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THE PETROGRAPHY OF SPECIMENS COLLECTED FROM THE LOWER RAMU-ATITAU AREA, T.P.N.G.

by

W.R. MORGAN

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The specimens described in this report were collected by Dr. D.W.P. Corbett in the Lower Ramu-Atitau Area of New Guinea during the 1958 Land and Regional Survey Expedition.

The descriptions have been arranged as follows:-

A. Specimens from the N.E. slopes of the Schrader Ranges: A.19, A.26, A.64, A.69, A.72, and A.74.

B. Specimens from the Adelberts Mountains: B.4, B.5, B.9, and B.23.

C. Specimens from the Northern Foothills: C.7, C.19, C.24, C.40, C.54, C.55, and C.64.

D. Specimens from the Simbai Area: A.29, A.31, A.35, A.36, A.39, A.42, and A.44.

E. Specimens from boulders in the Aunja and Dibor Rivers: A.77, C.73, and C.82.

Specimen Localities

No.	1-Mile Sheet	Location	Aerial Photo No.	Photo Ref.
A.19	Ramu West	Asai R., 2½ miles S.W. of Apenam.	Run 5, CAJ 80-5114	C, X1.6; Y0.5.
A.26	" "	Asai R., 3½ miles S.W. of Apenam.	R. 5, CAJ 80-5114	C, X0.9; Y1.1
A.64	" "	Asai R., 3 miles N.E. Giringin.	R. 5, CAJ 80-5112	A, X1.3; Y0.3.
A.69	" "	Tigananse R., 4 miles S.S.W. of Aisme.	R. 4, CAJ 80-5090	C, X0.5; Y1.0.
A.72	" "	Aunja R., 6½ miles W.N.W. of Dogara.	R.2, CAJ 80-5040	C, X0.6; Y0.5.
A.74	" "	Aunja R., 6½ miles W.N.W. of Dogara.	R.2, CAJ 80-5040	C, X0.7; Y0.2
B.4	Uvo	Adelberts Mts., ¾ miles N.W. of Kaove.	R.5, CAJ 61-5036	A, X1.4; Y1.6
B.5	"	"	" "	"
B.9	"	Adelberts Mts., 2½ miles N.W. of Kaove.	" "	C, X3.1; Y0.4
B.23	"	Adelberts Mts., 1 mile E. of Pangansop	R.4, CAJ 55-5028	C, X2.4, Y0.6
C.7	Nubia	3 miles E. of Rugasak	R.4, CAJ 79-5128	C, X2.0; Y1.0.
C.19	"	Bari Road, 2 miles E.N.E. of Rugasak	"	Approx. X2; Y0.5.
C.24	"	Rugasak village	"	A, X2.1; Y1.2
C.40	Malala	Kaukomba R., 4 miles N. of Mt. Uvo.	R.3, CAJ 72-5036	B, X0.9; Y0.8
C.54	Uvo	2½ miles N.N.E. of Ulatebun	R.2, CAJ 52-5090	C, X2.7; Y0.6
C 55	"	2 miles N.N.W. of Ulatebun	"	C, X2.1; Y0.6
C 64	"	2 miles S.S.W. of Ponpul.	"	B, X0.4; Y0.9

The following specimens were collected from the Simbai area on the Tunonk River, where there are no maps or photo coverage: A.29, A.31, A.35, A.36, A.39, A.42, A.44. Dr. Corbett was unable to supply precise localities for these specimens.

Specimens A.77 (from the Aunja River), C.73, and C.82 (both from the Dibor River) were boulders from river beds, and were collected in order to gain some idea of lithologies to be found in the Adelberts Mts., where the rivers have their source.

A. Specimens from the N.E. Slopes of the Schrader Ranges

A.19 Slide number 4657. Asai River, Ramu one-mile sheet.

The hand specimen is a fine-grained, pale greenish-grey rock which has a structure and sheen rather like that of a phyllite. Irregularly distributed veins of calcite and sericite are present.

In thin section the rock is seen to be microporphyritic, the flow oriented microphenocrysts ranging from 0.1 mm. to 0.3 mm. in size. The groundmass is hypidimorphic granular with an average grain size of 0.01 mm.

The groundmass consists of granular-tabular felspar and interstitial green chlorite. Regularly distributed granules of leuxocene are present. The microphenocrysts consist of partly or wholly sericitized albite, some of which is carbonated. Small irregular clots of calcite are distributed unevenly throughout the rock.

The rock is cut by numerous irregular veins ranging between 0.03 mm. and 1.6 mm. in thickness. They are composed of calcite, sericite, chlorite and leucoxene, although, in some, calcite is missing. The thicker veins commonly transgress the direction of phenocryst orientation, but the vein minerals have crystallized as coarse parallel aggregates in line with the flow orientation.

The rock appears to be a veined and sericitized keratophyre.

A.26 Slide number 4658. Asai River, Ramu one-mile sheet.

The hand specimen is a fine- to medium-grained greyish-black slate-like rock with two apparent cleavages, shown by fracture surfaces, lying at approximately 35° to one another.

In thin section, the rock is somewhat inequigranular, the average grain size being 0.06 mm. The texture is schistose, and the rock contains roughly tabular to lenticular grains of quartz and albite with a common orientation - an optical parallelism of the quartzes may be seen on insertion of the gypsum plate. Subordinate sericite forms elongated flakes which tend to be wrapped around quartz and felspar grains, but which follow the two trends of the fracture surfaces. Some opaque (?)carbonaceous dust is mixed with the sericite. Scattered, short stubby flakes of light brown biotite are present, lying obliquely to the fracture surfaces.

Some accessory zircon and epidote are present. Cubic crystals of hydrated iron oxide, probably pseudomorphing pyrites are commonly surrounded by a rim of quartz showing strain shadows.

The rock appears to be a low-grade metamorphosed arkose, and may be termed a schistose arkose siltstone although more specifically, it is a (?)carbonaceous biotite-sericite-albite-quartz-schist.

A.64. Slide number 4667. Upper Asai River, Ramu one-mile sheet.

In hand specimen this is a dark-grey, fine- to medium-grained phyllite-like calcite rock, showing thin laminations which are, in places, somewhat contorted. The specimen is cut by veins, measuring up to a centimeter in width, composed coarse white calcite. Both the veins and the enclosing rock react vigorously with dilute hydrochloric acid.

In thin section the rock is seen to have a cataclastic texture, and is composed mostly of inequigranular calcite, together with sparsely distributed granular quartz and subhedral albite. The calcite shows some wavy lamination which appears to have resulted from the break-down and granulation of coarser calcite grains, twinned and microfaulted remnants of which may be seen in places. Quartz and albite tend to occur in lenticular clusters elongated along the lamination. The lamination is commonly marked by thin lines of opaque dust.

The rock is cut by veins of coarse, anhedral calcite, with some subhedral quartz. The calcite shows curved multiple twinning.

The specimen is a veined phyllonitic marble.

A.69. Slide number 4668. Tigananse River, on the Ramu one-mile Sheet.

The hand specimen is of a greyish-black, fine-grained, slate-like rock. The apparent slate-like character is caused by minute lithological banding, rather than by slaty cleavage. Rarely, this banding is displaced 1-2 mm. by minute faulting running at right angles to the banding. The presence of calcite is revealed on application of dilute hydrochloric acid.

In thin section the rock is seen to be fine-grained and inequigranular, with an average grain-size of 0.035 mm. The texture is granular-lepidoblastic. Tabular to lenticular quartz and albite grains have parallel optical and physical orientation and in addition, albite forms rare, small porphyroblasts which tend to be clustered. Calcite, like albite, forms grains similar to those of quartz. Sericite commonly occurs as lineated, lean and rather tabular flakes which tend to be wrapped around grains of quartz, calcite and albite. More rarely it forms short stubby flakes lying obliquely to the lineation. Pale green to colourless chlorite, and very rare pale brown biotite, have a similar occurrence to the latter form of sericite. Opaque, dusty (?)carbonaceous material is associated with sericite. Black iron ore forms small granules. Rarely, irregular grains, and small lenticular bodies of pyrite are present. Rare accessory tourmaline, zircon, and (?)epidote are present.

The rock is a (?)carbonaceous albite-chlorite-calcite-sericite-quartz-schist.

A.72 and A.74. Slide numbers 4669 and 4670, respectively. Aunja River, Ramu one-mile sheet.

Both rocks are fine- to medium-grained. Number A.72 is a pale grey granular schist formed mainly of quartz, felspar and mica, and has the appearance of a sandstone with very thin folio of lineated mica. Number A.74 is a darker grey and somewhat harder rock which shows thin lithological banding, probably relict sedimentary structures: an indistinct schistosity cuts across this banding at a large angle. A vein of dark material cuts across both the banding and the schistocity.

The specimens are very similar to one another in thin section. Sub-angular grains of quartz and slightly sericitized felspar, ranging from 0.1 mm. to 0.3 mm. in size, and flexed, lineated flakes of sericite, up to 0.5 mm. in length, are enclosed in a fine granular groundmass of quartz and felspar grains whose average size is 0.02 mm. The sericite flakes tend to be wrapped around the coarse quartz and albite grains, especially in specimen A.74. Greenish chlorite forms small flakes occurring either in association with sericite, or as aggregates in small, rounded patches. Rare, (?)originally detrital, grains of greenish epidote, brownish sphene, and colourless zircon are present as are some small sub-tabular to rounded grains of colourless zoisite. A colourless prismatic mineral, measuring up to 0.15 mm. in length, and having a strong transverse cleavage, a moderate birefringence and straight extinction, is possibly tourmaline. It commonly lies across the schistocity, suggesting that it has been introduced subsequent to the regional metamorphism affecting the rock. Some grains of opaque leucoxene are present, and dust composed of this mineral is associated with sericite, especially in number A.74.

Both rocks are chlorite-albite-sericite-quartz-schists.

Note. Four out of the five metamorphic specimens just described are low-grade derivatives of arkosic siltstones (A.26 and A.69), and probable greywackes or arkoses (A.72 and A.74). They may be placed in the Greenschist Facies of regional metamorphism. Specimen A.64 is a marble showing pronounced effects of shearing, and may also be probably classed with the greenschists.

B. Specimens from the Adelberts Mountains.

B.4. Slide number 4672, and B.5., Slide number 4673.

Both specimens were collected from the Adelberts River, on the Uvo one-mile sheet.

In hand specimens, both are greenish-black, fine-grained, porphyritic and amygdaloidal igneous rocks. The phenocrysts consist of ferromagnesian minerals, mostly pyroxene. The amygdales, which are more common in B.5., appear to be composed of white, fibrous zeolitic material, and are spherical, measuring up to 6 mm. in diameter.

In thin section, specimen B.5 is serriate porphyritic, with a fine- to medium-grained hypidiomorphic-inequigranular, and interstitial doleritic groundmass enclosing large euhedral phenocrysts. The rock is amygdaloidal, the amygdales ranging from interstices in the groundmass to large amygdales, 2.1 mm. in diameter.

The phenocrysts consist of euhedral, colourless or very pale green augite up to 3.2 mm. in size, and of subordinate euhedral to rounded pseudomorphs after olivine, which are composed of fine bowlingite , talc, and chlorite. These pseudomorphs are up to 1 mm. in size.

The groundmass consists of lean, tabular laths of strongly sericitized plagioclase, whose average measurements are 0.02 mm. wide by 0.16 mm. long, and which have a refractive index greater than that of Canada balsam; granular to prismatic augite and pseudomorphs after olivine, 0.07 mm. in size; interstitial, pale green chlorite and colourless (?)sericite; and cubic to skeletal crystals of nearly opaque hydrated iron oxide.

The amygdales are filled with small spherulites composed of radiating fibres of (?)thomsonite.

An estimation of the percentages of minerals present is:- plagioclase: 40, augite: 25, olivine: 10, chlorite: 15, hydrated iron oxide: 7, and (?)thomsonite: 3. The rock is a sericitized and serpentinized amygdaloidal limburgitic basalt.

Specimen B.4 could not be sectioned satisfactorily. The slide was composed mostly of fractured phenocrysts of augite with here and there, portions of groundmass. It seems that this specimen is similar to B.5.

B.9. Slide number 4674. Adelberts River, Uvo one-mile sheet.

The hand specimen is similar in appearance to those of B.4. and B.5., except that phenocrysts of plagioclase are present.

The rock has a porphyritic, medium-grained, hypidiomorphic, interstitial and sub-oplitic texture. Numerous amygdales are present.

The groundmass is composed of lean laths of altered plagioclase averaging 0.14 mm. long by 0.02 mm. broad; prismatic and sub-ophitic, colourless to pale green augites whose average size is 0.1 mm., and interstitial green chlorite commonly charged with opaque dust. Much granular to octahedral black-iron ore is present, and very fine acicular crystals of opaque ore are commonly seen.

The phenocrysts consist of augite and labradorite, and range in size between 0.15 mm. and 3.0 mm. Augite occurs as anhedral to euhedral prismatic, colourless to very pale green crystals. It contains inclusions of black iron ore and zeolite, and is, in places, cut by thin veins of green chlorite. Labradorite (An_{68}) forms large, tabular crystals very commonly replaced by small, fibrous sheaves of zeolite. The felspar contains inclusions of black iron ore, and is veined by green chlorite.

Many amygdales are present, ranging in size from 4 mm. (as seen in the hand specimen) down to interstices in the groundmass. Several have a very thin rim composed of fine green chlorite, enclosing zeolite. Many are completely filled with zeolite. At least four types of zeolite are present: (i) nearly isotropic (?)analcite which forms single grains, and may show complex twinning; (ii) fibrous sheaves of thomsonite; (iii) possible stilbite, having a low, negative, optic axial angle; and (iv) (?)mordenite, forming plate-like grains and having a high, negative, optic axial angle. In addition, there appears to be another fibrous variety of zeolite having a lower

birefringence and refractive index than thomsonite.

The phenocryst and groundmass plagioclase appear to be replaced by thomsonite.

An estimation of the percentages of minerals present, assuming the plagioclase to be unaltered, is: - labradorite: 35, augite: 20, chlorite: 20, black iron ore: 10, and amydaloidal material: 10. The rock is a porphyritic zeolitized basalt.

B.23. Slide number 4675. Adelberts Mts., Uvo one-mile sheet.

The hand specimen is a very porphyritic, basic igneous rock in which phenocrysts of amphibole and plagioclase are enclosed in a sparse amygdaloidal groundmass. The rock is weathered, and a rather unsatisfactory thin section was made with difficulty.

In thin section, the rock is seen to be extremely porphyritic. The phenocrysts are enclosed in a groundmass which, in the thinner parts of the slide, appears to be fine-grained, hypidiomorphic and doleritic. In the thicker portions of the slide, the groundmass is nearly opaque, and the textural characteristics may be distinguished only with difficulty.

The groundmass consists of randomly oriented thin laths of zeolitized plagioclase, prismatic amphibole, a few small granules of greenish augite that are faintly pleochroic, fine acicular opaque ore and granules of black iron ore, and interstitial chlorite and zeolite.

The large tabular felspar phenocrysts have been entirely replaced by small, spherulites-like sheaves of fibrous zeolite, possibly thomsonite. Prismatic hornblende is pleochroic in olive green and some subhedral to prismatic pale green augite is present.

The amygdales appear to be composed of a thin rim of chlorite enclosing masses of fibrous zeolite.

It would be difficult to give an accurate estimation of the percentages of minerals present. Hornblende is the dominant ferromagnesian present, and the amount of plagioclase present greatly exceeds that of augite: the total ferromagnesian content exceeds that of the zeolitized felspar. The rock is best called a porphyritic, zeolitized hornblende basalt.

C. Specimens from the Northern Foothills.

C.7. Slide number 4676. Sakula River (Bogia), Nubia one-mile sheet.

The hand specimen is a dark purplish-grey, fine-grained basic igneous rock. It is cut by numerous veins that are composed of calcite.

In thin section, the texture of this specimen is aphyric, and hypidiomorphic, variolitic and amygdaloidal. Slightly sericitized laths of albite, whose average measurements are 0.03 mm. wide by 0.4 mm. long, are arranged sub-radially, or occur in flow-oriented bundles. Many of them are stained by hydrated iron oxide. Pegeonite forms bunches of sub-radiating growths of skeletal crystals with nearly opaque hydrated iron oxide concentrated along their cleavage planes. Abundant

(?)haematite and a little chlorite are present interstitially. Small amygdales are filled with calcite.

Some basic inclusions in the rock, formed by sub-prismatic crystals of pigeonite, are possibly cognate xenoliths.

The rock is cut by veins composed of calcite, and of (?)analcite.

The specimen is a variolitic, amygdaloidal spilite.

C.19. Slide number 4677. Bari Road, Nubia one-mile sheet.

In hand-specimen this is a pale greenish-cream, sparsely porphyritic igneous rock with an aphanitic groundmass. An indistinct linear fabric may be seen. Some staining by hydrated iron oxide is present.

In thin section, the rock is sparsely porphyritic, the sizes of the phenocrysts ranging from 0.05 mm. to 0.5 mm. The groundmass is fine-grained, holocrystalline and spherulitic. Irregular patches and trains of micaceous material suggest a fluxion texture.

The groundmass contains innumerable minute spherulites whose diameters average 0.02 mm. The refractive index of the material is uniformly less than that of Canada balsam, suggesting that they are composed of alkali felspar, or an intergrowth of this felspar and tridymite. Fine flakes of brown nontronite, and, more rarely, green chlorite, form the patches and fluxion trains described above. Fine opaque dust is present.

Most of the phenocrysts are composed of tabular, in places, corroded and micro-fractured crystals of oligoclase. Rare phenocrysts of sanidine and corroded quartz were observed. Some patches of nontronite and chlorite have structures suggesting that they pseudomorph biotite or amphibole.

In places, aggregates of cubic grains of black iron ore and hydrated iron oxide are present. Some accessory apatite may be seen.

The rock is a porphyritic rhyolite, or trachyte depending on the amount of tridymite, if any, in the groundmass.

C.24. Slide number 4678. Silak Creekl Bogia. Nubia one-mile sheet.

The hand specimen is a dull grey, very fine-grained and sparsely porphyritic acid or intermediate igneous rock.

In thin section, the rock appears to be a silicified porphyritic volcanic rock. It contains sparse phenocrysts of tabular kaolinized albite, and of prismatic grains now composed of masses of fine nontronite flakes which appear to pseudomorph amphibole.

The phenocrysts are enclosed in a fine-grained groundmass that has a pilotaxitic and interstitial texture. Small, lean laths of albite have a flow-texture. In places the material interstitial to the albite laths is composed of fine flakes of chlorite and nontronite. Much of the groundmass consists of secondary quartz, which forms a mosaic of interlocking amoeboid

grains which "poikilitically" enclose the felspar laths in the groundmass. The groundmass is dusted with fine cubes of black iron ore and hydrated iron oxide. Some accessory sphene and very rare (?)rutile were noted. The rock is probably a silicified porphyritic keratophyre.

The rock is cut by several thin veins of quartz. These veins, and some of the phenocrysts, are cut by a series of microfractures.

The fine-grained material encloses an apparent cognate xenolith composed of medium-grained, sub-radial laths of plagioclase, cubic black iron ore, and interstitial flakes of chlorite.

C.40. Slide number 4679. Tributary of Kankomba River, Malala one-mile sheet.

The hand specimen is a pale cream-grey, fine-grained limestone which reacts vigorously on application of dilute hydrochloric acid. Some thin bedding, up to 5 mm. thick is visible.

The thin section is composed entirely of calcite. It is apparently unmetamorphosed, although there is some minor displacement along very thin fractures. The specimen consists of a groundmass of medium-grained, granular calcite enclosing irregular areas of dense, very fine-grained granular calcite, some of which contains organic structures.

The rock is cut by thin veins of coarse calcite, some of which occur in fracture planes. Small vugs of calcite are also present. Small amounts of hydrated iron oxide are present along some of the veins.

The specimen is an organic limestone, possibly klintite.

C.54. Slide number 4680. Kumil River, Uvo one-mile sheet

The hand specimen is a dark grey, medium-grained basic igneous rock that has zones of granulation. The rock is cut by thin veins of (?)zeolite and calcite.

The thin section shows the rock to be medium-grained with rare phenocrysts; the constituent grains are strained, and scattered zones of granulation are present.

Labradorite (zoned from An_{64} to An_{36}) forms thin laths which are now mostly altered to zeolite. The laths are ophitically enclosed by colourless, sub-prismatic augite, and by (?) olivine: the latter mineral is now pseudomorphed entirely by green, spherulitic chlorite and brown (?)iddingsite. The rare phenocrysts are formed by prismatic augite and tabular, partly altered plagioclase.

Throughout the rock, plagioclase and augite crystals show straining and microfracturing. In places, there are zones, ranging from 0.2 mm. to 0.75 mm. in thickness, which are composed of granulated doleritic material. Interstitial chlorite and black iron ore are found in these zones. Cutting these zones, and commonly following them, are veins of zeolite and these are cut by veins containing calcite. Irregular cavities, filled with calcite, are present.

The rock is a granulated and veined, chloritized, serpentinized and zeolitized olivine basalt.

C.55. Slide number 4681. Kumil River, Uvo one-mile sheet.

In hand specimen this is a dark greyish green, porphyritic basic igneous rock with a fine-grained, somewhat amygdaloidal groundmass enclosing phenocrysts of pyroxene and felspar. The specimen is cut by thin veins of calcite and zeolite. The rock appears to be strongly altered, and is rather friable, a thin section being made only with difficulty.

In thin section, phenocrysts of tabular, and commonly completely zeolitized labradorite (An 55-60), and of prismatic augite are seen to be enclosed in a hyaloophitic groundmass that contains flow oriented, zeolitized microlitic laths of plagioclase and granules of pyroxene which are embedded in dark greenish (?)palagonite. Fine granules of black iron ore are present. In places the palagonite enclosed minute sphenilites of greenish serpentinous material. Small amygdales are composed of radially fibrous green nontronite-like material, and of zeolite.

The rock is cut by thin veins of calcite and zeolite. The latter, which is nearly isotropic, also replaces the plagioclase, and occupies thin veins that cut augite phenocrysts.

The rock appears to be a porphyritic palagonite basalt.

C.64. Slide number 4682. Kumil River, Uvo one-mile sheet.

The hand specimen is a speckled, greyish-green, medium-grained basic igneous rock. It contains tabular white felspar, and somewhat granular dark pyroxene. Very small amounts of quartz are present. The weathered surfaces are stained by hydrated iron oxide.

The thin section shows an aphyric, medium-grained, hypidiomorphic-inequigranular texture. Tabular crystals of plagioclase range in length from 0.3 mm. to 2.5 mm., and show only very slight alteration to kaolin and granular epidote. The felspar is strongly zoned, and its composition appears to be between An_{70} at the crystal cores to An_{50} at their margins. Augite (possibly titaniferous) forms prismatic to granular crystals which are faintly pleochroic:- X=Y= very pale lavender-pink, Z = very pale green. The crystals have an average size of 0.5 mm. Black iron ore occurs in octahedral and granular forms and shows some alteration to hydrated iron oxide. Pale green chlorite occurs interstitially, and is charged with hydrated iron oxide dust. (?)Chabazite is also interstitial, and forms as fibrous crystals, sometimes intermixed with quartz, which appear to corrode felspar crystal margins. Numerous minute acicular crystals of a colourless mineral, possibly soda-tremolite, are associated with (?)thomsonite. Small amounts of calcite occur in amygdale-like cavities. In the centre of one, a euhedral crystal of quartz was observed.

An estimate of the percentages of minerals present is: plagioclase: 45, augite: 30, chlorite: 3, black iron ore: 14, (?)thomsonite: 8. The rock is a zeolitic basalt.

D. Specimens from the Simbai Area.

A.29. Slide number 4659. Tunonk River.

The hand specimen is a pale greenish-white, apparently weathered and friable igneous rock with abundant phenocrysts enclosed in a fine-grained, seemingly quartz-free groundmass. Phenocryst plagioclase forms tabular white crystals up to 9 mm. long; some of them have a thin border of ferruginous material. Other phenocrysts are composed of prismatic, somewhat acicular greenish black amphibole, up to 4 mm. in length.

In thin section, the rock is seen to be far more fresh than may be supposed from examination of the hand specimen. The groundmass is hypidiomorphic-granular, with an average grain-size of 0.06 mm. The abundant phenocrysts are idiomorphic, and plagioclase ranges from 1 mm. to 6.25 mm. in size, and hornblende ranges from 0.1 mm. and 2.25 mm.

The groundmass is composed of granular-tabular sodic plagioclase, prismatic green hornblende, and rare granular quartz. Minute flakes of brownish biotite, or (?)nontronite, are present. Granular black iron ore, some of it altering to leucoxene, may be seen.

The phenocrysts consist of andesine and hornblende. Andesine forms tabular crystals which commonly have a very thin rim of hydrated iron oxide. The borders of andesine crystals appear to have been altered to somewhat kaolinized potash felspar, in which are enclosed granules of epidote. In some places, an anti-perthitic relationship of potash felspar lamellae to host andesine may be seen, the lamellae originating from the potash felspar borders. In one crystal it was noted that andesine and potash felspar were both twinned on the same Carlsbad plane. Rarely, tabular crystals of felspar now consist entirely of potash felspar.

Hornblende phenocrysts are euhedral and prismatic, and are commonly clustered. The hornblende is pleochroic, with X = very pale green, Y = Z = olive green. Some crystals are zoned, having a paler green border. Hornblende phenocrysts commonly have a thin rim of minute flaky biotite or (?)nontronite crystals stained by hydrated iron oxide.

Rare amygdales are seen, one of which was 1 mm. in diameter, and consisted of a rim of small acicular hornblendes, the interior being filled with quartz.

A visual estimation of the percentages of minerals present is: - andesine anti-perthite: 50, hornblende: 40, quartz: 5, accessories: 5. The rock is a porphyritic quartz-bearing hornblende andesite.

A.31. Slide number 4660, and A.36. Slide number 4662.
Both specimens from Tunonk River.

The hand specimen of A.31 is a somewhat weathered and friable, pinkish-brown, fine-grained, and apparently porphyritic igneous rock studded with coarse crystals of dull green pyroxene. Little evidence of the fragmental nature of the rock can be seen. The hand specimen of A.36 is less friable, and to consist of small fragments of dull red-purple fine-grained volcanic material. Adjoining this is a layer of laminated sedimentary or tuffaceous matter.

In thin section, specimen A.31 is seen to be composed of fragments of porphyritic, fine-grained igneous rock and of isolated crystals. The angular to sub-angular, poorly sorted fragments are from 0.35 mm. and 7 mm. in size. The sparse groundmass to the fragments consists of fine grains of felspar, augite and black iron ore: some shard-like grains of felspar were noted.

The fragments themselves are dominantly seriate microporphyritic; the microphenocrysts being up to 0.3 mm. in size. More rarely, macrophenocrysts, up to 1 mm., or more, in size, are present. The phenocrysts are (?)andesine and colourless to pale green augite: rare hornblende, pleochroic in green is almost invariably surrounded by a rim of hydrated iron oxide. The groundmass is partly very fine-grained, and almost indeterminate even under a high power lens: it is apparently holocrystalline, and consists of fine felspathic and (?)chloritic material. Accessory black iron ore, granular epidote and prismatic apatite may be seen. A few haematite-impregnated grains of olivine were noted. In texture, the rock fragments are commonly pilotaxitic, and only one or two show any pronounced flow orientation of the microphenocrysts. The fragments appear to be of <u>augite-andesite</u>, and <u>hornblende-augite-andesite</u>.

The groundmass of a few of the fragments is nearly opaque because of large amounts of hydrated iron oxide which is present.

The individual crystals present are mainly plagioclase and greenish augite.

The thin section of A.36 shows a very similar fragmental rock, except that here, hornblende is more common, and occurs as both micro- and macrophenocrysts. A brownish serpentinous mineral is seen to pseudomorph rare crystals of olivine. A somewhat fibrous, yellow, epidote-like mineral is seen to occupy uncommon amygdales.

Both rocks are <u>andesitic lithic and crystal tuffs</u>.

<u>A.35</u>. Slide number 4661. Tunonk River.

The hand specimen is a fine-grained, porphyritic igneous rock: it has a purple groundmass that encloses numerous flow-oriented tabular white phenocrysts of felspar, and some prismatic ferro-magnesian minerals.

In thin section, the euhedral phenocrysts are seen to be enclosed in a fine-grained hypidiomorphic inequigranular and interstitial groundmass with an average grain size of 0.05 mm. A slight flow-texture is present. The size of the phenocrysts is 0.5 mm. to 2mm.

The groundmass consists of tabular plagioclase and interstitial green chlorite: some tabular areas are composed of flaky aggregates of chlorite. Hydrated iron oxide commonly forms highly irregular grains, often in aggregates.

The phenocrysts consist mostly of tabular, sometimes corroded, crystals of albite, commonly somewhat altered to epidote, sericite, chlorite and quartz: some crystals enclose aggregates of hydrated iron oxide. Rarely, albite is almost entirely replaced by quartz. The other phenocrysts consist of olivine and augite. The olivine is a relatively iron-rich variety; it has $2V_x = 70^\circ-80^\circ$. It is also stained brown by haematite.

Olivine is commonly altered to a serpentine mineral, and is replaced by hydrated iron oxide or hematite along its margins and cracks. These alteration products occur particularly where quartz is present. Augite forms euhedral crystals partly, and sometimes almost entirely replaced by quartz and showing some alteration to greenish chlorite along cracks.

One or two thin veins are composed of granular quartz: where they cut albite phenocrysts, part of the felspar is replaced by quartz.

Accessory apatite is enclosed as fine needles in albite.

An estimation of the percentages of minerals present is:- albite: 60, chlorite: 15, olivine: 5, augite: 3, hydrated iron oxide: 12. The rock is a saussuritized, silicified porphyritic olivine spilite.

A.39. Slide number 4663. Tunonk River.

The hand specimen is a dark greenish-grey basic igneous rock in which a very fine-grained groundmass encloses small prismatic phenocrysts of a ferromagnesian mineral. Thin veins of calcite cut the rock.

In thin section the rock is seen to be fine-grained and seriate glomeroporphyritic. The groundmass has a pilotaxitic, intergranular and interstitial texture. The specimen is amygdaloidal. The groundmass has an average grain-size of 0.04 mm, and sizes of the porphyritic crystals range between that of the groundmass and 1.75 mm.

The groundmass is composed of lean laths of flow-oriented (?)albite, prismatic augite, and interstitial pale green chlorite. Granules of black iron ore are present. The phenocrysts consist almost entirely of clustered prismatic crystals of colourless augite. Some of them have been replaced by pale green chlorite and subordinate calcite. Chlorite also occupies interstices between clustered augite phenocrysts.

The amygdales range from 0.2 mm. and 5.8 mm. in size, and are elongated in the direction of the flow structure. They are composed of minute spherules and part spherules of pale green chlorite, or granular calcite; - those containing the latter mineral have a thin rim of chlorite. Around some of the calcite-bearing amygdales the groundmass is enriched in chlorite, and contains a few granules of epidote, pleochroic in yellow, and abundant pumpellyite, pleochroic from colourless to bluish-green. Aggregates of pumpelleyite and chlorite are also present in these amygdales.

The rock is cut by an irregular net-work of thin veins containing granular epidote, and, more rarely, pumpellyite. Small amounts of granular sphene are present.

An estimation of the percentages of minerals present in the rock is:- albite: 55, augite: 23, chlorite: 30, black iron ore, etc.: 2. The rock is a porphyritic amygdaloidal spilite.

A.42. Slide numbers 4664, 4665, and 4986. Tunonk River.

These two specimens are composite. In one, a pale cream rock is in irregular contact with a dark grey rock: some mixing of the two is apparent, and small fragments of the darker material are found enclosed in the cream rock, as though the latter has intruded the former. In the other specimen, the cream, fine-grained rock is in sharp contact with an acid porphyritic igneous rock. This rock has a fine-grained groundmass enclosing coarse phenocrysts of rounded quartz, tabular felspar, and prismatic, amphibole-like minerals. The porphyry is said by Dr. Corbett to be from a dyke which intrudes the fine-grained rocks.

In thin section, the two fine-grained rocks (4664 and 4986) are rather similar to one another, except that the darker rock has a fair amount of leucoxenic matter present. In each, rounded to angular grains of quartz, and tabular crystals of (?)albite, whose average size is 0.035 mm., are scattered through a finer groundmass of average grain-size 0.007 mm. The groundmass apparently consists of sericite, chlorite, felsic material, and rare nontronite. Some (?)zeolite occupies apparent cavities, and, in places, cubic pseudomorphs of hydrated iron oxide may be seen commonly associated with sericitic veins. Some veins and irregular aggregates of carbonate are present.

The micaceous minerals have a preferred orientation which continues through the light and dark materials alike, but, the tabular felspars have random orientation. The micaceous lineation is broken by apparent lines of shear. From this, it seems possible that both rocks are acid ashstones that have suffered some low grade metamorphism, and subsequent shearing.

The porphyry has a fine-grained (average size 0.014 mm.) hypidiomorphic-granular groundmass enclosing numerous phenocrysts which range from 0.1 mm. and 3.5 mm. in size.

With regard to the phenocrysts, albite (An9) forms tabular, somewhat sericitized and kaolinized crystals. One albite phenocryst appears to be antiperthitic, as it has a rim of apparent potash felspar from which exsolution almellae of this mineral extend across the crystal. The potash felspar has a low refringence and a low negative optic axial angle. Amphibole is pseudomorphed mostly by fine flakes of green chlorite and small amounts of nontronite, sericite and leucoxene. Two kinds of chlorite are present, one having anomalous brown, and the other anomalous blue interference colours. Quartz forms anhedral, rounded grains which show corrosion.

The groundmass contains granular to tabular felspar, rounded to poikilitic quartz grains, chlorite pseudomorphing amphibole prisms, and flakes of sericite. Accessory apatite and leucoxene are present. Hydrated iron oxide forms rare cubic grains and may pseudomorph pyrite.

A visual estimation of the amounts of minerals present is:- albite: 63, chloritized amphibole: 15, quartz: 15, sericite: 5, others: 2. The rock is a chloritized amphibole granodiorite porphyry.

A.44. Slide number 4666. Tunonk River.

The hand specimen is seen to be a dark greyish-green, somewhat basic amygdaloidal and porphyritic igneous rock, in which the phenocrysts are enclosed in a dark, fine-grained groundmass. The phenocrysts consist mostly of tabular white felspar, measuring up to 1.5 mm. in size. Some euhedral phenocrysts of pyroxene are present ranging up to 4 mm. in size. The amygdales are roughly spherical, and measure up to 5 mm. in diameter.

In thin section, the rock is seen to be glomeroporphyritic, with a fine-grained holocrystalline hypidiomorphic and ophitic groundmass that encloses subhedral to euhedral phenocrysts of albite and augite. The groundmass is amygdaloidal.

Albite phenocrysts form tabular, frequently clustered, crystals that range in size between 0.2 mm. and 1.0 mm. The mineral shows slight sericitization, and some alteration to granular epidote. Augite forms euhedral to subhedral colourless to very pale green prismatic crystals, ranging in size between 0.3 mm. and 5.0 mm. Their margins are somewhat corroded and fine granules of pyroxene, mixed with hydrated iron oxide dust, occur there. Slight alteration to chlorite has taken place, and the larger augites are cut by thin veins of quartz and pale green penninite. Granular-prismatic crystals of epidote may be associated with augite phenocrysts. Some ferromagnesian mineral, possibly pyroxene, has been completely pseudomorphed by fine-grained chlorite and subordinate calcite.

The groundmass is composed of albite, chlorite and augite, with leucoxene and some hydrated iron oxide. Lean tabular laths of albite, 0.1 mm. in length, are in ophitic relationship to plates of interstitial, pale green chlorite. Augite forms minute granules, 0.01 mm. in size, and, more rarely, larger grains 0.06 mm. to 0.1 mm. in size, ophitically enclosing albite. Some granular leucoxene and more rare hydrated iron oxide are present. Small amounts of granular epidote may be seen.

Several amygdales are present in the slide, ranging between 0.5 mm. and 2.75 mm. They consist mostly of aggregates of minute spherules and part spherules of pale yellow-green chlorite, which grow more coarse towards the amygdale centres. Some amygdales have a discontinuous rim of sub-spherulite-like tabular crystals of colourless to pale yellow epidote. One amygdale has a thin rim of chlorite, its centre being filled with black iron ore.

The specimen is cut by several very thin veins that are composed of green penninite and some quartz. A vein, 1 mm. to 2 mm. broad is composed partly of a mosaic of sub-amoeboid grains which enclose flakes of sericite and prisms of apatite. In places, the vein is almost completely filled with sericite, mixed with sub-spherulite-like growths of prismatic apatite. Yellowish, granular epidote may be found along the veins margins, and around incorporated phenocrysts.

An estimation of the amounts of minerals present is:- albite: 45, chlorite: 30, augite: 20, others: 5. The rock is a porphyritic amygdaloidal spilite.

E. Specimens from Boulders in the Beds of the Aunja and Dibor Rivers.

A.77. Slide number 4671. Aunja River, Ramu 1-mile sheet.

The hand specimen, stated by Dr. Corbett to be from a boulder of igneous rock, is purplish and fine- to medium-grained rock. Two of its surfaces are covered with probable vein material, which consists of quartz, epidote, and a fibrous, pale bluish amphibole-like mineral.

In thin section, the specimen is seen to be a fine- to medium-grained igneous rock. It has an aphyric, hypidiomorphic-inequigranular and interstitial texture, and the grain-sizes range between 0.05 mm. and 0.4 mm. Somewhat sericitized albite forms stubby tabular crystals that are closely crowded, and whose long axes are, in places, sub-parallel. The crystals have ragged margins, and microfractures are filled with sericite. Augite occurs as colourless, anhedral to euhedral, rarely clustered crystals. Interstitial material is composed of pale green chlorite, fine, granular leucoxene, and haematite. The latter mineral forms cubic to highly irregular skeletal grains. Some accessory apatite, occurring as fine acicular prismatic crystals, were noted. An estimation of the percentages of minerals present is:- albite: 65, augite: 20, and chlorite, hydrated iron oxide and leucoxene: 15. The rock is a spilite.

Here and there the spilite is seen to have been somewhat brecciated. Thin lines of fine, granular material thicken into zones of similar material, enclosing fragments of spilite, and porphyroclasts of somewhat microfaulted albite and augite. Much fine (?)leucoxenic material is present. Fine needles of some faintly green acicular mineral, possibly an amphibole, are present in the fine material and cross adjacent grains without being broken, suggesting emplacement subsequent to the brecciation.

Cutting the specimen is a thick vein composed mainly of coarse, granular epidote that is pleochroic in yellow, small amounts of unaltered albite, and of a colourless fibrous mineral with near parallel extinction, probably soda tremolite. One or two thin veins composed of fresh albite, small amounts of pale green chlorite, and fine needles of (?)amphibole like that occurring in the groundmass of brecciated material, originate from the epidote vein. One vein albite crystal showing albite twinning is apparently continuous with a somewhat sericitized albite belonging to the spilite.

The rock is, therefore, a veined and brecciated spilite.

C.73. Slide number 4683. Boulder from conglomerate, Dibor River, Uvo one-mile sheet.

The hand specimen is seen to be a dark basic igneous rock containing large euhedral phenocrysts of pyroxene, ranging up to 8 mm. in size, and smaller tabular phenocrysts of felspar. All are enclosed in a fine-grained amygdaloidal groundmass. The amygdales are seen to contain white zeolite. A reddish tinge present in the groundmass may be attributed to hydrated iron oxide.

In thin section the rock is seen to be seriate porphyritic, the subhedral phenocrysts being enclosed in a very fine-grained hypidiomorphic-granular and interstitial, amygdaloidal groundmass. A slight flow-texture is present.

Augite phenocrysts are subhedral to euhedral and prismatic, showing some corrosion on their margins. Augite is pale green. Some zoning is seen to be present under crossed nicols. The smaller labradorite (An65) phenocrysts are tabular, and are commonly partly altered to zeolite.

The groundmass is composed of minute laths of zeolitized plagioclase, granular to sub-ophitic greenish-yellow pyroxene, and interstitial chloritic and zeolitic material. Hydrated iron oxide forms minute granules in the groundmass, and pseudomorphs small phenocrysts of olivine. Inclusions of uncertain identity are abundant in some of the pseudomorphs.

Numerous interstitial to amygdaloidal structures are present. They contain a thin rim of isotropic zeolitic material, (?)analcite, that encloses masses of a fibrous zeolite possible thomsonite. Some greenish chlorite is rarely present.

An estimation of the percentages of minerals that are present is: labradorite (with its alteration products): 35, augite: 35, black iron ore: 10, amygdaloidal zeolites: 15, chlorite: 5. The rock is a porphyritic amygdaloidal basalt.

C.82. Slide number 4684. Boulder from beach, Dibor River, Uvo one-mile sheet.

The hand specimen is seen to be a dull red, porphyritic igneous rock; the phenocrysts of greenish pyroxene and whitish felspar, which range up to 4 mm. in size, are enclosed in a fine-grained amygdaloidal groundmass. Cubic-shaped grains of hydrated iron oxide are scattered through the rock.

In thin section the rock is seen to have coarse, strained and fractured phenocrysts of labradorite (An50) and greenish prismatic, but corroded pyroxene enclosed in a very fine-grained groundmass that contains minute laths of plagioclase in "ophitic" relationship to reddish hydrated iron oxide. In addition, fine granules of hydrated iron oxide, and interstitial masses of chlorite flakes are present. A few pseudomorphs of hydrated iron oxide after olivine may be seen.

About 35% of the rock is formed of zeolite, which occupies amygdale-like cavities and veins. The cavities, containing (?)analcite and (?)stilbite, are irregular to rounded in shape. The veins, containing (?)stilbite and traces of hydrated iron oxide dust, range between 0.5 mm. and 1 mm. in thickness.

The rock appears to be a zeolitized, ferruginous porphyritic olivine basalt.