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RECORDS:

THE PETROLOGY OF SOME CAINOZOIC OLIVINE BASALTS FROM THE CAIRNS HINTERLAND, NORTH QUEENSLAND.

by

W.R. Morgan.

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THE PETROLOGY OF SOME CAINOZOIC OLIVINE BASALTS FROM THE CAIRNS HINTERLAND, NORTH QUEENSLAND

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SUMMARY

The Cainozoic basalts of the McBride, Atherton, Wallaroo, Sturgeon, and Mt. Fox Provinces in North Queensland belong to the continental non-orogenic olivine basalt association of Turner and Verhoogen, (1960). The Atherton Basalt is similar to the Older McBride Basalt, and it may suggest that these basalts are the same age.

In some basalts olivine phenocrysts contain an iddingsitized zone between a fresh core and the margin; the iddingsitization is probably late-magmatic. Acid inclusions in some basalts are surrounded by reaction veins, and some inclusions are partly vitrified. One basalt (G.82) contains glassy inclusions with amygdale-like structures suggesting that these inclusions were once an acid liquid immiscible with the basalt magma.

Chemical analyses of two of the basalts, A1400 (Younger McBride Basalt) and 2/4/67 (Kinrara Basalt), show that they are poor in SiO_2, and rich in Na_2O and K_2O. The calculation of molecular norms from the analyses of the two basalts show high percentages of the nepheline molecule, which is probably represented by analcite in one basalt, and which is presumably part of the abundant mesostasis glass in the other.

INTRODUCTION

This report contains petrographical descriptions of thirty-seven specimens collected from Cainozoic basalts in the Cairns Hinterland, North Queensland (Plate 1). Most of the specimens were collected by J.G. Best in 1958 and 1959; nine (G.6, G.10, G.54, G.67, G.70, G.81a, G.81b, G.82, and 54/3) were collected by C.E. Prichard in 1954 when he was a member of a C.S.I.R.O. Land-use survey in the Leichardt-Gilbert area, and were described by R.D. Stevens. These descriptions, with some amendments, are included in this report.

Most of the specimens are from the Atherton and McBride Basalt Provinces; two specimens were obtained from the Wallaroo Basalt, four from the basalts of the Mount Fox volcanic sequence. The locations of most of the specimens are shown on Plate 1.

The lavas of the McBride Province are divided by Best (1960) into four groups; these are, in order of superposition:

Kinrara Basalt.
Undara Basalt.
Younger McBride Basalt.
Older McBride Basalt.

Specimens from each of the four groups are described. In the Atherton Province the basalts are overlain by basic pyroclastics, indicating explosive vulcanicity. No specimens of the pyroclastics are described.

The petrographic study was undertaken to compare the basalts of the Atherton and of the McBride Provinces, and to find, if possible, some indication of the cause of the explosive vulcanicity in the Atherton Province.

GENERAL PETROLOGY

The basalts belong to the continental non-orogenic olivine basalt type (Turner and Verhoogen,1960). In the specimens described no late stage differentiates have been found. However, the low silica and high alkali oxides noted in the two chemical analyses suggest that any differentiates may also be alkaline.

Comparison of the McBride and Atherton Basalts. In the summary of petrography (Appendix 1) some similarities were noted between the lavas of the Atherton Province and those of the Older and Younger McBride Basalts. The most important of these is altered olivine, which, except for one specimen, was not seen in the Undara and Kinrara Basalts. This suggests that the altered olivine basalts are similar in age, and that the Undara and Kinrara Basalts are younger, possibly equivalent to the basic pyroclastics of the Atherton Province. However, correlation by petrography alone is tenuous, and further mapping is required to solve the problem.

The Wallaroo, Sturgeon, and Mount Fox Basalts are isolated from both the Atherton and the McBride Provinces; only a few specimens were collected. All except A1353 (Wallaroo) are olivine basalts, and in most specimens the olivine is partly altered. A1353 is a zeolite basalt and contains no plagioclase.

Alteration of Olivine. In some specimens, e.g., G.6, the olivine phenocrysts contain an iddingsitized zone between a fresh core and the margin. Edwards (1938a, and 1938b) described similar structures in the newer Tertiary basalts of Victoria; he considered that the olivine phenocrysts were formed prior to eruption and that, on eruption, the volatile phases were liberated from the lava and oxidised the olivine to form iddingsite. Subsequently, crystallization of olivine was resumed and a rim of olivine was formed around the iddingsite/olivine core. Edwards does not favour weathering of olivine to form iddingsite, because of the irregular form of the iddingsite zone, i.e., the zone corresponds to the form of an embayed crystal margin, and is too irregular to represent a compositional zone.

Wiltshire (1958) agrees that alteration to bowlingite is due to magmatic activity, and states that it may later be

converted to iddingsite by the addition of goethite by weathering. Wiltshire considers that both bowlingite and iddingsite are approximately the same mineral, smectite-chlorite.

Gay and LeMaitre (1961) concluded that iddingsite forms at intermediate temperatures in . cooling lavas, below temperatures necessary for structural reorganization, and above those at which the rock becomes completely solidified.

Acid inclusions. Acid inclusions were observed in several specimens. In G81a grains of quartz are surrounded by a thin rim of yellow-brown glass and an outer corona of fine clino-pyroxene crystals. Other authors, e.g., Lacroix (1893), have described similarly affected inclusions in basic lavas.

In specimen A1108 there is an inclusion which consists of a few isolated grains of quartz embedded in glass partly devitrified to fine-grained felsic material. This has some petrogenetic significance, because Holmes (1936) showed that in some basic lavas from Uganda the glass surrounding the quartz inclusions has a rhyolitic composition and does not consist of pure silica. He considered that the glass was formed in the solid state.

Steiner (1958) studied siliceous and glassy inclusions from the lava erupted in 1954 from Ngauruhoe Volcano in New Zealand. He considered that the included acid glass, because it is vesicular, was liquid. This suggests that the acid liquid inclusions were immiscible with the enclosing basic lava. The thin section of G.82 (p.25 of this report) contains an inclusion which consists mainly of fox-brown glass and clinopyroxene. These substances enclose strongly embayed grains of plagioclase, and also two amygdale-like structures containing zeolites (Figure 6). The glass in the inclusion has a refractive index lower than that of the pale brown glass in the enclosing basalt. So far, I have been unable to extract the glass in the inclusion from the hand specimen to measure its refractive index. If the determination of the relative indices of the two glasses is correct, the inclusion glass is probably richer in silica than the basalt glass. The two zeolite-filled structures are like amygdales, and, if this is correct, it suggests that this acid inclusion was at one stage a globule of liquid immiscible with the enclosing basalt.

Steiner (op.cit.) and Holgate (1954) regard these and similar phenomena petrogenetically important. Both writers are of the opinion that the observations indicate that acid magma may be formed by deep seated melting of sialic material by basaltic magma, and they believe that the resultant acid and basic magmas are immiscible.

CHEMICAL ANALYSES.

Two analyses are shown in Table 1. These are of A1400 (Younger McBride Basalt,p.4) and 2/4/67(Undara Basalt,p.4). In comparing these analyses with those of other continental and oceanic basalts, the North Queensland basalts are slightly less rich in SiO_2 than is apparently normal, and Na_2O and K_2O are higher. The alkali percentages of the two specimens are similar to an analysis of a basalt from Gough Island (Barth,1952). The molecular norms are calculated from these two analyses.

TABLE 1.

Chemical Analyses.

A1400				2/4/67			
Analyses		Norm.		Analysis		Norm.	
SiO_2	44.68	Orthoclase	13.4	SiO_2	47.00	Orthoclase	13.3
Al_2O_3	15.56	albite	5.3	Al_2O_3	16.49	albite	16.2
Fe_2O_3	4.17	anorthite	14.0	Fe_2O_3	5.25	anorthite	13.6
FeO	7.01	nepheline	19.9	FeO	5.98	nepheline	16.5
MgO	9.84	diopside	Wo 11.9	MgO	8.17	diopside	wo9.1
			en 7.8				en6.2
CaO	8.70		fs 3.2	CaO	7.32		fs2.1
Na_2O	4.88	olivine	fo 11.8	Na_2O	5.51	olivine	fo10.1
			fa 3.5				fa 2.5
K_2O	2.27			K_2O	2.28		
$H_2O(105^oc)$	0.45	magnetite	6.0	$H_2O(105^oc.)$	0.45	magnetite	7.7
H_2O (ignition)	0.68	ilmenite	2.9	H_2O (ignition)	0.10	ilmenite	2.4
TiO_2	1.48	apatite	0.3	TiO_2	1.28	apatite	0.3
P_2O_5	0.16	TOTAL	100.0	P_2O_5	0.14	TOTAL	100.0
MnO	0.40			MnO	0.40		
TOTAL	100.28			TOTAL	100.22		

A1400. Olivine-titanaugite basalt, Younger McBride Basalt. Two miles north-west of "Gunnawarra" Homestead. (Petrography on p.6).

2/4/67. Olivine-augite basalt, Undara Basalt. Chubbers Hill, two miles north-east of "Meadowbank"Homestead. (Petrography on p.).

The interesting feature of these is the high normative content of nepheline.

The thin section of A1400 (p.22) does not contain nepheline, but it does contain analcite, and the high percentage of nepheline in the norm is probably due to the analcite. Neither nepheline nor analcite was observed in the thin section of 2/4/67 (p. 26), but it does contain an abundant glass mesostasis, which may be normative nepheline.

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APPENDIX I - PETROGRAPHY

Summary of Petrography. With five exceptions, all the specimens are olivine basalt. Three are olivine zeolite basalts and contain no plagioclase (5/7/67, A1108, and A1353); another is an ultramafic rock (97535); and the third is a probable basaltic andesite.

(a) Textures. The textures of the basalts are either intergranular, ophitic, intersertal, or hyalo-ophitic. Most of the specimens are porphyritic. The main difference between specimens of the Atherton Province and those of the McBride is that the hyalo-ophitic texture is more common in the McBride; this texture is found mainly in specimens from the Undara and Kinrara Basalts, which means that glass is more prevalent in those basalts.

(b) Mineralogy. No optical or universal stage determinations have been made for this report, hence all remarks made here must be tentative.

i. Olivine in all specimens appears to be of uniform composition, i.e., 2V is about 90°, which suggests a composition of Fa_{15-20}. In the specimens of Atherton, and of Older and Younger McBride Basalts, most of the olivine is partly or almost entirely altered to iddingsite and, more rarely, to bowlingite, hydrated iron oxide, or serpentine. In the Undara and Kinrara Basalts, olivine is altered in one specimen only (2/4/67). All the porphyritic rocks in both the Atherton and McBride Provinces contain olivine phenocrysts.

ii. Pyroxene. There is pale purple titanaugite and colourless augite in rocks from both Provinces. Titanaugite is more common in the McBride specimens than in those from the Atherton Province. In the porphyritic rocks, clinopyroxene phenocrysts are more common in the Atherton Province; in the specimens of the McBride Province, these phenocrysts are absent from the Undara and Kinrara Basalts.

iii. Plagioclase. The plagioclase from all the specimens examined had an average composition of An_{67}, and the observed compositions range from An_{60} to An_{75}. There is little or no difference in the average compositions of plagioclase from the two provinces.

Rare plagioclase phenocrysts occur in three specimens from each of the provinces. They are usually strongly embayed, and all contain finely intergrown opaque iron ore, or haematite (Figure viii). Various authors (e.g., Carstens, 1955, Tomisaka, et al., 1957) suggest that these inclusions are iron exsolved from the feldspar on cooling.

iv. Interstitial minerals. Glass (including palagonite) is present in many specimens, and it is more abundant in the McBride Basalt, and especially in the Undara and Kinrara Basalts. There is analcite in both provinces, and it is more common in the Atherton specimens. Other interstitial minerals are alkali-feldspar, chlorite, bowlingite, nontronite, and rare calcite.

A. ATHERTON PROVINCE

A1092 (slide number 6130). Atherton 4-mile Sheet Run 12 photo 5103. Mandalee/Glen Gordon Homesteads roadside.

Porphyritic analcite-iddingsite-olivine basalt. (Figure 1).

In hand-specimen, the basalt is fine-grained; small red, iddingsitized porphyritic crystals of olivine can be seen with a hand lens.

In thin section, the basalt is seen to have a holocrystalline, intergranular and indistinct pilotaxitic texture. Porphyritic crystals of strongly iddingsitized olivine up to 0.75 mm. in size and bundles of pellucid plagioclase (An_{75} zoned to andesine) laths that average 0.25 mm. length, are enclosed in a dark matrix which, under high power, resolves to show clusters of granular to prismatic colourless clinopyroxene and iddingsitized olivine crystals, and interstitial analcite, (?)alkali-feldspar, and minor chlorite. Black iron ore is octahedral. Rare porphyritic crystals of strongly embayed and zoned plagioclase are present.

A quartz inclusion is surrounded by a reaction zone containing fine circular crystals of diopsidic augite arranged perpendicularly on its margin, and embedded in probable glass.

The percentages of minerals are : - plagioclase, 40; clinopyroxene, 30; olivine, 20; analcite and (?)alkali-feldspar, 5; black iron ore, 5; chlorite, less than 1.

A1096 (slide number 6131). Atherton 4-mile Sheet, Run 9, photo 5103. Tomoulin/Kaban road.

Porphyritic and vesicular iddingsite-olivine-titanaugite basalt.

The hand-specimen is dyscrystalline and porphyritic. The small phenocrysts consist of reddish-green olivine and black pyroxene, and the vesicles, some of which are filled with calcite, measure up to about 2 mm. in diameter.

In thin section the olivine phenocrysts range up to 1.75 mm.; they are subhedral and commonly partly replaced by red iddingsite. Augite commonly forms groups of intergrown phenocrysts; the groups and single phenocrysts are mainly colourless, but they have a thin margin that is pleochroic from very pale purple to extremely pale yellowish brown. Some of the augite shows faint oscillatory zoning; commonly, the groups have cores or marginal zones which contain fine intergrown inclusions of opaque ore.

The groundmass is holocrystalline and intergranular. Pellucid laths of plagioclase (An_{66}) range from 0.05 mm. to 1 mm. in length, and form an interlacing meshwork. Colourless partly iddingsitized olivine and pale purple titanaugite have a prismatic habit. Green chlorite is interstitial, and is charged with fine opaque material (?)leucoxene. Black iron ore is octahedral (magnetite) and acicular (ilmenite).

Alkali-feldspar is rare and interstitial, and acicular apatite is accessory. Plates of calcite fill small amygdales.

Percentages of minerals are :- plagioclase, 40; augite and titanaugite; 35; olivine,15; black iron ore, 8; and chlorite and alkali feldspar, 2.

A1108 (slide number 6132) Atherton 4-mile Sheet, Run 12, photo 5103. 3 miles north-east of Glen Gordon Homestead.

Porphyritic bowlingite-olivine-titanaugite analcitite. This specimen comes from a flow probably belonging to the Atherton Province. The hand-specimen is porphyritic and fine-grained, and contains some vesicles. It encloses some angular, pale, quartz-rich inclusions.

In thin section phenocrysts of olivine (mostly altered to bowlingite)

Fig.1. Intergranular texture. The dark grey,sub-prismatic crystals are partly iddingsitized olivine phenocrysts. Ordinary light, x 50. Negative: G/3372 (specimen A1092)

and rare prismatic, pale purple titanaugite are enclosed in a very fine-grained, hypocrystalline groundmass. The phenocrysts range from groundmass grain size to 1.4 mm.

The groundmass contains small columnar crystals of pale purple clinopyroxene (average size 0.03 mm. long by 0.01 mm. wide), granular black iron ore dust, and some bowlingitized olivine, all embedded in zeolite (mostly(?) analcite). Small amounts of pale brown glass have a refractive index less than that of Canada balsam, and greater than that of the analcite. Small amygdales contain analcite and (?)thomsonite.

The lava encloses a few siliceous and feldspathic xenoliths. A quartz grain with rounded margins is surrounded by a reaction rim containing needles of clinopyroxene that are embedded in brown devitrified (?)glass. Another xenolith consists of a few quartz grains embedded in a partly devitrified felsic glass. Potash-feldspar with small amounts of graphically intergrown quartz, and a quartz-albite granulite have irregular, though rounded, margins surrounded by reaction zones similar to that of the quartz grain.

The percentages of constituent minerals are zeolites:55; clinopyroxene: 27; olivine: 10; black iron ore: 8.

A1117 (slide number 6136). Atherton 4-mile Sheet, Run 9, photo 5103. Half a mile south of Evelyn Homestead.

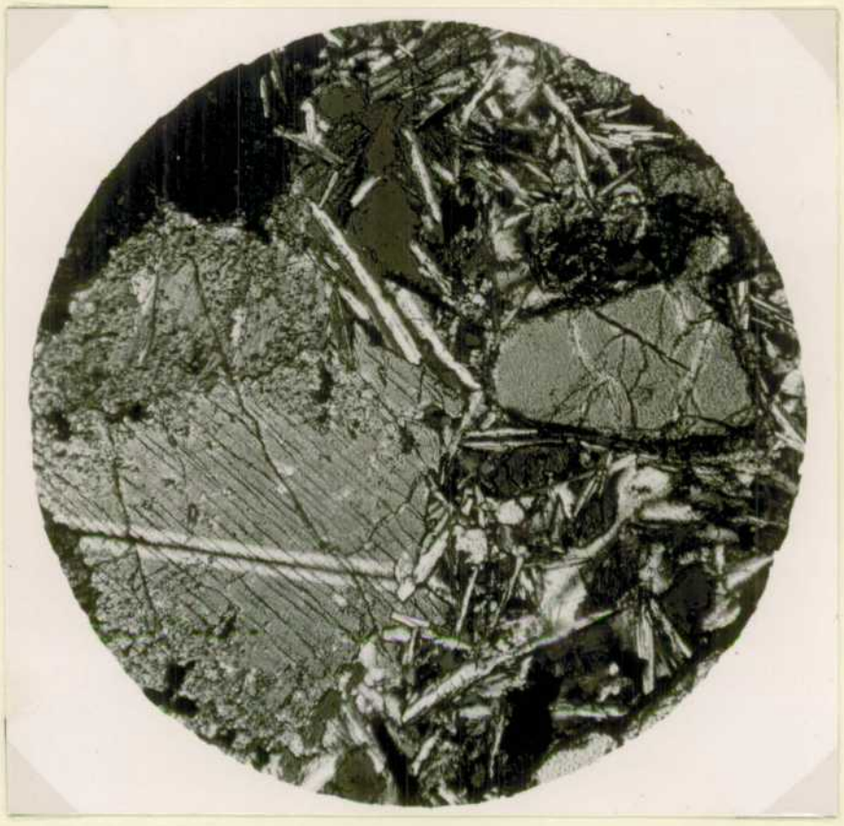
Porphyritic analcitic iddingsite-olivine-titanaugite basalt. (Figure 2).

The hand specimen is a greyish-black, vesicular, dyscrystalline basalt studded with small phenocrysts of reddish green olivine and black pyroxene.

In thin section the basalt is seen to be seriate glomeroporphyritic, the phenocrysts ranging from groundmass size to 3.7 mm.. The phenocrysts comprise olivine, titanaugite, and rare plagioclase. The olivine forms subhedral, commonly embayed crystals that are partly replaced by iddingsite. Titanaugite forms groups of intergrown crystals similar to those described in specimen A1096 (page 7), except that the margins of the groups are ophitically intergrown with groundmass plagioclase (Figure 2). Titanaugite is pale purple, the colour deepening at the crystal and crystal-group margins. Rare plagioclase phenocrysts are embayed, and their cores have intergrown inclusions of (?)leucoxene.

The groundmass is holocrystalline, and has an average grain-size of 0.3 mm; it contains pellucid laths of plagioclase (An_{70}) ophitically intergrown with fairly deep purple titanaugite and granular to prismatic olivine. Alkali feldspar, analcite, and green chlorite are interstitial, and black iron ore frons small needles (ilmenite) and octahedra (magnetite). Minute, acicular crystals of apatite are enclosed in plagioclase.

The percentages of the constituent minerals are : - plagioclase, 40; titanaugite,35; olivine, 15; alkali-feldspar, analcite, and chlorite,5; black iron ore,5.



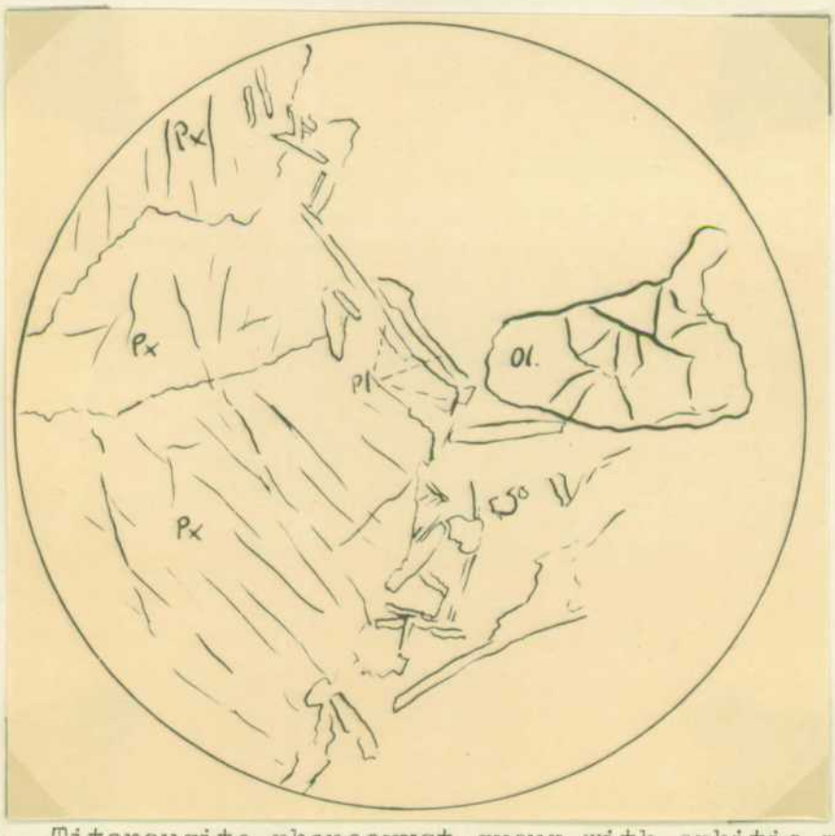


Fig.2. Titanaugite phenocryst group with ophitic margins. Crossed nicols, x 50. Negative : G/3378. Px = titanaugite, Ol.= olivine, Pl.= plagioclase. (Specimen A1117).

A1202 (slide number 6181). Atherton 4-mile Sheet. One mile east-north-east of Kaban (McKinley's dam).

Porphyritic analcitic iddingsite-olivine-titanaugite basalt. In hand-specimen the basalt is fine-grained, dyscrystalline, and porphyritic. The phenocrysts consist of olivine and pyroxene-the latter also forms larger rounded grains up to 4 mm. diameter Small cavities and vesicles are fairly common, and some are filled with calcite.

In thin section shows that the basalt is seriate porphyritic. The phenocrysts range up to 5 mm. in size, and consist of groups of intergrown titanaugite crystals (like those described in specimens A1096 and A1117), and of clustered, slightly iddingsitized olivine crystals that show some embayment, and which are 1.1 mm. in maximum width.

The groundmass is holocrystalline and contains randomly oriented, pellucid laths of plagioclase (An_{68}) 0.5 mm. long, prismatic to sub-ophitic purple titanaugite, and granular olivine embedded in a dark, fine matrix. The matrix, under a high-power objective, may be seen to consist of acicular black iron ore (ilmenite), and minute crystallites of plagioclase and black ore enclosed in faintly birefringent analcite, alkali-feldspar, and green chlorite. There are some minute acicular crystals of accessory apatite and some interstitial calcite.

The percentages of the constituent minerals are : -

plagioclase, 30; titanaugite,25; olivine 20; interstitial minerals, 17; black iron ore, 8.

A1242 (slide number 6205) Atherton 4-mile Sheet, Run 11, photo 5011. One quarter mile east of Woodleigh Homestead, in a small creek.

Porphyritic, analcitic iddingsite-olivine-titanaugite basalt.

The hand-specimen is a dense, black, aphanitic, and amygdaloidal basalt.

In thin section the basalt is seen to be hypocrystalline and seriate porphyritic. The olivine is almost entirely replaced by reddish-brown iddingsite. It occurs as prismatic, commonly somewhat embayed crystals ranging in size from 0.02mm. in the groundmass to porphyritic crystals 0.9 mm. long. One crystal has a core replaced by bowlingite. Plagioclase (An_{72-4}) forms thin laths, and prismatic, pale purple titanaugite occurs mostly in the groundmass, but there are some almost colourless porphyritic crystals. Brown palagonite is hyalo-ophitic, and encloses trichytes of black iron ore, and translucent arborescent crystallites of an undetermined mineral. Analcite is interstitial and, with hydrated iron oxide, fills the amygdales. Black iron ore is octahedral.

The percentages of minerals are: -

plagioclase, 30; titanaugite,25; iddingsitized olivine, 15; palagonite, 15; analcite,10; black iron ore, 5.

A1309 (slide number 6203) Atherton 4-mile Sheet, Run 10, Photo 5181. Near Vine Creek, off the Ravenshoe/Wooroora road.

Porphyritic olivine-iddingsite-andesitic basalt. (Figure 3)

The hand-specimen is pale grey, and laminated, probably due to the flow-texture observed in the thin section. Small phenocrysts of olivine and pyroxene are enclosed in an aphanitic groundmass.

In thin section the specimen is seen to be glomeroporphyritic; the phenocrysts consist of subhedral partly iddingsitized olivine and very pale green augite; grains of both minerals are embayed, and the augite shows oscillatory zoning.

The groundmass is hypocrystalline, and consists mostly of a felted mass of thin, flow-oriented laths of plagioclase which average 0.02 mm. wide by 0.2 mm. long. Very pale green augite forms clustered, prismatic crystals 0.03 mm. in size, and olivine is granular and commonly pseudomorphed by brown bowlingite. Alkali-feldspar, colourless glass (refractive index less than that of balsam), and analcite are interstitial. Black iron ore is octahedral, although it tends to enclose plagioclase laths. Acicular apatite is accessory. The rock is cut by thin veins containing bowlingite.

The percentages of minerals are : -

plagioclase, 65; augite, 15; olivine,10; black iron ore,5; alkali feldspar, glass, and analcite,5.

The extinction angles of plagioclase in the symmetrical zone on a dozen microlites were measured, and gave a composition of An_{55}; similar measurements on combined Carlsbad and Albite twins on four crystals gave results ranging from An_{56} to An_{72}. The felted texture and the leucrocratic nature of the specimen suggests that the rock is an andesitic basalt.

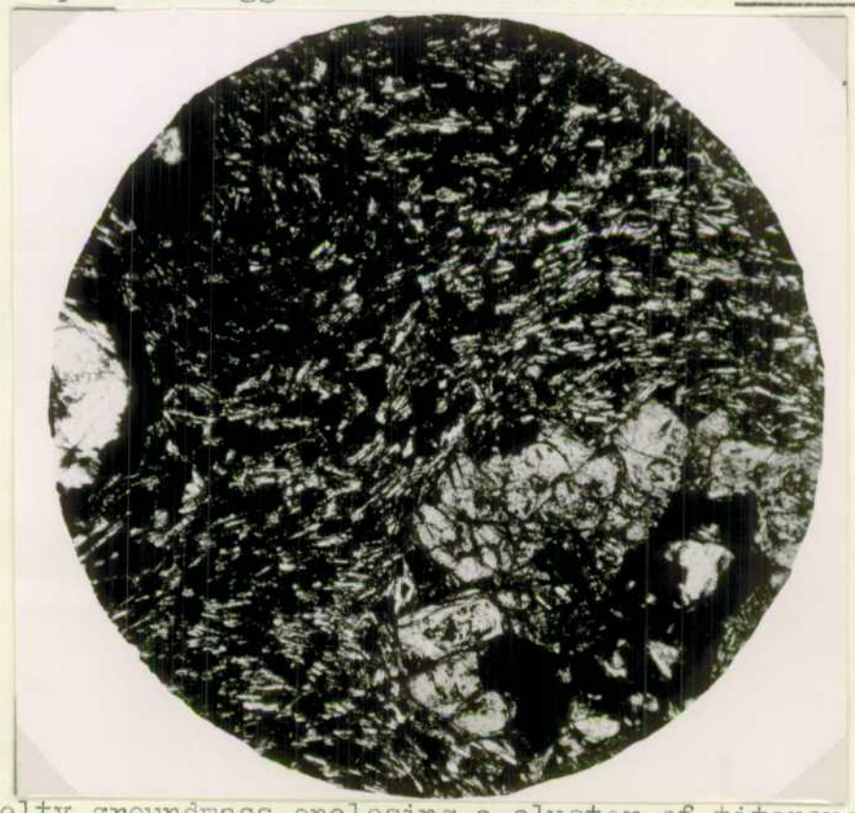


Fig.3. A felty groundmass enclosing a cluster of titanaugite and olivine phenocrysts. Ordinary light,x 35. Negative G/3382. (Specimen A1309).

A1312 (slide number 6206). Atherton 4-mile Sheet, Run 10, photo 5181. Wooroora Homestead.

Bowlingite-olivine-augite basalt (Figure 4).

The hand-specimen is aphyric, fine-grained and dyscrystalline; vesicles and amygdales are sparse.

In thin section the texture is found to be hyalo-ophitic and intergranular. Plagioclase (An_{60}) forms randomly oriented laths whose average length is 0.2 mm. Colourless to very pale green augite is granular to prismatic, and olivine forms rounded, prismatic crystals, some of which are partly pseudomorphed by bowlingite. All these minerals are embedded in a brown basaltic glass that has a refractive index lower than that of Canada balsam. Also enclosed in the glass are trichytes of black iron ore, and crystallites of plagioclase and clinopyroxene. Small amounts of brownish-green nontronite and colourless analcite are present. Black iron ore is also octahedral.

In some places there are irregularly shaped glass-rich pockets, up to 5 mm. across; some of the pockets contain small central amygdales. In some places the margins of the pockets are sharp, but in others the change from normal to glass-rick rock is marked by a gradual decrease in the amount of plagioclase. These glass-rich pockets contain glass, arborescent crystallites of black iron ore, and very small microlites of plagioclase. In addition they contain acicular skeletal crystals of pale purple titanaugite; basal sections of these show that their cores are commonly occupied by green chlorite - some in fact have a prism face missing (Figure 4). The skeletal crystals probably indicate that the material to form titanaugite was depleted, and crystallization within the area of the crystals was completed by chlorite. The thin section contains one or two apparent cognate xenoliths of rather similar but finer-grained basalt.

The percentages of the constituents are : -
plagioclase, 25; clinopyroxene,15; glass, 45; olivine,5; black iron ore,5; analcite and nontronite, 5.

The amygdales contain (?)thomsonite and analcite, commonly occurring in an outer zone enclosing fibrous nontronite.

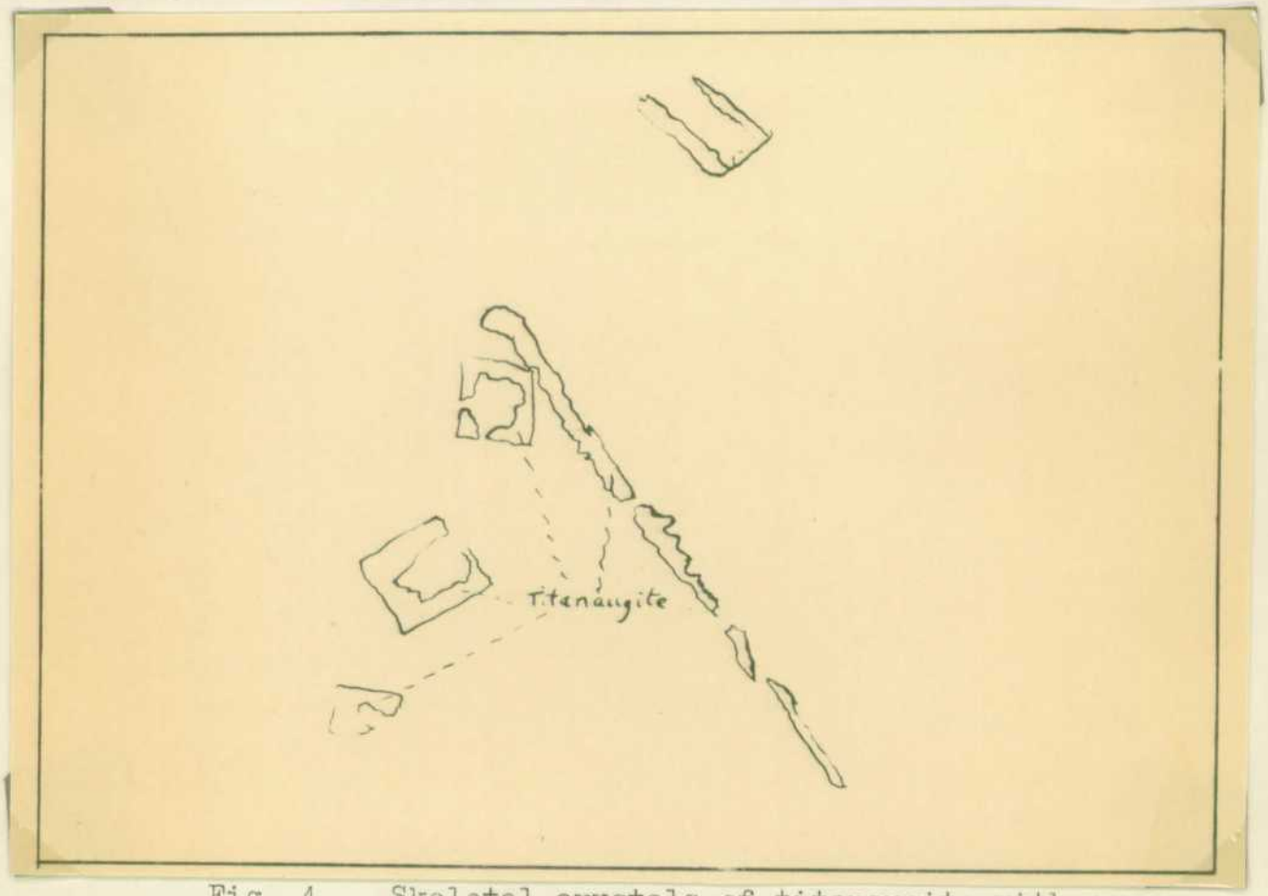


Fig. 4. Skeletal crystals of titanaugite with cores of chlorite. Ordinary light x 145. Negative G/3368 (Specimen A1312).

A1323 (slide number 6189). Atherton 4-mile Sheet, Run 11, Photo 5009. Mount Ronald Homestead.

Porphyritic analcitic iddingsite-olivine-augite basalt.

The basalt, in hand-specimen, is very fine-grained and sparsely porphyritic. There are a few amygdales, containing probable zeolite, which range up to 4 mm. in diameter.

In thin section phenocrysts up to 2 mm. long are present, and consist of olivine and some plagioclase. They have rounded and embayed margins, and the olivine is rimmed by iddingsite and hydrated iron oxide.

The groundmass is intergranular and pilotaxitic and has an average grain-size of 0.15 mm. It consists of flow-oriented laths of plagioclase (An_{60-66}), prismatic to granular olivine and pale green augite, octahedral black iron ore, and interstitial alkali-feldspar, analcite, and nontronite. Acicular apetite is accessory.

The percentages of constituent minerals are : -

plagioclase, 50; olivine,15; augite,20; interstitial minerals, 10; black iron ore, 5.

A1327 (slide number 6182). Atherton 4-mile Sheet. Waterfall south of Malanda.

Porphyritic bowlingite -olivine-augite basalt.

The hand-specimen is a dark greenish-black, dyscrystalline, and porphyritic basalt.

In thin section the phenocrysts range up to 1.5 mm. across, and consist mainly of subhedral embayed olivine that is mostly replaced by bowlingite. There are a few small porphyritic crystals of very pale green augite.

The texture of the groundmass is intergranular and intersertal. Pellucid plagioclase (An_{66-72}) laths, with an average length of 0.35 mm., are randomly oriented; granular to prismatic augite and olivine form clusters of small crystals between the laths; olivine is commonly pseudomorphed by bowlingite. Brown bowlingite((?)devitrified glass), and smaller amounts of brown glass enclose the other minerals. Black iron ore is octahedral and acicular and also forms fine granules enclosed in glass.

The percentages of the constituents are : -

plagioclase,45; augite,15; olivine and pseudomorphous bowlingite,10; interstitial bowlingite and glass,25; black iron ore,5.

A1380 (slide number 6198). Innisfail 4-mile Sheet. 3 miles north of Tully Falls on timber cutters' road.

Porphyritic bowlingite-olivine-augite basalt. (Figure 5)

In hand-specimen the basalt is a dark grey, massive, aphanitic rock with sparse phenocrysts of olivine and some quartz inclusions.

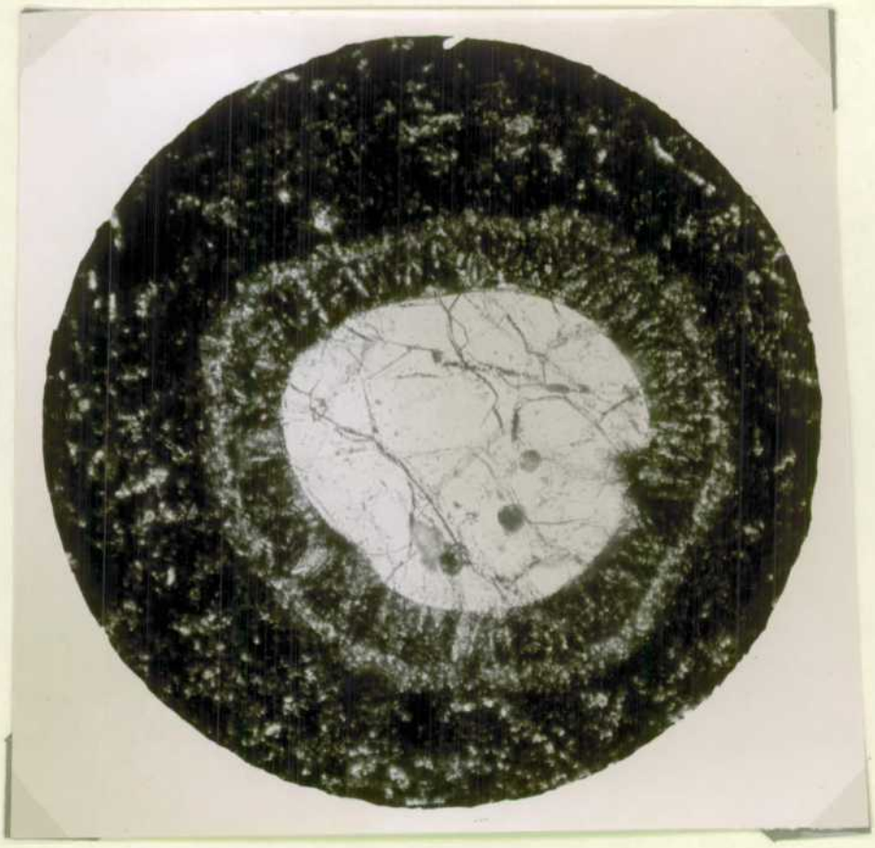
In thin section the basalt is seriate porphyritic; the embayed prismatic phenocrysts of partly bowlingitized olivine range up to 2 mm. in length.

The groundmass is hypocrystalline; pilotaxitic, and intergranular. Plagioclase (An_{58}) forms roughly flow-oriented laths (0.14 mm. average length), augite occurs as small colourless columnar crystals about 0.03 mm. long, and olivine is prismatic. Pale brown glass (refractive index less than that of Canada balsam) and alkali-feldspar are interstitial; the glass is, in places, devitrified to minute flakes of brown bowlingite. Black iron ore is octahedral, and accessory apatite is acicular.

A rounded quartz inclusion is surrounded by a reaction rim of pale green, columnar diopsidic augite embedded in probable alkali-feldspar. The diopsidic augite crystals are arranged perpendicularly to the margin of the inclusion (Figure 5.).

The percentages of the constituents are: -

plagioclase, 47; augite, 25; olivine, 15; glass, bowlingite, and alkali feldspar, 5; black iron ore, 7.



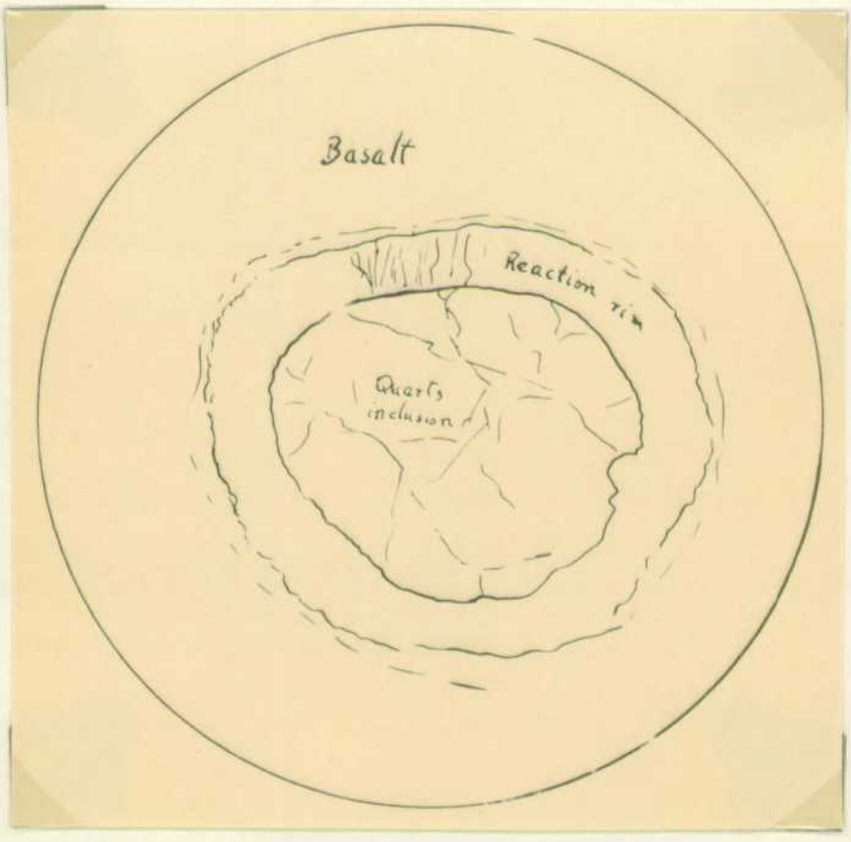


Fig. 5. Specimen A1380. An inclusion of quartz enclosed by a reaction rim composed of diopside and small amounts of alkali feldspar. Crossed nicols x 50. Negative: G/3369.(Specimen A1380).

B. McBRIDE PROVINCE.

1. Older McBride Basalt.

1/4/67 (slide number 6116). Einasleigh 4-mile Sheet. Crest of old vent half mile west of Meadowbank Homestead.

Weathered olivine basalt.

In hand-specimen a fine-grained, brick red, aphanitic groundmass encloses small, darker red grains. The specimen contains many vesicle-like cavities.

The thin section shows a dense, fine-grained, translucent to opaque, dull red groundmass enclosing euhedral, embayed crystals of almost entirely iddingsitized olivine. The groundmass appears to consist of hydrated iron oxide; numerous flow-oriented vesicles give it a spongy appearance.

5/7/67 (slide number 6111) Einasleigh 4-mile Sheet. Crest of Mt. Munana.

Porphyritic olivine analcitite.

The hand-specimen is a dark reddish-brown porphyritic and vesicular lava; small red phenocrysts of altered olivine are enclosed in an aphanitic groundmass. The vesicles are elongated and flow-oriented, and are 3 mm. average diameter. Some small xenolithic inclusions consist of basalt and a medium-grained ultrabasic rock. The specimen shows irregular weathered areas.

In thin section the basalt is seen to be porphyritic and has an extremely fine-grained groundmass. The phenocrysts are olivine and clinopyroxene. The olivine is mostly replaced by hydrated iron oxide, and the clinopyroxene, which shows oscillatory zoning, is stained yellow.

The groundmass mineralogy and texture is generally similar to that of A1108 (page 8). There is a small inclusion of basalt in the thin section. Irregularly shaped areas corresponding to the weathered rock noted in the hand-specimen are composed of yellowish translucent to opaque material that may have resulted from alteration of the groundmass zeolite

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97521 (slide number 6065). Einasleigh 4-mile Sheet. 3 miles west of Rocky Dam.

Porphyritic analcitic bowlingite-olivine-titanaugite basalt.

The hand-specimen is dark reddish-brown porphyritic basalt in which small phenocrysts of olivine are enclosed in a fine-grained, dyscrystalline groundmass.

In thin section the basalt is found to be seriate

glomeroporphyritic and holocrystalline. The grain-sizes range from 0.03 mm. in the groundmass to phenocrysts of 1.2 mm. The phenocrysts consist of subhedral, embayed olivine that is partly replaced by bowlingite.

In the groundmass, olivine is granular to euhedral, and pale purple titanaugite is usually prismatic, and in one or two places it is sub-ophitically intergrown with plagioclase. Plagioclase (An_{68}) forms clusters of randomly oriented laths. (?)Thomsonite and analcite, with more rare brown bowlingite and green chlorite, are interstitial. In places the zeolites partly replace plagioclase. Black iron ore encloses both plagioclase and titanaugite,and it is octahedral.

The percentages of minerals are:-

plagioclase,30; titanaugite,25; olivine,20; zeolite,15; bowlingite and chlorite,5; black iron ore 5.

97535 (slide number 6115) Einasleigh 4-mile Sheet. An ultra-basic bomb from near the lava tunnel near the crest of Mt.Lang.

Olivine-lamprobolite pyroxenite.

The hand-specimen is very dark grey in places,and is weathered to a brick-red; some surfaces are covered by a veneer of hydrated iron oxide.

In thin section the texture is seen to be holocrystalline and xenomorphic-inequigranular. The grain-size ranges mostly between between 0.2 mm. and 1.0 mm.. Augite, the most abundant mineral, is anhedral to sub-prismatic. Lamprobolite is mostly anhedral, and commonly forms poikilitic plates, some of which range up to 2.5 mm. across; it also partly replaces augite, and some of it may have completely pseudomorphed olivine grains. The lamprobolite is pleochroic from rich red-brown to pale golden yellow. Olivine is rare, and forms anhedral grains. Black iron ore is octahedral to anhedral, and is abundant; commonly the minerals immediately surrounding black iron ore are stained with hydrated iron oxide. Plagioclase is very rare, and is tabular. Analcite, and in some places, chalcedony, occur partly or completely filling small amygdale-like voids.

The percentages of minerals are : -

augite,55; lamprobolite,20; black iron ore,19; olivine,5; plagioclase, analcite, and chalcedony 1.

G.81(a) (slide number 205). Rosella Plains; latitude 18°27'S; longitude 144°26'E.

Iddingsite-olivine basalt.

In hand-specimen this is a very fine-grained dark grey basaltic rock which contains a few macroscopically visible olivine phenocrysts and has a distinct sub-conchoidal fracture. Vesicles, ranging from 0.2 mm. to 1 cm. in diameter, are common, and may be filled with calcite. Joint planes are also calcite-covered.

In thin section the rock is seen to be hyalo-ophitic, and consists of plagioclase (35%), olivine (15%), and glass(50%). Plagioclase (about An_{60}), forms small laths and microlites that are poorly twinned, and contain small inclusions of olivine, apatite, and fine crystallites of (?)clinopyroxene. Olivine forms subhedral, commonly deeply embayed crystals that are partly or entirely altered to iddingsite. Its crystals range from less than 0.05 mm. to 0.7 mm. across, and in the hand-specimen there are a few phenocrysts measuring up to 5 mm. in diameter.

Enclosing the plagioclase and olivine is a brown, semi-opaque glass that has a refractive index slightly higher than that of Canada balsam. In the glass are minute inclusions of grains and rods of black iron ore, crystallites of (?)clinopyroxene, and innumerable other unidentified fine, needle-like crystallites.

Some vesicles contain calcite and rare bowlingite. Xenoliths of quartz about 0.5 mm. across are uncommon and are surrounded by a narrow inner reaction-rim of yellow-brown glass and an outer corona of finely crystalline pyroxene.

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2. Younger McBride Basalt.

G.67 (slide number 203) Glendhu; latitude 18°27'S, longitude 145°05'E

Vesicular-iddingsite olivine basalt.

The hand-specimen is a moderately vesicular, pale grey basaltic rock which contains elongated vesicles with an average diameter of 5mm. Brown altered microphenocrysts of olivine are of frequent occurrence.

In thin section the basalt is seen to be holocrystalline, and the essential minerals are plagioclase (55%), titaniferous augite (25%) altered olivine (15%), and black iron ore (5%). Plagioclase (An_{66}) forms small well-formed laths averaging about 0.5 mm.. Olivine occurs as microphenocrysts up to 1 mm. across and as small grains with a diameter of 0.1 to 0.2 mm. that are intergranular to the feldspar laths. The porphyritic olivine is almost completely pseudomorphed by iddingsite, and the intergranular crystals are considerably less iddingsitized, though still slightly so. These are commonly associated with and include granular iron oxide, and the smaller olivine crystals are commonly included in feldspar.

(?)Titaniferous augite is ophitically intergrown with plagioclase but individual pyroxene areas seldom exceed 1 mm. across. The pyroxene is colourless to pale purple. Interstitial material is composed of alkali-feldspar, chlorite, and indefinite small opaque grains - probably iron oxides.

G.81(b) (slide number 206). Rosella Plains; latitude 18°27'S; longitude 144°26'E.

Iddingsite olivine basalt.

In hand-specimen the basalt is medium-grained and dark grey; pyroxene, plagioclase, and brownish olivine are readily identified with a hand lens.

In thin section the basalt is seen to be holocrystalline and sparsely porphyritic, and is composed essentially of plagioclase (60%), titanaugite (20%), olivine (15%), and magnetite (5%).

Plagioclase (An_{66}) forms an interlacing meshwork of pellucid laths that average about 1 mm. in length. Pale purple titanaugite is granular-prismatic, and forms rare phenocrysts; the phenocrysts are grouped similarly to those in specimen A1117 (Figure 2). The titanaugite is weakly pleochroic and is zoned. Olivine crystals are subhedral; their diameter averages 5 mm., and they are commonly completely altered to iddingsite: several crystals however, have a thin external rim of fresh olivine. Accessory minerals include interstitial greenish pyroxene - (?)aegirine augite - and some alkali-feldspar and minute, acicular apatite crystals.

G.82(Slide number 207). Black Top; latitude 18°22'S; longitude 144°23'E.

Olivine basalt. (Figure 6).

The hand-specimen is very fine-grained and is dark grey; a few phenocrysts of olivine range up to 5 mm. in size, but mostly they do not exceed 2 mm.

In thin section the basalt is found to be porphyritic-pilotaxitic, and hyalo-ophitic. The essential minerals are plagioclase (30%), olivine(10%), augite (30%), glass (20%) and black iron ore (10%).

Plagioclase (An_{60}) forms small stumpy laths (0.1 mm.). Olivine occurs as small porphyritic crystals measuring about 0.3 mm. long, and in places is altered to colourless serpentine and green chlorite. Prismatic crystals of augite measure 0.05 mm. long. All these crystals are enclosed in a pale fawn-brown glass that is crowded with minute, unidentified crystallites and globulites and which have refractive indices lower than that of Canada balsam. Small amygdales and irregular openings are filled with (?)mesolite and rare chlorite.

Figure 6 is a photomicrograph of an inclusion in the basalt.

At the core are two amygdale-like structures containing zeolite (probable natrolite, analcite, thompsonite, and stilbite) enclosed in a rim of chlorite. In the chlorite around the larger "amygdale" are enclosed some clinopyroxene crystals, some of which are skeletal. Surrounding this "amygdale" is a zone consisting of relatively coarse acicular crystals of clinopyroxene that are oriented perpendicularly to the margin of the "amygdale". This coarse clinopyroxene is also associated with the margin of the smaller vesicle, but here it forms more diffuse patches embedded in a fox-brown glass that contains randomly oriented arborescent trichites of black iron ore. The "amygdales" and their surrounding zones of pyroxene and glass are enclosed in an outer zone composed of fine-grained, randomly oriented clinopyroxene embedded in the fox-brown glass. Two large crystals of strongly embayed plagioclase are enclosed by the inner pyroxene glass zone.

The basalt immediately around the inclusion contains augite and olivine microphenocrysts embedded in the pale buff, basaltic glass, and plagioclase is absent. The glass of the inclusion grades fairly rapidly into the basaltic glass. The R.I. of the included fox-brown glass could not be measured, but on Becke-line test it may be lower than that of the basaltic glass.

See Figure 6. page 23.

A1400 (slide number 6118). Atherton 4-mile Sheet. 2 miles north-west of Gunnawarra Homestead.

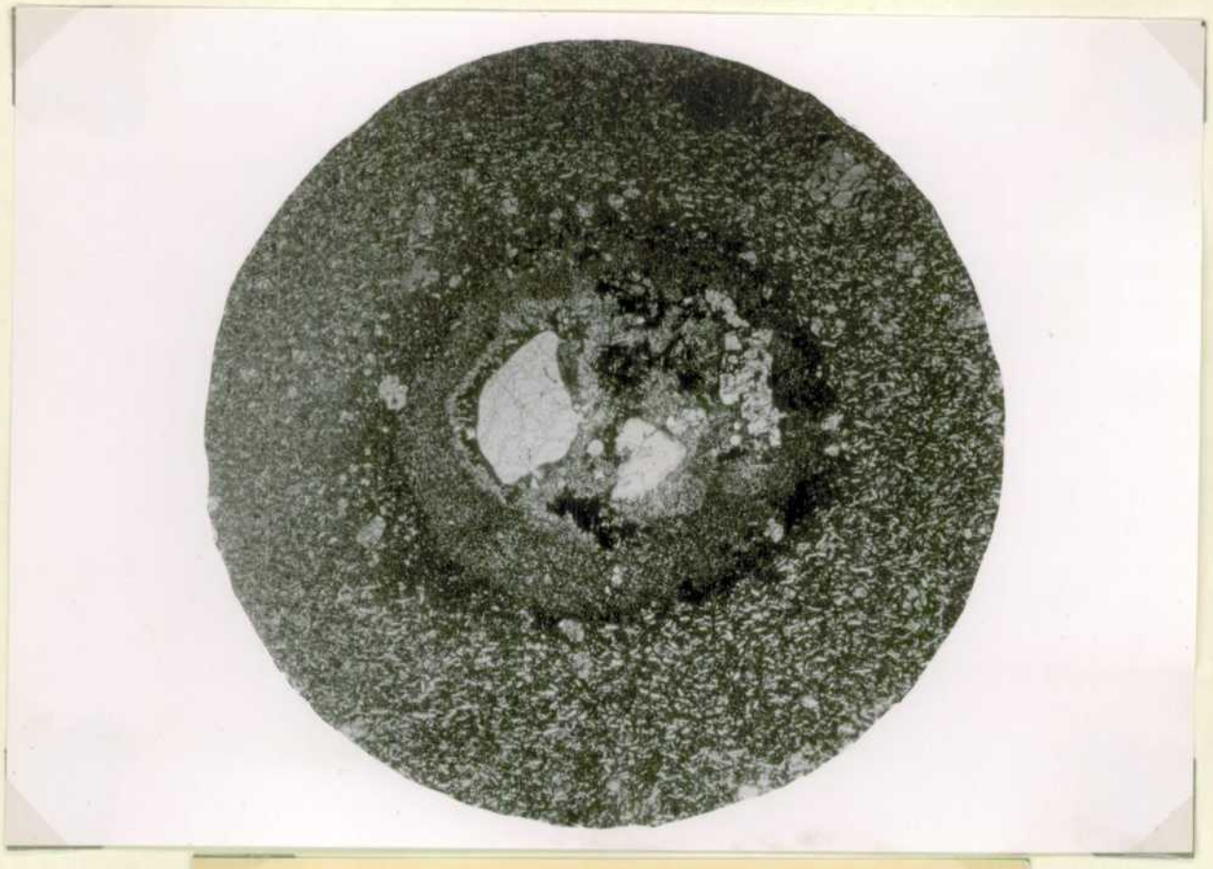
Vesicular analcitic iddingsite-olivine-titanaugite basalt. (Figure 7).

The hand-specimen is dark grey, dyscrystalline and aphyric. It contains numerous small vesicles and cavities about a millimeter across and a few larger vesicles measuring up to 1.5 cm. in diameter which are partly filled with calcite.

In thin section, randomly oriented laths of plagioclase (An_{70-75}) 0.25 mm. long, deep purple titanaugite ophitically intergrown with plagioclase, and partly iddingsitized prismatic olivine, are seen to be embedded in an interstitial matrix of chlorite, less common analcite, and alkali feldspar, and rare brown glass. The chlorite is highly charged with fine opaque dust. Numerous small cavities in the groundmass are partly rimmed by analcite, suggesting that most of the analcite has been torn out during sectioning, and that the percentage actually present is greater than that given below. This is borne out by the calculated norm of the rock (p. 4), which shows nearly 20% of normative nepheline.

The percentages of minerals are plagioclase 35, titanaugite 30, olivine 10, chlorite 15 and analcite, alkali feldspar, and glass 10.

(See Figure 7 on page25)



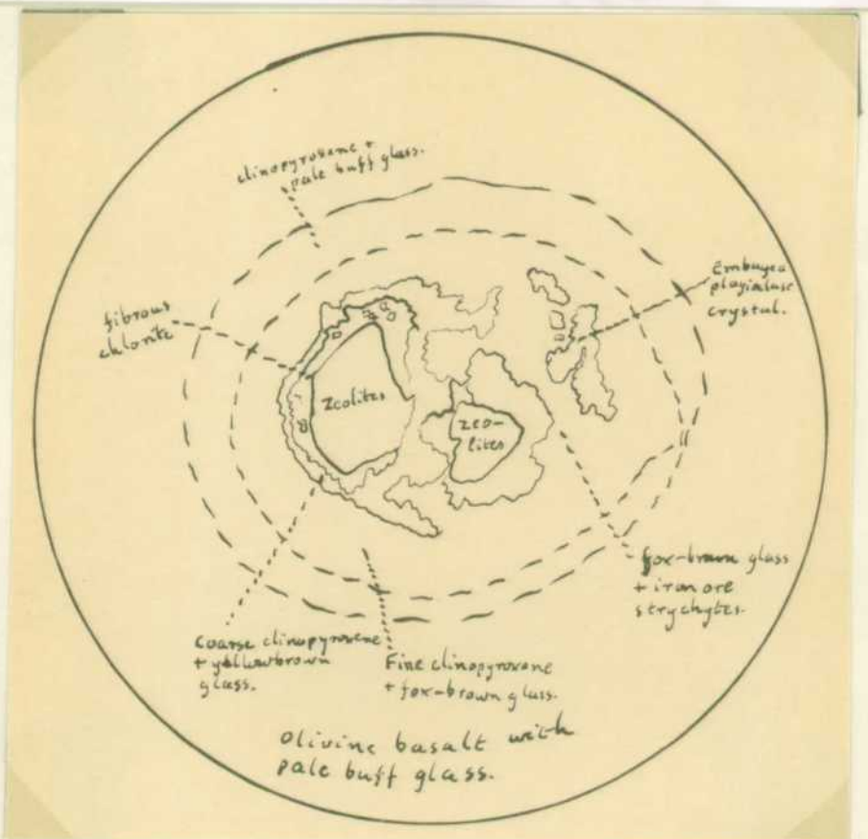


Fig. 6. Glassy inclusion in olivine basalt. Ordinary light, x 12. Negative G.3531 (Specimen G.82).

97538 (slide number 6112). Einasleigh 4-mile Sheet. Wyandotle Creek, 4 miles north-east of Conjuboy Homestead.

Porphyritic olivine-titanaugite basalt.

The hand specimen is a dark grey, vesicular, and porphyritic basalt, which contains a dyscrystalline groundmass enclosing a small phenocryst of olivine. The vesicles range from minute openings in the groundmass to ellipsoidal, flow-oriented cavities whose larger diameters are 7 mm..

In thin section the basalt is seriate glomeroporphyritic. The phenocrysts are composed of olivine, and range up to 2.6mm. long; commonly they have embayed margins.

The groundmass is hyalo-ophitic and has an indistinct pilotaxitic texture. Bundles of pellucid plagioclase (An_{70}) laths with an average length of 0.5 mm., prismatic to sub-ophitic, zoned purple titanaugite, and granular-prismatic olivine are enclosed in a dark matrix composed of partly devitrified glass mixture with fine flakes of (?)nontronite. Black iron ore is octohedral. The vesicles are lined with an outer zone of fibrous carbonate (?aragonite) and colloform hydrated iron oxide, and an inner zone of more granular, but radially oriented carbonate.

The percentages of the constituent minerals are :-

plagioclase 35, titanaugite 30, olivine 20, devitrified glass and (?)nontronite 10, black iron ore 5 and some minute acicular crystals of apatite.

(See Figure 7 Page 25)

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3. Undara Basalt.

2/4/59 (slide number 6117). Einasleigh 4-mile Sheet. Kalkani cone, 200 yards north of Mount Surprise, Hann Highway road. (Probable Undara Basalt).

Highly vesicular porphyritic olivine basalt.

In hand-specimen the basalt is highly vesicular, almost scoriaceous. The vesicles are flow-oriented, and are 2.7 cm. long. The basalt has small phenocrysts enclosed in an aphanitic groundmass.

In thin section the basalt is found to be hyalo-ophitic and seriate porphyritic; the grain sizes range from 0.01mm. in the groundmass to phenocrysts 2.6 mm. in diameter. The rock consists of plagioclase (30%), palagonite (30%), clinopyroxene (25%), olivine 15% and small amounts of black iron ore. Randomly oriented microlites and laths of pellucid plagioclase (An_{70}), prismatic grains and porphyritic crystals of colourless to very pale purple clinopyroxene, and granular-prismatic phenocrysts and groundmass crystals of olivine, are embedded in the palagonite matrix. Black iron ore and haematite are granular.

Fig.7. Ophitic texture. Ordinary light, x 50.
Negative: G/3380. Px= titanaugite, Ol.=olivine,
Pl.= plagioclase. (Specimen A1400).

5/4/59 (slide number 6108). Einasleigh 4-mile Sheet. From the north edge of the west Undara lava tunnel, $\frac{3}{4}$ mile south of Kalkani Crater.

Porphyritic olivine-titanaugite basalt.

The hand-specimen has a dark dyscrystalline groundmass that encloses small, green phenocrysts of olivine. There are a few conspicuous vesicles disposed in parallel strings. The diameter of the vesicles is 5 mm.; however, on close examination, numerous small cavities about a millimeter across may be seen.

In thin section the phenocrysts are commonly seen to be clustered, and are 2.75 mm. long; they are composed of prismatic olivine, and some are strongly embayed.

The groundmass is holocrystalline and intergranular, and has an indistinct pilotaxitic texture: the average grain-size is 0.12 mm. Plagioclase (An_{70}) forms bundles of pellucid laths, and titanaugite occurs as pale purple, prismatic crystals. Olivine is prismatic to granular, and black iron ore is octahedral and acicular. Hydrated iron oxide stains the margins of olivine crystals.

The constituent minerals present are :-

plagioclase, 45%; clinopyroxene, 37%; olivine, 15%; black iron ore, 3%.

2/4/67 (slide number 6216). Einasleigh 4-mile Sheet. Chubbers Hill, 2 miles north-east of Meadowbank Homestead.

Porphyritic iddingsite-olivine-augite basalt.

The hand-specimen is dark grey, fine-grained, vesicular, and porphyritic. The maximum diameter of the vesicles is about 5 mm. and the vesicles are flow oriented.

In thin section the porphyritic crystals are found to be mostly olivine, with rare plagioclase. Their lengths range from groundmass crystals to 1.1 mm., and they have embayed margins. The olivine crystals have their rims replaced by iddingsite, and the core of the plagioclase contains black iron ore.

The groundmass is holocrystalline, intergranular, and intersertal. Randomly oriented plagioclase laths (An_{65}) range between 0.08 mm. and 0.6 mm. long. Colourless to very pale green augite is granular to prismatic, and subhedral olivine is partly replaced by iddingsite. Alkali-feldspar is interstitial and black iron ore is octahedral. Small amounts of interstitial calcite, and acicular accessory apatite are present.

The percentages of minerals are : - plagioclase,45; augite, 20; olivine, 15; alkali-feldspar,15; black iron ore,3.

1/7/67 (slide number 6110). Einasleigh 4-mile Sheet. 200 yards north-east of North Tabletop.

Vesicular and porphyritic olivine basalt.

A vesicular dark grey hand-specimen containing phenocrysts of olivine that are enclosed in an aphanitic groundmass. The walls of the vesicles are coated with a soft, white powdery substance.

In thin section the phenocrysts are all seen to be subhedral olivine crystals which range up to 1.25 mm. long. They are in clusters and are commonly embayed.

The groundmass is hyalo-ophitic and has a pilotaxitic texture. Flow-oriented, pellucid microlites of plagioclase (An_{70-80}) form about 35% of the rock, and, with prismatic pale purple titanaugite (30%) and granular olivine phenocrysts), are embedded in a pale brown to colourless glass (20%) that has a refractive index less than that of Canada Balsam. Black iron ore is octahedral, and also occurs as needles. Acicular apatite is accessory. The material lining the vesicles is probable analcite mixed with very fine green flakes of (?)nontronite.

4/7/67 (slide number 6113). Einasleigh 4-mile Sheet. Murronga Crater. Probable Undara Basalt.

Vesicular and porphyritic olivine-titanaugite basalt.(Figure 8)

The hand-specimen has phenocrysts of green olivine enclosed in a dark brownish-grey, dyscrystalline groundmass. Numerous vesicles are elongated and flow oriented, and range up to 4 mm. in diameter.

In thin section the rock is seen to be glomeroporphyritic, the phenocrysts having an average size of 1.3 mm.; they are mostly euhedral to subhedral olivine crystals. Plagioclase (probable labradorite) phenocrysts are rare, and, where seen, have embayed margins and a general appearance of being partly resorbed; the crystals have either marginal or core-zones in which apparent hematite assumes a micro-cellular habit and is intergrown with the plagioclase. (Figure 8).

The groundmass is holocrystalline and intergranular. Randomly oriented laths of plagioclase (An_{66}) are lightly sericitized, and enclosed in an apparently opaque matrix. This, on close examination, is seen to consist of plumose-acicular to prismatic, pale purple titanaugite, granular olivine, and needles and rare octahedra of black iron ore. There are small quantities of interstitial chlorite and bowlingite. All grains have a thin layer of hydrated iron oxide around their margins.

An estimation of the percentages of minerals present is:-

plagioclase, 40; titanaugite,35; olivine,20; black iron ore,5.

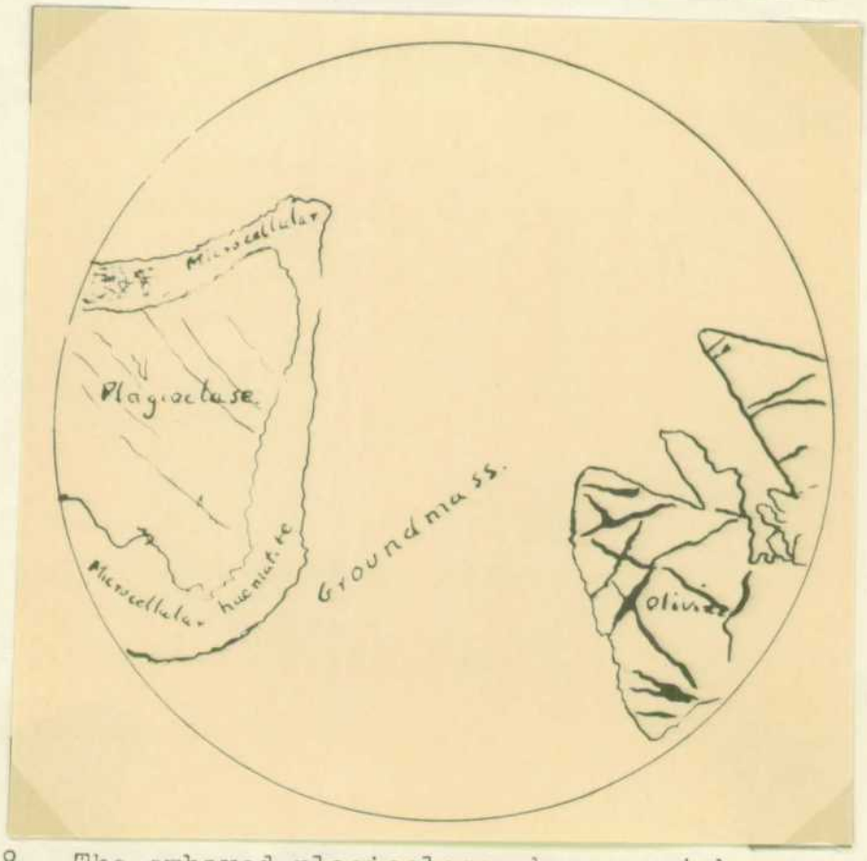


Fig. 8. The embayed plagioclase phenocryst has a marginal zone that includes fine(?)hematite with a microcellular habit. Crossed nicols, x 50. Negative: G3374 (Specimen 4/7/67).

4. Kinrara Basalt.

3/6/19 (slide number 6109). Einasleigh 4-mile Sheet. Western edge of Kinrara Basalt, ¼ mile east of Kinrara Crater.

Vesicular and porphyritic olivine-titanaugite basalt. (Figure 9)

The hand-specimen is vesicular, dyscrystalline basalt in which small phenocrysts of olivine may be discerned. The vesicles are elongated, and have a preferred orientation; some range up to 3 to 4 mm. long.

The thin section shows that the rock consists of plagioclase (35%), olivine (20%), glass (30%), titanaugite (15%) and black iron ore. The subhedral phenocrysts are of olivine, and rare embayed pale purple prisms of titanaugite; granular olivine is embedded in a pale brown glass that has a refractive index lower than that of Canada balsam. The glass contains many fine needles of black iron ore.

Fig. 9. Hyalo-ophitic texture. Plagioclase laths and titanaugite and olivine embedded in glass. Crossed nicols, x 50. Negative: G/3373 (Specimen 3/6/19).

97534. (slide number 6066). Einasleigh 4-mile Sheet. From the lower end of the basalt flow in the Burdekin River, near Lagoona.

Vesicular and porphyritic olivine basalt.

The hand-specimen is a highly vesicular porphyritic basalt in which small phenocrysts are enclosed by a fine, dyscrystalline groundmass.

In thin section the basalt is seen to be seriate glomeroporphyritic, the porphyritic crystals of embayed olivine ranging up to 1.0 mm. in size. The groundmass is hyalo-ophitic, and is similar to that of specimen 3/6/19; it contains pellucid microlites of plagioclase (An_{70}), and clinopyroxene and olivine. The clinopyroxene commonly forms arborescent-fibrous crystallites, and only rarely occurs as colourless prismatic crystals. There are trichites of black iron ore, and all are embedded in a dark brown (?)palagonitic glass. The vesicles are lined with fine flakes of nontronite.

The percentages of constituents are: plagioclase, 40; clinopyroxene, 30; olivine, 15; palagonite, 15.

G.54 (slide number 202). Reedy Brook; latitude 18°42'S, longitude 145°3'E.

Vesicular olivine basalt.

In hand-specimen this is a fine-grained, dark grey, highly vesicular basalt with small olivine phenocrysts. The vesicles average about 1 cm. in diameter and are commonly lined with white zeolitic material.

In thin section the basalt is found to be hyalo-ophitic and porphyritic. Plagioclase (An_{70}) laths are about 0.5 mm. long, and have ragged terminations. The laths are traversed by rare chlorite veins. Euhedral olivine microphenocrysts about 0.75 mm. in diameter contain abundant magnetite inclusions. The crystalline constituents are enclosed in a deep brown basaltic glass that is slightly devitrified and chloritized. Minute rods of black iron ore, thin needles of pyroxene, and vague feldspathic bodies crowd the glass.

The percentages of constituents are : plagioclase, 30; olivine, 20; glass with its inclusions, 50.

An isotropic zeolite, probably analcite, lines some of the vesicles.

G.70 (slide number 204). West of Kinrara; latitude 18°33', S.
longitude 144°56' E.

Vesicular olivine basalt.

In hand-specimen the basalt is dark greyish-black, ropy, and vesicular; the vesicles are 5 mm. (max.) wide and 14 mm. long. Small olivine phenocrysts are visible with a hand lens.

In thin section the basalt is seen to be porphyritic and hyalo-ophitic, and consists essentially of glass (60%), olivine (20%), and plagioclase (20%).

Plagioclase (An_{72}) forms euhedral laths with an average length of 0.15 mm.. Porphyritic olivine crystals measure about 0.4 mm. across, although one was observed to be 1.7 mm. long. The glass is almost opaque, and is mostly devitrified to a faintly anisotropic material.

C. WALLAROO BASALT.

A1353 (slide number 6176) Einasleigh 4-mile Sheet. Wallaroo Hill, 2 miles west-south-west of Glen Eagle Homestead.

Porphyritic olivine-zeolite basalt.

A dark reddish-black basalt with an aphanitic groundmass enclosing small dark red-brown phenocrysts of altered olivine.

As seen in thin section, the phenocrysts are 1.1 mm. across and consist of embayed and partly iddingsitized olivine, and pale purple, prismatic titanaugite which shows hour-glass and oscillatory zoning.

The groundmass contains columnar to acicular crystals of clinopyroxene (average size 0.02 mm. by 0.003 mm.) with random orientation and more rare, equally small, prismatic iddingsitized olivines and fine, granular black iron ore all enclosed in a fine mosaic of zeolite. Plagioclase was not observed, although when the slide was examined with a low power objective lens, some randomly oriented tabular areas that possibly represent replaced plagioclase were observed. The zeolites may be thomsonite, (?)stilbite, and analcite. There are some fine acicular crystals of accessory apatite.

The percentages of minerals present are zeolites, 55; clinopyroxene, 27; olivine, 10; black iron ore, 8.

97482 (slide number 6064) Einasleigh 4-mile Sheet. Cameron Creek, ½ mile west of Mount Cameron, 200 yards west of yard.

Porphyritic olivine basalt.

The hand-specimen is a dark grey basalt in which small phenocrysts are enclosed in an aphanitic groundmass.

As seen in thin section the average size of the porphyritic crystals is 0.6 mm. They consist of olivine and rare plagioclase; crystals of both minerals are strongly embayed.

The groundmass is hyalo-ophitic; plagioclase (An_{60}) forms randomly oriented laths, and olivine is granular. Both minerals are embedded in dark brown(?)palagonite. With a high power objective lens the probable palagonite is seen to enclose fine, matted, and fibrous crystallites of (?)pyroxene and trichites of black iron ore.

The percentages of constituents are: plagioclase, 50; olivine, 15; (?)clinopyroxene,25; (?)palagonite,10.

D. STURGEON BASALT.

A.1352 (slide number 6192). Hughenden 4-mile Sheet. White Cliffs Creek, 45 miles north of Hughenden on the road to Mount Garnet.

Porphyritic, analcitic, iddingsitized olivine basalt.

The hand-specimen is dark reddish-black and highly vesicular. The aphanitic groundmass encloses small reddish-brown phenocrysts of altered olivine. The diameter of the elongated vesicles ranges to 15 mm.; they are flow-oriented and are arranged in trails.

In thin section the rock is found to be glomeroporhyritic. The phenocrysts are mainly clustered, almost entirely iddingsitized olivine; rare porphyritic crystals of plagioclase are also present. The crystals of both minerals have embayed margins, and the plagioclase has inclusions of black iron ore.

In the groundmass randomly oriented plagioclase (An_{66-74}) laths and clustered prisms of red, iddingsitized olivine are set in a very dark matrix which, with a high-power objective may be resolved to show fibrous, sometimes arborescent crystallites of a colourless clinopyroxene enclosing small microlites of plagioclase. There are some trichites of black iron ore and interstitial alkali-feldspar. Very small amounts of analcite were observed.

The percentages of minerals are : plagioclase, 40; olivine,18; clinopyroxene, 25; alkali-feldspar and analcite, 10; black iron ore, 2.

G.6 (slide number 201). Bogglewallah; latitude 20°45'S, longitude 144°11'E.

Iddingsite-olivine basalt.

In hand-specimen the basalt is light grey and moderately coarse-grained, becoming almost doleritic in grain-size. Reddish-brown iddingsitized olivine and black pyroxene are clearly visible under a hand lens.

In thin section the specimen is seen to be sparsely porphyritic, and has a holocrystalline, ophitic texture. The essential minerals are plagioclase (60%), clinopyroxene (30%), and olivine (10%).

Plagioclase (An_{60}) forms pellucid laths that are ophitically enclosed by faint lilac-coloured plates of titanaugite that measure up to 2 mm. in diameter. Microporphyritic olivine is partly or completely replaced by iddingsite, but commonly has a thin rim of fresh olivine. In the groundmass the granular olivine is free from alteration.

Masses of interstitial carbonate are common, and the plagioclase is generally slightly replaced by carbonate. Black iron ore forms octahedral crystals, irregular grains, and thin rods.

G.10. (slide number 200). Mount Sturgeon. Latitude 20°15'S, longitude 144°27'E.

Microporphyritic olivine basalt.

The hand-specimen is a very fine-grained, dark, dense basaltic rock with a slaggy "micro-pillow" structure. The individual pillows are about 2 cm. across and very closely packed together. Minute, brownish olivine microphenocrysts are visible under a hand lens.

In thin section the basalt is found to be microporphyritic and has an intergranular texture. The essential minerals are plagioclase (55%), clinopyroxene (20%), olivine (15%), and magnetite (10%).

Plagioclase (An_{60}) forms small (0.2 mm.), well-formed laths. Plagioclase occurring as more anhedral grains interstitial to the laths are rather more sodic in composition. The diameter of olivine microphenocrysts is usually about 0.3 mm. and they form subhedral to euhedral crystals. They are strongly embayed and are commonly slightly altered to bowlingite; in the places where alteration is more intense, the olivine contains many small magnetite grains. Clinopyroxene forms very small subhedral to prismatic grains that are intergranular to the feldspar and have a very pale green colour due to incipient chloritization. Inclusions of minute magnetite grains are very common. Small grains of black iron ore (0.01 mm. and less) are abundant, and minute flakes of strongly pleochroic brown biotite are, in some places, associated with it.

The interstitial material is mostly alkali-feldspar and an almost isotropic zeolite (possible mesolite). Thin acicular apatite crystals and occasional flakes of biotite

accompany the late stage minerals. Narrow veins are in some places filled with coarsely crystalline, colourless to purple fluorspar.

54/3. (slide number 211). North of Marathon; latitude 20°38'S. longitude 143°33'E.

Vesicular iddingsite-olivine basalt.

The hand-specimen is vesicular and fine-grained, and has small phenocrysts of brownish altered olivine. The vesicles are elongated and flattened, and are usually lined with, and in some places completely filled with, calcite.

In thin section the basalt is seen to be porphyritic and holocrystalline and has an ophitic texture. The essential minerals are plagioclase (55%), pyroxene (25%), olivine (15%), and black iron ore (5%).

Plagioclase (An_{70}) forms a mesh-work of well-formed laths that are ophitically enclosed by zoned, pale purple titanaugite. Olivine occurs as euhedral porphyritic crystals about 1 mm. in diameter, and as smaller grains that measure 0.5 mm. and less across. The porphyritic crystals are marginally iddingsitized. Many of the smaller olivine grains are almost entirely replaced by iddingsite, and are in some places enclosed by titanaugite. Black iron ore forms octahedral to anhedral grains about 0.25 mm. across. Apatite is a rare accessory.

E. MOUNT FOX BASALT.

97488 (slide number 6114). Ingham 4-mile Sheet. Mount Fox on Kangaroo Hills/Ingham road.

Vesicular olivine basalt.

The hand-specimen is a dark reddish-brown vesicular basalt containing small phenocrysts of olivine. The vesicles are elongated, and are flow-oriented, and up to 5 mm. in diameter.

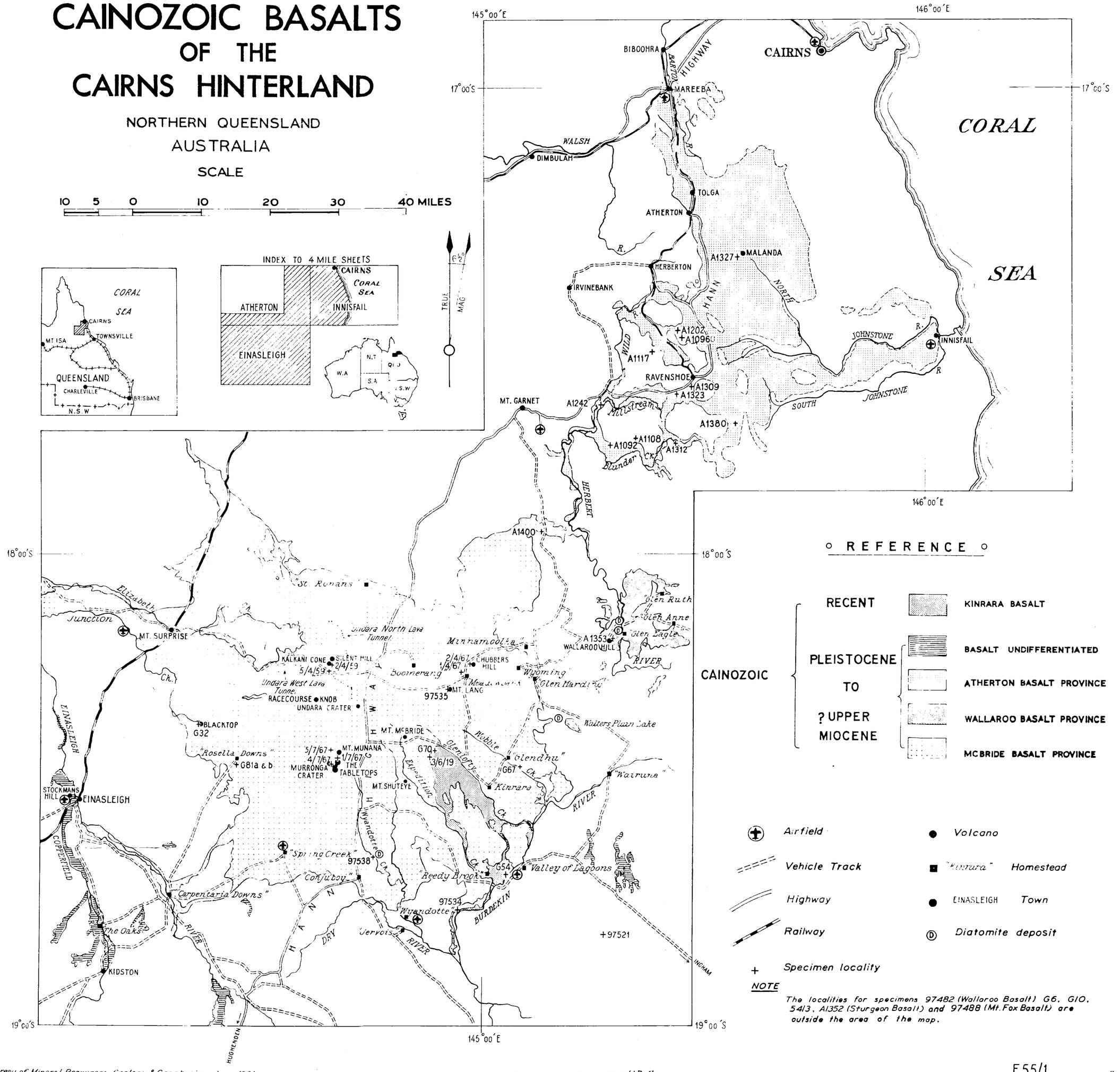
In thin section the rock is found to be seriate porphyritic; the porphyritic crystals tend to be clustered, and range up to 0.4 mm. in size. They consist of partly iddingsitized olivine and pale brown acicular clinopyroxene. In the groundmass a pale brown glass with a refractive index lower than that of Canada balsam encloses prismatic clinopyroxene, tabular (undetermined) plagioclase, and granular, partly iddingsitized olivine. The average grain size of the groundmass is 0.01 mm..

CAINOZOIC BASALTS OF THE CAIRNS HINTERLAND

NORTHERN QUEENSLAND
AUSTRALIA

SCALE

10 5 0 10 20 30 40 MILES



REFERENCE

CAINOZOIC	RECENT	KINRARA BASALT
	PLEISTOCENE TO ? UPPER MIOCENE	BASALT UNDIFFERENTIATED
		ATHERTON BASALT PROVINCE
		WALLAROO BASALT PROVINCE
		MCBRIDE BASALT PROVINCE

Airfield
Vehicle Track
Highway
Railway
Specimen locality
Volcano
"Kinrara" Homestead
EINASLEIGH Town
Diatomite deposit

NOTE

The localities for specimens 97482 (Wallaroo Basalt) G6, G10, 5413, A1352 (Sturgeon Basalt) and 97488 (Mt. Fox Basalt) are outside the area of the map.

Bureau of Mineral Resources, Geology & Geophysics. June 1961.

To accompany Record 1961/124

E55/1