

**THE GEOCHEMISTRY AND PETROGENESIS OF LAVAS FROM THE
COMORES ARCHIPELAGO, WESTERN INDIAN OCEAN**

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VOLUME 2: APPENDICES

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APPENDIX A1: ANALYTICAL TECHNIQUES

A1.1 Electron Microprobe Analysis

The mineral major element compositions presented in this study were determined using the Cameca CAMEBAX 4 channel electron microprobe of the Department of Geological Sciences at the University of Cape Town. The instrument was routinely run at an accelerating voltage of 15 kV, a beam current of about 40 nA and with a narrowly focused beam (analysed area about 4-5 μm in diameter). X-ray emissions by the major elements were detected using TLAP (Na, Mg, Si, Al), LiF(200) (Fe, Mn, Ni) and PET (Ca, K, Ti, Cr) analysing crystals. Ten second counting times at peak and background positions were used in all cases, except Ni in olivine, for which counting times were increased to 30 seconds. On-line data reduction was carried out according to the method of Bence and Albee (1968), using factors from Albee and Ray (1970).

A1.2 X-Ray Fluorescence (XRF) Spectrometry

Bulk rock samples were analysed for major, minor and selected trace element concentrations using the Phillips PW1400 and Siemens SRS303AS XRF spectrometers of the Department of Geological Sciences at UCT at operating conditions adopted for routine analysis in the department. The sample preparation and analytical procedures followed were those described by Duncan *et al.* (1984). All major and minor elements except Na were determined using the lithium tetraborate fusion method of Norrish and Hutton (1969). Trace element and Na concentrations were determined by analysis of pressed powder briquettes. A loss-on-ignition (LOI) value was determined for each sample by heating in a furnace for 12 hours at 950°C. Analytical errors and detection limits for the trace elements are similar to those given by le Roex and Dick (1981).

A1.3 High Performance Ion Chromatography (HPIC)

The concentrations of 11 REE (La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Er, Yb) in selected Comores samples were determined by the HPIC technique in routine use in the Department of Geological Sciences, UCT (le Roex and Watkins, 1990; Watkins and le Roex, 1992, 1993). This analytical method involves three stages: sample dissolution, matrix removal and REE determination. Sample dissolution was accomplished by HF/HClO₄ digestion in open teflon vessels. Any undigested residue was subsequently fused with KHF₂. To prevent overloading of the low capacity HPIC separator column, the bulk of the sample matrix was removed on columns of a strong acid cation exchange resin (Spectra/Gel® 75-150 μm 50X8, H⁺ form) using HCl eluents, prior to REE analysis. Columns of two different sizes were used with equal success during matrix separation. Watkins and le Roex (1992, 1993) described the use of the larger (19x2 cm) columns. The initial sample size for these bigger columns was 1 gram. In an effort to reduce the substantial amounts of HCl eluent used during the matrix elimination procedure (550 ml 1.75M HCl + 550 ml 4.2M HCl for the large columns), small glass

columns were made and tested with a resin bed of 1 cm diameter and 20 cm height. The amount of sample was reduced to 0.5 gram for these smaller columns and the consumption of HCl during matrix removal was lowered significantly (110 ml 1.75M HCl + 150 ml 4.2M HCl). The results from the smaller and larger matrix separation columns were found to be of equally high quality. Following the matrix separation, REE concentrations were determined, as described by Dionex® (1987), le Roex and Watkins (1990) and Watkins and le Roex (1992, 1993), using a Dionex® 4000i gradient ion chromatograph fitted with a Dionex® CS-5 separator column and a Dionex® CG-5 guard column. Traces of transition metals that would otherwise coelute with the REE were eluted with pyridine-2,6-dicarboxylic acid (PDCA), following which the REE were separated using opposing gradients of oxalic acid and diglycolic acid. Detection was by means of a Dionex® UV/VIS detector at a wavelength of 520 nm after post-column reaction with 4-(2-pyridylazo)resorcinol (PAR). Element concentrations were determined against a mixed REE standard solution, prepared from commercially available REE standard solutions. REE concentrations were calculated using peak height, except for Nd, for which peak area was used. The accuracy and precision of REE determination by this technique have been discussed by le Roex and Watkins (1990) and Watkins and le Roex (1992, 1993). The precision for all REE determined by this technique is typically better than 5%. The concentrations of La, Ce and Nd determined by HPIC compare favourably with those determined by XRF spectroscopy, although, relative to HPIC results, the XRF results tend to overestimate REE contents somewhat.

A1.4 Isotopes

The $^{87}\text{Sr}/^{86}\text{Sr}$ and $^{143}\text{Nd}/^{144}\text{Nd}$ ratios of selected Comores lavas were determined in the radiogenic isotope facility (RIF) of the Department of Geological Sciences at UCT, using a VG Sector multiple collector thermal ionisation mass spectrometer in multi-dynamic mode (analysts: R.A. Armstrong, S.H. Richardson). The technique followed for the chemical separation of Sr and the mass spectrometric determination of $^{87}\text{Sr}/^{86}\text{Sr}$ was similar to that of Hart and Brooks (1977). Single HF/HNO₃/HClO₄ dissolutions of 200 mg, natural (unspiked), whole rock powders were used for measuring combined Sr and Nd isotopic compositions. After digestion and evaporations, the samples were dissolved in 2.5N HCl, centrifuged and introduced into cation-exchange columns (column material: AG50WX8 cation resin; bed dimensions: ~20 x 0.8 cm), from which Sr was eluted with 2.5N HCl. Sr was run as nitrate on single Ta filaments. Using a procedure similar to that described by Zindler (1980), Nd separation was accomplished on a second set of ion-exchange columns (column material: teflon powder coated with HDEHP; bed dimensions: ~7 x 0.8 cm), from which Nd was eluted with 0.25N HCl. A double-filament technique (Zindler et al., 1979: Ta side filament, Re centre filament) was used to determine the Nd isotopic compositions, with the samples loaded as chlorides onto the Ta side filament. $^{143}\text{Nd}/^{144}\text{Nd}$ ratios were normalised to a value of 0.51182 for La Jolla. Since the RIF mass spectrometer consistently generates accurate and precise results for the $^{87}\text{Sr}/^{86}\text{Sr}$ ratio of the standard SRM 987, no normalisation was required for the $^{87}\text{Sr}/^{86}\text{Sr}$ ratios of the samples. The $2\text{-}\sigma_{\text{mean}}$ errors on in-run statistics for the isotope determinations are shown in Tables 4.5, 5.5 and 6.11. Due to the very young ages of Comorean lavas, no age corrections were necessary on any of the samples.

APPENDIX A2: ADDITIONAL MINERAL CHEMISTRY DATA FOR MAYOTTE LAVAS

The clinopyroxene, olivine and feldspar analyses presented in Tables 6.1, 6.3 and 6.4 of Chapter 6 represent only subsets of the entire database acquired for these minerals in lavas from Mayotte. The complete sets of data for these three minerals from the lavas of Mayotte are listed in Tables A2.1, A2.2 and A2.3 below.

TABLE A2.1
Clinopyroxene analyses from Mayotte lavas

<i>KT Shield-building Phase</i>			<i>LGT Shield-building Phase</i>		<i>Post-erosional Phase</i>					
<i>Sample</i>	<i>MA-30</i>	<i>MA-30</i>	<i>MA-60</i>	<i>MA-60</i>	<i>MA-55</i>	<i>MA-55</i>	<i>MA-55</i>	<i>MA-55</i>	<i>MA-55</i>	<i>MA-73</i>
SiO ₂	50.94	50.96	49.23	49.56	43.70	45.36	45.16	45.81	47.77	48.12
TiO ₂	1.05	1.13	1.43	0.99	4.37	3.20	3.65	3.03	2.52	1.20
Al ₂ O ₃	2.76	2.79	4.20	4.08	9.29	7.30	7.48	7.56	5.97	3.61
Cr ₂ O ₃	0.52	0.40	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>
FeO	6.05	6.23	8.17	8.77	8.45	12.71	10.37	7.25	6.32	14.58
MnO	0.15	0.15	0.24	0.21	<i>n.d.</i>	0.32	0.25	<i>n.d.</i>	0.13	0.65
MgO	15.61	15.54	13.35	12.82	10.14	8.27	9.51	12.13	13.20	8.27
CaO	21.87	22.01	22.36	22.12	22.86	22.01	23.02	23.52	23.38	21.76
Na ₂ O	0.29	0.25	0.66	0.87	0.73	1.11	0.78	0.57	0.47	1.31
Total	99.23	99.45	99.64	99.41	99.53	100.28	100.21	99.87	99.76	99.49
Wo	0.45	0.46	0.47	0.47	0.52	0.50	0.52	0.51	0.50	0.48
En	0.45	0.44	0.39	0.38	0.32	0.26	0.30	0.37	0.39	0.26
Fs	0.10	0.10	0.14	0.15	0.15	0.23	0.18	0.12	0.11	0.26

TABLE A2.1 continued

<i>P-E Phase</i>		<i>Karthala-type Rejuvenescent Phase</i>								
<i>Sample</i>	<i>MA-73</i>	<i>MA-1</i>	<i>MA-1</i>	<i>MA-3</i>	<i>MA-3</i>	<i>MA-3</i>	<i>MA-6</i>	<i>MA-6</i>	<i>MA-6</i>	<i>MA-6</i>
SiO ₂	48.60	50.19	50.32	47.76	47.80	48.98	45.43	49.14	49.28	50.06
TiO ₂	1.21	1.37	1.46	2.28	2.52	2.34	2.83	1.10	1.36	1.63
Al ₂ O ₃	3.52	3.01	3.04	6.16	6.42	5.33	7.54	4.57	4.79	4.17
Cr ₂ O ₃	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	0.13	0.17	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	0.12
FeO	13.30	7.89	8.29	7.06	6.90	7.04	10.03	10.43	9.82	7.42
MnO	0.49	0.15	0.18	0.15	<i>n.d.</i>	0.19	0.20	0.32	0.29	<i>n.d.</i>
MgO	9.06	14.40	14.60	13.47	13.27	13.58	10.98	11.87	11.83	14.58
CaO	21.71	22.04	22.04	22.93	22.98	22.65	21.89	22.01	22.45	21.82
Na ₂ O	1.33	0.45	0.47	0.46	0.42	0.54	0.78	0.89	0.78	0.44
Total	99.22	99.50	100.39	100.40	100.48	100.65	99.68	100.34	100.59	100.24
Wo	0.48	0.46	0.45	0.48	0.49	0.48	0.48	0.47	0.48	0.46
En	0.28	0.41	0.41	0.40	0.39	0.40	0.34	0.35	0.35	0.42
Fs	0.24	0.13	0.14	0.12	0.11	0.12	0.18	0.18	0.17	0.12

n.d. = not detected. *KT*=Karthala-type; *LGT*=La Grille-type; *P-E*=Post-erosional Phase.

TABLE A2.1 *continued*

<i>Karthala-type Rejuvenescent Phase</i>										
<i>Sample</i>	<i>MA-6</i>	<i>MA-8</i>	<i>MA-8</i>	<i>MA-8</i>	<i>MA-8</i>	<i>MA-8</i>	<i>MA-8</i>	<i>MA-8</i>	<i>MA-9</i>	<i>MA-11</i>
SiO ₂	48.67	46.78	46.96	48.15	48.78	48.88	49.66	50.58	49.02	49.73
TiO ₂	2.01	2.53	2.55	1.66	1.66	1.68	1.39	1.21	1.73	0.86
Al ₂ O ₃	5.67	6.73	6.80	6.15	6.04	5.71	5.30	3.97	4.76	3.08
Cr ₂ O ₃	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	0.88	0.55	<i>n.d.</i>	<i>n.d.</i>
FeO	8.00	7.79	7.76	9.29	8.21	8.55	6.34	6.22	7.55	12.70
MnO	<i>n.d.</i>	0.12	<i>n.d.</i>	0.28	0.21	0.13	<i>n.d.</i>	<i>n.d.</i>	0.13	0.49
MgO	13.50	12.86	12.83	13.32	13.11	12.86	14.54	15.21	14.07	10.04
CaO	22.36	22.28	22.32	21.30	21.47	21.51	21.73	22.05	21.82	21.34
Na ₂ O	0.59	0.57	0.50	0.89	0.76	0.77	0.51	0.41	0.44	1.06
Total	100.73	99.66	99.72	100.03	100.24	100.10	100.35	100.18	99.51	99.30
Wo	0.45	0.48	0.48	0.46	0.46	0.47	0.46	0.46	0.46	0.47
En	0.42	0.39	0.39	0.37	0.39	0.39	0.43	0.44	0.41	0.31
Fs	0.13	0.13	0.13	0.16	0.14	0.15	0.11	0.10	0.13	0.23

TABLE A2.1 *continued*

<i>Karthala-type Rejuvenescent Phase</i>										
<i>Sample</i>	<i>MA-11</i>	<i>MA-14a</i>	<i>MA-14a</i>	<i>MA-14a</i>	<i>MA-14a</i>	<i>MA-14a</i>	<i>MA-18</i>	<i>MA-35</i>	<i>MA-35</i>	<i>MA-35</i>
SiO ₂	48.57	47.84	48.35	48.45	49.20	49.79	49.20	45.99	46.52	47.93
TiO ₂	1.63	1.65	1.49	1.40	1.48	1.38	1.63	2.26	2.26	2.05
Al ₂ O ₃	5.42	5.32	5.63	5.42	5.16	4.88	4.36	6.91	6.71	6.29
Cr ₂ O ₃	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	0.30	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>
FeO	9.29	10.30	10.20	9.84	9.07	7.09	8.09	10.45	10.23	8.45
MnO	0.19	0.31	0.26	0.29	0.24	0.13	0.18	0.29	0.28	0.15
MgO	12.41	11.41	11.10	11.60	12.58	14.46	13.12	10.39	10.59	12.73
CaO	21.35	22.03	21.92	21.91	21.78	21.49	22.23	22.49	22.39	22.29
Na ₂ O	0.88	0.73	0.91	0.85	0.69	0.54	0.60	0.99	0.91	0.77
Total	99.74	99.60	99.85	99.76	100.20	100.07	99.41	99.76	99.89	100.65
Wo	0.46	0.48	0.48	0.48	0.47	0.45	0.47	0.50	0.49	0.48
En	0.38	0.34	0.34	0.35	0.38	0.43	0.39	0.32	0.32	0.38
Fs	0.16	0.18	0.18	0.17	0.15	0.12	0.14	0.18	0.19	0.14

n.d. = not detected.

TABLE A2.1 *continued*

<i>Sample</i>	<i>Karthala-type Rejuvenescent Phase</i>						<i>La Grille-type Rejuvenescent Phase</i>			
	<i>MA-35</i>	<i>MA-59</i>	<i>MA-59</i>	<i>MA-66</i>	<i>MA-67</i>	<i>MA-67</i>	<i>MA-7</i>	<i>MA-7</i>	<i>MA-7</i>	<i>MA-7</i>
SiO ₂	48.68	47.34	47.74	47.82	48.91	49.50	46.78	46.80	46.96	47.84
TiO ₂	1.64	1.89	2.13	1.89	1.72	1.64	2.58	2.50	2.66	1.91
Al ₂ O ₃	5.30	6.14	6.03	6.16	4.08	3.74	7.14	6.78	6.93	6.93
Cr ₂ O ₃	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>
FeO	9.12	10.31	8.08	9.09	8.35	9.16	8.30	7.93	8.06	8.70
MnO	0.15	0.30	0.21	0.18	0.29	<i>n.d.</i>	<i>n.d.</i>	0.13	<i>n.d.</i>	0.20
MgO	12.05	10.63	12.46	11.99	13.08	14.30	12.82	12.92	12.87	12.73
CaO	22.55	22.59	22.89	21.04	22.86	20.83	22.17	22.21	22.39	21.40
Na ₂ O	0.85	0.95	0.75	0.91	0.63	0.42	0.54	0.50	0.49	0.73
Total	100.32	100.15	100.29	99.07	99.92	99.58	100.33	99.76	100.35	100.44
Wo	0.48	0.50	0.49	0.47	0.48	0.44	0.48	0.48	0.48	0.46
En	0.36	0.32	0.37	0.37	0.38	0.42	0.38	0.39	0.38	0.38
Fs	0.16	0.18	0.14	0.16	0.14	0.14	0.14	0.14	0.14	0.16

TABLE A2.1 *continued*

<i>Sample</i>	<i>La Grille-type Rejuvenescent Phase</i>									
	<i>MA-7</i>	<i>MA-7</i>	<i>MA-7</i>	<i>MA-12</i>	<i>MA-12</i>	<i>MA-12</i>	<i>MA-12</i>	<i>MA-12</i>	<i>MA-12</i>	<i>MA-12</i>
SiO ₂	48.07	48.65	48.83	47.31	47.67	47.73	48.13	49.96	50.11	50.25
TiO ₂	1.90	1.21	1.59	2.20	1.93	2.14	1.71	1.29	1.41	1.46
Al ₂ O ₃	5.78	5.36	5.46	6.52	6.05	6.16	5.98	4.52	3.98	3.77
Cr ₂ O ₃	<i>n.d.</i>	<i>n.d.</i>	0.74	0.25	0.54	0.17	<i>n.d.</i>	0.13	0.23	0.31
FeO	8.45	9.65	6.47	7.97	7.12	7.35	8.43	7.33	6.90	7.30
MnO	0.16	0.15	<i>n.d.</i>	0.13	<i>n.d.</i>	<i>n.d.</i>	0.16	0.18	<i>n.d.</i>	<i>n.d.</i>
MgO	12.60	12.17	14.31	13.19	13.55	13.38	12.66	13.64	14.82	15.02
CaO	21.85	21.52	21.71	22.17	22.02	22.15	21.83	22.28	22.21	21.64
Na ₂ O	0.77	0.77	0.56	0.55	0.60	0.51	0.85	0.77	0.41	0.40
Total	99.58	99.48	99.66	100.29	99.47	99.60	99.75	100.08	100.07	100.14
Wo	0.47	0.47	0.47	0.47	0.47	0.48	0.47	0.47	0.46	0.45
En	0.38	0.37	0.43	0.39	0.41	0.40	0.38	0.40	0.43	0.43
Fs	0.15	0.16	0.11	0.14	0.12	0.12	0.15	0.13	0.11	0.12

n.d. = not detected.

TABLE A2.1 *continued*

<i>La Grille-type Rejuvenescent Phase</i>										
<i>Sample</i>	<i>MA-17</i>	<i>MA-17</i>	<i>MA-17</i>	<i>MA-22</i>	<i>MA-22</i>	<i>MA-22</i>	<i>MA-33</i>	<i>MA-33</i>	<i>MA-33</i>	<i>MA-34</i>
SiO ₂	48.43	48.76	49.82	49.84	47.63	49.78	45.31	47.71	47.77	48.63
TiO ₂	1.69	1.45	1.42	1.37	2.40	1.65	2.54	2.20	2.25	1.55
Al ₂ O ₃	5.20	5.26	3.95	3.54	5.51	4.09	7.41	5.45	5.31	4.79
Cr ₂ O ₃	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	0.11	0.39	<i>n.d.</i>	0.14	<i>n.d.</i>	<i>n.d.</i>
FeO	8.58	8.98	7.41	9.08	7.54	5.96	10.92	6.36	7.19	9.20
MnO	0.23	0.23	0.14	0.21	<i>n.d.</i>	<i>n.d.</i>	0.31	<i>n.d.</i>	<i>n.d.</i>	0.23
MgO	12.65	12.22	14.49	12.12	13.45	14.62	9.65	13.61	13.58	12.12
CaO	22.28	21.99	21.63	22.71	23.35	23.06	22.14	23.63	23.11	22.23
Na ₂ O	0.69	0.82	0.51	0.60	0.34	0.33	1.17	0.47	0.42	0.81
Total	99.76	99.71	99.37	99.46	100.31	99.89	99.44	99.56	99.62	99.56
Wo	0.48	0.48	0.45	0.48	0.49	0.48	0.50	0.50	0.49	0.48
En	0.38	0.37	0.42	0.36	0.39	0.42	0.30	0.40	0.40	0.36
Fs	0.16	0.15	0.13	0.16	0.12	0.10	0.20	0.10	0.11	0.16

n.d. = not detected.

TABLE A2.2
Olivine analyses from Mayotte lavas

Sample	Karthala-type Shield-building Phase										La Grille-type Shield-bldg Phase				Karthala-type Rejuvenescent Phase					
	MA-29	MA-29	MA-29	MA-29	MA-30	MA-30	MA-30	MA-30	MA-30	MA-30	MA-60	MA-60	MA-60	MA-60	MA-1	MA-1	MA-1	MA-1	MA-1	MA-8
SiO ₂	39.94	39.85	38.15	38.95	38.76	39.39	39.44	39.74	39.90	39.95	39.59	39.75	40.10	40.29	37.54	37.54	37.60	37.81	37.84	39.00
TiO ₂	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	0.08	<i>n.d.</i>
Al ₂ O ₃	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	0.14	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>
Cr ₂ O ₃	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>
FeO	12.66	13.84	23.18	19.38	20.64	15.80	15.15	13.44	13.62	12.67	16.18	15.45	12.56	12.20	24.33	24.32	23.80	23.75	23.82	17.87
MnO	0.17	0.19	0.31	0.26	0.35	0.30	0.22	0.20	0.19	0.20	0.20	0.16	0.17	0.20	0.33	0.28	0.33	0.26	0.26	0.22
MgO	46.25	45.09	37.98	41.16	40.22	43.53	44.10	45.40	45.15	45.97	42.91	43.16	45.77	45.85	36.99	36.90	37.76	37.32	37.19	42.64
CaO	0.25	0.29	0.31	0.29	<i>n.d.</i>	0.39	0.34	0.32	0.35	0.28	0.25	0.37	0.29	0.31	0.20	0.21	0.22	0.30	0.23	0.27
NiO	0.32	0.27	0.21	0.29	<i>n.d.</i>	0.17	0.23	0.26	0.28	0.28	0.27	0.19	0.25	0.18	0.17	0.19	0.22	<i>n.d.</i>	0.18	0.27
Total	99.60	99.53	100.14	100.33	99.97	99.56	99.53	99.36	99.48	99.35	99.40	99.23	99.14	99.03	99.55	99.44	99.92	99.43	99.59	100.28
Fo	0.86	0.85	0.74	0.79	0.77	0.83	0.83	0.85	0.85	0.86	0.82	0.83	0.86	0.87	0.73	0.73	0.73	0.73	0.73	0.81

n.d. = not detected

TABLE A2.2 continued

Sample	Karthala-type Rejuvenescent Phase													La Grille-type Rejuvenescent Phase						
	MA-8	MA-8	MA-8	MA-9	MA-9	MA-11	MA-11	MA-11	MA-66	MA-66	MA-66	MA-67	MA-67	MA-7	MA-7	MA-7	MA-7	MA-12	MA-12	MA-12
SiO ₂	39.10	39.24	39.33	37.93	38.75	39.33	39.06	38.56	39.17	38.96	40.15	38.12	38.91	38.47	38.74	38.87	39.00	38.68	39.01	39.04
TiO ₂	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>
Al ₂ O ₃	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>
Cr ₂ O ₃	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>
FeO	17.97	17.57	17.26	23.85	19.02	18.51	17.95	21.60	17.78	19.27	13.56	18.70	16.77	20.41	19.56	18.15	18.33	18.70	18.23	18.15
MnO	0.24	0.27	0.20	0.30	0.25	0.19	0.16	0.26	0.20	0.27	0.19	0.22	0.18	0.26	0.25	0.26	0.24	0.16	0.22	0.25
MgO	41.90	42.85	43.06	37.08	40.95	41.71	41.81	39.27	42.40	41.06	45.06	41.95	43.20	40.03	40.59	41.68	41.71	41.48	42.00	41.55
CaO	0.28	0.27	0.29	0.15	0.31	0.18	0.22	0.22	0.17	0.27	0.23	0.19	0.18	0.16	0.16	0.31	0.16	0.24	0.25	0.25
NiO	0.20	0.24	0.24	0.13	0.20	0.29	0.29	0.22	0.19	0.19	0.29	0.32	0.36	0.19	0.26	0.18	0.15	0.31	0.24	0.22
Total	99.69	100.43	100.38	99.44	99.47	100.22	99.48	100.12	99.90	100.02	99.48	99.49	99.60	99.51	99.56	99.45	99.58	99.57	99.94	99.45
Fo	0.80	0.81	0.81	0.73	0.79	0.80	0.80	0.76	0.81	0.79	0.85	0.80	0.82	0.77	0.78	0.80	0.80	0.79	0.80	0.80

n.d. = not detected

TABLE A2.2 *continued**La Grille-type Rejuvenescent Phase*

<i>Sample</i>	<i>MA-12</i>	<i>MA-12</i>	<i>MA-22</i>	<i>MA-22</i>	<i>MA-33</i>	<i>MA-33</i>	<i>MA-33</i>	<i>MA-33</i>	<i>MA-33</i>
SiO ₂	39.18	39.81	39.81	39.84	39.15	39.40	39.88	39.90	40.33
TiO ₂	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>
Al ₂ O ₃	<i>n.d.</i>	0.06	0.08	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>
Cr ₂ O ₃	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>
FeO	16.51	14.31	13.58	14.92	15.95	16.06	14.25	14.19	12.51
MnO	0.23	0.15	0.21	0.12	0.22	0.21	0.19	0.17	<i>n.d.</i>
MgO	43.01	44.76	45.19	44.49	43.74	43.64	44.76	45.01	46.39
CaO	0.25	0.24	0.25	0.22	0.22	0.26	0.24	0.24	0.20
NiO	0.25	0.27	0.29	0.28	0.13	0.24	0.18	0.26	0.32
Total	99.43	99.59	99.41	99.87	99.42	99.81	99.50	99.77	99.75
Fo	0.82	0.84	0.85	0.84	0.83	0.82	0.85	0.85	0.87

n.d. = not detected

TABLE A2.3
Feldspar analyses from Mayotte lavas

Karthala-type Rejuvenescent Phase

<i>Sample</i>	<i>MA-3</i>	<i>MA-3</i>	<i>MA-3</i>	<i>MA-3</i>	<i>MA-5</i>	<i>MA-6</i>	<i>MA-6</i>	<i>MA-9</i>	<i>MA-11</i>	<i>MA-11</i>	<i>MA-11</i>	<i>MA-14</i>
SiO ₂	53.77	53.50	54.68	55.71	63.36	58.57	59.56	61.08	61.54	59.00	59.27	63.29
Al ₂ O ₃	29.47	29.05	29.17	28.26	24.32	25.93	25.93	24.66	24.77	26.05	25.72	23.36
FeO	0.36	0.47	0.41	0.35	0.24	0.28	0.29	0.25	0.18	0.30	0.31	0.22
MgO	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>0.06</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>
CaO	12.75	12.09	10.95	13.53	5.12	7.96	7.45	5.76	5.83	7.84	7.69	4.17
Na ₂ O	3.85	4.13	4.64	23.17	5.99	6.01	6.37	6.61	6.67	5.79	5.75	6.68
K ₂ O	0.27	0.23	0.36	0.37	1.51	0.64	0.73	1.15	1.00	0.66	0.76	1.96
Total	100.47	99.46	100.32	100.26	100.54	99.38	100.33	99.51	99.99	99.64	99.49	99.68
An	0.64	0.61	0.55	0.49	0.29	0.41	0.38	0.30	0.31	0.41	0.40	0.22
Ab	0.34	0.38	0.42	0.40	0.61	0.55	0.58	0.63	0.63	0.55	0.55	0.65
Or	0.02	0.01	0.03	0.11	0.10	0.04	0.04	0.07	0.06	0.04	0.05	0.13

n.d. = not detected

TABLE A2.3 continued

Karthala-type Rejuvenescent Phase

<i>Sample</i>	<i>MA-14</i>	<i>MA-18</i>	<i>MA-18</i>	<i>MA-18</i>	<i>MA-18</i>	<i>MA-18</i>	<i>MA-20</i>	<i>MA-20</i>	<i>MA-20</i>	<i>MA-20</i>	<i>MA-59</i>
SiO ₂	62.38	61.64	60.79	63.86	63.12	62.68	66.81	67.73	66.42	66.84	58.91
Al ₂ O ₃	23.97	24.37	25.22	23.66	23.97	23.81	19.87	20.33	19.44	20.66	26.08
FeO	0.26	0.35	0.23	0.20	0.33	0.28	0.33	0.24	0.44	0.42	0.34
MgO	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>
CaO	4.93	5.85	6.59	4.53	5.14	5.18	0.23	0.35	0.18	0.76	8.20
Na ₂ O	7.17	6.39	6.43	6.61	6.76	6.76	5.17	5.53	5.55	6.85	6.20
K ₂ O	1.34	1.03	0.82	1.41	1.20	1.21	7.78	6.37	7.94	5.17	0.68
Total	100.05	99.63	100.07	100.27	100.51	99.92	100.19	100.56	99.97	100.69	100.41
An	0.25	0.31	0.34	0.25	0.27	0.27	0.01	0.02	0.01	0.04	0.41
Ab	0.67	0.62	0.61	0.66	0.65	0.65	0.50	0.56	0.51	0.64	0.55
Or	0.08	0.07	0.05	0.09	0.08	0.08	0.49	0.42	0.48	0.32	0.04

n.d. = not detected

TABLE A2.3 *continued*

<i>Karthala-type Rejuvenescent Phase</i>											
<i>Sample</i>	<i>MA-59</i>	<i>MA-59</i>	<i>MA-59</i>	<i>MA-65</i>	<i>MA-65</i>	<i>MA-65</i>	<i>MA-65</i>	<i>MA-65</i>	<i>MA-65</i>	<i>MA-65</i>	<i>MA-66</i>
SiO ₂	58.77	59.58	63.64	62.79	61.31	62.51	62.78	61.33	64.00	61.97	61.31
Al ₂ O ₃	26.03	25.57	23.04	24.52	24.85	24.09	23.97	24.77	23.14	24.16	24.77
FeO	0.30	0.26	0.23	0.24	0.22	0.24	0.19	0.24	0.25	<i>n.d.</i>	0.28
MgO	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>
CaO	7.93	7.34	4.15	4.73	5.69	4.80	4.54	5.83	3.62	5.40	5.91
Na ₂ O	6.38	6.57	7.52	6.12	6.65	6.74	6.77	6.78	6.80	6.99	5.94
K ₂ O	0.71	0.81	1.83	1.22	1.06	1.41	1.50	1.01	1.86	1.05	1.16
Total	100.12	100.12	100.40	99.61	99.77	99.80	99.75	99.96	99.67	99.57	99.37
An	0.39	0.36	0.21	0.27	0.30	0.26	0.24	0.30	0.20	0.28	0.33
Ab	0.57	0.59	0.68	0.64	0.63	0.65	0.66	0.64	0.68	0.66	0.60
Or	0.04	0.05	0.11	0.09	0.07	0.09	0.10	0.06	0.12	0.06	0.07

n.d. = not detectedTABLE A2.3 *continued*

<i>KT Rej. Phase</i>	<i>La Grille-type Rejuvenescent Phase</i>										
<i>Sample</i>	<i>MA-66</i>	<i>MA-17</i>	<i>MA-17</i>	<i>MA-17</i>	<i>MA-34</i>	<i>MA-34</i>	<i>MA-34</i>	<i>MA-34</i>	<i>MA-34</i>	<i>MA-34</i>	<i>MA-34</i>
SiO ₂	59.02	58.03	60.00	59.85	64.81	61.51	63.42	62.91	66.52	62.69	63.80
Al ₂ O ₃	26.04	26.44	25.51	25.43	21.29	24.10	22.56	22.71	20.58	23.40	21.82
FeO	0.33	0.32	0.24	0.24	0.22	0.30	0.32	0.32	<i>n.d.</i>	0.24	0.28
MgO	<i>n.d.</i>	0.06	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>	<i>n.d.</i>
CaO	7.94	8.98	7.77	7.63	2.83	5.89	4.21	3.82	1.79	5.04	3.52
Na ₂ O	5.44	5.89	6.49	6.67	7.02	7.09	7.26	7.45	7.51	7.63	7.75
K ₂ O	0.70	0.49	0.66	0.74	3.49	1.12	2.04	2.32	4.18	1.37	2.44
Total	99.47	100.21	100.67	100.55	99.65	100.00	99.81	99.53	100.57	100.37	99.60
An	0.43	0.44	0.38	0.37	0.14	0.29	0.21	0.19	0.09	0.25	0.17
Ab	0.53	0.53	0.58	0.59	0.65	0.64	0.66	0.67	0.67	0.67	0.69
Or	0.04	0.03	0.04	0.04	0.21	0.07	0.12	0.14	0.24	0.08	0.14

n.d. = not detected; *KT Rej.* = *Karthala-type Rejuvenescent*.

APPENDIX A3: MINERAL-MELT DISTRIBUTION COEFFICIENTS

	<i>Ol</i>	<i>Opx</i>	<i>Cpx</i>	<i>Gt</i>	<i>Sp</i>	<i>Fsp</i>	<i>Amph</i>	<i>Phlog</i>	<i>Ti-Mgt</i>	<i>Apatite</i>	<i>Sph</i>
Ba	0.01	0.01	0.001 ^a	0.02 ^b	-	0.1-1.65 ^{d**}	0.4-0.5 ⁱ	1.1 ^b	0.01	0.01	0.01
Rb	0.02 ⁱ	0.01	0.001-0.3 ^{a,i}	0.015 ^g	-	0.01	0.2-0.6 ^{b,c,i}	1.6 ^b	0.01	0.01	0.01
K	0.01	0.01	0.0072 ^b	0.015 ^b	-	-	-	-	-	-	-
Nb	0.001	0.001	0.0077-0.09 ^{b,i}	0.03 ^m	0.01	0.01	0.4-0.9 ⁱ	0.5 ^{d,e}	2.16 ^d	0.01	0.01
La	0.01 ⁱ	0.01	0.09-0.15 ^{b,i}	0.01	-	0.09 ^o	0.25-0.35 ^{i,j}	0.3 ^d	0.05	15-35	20-30 ⁱ
Ce	0.009 ^k	0.035 ^k	0.0858 ^b	0.2	-	0.08 ^d	0.1-0.3 ^k	0.3 ^d	0.05	20-40	25 ⁱ
Nd	0.01 ^k	0.06 ^k	0.25-0.3 ^{b,i}	0.06 ⁿ	-	0.11 ^p	0.4 ⁱ	0.339 ^k	0.05	35-60	35 ⁱ
Sr	0.05	0.05	0.13 ⁿ	0.05	-	1.27-5 ^{b,d**}	0.641 ^b	0.672 ^b	0.01	0.01-10 ^{d,i}	0.01
P	0.01	0.01	0.01	0.1 ^m	-	-	1.0	1.0	-	-	-
Zr	0.01	0.05 ⁿ	0.1234-0.15 ^{b,i}	1.0 ^{m,n}	0.01	0.01	0.8 ⁱ	0.8 ^d	0.24 ⁱ	0.01	0.01
Ti	0.07 ^j	0.1 ^f	0.546 ^b	0.6 ⁿ	-	-	1.0	0.8	-	-	-
Y	0.13 ^c	0.1 ^m	0.5-0.7 ^{c,f}	2.0 ^{c,g}	-	0.01-0.03	1.0 ⁱ	0.8 ^d	0.18 ⁱ	25-40	0.01
Ni	*	3.0 ^m	2.0 ⁱ	-	0.1	0.01	0.01-0.5 ^c	-	5-20 ^{d,i}	0.01	0.01
Sc	0.14 ⁱ	-	0.5-4.0 ^{b,j}	-	-	0.01	1.8-2.9 ^{c,i}	-	0.8-3 ^{d,j}	0.01	0.01
V	0.01	-	1.2 ⁱ	-	-	0.01	1.0-1.7 ^{c,i}	-	10-20 ⁱ	0.01	0.01
Zn	1.4 ⁱ	-	0.5 ⁱ	-	-	0.01	0.7-0.9 ⁱ	-	4.0 ⁱ	0.01	0.01
Co	5.4 ^d	-	1.3 ^d	-	-	0.01	1.0-1.8	-	5-10 ^j	0.01	0.01

* (124/MgO)-0.9 (Hart and Davies, 1978); ** dependant on feldspar composition; *Sph* = sphene; *Sp* = spinel

Sources: a Shimizu (1974); b Philpotts and Schnetzler (1970); c Irving and Price (1981); d le Roex (1985) and references therein; e le Roex (1980); f Pearce and Norry (1979); g Frey *et al.* (1978); h Hart and Dunn (1993); i le Roex *et al.* (1990) and references therein; j Irving (1978); k Schnetzler and Philpotts (1970); l Lemarchand *et al.* (1987); m le Roex *et al.* (1981) and references therein; n Johnson *et al.* (1990) and references therein; o Frey *et al.* (1974); p Schnetzler and Philpotts (1968); McCallum and Charette (1978).

APPENDIX A4: PETROGRAPHIC DESCRIPTIONS AND SAMPLE LOCATIONS

(All sample locations from Emerick ,1985; all percentages estimated)

A4.1 Grande Comore

A4.1.1 Karthala

GC-1: (Flow; Itsandra beach; 10°40'S 43°15.5'E)

Alkali Olivine Basalt

A slightly vesicular (5-10 vol.%), moderately porphyritic rock. Phenocrysts and microphenocrysts, 60% of which are olivines and 40% are clinopyroxenes, make up about 10% of this rock. Rare plagioclase phenocrysts also occur. The modes are clinopyroxene (40%), olivine (30%), plagioclase (25%) and Fe-Ti oxide (5%). The subhedral olivine phenocrysts (usually around 1-2 mm, but up to 5 mm and more) and rare microphenocrysts (less than 0.5 mm) have slightly altered rims and contain finely disseminated inclusions of Fe-Ti oxide. Clinopyroxene occurs as subhedral, grey to pale tan, augitic phenocrysts (up to about 2 mm) and tan microphenocrysts (around 0.5 mm and less). The elongate clinopyroxene microphenocrysts sometimes occur as glomerophyric clusters or radiating aggregates. Plagioclase is present as slightly flow-aligned laths in the groundmass and as rare microphenocrysts (up to about 1 mm). The fine- to very fine-grained to cryptocrystalline and partly glassy groundmass is dark grey in colour and contains mainly clinopyroxene, plagioclase, Fe-Ti oxide and smaller amounts of olivine.

GC-2: (Block included in tuff cone; N-Gouni; 11°44'S 43°13.5'E; no analyses)

Alkali Olivine Basalt

A slightly vesicular (<5 vol.%), coarsely olivine and clinopyroxene phyric rock. Phenocrysts and macrophenocrysts, 50% of which are olivines and 50% are clinopyroxenes, make up approximately 40% of this rock. The modal composition is: 45% clinopyroxene, 35% olivine, 15% plagioclase and 5% Fe-Ti oxide. The fresh, euhedral to subhedral clinopyroxene phenocrysts (mostly between 0.5 and 2 mm) and macrophenocrysts (up to 5 mm and more) are light greenish-grey to tan in colour and some contain fine Fe-Ti oxide inclusions. Simple twinning and oscillatory zonation are common. The unaltered, subhedral to euhedral phenocrysts (mostly 0.5-2 mm) and macrophenocrysts (up to about 5 mm) of olivine also contain inclusions of fine-grained Fe-Ti oxide. The homogeneous, dark grey, fine- to very fine-grained and partly glassy groundmass contains clinopyroxene, plagioclase, Fe-Ti oxides and rare olivine.

GC-3: (Flow; S of Bandani; 11°45'S 43°13.5'E)

Ankaramite

A vesicular (5-10 vol.%), sparsely porphyritic rock. Phenocrysts, of which 55% are clinopyroxenes and 45% are olivines, make up between 5 and 10% of the rock. Rare microphenocryst-sized clinopyroxene crystals occur. The modal composition is: clinopyroxene (40%), plagioclase (30%), olivine (25%) and Fe-Ti oxide (5%). Clinopyroxene occurs as fresh, subhedral phenocrysts (up to about 2 mm), typically with light grey-tan augitic cores and darker tan-violet titanaugite rims and also as tan-violet microphenocrysts (around 0.5 mm). Olivine is present as relatively fresh, subhedral to anhedral phenocrysts (up to about 3 mm). The fine-grained groundmass is dominated by flow-aligned plagioclase laths with intergranular, tan-coloured clinopyroxene, Fe-Ti oxides and lesser amounts of olivine.

GC-4: (Lower part of flow; N of Moroni; 11°41'S 43°15'E; no analyses)

Alkali Olivine Basalt

A highly vesicular (15-20 vol.%), coarsely porphyritic and glomerophyric rock, containing phenocrysts of olivine and clinopyroxene. The phenocrysts, 50-55% of which are olivines and 45-50% are clinopyroxenes, comprise about 15% of this rock. The modal composition is as follows: clinopyroxene (40%), olivine (30%), plagioclase (25%) and Fe-Ti oxide (5%). The relatively fresh to slightly altered, subhedral macrophenocrysts (up to around 4 mm) and phenocrysts (around 2 mm) of olivine contain fine-grained inclusions of Fe-Ti oxides. The relatively fresh, subhedral, pale greenish-grey clinopyroxene phenocrysts and microphenocrysts (around 1.5-0.5 mm and less) commonly occur as irregular clusters. Some of the clinopyroxene phenocrysts show oscillatory zonation patterns and simple twins occur frequently. The fine- to very fine-grained and partly glassy groundmass consists predominantly of small plagioclase laths, clinopyroxene, Fe-Ti oxide, lesser olivine and accessory biotite.

GC-5: (Upper part of flow; N of Moroni; 11°41'S 43°15'E)

Hawaiite

A slightly vesicular (<5 vol.%), sparsely olivine and clinopyroxene phyric rock. The phenocrysts, 65% of which are olivines and 35% are clinopyroxenes, make up less than 5% of the rock. The modes are plagioclase (40%), clinopyroxene (30%), olivine (25%) and Fe-Ti oxide (5%). Olivine occurs as isolated, fresh, anhedral phenocrysts (around 1 mm), while the unaltered, subhedral clinopyroxene phenocrysts (around 1 mm) typically have light grey-tan cores and darker tan rims. The groundmass is fine-grained to cryptocrystalline and has a subtrachytic texture dominated by flow-aligned plagioclase laths with intergranular tan-coloured clinopyroxene, olivine, very fine-grained Fe-Ti oxides and accessory apatite.

RH-1a: (Lower part of flow, 1977 eruption; Singani; 11°50.5'S 43°18.5'E; no analyses)

Alkali Olivine Basalt

A vesicular (5 vol.%), coarsely porphyritic, seriate-textured rock. Phenocrysts, 70% of which are olivines and 30% are clinopyroxenes, make up 35-40% of this rock. The modal composition is: olivine (35-40%), clinopyroxene (30-35%), plagioclase (5%), Fe-Ti oxide (5%) and groundmass (20%). The subhedral to euhedral olivine macrophenocrysts (up to 5 mm) and phenocrysts (around 2-0.5 mm) are virtually unaltered and contain inclusions of Fe-Ti oxides and very small, needle-shaped microlites. Some olivine phenocrysts show signs of minor resorption. Clinopyroxene occurs as pale tan to pale green, subhedral to euhedral macrophenocrysts (up to 5 mm) and phenocrysts (2-0.5 mm), some of which display oscillatory zonation patterns and contain very fine, needle-shaped microlites. The dark-grey, fine-grained to glassy groundmass contains Fe-Ti oxides, tan-coloured clinopyroxene, plagioclase and lesser amounts of olivine.

RH-1b: (Upper part of flow, 1977 eruption; Singani; 11°50.5'S 43°18.5'E)

Alkali Olivine Basalt

A vesicular (10-15 vol.%), porphyritic rock with a seriate texture. Phenocrysts and microphenocrysts, 55% of which are olivines, 35% are clinopyroxenes and 10% are plagioclases, comprise about 15% of this rock. The modal composition is: clinopyroxene (40%), plagioclase (25%), olivine (20%) and Fe-Ti oxides (15%). The relatively unaltered, subhedral to anhedral olivine phenocrysts (up to 4 mm) and fewer microphenocrysts (around 0.5-1 mm) contain inclusions of Fe-Ti oxides. The tan-coloured clinopyroxene occurs as rare phenocrysts (around 2 mm) and more commonly as microphenocrysts (0.5-1 mm) and as abundant, fine-grained groundmass phase. Clinopyroxene microphenocrysts often occur in glomerophytic clusters. In rare cases, the clinopyroxene phenocrysts have greenish, sieve-textured cores with Fe-Ti oxide inclusions, and clear rims. Microphenocryst-sized (around 0.5 mm) laths of plagioclase occur. The dark grey, fine-grained to cryptocrystalline and partly glassy groundmass contains clinopyroxene, plagioclase, Fe-Ti oxides and lesser amounts of olivine.

A4.1.2 La Grille

RH-2b: (Block in pyroclastic cone; Lac du Sal; 11°22'S 43°22'E; no analyses)

Basanite

A seriate-textured, porphyritic rock with a somewhat altered appearance (clay minerals). Phenocrysts and microphenocrysts, 70% of which are olivines and 30% are clinopyroxenes, make up 35-40% of the rock. The modal composition is: olivine (45%), clinopyroxene (35%), Fe-Ti oxides (5%) and glass (15%). The slightly resorbed and altered olivine phenocrysts range in size from macrophenocrysts (up to 5 mm) to

microphenocrysts (0.5 mm and less). Clinopyroxene phenocrysts (around 1 mm) and microphenocrysts (0.5 mm and less) typically have lighter greenish-grey cores and darker tan-violet titanite rims. Some of the clinopyroxene phenocrysts have sieve-textured cores, but clear rims, whereas the microphenocrysts sometimes occur in glomerophytic clusters. The dark brown groundmass is fine- to very fine-grained and partly glassy, containing tan clinopyroxene, Fe-Ti oxides and olivine. The rock contains one large xenolith (about 1.2 cm long) of harzburgitic (lherzolitic ?) composition.

RH-6: (Flow; N side of Dinde cinder cone; 11°22.5'S 43°21.5'E; no analyses)

Basanite

A vesicular (8-10 vol.%), porphyritic rock. Phenocrysts, 95% of which are olivines and 5% are clinopyroxenes, comprise 15-20% of this rock. The modal composition is: olivine (50%), clinopyroxene (30%), plagioclase (15%) and Fe-Ti oxides (5%). The subhedral phenocrysts (1-3 mm) and microphenocrysts (1-0.5 mm) of olivine are slightly iddingsitised, contain inclusions of Fe-Ti oxides and sometimes show signs of partial resorption. The tan-coloured, subhedral to anhedral clinopyroxene microphenocrysts (1-0.5 mm) typically occur as glomerophytic aggregates. The dark grey to brown groundmass is fine- to very fine-grained and partly glassy and consists of abundant, very fine-grained, tan clinopyroxene, small plagioclase laths, Fe-Ti oxides and olivine.

RH-7: (Block in pyroclastic cone; Goulaivoine; 11°23.5'S 43°23.5'E)

Basanite

A pervasively altered (abundant clay minerals), vesicular (about 5 vol.%), porphyritic to microporphyritic rock. Of the phenocrysts and microphenocrysts, which comprise 10-15% of the rock, 97% are olivines and 3% are clinopyroxenes. The modal composition is: olivine (50%), clinopyroxene (40%), plagioclase (5%) and Fe-Ti oxides (5%). Olivine occurs as partly resorbed and altered, subhedral to anhedral phenocrysts (around 1 mm) and predominantly microphenocrysts (<1 mm). Rare, altered, light grey to tan clinopyroxene microphenocrysts, some with sieve-textured cores, are present. The altered, very fine-grained to cryptocrystalline and partly glassy groundmass contains tan-coloured clinopyroxene, plagioclase, olivine and Fe-Ti oxides. The rock contains one altered xenolith (around 6-7 mm), apparently of harzburgitic (lherzolitic ?) composition.

RH-9: (Beach cobble; Ivoini; 11°23'S 43°23'E)

Basanite

A vesicular (5-8 vol.%), porphyritic to microporphyritic rock with a seriate texture. Of the phenocrysts, which comprise about 20% of this rock, 99% are olivines and only 1% are clinopyroxenes. The approximate modal composition is: olivine (55%), clinopyroxene (30%), plagioclase (10%), Fe-Ti oxides (5%). The anhedral, unaltered, but partly

resorbed olivine phenocrysts range in size from a single macrophenocryst (about 4 mm), through phenocrysts (2-0.5 mm) to microphenocrysts (<0.5 mm). Rare microphenocrysts (around 0.5 mm) of pale tan clinopyroxene occur singly and as glomerophyric aggregates. The very fine-grained to cryptocrystalline and partly glassy groundmass contains abundant clinopyroxene and plagioclase, with smaller amounts of Fe-Ti oxides and olivine.

RH-11: (Pillow lava; N of Mitsamiouli; 11°23'S 43°17'E)

Basanite

A vesicular (10-15 vol.%), porphyritic rock with a seriate texture. Phenocrysts and microphenocrysts, 60% of which are clinopyroxenes and 40% are olivines, make up 30-40% of this rock. The modal composition is: clinopyroxene (50-55%), olivine (40-45%) and Fe-Ti oxides (5%). The subhedral phenocrysts and microphenocrysts (range of sizes, around 1 mm and less) of clinopyroxene typically have pale grey-tan cores and slightly darker tan to violet titanite rims. The zoned and sometimes twinned clinopyroxene phenocrysts often occur in glomerophyric clusters. Some clinopyroxene phenocrysts have sieve-textured cores and clear rims. Some of the subhedral olivine phenocrysts and microphenocrysts (range of sizes up to about 2 mm) show signs of resorption. The dark grey-brown groundmass is very fine-grained to cryptocrystalline and partly glassy and appears to contain predominantly tan-coloured clinopyroxene and Fe-Ti oxide, with smaller amounts of olivine.

A4.2 Moheli

A4.2.1 Alkali Basalts

RH-15: (Flow; 1 km E of Sambia; 12°22'S 43°47'E)

Alkali Olivine Basalt

A slightly vesicular (5 vol.%), coarsely olivine and clinopyroxene phyric rock. Phenocrysts, 50% of which are olivines and 50% are clinopyroxenes, make up 40-45% of the rock. The modes are clinopyroxene (40%), olivine (30%), plagioclase (20%) and Fe-Ti oxides (10%). Slightly iddingsitised, euhedral to subhedral olivine macrophenocrysts (up to 4 mm) and phenocrysts (around 1 mm) occur. Subhedral to euhedral, seriate-textured clinopyroxene crystals vary in size from macrophenocrysts (up to 5 mm and more) through phenocrysts (around 1 mm) to microphenocrysts (around 0.5 mm). The clinopyroxene phenocrysts show small-scale oscillatory zonation and some of the microphenocrysts occur in glomerophyric clusters of radiating crystals. Some microphenocryst-sized plagioclase laths occur. The groundmass is fine-grained and consists mainly of plagioclase laths and interstitial clinopyroxene and Fe-Ti oxides.

RH-16: (Flow; 0.5 km E of Sambia; 12°22'S 43°47'E)

Alkali Olivine Basalt

A sparsely porphyritic rock containing anhedral phenocrysts and microphenocrysts of olivine and clinopyroxene. Phenocrysts and microphenocrysts, 65% of which are olivines and 35% are clinopyroxenes (mainly microphenocrysts), make up 5% of the rock. The modes are plagioclase (35%), olivine (30%), clinopyroxene (25%) and Fe-Ti oxides (10%). Some of the clinopyroxene crystals have zoned rims and many have sieve-textured cores. The fine-grained groundmass consists predominantly of plagioclase with intergranular clinopyroxene, Fe-Ti oxides and olivine.

RH-17: (Flow; 0.5 km W of Moibani; 12°22'S 43°46.5'E)

Ankaramite

A coarsely clinopyroxene and olivine phyric, slightly vesicular (5 vol.%) and slightly altered rock. Phenocrysts, 55% of which are clinopyroxenes and 45% are olivines, make up 35-40% of the rock. The modes are clinopyroxene (35%), plagioclase (35%), olivine (25%) and Fe-Ti oxides (5%). The tan-coloured clinopyroxene phenocrysts, ranging in size from around 5 mm (macrophenocrysts) to 0.5 mm (microphenocrysts), often exhibit oscillatory zonation, twinning and minor inclusions of the other phases present. Clinopyroxene microphenocrysts often occur in glomerophytic clusters. The anhedral to subhedral olivine macrophenocrysts (up to 5 mm) and phenocrysts show only slight signs of alteration. Flow-aligned plagioclase laths, up to 0.5 mm long, are the predominant phase in the fine-grained to cryptocrystalline and partly glassy groundmass with intergranular clinopyroxene and Fe-Ti oxides.

RH-28: (Flow; Domoni; 12°15'S 43°38.5'E)

Alkali Olivine Basalt

A highly vesicular (25 vol.%), olivine and clinopyroxene phyric rock. Phenocrysts, 60% of which are olivines and 40% are clinopyroxenes, make up 10-15% of the rock. Mineral phases present are: olivine (35%), clinopyroxene (35%), plagioclase (20%) and Fe-Ti oxides (10%). The olivine phenocrysts and microphenocrysts are partly iddingsitised and many show signs of resorption. Clinopyroxene occurs as elongate microphenocrysts, commonly clustered in small radiating aggregates. The dark brown groundmass consists of plagioclase, Fe-Ti oxides, clinopyroxene, olivine and cryptocrystalline to glassy material.

RH-42: (Stream boulder; 4 km up Rio Ouamlembini; 12°17.5'S 43°42.5'E)

Alkali Basalt

A medium- to coarse-grained, slightly vesicular (5 vol.%) rock with a seriate texture of interlocking crystals. The modes are plagioclase (40%), clinopyroxene (35%), olivine (25%) and Fe-Ti oxides (5%). Olivine and clinopyroxene appear intergranular within a framework of interlocking plagioclase laths (up to 4 mm long, but mostly around 1 mm). Many clinopyroxene crystals display slightly sieve-textured, greenish, diopsidic cores and tan to violet titanite rims. The finer-grained clinopyroxene crystals are tan to purple titanites. The olivine is partially iddingsitised. Relatively coarse-grained (up to 0.7 mm), angular crystals of Fe-Ti oxides sometimes partially or entirely enclose plagioclase and clinopyroxene.

A4.2.2 Basanites

RH-12a: (Flow; 1 km N of Sambia; 12°21.5'S 43°47.5'E)

Basanite

A slightly vesicular (5 vol.%), olivine and clinopyroxene phyric rock. Phenocrysts, 65% of which are olivines and 35% are clinopyroxenes, make up 20% of the rock. The approximate modal composition is: olivine (40%), clinopyroxene (30%), Fe-Ti oxides (15-20%) and nepheline (5-10%). The subhedral to anhedral phenocrysts and microphenocrysts of olivine display a seriate texture (grainsizes vary from 1.5 to <0.5 mm) and some show signs of resorption. The clinopyroxene phenocrysts (around 1 mm) and microphenocrysts display oscillatory zoning and are often strongly altered. Clinopyroxene phenocrysts with greenish, diopsidic, sieve-textured cores with abundant inclusions of Fe-Ti oxides, and tan titanite rims are common. The very fine-grained to cryptocrystalline groundmass consists predominantly of clinopyroxene, Fe-Ti oxides and nepheline.

RH-21: (Flow; 1 km SW of Hagnamoida; 12°20'S 43°51'E)

Basanite

An olivine and clinopyroxene phyric, slightly vesicular (<5 vol.%) rock with a somewhat altered appearance. Phenocrysts and microphenocrysts, 55% of which are olivines and 45% are clinopyroxenes (mainly microphenocrysts), make up 35-40% of the rock. The modes are as follows: olivine (45%), clinopyroxene (40%), Fe-Ti oxides (10%) and nepheline (5%). The olivine occurs as subhedral phenocrysts (up to 2 mm) and microphenocrysts with iddingsitised rims. Many olivine phenocrysts shows signs of resorption. Clinopyroxene is present mainly as light grey, augitic, anhedral microphenocrysts (1.0 to 0.5 mm) with tan titanite rims displaying fine oscillatory zoning. The groundmass is cryptocrystalline to partly glassy and appears to consist

predominantly of clinopyroxene, Fe-Ti oxides and possibly nepheline.

RH-26: (Flow; 2 km NW of Fombani; 12°16'S 43°43'E)

Basanite

A vesicular (5-10 vol.%), porphyritic rock containing phenocrysts and microphenocrysts of olivine and clinopyroxene. Phenocrysts and microphenocrysts, 55% of which are olivines and 45% are clinopyroxenes, make up 20-25% of the rock. The modes are clinopyroxene (35-40%), olivine (35%) and Fe-Ti oxides (10%) with the remainder of the rock being made up of glassy groundmass. Olivine occurs as subhedral phenocrysts, mostly about 0.5-1.0 mm, but up to 2.5 mm in size. Clinopyroxene is present mainly as subhedral microphenocrysts (0.5 mm and less) with grey, augitic cores and tan to violet titanite rims. A few phenocrysts (around 1 mm) of clinopyroxene are observed, generally with oscillatory zoning and greenish, diopsidic, sieve-textured cores with inclusions of Fe-Ti oxides, and tan to violet titanite rims. The fine-grained to partially glassy groundmass consists predominantly of clinopyroxene and Fe-Ti oxides.

RH-27: (Flow; 1.2 km N of Fombani; 12°16'S 43°43'E)

Basanite

A vesicular (10 vol.%), porphyritic rock containing clinopyroxene and olivine phenocrysts and microphenocrysts. Phenocrysts and microphenocrysts, 55% of which are clinopyroxenes and 45% are olivines, make up 35% of the rock. The modes are clinopyroxene (45-50%), olivine (35-40%) and Fe-Ti oxides (15%). Clinopyroxene occurs as anhedral, zoned phenocrysts (up to 3.5 mm), but more commonly as microphenocrysts (around 1 mm). Many of the clinopyroxene phenocrysts have sieve-textured cores with inclusions of Fe-Ti oxides and zoned tan to purple rims. The subhedral olivine phenocrysts (up to 2 mm) and microphenocrysts have iddingsitised rims and sometimes show signs of resorption. The very fine-grained to partially cryptocrystalline and glassy groundmass contains Fe-Ti oxides, clinopyroxene and possibly accessory nepheline.

RH-29: (Dike; Domoni; 12°15'S 43°38.5'E)

Basanite

A vesicular (10 vol.%), microporphyritic/vitrophyric rock, containing microphenocrysts of clinopyroxene, olivine and Fe-Ti oxides in a brown, glassy groundmass. Microphenocrysts, 45% of which are clinopyroxenes, 35% are olivines and 10% are Fe-Ti oxides, make up 20% of this rock. The lath-shaped, anhedral clinopyroxene microphenocrysts (0.5 mm and less) are zoned (some showing hourglass zonation) and exhibit a partially glomerophytic texture. Besides one agglomeration (xenolith ?) of relatively unaltered olivine, all olivine phenocrysts are totally iddingsitised. Relatively coarse (up to about 0.7 mm), angular grains of Fe-Ti oxides sometimes occur in small

clusters.

RH-30: (Flow; 0.5 km N of Domoni; 12°14.5'S 43°38.5'E)

Basanite

A strongly altered, porphyritic rock containing phenocrysts and microphenocrysts of olivine and clinopyroxene. Phenocrysts and microphenocrysts, 85% of which are olivines and 15% are clinopyroxenes, make up 20% of the rock. The modes are clinopyroxene (40%), olivine (35%), nepheline (15%) and Fe-Ti oxides (10%). The anhedral phenocrysts (up to about 2 mm) and microphenocrysts (0.5 mm and less) of olivine are strongly to totally iddingsitised. The few anhedral phenocrysts (1.0-1.5 mm) and microphenocrysts (0.5 mm and less) of clinopyroxene have greenish, diopsidic, sieve-textured cores and tan titanite rims. Clinopyroxene also occurs as prismatic and lath-shaped crystals in the groundmass. Some clinopyroxene phenocrysts contain inclusions of relatively coarse-grained Fe-Ti oxides. The groundmass is fine-grained, containing primarily clinopyroxene, Fe-Ti oxides, nepheline and small amounts of olivine.

RH-33: (Flow; Gnambo-Yamabre; 12°15'S 43°40'E)

Basanite

An altered, vesicular (15 vol.%) rock with a relatively coarser-grained seriate texture. Phenocrysts (around 1.0 mm) and microphenocrysts (0.5 mm and less) of clinopyroxene and olivine occur. Of the phenocrysts and microphenocrysts 60% are clinopyroxenes and 40% are olivines. The modes are clinopyroxene (45%), nepheline (25%), olivine (20%) and Fe-Ti oxides (10%). The larger clinopyroxene phenocrysts have greenish, diopsidic, sieve-textured cores and show oscillatory zoning. Some of the strongly to completely iddingsitised phenocrysts and microphenocrysts of olivine show signs of resorption. Fe-Ti oxides occur as relatively coarse, angular grains and sometimes as inclusions in clinopyroxene. The relatively coarse-grained groundmass consists of nepheline, clinopyroxene, Fe-Ti oxides and olivine and contains abundant elongate and needle-shaped microlites of clinopyroxene and possibly apatite.

RH-36: (Flow; 1 km E of Djoiezi; 12°18'S 43°47'E)

Basanite

A vesicular (10 vol.%), olivine phyric rock with a modal composition of clinopyroxene (40%), olivine (30%), nepheline (15%) and Fe-Ti oxides (15%). Phenocrysts and microphenocrysts of olivine make up 15-20% of this rock. Olivine occurs as anhedral, mildly to strongly iddingsitised phenocrysts (around 1.5-2.0 mm) and microphenocrysts (<1.0 mm), many of which show signs of resorption. Extremely few phenocrysts of clinopyroxene are present, but this mineral is abundant as prismatic and elongate crystals in the groundmass. Nepheline occurs in the groundmass, poikilitic to clinopyroxene, while

the Fe-Ti oxides show a seriate texture, ranging in grainsize from very fine to almost microphenocryst-size (up to about 0.4 mm). The groundmass is very fine-grained to cryptocrystalline and consists of clinopyroxene, nepheline, Fe-Ti oxides and small amounts of olivine.

RH-39: (Flow; Djoiezi; 12°18'S 43°46.5'E)

Basanite

An altered, vitrophyric rock containing clinopyroxene and olivine phenocrysts and microphenocrysts. Phenocrysts and microphenocrysts, 52% of which are clinopyroxenes and 48% are olivines, make up 15% of the rock. The modes are clinopyroxene (30%), olivine (25%) and Fe-Ti oxides (10%), with accessory nepheline and a glassy groundmass making up the rest of the rock. Altered, anhedral phenocrysts (up to about 1.5 mm) and microphenocrysts (0.5 mm and less) of clinopyroxene occur. The larger clinopyroxene phenocrysts generally exhibit greenish, diopsidic, sieve-textured cores and tan rims. Slightly iddingsitised, subhedral phenocrysts (up to 2.5 mm) and considerably altered microphenocrysts (<0.5 mm) of olivine are present. The groundmass is glassy and appears to contain Fe-Ti oxides, clinopyroxene and nepheline.

A4.2.3 Nephelinites

RH-14: (Flow; 1 km W of Sambia; 12°22'S 43°48.5'E)

Olivine Nephelinite

A slightly vesicular (5 vol.%), porphyritic rock, containing phenocrysts and microphenocrysts of olivine and clinopyroxene. Phenocrysts and microphenocrysts, 95% of which are olivines and 5% are clinopyroxenes, make up 20-25% of the rock. The modes are as follows: olivine (30%), clinopyroxene (30%), nepheline (25%), Fe-Ti oxides (10%) and biotite (5%). The olivine phenocrysts (up to 2.5 mm) and microphenocrysts (around 0.5 mm) are slightly iddingsitised and some show signs of resorption. Clinopyroxene is present predominantly as tan-coloured microphenocrysts (<0.5 mm) and as elongate, flow-aligned crystals in the groundmass. Oscillatory and hourglass zoning is observed in the clinopyroxene microphenocrysts. Clinopyroxene, Fe-Ti oxides and nepheline, together with much smaller amounts of olivine and biotite make up the fine-grained groundmass.

RH-18: (Flow; 0.5 km W of Moibani; 12°22'S 43°46.5'E)

Olivine Nephelinite

A porphyritic rock containing anhedral olivine phenocrysts and microphenocrysts (mostly <0.5 mm). Olivine phenocrysts and microphenocrysts make up 15-20% of the rock. The

modal composition is: olivine (40%), clinopyroxene (25%), nepheline (20%), Fe-Ti oxides (15%) and accessory amounts of biotite. The groundmass is very fine-grained to cryptocrystalline and consists of clinopyroxene, Fe-Ti oxides, nepheline and very small amounts of olivine and biotite and furthermore contains abundant needle-shaped microlites (clinopyroxene, apatite ?).

RH-31: (Flow; 1 km W of Domoni; 12°15'S 43°38'E)

Olivine Nephelinite

A porphyritic rock containing phenocrysts and microphenocrysts of olivine and a small proportion of clinopyroxene phenocrysts. Phenocrysts and microphenocrysts, 99% of which are olivines, make up 15% of the rock. The modes are olivine (30%), clinopyroxene (30%), nepheline (25%) and Fe-Ti oxides (15%). Unaltered, subhedral to anhedral olivine phenocrysts (up to 2.5 mm) and microphenocrysts (<0.5 mm) are present, some of which show signs of resorption. Very few, altered clinopyroxene microphenocrysts (<0.5 mm) occur. One strongly corroded phenocryst/xenocryst ? of clinopyroxene (about 2 mm in size) has a greenish, diopsidic, sieve-textured core and a tan titanite rim. Clinopyroxene occurs predominantly as tan-coloured, fine-grained, elongate groundmass crystals. Nepheline is an abundant phase in the fine-grained groundmass, generally displaying a poikilitic relationship with the other main groundmass phases, clinopyroxene and Fe-Ti oxides.

RH-41: (Stream boulder; 4 km up Rio Ouamlembini; 12°17.5'S 43°42'E)

Nephelinite

A vesicular (10 vol.%), porphyritic rock containing phenocrysts and microphenocrysts of clinopyroxene and olivine. The phenocrysts and microphenocrysts, of which 55% are clinopyroxenes and 45% are olivines, make up 20% of the rock. The modes are clinopyroxene (40%), olivine (30%), Fe-Ti oxides (15%) and nepheline (15%). Clinopyroxene occurs mainly as microphenocrysts (1 mm and less), but some phenocrysts (up to 4 mm) are present. The anhedral clinopyroxene crystals often have sieve-textured cores and tan titanite rims and commonly display oscillatory zoning. The olivine phenocrysts and microphenocrysts are slightly iddingsitised and some show signs of resorption. Clinopyroxene, Fe-Ti oxides and nepheline make up the very fine-grained to cryptocrystalline groundmass.

A4.3 Mayotte

A4.3.1 Shield-Building Phase

A4.3.1.1 La Grille-Type

MA-60: (Flow; roadcut 1.5 km S of Dembeni; 12°51'S 45°11.5'E)

Basanite

An altered, seriate-textured, porphyritic rock. Phenocrysts and microphenocrysts, 50% of which are olivines and 50% are clinopyroxenes, make up around 20% of this rock. The modes are clinopyroxene (35%), olivine (30%), Fe-Ti oxide (5%) and groundmass (25-30%). Phenocrysts (up to 1.5 mm) and microphenocrysts (0.5 mm and less) of clinopyroxene typically have pale grey-green or green cores and slightly darker tan-violet rims. The clinopyroxene phenocrysts often contain Fe-Ti oxide inclusions and sometimes occur as small clusters. The anhedral to subhedral, partly to strongly iddingsitised phenocrysts of olivine range in size from macrophenocrysts (about 5 mm) to microphenocrysts (around 0.5 mm and less) and commonly show signs of partial resorption. The altered, dark grey, fine- to very fine-grained and partly glassy groundmass appears to contain clinopyroxene, Fe-Ti oxides, nepheline, olivine and accessory biotite and apatite.

MA-61: (Stream boulder; N of Bambo-Est; 12°55.5'S 45°10.5'E)

Nephelinite

A slightly altered (chloritised), coarsely porphyritic rock. Phenocrysts and microphenocrysts, 85% of which are clinopyroxenes and 15% are Fe-Ti oxides, make up 35-40% of this rock. The modal composition is: clinopyroxene (55%), Fe-Ti oxide (10-15%) and groundmass (30%, nepheline, biotite). Euhedral to subhedral clinopyroxene phenocrysts, ranging in size from macrophenocrysts (around 5 mm) to microphenocrysts (around 0.5 mm and less) occur. These clinopyroxene phenocrysts are pale tan to pale tan-violet in colour, contain Fe-Ti oxide inclusions and display oscillatory and irregular, fine-scale zonation patterns. Anhedral phenocrysts (around 1 mm) and microphenocrysts (around 0.5 mm and less) of Fe-Ti oxide occur. The fine- to very fine-grained and partly glassy groundmass contains clinopyroxene, Fe-Ti oxides, nepheline and accessory biotite and apatite.

A4.3.1.2 Karthala-Type

MA-29: (Flow; roadcut, N tip of Magi Agnoughni; 12°40'S 45°5'E)

Alkali Basalt

A slightly vesicular (<5 vol.%), porphyritic rock. Except for rare clinopyroxene and Fe-Ti oxide microphenocrysts, all of the phenocrysts and microphenocrysts, which comprise about 10% of this rock, are olivines. The modes are olivine (55%), clinopyroxene (30%), plagioclase (10%) and Fe-Ti oxide (5%). Olivine occurs as subhedral to anhedral, relatively fresh to slightly iddingsitised phenocrysts (up to about 2 mm) and more commonly microphenocrysts (around 0.5 mm and less). Rare microphenocrysts of clinopyroxene and Fe-Ti oxide occur. The very fine-grained to cryptocrystalline and partly glassy groundmass contains clinopyroxene, plagioclase, olivine and Fe-Ti oxides.

MA-30: (Flow below MA-29; N tip of Magi Agnoughni; 12°40'S 45°5'E)

Alkali Basalt

A slightly altered, moderately vesicular (5-8 vol.%), seriate-textured rock. Phenocrysts and microphenocrysts, 50% of which are olivines and 50% are clinopyroxenes, comprise about 20% of the rock. The modal proportions are: 35% clinopyroxene, 30% olivine, 25-30% plagioclase and 5% Fe-Ti oxide. The slightly iddingsitised, anhedral to subhedral phenocrysts and microphenocrysts (around 1 mm to 0.5 mm) of olivine show signs of partial resorption. Clinopyroxene occurs as pale tan coloured, subhedral phenocrysts and microphenocrysts (usually between 1 mm and 0.5 mm), commonly clustered into small, sometimes radiating, aggregates. The fine-grained groundmass contains clinopyroxene, laths of plagioclase, Fe-Ti oxides and olivine.

A4.3.2 Post-Erosional Phase

MA-55: (Flow; roadcut N of Sada; 12°51'S 45°6'E)

Tephrite

A moderately porphyritic rock. Of the phenocrysts and microphenocrysts, which comprise 10-15% of the rock, 90% are clinopyroxenes and 10% are Fe-Ti oxides. The modal proportions are: clinopyroxene (35-40%), Fe-Ti oxides (10%) and groundmass (50-55%, clinopyroxene, nepheline, glass). Clinopyroxene occurs as subhedral phenocrysts, ranging in size from macrophenocrysts (around 5 mm) to microphenocrysts (0.5 mm and less) and often contains Fe-Ti oxide inclusions. The zoned clinopyroxene phenocrysts are typically pale tan, but commonly have pleochroic green or violet cores and pale tan to tan-violet rims. Glomerophytic clusters of clinopyroxene are common. Angular phenocrysts (up to about 1 mm) and microphenocrysts (around 0.5 mm and less) of Fe-Ti

oxide occur. The very fine-grained to cryptocrystalline and partly glassy groundmass contains clinopyroxene, Fe-Ti oxides, nepheline and accessory apatite.

MA-73: (Flow; roadcut 1.5 km E of Boueni; 12°54'S 45°5.5'E)

Nephelinite

A seriate-textured, porphyritic rock. Of the phenocrysts and microphenocrysts, which comprise about 10% of this lava, 53% are nephelines, 40% are clinopyroxenes (aegirine/aegirine-augite) and 7% are garnets (schorlomite). The modal composition is: nepheline (45-50%), clinopyroxene (45-50%) and garnet (5%). The angular, euhedral to subhedral nepheline phenocrysts (up to about 2 mm) and microphenocrysts (around 0.5 mm and less) with cubic or hexagonal sections sometimes contain inclusions of clinopyroxene. Clinopyroxene occurs as anhedral to subhedral, pale green to green, pleochroic aegirine/aegirine-augite phenocrysts (up to about 1.5 mm) and microphenocrysts (0.5 mm and less). Anhedral to subhedral, dark brown microphenocrysts (around 0.5 mm) of schorlomite occur. The slightly altered, fine- to very fine-grained groundmass consists of abundant nepheline and green aegirine/aegirine-augite, with rare Fe-Ti oxides and accessory apatite.

A4.3.3 Rejuvenescent Phase

A4.3.3.1 La Grille-Type

MA-2: (Block in tuff cone; Dziani Dzaha, N Pamanzi; 12°46'S 45°17.5'E)

Basanite

An altered (veins filled with secondary clay minerals and/or carbonate material), slightly vesicular (5 vol.%), moderately porphyritic rock with a seriate texture. Phenocrysts and microphenocrysts, 90-95% of which are pseudomorphs after olivine and amphibole, 5% are clinopyroxenes and less than 5% are Fe-Ti oxides, comprise about 10% of the rock. The modes are plagioclase (40%), amphibole and olivine pseudomorphs (30%), clinopyroxene (20-25%) and Fe-Ti oxide (5-10%). The subhedral phenocryst- and microphenocryst-sized (range of sizes around 1 mm and less) pseudomorphs after amphibole and olivine show signs of resorption and frequently enclose Fe-Ti oxides. The isolated microphenocrysts (<0.5 mm) of clinopyroxene often contain inclusions of Fe-Ti oxide. Isolated microphenocryst-sized (<0.5 mm) Fe-Ti oxide grains also occur. The fine- to medium-grained, altered groundmass contains plagioclase, Fe-Ti oxides, clinopyroxene, altered amphibole and olivine and accessory apatite.

MA-4: (Block in tuff cone; Dziani Dzaha, N Pamanzi; 12°46'S 45°17.5'E)

Basanite

An altered (cracks and amygdales filled with calcite and/or clay minerals), slightly vesicular (<5 vol.%), slightly porphyritic rock. Phenocrysts of olivine, clinopyroxene and Fe-Ti oxide make up 5-10% of this rock. The modal composition is: plagioclase (45%), clinopyroxene (35%), olivine (5-10%), Fe-Ti oxide (10%) and biotite (<5%). The majority of olivine and clinopyroxene phenocrysts have been almost entirely altered and only isolated microphenocrysts of these phases remain relatively unaltered. Rare microphenocryst-sized grains of Fe-Ti oxide occur. The altered, fine- to relatively medium-grained groundmass consists predominantly of plagioclase laths, tan-violet titanite and Fe-Ti oxides with accessory biotite and olivine.

MA-7: (Flow; W of Kongo; 12°44'S 45°12'E)

Subalkali Basalt

An altered, vesicular (5-10 vol.%), porphyritic rock with a seriate texture. Phenocrysts and microphenocrysts, of which 60% are clinopyroxenes and 40% are olivines, comprise approximately 15% of this rock. The modal composition is: clinopyroxene (40%), plagioclase (30%), olivine (25%) and Fe-Ti oxide (5%). Clinopyroxene occurs as zoned, subhedral phenocrysts (up to 3 mm) and microphenocrysts (around 0.5 mm and less). The clinopyroxene phenocrysts often have pale green, sometimes sieve-textured, cores and tan rims. Anhedral, partially resorbed and moderately to strongly iddingsitised phenocrysts (up to 2 mm) and microphenocrysts (around 0.5 mm) of olivine occur. The somewhat altered, fine- to very fine-grained and partly glassy groundmass contains abundant plagioclase with subordinate amounts of Fe-Ti oxides, clinopyroxene and iddingsitised olivine.

MA-12: (Flow; 1 km SE of Kongo; 12°44.5'S 45°13'E)

Alkali Basalt

A slightly vesicular (<5 vol.%), porphyritic and microporphyritic rock with a seriate texture. Phenocrysts, of which 50% are clinopyroxenes and 50% are olivines, comprise about 20% of this rock. The modal composition is: plagioclase (40%), clinopyroxene (30%), olivine (25%) and Fe-Ti oxide (5%). Subhedral to anhedral clinopyroxene phenocrysts (up to 1.5 mm) and microphenocrysts (around 0.5 mm) with oscillatory zonation patterns occur. These phenocrysts are typically light tan in colour, although some have pale tan-violet rims and many have pale green cores. Some clinopyroxene phenocrysts have sieve-textured cores and some have inclusions of Fe-Ti oxides concentrated in their cores. The subhedral to anhedral olivine phenocrysts (up to around 2 mm) and microphenocrysts (0.5 mm and less) are strongly to totally iddingsitised and partially resorbed. Rare microphenocryst-sized (around 1-0.5 mm and less) grains of plagioclase and Fe-Ti oxide are also present. The light coloured, fine- to medium-grained

groundmass has a subtrachytic texture, dominated by moderately flow-aligned plagioclase laths with intergranular clinopyroxene, Fe-Ti oxides, lesser olivine and accessory alkali feldspar and apatite.

MA-17: (Flow; .25 km E of Kangani; 12°43.5'S 45°11.5'E)

Shoshonite

A slightly altered, vesicular (10-15 vol.%), porphyritic rock with a subtrachytic texture. Phenocrysts, of which 90% are amphiboles, 6% are feldspars and 4% are clinopyroxenes, comprise about 10-15% of this rock. The approximate modal proportions are: plagioclase (55-60%), amphibole (20-25%), alkali feldspar (10%), clinopyroxene (5%) and Fe-Ti oxide (5%). Amphibole occurs as subhedral to anhedral, isolated macrophenocrysts (up to 4 mm), but mainly as phenocrysts (around 0.5-2 mm), with opaque Fe-Ti oxide rims. Rare phenocrysts (around 1 mm, up to about 3.5 mm) of feldspar and corroded remnants of pale green clinopyroxene occur. The slightly altered, light grey, fine-grained groundmass has a subtrachytic texture, dominated by flow-aligned plagioclase laths with subordinate Fe-Ti oxides, alkali feldspar, relatively abundant apatite and possibly accessory titanite (sphene).

MA-22: (Flow; .75 km W of Mitseni; 12°43.5'S 45°8'E)

Basanite

A vesicular (5 vol.%), porphyritic, seriate-textured rock. Phenocrysts and microphenocrysts, of which 65% are olivines and 35% are clinopyroxenes, make up approximately 10% of this rock. The modal composition is: clinopyroxene (40%), olivine (30%), nepheline (25%) and Fe-Ti oxide (5%). The subhedral to anhedral phenocrysts (up to 1.5 mm) and microphenocrysts (0.5 mm and less) of olivine sometimes occur in small clusters, show signs of resorption and are moderately to strongly iddingsitised. Clinopyroxene occurs as subhedral to anhedral phenocrysts (up to 2 mm) and microphenocrysts (0.5 mm and less), which typically have grey-tan to pale green, sometimes sieve-textured, cores and darker tan-violet rims. Many clinopyroxene phenocrysts contain Fe-Ti oxide inclusions. The fine-grained groundmass has a granular texture and consists predominantly of tan-violet clinopyroxene and interstitial to poikilitic nepheline with smaller amounts of seriate-textured Fe-Ti oxides and olivine.

MA-33: (Boulder; 2 km W of Passamainti; 12°47'S 45°11.5'E)

Basanite

A slightly vesicular (about 5 vol.%), seriate-textured, porphyritic rock. Phenocrysts and microphenocrysts, 58% of which are clinopyroxenes, 37% are olivines and 5% are Fe-Ti oxides, make up about 35% of this rock. The modes are clinopyroxene (45%), olivine (25%), plagioclase (25%) and Fe-Ti oxide (5%). The subhedral phenocrysts (up to 2.5

mm) and microphenocrysts (0.5 mm and less) of clinopyroxene typically have pale grey-tan or pale green cores and darker tan to tan-violet rims. Clinopyroxene phenocrysts and microphenocrysts frequently occur in glomerophytic clusters, show irregular and oscillatory zonation patterns, contain Fe-Ti oxide inclusions and sometimes have sieve-textured cores. The anhedral phenocrysts (up to about 2.5 mm) and microphenocrysts (around 0.5 mm and less) of olivine have moderately to considerably iddingsitised rims, contain Fe-Ti oxide inclusions and frequently display signs of partial resorption. Isolated microphenocryst-sized Fe-Ti oxide grains occur. The fine-grained and partly glassy groundmass contains clinopyroxene, plagioclase, Fe-Ti oxides, lesser olivine and accessory apatite. Glassy patches contain abundant microlite needles.

MA-34: (Flow; roadcut W of Passamainti; 12°47.5'S 45°11.5'E)

Shoshonite

A moderately porphyritic rock with a subtrachytic texture. Phenocrysts and microphenocrysts, of which 45% are clinopyroxenes, 30% are amphiboles, 20% are alkali feldspars and 5% are Fe-Ti oxides, comprise 5-10% of this rock. The modal composition is: plagioclase (45%), clinopyroxene (25%), amphibole (15%), alkali feldspar (10%) and Fe-Ti oxide (5%). The pale tan to pale green, subhedral clinopyroxene phenocrysts and microphenocrysts (range of sizes from less than 0.5 mm to about 1.5 mm) commonly occur in clusters and contain inclusions of Fe-Ti oxides. The anhedral phenocrysts (up to 1.5 mm) and microphenocrysts (0.5 mm and less) of amphibole have opaque rims, rich in Fe-Ti oxides. Anhedral to subhedral phenocrysts (up to 3 mm) and microphenocrysts (0.5 mm and less) of alkali feldspar occur. Some microphenocryst-sized Fe-Ti oxide grains are present. The fine-grained, subtrachytic groundmass is dominated by flow-aligned plagioclase laths with interstitial Fe-Ti oxides, clinopyroxene, amphibole, alkali feldspar and accessory apatite.

A4.3.3.2 Karthala-Type

MA-1: (Flow; S of west pier, Djaoudji; 12°47'S 45°15'E)

Basanite

A highly vesicular (15-20 vol.%), microporphyritic rock. Microphenocrysts, of which 75% are olivines, 20-25% are clinopyroxenes and <5% are Fe-Ti oxides, make up about 15% of the rock. The modal composition is as follows: olivine (50%), clinopyroxene (35%), Fe-Ti oxide (5%), glass and plagioclase (10%). Olivine occurs as subhedral, slightly to entirely iddingsitised microphenocrysts (around 0.5 mm and less). The light grey-tan, augitic, frequently altered clinopyroxene microphenocrysts (around 0.7 mm and less) often occur in small glomerophytic aggregates. Many individual clinopyroxene crystals, as well as some of the aggregates, display sieve-textured cores and clear rims. Fe-Ti oxides occur as isolated microphenocrysts (around 0.2 mm), as inclusions in clinopyroxene and olivine microphenocrysts and as a fine-grained groundmass phase. The

dark grey-brown, very fine-grained to cryptocrystalline and partly glassy groundmass contains clinopyroxene, Fe-Ti oxides, fine laths of plagioclase, olivine and glass.

MA-3: (Block in tuff cone; Dziani Dzaha, N Pamanzi; 12°46'S 45°17.5'E)

Phonotephrite

A porphyritic rock with a seriate texture. Phenocrysts of amphibole (45%), clinopyroxene (45%), plagioclase (5%) and Fe-Ti oxides (5%) make up around 30% of this rock. The modal composition is: plagioclase (40%), clinopyroxene (35%), amphibole (20%) and Fe-Ti oxide (5%). The subhedral to anhedral, pleochroic brown kaersutite phenocrysts (up to 2 mm) and fewer microphenocrysts (around 0.5 mm) show Fe-Ti oxide rich rims and contain inclusions of Fe-Ti oxides, clinopyroxene, plagioclase and apatite. Clinopyroxene occurs as light grey-tan to sometimes pale violet, subhedral phenocrysts (2-2.5 mm) and microphenocrysts (0.5 mm and less) which contain Fe-Ti oxide inclusions. The clinopyroxene phenocrysts sometimes occur in glomerophytic clusters and exhibit oscillatory and more complex zonation patterns. Lath-shaped plagioclase phenocrysts (up to about 2 mm) and microphenocrysts (around 1-0.5 mm) are present. Phenocrysts and microphenocrysts (about 1-0.3 mm) of Fe-Ti oxides also occur. The fine-grained to cryptocrystalline, subtrachytic groundmass consists mainly of plagioclase with smaller amounts of Fe-Ti oxides, clinopyroxene (augite and aegirine-augite) and apatite.

MA-5: (Boulder; E of Trevani; 12°44'S 45°12'E)

Trachyte

An aphyric to sparsely porphyritic rock with a trachytic texture. Of the phenocrysts and microphenocrysts which comprise about 5% of this rock, 85% are plagioclases and 15% are amphiboles (totally replaced by Fe-Ti oxides). The modes are plagioclase (85%), aegirine-augite (10%) and Fe-Ti oxide (5%, including replaced amphibole). Isolated subhedral phenocrysts (up to 2.5 mm) and microphenocrysts (around 0.5 mm) of plagioclase occur. Isolated amphibole phenocrysts and microphenocrysts have been entirely replaced by Fe-Ti oxides. The fine-grained, light-coloured groundmass has a trachytic texture, consisting almost entirely of flow-aligned plagioclase laths with minor interstitial, green aegirine-augite, Fe-Ti oxides and accessory apatite.

MA-6: (Boulder; E of Trevani; 12°44'S 45°12'E)

Mugearite

A slightly vesicular (<5 vol.%), porphyritic rock with a seriate texture. Of the phenocrysts and microphenocrysts, which comprise about 40% of this rock, 55% are amphiboles, 15% are clinopyroxenes, 15% are plagioclases, 5% are olivines, 5% are alkali feldspars and <5% are Fe-Ti oxides. The modal proportions are approximately as follows: 35% plagioclase, 25% amphibole, 20% clinopyroxene, 10% alkali feldspar, 5%

olivine and 5% Fe-Ti oxide. The abundant euhedral to subhedral amphibole phenocrysts (up to 2.5 mm) and microphenocrysts (around 0.5 mm and less) are commonly twinned and zoned and contain inclusions of clinopyroxene and apatite. The amphibole phenocrysts have Fe-Ti oxide rich, opaque rims. The anhedral phenocrysts (up to 3 mm), microphenocrysts (around 0.5 mm) and one ophitic megacryst (>5 mm) of plagioclase totally or partially include abundant clinopyroxene, amphibole, Fe-Ti oxide and apatite crystals. Clinopyroxene occurs as light tan to light green, subhedral to anhedral phenocrysts (around 1 mm) and microphenocrysts (0.5 mm and less) that display oscillatory zonation patterns. Isolated phenocrysts (up to about 2 mm) and microphenocrysts (around 0.5 mm and less) of olivine, alkali feldspar and Fe-Ti oxide also occur. The fine- to very fine-grained groundmass has a subtrachytic texture dominated by flow-aligned plagioclase laths with intergranular Fe-Ti oxides, light tan to light green clinopyroxene and alkali feldspar.

MA-8: (Flow; E Kongo; 12°44'S 45°12.5'E)

Alkali Basalt

A slightly vesicular (<5 vol.%), porphyritic rock with a seriate texture. The phenocrysts, 55% of which are clinopyroxenes and 45% are olivines, comprise about 20% of this rock. The modal proportions are as follows: clinopyroxene (45%), plagioclase (30%), olivine (20%) and Fe-Ti oxide (5%). The euhedral to subhedral phenocrysts (up to 2.5 mm) and microphenocrysts (around 0.5 mm and less) of clinopyroxene display oscillatory zonation and often have pale tan to pale greenish-grey cores, some of which are sieve-textured, and tan-violet rims. Fe-Ti oxides are common inclusions in clinopyroxene phenocrysts. Olivine occurs as subhedral, moderately to strongly iddingsitised, partly resorbed phenocrysts (up to 2 mm), but mainly as microphenocrysts (0.5 mm and less). Rare microphenocryst-sized (<0.5 mm) Fe-Ti oxide grains occur, but this phase is mainly present as part of the groundmass. The light grey, fine-grained groundmass contains laths of plagioclase with intergranular, tan coloured clinopyroxene, Fe-Ti oxides, altered olivine and accessory alkali feldspar.

MA-9: (Flow; 1 km E of Kongo; 12°44'S 45°12.5'E; same flow as MA-8)

Hawaiite

A slightly vesicular (<5 vol.%), porphyritic, seriate-textured rock. Phenocrysts and microphenocrysts, of which 60% are clinopyroxenes and 40% are olivines, make up about 20% of this rock. The approximate modal composition is: 50% clinopyroxene, 25% plagioclase, 20% olivine and 5% Fe-Ti oxide. The euhedral to subhedral clinopyroxene phenocrysts (up to about 2.5 mm) and microphenocrysts (around 0.5 mm and less) commonly display oscillatory zonation patterns and frequently have pale greenish-grey cores and tan-violet rims. Sieve-textured cores, containing inclusions of Fe-Ti oxides are common amongst the clinopyroxene phenocrysts. The strongly to entirely iddingsitised, subhedral phenocrysts (up to 2 mm) and microphenocrysts (0.5 mm and less) of olivine show signs of partial resorption. Plagioclase is an abundant groundmass phase, but also

occurs as rare microphenocrysts (0.5 mm and less) and phenocrysts (around 1.5 mm). Rare microphenocryst-sized Fe-Ti oxide grains are also present. The fine-grained, slightly altered groundmass consists of plagioclase laths with intergranular clinopyroxene, Fe-Ti oxides, lesser iddingsitised olivine and accessory alkali feldspar.

MA-11: (Flow; E of Magikhavo II; 12°44'S 45°13.5'E)

Potassic Trachybasalt

A porphyritic rock, 15-20% of which is comprised of phenocrysts and microphenocrysts. The proportions of phenocryst phases are as follows: 40% alkali feldspar, 35-40% clinopyroxene, 10-15% olivine, 8% Fe-Ti oxide and 2% amphibole. The modal composition is: clinopyroxene (30%), alkali feldspar (30%), plagioclase (10-15%), olivine (10%), Fe-Ti oxide (7%) and amphibole (3%). The anhedral phenocrysts (up to 2.5 mm), one macrophenocryst (about 5 mm) and microphenocrysts (around 0.5 mm and less) of alkali feldspar have strongly altered rims. Euhedral to subhedral phenocrysts (up to about 2 mm) and microphenocrysts (about 0.5 mm and less) of clinopyroxene often show oscillatory zonation and contain inclusions of Fe-Ti oxides. Clinopyroxene phenocrysts typically are tan-coloured, but frequently have lighter tan or pale green cores and darker tan-coloured rims. Clinopyroxene phenocrysts commonly occur in glomerophytic clusters. The subhedral phenocrysts (up to 2 mm) and microphenocrysts (around 0.5 mm and less) of olivine are iddingsitised around their edges. Rare anhedral phenocrysts (up to about 2 mm) and microphenocrysts (around 0.5 mm) of amphibole, strongly replaced by Fe-Ti oxides, occur. Microphenocryst-sized Fe-Ti oxide grains are also present. The very fine-grained to cryptocrystalline groundmass consists predominantly of plagioclase, Fe-Ti oxides, clinopyroxene, alkali feldspar and small amounts of olivine. Apatite is an accessory phase.

MA-14a: (Beach boulder; sea cliffs .5 km E of Kangani; 12°43.5'S 43°11.5'E)

Benmoreite

A porphyritic rock with a trachytic texture. Phenocrysts and microphenocrysts, 80% of which are amphiboles, 10% are clinopyroxenes, 5% are feldspars and 5% are Fe-Ti oxides, comprise about 15% of the rock. The modes are plagioclase (45%), amphibole (30%), clinopyroxene (10%), alkali feldspar (10%) and Fe-Ti oxide (5%). The subhedral amphibole phenocrysts (up to 2.5 mm) and microphenocrysts (around 0.5 mm) contain inclusions of Fe-Ti oxides, clinopyroxene and apatite. The amphibole phenocrysts have thick rims, rich in Fe-Ti oxides, and some of the smaller microphenocrysts are entirely replaced by Fe-Ti oxides. Simple twinning is common amongst the amphibole phenocrysts. Clinopyroxene occurs as subhedral to anhedral, pale greenish-grey phenocrysts (up to 2 mm) and microphenocrysts (around 0.5 mm and less). Rare phenocrysts (around 1 mm) and microphenocrysts (around 0.5 mm and less) of alkali feldspar, plagioclase and Fe-Ti oxide also occur. The fine-grained, light grey, crystalline groundmass has a trachytic texture that consists of flow-aligned plagioclase laths with intergranular Fe-Ti oxides, alkali feldspar, clinopyroxene and relatively abundant,

sometimes quite coarse-grained (<0.5 mm) apatite.

MA-18: (Flow; .25 km W of Kangani; 12°43.5'S 45°11'E)

Phonolite

A porphyritic rock with a subtrachytic texture. Phenocrysts and microphenocrysts make up approximately 15-20% of this rock. Of these phenocrysts and microphenocrysts, 35% are amphiboles, 35% are alkali feldspars, 20% are plagioclases, 5% are clinopyroxenes and 5% are Fe-Ti oxides. The modes are as follows: plagioclase (35%), alkali feldspar (25%), amphibole (10-15%), clinopyroxene (10-15%), Fe-Ti oxide (5%) and accessory phases (5%, apatite, sphene). The subhedral to anhedral phenocrysts (up to about 2.5 mm) and microphenocrysts (around 0.5 mm and less) of amphibole have thick Fe-Ti oxide rich rims and contain inclusions of Fe-Ti oxides, clinopyroxene and apatite. Abundant phenocrysts (up to about 4 mm) and microphenocrysts (0.5 mm and less) of alkali feldspar and plagioclase are present, whereas phenocrysts and microphenocrysts of clinopyroxene and Fe-Ti oxide are rare. The slightly altered, fine-grained, subtrachytic groundmass contains moderately flow-aligned plagioclase laths, alkali feldspar, Fe-Ti oxides, clinopyroxene and abundant apatite and (relatively coarse-grained, microphenocryst-sized) titanite (sphene).

MA-19: (Block in tuff deposit; E of M'Gombani; 12°43.5'S 45°10.5'E; no analyses)

A sparsely porphyritic rock with a trachytic groundmass. Of the phenocrysts and microphenocrysts, which make up around 5% of this rock, 40% are alkali feldspars, 20% are plagioclases, 20% are clinopyroxenes, 15% are amphiboles and 5% are Fe-Ti oxides. The modal proportions are: plagioclase (40%), alkali feldspar (35%), clinopyroxene (15%), amphibole (5%) and Fe-Ti oxide (5%). Anhedral phenocrysts (up to 2 mm) and microphenocrysts (around 0.5 mm and less) of alkali feldspar and plagioclase contain fine-grained inclusions of Fe-Ti oxides and clinopyroxene. Subhedral to anhedral, pale grey-tan clinopyroxene phenocrysts (around 1 mm) and microphenocrysts (0.5 mm and less) are also present. The altered, anhedral phenocrysts (up to about 2.5 mm) and microphenocrysts (0.5 mm and less) of amphibole have thick Fe-Ti oxide-rich rims and contain inclusions of clinopyroxene, feldspar and Fe-Ti oxide. Microphenocrysts (around 0.5 mm and less) of Fe-Ti oxide also occur. The fine- to very fine-grained, light grey groundmass is trachytic in texture and consists of flow-aligned plagioclase laths with interstitial alkali feldspar, Fe-Ti oxides, altered amphibole, clinopyroxene and possibly very fine-grained, accessory apatite.

MA-20: (Tuff deposit; Pointe de Longoni; 12°43'S 45°9.5'E)

Trachyte

A somewhat altered (clay minerals), vesicular (about 7 vol.%), sparsely porphyritic rock with trachytic texture. All of the phenocrysts, which comprise only 5% or less of this

rock, are alkali feldspars. The modal proportions are: plagioclase (65-70%), alkali feldspar (25-30%), Fe-Ti oxide (5%) and aegirine-augite (2-3%). Rare anhedral phenocrysts (around 1 mm) and microphenocrysts (around 0.5 mm and less) of alkali feldspar are present. The slightly altered, fine-grained, light-coloured groundmass has a trachytic texture dominated by flow-aligned plagioclase laths with interstitial alkali feldspar, Fe-Ti oxides and rare pale green aegirine-augite.

MA-31: (Flow below MA-30; N tip of Maji Anouni; 12°40'S 45°5'E; no analyses)

A slightly altered, slightly vesicular (<5 vol.%), seriate-textured, porphyritic rock. Of the phenocrysts and microphenocrysts, which make up about 8% of this lava, all are olivines, except a few rare clinopyroxenes. The approximate modal composition is: clinopyroxene (35%), olivine (30-35%), plagioclase (20%) and Fe-Ti oxide (10%). The slightly to considerably iddingsitised, anhedral to subhedral olivine phenocrysts and microphenocrysts (sizes range from about 0.5 mm and less to about 1.5 mm) commonly show signs of resorption. Rare microphenocrysts of pale tan clinopyroxene occur. The very fine-grained to cryptocrystalline groundmass contains abundant fine-grained clinopyroxene, together with plagioclase, Fe-Ti oxides and olivine.

MA-35: (Flow; 2.25 km W of Passamainti; 12°47.5'S 45°11.5'E)

Alkali Basalt

A somewhat altered, slightly vesicular (<5 vol.%), porphyritic rock with a seriate texture. Phenocrysts and microphenocrysts, 55% of which are amphiboles, 40% are clinopyroxenes and 5% are Fe-Ti oxides, comprise 10-15% of this rock. The modal proportions are: plagioclase (32-35%), amphibole (30%), clinopyroxene (30%) and Fe-Ti oxide (5-8%). Subhedral to anhedral amphibole phenocrysts range in size from around 0.5 mm to 4 mm, are partially resorbed and contain inclusions of Fe-Ti oxides and clinopyroxene. The subhedral phenocrysts (up to 2 mm) and microphenocrysts (around 0.5 mm and less) of clinopyroxene are typically pale tan in colour, but often have pale green cores. Clinopyroxene phenocrysts frequently occur in small clusters and often contain Fe-Ti oxide inclusions. Phenocryst- and microphenocryst-sized (around 0.5-1 mm) Fe-Ti oxide grains occur. The fine- to very fine-grained and partly glassy groundmass contains abundant plagioclase laths with intergranular clinopyroxene, Fe-Ti oxides and amphibole.

MA-59: (Flow; Trotrougeu, S of Passamainti; 12°48'S 45°9'E)

Benmoreite

A slightly porphyritic, trachytic and subtrachytic rock. Phenocrysts and microphenocrysts, 50% of which are amphiboles, 35% are plagioclases, 5-8% are clinopyroxenes, 5-8% are alkali feldspars and 5% are Fe-Ti oxides, comprise about 5% of this rock. The modal proportions are as follows: 55% plagioclase, 15% amphibole, 15% alkali feldspar, 10%

clinopyroxene and 5% Fe-Ti oxide. The subhedral to anhedral phenocrysts (up to 2 mm) and microphenocrysts (around 0.5 mm) of amphibole have thin opaque rims and contain inclusions of plagioclase, apatite and Fe-Ti oxide. Subhedral plagioclase phenocrysts (1-3 mm) and rare alkali feldspar phenocrysts (around 1 mm) occur. A few pale greenish-grey, subhedral clinopyroxene phenocrysts (about 1.5 mm) and isolated microphenocrysts (around 0.5 mm) of Fe-Ti oxide are also present. The medium- to fine-grained and partly glassy groundmass is trachytic to subtrachytic in texture, containing flow-aligned plagioclase laths with intergranular clinopyroxene, alkali feldspar, Fe-Ti oxides and accessory apatite.

MA-65: (Boulder; 4 km W of Mamutzu, on M'Sapere trail; 12°46'S 45°11.5'E)

Trachyte

A moderately porphyritic rock with a subtrachytic texture. Phenocrysts and microphenocrysts, 50% of which are feldspars and 50% are amphiboles, make up 5-10% of this rock. The modes are feldspar (75%; alkali feldspar and plagioclase), clinopyroxene (10%), amphibole (5-10%) and Fe-Ti oxide (5%). Slightly altered, anhedral feldspar phenocrysts range in size from about 1 mm to about 3.5 mm. Amphibole phenocrysts (up to 2.5 mm) and microphenocrysts (around 0.5 mm) have been strongly to totally replaced by Fe-Ti oxide. The light-coloured, fine-grained groundmass has a subtrachytic texture, dominated by flow-aligned feldspar with fine-grained, intergranular, pale green aegirine-augite, Fe-Ti oxides and accessory apatite.

MA-66: (Stream boulder; above Majimbini; M'Sapere trail end; 12°46'S 45°11'E)

Basanite

A porphyritic rock, containing about 15 vol.% of phenocrysts and microphenocrysts, 30% of which are olivines, 30% are amphiboles, 30% are clinopyroxenes, 5% are alkali feldspars, 5% are plagioclases and less than 5% are Fe-Ti oxides. The modal composition is: feldspar (40%), clinopyroxene (35%), olivine (10%), amphibole (10%) and Fe-Ti oxide (5%). The subhedral to anhedral phenocrysts (about 0.5-3 mm) of amphibole have thick opaque rims and some are entirely replaced by Fe-Ti oxides. Amphibole phenocrysts contain inclusions of clinopyroxene and Fe-Ti oxide. The subhedral to anhedral phenocrysts (up to about 2.5 mm) and microphenocrysts (0.5 mm and less) of olivine have slightly iddingsitised rims and show signs of resorption. Clinopyroxene occurs as pale tan to pale green, subhedral to anhedral phenocrysts (up to 3 mm) and microphenocrysts (0.5 mm and less), containing Fe-Ti oxide inclusions. A few anhedral phenocrysts (0.5-1 mm) of plagioclase and alkali feldspar, as well as occasional microphenocrysts (<0.5 mm) of Fe-Ti oxide are also present. The fine- to very fine-grained groundmass contains plagioclase, alkali feldspar, clinopyroxene, Fe-Ti oxides, small amounts of olivine and accessory apatite.

MA-67: (Flow; 1.5 km W of Mamutzu, M'Sapere trail; 12°46.5'S 45°12.5'E)

Hawaiite

A vesicular (5 vol.%), microporphyritic rock. Microphenocrysts, 95% of which are olivines and 5% are clinopyroxenes, comprise 10-15% of the rock. The modal composition is: plagioclase (50%), clinopyroxene (25%), olivine (15-20%) and Fe-Ti oxide (5-10%). The anhedral olivine microphenocrysts (around 0.5 mm and less) are strongly iddingsitised. Rare pale tan-violet clinopyroxene microphenocrysts (around 0.5 mm) occur. The fine- to very fine-grained groundmass consists of plagioclase, clinopyroxene, Fe-Ti oxides and olivine.

Grande Comore

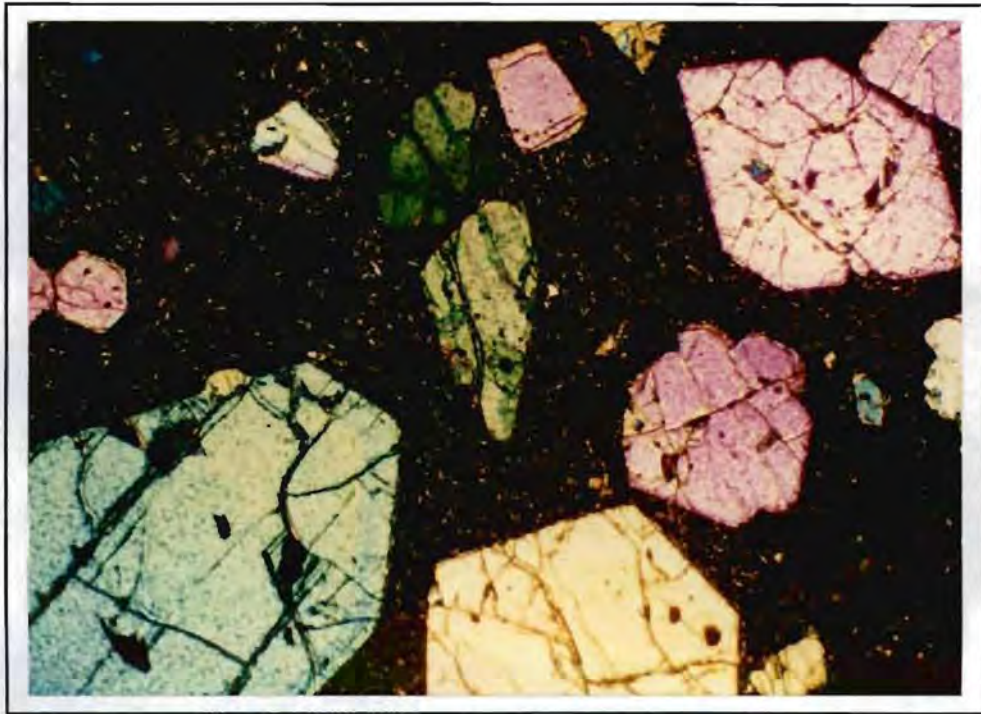


PLATE 1. Photomicrograph of GC-2 (Karthala); crossed polars; field of view: 6.5 mm across. Clinopyroxene and olivine phenocrysts set in a very fine-grained and partly glassy groundmass containing clinopyroxene, plagioclase, Fe-Ti oxide and rare olivine.



PLATE 2. Photomicrograph of GC-3 (Karthala); plane-polarised light; field of view: 3.25 mm across. Clinopyroxene phenocryst with pale grey core and darker grey-tan rim, set in a fine-grained groundmass containing plagioclase laths, tan-coloured clinopyroxene, Fe-Ti oxide and minor olivine.



PLATE 3. Photomicrograph of GC-4 (Karthala); plane-polarised light; field of view: 3.25 mm across. Olivine phenocryst and glomerophyric cluster of clinopyroxene in a fine-grained, vesicular groundmass containing plagioclase, clinopyroxene, Fe-Ti oxide and minor olivine.

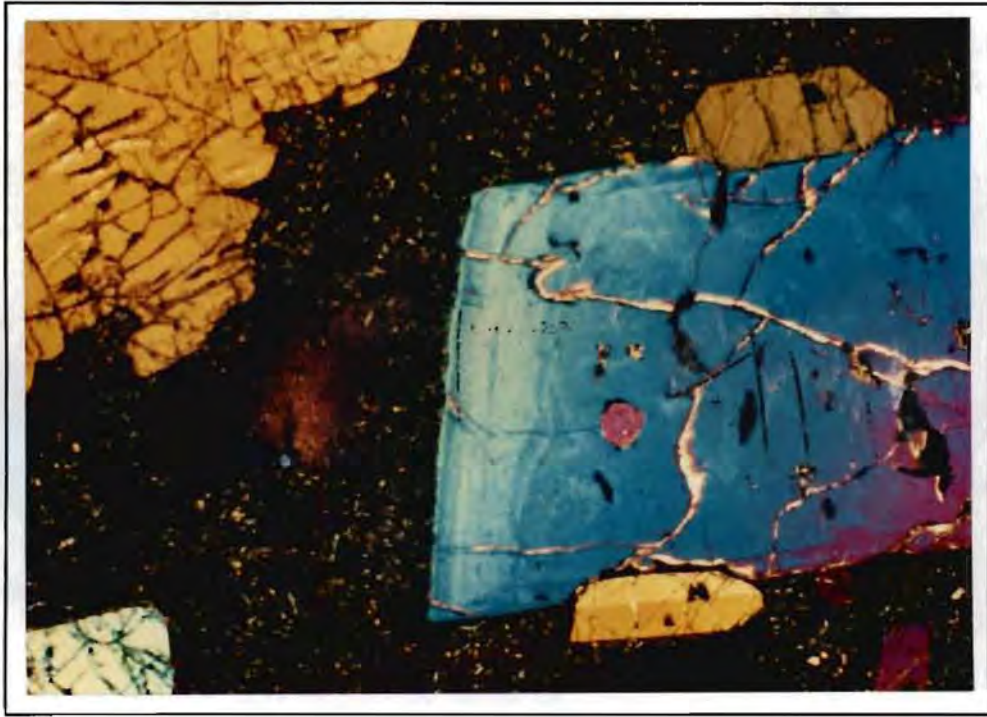


PLATE 4. Photomicrograph of RH-15 (alkali basalt); crossed polars; field of view: 6.5 mm across. Macrophenocrysts of olivine and clinopyroxene (showing oscillatory zonation) set in a slightly vesicular, fine-grained groundmass that contains plagioclase, clinopyroxene, Fe-Ti oxide and minor olivine.

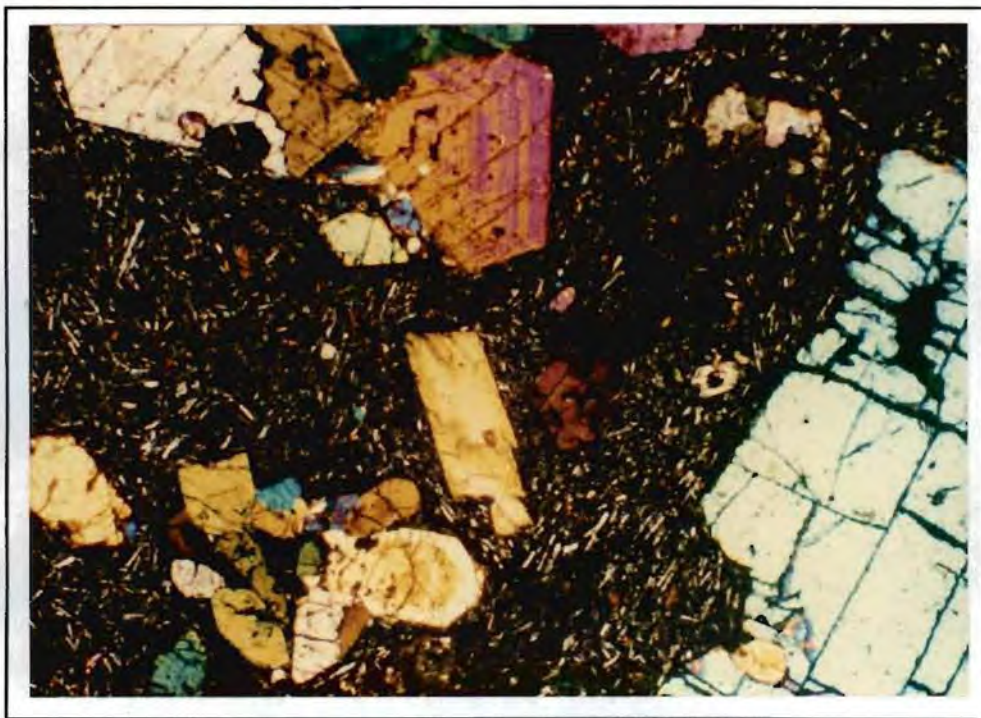


PLATE 5. Photomicrograph of RH-17 (alkali basalt); crossed polars; field of view: 6.5 mm across. An Olivine macrophenocryst and microphenocrysts, and a zoned clinopyroxene macrophenocryst and microphenocrysts in a fine-grained groundmass containing plagioclase laths, clinopyroxene and Fe-Ti oxide.

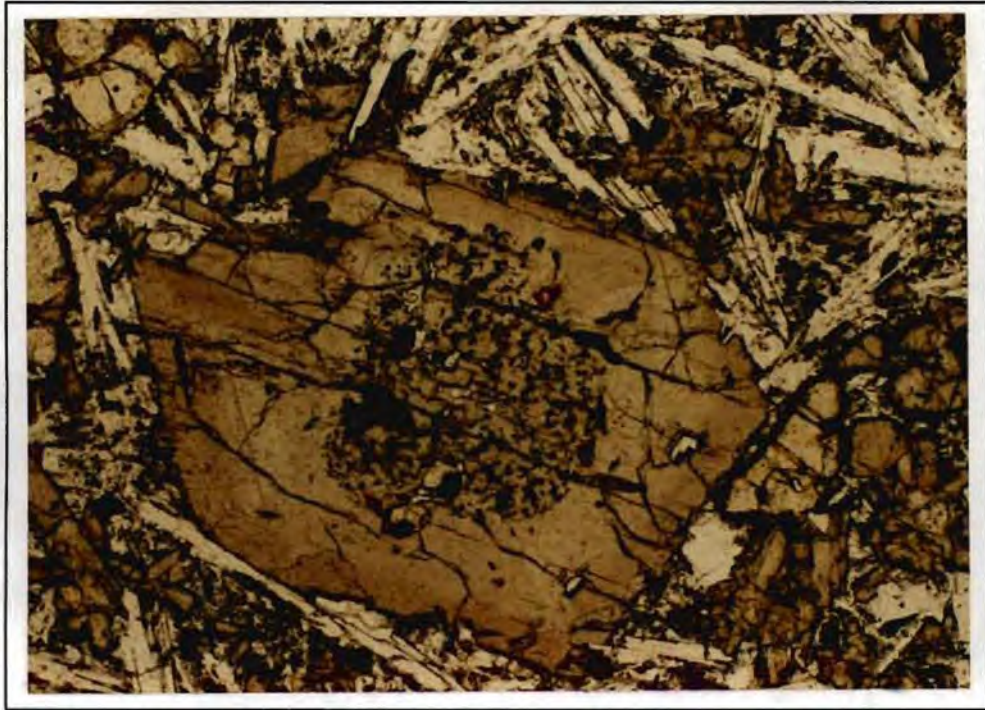


PLATE 6. Photomicrograph of RH-42 (alkali basalt); plane-polarised light; field of view: 3.25 mm across. A clinopyroxene phenocryst with a rounded, sieve-textured core, pale grey-tan mantle and darker tan-violet rim, set in a relatively coarse-grained groundmass of interlocking plagioclase, clinopyroxene, olivine and Fe-Ti oxide crystals.

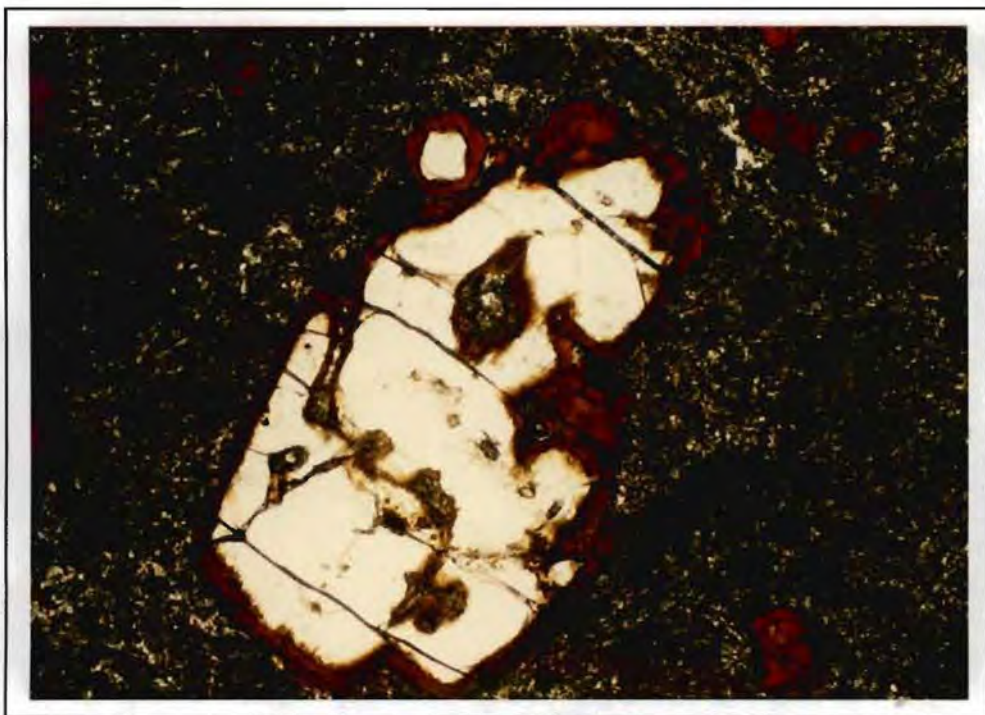


PLATE 7. Photomicrograph of RH-30 (basanite); plane-polarised light; field of view: 3.25 mm across. A partly resorbed olivine phenocryst with a brown, iddingsitised rim, set in a fine-grained groundmass containing clinopyroxene, Fe-Ti oxide, minor olivine and possibly nepheline. Note the totally iddingsitised olivine microphenocrysts.

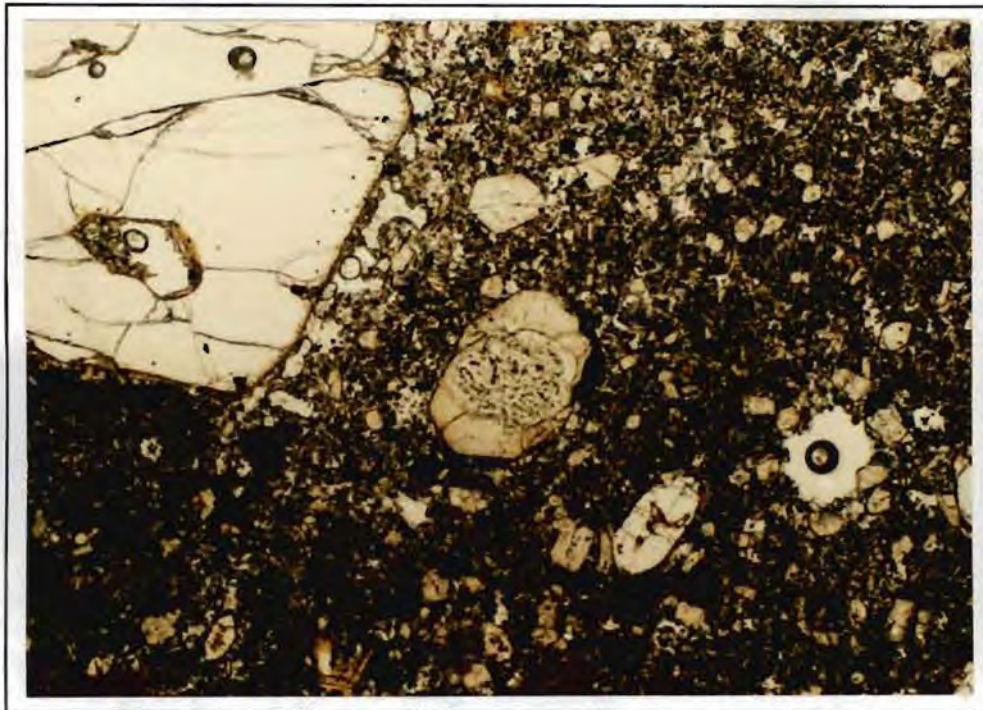


PLATE 8. Photomicrograph of RH-26 (basanite); plane-polarised light; field of view: 3.25 mm across. Olivine and clinopyroxene phenocrysts and microphenocrysts in a vesicular, fine-grained groundmass containing predominantly clinopyroxene and Fe-Ti oxide. The clinopyroxene in the centre has a green, sieve-textured core.

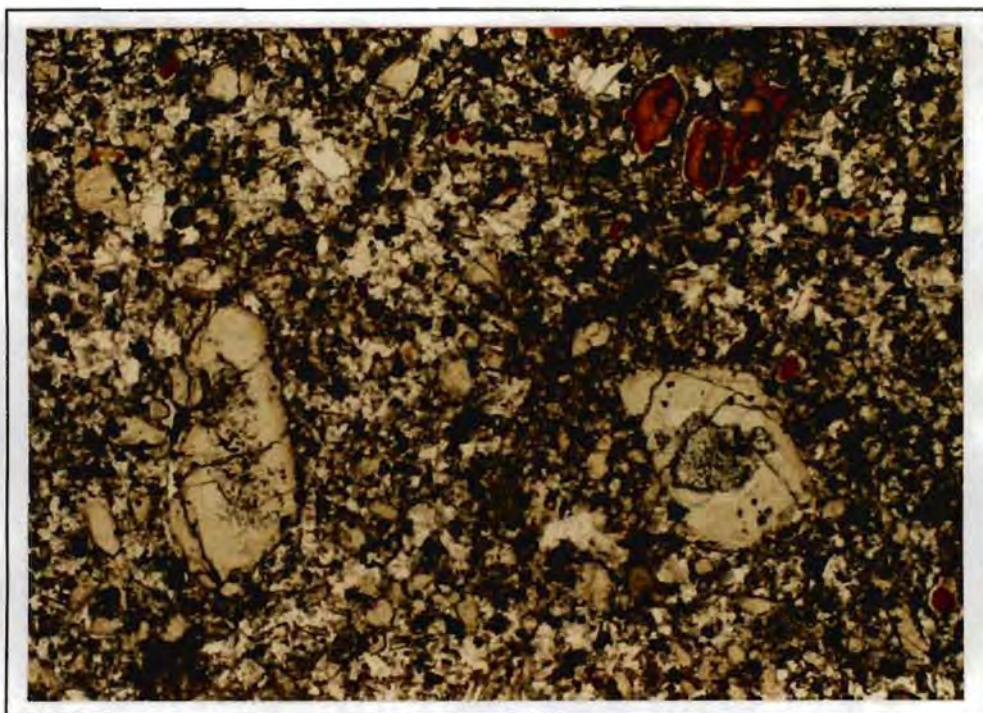


PLATE 9. Photomicrograph of RH-33 (basanite); plane-polarised light; field of view: 3.25 mm across. Clinopyroxene phenocrysts with sieve-textured cores, pale grey-tan mantles and darker tan rims, set in a relatively coarse-grained groundmass that contains clinopyroxene, nepheline, Fe-Ti oxide and olivine.

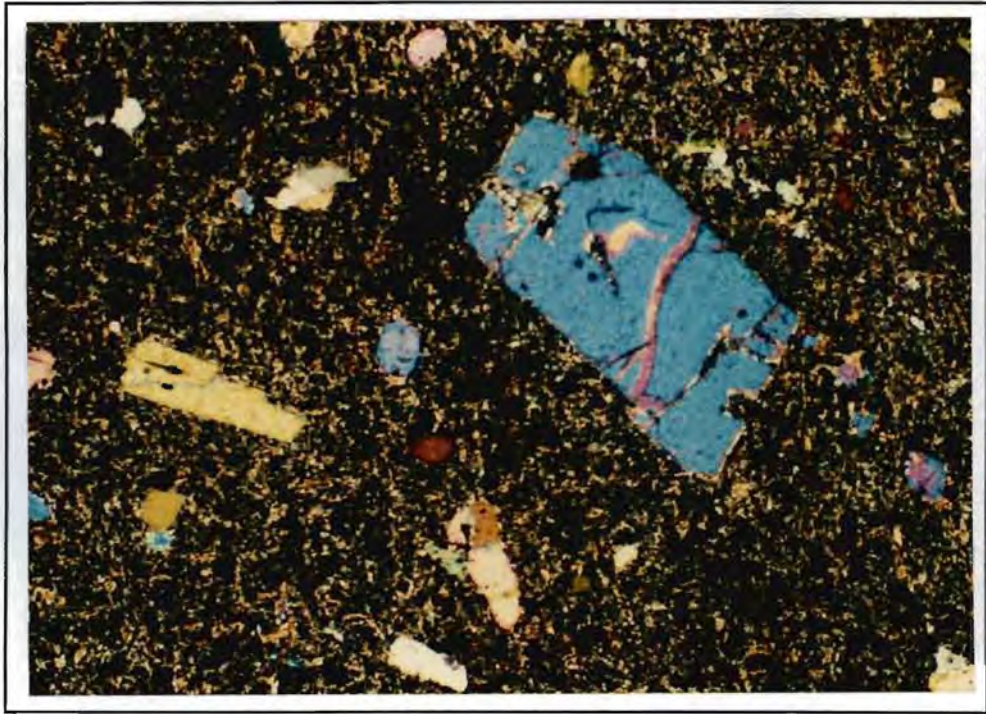


PLATE 10. Photomicrograph of RH-18 (nephelinite); crossed polars; field of view: 3.25 mm across. Olivine phenocrysts and microphenocrysts set in a very fine-grained groundmass that contains clinopyroxene, nepheline, Fe-Ti oxide, minor olivine and accessory biotite.

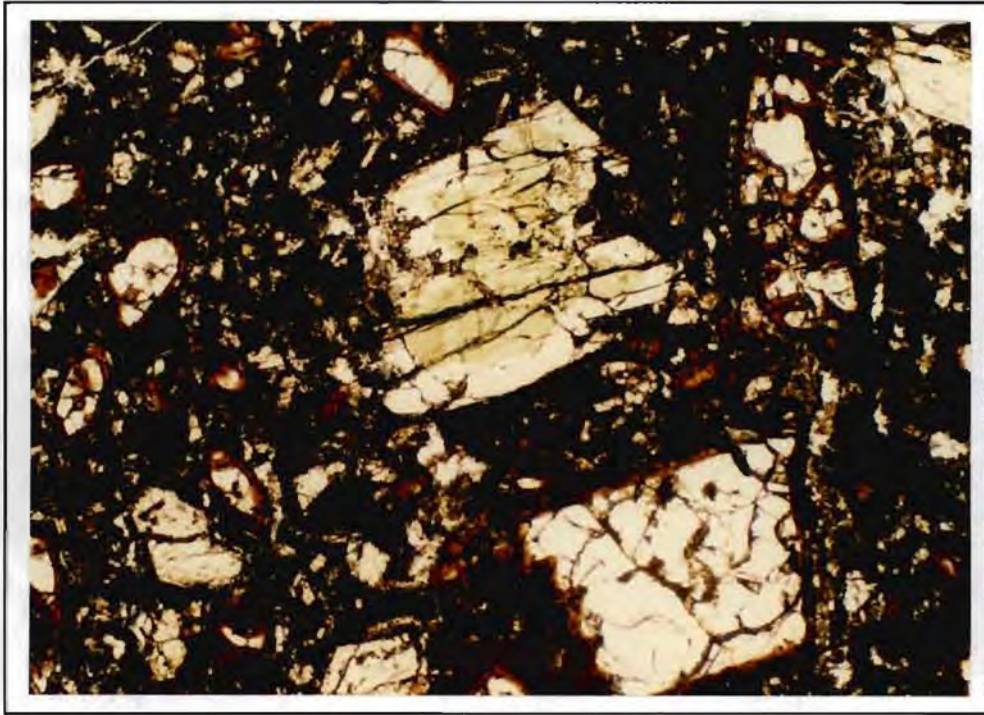


PLATE 11. Photomicrograph of MA-60 (La Grille-type Shield-building Phase basanite); plane-polarised light; field of view: 3.25 mm across. Olivine and clinopyroxene phenocrysts and microphenocrysts set in a fine- to very fine-grained and partly glassy groundmass containing clinopyroxene, Fe-Ti oxide and olivine. The olivine phenocrysts and microphenocrysts have iddingsitised rims. The clinopyroxene in the centre has a green core and a pale grey rim.

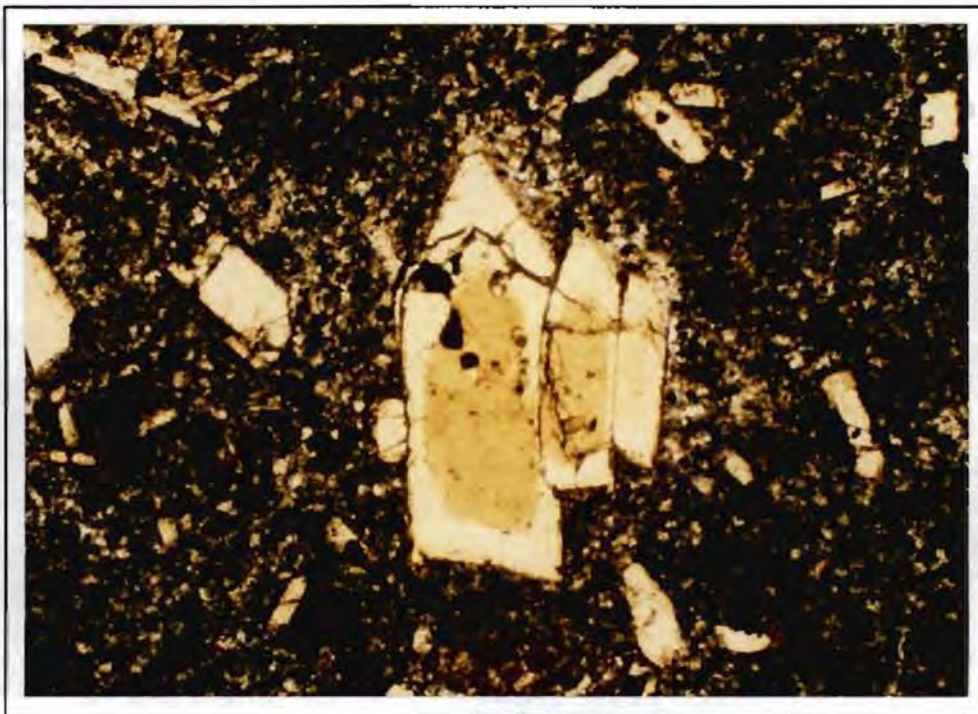


PLATE 12. Photomicrograph of MA-55 (Post-erosional Phase tephrite); plane-polarised light; field of view: 3.25 mm across. Clinopyroxene phenocrysts and microphenocrysts set in a very fine-grained to cryptocrystalline and partly glassy groundmass containing mainly clinopyroxene, Fe-Ti oxide and nepheline. Two of the phenocrysts have dark-coloured cores and pale grey-tan rims.

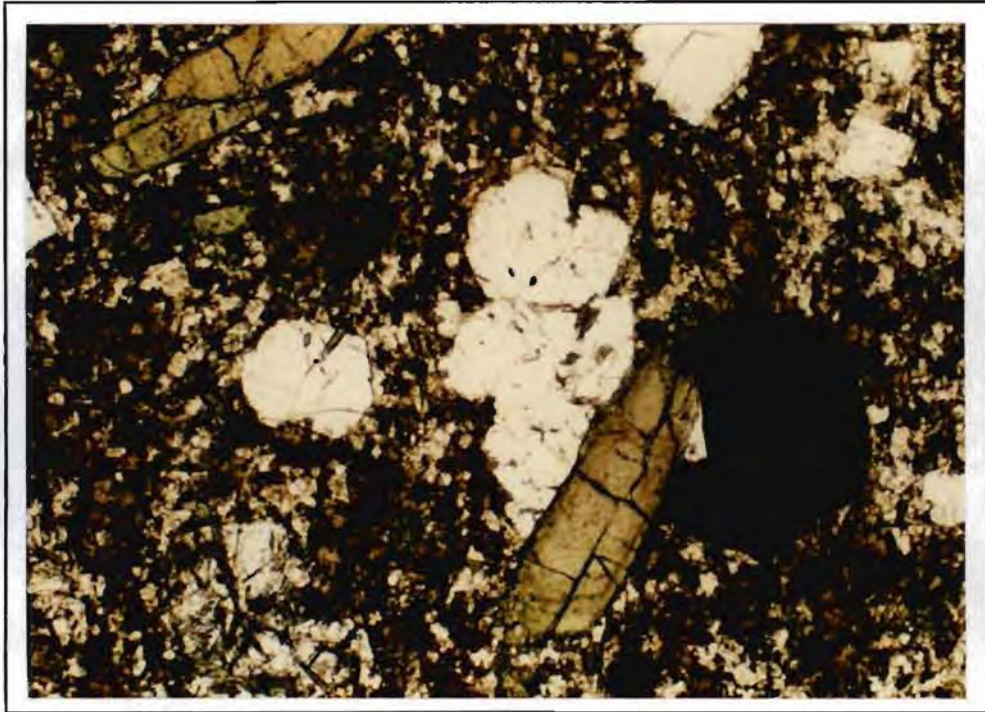


PLATE 13. Photomicrograph of MA-73 (Post-erosional Phase nephelinite); plane-polarised light; field of view: 3.25 mm across. Phenocrysts and microphenocrysts of green clinopyroxene (aegirine-augite), isotropic garnet (schorlomite) and colourless nepheline, set in a fine-grained groundmass containing abundant nepheline and clinopyroxene, rare Fe-Ti oxide and accessory apatite.

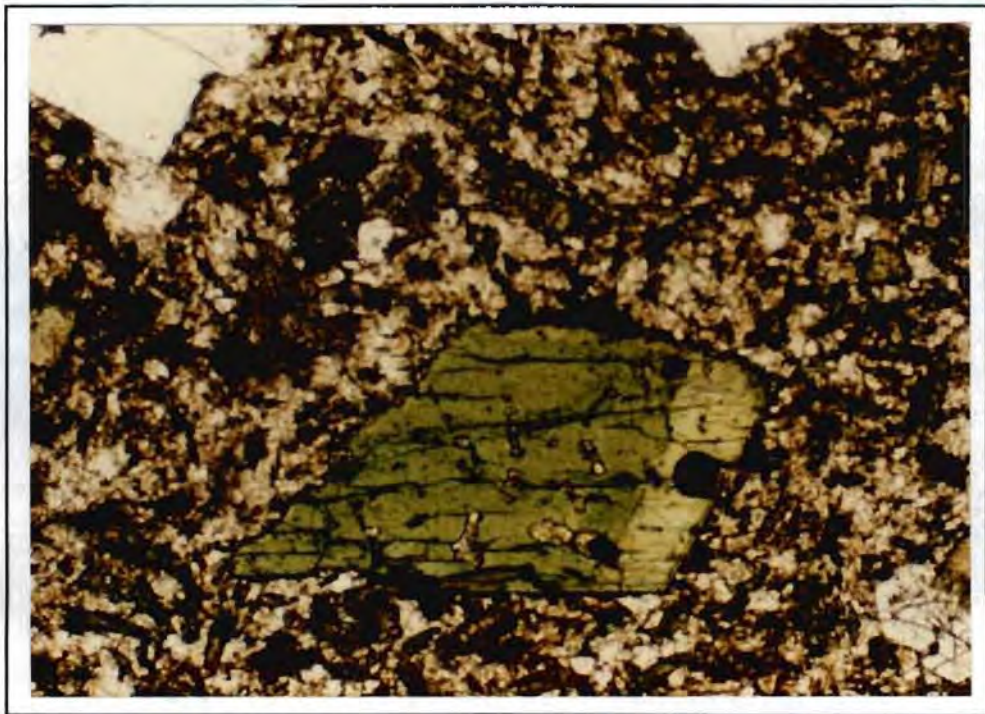


PLATE 14. Photomicrograph of MA-73 (Post-erosional Phase nephelinite); plane-polarised light; field of view: 3.25 mm across. Zoned, pleochroic green clinopyroxene (aegirine-augite) phenocryst and colourless nepheline phenocrysts in a fine-grained groundmass of predominantly nepheline and clinopyroxene, with rare Fe-Ti oxide and accessory apatite.

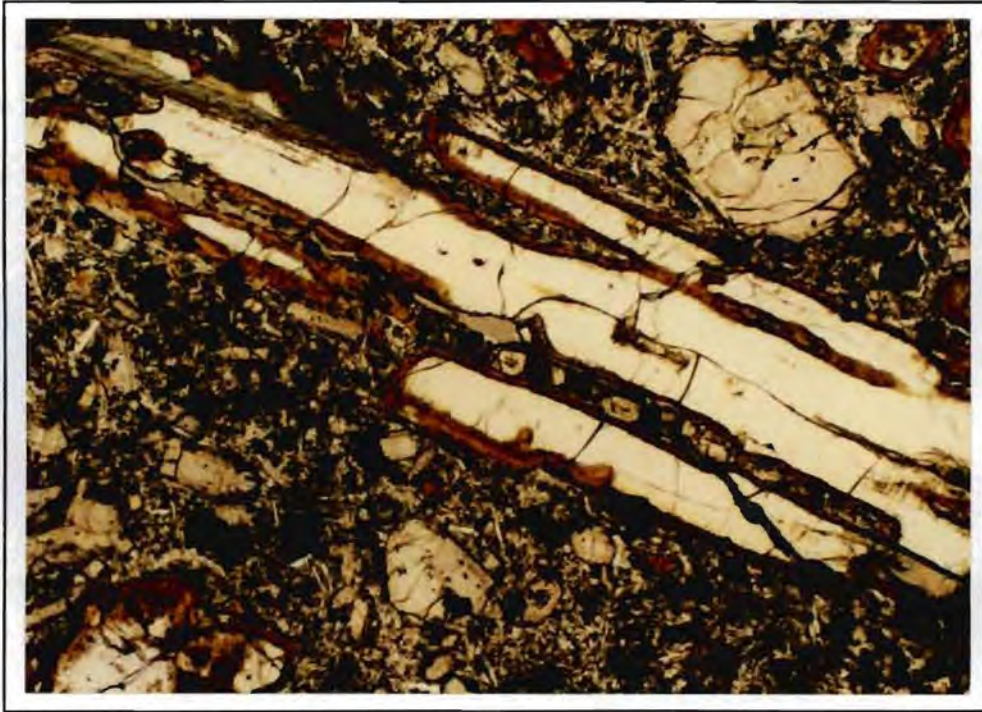


PLATE 15. Photomicrograph of MA-33 (La Grille-type Rejuvenescent Phase basanite); plane-polarised light; field of view: 3.25 mm across. A partially resorbed and iddingsitised olivine phenocryst, olivine microphenocrysts and clinopyroxene phenocrysts and microphenocrysts, set in a fine-grained groundmass of clinopyroxene, plagioclase, Fe-Ti oxide, lesser olivine and accessory apatite.

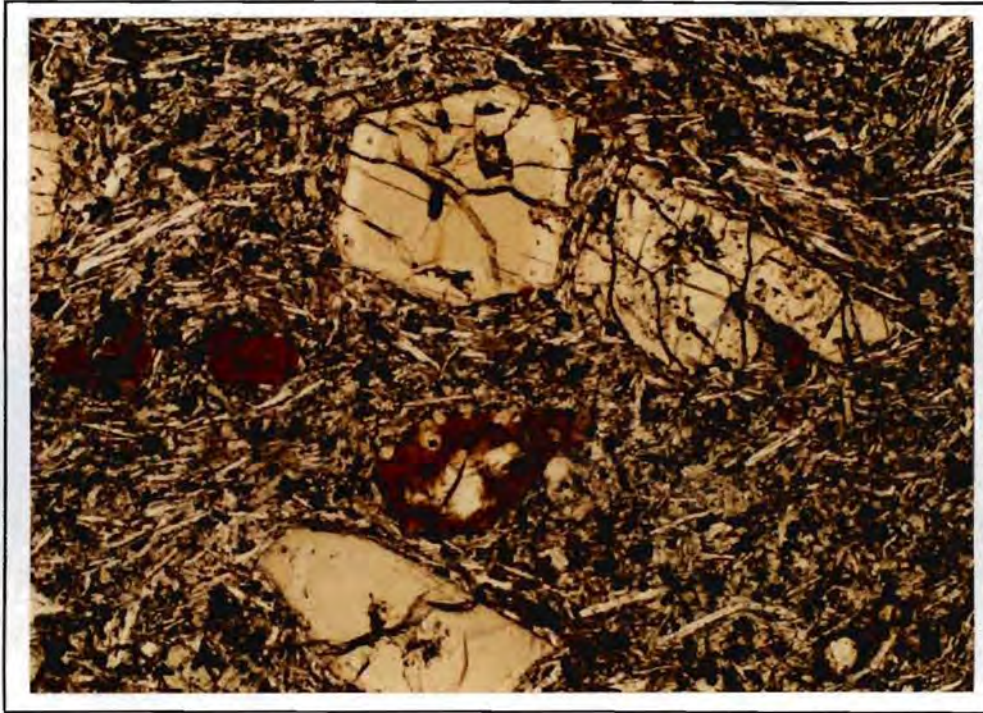


PLATE 16a. Photomicrograph of MA-12 (La Grille-type Rejuvenescent Phase alkali basalt); plane-polarised light; field of view: 3.25 mm across. Phenocrysts and microphenocrysts of zoned clinopyroxene and iddingsitised olivine, set in a fine-grained groundmass containing predominantly plagioclase laths, Fe-Ti oxide, clinopyroxene and lesser olivine.

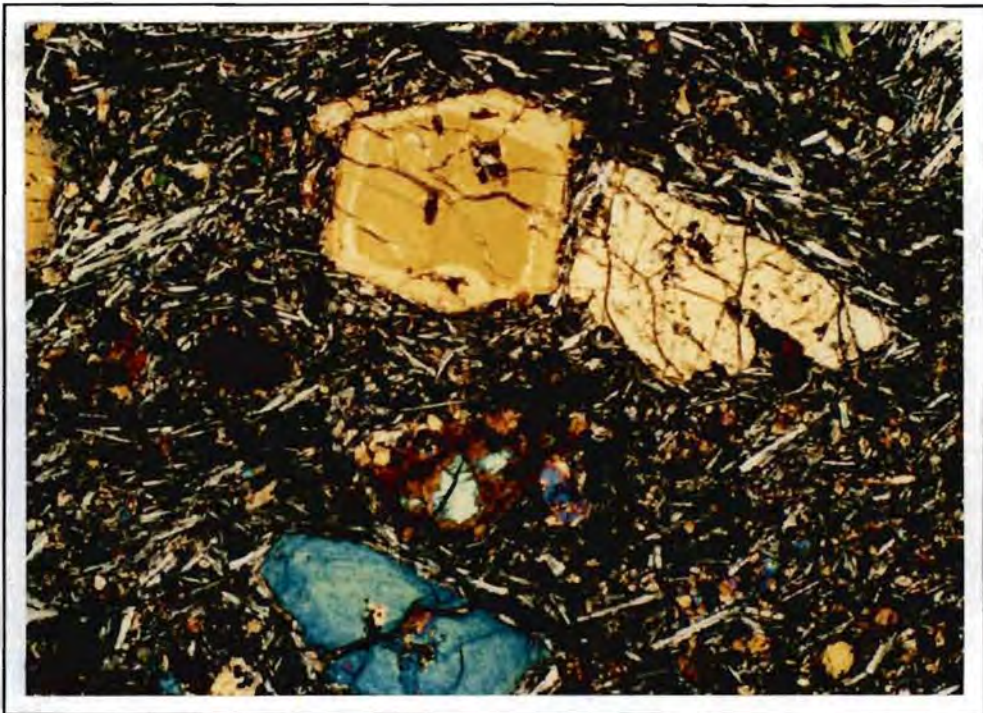


PLATE 16b. Photomicrograph of MA-12; crossed polars.



PLATE 17. Photomicrograph of MA-8 (Karthala-type Rejuvenescent Phase alkali basalt); plane-polarised light; field of view: 3.25 mm across. Clinopyroxene phenocrysts and microphenocrysts set in a fine-grained groundmass of plagioclase, clinopyroxene, Fe-Ti oxide and iddingsitised olivine. The two larger phenocrysts have irregular green cores and pale grey-tan to slightly darker tan rims.

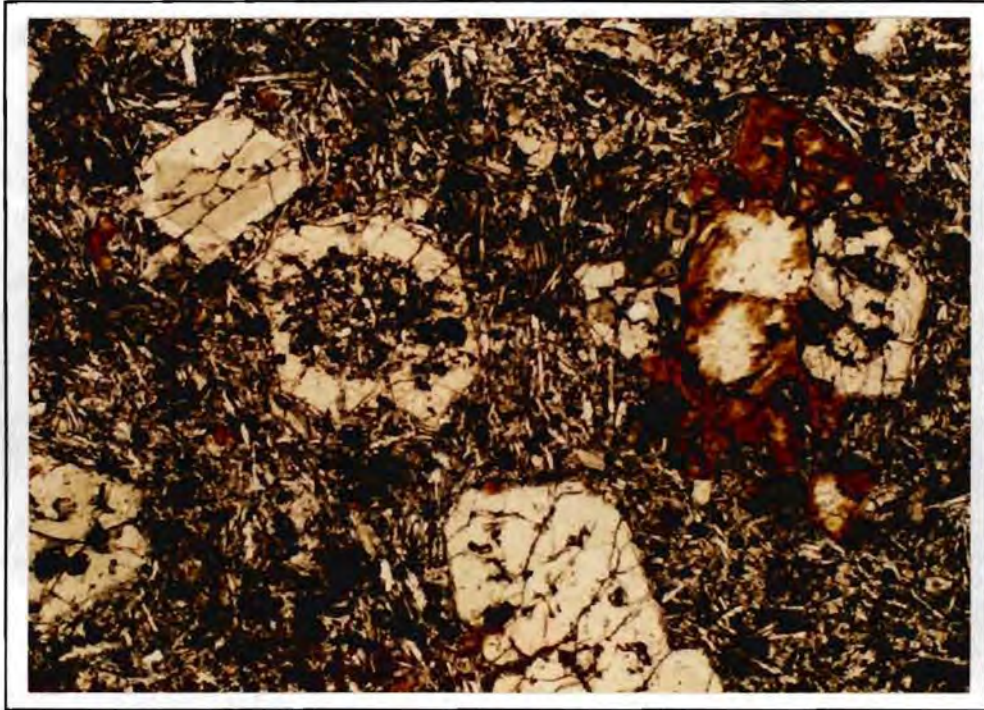


PLATE 18a. Photomicrograph of MA-9 (Karthala-type Rejuvenescent Phase hawaiiite); plane-polarised light; field of view: 3.25 mm across. Phenocrysts and microphenocrysts of clinopyroxene and olivine set in a fine-grained groundmass containing plagioclase, clinopyroxene, Fe-Ti oxide and small amounts of iddingsitised olivine. Of the two clinopyroxene phenocrysts to the left, one has a sieve-textured core, rich in Fe-Ti oxide, and the other has an irregular, rounded darker green core.



PLATE 18b. Photomicrograph of MA-9; crossed polars.

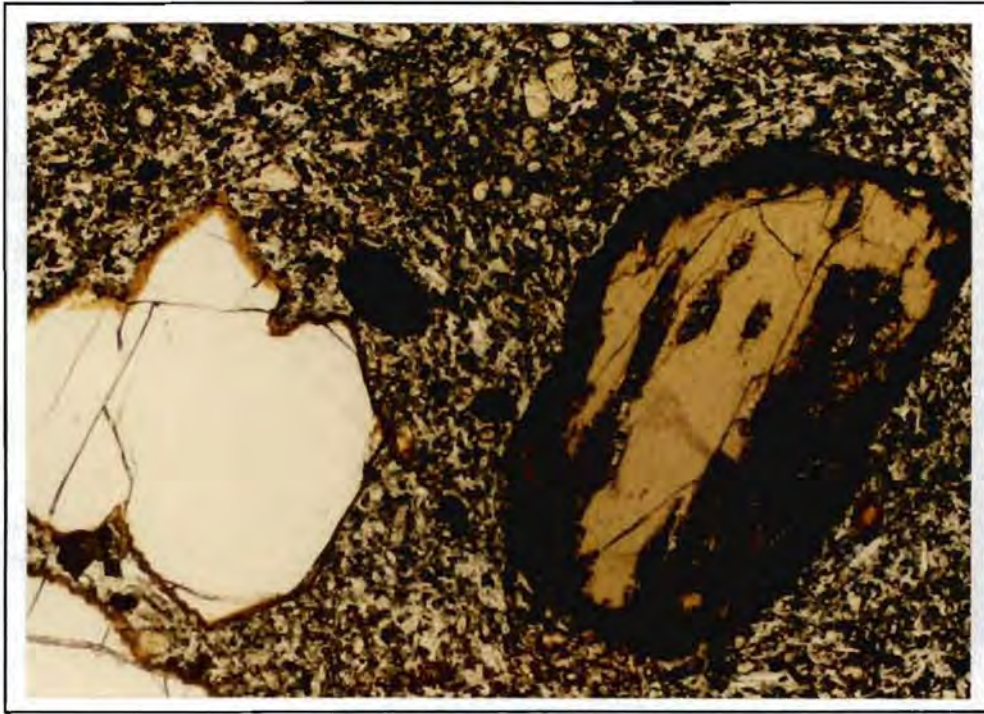


PLATE 19. Photomicrograph of MA-66 (Karthala-type Rejuvenescent Phase basanite); plane-polarised light; field of view: 3.25 mm across. Phenocrysts of olivine and amphibole in a fine- to very fine-grained groundmass containing feldspar, clinopyroxene, Fe-Ti oxide, small amounts of olivine and accessory apatite. The amphibole phenocrysts has a thick opaque rim.

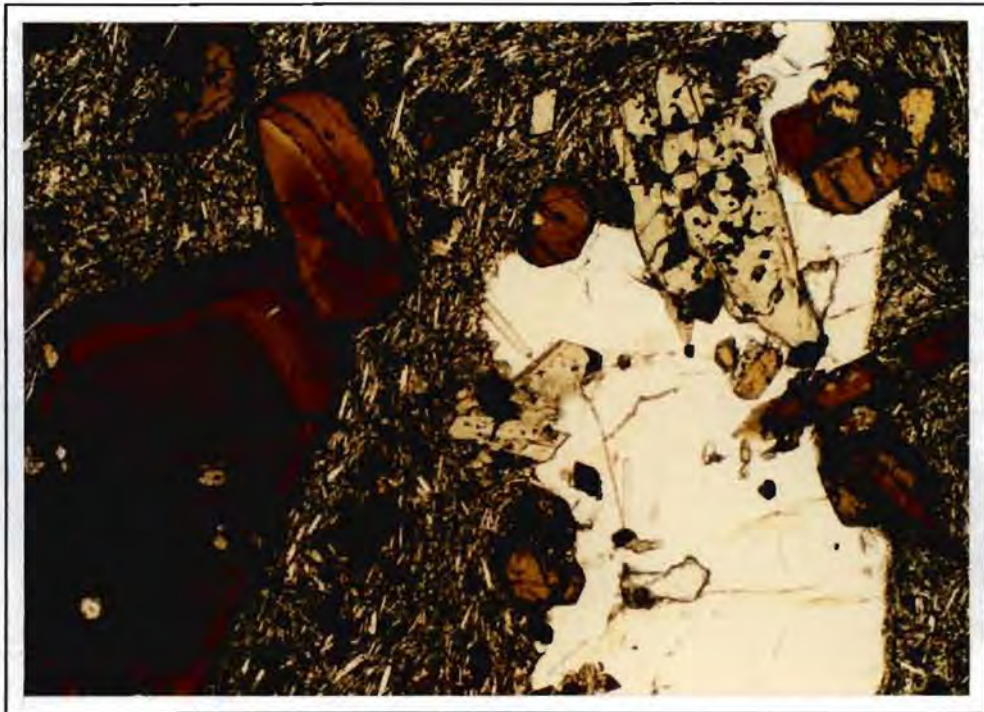


PLATE 20. Photomicrograph of MA-6 (Karthala-type Rejuvenescent Phase mugearite); plane-polarised light; field of view: 3.25 mm across. Phenocrysts and microphenocrysts of amphibole, plagioclase and clinopyroxene set in a very fine-grained groundmass containing abundant plagioclase and lesser Fe-Ti oxide, clinopyroxene and alkali feldspar. The plagioclase phenocrysts partially or entirely enclose crystals of clinopyroxene, amphibole and apatite. The zoned amphibole phenocrysts contain apatite inclusions.



PLATE 21. Photomicrograph of MA-3 (Karthala-type Rejuvenescent Phase phonotephrite); crossed polars; field of view: 3.25 mm across. Phenocrysts of plagioclase and zoned clinopyroxene in a fine-grained groundmass of flow-aligned plagioclase laths, Fe-Ti oxide, clinopyroxene and accessory apatite.

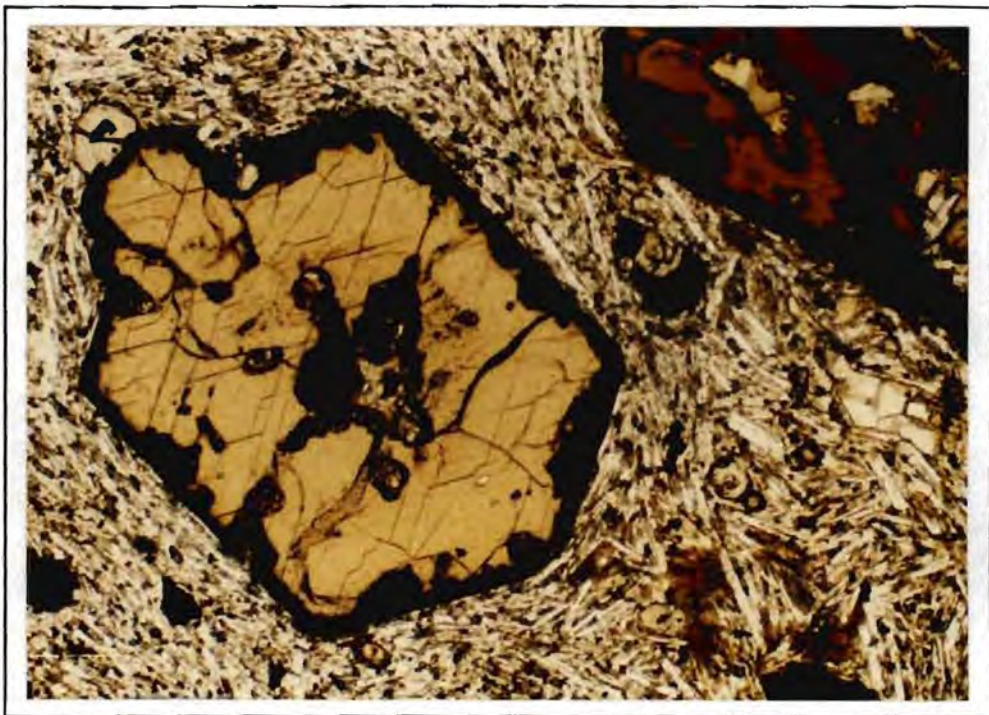


PLATE 22. Photomicrograph of MA-14a (Karthala-type Rejuvenescent Phase benmoreite); plane-polarised light; field of view: 3.25 mm across. Phenocrysts of amphibole with opaque rims, set in a fine-grained, trachytic groundmass of predominantly plagioclase and lesser Fe-Ti oxide, clinopyroxene, alkali feldspar and accessory apatite.

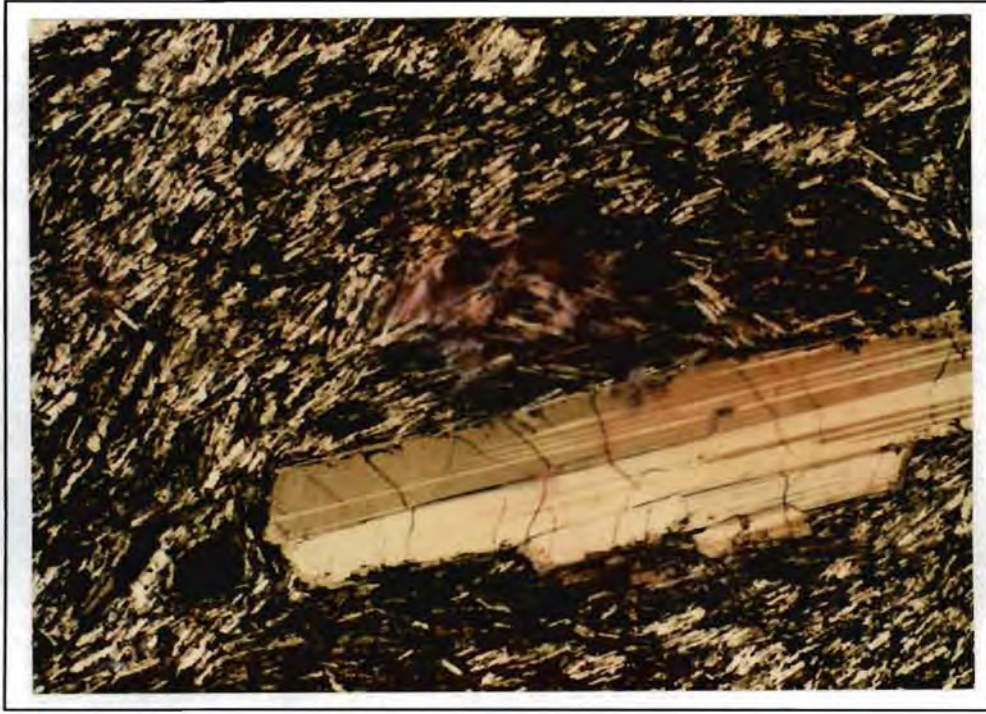


PLATE 23. Photomicrograph of MA-5 (Karthala-type Rejuvenescent Phase tephrite); crossed polars; field of view: 3.25 mm across. Phenocrysts of plagioclase and Fe-Ti oxide set in a fine-grained, trachytic groundmass consisting almost entirely of flow-aligned plagioclase laths with minor clinopyroxene, Fe-Ti oxide and accessory apatite.

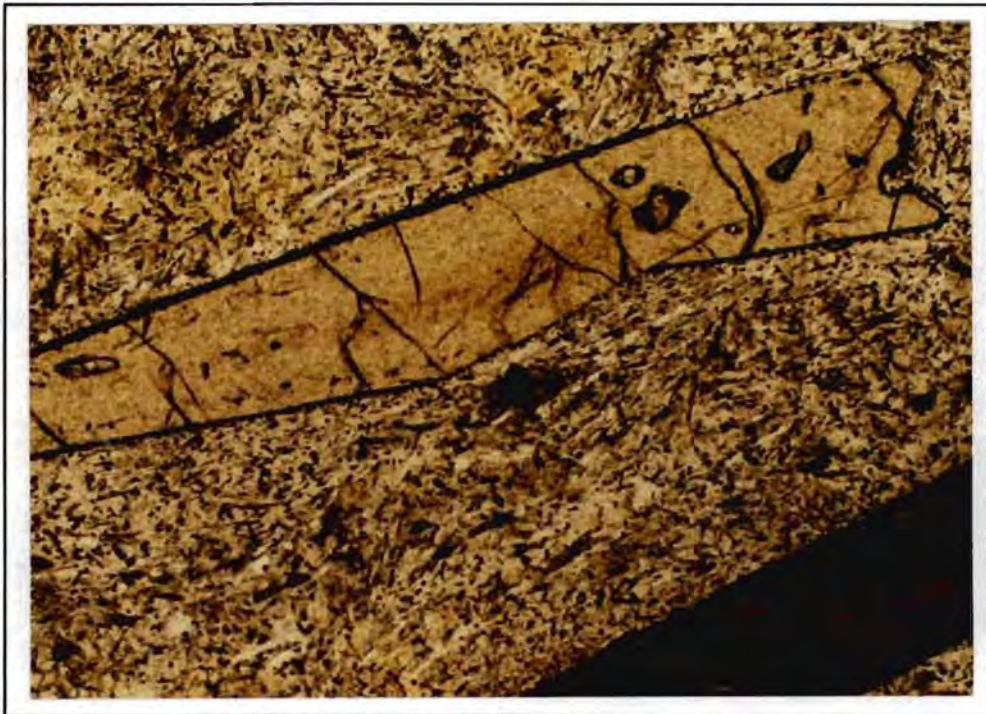


PLATE 24. Photomicrograph of MA-18 (Karthala-type Rejuvenescent Phase phonolite); plane-polarised light; field of view: 3.25 mm across. Large, elongate phenocrysts of titanite (sphene) and amphibole set in a fine-grained, sub-trachytic groundmass of plagioclase and lesser Fe-Ti oxide, alkali feldspar, clinopyroxene, apatite and titanite.

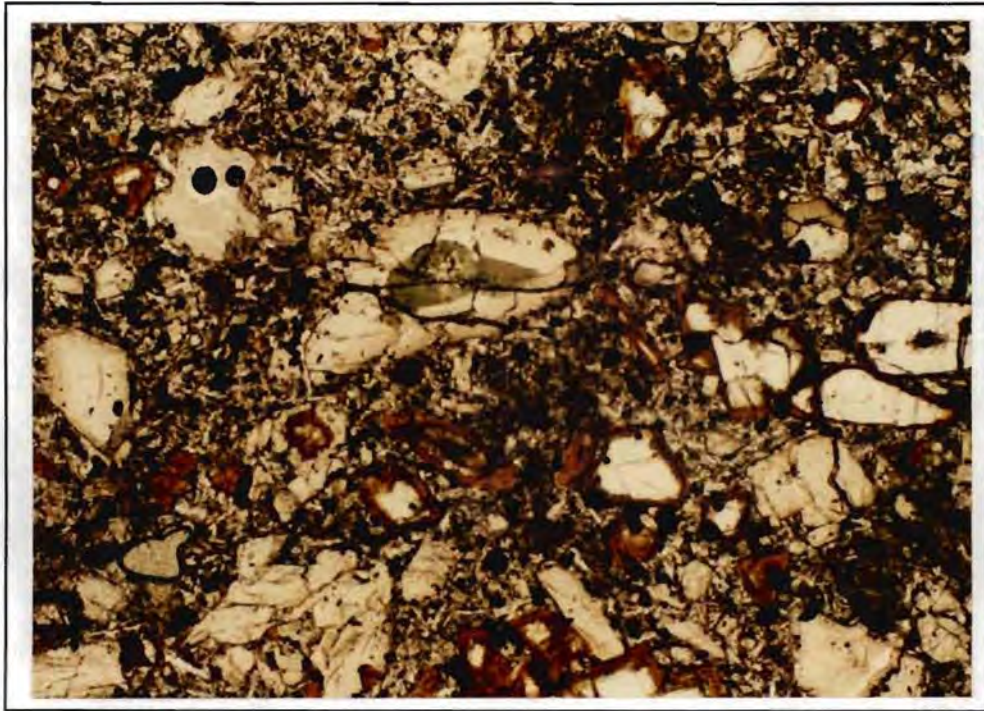


PLATE 25a. Photomicrograph of MA-33 (La Grille-type Rejuvenescent Phase basanite); plane-polarised light; field of view: 3.25 mm across. Phenocrysts and microphenocrysts of clinopyroxene and olivine in a fine-grained groundmass of clinopyroxene, plagioclase, Fe-Ti oxide, lesser olivine and accessory apatite. The clinopyroxene in the lower centre has a dark green core, a colourless to pale grey mantle and a slightly darker, pale tan rim. The olivine crystals have rims of brown iddingsite.

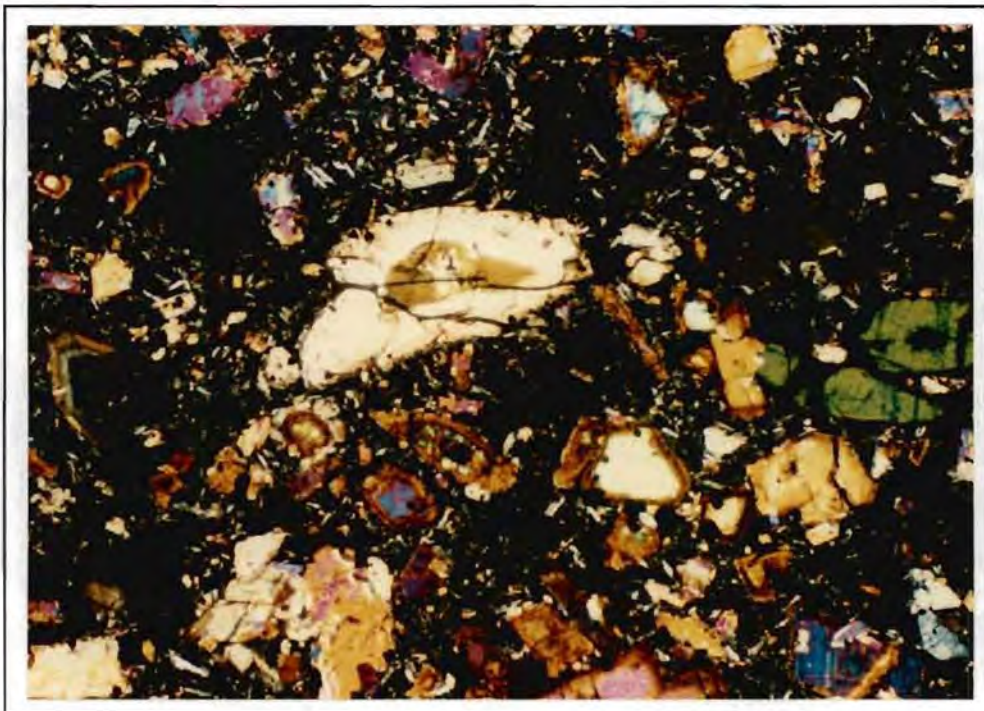


PLATE 25b. Photomicrograph of MA-33; crossed polars.