45	3			1	47			
	G	2		2					2			
	I	100		83	9	8			38			
	CD	1		1					1			
TOTALS	G	569	2	455	78	36	109	123	298	40	mauve red orange pink black green	
	G	332		272	47	13		8	283	3		
	G	385		334	46	5		13	342	8		
	G	116		111	5			1	111	8		
	I	1175		1010	114	51			497			
	CD	138		114	20	4			95	56		

-Abbreviations as for Table II

TABLE VII

Borehole No. 15/25	Type of mineral	No. of grains	No. of grains examined in SEM	Shape			Surface textures				Colour of garnet
				Ang	Sub rounded	Well rounded	ROK	SKS	SS	Diagenetic features	
30m	G G G G I	72 10 8 12 100		69 10 8 12 91	3 8	 1		10	62 9 8 12 12	3 1 1	mauve red orange pink
40m	G G G G I	77 18 9 8 100		67 12 6 8 81	6 4 3 15	4 2 4		17	60 18 9 8 41	2 2 3	mauve red orange pink
50m	G G G G I	69 12 15 12 100		54 12 15 10 87	11 2 10	4 3		20 1	49 11 15 11 65	5 1 3 1	mauve red orange pink
60m	G G G I	34 36 31 100		25 29 28 76	6 4 3 16	3 3 8		24 4	10 32 27 21	3 4 1	mauve red orange
70m	G G G G I	37 31 29 20 100		29 26 24 17 88	5 3 4 2 9	3 2 1 1 3	7	16 2 4 2	14 29 25 18 45	4 2 6 1	mauve red orange pink
80m	G G G G I CD	43 29 30 10 100 4		34 25 26 10 80 4	5 3 4 14	4 1 6	14 2	10 1	19 20 24 10 48 4	2 6 3	mauve red orange pink
90m	G G G G I CD	26 26 32 19 100 7		19 22 30 17 90 7	4 2 2 2 8	3 2 2	9	13 2 3 7	4 24 29 12 35 7	1 2 2	mauve red orange pink
100m	G G G G I CD	45 32 22 10 100 4	1	36 22 16 10 92 4	5 8 4 6	4 2 2 2	11 4 2	18 1	16 28 19 10 31 3	3	mauve red orange pink
110m	G G G G I CD	34 29 36 17 100 54		27 25 34 17 91 49	4 3 2 6 4	3 1 3 1	13	10	11 29 36 17 20 43	1 11	mauve red orange pink
120m	G G G G I CD	40 27 36 13 100 4		33 24 34 13 78 4	5 3 2 12	2 10	17	11 1	12 26 36 13 41 2	1 2	mauve red orange pink
TOTALS	G G G G I CD	477 250 248 172 1000 73	1	393 207 221 114 854 68	54 30 24 6 104 4	30 13 3 1 42 1	71 4 4	149 10 8 10	257 226 228 111 359 59	19 10 25 5 18	mauve red orange pink black green

Abbreviations as for Table II.

TABLE VIII

Relationship between surface features and colour of garnets from
the Jwaneng kimberlite pipe.

Colour of garnet	No. of grains examined	% of garnet in total population	% of kelyphite-encrusted garnets	% of garnets with sub-kelyphitic surfaces	% of garnets with sculptured surfaces
Mauve	3001	39	21	44	37
Red	1887	25	4	14	80
Orange	1943	25	7	11	79
Pink	858	11	3	22	68
TOTAL	7689	100	(9)	(23)	(66)

Data compiled from Tables II to VII.

Figures in brackets represent averages for each type of surface feature.

TABLE IX

Proportion of sculptured ilmenite and chrome diopside from Jwaneng

Type of mineral	No. of grains examined	No. of grains with sculptured surfaces	% of grains with sculptured surfaces
Ilmenite	7006	2802	40
Chrome diopside	3174	2254	71

Data compiled from Tables II to VII.

TABLE X

PROPORTION OF GARNET, ILMENITE AND CHROME DIOPSIDE
EXHIBITING DIAGENETIC ETCH FEATURES FROM
JWANENG

Type and Colour of mineral	No. of grains examined	No. of grains displaying diagenetic etch features	Percentage of grains showing diagenetic etch features
Mauve garnet	3001	121	4
Red garnet	1887	21	1
Orange garnet	1943	57	3
Pink garnet	858	30	3
TOTAL	7689	229	3
Ilmenite	7006	1	0,01
Chrome Diopside	3174	591	19
Grand Total	17 869	821	4,5

Data compiled from Tables II to VII.

TABLE XI

Surface characteristics of mineral grains from the Montrose No. 3 kimberlite pipe.

SAMPLE NO. WEST CUT	MESH SIZE	TYPE OF MINERAL	NO. OF GRAINS	NO. OF GRAINS EXAMINED IN SEM	S H A P E			SLIGHTLY ABRADED	SURFACE FEATURES				% OF ETCHED GRAINS
					ANG.	SUB ROUNDED	WELL ROUNDED		ROK	SKS	SS	DIAGENETIC FEATURES	
AHP 006 SURFACE RED BROWN SOIL	+16	I	+100	-	88	5	7	3	-	-	38	-	-
	+28	I	+100	-	89	3	8	1	-	-	27	-	-
	+28	C	19	3	18	1	-	-	1	3	7	9	47
	+35	I	+100	-	83	15	2	-	-	-	33	-	-
	+35	C	24	-	23	1	-	-	-	-	17	11	46
TOTAL C			43	3	41	2	17	4	1	3	24	20	46
TOTAL I			300		260	23					98		
AHP 007 TOP OF FERRICRETE	+16	I	+100	3	93	3	4	-	-	-	48	2	2
	+28	C	9	-	9	-	-	-	-	2?	4	4	44
	+28	I	+100	-	93	5	2	3	-	-	36	-	-
	+35	C	13	1	13	-	-	-	-	-	9	7	54
	+35	I	+100	-	96	4	-	-	-	-	36	-	-
TOTAL C			22	1	22		6	3		2?	13	11	49
TOTAL I			300	3	282	12					120	2	
AHP 008 BASE OF FERRICRETE	+16	C	2	2	1	1	-	-	-	-	1	2	100
	+16	I	+100	1	95	5	-	2	-	-	59	-	-
	+28	C	13	-	13	-	-	-	-	-	6	7	54
	+28	I	+100	-	93	5	2	2	-	-	53	-	-
	+35	C	19	1	19	-	-	-	-	-	6	12	63
+35	I	+100	-	92	3	5	-	-	-	25	-	-	
TOTAL C			34	3	33	1	7	4			13	21	72
TOTAL I			300	1	280	13					137		
AHP 009 VERY WEATHERED KIMBERLITE	+16	C	1	-	1	-	-	-	-	-	-	-	-
	+16	I	+100	-	91	6	3	-	-	-	58	-	-
	+28	C	9	1	9	-	-	-	-	-	2	2	22
	+28	I	+100	-	94	2	4	-	-	-	60	-	-
	+35	C	14	1	14	-	-	-	1	-	2	4	29
+35	I	+100	1	95	3	2	-	-	-	45	-	-	
TOTAL C			24	2	24		9		1		4	6	25
TOTAL I			300	1	280	11					163		
AHP 010 WEATHERED KIMBERLITE	+16	C	8	2	2	5	2	-	4	7	-	-	-
	+16	I	+100	-	97	3	-	-	-	-	68	-	-
	+16	CD	2	1	2	-	-	-	-	-	1	17	50
	+28	C	15	2	15	-	-	-	4	-	-	9	60
	+28	I	+100	-	94	6	-	-	-	-	55	-	-
	+28	CD	19	2	16	3	-	-	-	-	12	9	47
	+35	C	5	-	5	-	-	-	2	1	-	-	-
	+35	I	+100	-	95	5	-	-	-	-	60	-	-
+35	CD	5	-	5	-	-	-	-	-	5	-	-	
TOTAL C			28	4	22	5	2		10	8		9	20
TOTAL I			300		286	14					183		-
TOTAL CD			26	3	23	3					18	10	32

TABLE XI (contd.)

SAMPLE NO. EAST CUT	MESH SIZE	TYPE OF MINERAL	NO. OF GRAINS	NO. OF GRAINS EXAMINED IN SEM	SHAPE			SLIGHTLY ABRADED	SURFACE TEXTURES			% OF ETCHED GRAINS
					ANG.	SUB ROUNDED	WELL ROUNDED		ROK	SS	DIAGENETIC FEATURES	
AHP 001 SURFACE	+16	G	8	3	8	-	-	-	-	4	3	38
RED	+16	I	+100	3	100	-	-	-	-	93	2	2
BROWN	+28	I	+100	1	100	-	-	-	-	87	1	2
SOIL	+35	G	5	-	4	1	-	-	-	4	4	80
	+35	I	+100	2	96	2	2	2	-	79	-	-
TOTAL G			13	3	12	1				8	7	59
TOTAL I			300	6	296	2	2	2		259	3	2
AHP 002 TOP OF FERRICRETE	+16	I	+100	2	100	-	-	-	-	81	2	2
	+28	G	8	2	7	1	-	-	-	4	4	50
	+28	I	+100	2	98	2	-	-	-	64	1	1
	+35	G	5	1	5	-	-	-	12	3	4	80
TOTAL G			13	3	12	1			1	7	8	65
TOTAL I			200	4	198	2				145	3	2
AHP 003 BASE OF FERRICRETE	+16	G	4	2	2	2	1	-	-	1	1	25
	+16	I	+100	3	100	-	-	-	-	92	3	3
	+28	G	5	2	5	-	-	-	-	3	5	100
	+28	I	+100	1	100	-	-	-	-	42	1	-
	+35	G	1	-	1	-	-	-	-	1	1	100
	+35	I	+100	2	18	72	10	-	-	12	70	-
TOTAL G			10	4	8	2	1			5	7	75
TOTAL I			300	6	218	72	10			146	4	2
AHP 004 VERY WEATHERED KIMBERLITE	+16	I	+100	1	100	-	-	-	-	88	-	-
	+28	G	11	1	11	-	-	-	-	1	7	64
	+28	I	+100	1	100	-	-	-	-	71	-	-
	+35	G	4	1	4	-	-	-	-	1	3	75
TOTAL G			15	2	15					2	10	69
TOTAL I			200	2	200					159		
AHP 005 WEATHERED KIMBERLITE	+16	I	+100	-	100	-	-	-	-	88	-	-
	+16	G	1	-	1	-	-	-	-	1	-	-
	+28	G	3	1	3	-	-	-	-	-	2	66
	+28	CD	1	1	1	-	-	-	-	-	1	-
	+35	I	+100	1	100	-	-	-	-	76	1	1
TOTAL G			4	1	4					1	2	66
TOTAL I			200	1	200					64	1	1
TOTAL CD			1	1	1						1	

- G - kimberlitic garnet
- I - ilmenite possibly of kimberlitic origin
- CD - chrome diopside
- ROK - remnant of kelyphite
- SKS - sub-kelyphitic surface
- SS - sculptured surface
- SEM - scanning electron microscope

TABLE XII

Surface characteristics of mineral grains from the Dullstroom kimberlite fissure.

Location of Samples	Sample No.	No. of garnets grains	No. of grains examined in SEM	Shape and degree of abrasion		Surface textures		
				Ang	Sub-rounded	SS	Diagenetic etching	% etched garnets
Top of black sandy soil	301	3	1	2	1	3	3	100
	302	7	2	7	-	5	3	43
	303	4	2	2	2	3	3	75
Total/ Average %	3	14	5	11	3	11	9	64%
Top of red sandy soil	304	1	1	1	-	1	1	100
	305	6	2	4	2	4	1	17
	306	5	2	5	-	4	1	20
Total/ Average %	3	12	5	10	2	9	3	25%
Top of ferricrete	307	4	2	4	-	3	4	100
	308	4	1	4	-	4	4	100
	309	3	1	3	-	2	3	100
Total/ Average %	3	11	4	11	-	9	11	100%
Centre of ferricrete	310	14	4	14	-	10	8	57
	311	14	3	14	-	9	11	79
	312	4	2	4	-	4	4	100
Total/ Average %	3	32	9	32	-	23	23	72%
Below base of ferricrete	313	129	5	129	-	100	± 73	57
	314	121	5	121	-	93	± 53	44
	315	19	2	19	-	4	8	42
Total/ Average %	3	269	12	269	-	197	± 134	50%
Very weathered kimberlite	316	142	4	142	-	112	32	23
Weathered kimberlite	317	521	5	521	-	500	± 54	10

SEM - scanning electron microscope

SS - sculptured surfaces

TABLE XIII

AMOUNT OF ILMENITE RECOVERED FROM MONTROSE SAMPLES

EAST CUT SAMPLE NO.	MASS OF ILMENITE RECOVERED (gms)	WEST CUT SAMPLE NO.	MASS OF ILMENITE RECOVERED (gms)
AHP 001	35.4	AHP 006	3.9
AHP 002	42.6	AHP 007	0.8
AHP 003	13.8	AHP 008	12.3
AHP 004	67.0	AHP 009	2.9
AHP 005	310.0	AHP 010	6.3
TOTALS	468.8		26.2

TABLE XIV

Number of kelyphite-encrusted garnets examined from thirty kimberlite occurrences having a global distribution.

KIMBERLITE LOCALITY	COUNTRY	NO. OF GARNETS EXAMINED
1) Koffyfontein (old plant site)	R.S.A.	11
2) Kimberlitic garnet from Dwyka tillite	R.S.A.	6
3) Newlands Mine	R.S.A.	21
4) Sloan 2 Colorado	U.S.A.	11
5) De Beers	R.S.A.	6
6) Premier Mine	R.S.A.	2
7) Massif <u>V</u>	ZAIRE	1
8) Disele	ZAIRE	1
9) Finsch Mine	R.S.A.	2
10) Berseba Reserve Lichtenfels, Gibeon	S.W.A.	1
11) Stampriet River, Keetmanshoop	S.W.A.	1
12) Grundorn & Gaus Sud, South of Gibeon	S.W.A.	1
13) Russia (locality unknown)	U.S.S.R.	1
14) Liphobong pipe	LESOTHO	2
15) Kamfersdam pipe	R.S.A.	2
16) Bells Bank fissure	R.S.A.	1
17) Lusu kimberlite	ZAMBIA	4
18) Rietkuil pipe	R.S.A.	1
19) Colossus pipe	RHODESIA	1
20) Bultfontein	R.S.A.	1
21) DuToits pan Mine	R.S.A.	1
22) Noozies District, Kenhardt	R.S.A.	1
23) 321/K1	ANGOLA	1
24) Monastery Mine	R.S.A.	1
25) Wesselton Mine	R.S.A.	3
26) Orapa pipe	BOTSWANA	3
27) Clarkton pipe	R.S.A.	14
28) Jwaneng Mine	BOTSWANA	733
29) Van Zyls Rust area, N. Cape Prov.	R.S.A.	1
30) Zarnitisa pipe	U.S.S.R.	23

TABLE XV

MICROPROBE ANALYSIS OF NODULAR GARNET FROM MUZA, U.S.S.R.

Grain No.	Position of analysis	SiO ₂	TiO ₂	Al ₂ O ₃	Cr ₂ O ₃	FeO *	MnO	MgO	CaO	Total
1	Edge	41.23	0.08	20.99	4.32	7.95	0.52	18.78	6.25	100.11
	Centre	41.12	0.16	22.80	2.02	9.44	0.47	18.77	4.92	99.69
	Edge	41.10	0.03	21.01	3.85	8.22	0.49	19.09	5.76	99.55
Mean values		41.15	0.09	21.6	3.40	8.54	0.49	18.88	5.64	99.78
2	Edge	42.20	0.04	21.47	3.62	8.27	0.49	19.38	5.76	101.24
	Centre	42.37	0.05	21.43	3.68	8.14	0.48	18.62	5.77	100.54
	Edge	42.45	0.03	21.11	3.57	8.03	0.47	18.96	5.65	100.27
Mean values		42.34	0.04	21.33	3.62	8.14	0.48	18.98	5.72	100.65
3	Edge	41.84	0.11	22.43	1.94	9.28	0.48	19.10	4.90	100.08
	Centre	41.01	0.13	22.63	1.98	9.34	0.48	19.01	4.91	99.49
	Edge	42.83	0.13	22.41	1.96	9.27	0.48	19.18	4.91	101.17
Mean values		41.89	0.12	22.49	1.96	9.29	0.48	19.09	4.90	100.22

* Total Fe expressed as FeO.

TABLE XVI

PROPORTION OF SCULPTURED GARNET GRAINS FROM KIMBERLITE

Type and Colour of garnet	No. of grains examined	% of garnet in total sample	No. of grains with sculptured surfaces	% of garnets with sculptured surface	Kimberlite and Location	
Mauve garnet	3001	39	1110	37	Jwaneng Mine (Botswana)	
red garnet	1887	25	1509	80		
orange garnet	1943	25	1535	79		
pink garnet	858	11	583	68		
SUB TOTAL	7689	100	4737			
Mauve garnet	5	36	1	20	Letseng La Terea satellite pipe (Lesotho)	
red garnet	-	-	-	-		
Orange garnet	7	50	3	42		
pink garnet	2	14	-	-		
SUB TOTAL	14	100	4	(31)		
Mauve garnet	277	28	197	71	Dullstroom Kimberlite Fissure (South Africa)	
red garnet	144	14	127	88		
orange garnet	113	11	106	94		
pink garnet	467	47	421	90		
SUB TOTAL	1001	100	851	(85)		
Garnet	206	-	77	37	Montrose No.3 Kimberlite (South Africa)	
Garnet	226	-	6	3	Redondao Kimberlite (Brazil)	
GARNET	MAUVE	3283	38	1308	40	5 Kimberlites
	RED	2031	23	1636	81	
	ORANGE	2063	24	1644	80	
	PINK	1327	15	1004	76	
TOTAL GARNET	9136	100	5675	62		

TABLE XVII

PROPORTION OF SCULPTURED ILMENITES FROM KIMBERLITE

No. of grains examined	No. of grains with sculptured surfaces	% of ilmenites with sculptured surfaces	Kimberlite and Location
2700	1474	55	Montrose No.3 kimberlite South Africa
111	81	73	Redondao kimberlite Brazil
7006	2802	40	Jwaneng kimberlite Botswana
2386	70	3	Black kimberlite
2107	33	2	Green kimberlite
1567	35	2	Grey kimberlite
290	9	3	Brown kimberlite
			Premier Mine South Africa
16167	4504	28	7

TABLE XVIII

PROPORTION OF SCULPTURED CHROME DIOPSIDE GRAINS FROM KIMBERLITE

No. of grains examined	No. of grains with sculptured surfaces	% of chrome diopside with sculptured surfaces	Kimberlite and Location
27	18	67	Montrose No.3 kimberlite South Africa
71	71	100	Redondao kimberlite Brazil
3174	2254	71	Jwaneng kimberlite pipe Botswana
373	183	49	Black kimberlite
1053	621	59	Green kimberlite
414	137	33	Grey kimberlite
30	6	20	Brown kimberlite
			Premier Mine South Africa
5142	3290	64	7

FIGURES

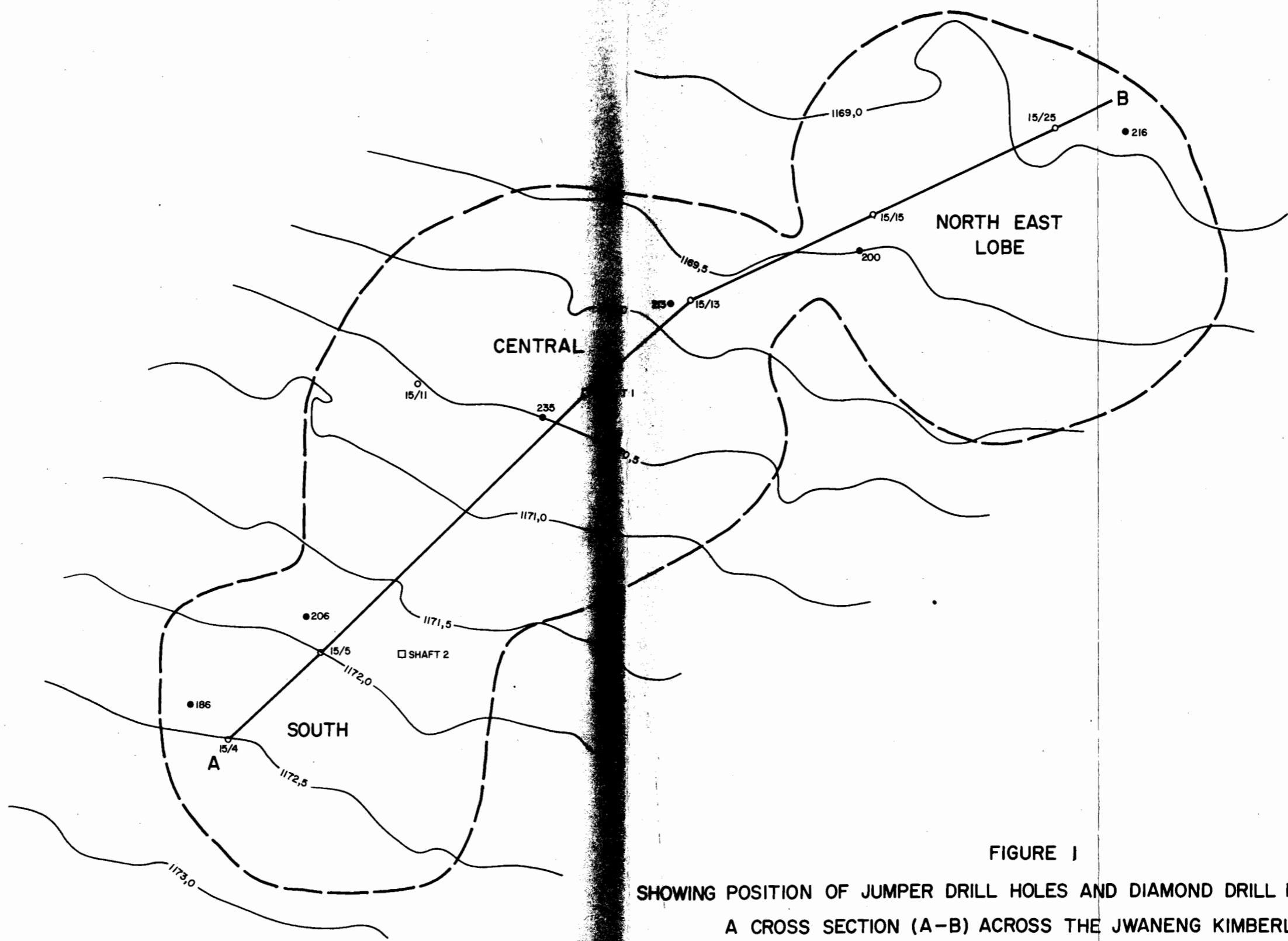
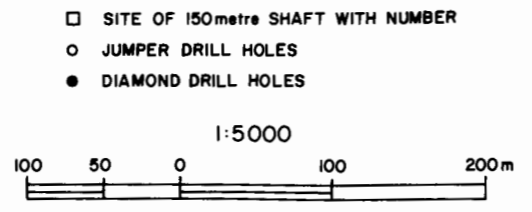
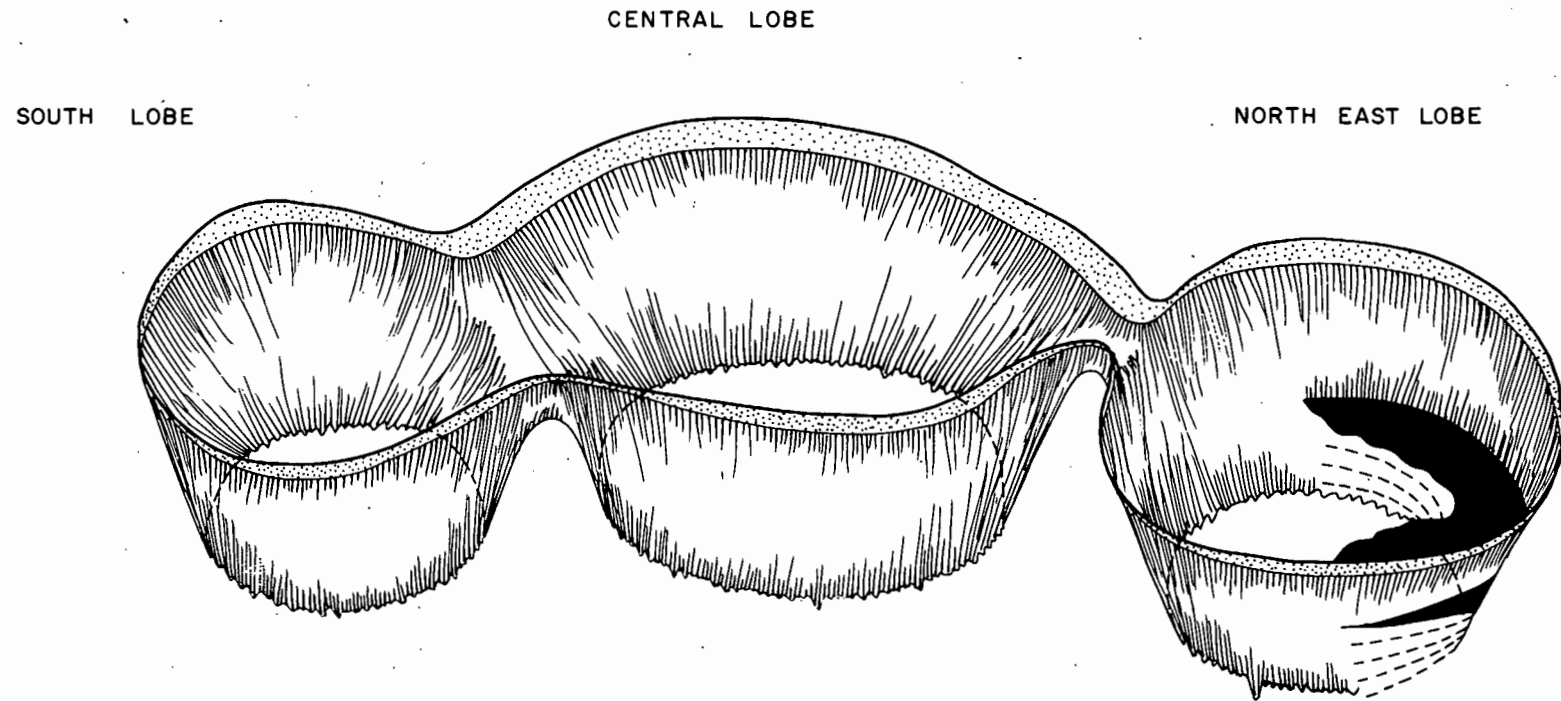


FIGURE 1
 SHOWING POSITION OF JUMPER DRILL HOLES AND DIAMOND DRILL HOLES FORMING
 A CROSS SECTION (A-B) ACROSS THE JWANENG KIMBERLITE PIPE

JWANENG KIMBERLITE PIPE



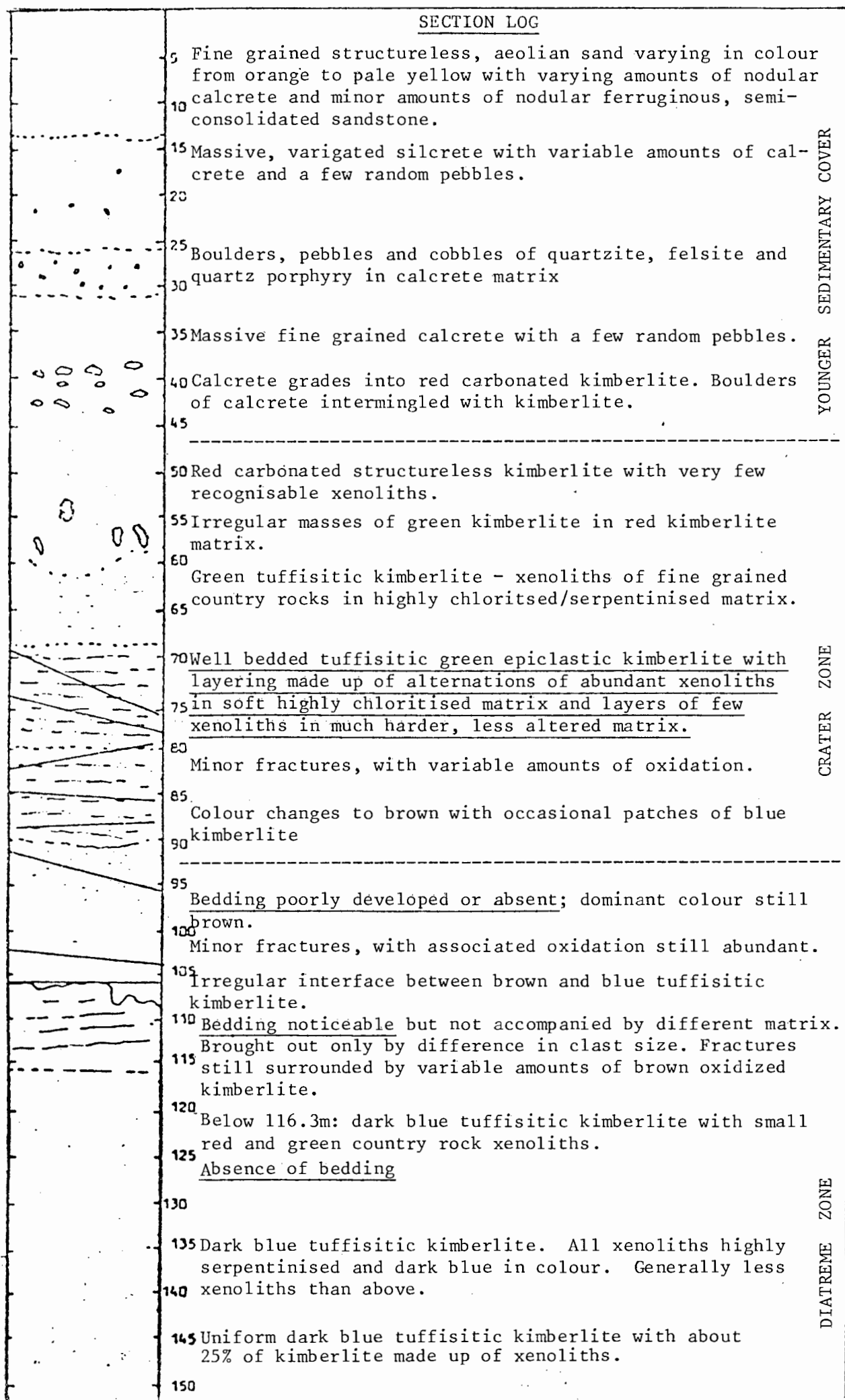


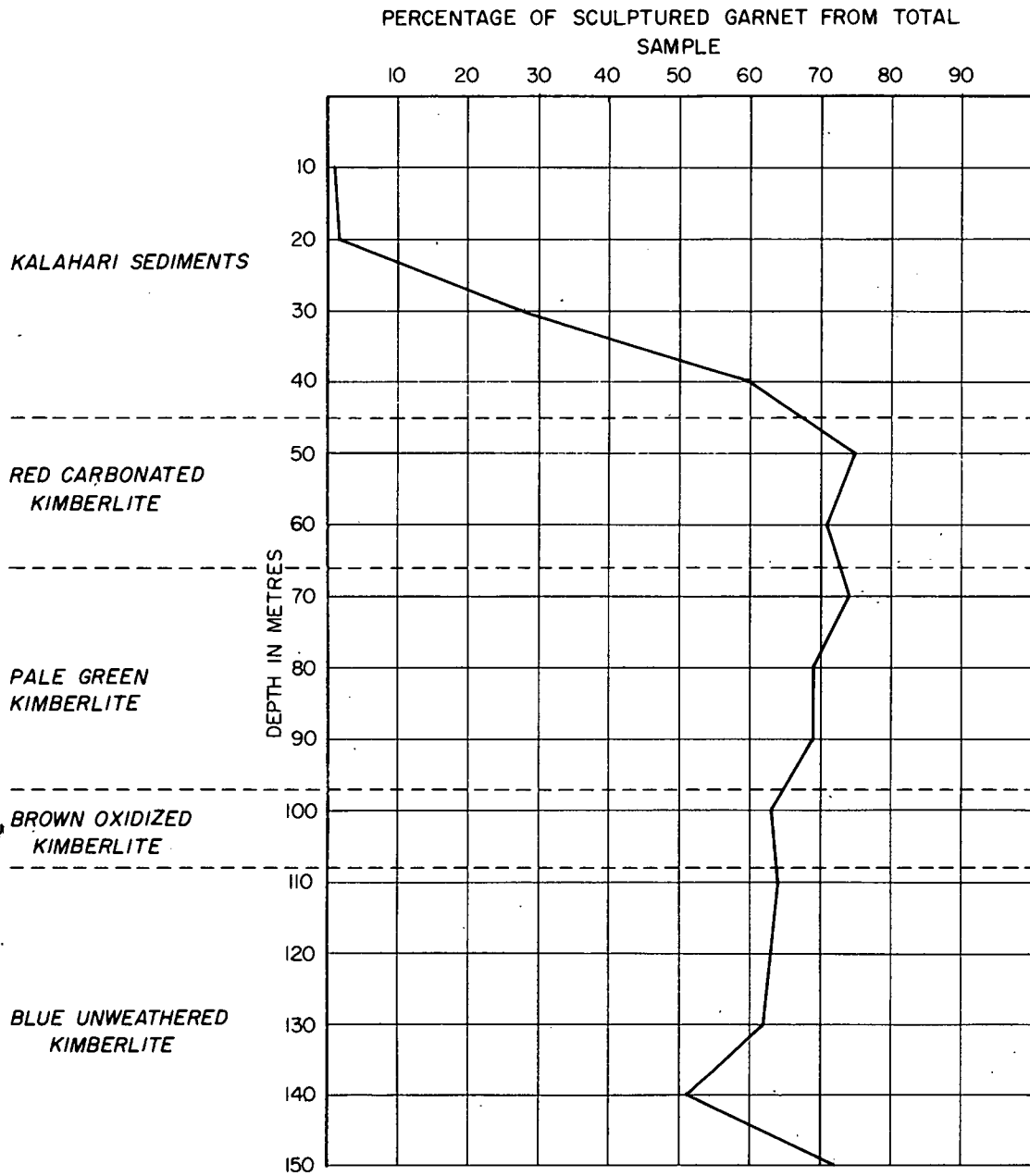
0 50 100 200 300 400 500metres

-  KALAHARI BEDS
-  KIMBERLITE
-  DOLERITE
-  SHALES

FIGURE 2
 DIAGRAM SHOWING TRILOBATE SHAPE OF
 JWANENG KIMBERLITE PIPE

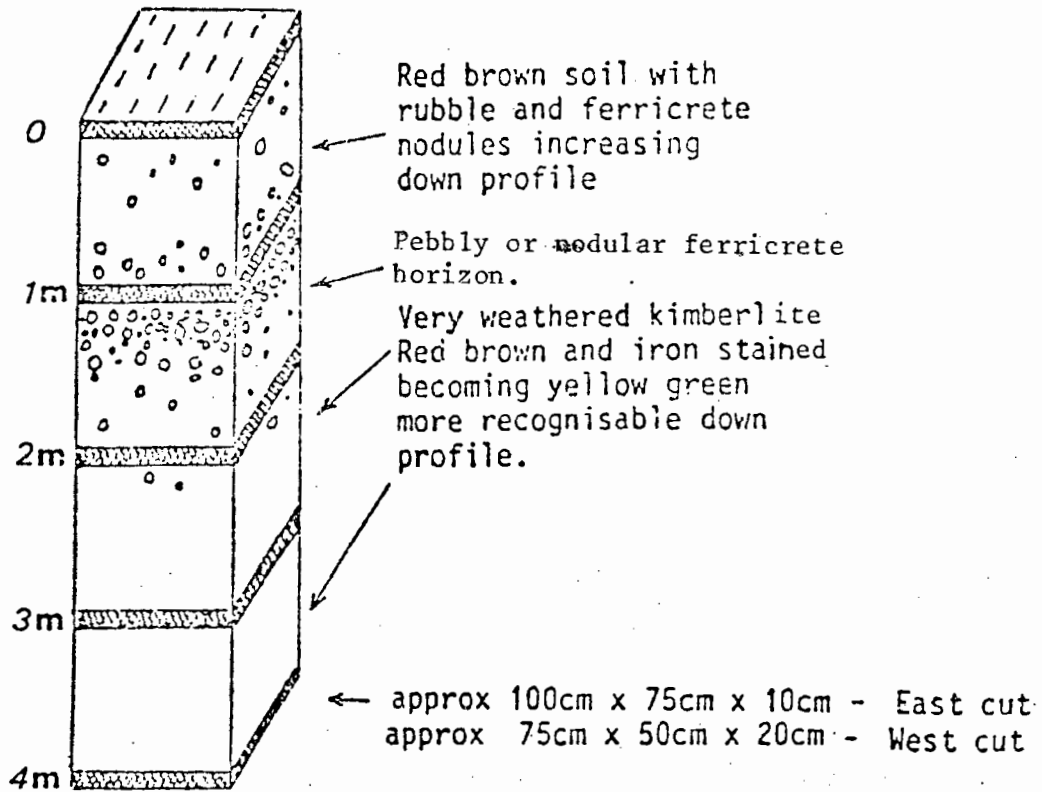
INFERRED FROM DRILLING INFORMATION





THE DISTRIBUTION OF THE COMBINED PERCENTAGE OF SCULPTURED GARNET FROM THE FOUR COLOUR GROUPS RECOVERED FROM THE SIX BOREHOLES, THROUGH THE WEATHERED PROFILE AT JWANENG

Figure 8 - Diagram showing position and dimensions of samples in soil profile overlying the Montrose No. 3. Kimberlite pipe.



scale 1:50

Both cuts follow this basic pattern.

<u>East Cut: Sample Number</u>		<u>Depth</u>
AHP 001		Surface
AHP 002		1 metre
AHP 003		2 metre
AHP 004		3 metre
AHP 005		4 metre
<u>West Cut:</u>		
AHP 006		Surface
AHP 007		1 metre
AHP 008		2 metre
AHP 009		3 metre
AHP 010		4 metre

Figure 9. Diagram showing position of samples in soil profile overlying the Dullstroom Kimberlite Fissure.

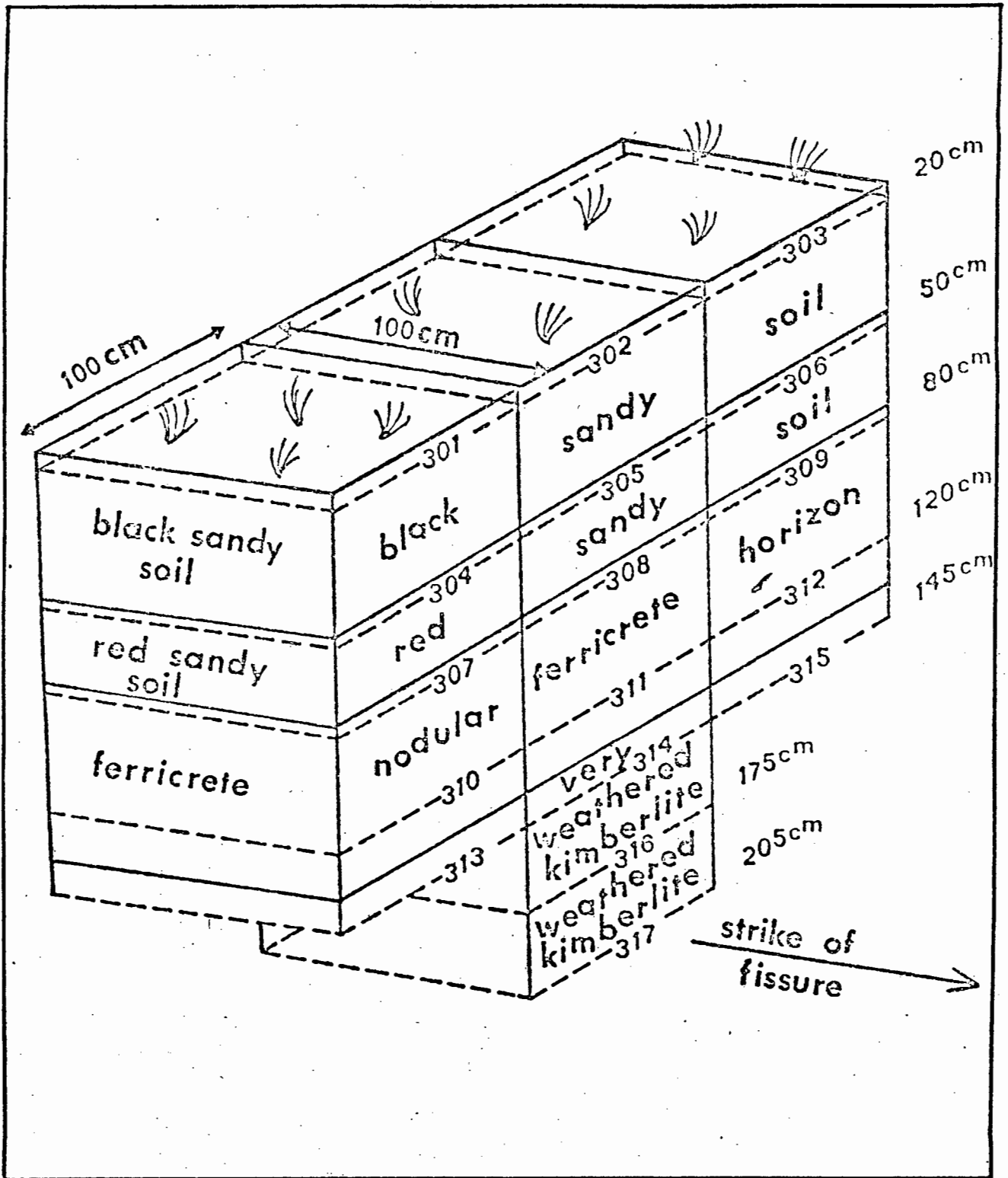


Figure 10 : Graph showing intensity of diagenetic etching on kimberlitic mineral grains in soil profile overlying the Montrose No. 3 kimberlite pipe

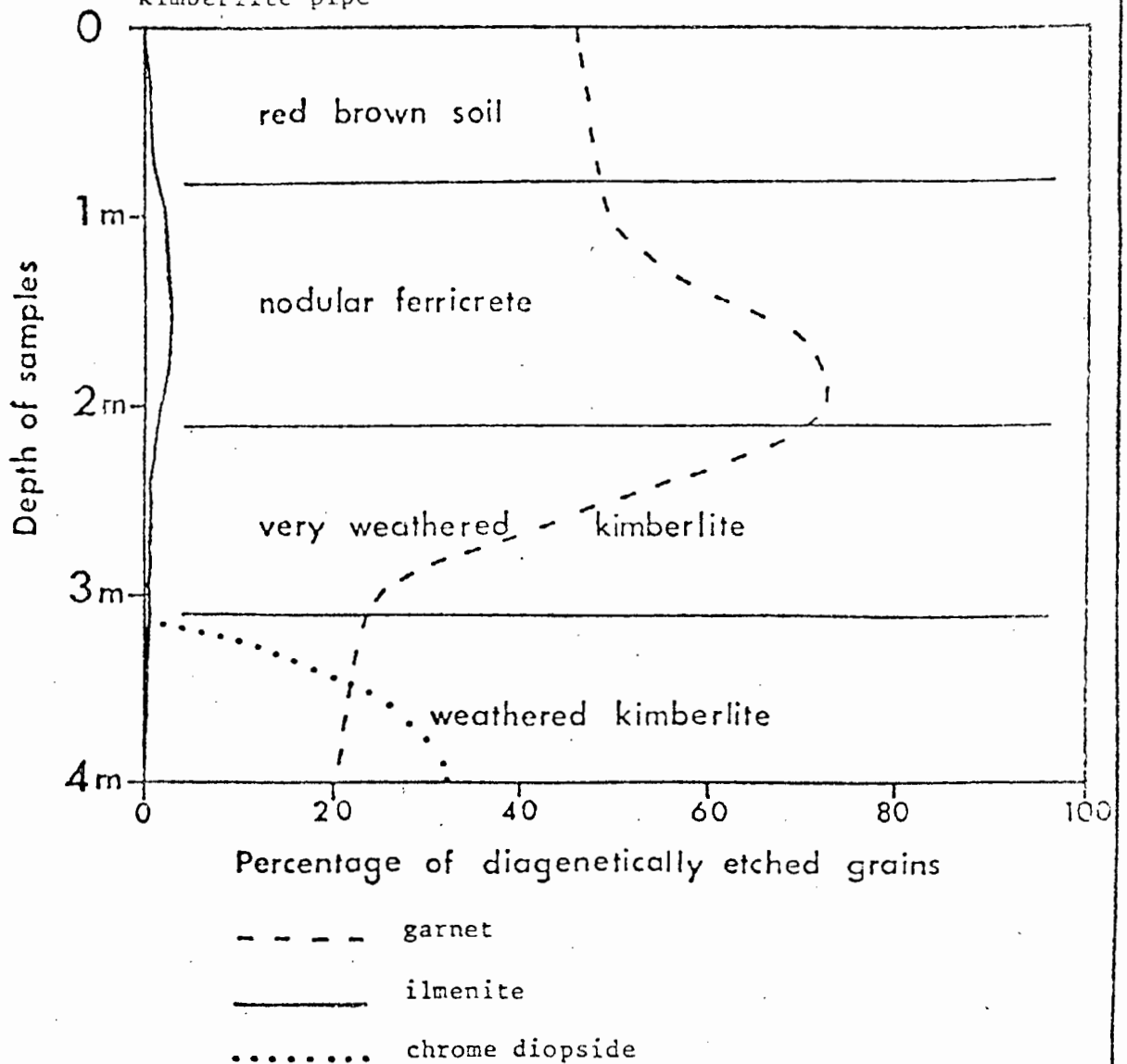


Figure 11.

Distribution trends of honeycomb surfaces on garnets and variation in garnet content of samples with depth.

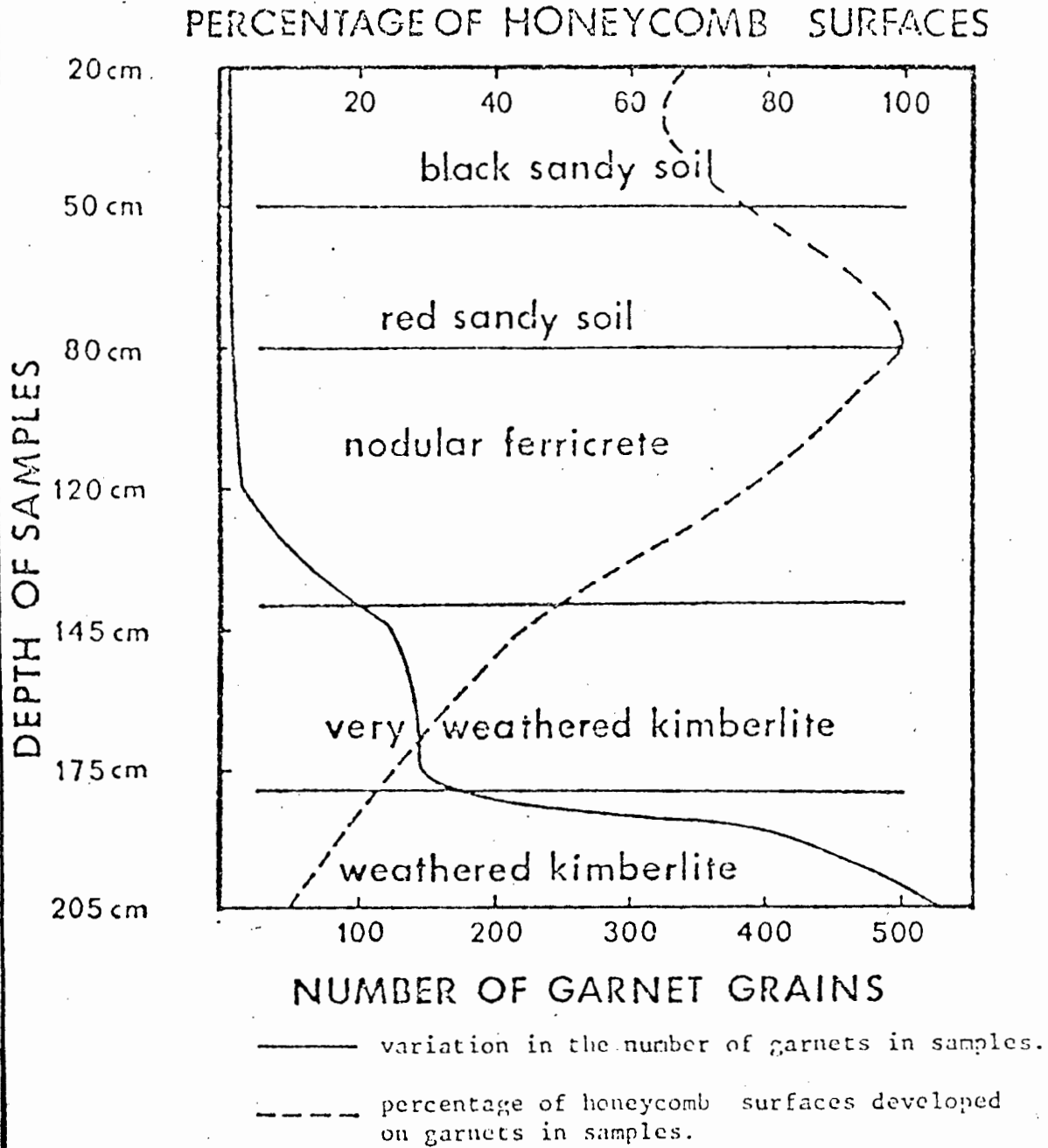


FIGURE 12. Schematic diagram showing structure of kelyphite shell surrounding a pyrope grain.

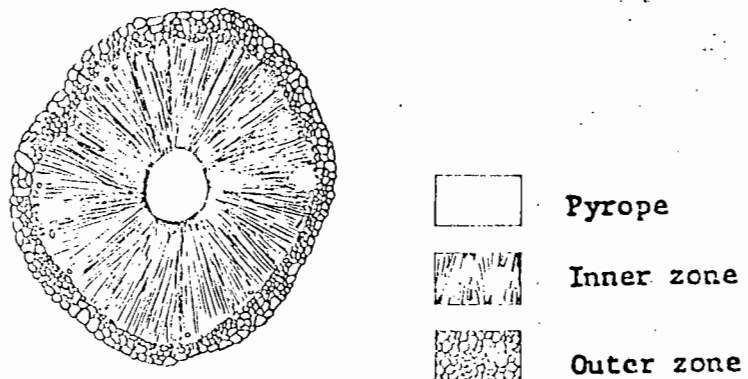


Figure 13

Locality map of kimberlites from which euhedral garnets have been found.



The numbered solid black diamonds are the position of kimberlites numbered as follows:-
1 Newlands Mine, Rietfontein pipe, Benfontein sill and Sekretariskop; 2 Premier Mine;
3 Kimberlite in the Van Zyl's Rust area N. Cape Province - South Africa; 4 Lusu
kimberlite - Zambia; 5 Massif V - Zaire; 6 Yakutian kimberlites - USSR; 7 Sloan kimberlite -
Colorado, U.S.A.

Figure 14 Stereographic projection, showing the shape and position of etch pits (after Mendelssohn 1971)

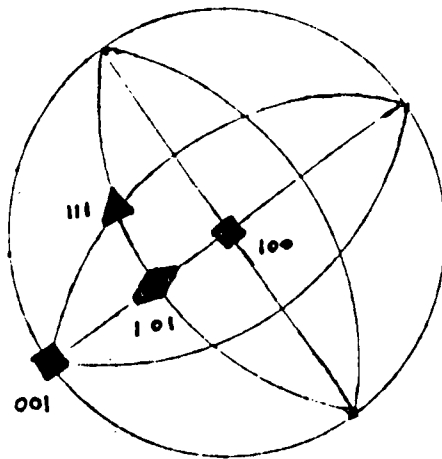


Figure 15

Stability of an etch pit on a slow etching surface when $R_d > R_a > R_s$.

Where R_s - etching rate along the surface
 R_a - etching rate at an angle to the surface
 R_d - etching rate along a dislocation or normal to the surface.

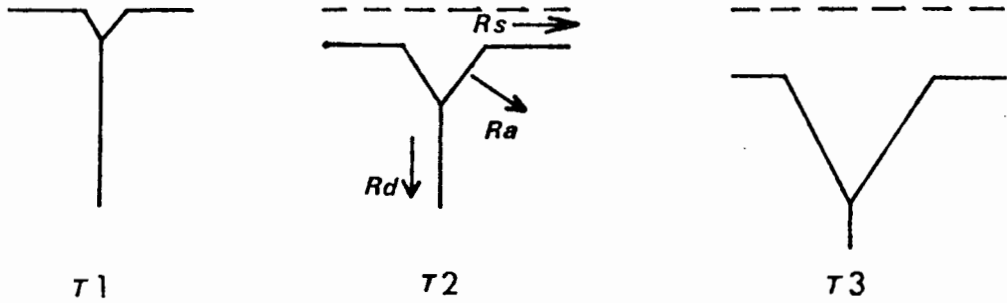


Figure 16

Instability of an etch pit on a fast etching surface when $R_s > R_a > R_d$.

Where R_s = etching rate along the surface
 R_a = etching rate at an angle to the surface
 R_d = etching rate along a dislocation or normal to the surface.

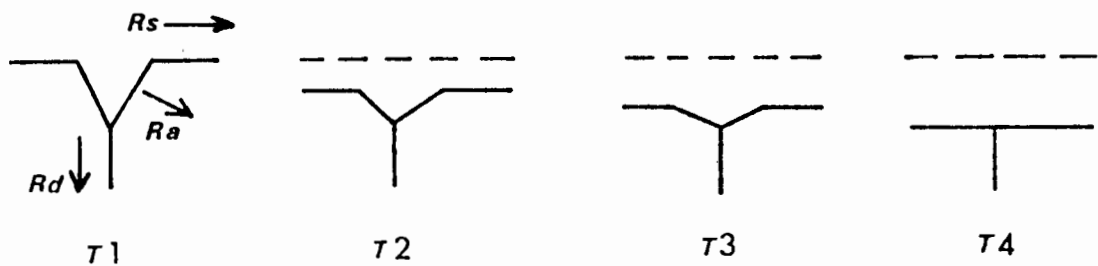
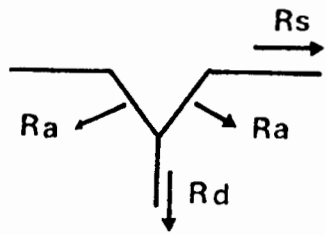


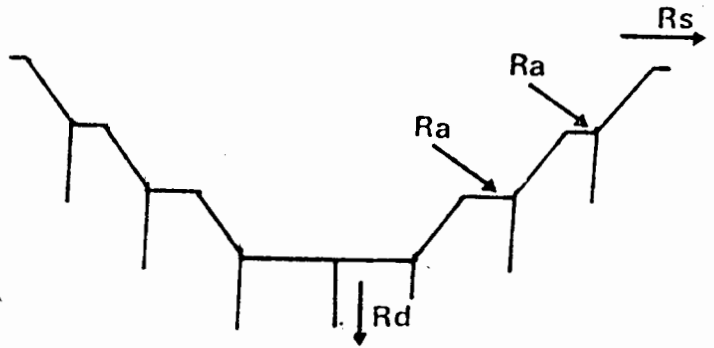
Figure 17: Schematic representation of etch pit formation

Rd - is etching rate along a crystal weakness
Rs - is etching rate along the crystal surface
Ra - is etching rate at an angle to the surface



Case I.

$$R_d > R_a > R_s$$



Case II.

$$R_d = R_a > R_s$$

Figure 18 Instability of a hillock on a slow etching surface

Where R_s - etching rate along the surface
 R_a - etching rate at an angle to the surface
 R_d - etching rate normal to the surface

$$R_s > R_a > R_d$$

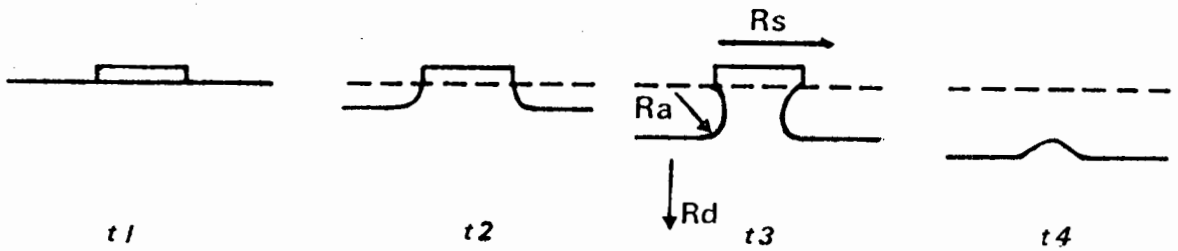


Figure 19 Stability of hillock on a fast etching surface

Where R_s - etching rate along the surface
 R_a - etching rate at an angle to the surface
 R_d - etching rate normal to the surface

$$R_d > R_a > R_s$$

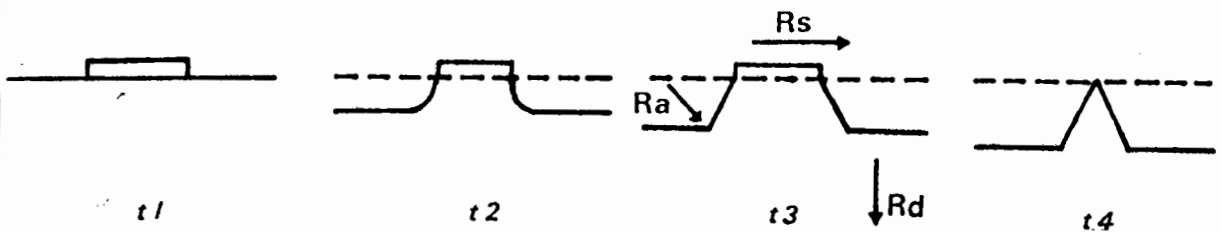
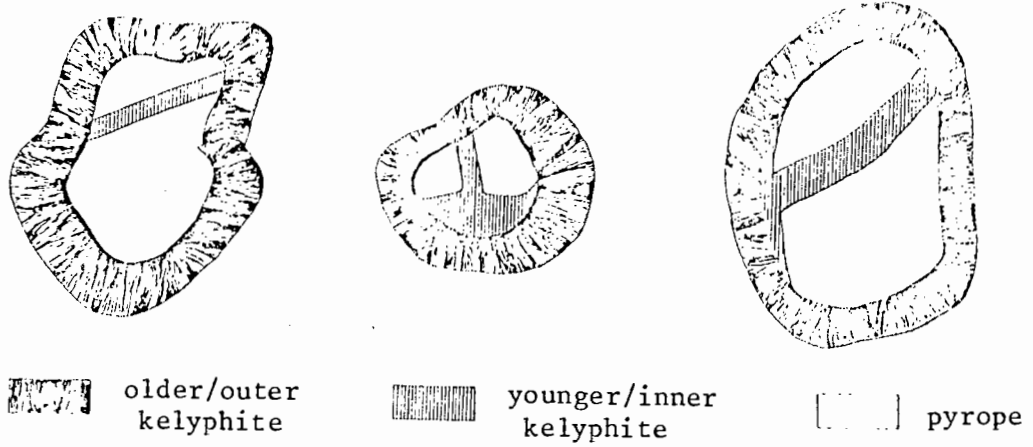


FIGURE 20 Possible relationship between older and younger generations of kelyphite formation (as suggested by Klein and Padéra, 1972).



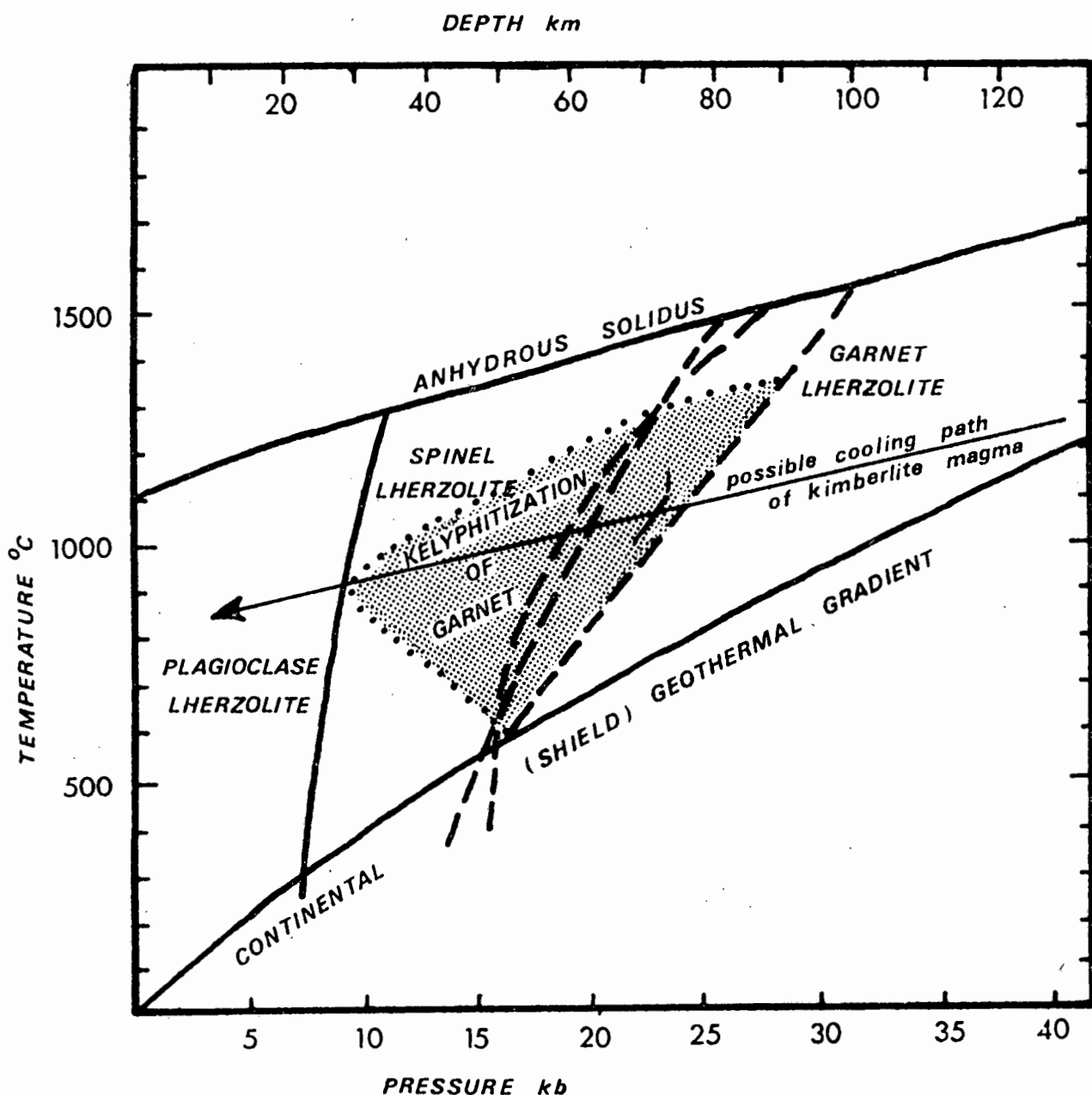


FIGURE 21. Pressure/temperature diagram showing a generalised field (hatched) for the proposed conditions of kelyphitization of pyrope in peridotite nodules during the ascent of kimberlite magma within the upper mantle. The P/T stability fields for various lherzolite assemblage types and the solidus curve correspond to those experimentally determined by Green and Ringwood (1967) for a pyrolite model composition. Dotted lines correspond to different positions for the spinel lherzolite \rightleftharpoons garnet lherzolite reaction boundary after (MacGregor 1974; Fujii, 1975 and Ernst, 1977). The line (1) for the reaction $\text{Opx} + \text{sp} = \text{gt} + \text{ol}$ in the system $\text{MgO}-\text{Al}_2\text{O}_3 - \text{SiO}_2$ was demonstrated by Wood (1977), and the continental (shield) geothermal gradient is from Clark and Ringwood (1964).

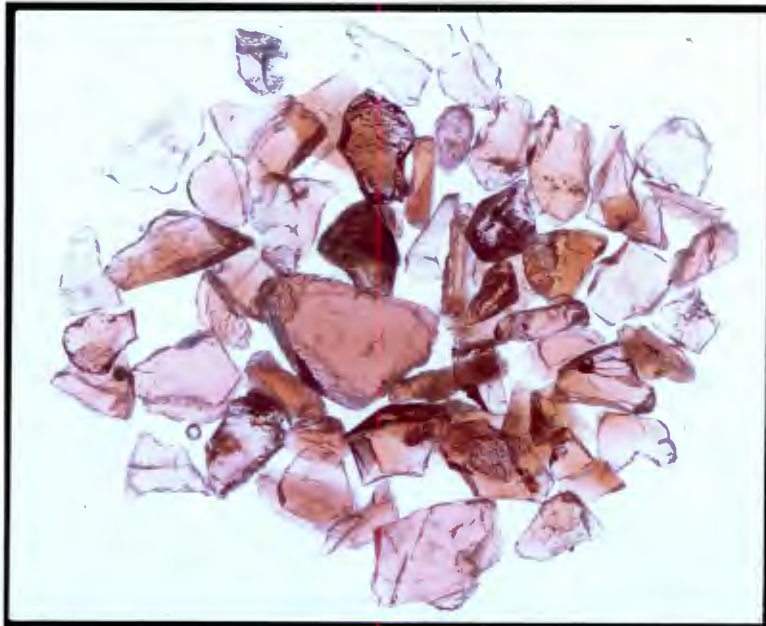
PLATES

COLOUR PLATE C



Orange-coloured garnet from kimberlite concentrate
Length across field of view = 10 mm.

COLOUR PLATE D



Pink-coloured garnet from kimberlite concentrate
Length across field of view = 10 mm.

COLOUR PLATE E



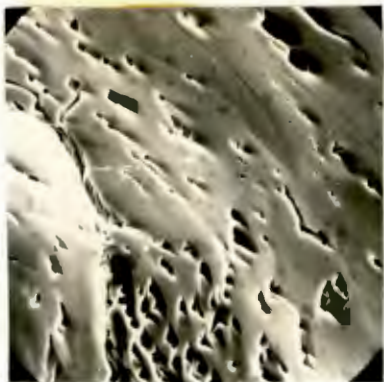
Polished mounts of microilmenite from kimberlite
varying from angular to rounded with character-
istic black colour and glassy lustre.
Length across field of view = 20 mm.

COLOUR PLATE F



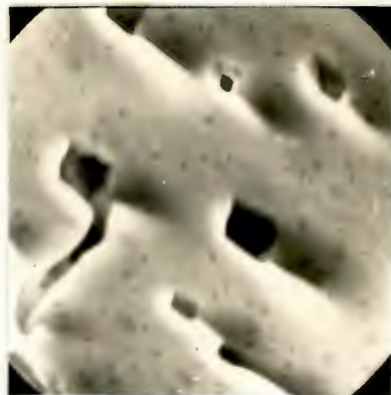
Polished mounts of bright emerald green
chrome diopside from kimberlite
Length across field of view = 15 mm.

Plate 1



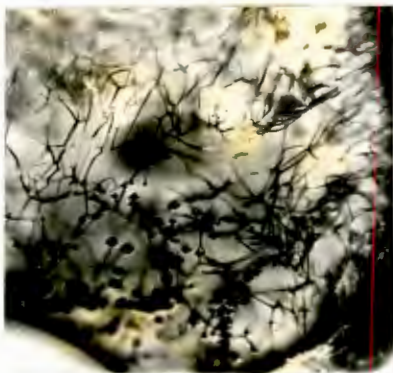
Square-shaped trichitic cavities coalescing to form branching grooves and hairlike cracks (SEM x 100, Grain 21, BH15/4, 60 m Jwaneng Mine, Botswana)

Plate 2



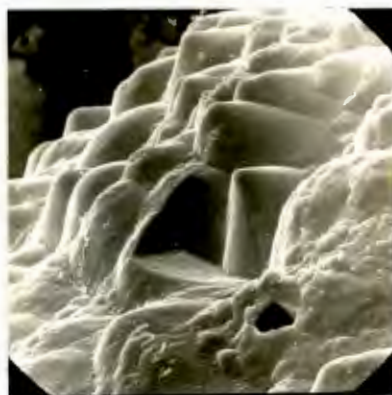
Square-shaped pits or openings to trichitic cavities (SEM x 4300).

Plate 3



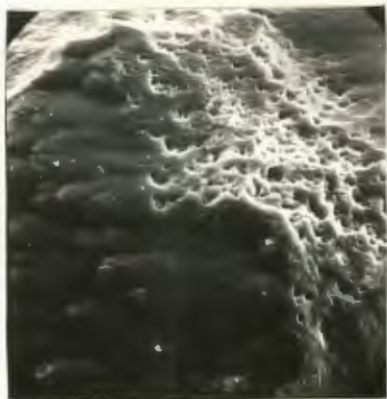
Irregularly shaped trichitic cavities penetrating towards the centre of a kimberlitic garnet. (Transmitted light, in immersion oil x 70).

Plate 4



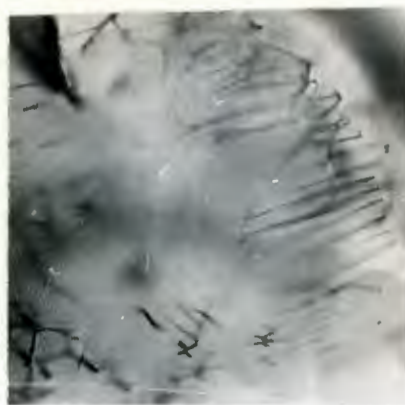
A single trichitic cavity developed on a hummocky surface (SEM x 937)

Plate 5



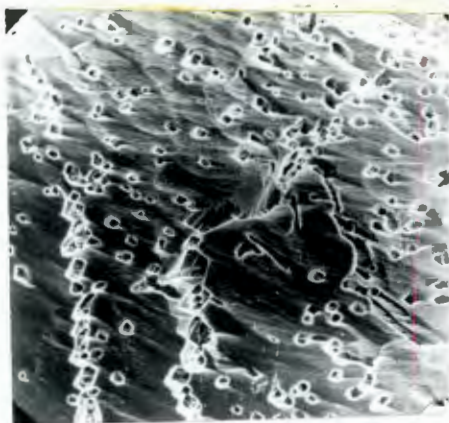
Trichitic cavities superimposed on sculptured surface on mauve garnet. (SEM x 1600, Grain No. 1, BH15/4 30m, Jwaneng Mine, Botswana).

Plate 6



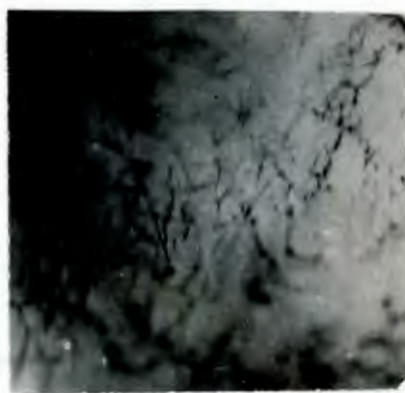
Straight, curved and branching trichitic tunnels penetrating in towards the centre of garnet grain (Transmitted light x 63, oil immersion).

Plate 7



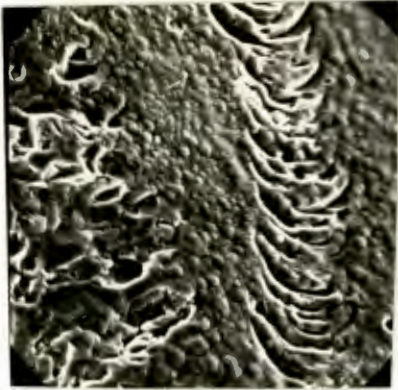
Numerous square to rounded trichitic voids, often concentrated along structural weaknesses (SEM x 268)

Plate 8



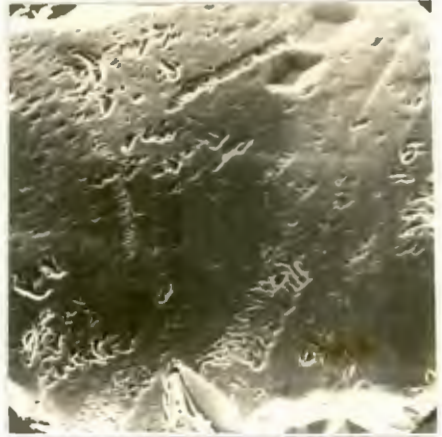
Tangled arrangement of trichitic cavities located along possible sub-grain boundaries within a pyrope grain (Transmitted light x 100 oil immersion).

Plate 9



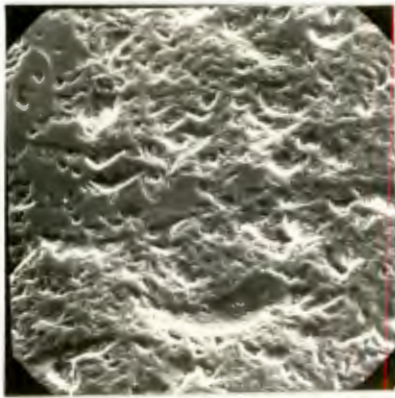
Uniformly spaced arcuate grooves forming chattermark trails superimposed on sculptured surface of a garnet grain (SEM x 750. Grain No. 1 BH/15/15). 70m Jwaneng Mine, Botswana.

Plate 10



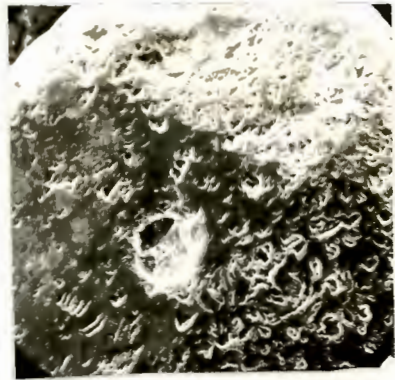
Chattermark trails and small oriented v-shaped diagenetic etch pits, superimposed on a large conchoidal fracture surface of a garnet grain (SEM x 360 Grain No. 4 BH/15/13 50m Jwaneng Mine, Botswana.

Plate 11



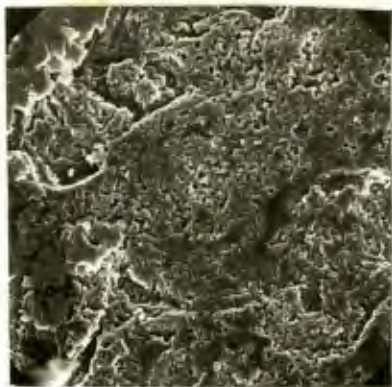
Oriented v-shaped solution pits on an orange garnet (SEM x 900, Grain No. 4 BH/15/13, 50 m, Jwaneng Mine, Botswana).

Plate 12



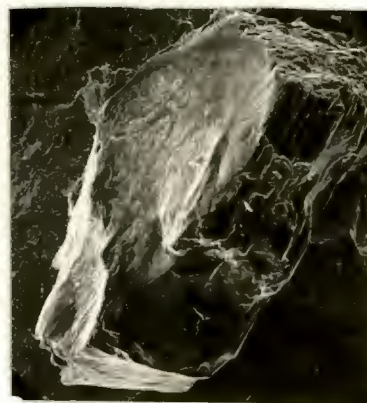
Small oriented v-shaped diagenetic etch pits and rows of arcuate grooves, superimposed on a large scale conchoidal fracture surface on a sub-rounded garnet grain (SEM x 225, Grain No. 9, Sample LS 873, White Cliffs, New South Wales, Australia).

Plate 13



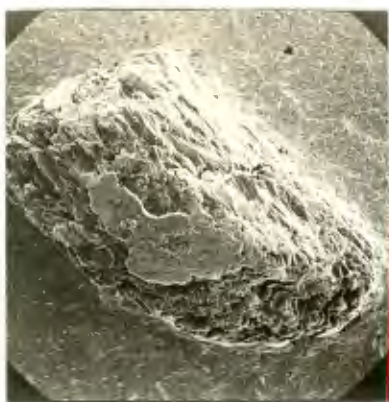
Irregular pattern of etch pits and grooves superimposed on conchoidal fractures on ilmenite (SEM x 750, Grain No. 11, BH 15/4, 40 m, Jwaneng Mine, Botswana).

Plate 14



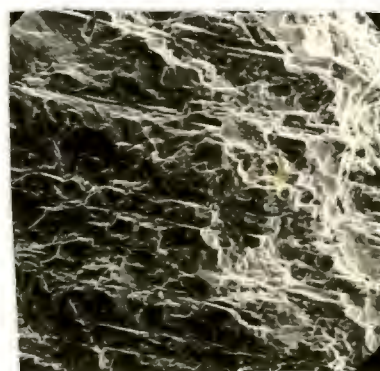
Angular chrome diopside with superimposed incipient diagenetic etching on conchoidal fracture and along cleavage planes (SEM x 150, Grain 23, BH 15/4, 60 m. Jwaneng Mine, Botswana).

Plate 15



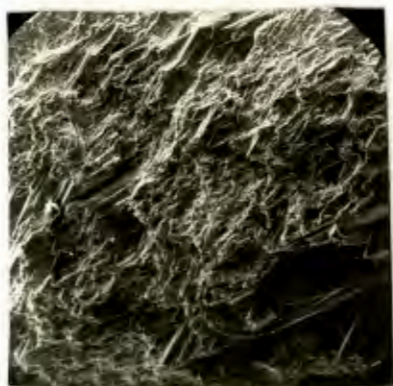
Whitish green chrome diopside, exhibiting pitted etched surfaces with irregular cracks and hollows due to diagenetic etching. Also partly coated by montmorillonite clays, which also fill cracks. (SEM x 43, Grain No. 6, BH15/5, 90m, Jwaneng Mine, Botswana).

Plate 16



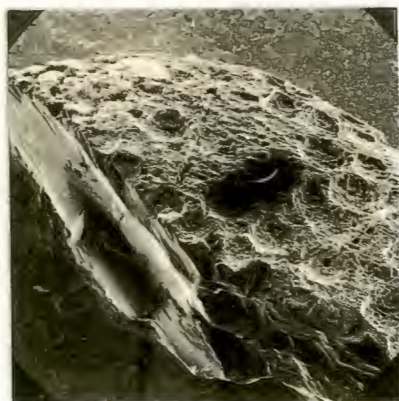
Partly decomposed chrome diopside with diagenetic etching concentrated along cleavage planes (SEM x 390, Grain No. 49, BH15/4, 130 m, Jwaneng Mine, Botswana).

Plate 17



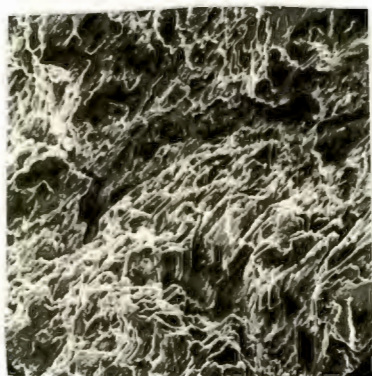
Progressive replacement of sculptured features (cockscomb terminations) by diagenetic etching on a chrome diopside grain (SEM x 160, Grain No. 48, BH15/4, 130m, Jwaneng Mine, Botswana).

Plate 18



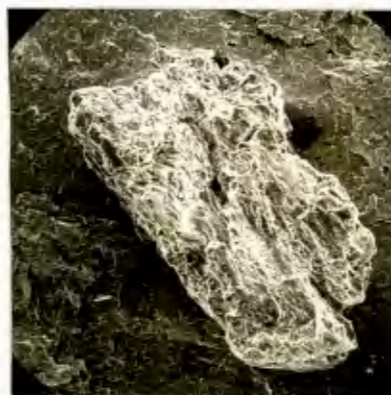
Dish shaped hollows forming fluted surfaces on chrome diopside grain. At top left of photograph the hollows are filled with montmorillonite clays (SEM x 43, Grain No. 7, BH15/5, 100m, Jwaneng Mine, Botswana).

Plate 19



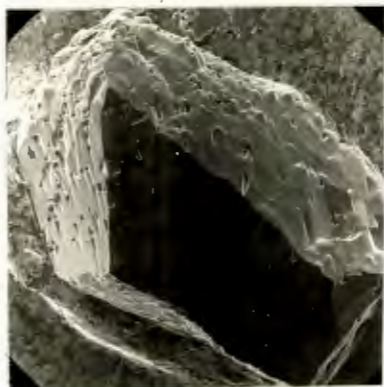
Diagenetically etched surface of chrome diopside with irregular hollows penetrating deep into grain. (SEM x 360, Grain No: 32, BH15/4, 80 m, Jwaneng Mine, Botswana).

Plate 20



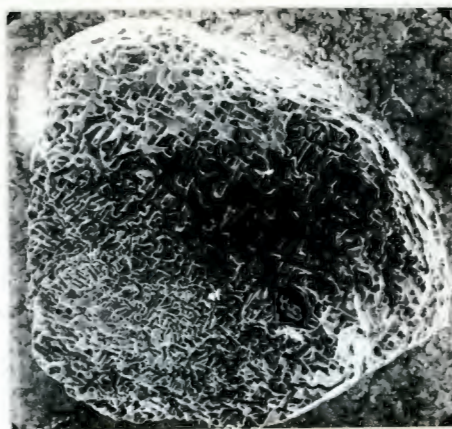
Extensively corroded chrome diopside grain showing irregular outline and maze of small pits resulting in loss of colour. (SEM x 110, Grain No. 32, BH15/4 80m, Jwaneng Mine, Botswana).

Plate 21



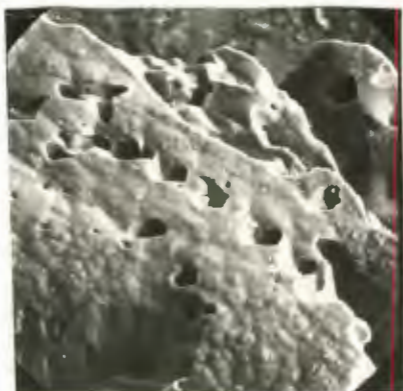
Cuboid-shaped garnet grain, exhibiting sculptured surfaces (SEM x 162, Grain No. 33, Sample AEJ 314, Dullstroom Kimberlite Fissure).

Plate 22



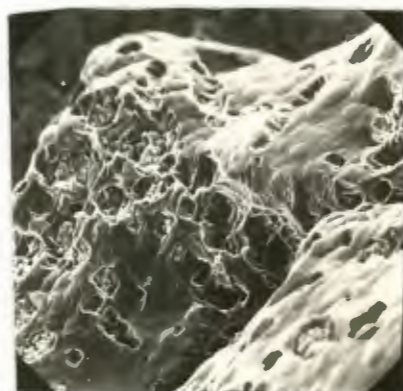
Kimberlitic garnet, displaying honeycomb textures, composed of a maze of oriented solution pits enlarged trichitic cavities and interconnecting hollows SEM x 81, Dullstroom Kimberlite Fissure.

Plate 23



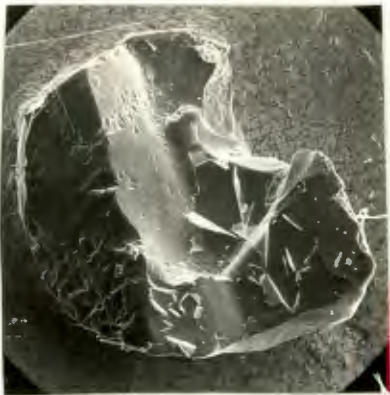
Enlarged trichitic cavities and irregularly shaped hollows concentrated along zones of weakness in the garnet grain (SEM x 360, Grain No. 27, Sample AHP 004 Montrose No. 3 kimberlite pipe).

Plate 24



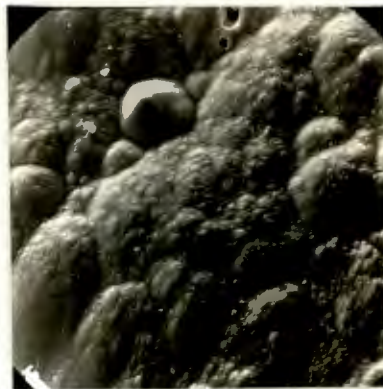
Alignment and coalescence of solution pits and deep crevasse-like hollows, forming at the expense of sculptured surfaces. (SEM x 330, Grain No. 1, Sample AHP 001, Montrose No. 3 Kimberlite pipe).

Plate 25



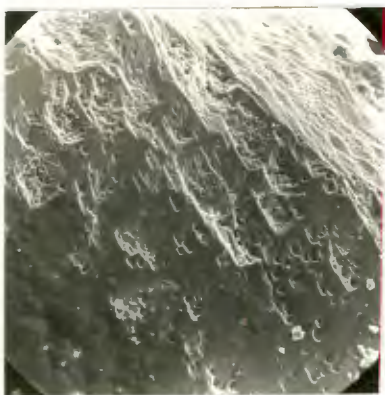
Angular mauve garnet grain, with remnants of sculptured surfaces, and superimposed diagenetic etch pits and anastomosing grooves on broken surfaces (SEM x 40, Grain No. 6, Sample AEJ 304, Dullstroom Kimberlite Fissure).

Plate 26



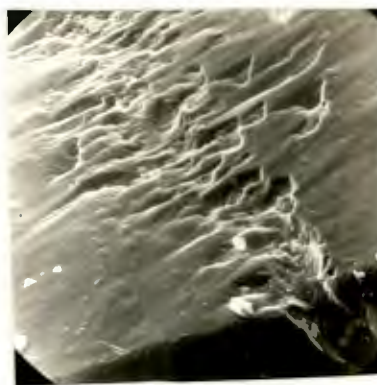
A series of smaller hillocks developed on larger ones. (SEM x 562, Grain No. 18, Sample AEJ 310, Dullstroom Kimberlite Fissure).

Plate 27



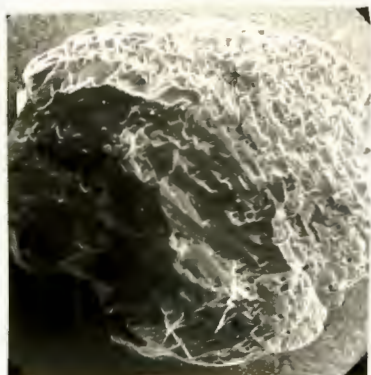
As etching proceeds trichitic cavities become larger and coalesce forming solution cavities. (SEM x 225, Grain No. 2, Sample AEJ 302 Dullstroom Kimberlite Fissure).

Plate 28



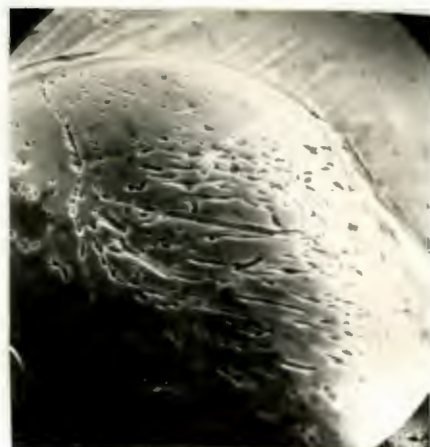
Coalescing of solution pits, concentrated along zones of weakness in the garnet crystals, gives rise to the formation of anastomosing grooves. (SEM x 268, Grain No. 6, Sample AEJ 304, Dullstroom Kimberlite Fissure).

Plate 29



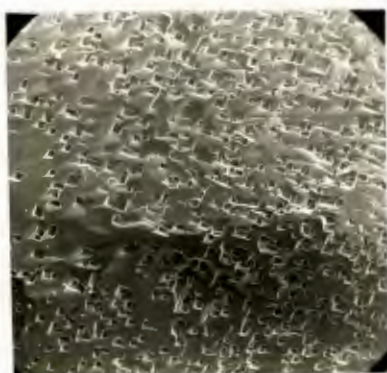
Partly corroded garnet grain, with a small portion of the original surface, surrounded by numerous solution cavities. (SEM x 268, Grain No. 36, Sample AEJ 316)

Plate 30



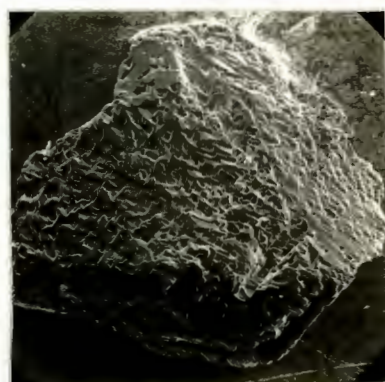
High concentration of trichitic cavities, results in the garnet surface having a milky appearance. (SEM x 375 AEJ. 312, Dullstroom Kimberlite Fissure).

Plate 31



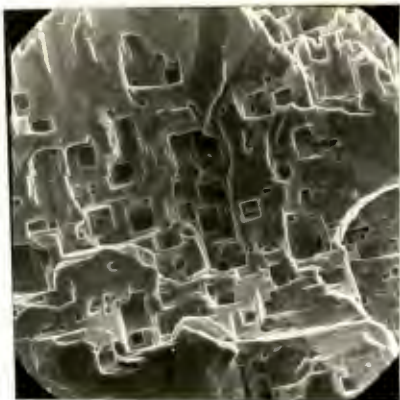
A high concentration of cavities gives the garnet surface a milky appearance (SEM x 500, Grain No. 43, Sample AEJ 317)

Plate 32



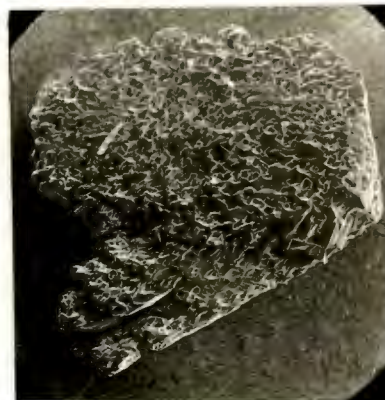
Coarse sugary etched surfaces, with only a small portion of the original surface preserved on the grain (SEM x 375, Grain No. 12, Sample AEJ 307)

Plate 33



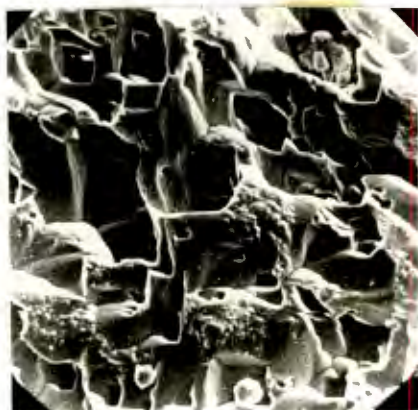
Masses of square shaped solution pits, having a strong preferred orientation. (SEM x 268, Grain No. 4, Sample AEJ 303).

Plate 34



Extensively dissolved garnet grain with a maze of hollows and pits, forming a honeycomb texture. (SEM x 268, Grain No. 23, Sample AEJ 312, Dullstroom Kimberlite Fissure).

Plate 35



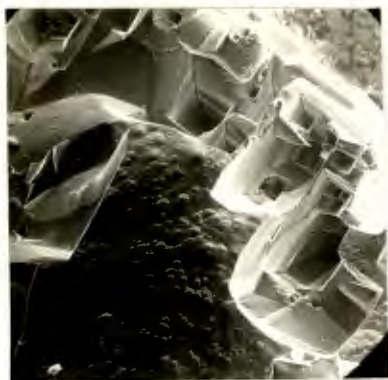
Small perched relics of the original surfaces surrounded by extensive development of solution pits (SEM x 225, Grain No. 13, Sample AEJ 308, Dullstroom Kimberlite Fissure).

Plate 36



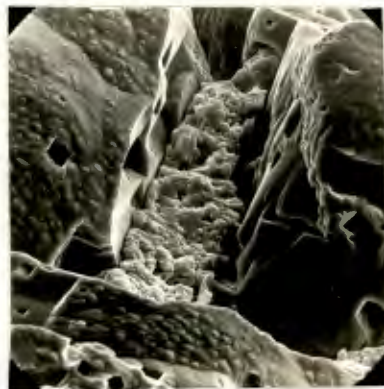
Extensively corroded mauve garnet grain partly dissolved by diagenetic etching (SEM x 206, Grain No. 44, Sample AEJ 317, Dullstroom Kimberlite Fissure).

Plate 37



Extremely coarse square shaped etch pits, penetrating deep into the centre of a mauve garnet grain, from the ferricrete horizon (SEM x 93, Grain No. 16, Sample AEJ 310, Dullstroom Kimberlite Fissure).

Plate 38



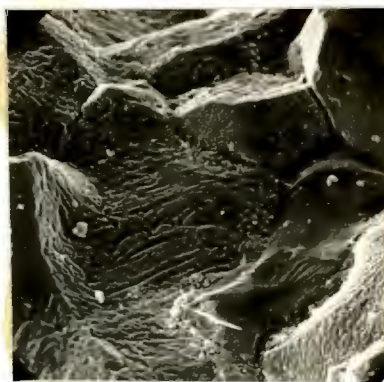
Deep hollows and cavities in a pink garnet grain filled with clay material. (SEM x 500, Grain No. 5, Sample AEJ 303, Dullstroom Kimberlite Fissure).

Plate 39



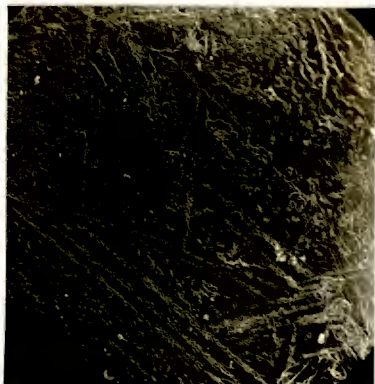
Composite ilmenite grain, with individual crystal faces, exhibiting small round etch pits, giving the surface a fine stippled appearance. (SEM x 270, Grain No. 18, Sample AHP 003, Montrose No. Kimberlite pipe).

Plate 40



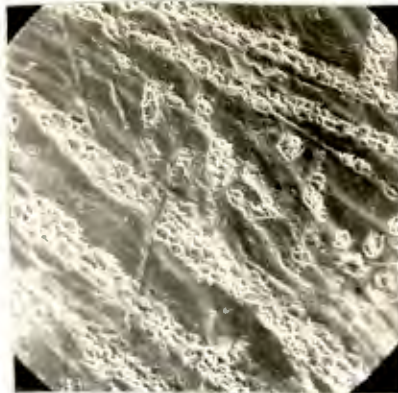
Sub-parallel sinuous grooves developed on a polycrystalline ilmenite grain, modified by diagenetic etching. (SEM x 300, Grain No. 7, Sample AHP 001, Montrose No. 3 Kimberlite Pipe).

Plate 41



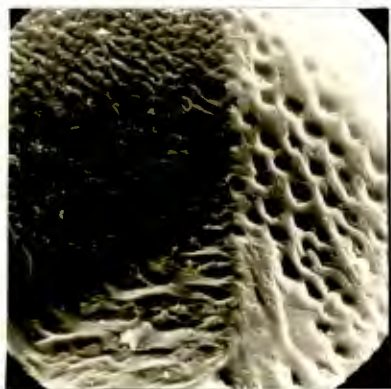
Oval etch pits and randomly oriented etch striations exposing hematite exsolution lamellae (SEM x 60, Grain No. 29, Zarnitsa pipe, U.S.S.R.).

Plate 42



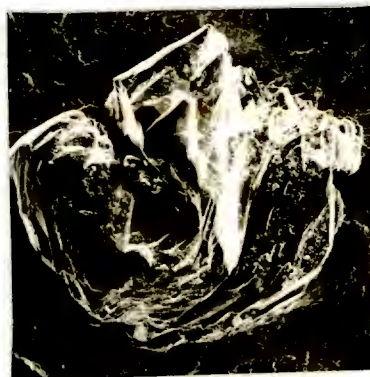
Preferential etching along exsolution lamellae (hematite?) on conchoidal fracture surface on ilmenite (SEM x 300, Grain No. 29, Zarnitsa pipe, U.S.S.R.).

Plate 43



Preferential dissolution of exsolution lamellae, forming striated grooves on surfaces parallel to lamellae and oval pits on surfaces at right angles to the lamellae (SEM x 1800, Grain No.1 Lusu, Zambia).

Plate 44



Angular chrome diopside grain exhibiting original surfaces, consisting of pointed hacksaw terminations. Note large cavernous hollow and small etch pits developed in centre of grain (SEM x 50, Grain No. 17 AHP 010, Montrose No. 3, Kimberlite Pipe)

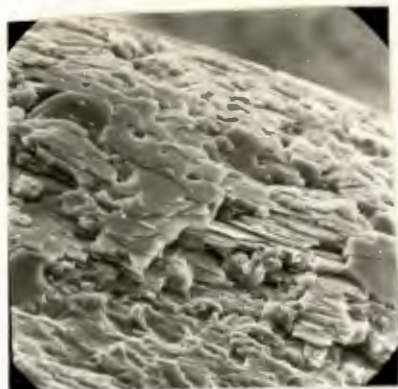
Plate 45



Subrounded extensively corroded chrome diopside grain, displaying a microscaly appearance, and is pale greenish-white in colour. (SEM x 110, Grain No. 18, Sample AHP 010, Montrose No. 3 Kimberlite Pipe).

University of Cape Town

Plate 46



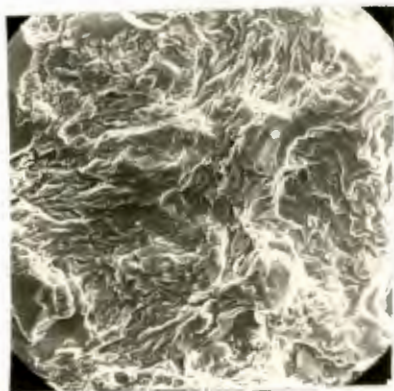
Platy development of phlogopite often associated with kelyphite crusts surrounding pyrope grains (SEM x 425 - Koffyfontein South Africa)

Plate 47



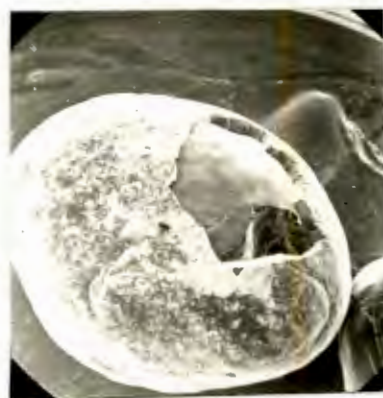
Kelyphite crust (K) consisting of radial pyroxene crystallites + spinel, with superimposed platy phlogopite (P) on a rounded garnet (SEM x 150 - Koffyfontein South Africa)

Plate 50

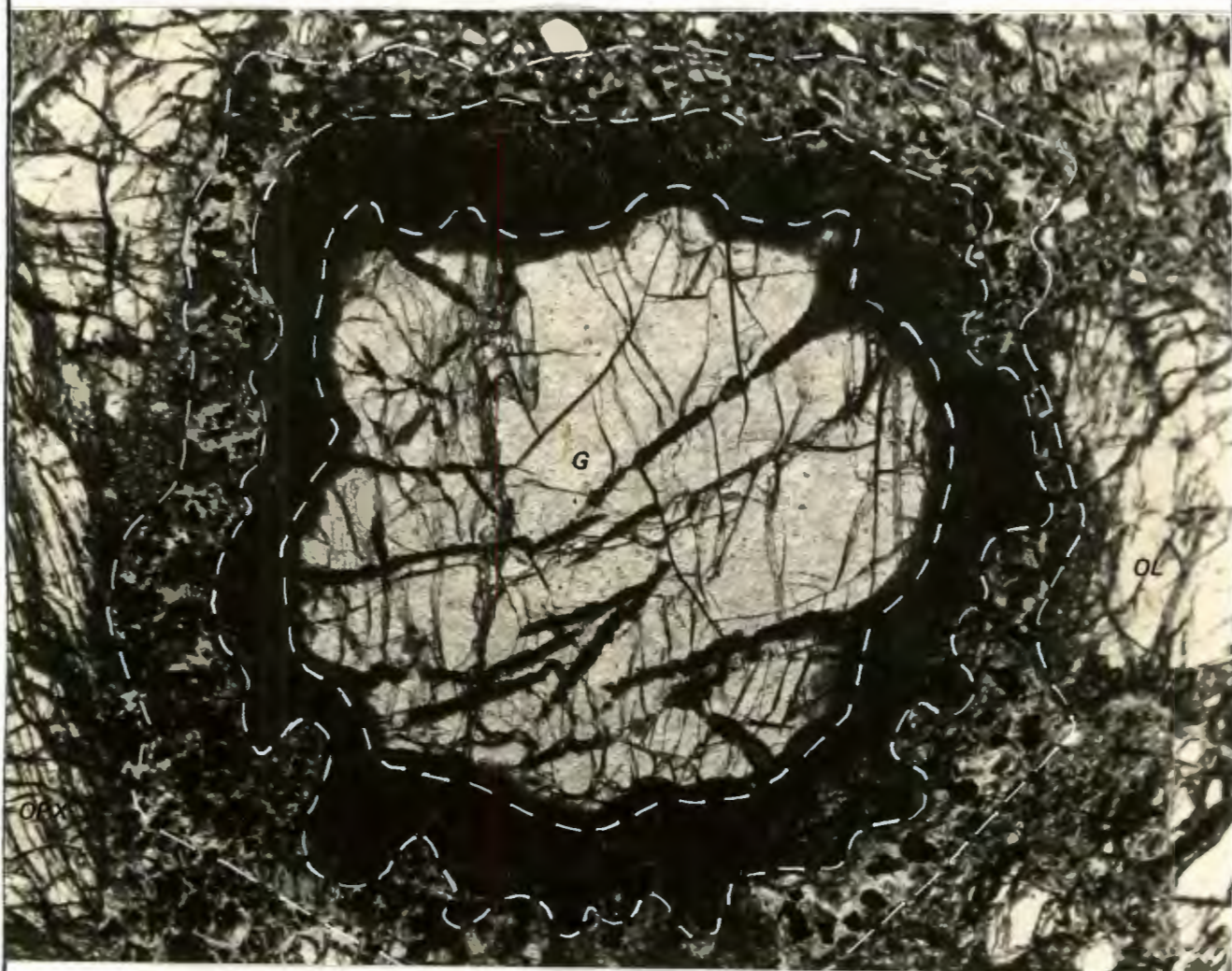


Contorted flaky impressions on the subkelyphitic surface of an orange garnet enclosed by kelyphite rich in phlogopite (SEM x 187, Grain No. 18, Zarnitsa pipe U.S.S.R.).

Plate 51

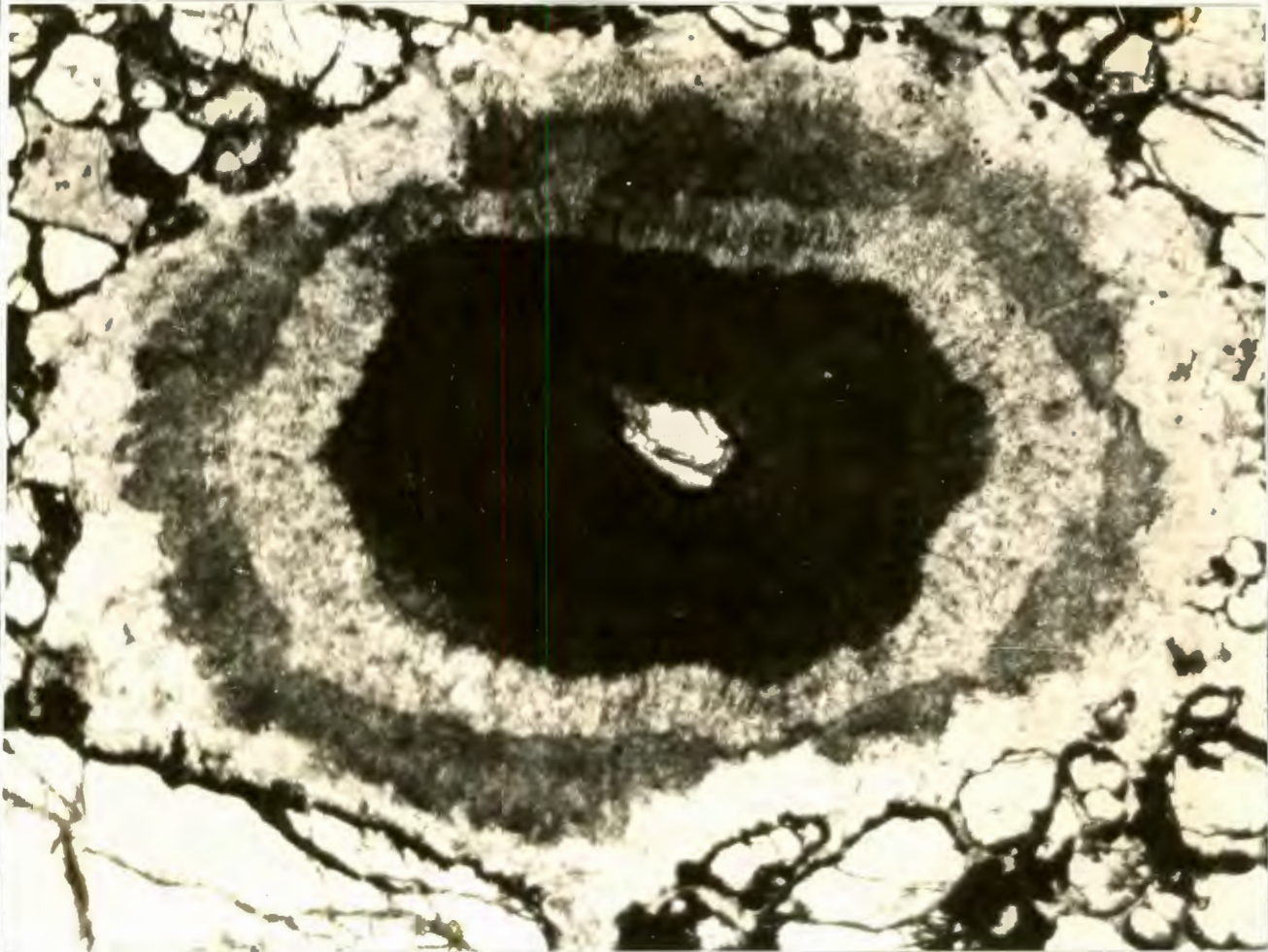


Kelyphite encrusted garnet, with portion of the kelyphite crust removed, exposing a smooth finely stippled surface. (SEM x 11 - Newlands Mine - South Africa).



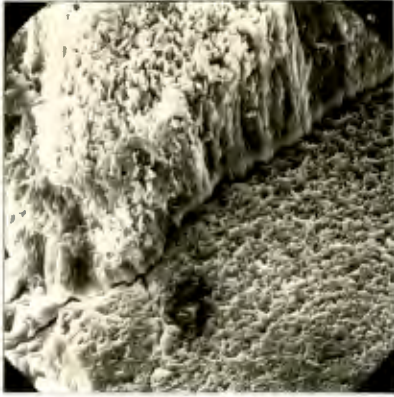
Photomicrograph of a kelyphite-encrusted garnet in a lherzolite nodule from Premier Mine, South Africa.

In thin section the garnet, which is surrounded by a kelyphite shell about 1.0 mm thick exhibits a sharp contact between the kelyphite and the groundmass. The latter is composed of orthopyroxene (opx) and olivine (ol). Prior to alteration the garnet was probably of an irregular shape, and was extensively cracked before or during kelyphitisation. These cracks are now filled with kelyphite composed mainly of orthopyroxene and spinel. These cracks display various local preferred orientations. The junction between the kelyphite and garnet surface is always sharp. Three zones can be recognised in the kelyphite shell. (magnification 250 x)



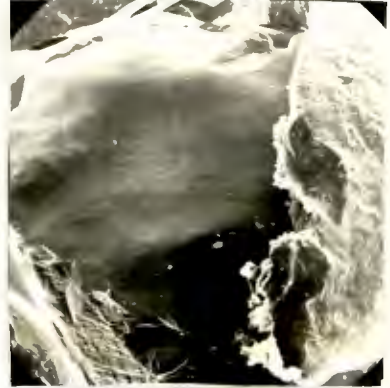
An extensively kelyphitised garnet in a garnet peridotite nodule from Premier Mine. A minute residual core or kernel of garnet is preserved in the kelyphite knot. The extremely thick shell of kelyphite (approximately 2 mm wide) is composed of numerous zones of orthopyroxene and phlogopite, with disseminated specks of chromite and accessory clinopyroxene. (Magnification 400 x)

Plate 52



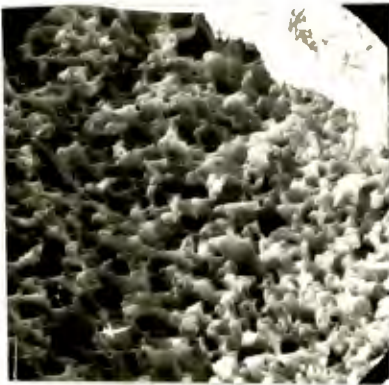
Radially structured kelyphite and exposed finely pitted sub-kelyphitic surface on orange garnet (SEM x 1000 Grain No. 29, BH15/4, 80m Jwaneng Mine, Botswana).

Plate 53



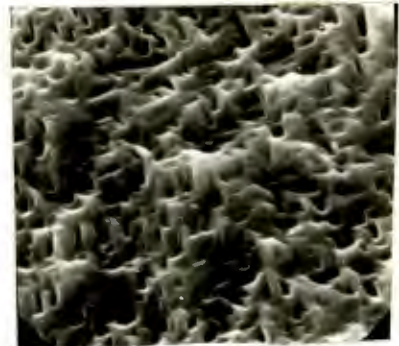
Finely stippled sub-kelyphitic surface, giving the garnet grain a matte appearance (SEM x 53 - Newlands Mine, South Africa).

Plate 54



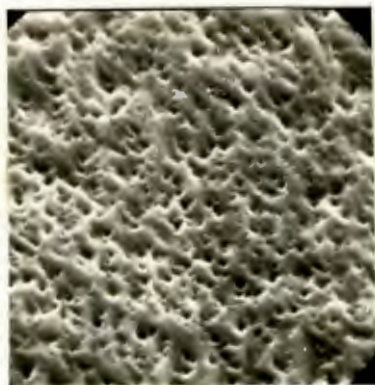
Finely pitted sub-kelyphitic surface on garnet grain, underlying the kelyphite shell at top right of photograph (SEM x 1687 - Newlands Mine, South Africa).

Plate 55



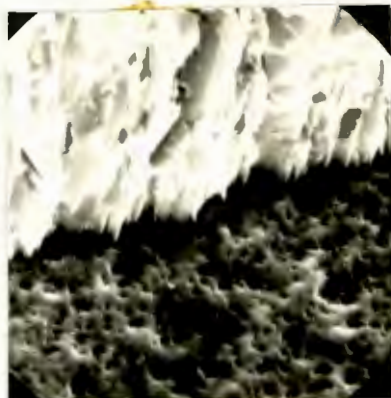
Sub-kelyphitic surface exhibiting numerous square-shaped hollows (SEM x 5625 - Newlands Mine, South Africa).

Plate 56



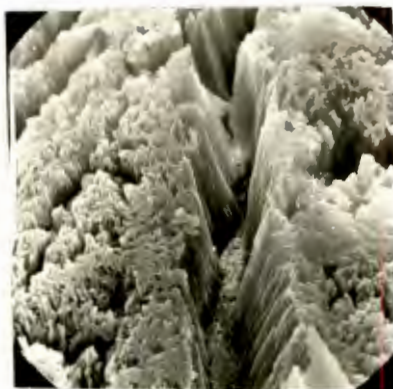
Triangular-shaped hollows, displaying a preferred orientation, on the sub-kelyphitic surface of a pyrope grain (SEM x 3125 - Newlands Mine, South Africa).

Plate 57



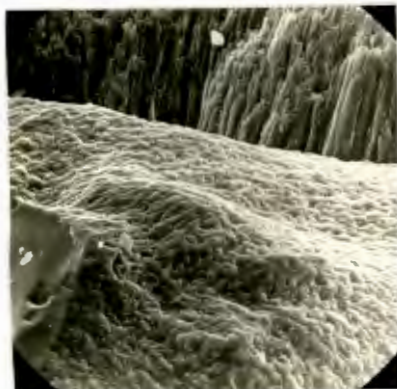
Radially oriented acicular pyroxene crystals penetrating the minute pits developed on the sub-kelyphitic surface on a garnet grain (SEM x 2437 - Newlands Mine, South Africa).

Plate 58



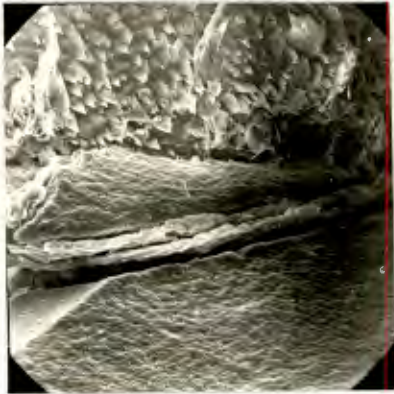
Acicular pyroxene crystals forming kelyphite crust, developed normal to the garnet surface. (SEM x 1125 - Koffyfontein Mine, South Africa).

Plate 59



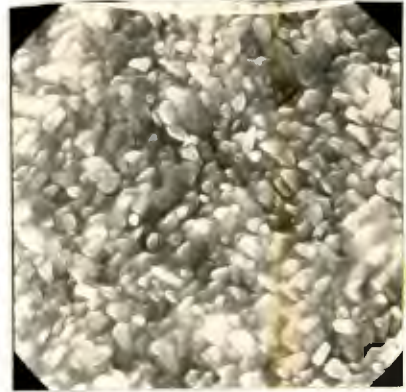
Rough undulating pitted sub-kelyphitic surface with radial structure of kelyphite crusts at top of field of view. (SEM x 343 - Wesselton Mine, South Africa).

Plate 60



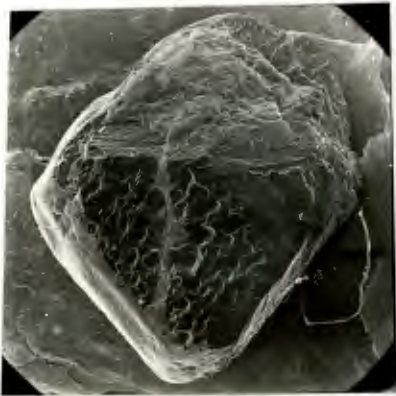
Portion of kelyphite crust peeled off revealing sharp pointed roots of acicular pyroxene crystals and pitted underlying garnet surface (SEM x 500 - Russia locality unknown).

Plate 61



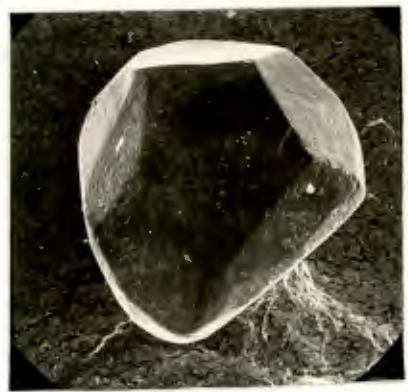
High magnification of the underside of a portion of kelyphite shell exhibiting masses of tiny rod-like crystals (SEM x 4687 - Newlands Mine, South Africa).

Plate 62



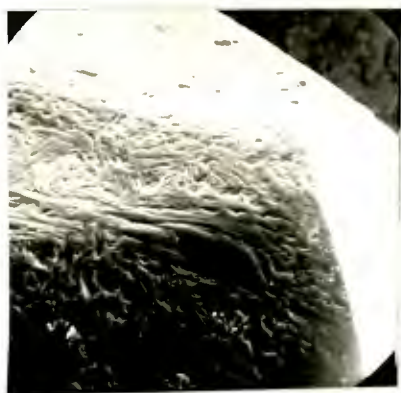
Kelyphite encrusted octahedral-shaped garnet from Premier Mine, South Africa (SEM x 26)

Plate 63



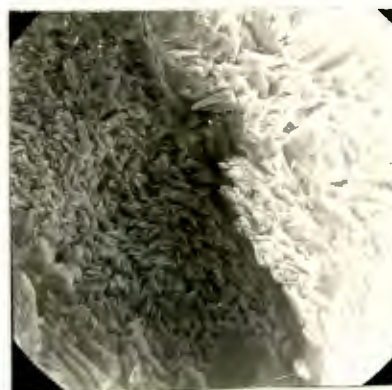
Euhedral garnets exhibiting finely pitted surfaces (SEM x 63 Kimberlite from Van Zyl's Rust area, N. Cape Province).

Plate 64



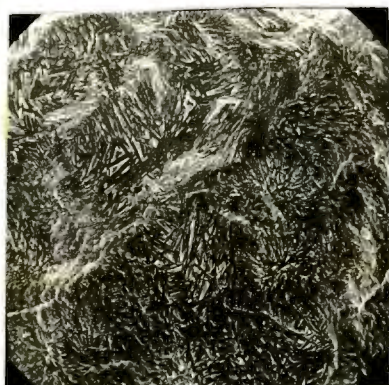
Sub-kelyphitic surface on a euhedral garnet grain, comprised of randomly intersecting, rod-like moulds of acicular pyroxene crystals (SEM x 938, Kimberlite in Van Zyl's Rust area, N. Cape Province).

Plate 65



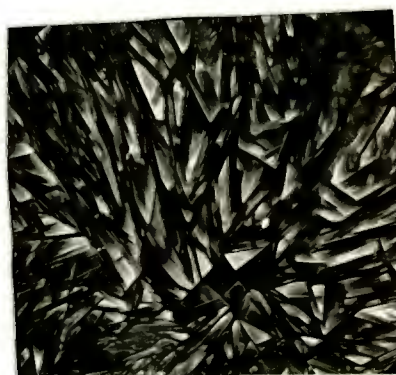
Irregular development of kelyphite crust with random orientation of pyroxene crystals (SEM x 500 - Liphobong, Lesotho).

Plate 66



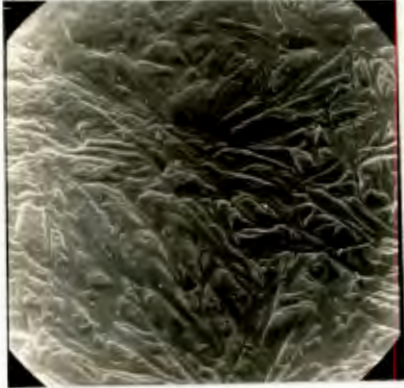
Rough sub-kelyphitic surface on a garnet, with an acicular-like texture (SEM x 112 Premier Mine, South Africa).

Plate 67



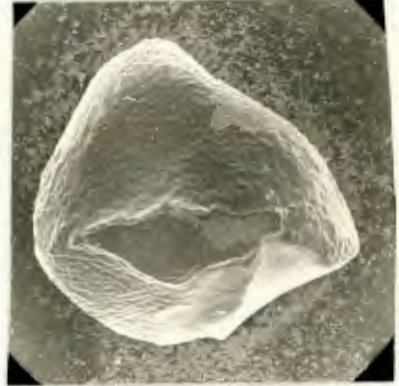
Randomly oriented and intersecting rod-like impression of the acicular pyroxene crystals forming geometric patterns on the sub-kelyphite surface (SEM x 812 - Premier Mine, South Africa).

Plate 68



Pattern developed on sub-kelyphitic surface on a garnet, underlying tangentially structured kelyphite coatings. (SEM x 300 - Finsch Mine, South Africa).

Plate 69



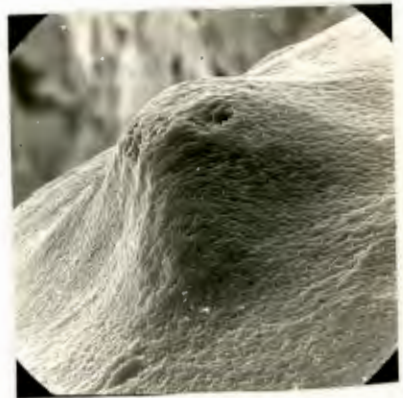
Wrinkled sub-kelyphitic surface on a garnet, with a small portion of kelyphite crust still preserved at top right hand side of grain (SEM x 243 Silcretes Zambia).

Plate 70



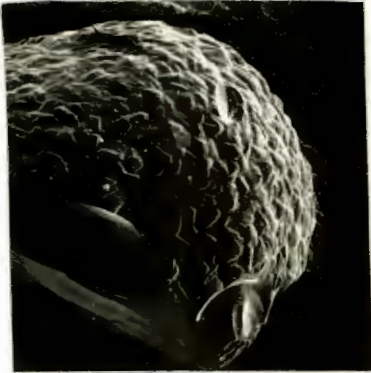
High magnification of garnet in Plate 24, showing wrinkled sub-kelyphitic surface, consisting of sharp smooth meandering ridges and pitted depressions adjacent to kelyphite coating. (SEM x 500 Silcretes Zambia).

Plate 71



Blocky humps on sub-kelyphitic surface of a garnet grain, with superimposed finely pitted surface (SEM x 468 - Noozies district - Kenhardt, South Africa).

Plate 72



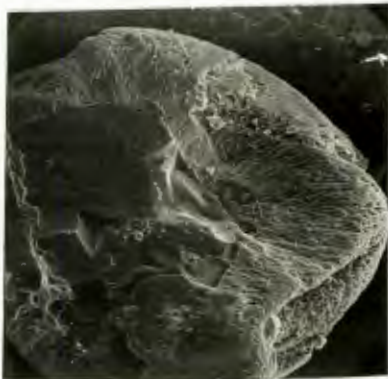
Well rounded mauve garnet displaying peculiar lumpy sub-kelyphitic surface (SEM x 24, Grain No. 5, BH 15/4 40m Jwaneng Mine, Botswana).

Plate 73



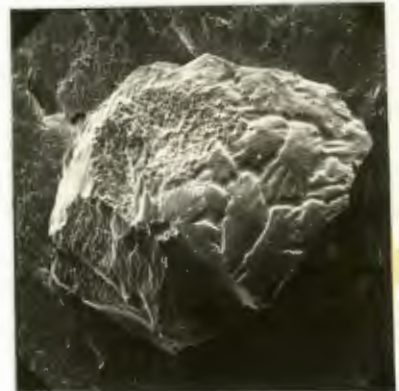
Lumpy sub-kelyphitic surface which is finely pitted due to kelyphite formation normal to garnet surface. (SEM x 187, Grain No. 5, BH 15/4, 40m Jwaneng Mine, Botswana).

Plate 74



Individual irregularities on the garnet surface gives rise to fan shaped radially structured inner shells, whilst the outer zone of kelyphite has a granular appearance (SEM x 1375, Grain No. 12, BH 15/5, 130m Jwaneng Mine, Botswana).

Plate 75



Sub-kelyphitic surface displaying a network of furrows, reminiscent of mudcracks. (SEM x 40, Grain No. 12, BH 15/4 50m Jwaneng Mine, Botswana).

Plate 76



Underside of kelyphite shell showing ridge-like features which occupy furrowed depressions on garnet surface (SEM x 56 Grain No. 4, BH 15/4, 110m Jwaneng Mine, Botswana).

Plate 77



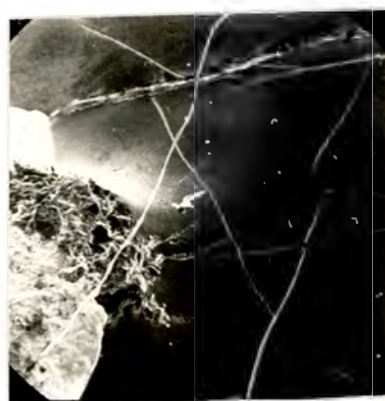
Radiating fan-shaped impressions on domed areas on lumpy sub-kelyphitic surface (SEM x 125, Grain No. 26, Sloan 2, Colorado).

Plate 78



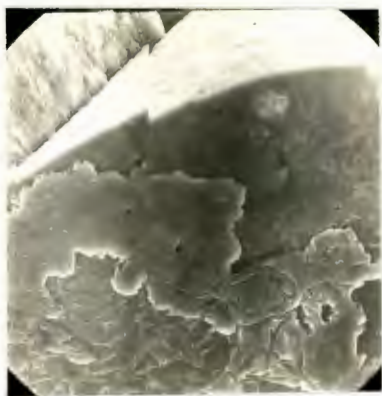
Inner kelyphite shell having a fan shaped aggregated structure, while outer kelyphite layer is granular in appearance (SEM x 24, Grain No.4, BH 15/5, 90m Jwaneng Mine, Botswana).

Plate 79



Thin cracks in garnet, filled with kelyphite, randomly traversing the sub-kelyphitic surface (SEMx 31 Massif 5, Zaire).

Plate 80



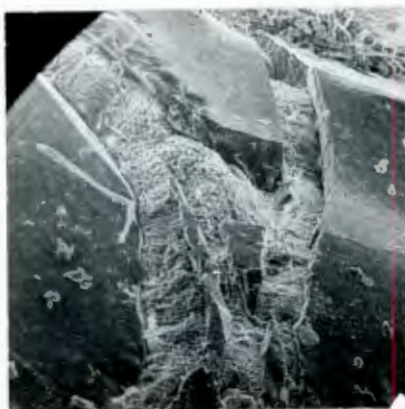
Thin layer of kelyphite developed in a crack in the garnet grain, exhibiting a random criss cross pattern. Note radially structured kelyphite shell at top right corner of photograph. (SEM x 500 - Colossus pipe, Rhodesia).

Plate 81



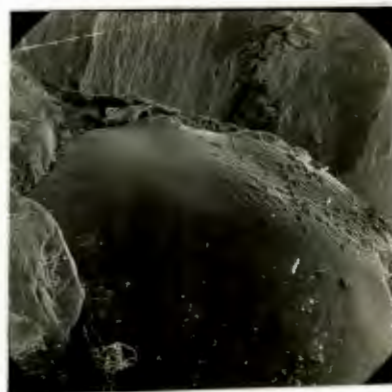
Randomly oriented mesh-like development of kelyphite, filling thin cracks in a garnet grain. (SEM x 500 - Colossus pipe, Rhodesia).

Plate 82



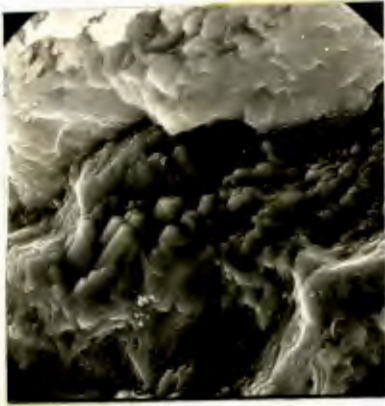
Asbestiform structured kelyphite, filling cracks in a garnet grain (SEM x 250 - Bellsbank fissure, South Africa).

Plate 83



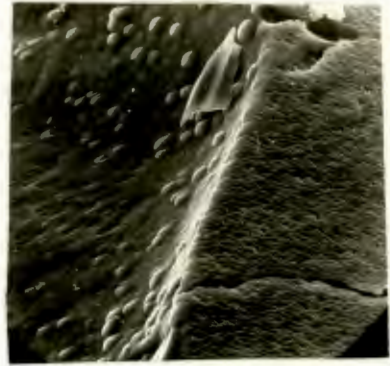
Sculptured features (conical hillocks) surrounded by finely pitted sub-kelyphitic surface adjacent to thick kelyphite crust on a garnet grain (SEM x 24 Bellsbank fissure, South Africa).

Plate 84



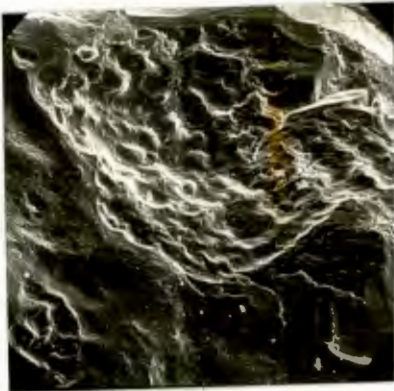
Imbricate wedge markings, adjacent to the protective kelyphite coating. These etch features are formed as a result of etching of exposed garnet surfaces by the kimberlite magma (SEM x 1125 - Kimb. garnet from Dwyka tillite, South Africa).

Plate 85



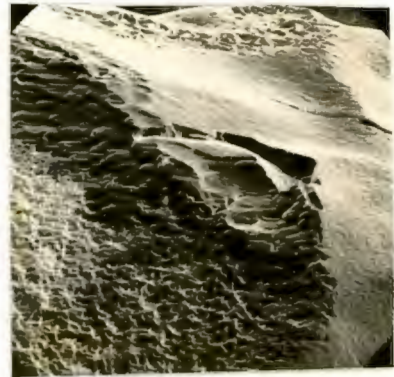
Rounded etch hillocks developed on a conchoidal fracture, which post date the adjacent finely pitted sub-kelyphitic surface (SEM x 562 Monastery Mine, South Africa).

Plate 86



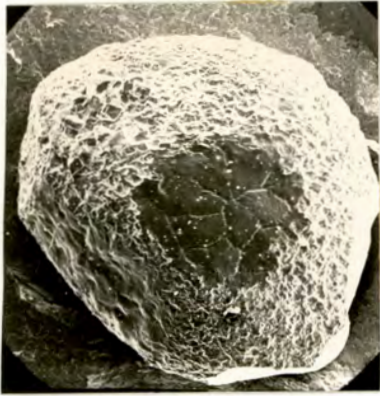
Exposed finely pitted sub-kelyphitic surface with sculptured features (hillocks, etch pits and imbricate wedge markings) in early stage of development in depressions (SEM x 187 Grain No. 1, BH 15/4, 30m Jwaneng Mine, Botswana).

Plate 87



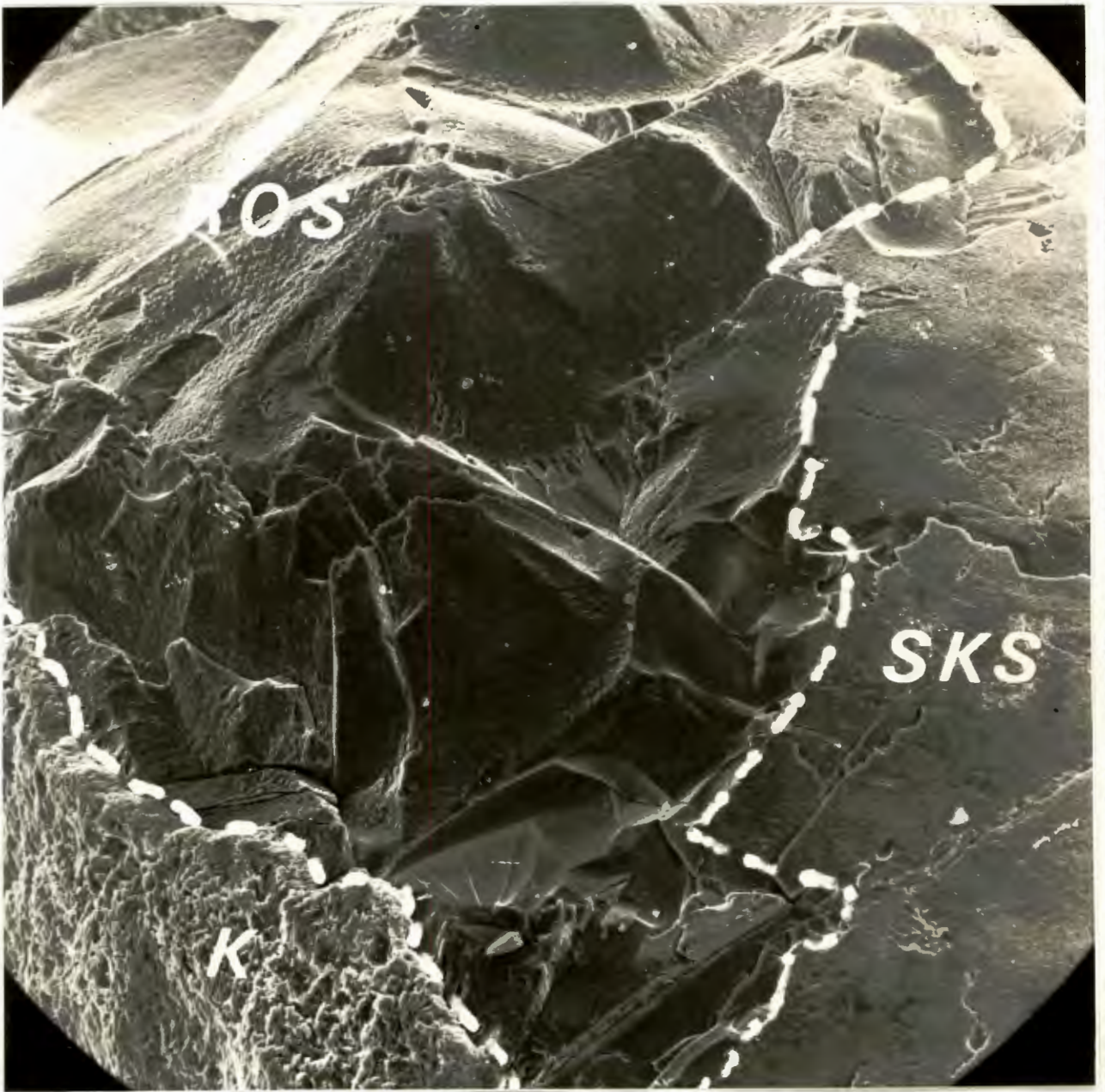
Crystallographically controlled sculptured features forming at expense of exposed finely pitted sub-kelyphitic surface (SEM x 206 Grain No. 14, BH 15/4, 50m Jwaneng Mine, Botswana).

Plate 88



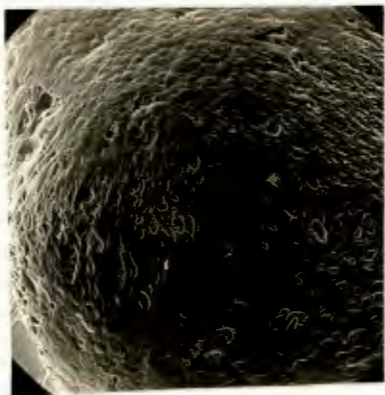
Well rounded mauve garnet, exhibiting initial development of sculptured features, surrounding relic of lumpy sub-kelyphitic surface (SEM x 37, Grain No. 20, BH 15/4, 60m Jwaneng Mine, Botswana).

University of Cape Town



Fragmentation and scouring off of the kelyphite crust (K) exposes the sub-kelyphitic surface (SKS) and freshly broken conchoidal fractures on the garnet to the kimberlite magma. This results in the formation of sculptured surfaces (ROS) on the fragmented, broken surfaces and appearance of irregular sinuous grooves on the sub-kelyphitic surfaces (SEM x 68 - Monastery Mine, South Africa).

Plate 90



Sculptured features on well rounded pyrope consisting of combinations of hillocks and etch pits SEM x 75

Plate 91



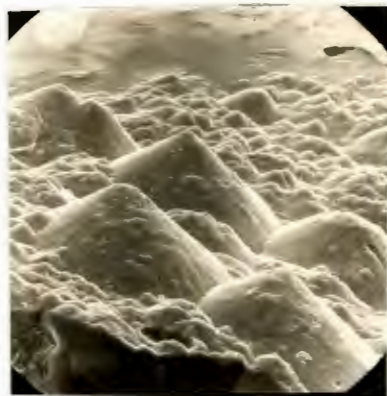
Very fine, flat topped polygonal etch features on artificially etched kimberlite garnet (TEM x 3125).

Plate 92



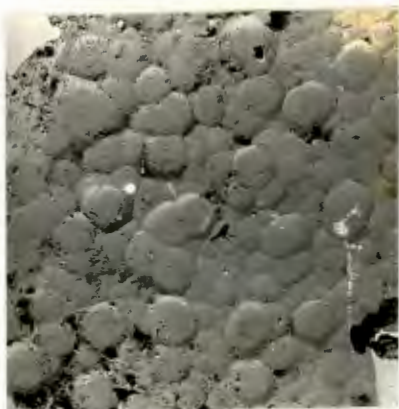
Red garnet with large pyramidal shaped hillocks, sometimes combined with adjacent hillocks in step-like fashion (SEM) x 100, BH 15/11 50m Jwaneng Mine, Botswana).

Plate 93



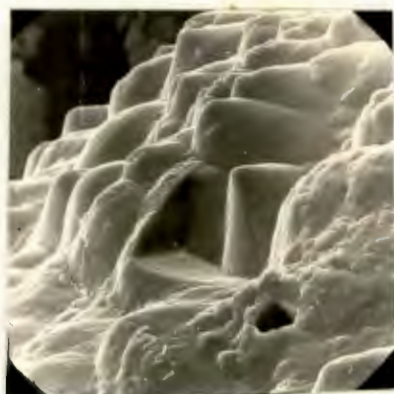
Sharp pointed conical hillocks massed close together, which in some cases coalesce. (SEM x 625) - Zambia.

Plate 94



Drop-like hillocks producing a hummocky surface. (TEM x 850)
- Botswana.

Plate 95



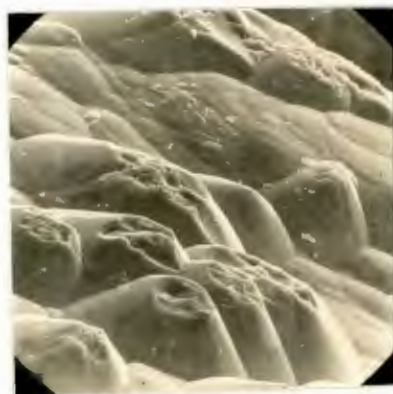
Spherical mounds and conical hillocks forming a mammillary surface on garnet from a Zambian prospecting sample (SEM x 937).

Plate 96



Large pyramidal and steplike hillocks surrounded by masses of small conical hillocks (SEM 300, BH 15/11, 50m Jwaneng Mine, Botswana).

Plate 97



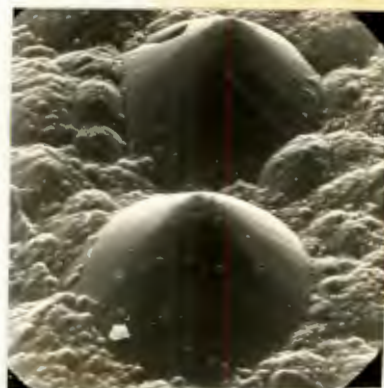
A complicated group of hillocks, some conical, others flat topped, stepped or terraced (SEM x 375), Bells Bank Mine, South Africa.

Plate 98



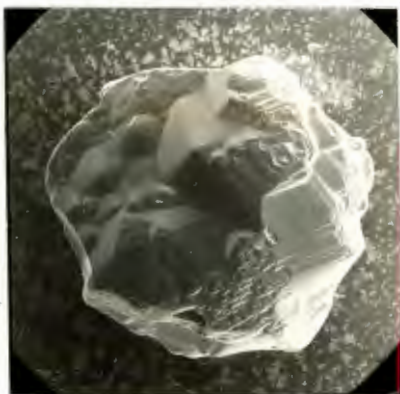
Imbricate wedge markings preferentially developed on dodecahedral surfaces on a mauve garnet from Jwaneng (SEM x 180, BH 15/5 90m).

Plate 99



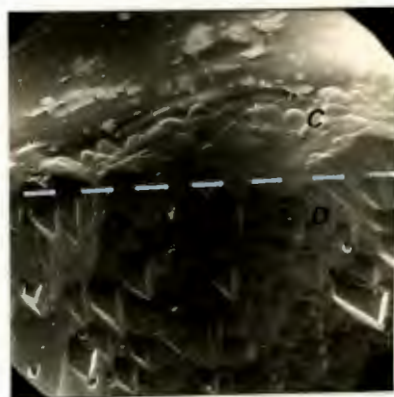
Well developed cones of dissolution on orange garnet from Dullstroom Kimberlite fissure (SEM x 470).

Plate 100



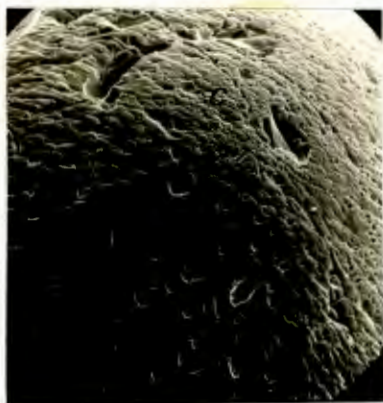
Extremely coarse pyramidal sculptures of octahedral form on pyrope. (SEM x 56) - SWA prospecting sample.

Plate 101



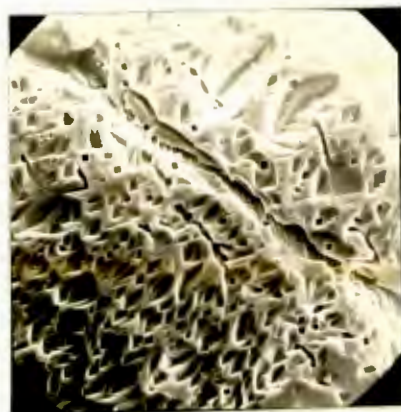
Rhombic-shaped etch pits developed on dodecahedral surface (D), with hillocks on adjacent cube surface (C) (SEM x 187)

Plate 102



Rounded garnet displaying hummocky surface on cube face (C) with rhombic-shaped pits only developed on dodecahedral surface (D) (SEM x 268) Zambia.

Plate 103



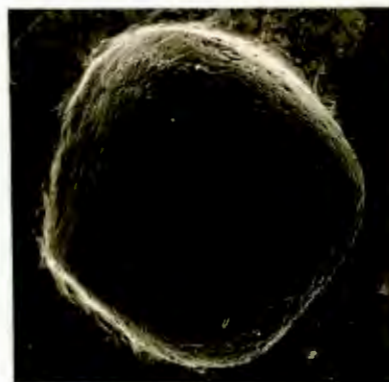
Triangular to rhombic shaped etch pits on the octahedral surface (SEM x 562). Also boat-shaped pits and curved grooves.

Plate 104



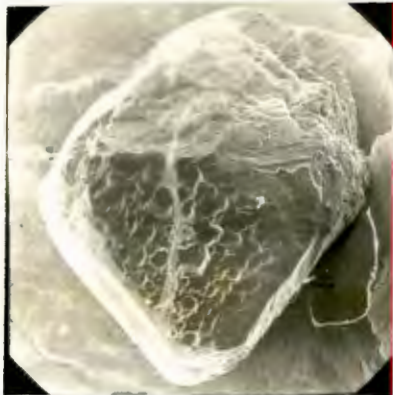
Euhedral non kimberlitic garnet (SEM x 56)

Plate 105



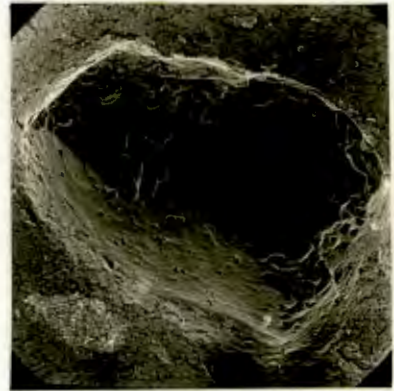
Example of an unbraded kimberlite garnet, having a rounded shape with a pitted matte appearance (SEM x 75)

Plate 106



Kelyphite-encrusted octahedral garnet from Premier Mine, South Africa (SEM x 26)

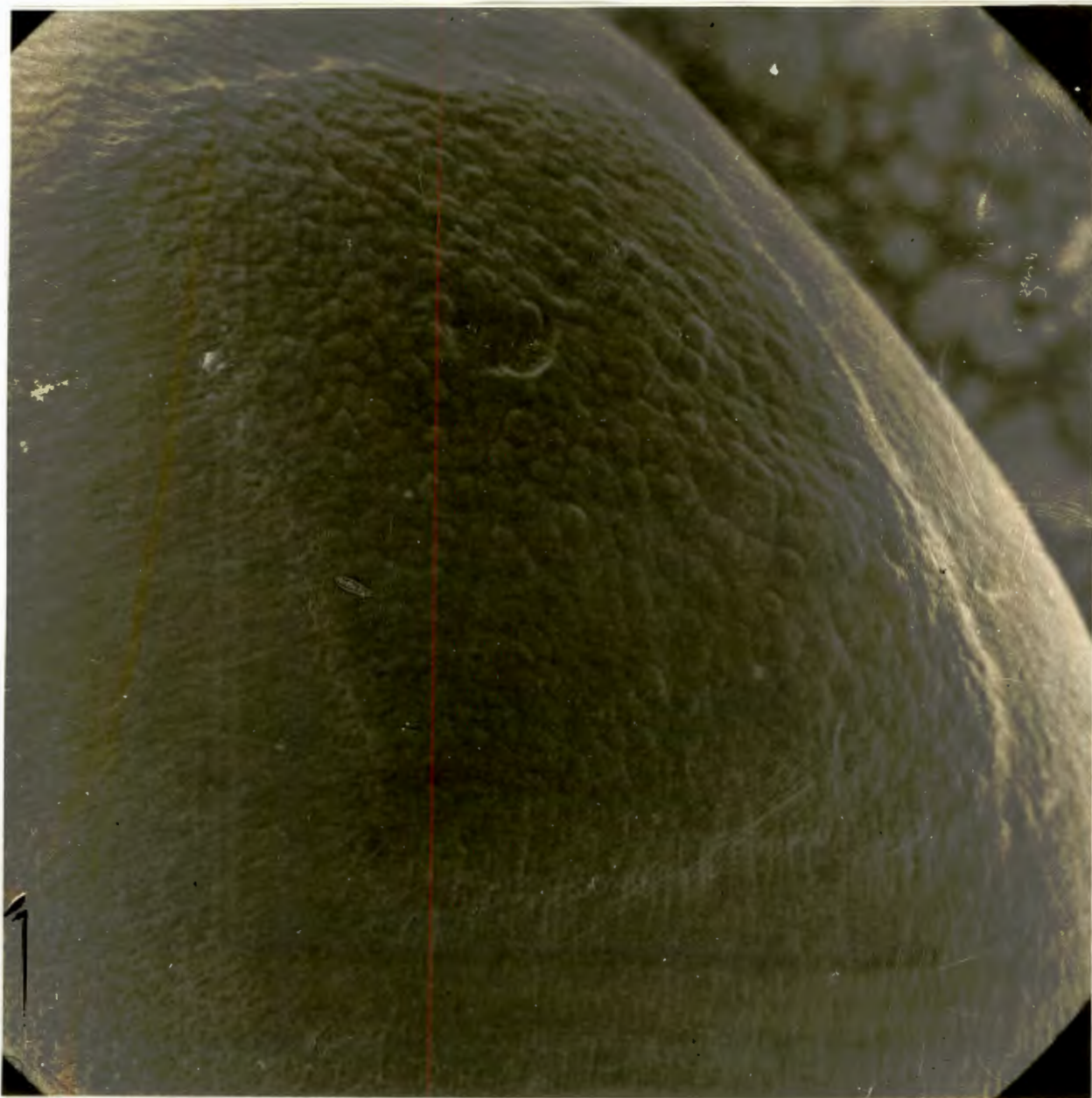
Plate 107



Cuboid shaped kimberlitic garnet, displaying etched surfaces (SEM x 68)

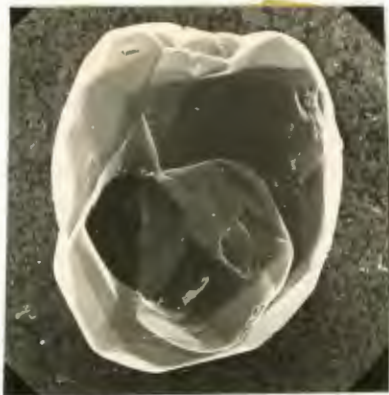


Rounded pyrope grain from Montrose No. 13 kimberlite pipe from the Premier kimberlite province near Pretoria, Transvaal at X 340 magnification. Although nearly spherical, subdued crystal edges and curved surfaces of uniform texture can just be distinguished. The lines drawn on to the photograph show some of the crystal surfaces which can be recognised by utilizing the relationship between surface features and garnet crystallography (ie. rounded hillocks develop on cubic surfaces, rhombic pits on dodecahedral surfaces and triangular pits on octahedral surfaces).



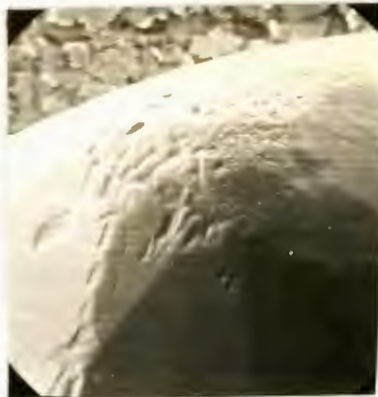
On the other side of the grain the raised, relatively coarsely hillocky, square feature, which escaped the second episode of etching. SEM x 680. K13 Premier satellite pipe, Transvaal.

Plate 110



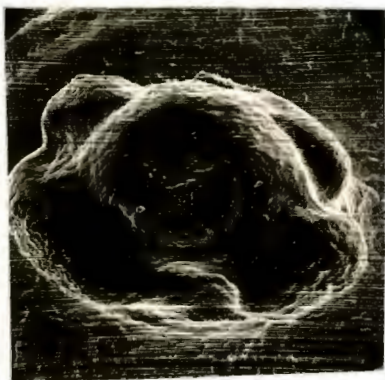
Complex garnet crystal with smooth crystal faces (SEM x 69, kimberlite from Van Zyl's Rust area N. Cape Province).

Plate 111



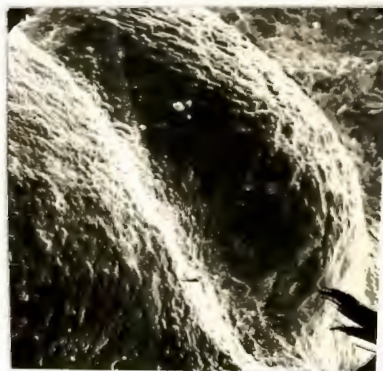
Sculptured surfaces consisting of rounded hillocks and rhombic shaped, etch pits (SEM x 375 Kimberlite from Van Zyl's Rust area N. Cape Province).

Plate 112



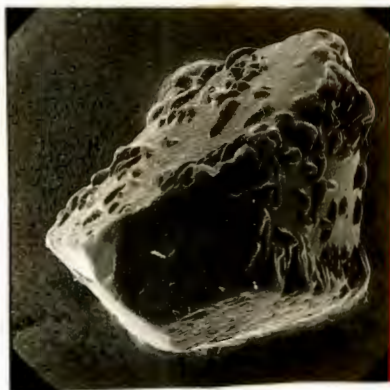
Rounded garnet displaying nodular protrusions resembling a garnet aggregate (SEM x 47, Sample Muza, USSR).

Plate 113



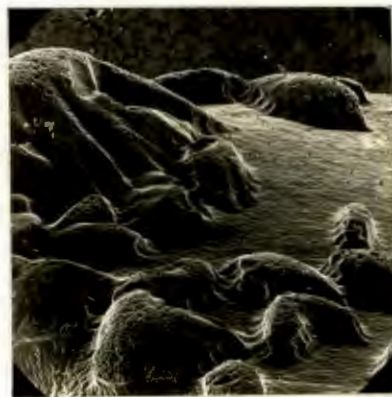
Sculptured surfaces consisting of imbricate wedge markings and rounded etch hillocks on a pyrope grain from Muza, U.S.S.R. (SEM x 220).

Plate 114



Extremely coarse etch hillocks on kimberlite garnet from Clarkton pipe, South Africa (SEM x 24).

Plate 115



Sharp sided-warty mounds and cirque edged hillocks standing as resistant islands on a flat etched surface (SEM x 150) Clarkton pipe, South Africa).

Plate 116



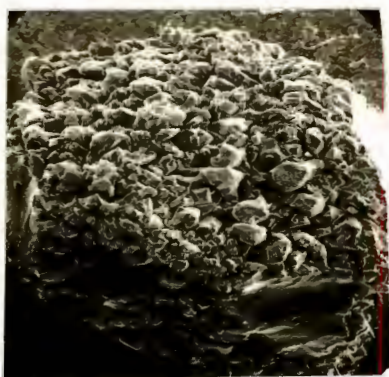
Rounded microilmenite grain, with rough etched surface (SEM x 36, Monastery Mine, South Africa).

Plate 117



Polycrystalline ilmenite grain (SEM x 60 Grain 6, BH 15/13 120m. Jwaneng Mine, Botswana).

Plate 118



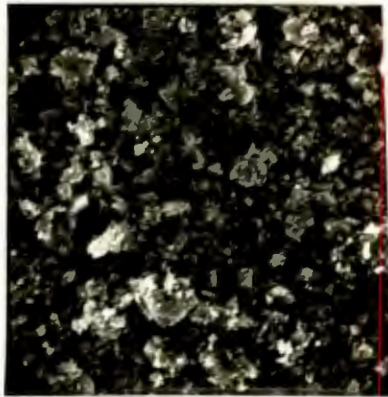
Rounded perovskite crystals superimposed on the sculptured surfaces on an ilmenite from De Beers Mine (SEM x 90, Grain B).

Plate 119



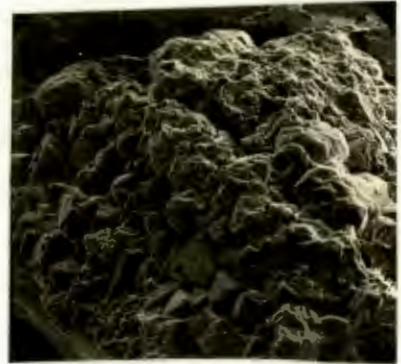
Thick development of greyish powdery perovskite surrounding kernel of ilmenite (SEM x 75, Grain E, De Beers Mine).

Plate 120



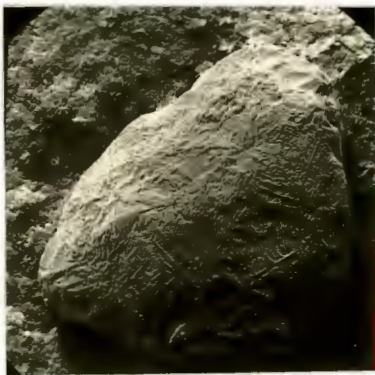
Fine granular texture of powdery perovskite crusts enclosing ilmenite from De Beers Mine (SEM x 2400, Grain E).

Plate 121



Powdery perovskite coating developed over blocky ilmenite surface consisting of triangular to octahedral shaped ilmenite protuberances (SEM x 240, S.W.A.).

Plate 122



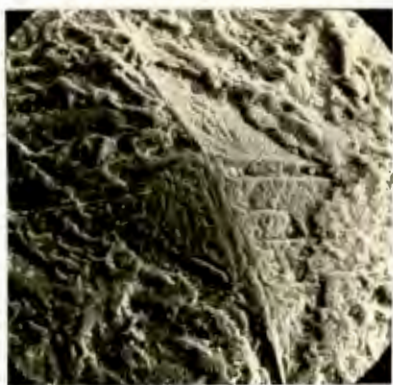
Rounded ilmenite from Redondao Kimberlite, Brazil, displaying mesh-like texture (SEM x 65, Grain 14).

Plate 123



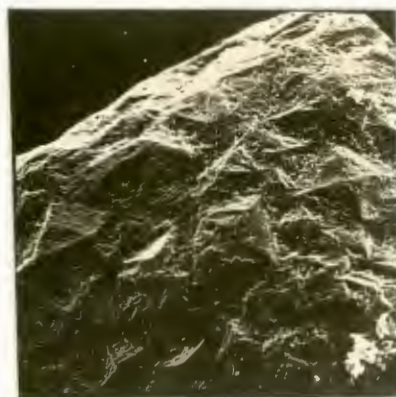
Fibrous crystal aggregate of Mg silicate (probably serpentine), forming thin coating on ilmenite (SEM x 330, Grain 15, Redondao Kimberlite Brazil).

Plate 124



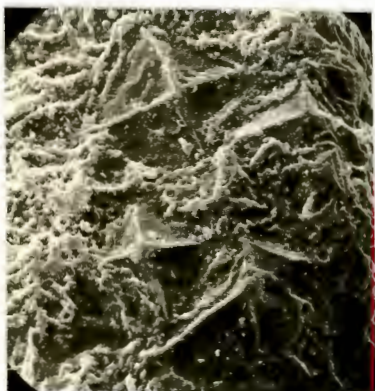
Pyramidal-shaped ilmenite protuberances with superimposed Mg silicate coating (SEM x 390, Grain 15 Redondao Kimberlite Brazil).

Plate 125



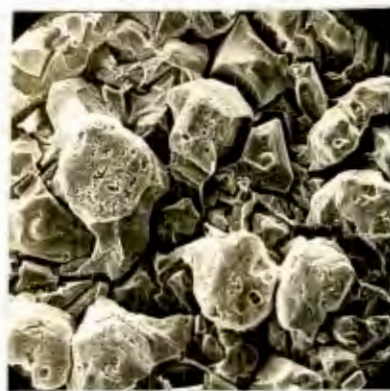
Flattish pyramidal shaped overgrowths (?) or protuberances on xenocrystic ilmenite (SEM x 160, Grain 3, Redondao Kimberlite, Brazil).

Plate 126



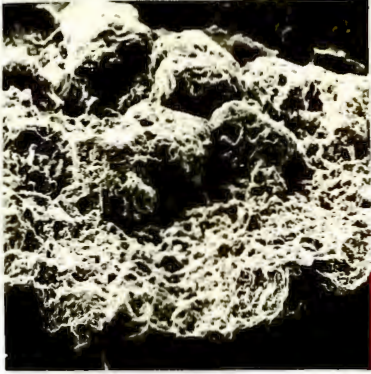
Ribbed pyramidal shaped ilmenite protuberances with Ti rich coating (leucoxene) developed on surface of ilmenite grain (SEM x 270. Grain 3. Redondao Kimberlite, Brazil).

Plate 127



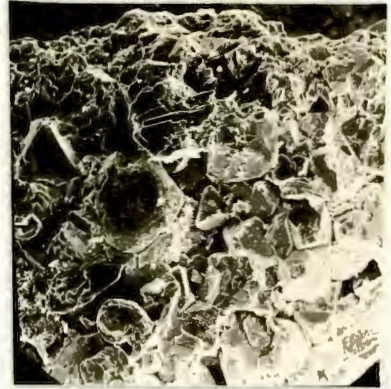
Rounded corroded crystals of perovskite superimposed on the sculptured surfaces of an ilmenite from De Beers Mine (SEM x 330 Grain B).

Plate 128

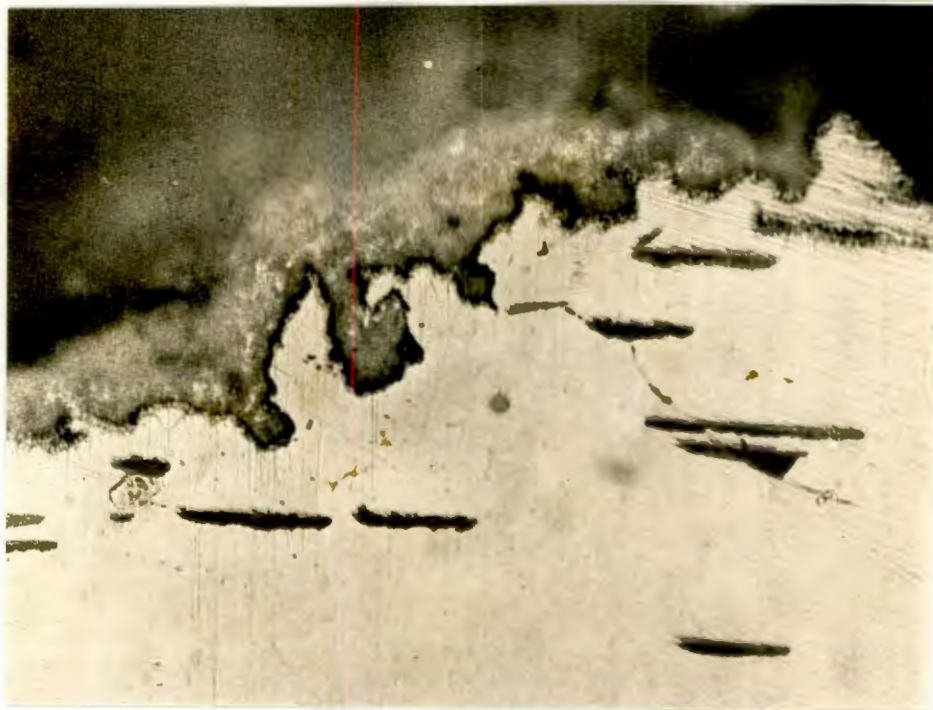


Rounded perovskite crystals moulded upon the sculptured surfaces of an ilmenite from Monastery Mine (SEM x 180).

Plate 129

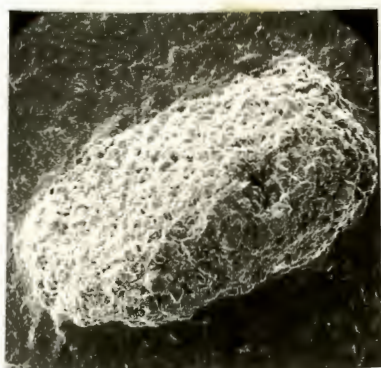


Thick reaction mantles surrounding an ilmenite from Wesselton Mine. Note the many small octahedral-shaped spinel crystals and rounded perovskite crystals forming the reaction mantles (SEM x 180).



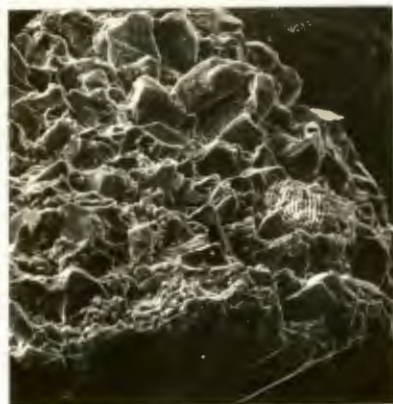
Polished section of contact between ilmenite and powdery perovskite coating on a grain from Montrose No.3 Kimberlite pipe, Transvaal. (Oil immersion magnification 155 x approximately height of field of view 0.3 mm).

Plate 131



Typical example of pimpled appearance of ilmenite from kimberlite (SEM x 39, Wesselton Mine, South Africa).

Plate 132



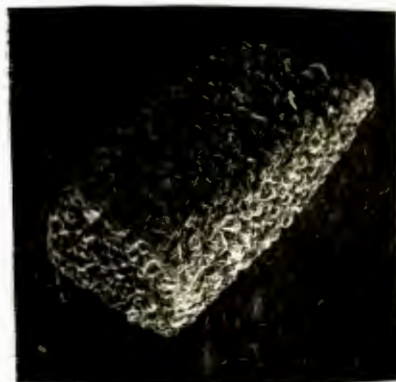
Rough etched surface on ilmenite from Jwaneng Mine, Botswana (SEM x 500 Grain No. 10, BH/15/4, 40m).

Plate 133

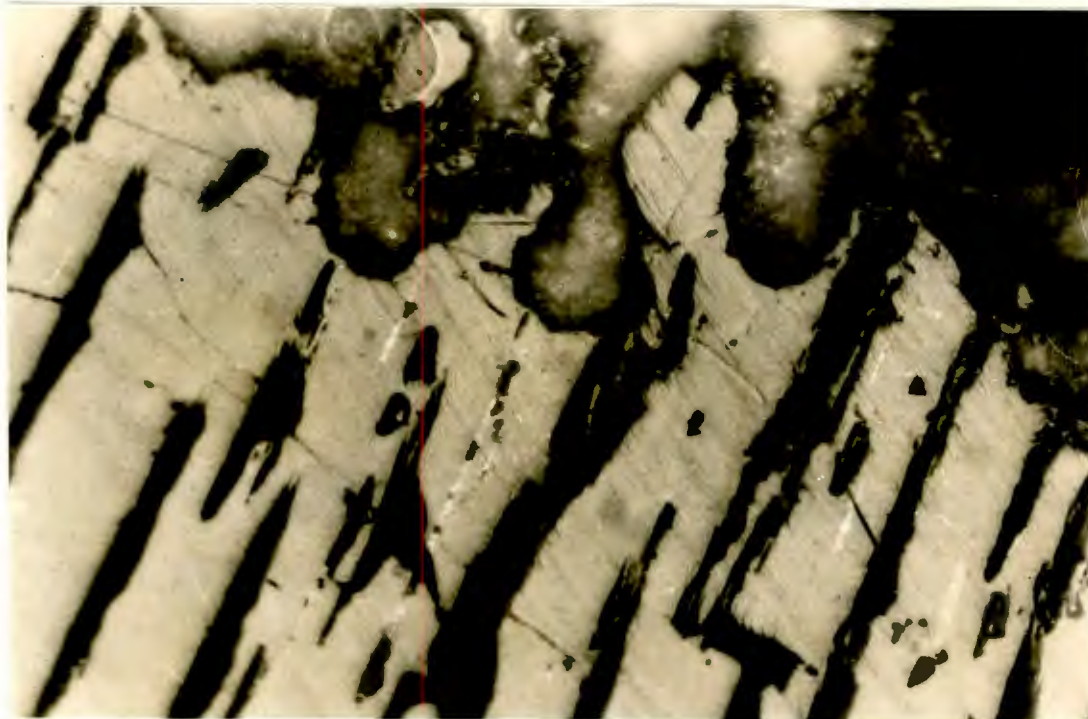


Blocky sculptured surface on ilmenite from Zarnitsa pipe U.S.S.R., consisting of euhedral, subhedral and anhedral ilmenite protuberances with interstitial powdery perovskite (SEM x 200, Grain 27).

Plate 134

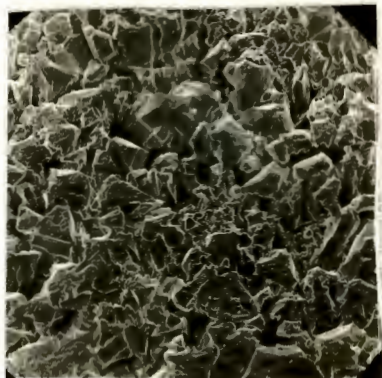


Euhedral tabular ilmenite displaying coarse sculptured surfaces which are identical on all crystal faces (SEM x 30. Grain A. De Beers Mine).



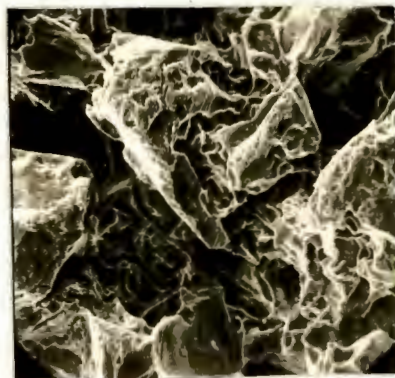
Irregular embayed contact between ilmenite and perovskite crust, which leaves no doubt that the perovskite has developed at the expense of the ilmenite. (Oil immersion magnification 740 x approx. width of field of view 0.13mm).

Plate 136



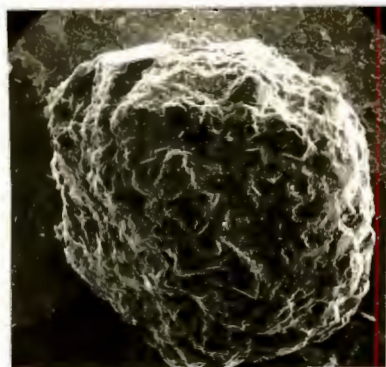
Exposed blocky sculptured surface on ilmenite (SEM x 160, Grain 17, Premier Mine, South Africa).

Plate 137



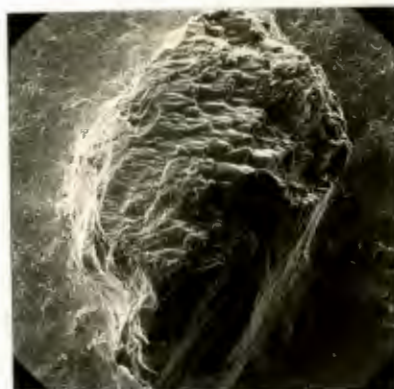
Development of irregular sculptured surface on ilmenite by corrosive agencies (SEM x 470, Grain C De Beers Mine, South Africa).

Plate 138



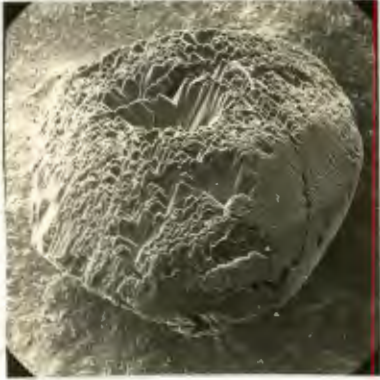
Thick coating of decomposed kimberlite (?) superimposed on rough blocky sculptured surface on ilmenite grain (SEM x 130, Grain 5, Zambia).

Plate 139



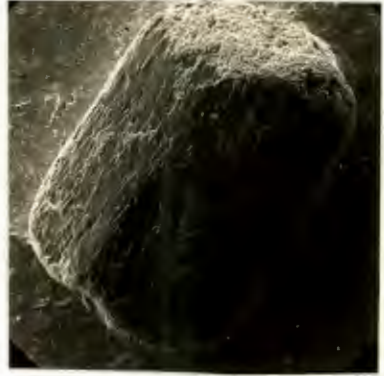
Angular sculptured chrome diopside grain from Zagadochnaya pipe in U.S.S.R. (SEM x 65, Grain 35).

Plate 140



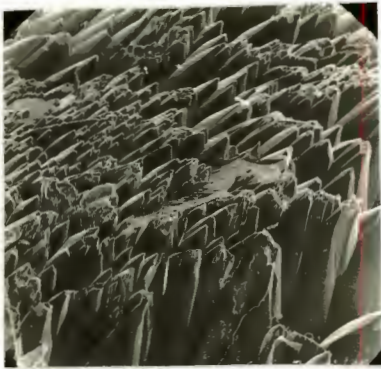
Rounded extensively resorbed chrome diopside with small portion of crystal faces still remain (SEM x 50, Grain No. 6, Redondao Kimberlite, Brazil).

Plate 141



Prismatic tabular crystal of chrome diopside exhibiting fine textured sculptured surfaces (SEM x 60, Grain 38, Zagadochnaya pipe, U.S.S.R.)

Plate 142



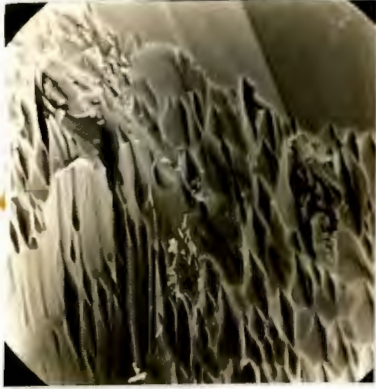
Sharp pointed hacksaw or cockscomb terminations formed on chrome diopside by dissolution processes during kimberlite emplacement (SEM x 150, Grain 9, Brazil).

Plate 143



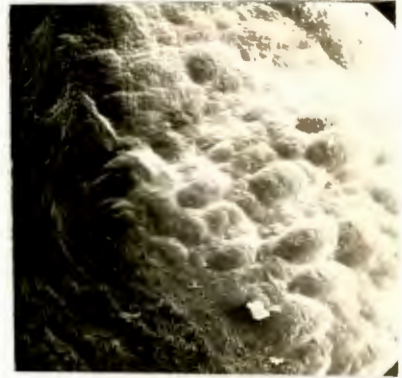
Coarsely sculptured chrome diopside grain, exhibiting large hacksaw terminations, on pyramidal surfaces and finely pitted surfaces on prism faces (SEM x 65, Grain 10, Brazil).

Plate 144



Rhombic to lens-shaped etch pits preferentially formed on prism surfaces parallel to c axis on chrome diopside (SEM x 750, Grain 17, Brazil).

Plate 145



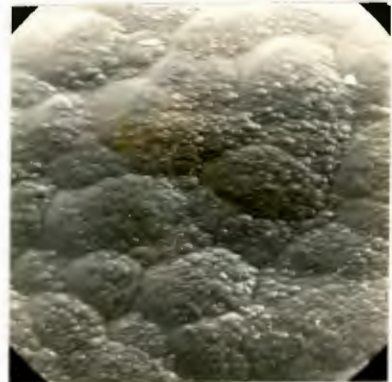
Subrounded chrome diopside with oval shaped hummocks developed on approx. cubic surfaces (100) at right angles to c axis. On the prism surfaces oriented lens like etch pits occur (SEM x 130, Grain 16 Benfontein Kimberlite Sill, Kimberley, South Africa).

Plate 146

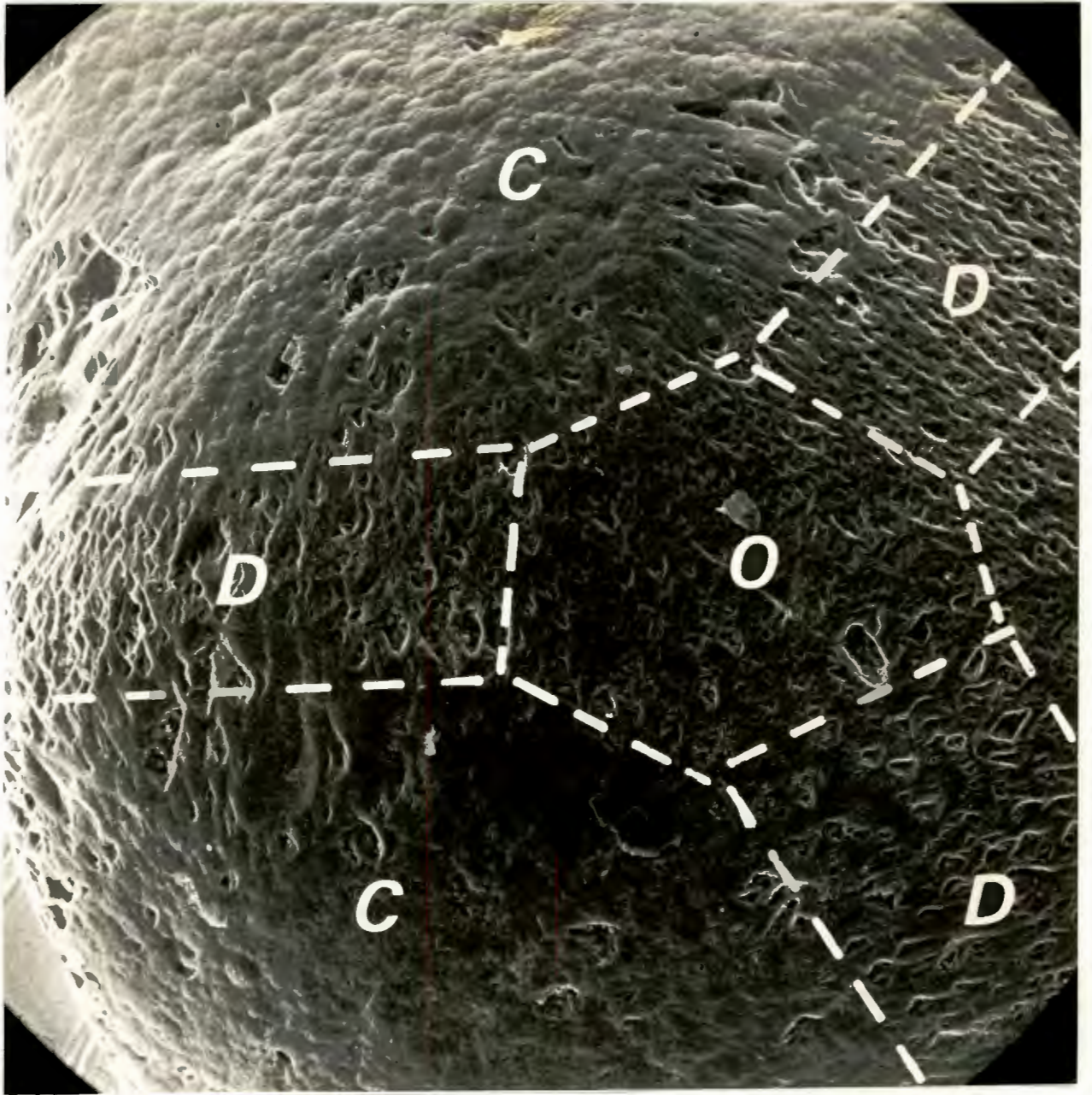


Unusual stepped or terraced etched surface of curved trigonal platforms, having a hummocky appearance. (SEM x 180, BH 15/11 70m. Jwaneng Kimberlite Pipe, Botswana).

Plate 147



Artificially produced series of small etch hillocks superimposed on larger drop-like rounded to hexagonal humps developed on a cuboid-shaped garnet. (SEM x 500).



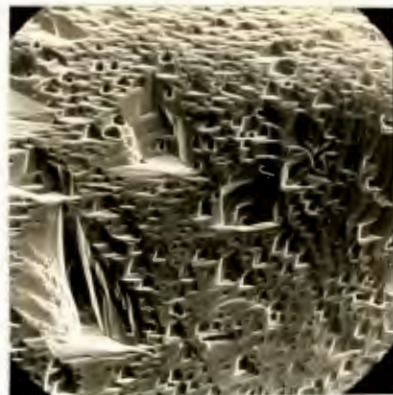
Rounded garnet covered entirely by etched surfaces. Hillocks developed on cube faces (C). Small rhombic to rectangular etch pits form on dodecahedral faces (D), whilst those on octahedral face (O) are triangular in shape. (SEM x 450).

Plate 149



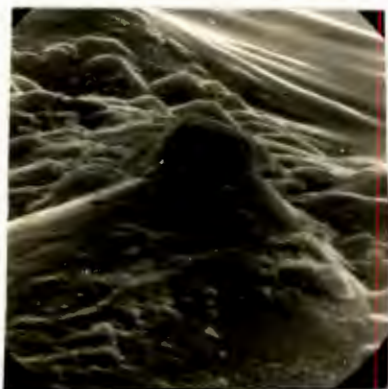
Rapid artificial etching of garnet produces a polished surface (SEM x 26).

Plate 150



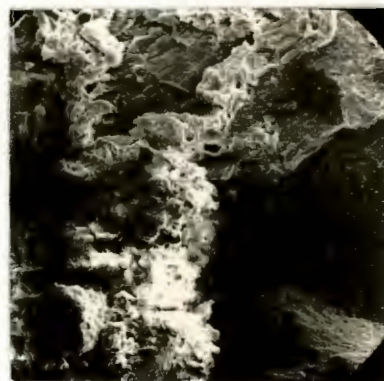
Step-like etch pits sometimes formed on dodecahedral faces, with removal of material layer by layer. (SEM x 268).

Plate 151



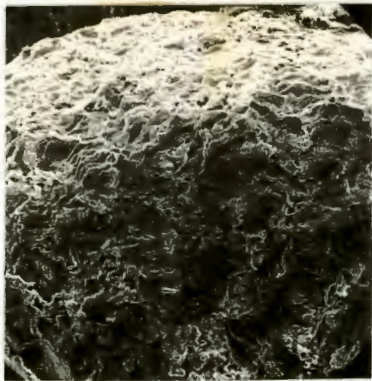
Flat-topped etch hillocks, capped by debris (SEM x 3125) Zambia.

Plate 152



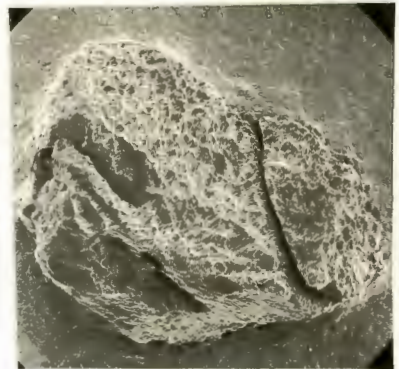
Artificially produced rough undulating reaction surfaces resembling rough blocky sculptured surfaces on ilmenite (SEM x 100, Grain 3, Wesselton Mine).

Plate 153



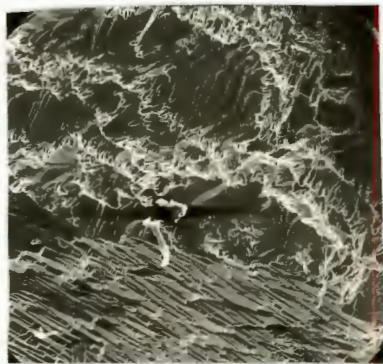
Formation of rounded brown crystals of perovskite (?) and whitish-brown coating experimentally produced on ilmenite (SEM x 220, Grain 3, Wesselton Mine).

Plate 154



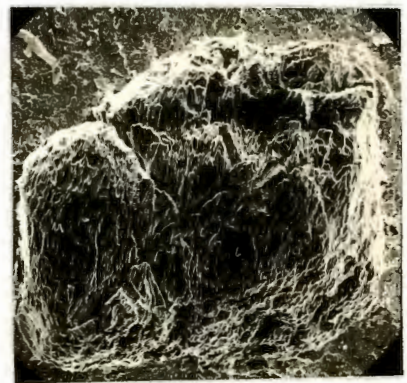
Rough etched surface and deep crevasse like grooves developed on ilmenite treated in hydrofluoric acid (SEM x 30, Grain 7, Wesselton Mine).

Plate 155



Stepped or layered etch features exhibiting strong crystallographic control formed on experimentally etched ilmenite (SEM x 180, Grain 10, Wesselton Mine).

Plate 156



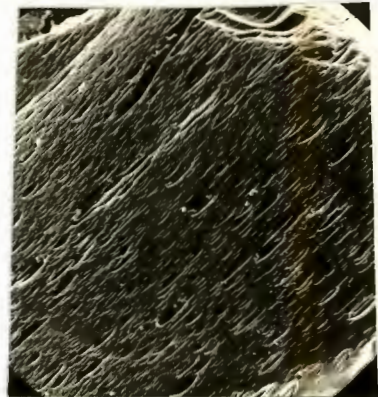
Subrounded chemically etched chrome diopside grain, covered by etch features, reminiscent of those formed on kimberlite chrome diopside (SEM x 75, Grain 13, Wesselton Mine).

Plate 157



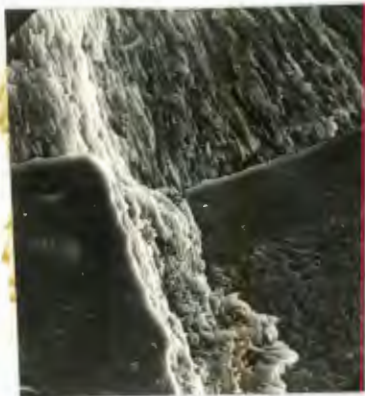
Plateau-like or terraced platforms grading into sharp pointed hacksaw terminations formed by artificial etching of chrome diopside in hydrochloric acid (SEM x 430, Grain 13, Wesselton Mine).

Plate 158



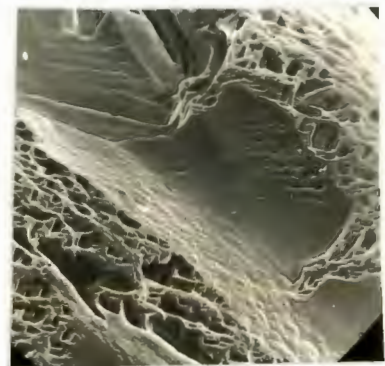
Finely pitted etch surfaces, consisting of masses of oriented lens-like pits parallel to c axis, formed by artificial etching (SEM x 220, Grain 13, Wesselton Mine).

Plate 159



Contact between outer radially structured kelyphite and randomly oriented kelyphite filling cracks within a pink garnet. (SEM x 937, Grain No.11, BH15/5 120m Jwaneng Mine, Botswana).

Plate 160



Kimberlitic garnet exhibiting original surfaces with large conchoidal fracture, also displaying etch hillocks and pits (SEM x 500).