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PART 3.

GRANITES OF KING GEORGE LAND AND ADELIE LAND

BY
H. S. SUMMERS, D.Sc., AND A. B. EDWARDS, PH.D.

WITH AN APPENDIX
BY
A. W. KLEEMAN, M.Sc.

WITH ONE PLATE.

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PART 3.

GRANITES

BY

H. S. SUMMERS, D.Sc., and A. B. EDWARDS, Ph.D.

[A.A.E. Reports, Series A, Vol. IV, Part 3, Pages 87–113.
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GRANITES OF KING GEORGE LAND AND ADELIE LAND

BY

H. S. SUMMERS, D.Sc., AND A. B. EDWARDS, Ph.D.

WITH AN APPENDIX BY A. W. KLEEMAN, M.Sc.

I.—INTRODUCTION.

THE Expedition collection from this region includes a number of specimens which fall within the division of the Granites. Dr. Stillwell has already described the granites from Mackellar Islet. For the rest, all but very few were collected as erratics from the Moraines at Cape Denison, and consequently represent types of rock existing to the south and to the south-west of that locality. Granites were found to exist *in situ* at Penguin Point.

Thanks to the courtesy of the Director of the Geological Survey of Victoria, six analyses were made, in the Mines Department Laboratory, of specimens considered to be fairly representative of the principal types. These analyses are recorded later.

Rosiwal determinations were made by means of a Leitz integration table which is a great advance over earlier apparatus for this class of work. This instrument is designed for use with the larger Leitz Petrological Microscope, but as the stage is locked when the instrument is attached, the section cannot be rotated under crossed nicols. By making a minor adjustment it was found possible to use the integration table with a Dick microscope, and we found this far more satisfactory as we could use the rotating nicols to determine the minerals without interfering with the regular reading of the instrument.

II. THE CHEMICAL COMPOSITIONS OF THE GRANITES.

The following table gives the compositions of the rocks analysed together with analyses of other granites from Antarctica previously recorded :—

	1	2	3	4	5	6	7	8	9	10
SiO_2 ...	76·50	73·52	72·50	76·34	76·99	77·95	71·87	69·85	71·10	68·33
Al_2O_3 ...	13·12	14·92	14·40	13·48	12·62	14·04	15·16	15·35	14·50	16·56
Fe_2O_3 ...	0·87	0·25	0·86	0·39	0·70	0·36	0·62	0·40	0·31	0·34
FeO ...	0·45	1·31	0·97	0·29	0·25	0·13	2·10	3·88	3·10	2·82
MgO ...	0·68	st. tr.	0·98	0·03	tr.	0·35	0·29	0·52	1·17	0·61
CaO ...	0·38	1·38	1·03	0·85	0·76	tr.	0·84	2·94	2·59	3·43
Na_2O ...	2·68	2·86	2·95	2·73	2·37	6·33	3·88	3·13	3·25	3·85
K_2O ...	4·91	5·22	4·88	5·43	5·87	0·38	4·72	2·87	4·02	3·56
H_2O+ ...	0·66	0·56	0·84	0·58	0·38	0·25	0·35	0·24	0·25	0·38
H_2O- ...	0·14	0·13	0·13	0·09	0·10	0·08	0·15	0·03	——	0·04
CO_2 ...	nil	nil	st. tr.	st. tr.	nil	nil	0·09	0·01	——	——
TiO_2 ...	0·13	0·23	0·35	ft. tr.	0·13	nil	0·25	0·36	0·46	0·29
P_2O_5 ...	tr.	ft. tr.	0·08	tr.	nil	tr.	tr.	0·50	——	0·23
MnO ...	0·15	0·07	st. tr.	tr.	tr.	nil	0·04	0·06	0·03	tr.
(NiCo)O ...	nil	nil	nil	nil	nil	nil	——	——	——	——
Li_2O ...	nil	tr.	tr.	tr.	ft. tr.	st. tr.	——	——	——	——
Cl ...	tr.	tr.	tr.	st. tr.	tr.	tr.	——	——	——	——
SO_3 ...	nil	nil	nil	nil	nil	nil	——	——	——	——
TOTAL ...	100·67	100·45	99·97	100·21	100·17	99·87	100·36	100·14	100·75	100·44
Sp. Gr. ...	2·6188	2·6376	2·6404	2·6167	2·6058	2·6263	——	——	——	——

(*See notations overleaf.*)

1. Pink Granite—Field No. 223. Erratic, Cape Denison. (P. G. W. Bayly and J. C. Watson.)
2. Pink Granite—Field No. 833. Erratic, Cape Denison. (P. G. W. Bayly and J. C. Watson.)
3. Grey Biotite Granite—Field No. 902. Erratic, Cape Denison. (P. G. W. Bayly and J. C. Watson.)
4. Grey Granite—Field No. 847. Erratic, Cape Denison. (P. G. W. Bayly and J. C. Watson.)
5. Fine-grained Granite—Field No. 901. Erratic, Cape Denison. (P. G. W. Bayly and J. C. Watson.)
6. Graphic Granite—Field No. 604. Erratic, Cape Denison. (P. G. W. Bayly and J. C. Watson.)
7. Hornblende Biotite Granite, C. Irizar (A. B. Walkom). Brit. Ant. Exp., 1907–9, Geology, vol. 2 (1916), p. 211.
8. Biotite Granite, Mt. Larsen (A. B. Walkom), *loc. cit. supra*, p. 211.
9. Granite, Wandel Island, Graham Land Region, Antarctica (Pisani). G. Gourdon Exp. Ant. Fr., Petrology vol., p. 144, 1908.
10. Grey Biotite Granite (Hornblende-free Granodiorite)—Field No. D9G. Granite Harbour (E. D. Mountain) Brit. Ant. (Terra Nova) Exp., 1910. Geol., vol. 1, No. 6 (1924), p. 197.

An examination of the first five analyses will show that the rocks are fairly normal granites, but No. 6, that of a Graphic Granite, is quite abnormal in that the percentage of potash is only 0·38, whereas there is 6·33% of soda. Albite practically completely replaces the potash felspar usually present in such rocks. Unfortunately, this specimen was not found *in situ* and, therefore, there is no knowledge of the plutonic types with which it occurred. The rocks were picked out for analysis before detailed microscopic examination had been undertaken, so that although several granodiorites have been described, no analysis of the less acid types was made.

III. NORMS AND POSITIONS IN QUANTITATIVE CLASSIFICATION.

The following list gives the norms and classification of the six analysed specimens :—

	1	2	3	4	5	6
Q	40·38	33·30	32·88	38·04	38·99	39·24
Or.	28·91	31·14	28·91	31·69	35·03	2·22
Ab.	22·53	24·10	25·15	23·06	19·91	53·45
An.	1·95	6·95	4·17	4·17	3·89	0·00
C.	2·65	2·04	2·65	1·63	0·92	3·16
Hy.	1·83	1·85	3·16	0·23	0·00	0·90
Mg.	1·16	0·46	1·16	0·70	0·46	0·46
Il.	0·30	0·46	0·61	0·00	0·30	0·00
H	...	...	...	...	0·32	...
Ap.	...	...	0·34	...	...	...

1. Pink Granite Field No. 223. I, 3, 1, 3, Alaskose.
2. Pink Granite Field No. 833. I, 4, 2, 3, Toscanose.
3. Gray Biotite Granite Field No. 902. I, 4, 2, 3, Toscanose.
4. Gray Granite Field No. 847. I, 3, 1/2, 3 Alaskose.
5. Fine grained Granite Field No. 901. I, 3, 1, 3/2 Alaskose.
6. Graphic Granite Field No. 604. I, 3, 1, 5 Westphalose.

IV. PETROLOGICAL DESCRIPTION OF THE GRANITES.

The granites have been grouped into (a) those with red or pink felspars (b) grey granites.

(a) *RED GRANITES :*

Rock No. 44, erratic from Cape Denison : This is an *unequal grained, epidotized, and saussuritized microcline granite.* The minerals present are quartz, microcline, albite, saussuritized plagioclase (? andesine), epidote, chloritized biotite, and a small amount of pyrite.

Quartz forms large interlocking crystals (allotriomorphic). It also occurs as interstitial granular matter, which is sometimes associated with epidote about the borders of saussuritized felspars. Strings of bubbles penetrate the crystals, often traversing several without any change of direction.

Microcline is the dominant felspar. It exhibits well-developed tartan twinning and peg structures and is always fresh and pellucid. Small pieces of microcline are occasionally found surrounded by saussuritized felspar.

A minor quantity of albite is present, and some of this may be of primary origin. Much of it is associated with the saussuritized felspar, and is clear, pellucid and often shows a wavy twinning and extinction. It is probably secondary, being set free during the epidotization and the saussuritization.

It is difficult to ascertain the composition of the plagioclase since it is generally hidden by a thick felted mass of saussurite flakes. It appears, however, to be of (— ve) character and shows twin lamellae. It is probably a basic oligoclase, (about $Ab_{75}An_{25}$). Associated with this altered felspar are numerous crystals of epidote and secondary albite.

Yellow to colourless epidote is fairly common. It exhibits distinct pleochroism and beautiful, high polarization colours. It occurs as interstitial matter, particularly in the neighbourhood of saussuritized plagioclase, but more commonly as veins or stringers which exhibit parallel relations to one another. Granulated quartz and albite are often associated with it, and in one case pyrite. The concentration of epidote varies greatly in different parts of the slide.

Chloritized and partially epidotized biotite occurs with the epidote in places. It is depositing iron ore, and never occurs plentifully.

It seems that the original rock was a microcline granite, which became epidotized and saussuritized either by hydrothermal pneumatolysis, or by some process of regional metamorphism. Some of the granular quartz associated with the epidote may have been precipitated with the formation of the latter. Migratory movements have affected the concentrations of the secondary minerals.

The texture varies from a medium-grained granite to locally granular patches which are of no great extent, and may represent interstitial final crystallization, or incipient granulation.

Rosiwal Analysis:—

Quartz	32·8
Microcline	29·6
Saussuritized felspar	23·3
Albite	8·7
Epidote	4·6
Biotite	1·0
	100·0

Owing to the inability to determine the exact degree of saussuritization, it is not possible to calculate the chemical composition. It is evident, however, that the rock was a potash granite of fairly normal composition.

Rock No. 200, erratic from Cape Denison: This is a *hornblende granodiorite* which has undergone shearing accompanied by saussuritization and the introduction of sulphides in some parts. The minerals present are quartz, saussuritized basic oligoclase (Ab_{70-75}), orthoclase, anorthoclase, hornblende biotite, iron ore, large apatites, zircons and rare grains of epidote. "Veins" of granular matter are observed, and the quartz crystals in their neighbourhood appear to be stretched or crushed so that they now show their long axes parallel to such veins. Some secondary quartz cement appears between the crystals.

The quartz is clear, but crowded with strings of bubbles. It often shows marked radial cracks which have been filled with iron ore. In places the individual crystals have been faulted (Plate IV., fig. 1.)

The plagioclase is fairly thoroughly saussuritized, but remnants remain, and the twinning can be distinguished. It shows a (— ve) figure and an extinction $\wedge$ of about 6-7°, so that it is interpreted as a basic oligoclase ($Ab_{75}An_{25}$). It is only slightly epidotized. It occurs as large crystals and is the dominant mineral of the rock, and includes numerous large round apatites, zircon prisms, and flakes of chloritized biotite. Veins and fractures occur in it, as in the quartz, and commonly are filled partially with iron ore.

Orthoclase and anorthoclase are minor constituents. The anorthoclase is distinguished from the orthoclase by its (+ ve) figure as against the (— ve) figure of the latter, its perthitic growth and its tartan twinning in some cases. It is possibly a potash albite, but has a very low refractive index for this — less than that of Canada Balsam. Its exact nature cannot be stated confidently.

The hornblende is a normal variety, showing a yellow to green pleochroism. It tends to be idiomorphic in moderately large crystals. It is present in greater amount than the biotite and is more stable than it.

Twisted flakes of chloritized biotite (originally a brown variety) occur and are generally included in the plagioclase, while the hornblende is not. It is commonly depositing iron ore.

Large apatites, rounded or oval in shape are not uncommon throughout the rock. Small double ended zircon prisms are found in the felspars. These also exhibit slight rounding, so that both the apatite and zircon might possibly be from foreign sources. Epidote forms rare grains in the saussuritized plagioclase.

Iron ore occurs interstitially and filling cracks. It is evidently of later origin than the rock, and was introduced during or after the shearing and compression. Pyrite is found associated with the hornblende in one case, and elsewhere in the quartz.

The rock was probably a normal granodiorite which has undergone metamorphism and hydrothermal pneumatolysis,the two being more or less contemporaneous, but later than the consolidation of the rock.

Rosiwal Analysis:—

Quartz	35·05
Plagioclase ($Ab_{75}An_{25}$)? saussuritized ...	40·00
Orthoclase & Anorthoclase	13·58
Hornblende	4·89
Biotite	3·72
Apatite	0·34
Pyrite	0·24
Granular Areas (Quartz and Felspar) ...	0·70
Iron Ores	0·48
	100·00

Rock No. 833, erratic, Cape Denison. This rock is an allotriomorphic *granite*, consisting of quartz, orthoclase and microcline, albite-oligoclase, biotite, sphene, and some allanite, chlorite, apatite and iron ore.

The quartz is clear with numerous strings of bubbles, and is commonly very much cracked. It is the dominant mineral and occurs in large allotriomorphic crystals. The quartz was apparently the last mineral to crystallize out, and in places, a little granular interstitial quartz is observed. Inclusions of quartz in the orthoclase show that both were crystallizing at one period.

The felspars are of three varieties: (1) orthoclase, (2) microcline, (3) albite-oligoclase.

The orthoclase is generally microperthitic, untwinned, (— ve), and is commonly strongly sericitized centrally. Some quartz is included. The orthoclase occurs in allotriomorphic plates, generally smaller than the quartz.

Microcline occurs sparingly with spindle twinning—generally a twinned core, dying out at the edges. Some crystals show fine tartan twinning. The crystals are not sericitized, and are generally much smaller than the other felspars in size.

Albite-oligoclase is fairly abundant and second to the orthoclase in quantity. Its composition appears to be about $Ab_{90}An_{10}$. It probably contains a fair amount of the orthoclase molecules—i.e., is a potash oligoclase-albite (cf. analysis). It occurs as plates parallel to 001 and to 010, the latter very large with perfect cleavage, quite free from sericitization, but slightly clouded from a streaky or spindly marking at a large angle to the cleavage—suggesting twinning or antiperthite.

Biotite is the only mica present. It is generally chloritized, and contains occasional small pleochroic haloes about zircons. It has deposited finely granular iron ore which has altered to leucoxene. Apatite is commonly included. The biotite appears to predate the orthoclase, and is generally corroded or irregularly shaped.

Leucoxene is a common accessory after iron ore. Its common association with chlorite, and shape suggest that it represents completely altered biotite. It is generally associated with biotite.

Allanite, which is zoned, is found associated with the biotite; occasionally it tends to be idiomorphic. The allanite is somewhat similar to allanite in rock No. 154, from C. Denison. It is not pleochroic and does not give a good figure.

Apatite crystals and grains are fairly frequent, but not abundant.

Rosiwal Analysis:—

Quartz	40·57
Orthoclase	28·56
Microcline	5·02
Plagioclase (Albite-Oligoclase)	21·64
Biotite, etc.	4·21
	100·0

The chemical analysis is given earlier. There is a discrepancy in the presence of chlorite and biotite in the section, while the analysis shows only a slight trace of MgO.

Order of Crystallization (completion of):—
Accessories (apatite and ilmenite), Albite, Oligoclase, Orthoclase, Biotite, Quartz.

Autopneumatolysis appears to have altered iron ore to leucoxene and chloritized the biotite.

Rock No. 223, erratic, Cape Denison. This is a *red granite* consisting of red felspar, some lighter in colour than the rest, quartz and biotite (Plate IV., fig. 4).

The quartz has been shattered and occurs in patches of interlocking grains. In some cases cracks occur, which in places form the junction between two grains, and in other places the same crack will cross or penetrate a grain.

The orthoclase is generally much altered, the kaolinized material being stained red by oxide of iron.

Microcline is fairly abundant and is rather fresher than the orthoclase, but centres of crystal are often kaolinized and in such cases the characteristic twinning of the microcline is not visible. It is probable that a proportion of the orthoclase recorded in the Rosiwal analysis may be altered microcline. In fact, the shearing that the rock has undergone as evidenced by the fracturing of the quartz would aid the inversion of orthoclase to microcline, which is the more stable form at low temperature.

The plagioclase is considerably altered, but appears to be oligoclase.

Biotite is somewhat altered and is very dark in colour, the pleochroism varying from dark brown to dark yellowish brown.

Muscovite is intergrown in places with biotite.

Magnetite and apatite are present, included in the biotite.

The chemical analysis of this specimen is given earlier.

Rosiwal Analysis:—

Quartz	38·7
Orthoclase	22·2
Microcline	13·5
Plagioclase	15·1
Biotite (inc. Muscovite) ...	10·5

The rock is crushed Biotite granite containing Microcline.

Rock No. 201 (i), erratic, Cape Denison. This rock is an uneven grained, *somewhat altered acid granite.* In the hand specimen it is seen to consist of quartz, red felspar and subordinate biotite.

The quartz occurs as large crystals, generally allotriomorphic but with occasional pieces showing crystal boundaries. Strings of bubbles are plentiful.

Orthoclase is largely kaolinized but is generally perthitic, and in such cases the included plagioclase is distinctly fresher. The red colour of the felspar is due to the kaolin decomposition product being stained red by oxide of iron derived from the alteration of the biotite.

A small amount of microcline is present but is also altered so that in general, orthoclase and microcline cannot be differentiated from one another.

The plagioclase is comparatively fresh and ranges from acid oligoclase to albite.

Biotite has been altered and is represented by chlorite, which in places is intergrown with muscovite.

Apatite and occasional zircon crystals occur, included in the chloritized biotite A few minute reddish crystals with pleochroic haloes also occur and are probably rutile.

Magnetite occurs as the result of the alteration of the biotite.

Rosiwal Analysis:—

Quartz	42·7
Orthoclase and Microcline ...	37·5
Plagioclase	17·7
Chloritized Biotite	2·1
	100·0

Rock No. 201 (ii), erratic, Cape Denison. This rock is very similar to No. 201 (i) ; except that a small amount of calcite occurs, the minerals are the same, and the proportions of the mineral also clearly agree.

Rosiwal Analysis:—

Quartz	44·1
Orthoclase and Microcline ...	36·2
Plagioclase	15·6
Biotite	3·3
Calcite	·8
	100·0

Rock No. 218, erratic, Cape Denison. This rock is an *adamellite*. In the hand specimen, it is seen to consist of red felspar, numerous black patches of biotite, and subordinate quartz.

Under the microscope, quartz is found to be more abundant than appeared from the hand specimen, but occurs largely as a mosaic of small interlocking crystal between the felspars.

The felspars are generally very altered and in places, cannot be determined satisfactorily, so that the Rosiwal Analysis is only approximate in respect to the relative proportions of orthoclase and plagioclase. The composition of the plagioclase was indeterminate.

The biotite is considerably altered, and a fair amount of magnetite has separated out, but it has not been converted to chlorite.

Rosiwal Analysis:—

Quartz	20·7
Orthoclase	39·8
Plagioclase	28·3
Biotite	11·2
	100·0

The rock might be called a quartz monzonite or adamellite.

(b) *GREY GRANITES*:

Rock No. 847, erratic, Cape Denison. This rock, a *granite*, consists of large (more or less euhedral) crystals of plagioclase, saussuritized to varying extents, numerous smaller (allotriomorphic) crystals of microperthite, orthoclase and microcline, and a considerable amount of granular quartz. There are practically no ferro-magnesian minerals present. A little white mica has been introduced by saussuritization, and one or two large sphenes were noted.

The plagioclase appears to be albite-oligoclase. It gives extinction of 10° on the 010 face, and sometimes over 5° on 001. It has a lower refractive index than the balsam in some cases, in some a higher one. It is probably about ($Ab_{85}An_{15}$). It forms

large plates with more or less regular boundaries, and is generally saussuritized. A little secondary mica is commonly associated with it. It commonly shows slight shearing and distortion.

Orthoclase, microperthite, microcline occur in considerable abundance, dominating over the plagioclase. All degrees of transition from the one to the other are found, suggesting that the original felspar was orthoclase, but incomplete inversion to microcline has since occurred. Much of the microperthite bears a close resemblance to myrmekite, and rare myrmekites have been seen in the section.

The quartz rarely appears as large crystals although it is the most abundant mineral. It appears as if large crystals of it have been crushed and granulated. The granulation is much more complete in the close vicinity of the felspars than away from them. There is a tendency for the quartz individuals to be drawn out and foliated in such cases.

The rock has the appearance of having suffered dynamic metamorphism, the quartz and the potash felspar to a lesser extent, suffering granulation, while the plagioclase resisted more strongly, and are only locally crumpled.

It is also possible that the metamorphism was such as to produce a recrystallization of plagioclase, and to some extent, orthoclase, and that the growing forces of the new crystals granulated the quartz.

The rock is a normal granite.

Rosiwal Analysis:—

Quartz	39·6
Orthoclase, Microperthite, Microcline ...	34·2
Plagioclase	25·2
Mica	1·0

Chemical Analysis:—

		Calculated Composition (ignoring Mica)
SiO_2	76·34	78·0
Al_2O_3	13·48	11·9
Fe_2O_3	0·39	——
FeO	0·29	——
MgO	0·03	——
CaO	0·85	0·8
Na_2O	2·73	2·5
K_2O	5·43	5·8
H_2O+	0·58	——
H_2O-	·09	——
	100·21	100·0

The complete chemical analysis is given in the table of analyses (p. 89).

Rock No. 901, erratic, Cape Denison. The rock is a fine grained allotriomorphic *granite*, consisting of quartz, orthoclase, anorthoclase (?), albite, and albite-oligoclase, together with a little biotite, iron-ore (ilmenite), sphene, epidote (rare), apatite, (rare) and muscovite (very rare). A little iron oxide (limonite) occurs as "cement" between some grains. Ferro-magnesians are of small quantity (cf. analysis).

The quartz occurs in very pellucid interlocking grains, generally free from strain polarization effects. The crystals are commonly traversed by more or less parallel strings of minute bubbles.

The plagioclase is probably albite-oligoclase, being (+ ve) and having extinction angles from 2° to 6°. It shows fine to fairly coarse lamellar twinning, and generally shows a central clouding or incipient saussuritization. The outer parts of such crystals are generally pellucid, but show no other difference from the central parts, thus suggesting the alteration to have taken place during crystallization.

Orthoclase is the dominant felspar (cf. analysis) and occurs in allotriomorphic plates. It apparently post-dates the plagioclase in order of crystallization, and it is occasionally perthitic. In some of the perthites the stringers of perthitic material seem to consist partly of quartz, being possibly allied to myrmekitic growths. Rare true myrmekitic growths are observed, generally with the plagioclase.

Some of the felspar appears to be a potash-albite. It shows a (+ ve) figure and very minute twinning, often only in part of the crystal.

There is a little chloritized biotite which was originally brown in colour. It is now showing a tendency to deposit iron ore, which in turn is altering to leucoxene.

A little allotriomorphic iron ore (ilmenite from analysis) is found, apparently of late origin.

A little interstitial "cement" of iron oxide (limonite) is found between quartz grains.

Occasional idiomorphic sphenes, rare granules of epidote, rare apatites, and very rare minute flakes of muscovite were noted.

Comparison with the analysis shows a marked agreement—very low iron, magnesia and lime, high silica and potash.

The grain size varies from moderately coarse to quite small individuals. In places it becomes locally coarsely granular, where the final consolidation has taken place.

Analysis		Calculated Analysis	Rosiwal Analysis	
		Assuming $Ab_{95}An_5$ for albite, $Ab_{60}Or_{40}$ for anorthoclase and neglecting the iron oxide cement.		
SiO_2	76·99	79·3		
Al_2O_3	12·62	10·1		
Fe_2O_3	0·70	0·5		
FeO	0·25			
MgO	trace	tr.		
CaO	0·76	0·2	Quartz	44·5
Na_2O	2·37	2·8	(Albite Ab-Oligo)	19·0
K_2O	5·87	5·0	Orthoclase	25·6
H_2O+	0·38	——	Anorthoclase Potash-Albite	8·3
H_2O-	0·10	——	Biotite	2·0
TiO_2	0·13	0·3	Iron Ore	0·6
TOTAL	100·17	98·2		100·0

Rock No. 902, erratic, Cape Denison. This rock is a *grey biotite granite*, allotriomorphic and of medium grain size. The minerals are quartz, microperthite, orthoclase, a little microcline, albite-oligoclase, biotite, rare sphenes, zircons and apatites, some secondary chlorite and iron ore. Myrmekitic intergrowths are a marked feature at the junctions of the orthoclase and albite-oligoclase.

The quartz is extremely pellucid, being very free from bubbles or inclusions. It forms small to moderately large (2·5 to 3 mm. max.) allotriomorphic crystals which have smooth edges against the felspars, but are crenulated against quartz.

Albite-oligoclase occurs as more or less idiomorphic crystals, often included in the orthoclase. The character is (+ ve) biaxial, refractive index less to slightly greater than the balsam (1·530 — 1·535) and extinction angles are very low. Fine Ab twinning and occasionally zoning occur. This felspar also shows a tendency to be saussuritized. Clear rims of orthoclase commonly enclose these plagioclase crystals.

Orthoclase is equally dominant and occurs in large more or less allotriomorphic plates. It generally tends to be microperthitic.

A very minor quantity of microcline is present. This microcline is generally associated with finely granular orthoclase patches.

Myrmekite growths are frequent. They develop between albite-oligoclase and orthoclase crystals; the former acts as their host, and they show a convex surface facing the orthoclase.

Normal brown to yellow biotite occurs sparingly. Occasionally it is partially chloritized and is depositing needles and grains of iron ore or rutile. It carries zircons with pleochroic haloes.

Rare apatite prisms occur in the felspars. A moderately large crystal of sphene was also observed.

The order of crystallization was :—Accessories, Biotite, Plagioclase, Orthoclase, Quartz.

Rosiwal Analysis:—

Quartz	34·0
Orthoclase	30·0
Plagioclase (Ab_{85})	30·4
Microcline	3·4
Biotite	2·2
	100·0

Chemical Analysis:—

		Calculated Composition
SiO_2	72·50	75·9
Al_2O_3	14·40	12·3
Fe_2O_3	0·86	——
FeO	0·97	——
MgO	0·98	——
CaO	1·03	1·0
Na_2O	2·95	3·0
K_2O	4·88	5·6
H_2O + ...	0·84	——
H_2O −	0·13	——
TiO_2	0·35	——
P_2O_5	0·08	97·8
		Biotite 2·2
	99·97	100·0

Rock No. 747, occurs *in situ* at Penguin Point, King George Land. The slide is that of a fresh *granodiorite*. It shows quartz, plagioclase (Oligoclase Ab_{70}-Ab_{75}), subordinate orthoclase, biotite, fresh or chloritized in part, a little muscovite, and large crystals of apatite.

The plagioclase occurs in large subhedral plates, occasionally showing embayments filled with quartz along the edges. It has a (— ve) character, and an extinction angle of from 8°-15° on the symmetrical zone, corresponding to Ab_{75}-Ab_{70}. Parts of the crystals do not extinguish equally although this inequality has no effect upon lamellar twinning which is superimposed. The rectangular edges of such areas suggest that they may be some form of interpenetration twin.

The orthoclase is of lesser quantity, and shows a partial sericitization.

The quartz is quite pellucid and free from bubbles. It forms large allotriomorphic plates.

The biotite is generally fresh and brown in colour, but in places, parts of the flakes are green from deuteric chloritization. Muscovite, in lesser quantity, occurs with the biotite or alone. Pleochroic haloes about zircons appear in the biotite, and large euhedral apatites occur associated with biotite or plagioclase.

The order of crystallization was apparently—apatite, biotite, oligoclase, orthoclase and quartz; the muscovite probably crystallized just before the quartz. Slight deuteric alteration followed before consolidation was complete.

The structure is typically granitic; individual crystals are up to 0·5 cm. in diameter or even larger.

Rosiwal Analysis:—

Quartz	52·3
Plagioclase	26·5
Orthoclase	8·5
Biotite	10·2
Muscovite	2·0
Apatite	0·5
	100·0

Rock No. 746, occurs *in situ* at Penguin Point, King George Land.

The rock is a grey *porphyritic granodiorite*. The general mass of the rock has a grain size about 5 mm. diameter. Studded through it are large porphyritic felspars as much as 7 cms. in length.

The slide represents a typical granodiorite, and closely resembles No. 747. The rock consists of quartz, plagioclase (oligoclase, Ab_{75}), subordinate orthoclase, biotite, fresh to chloritized, some muscovite, zircons, and rare large apatites and rarer sphene. A large myrmekite growth is also present (Plate IV., fig. 3).

The plagioclase forms large subhedral plates, is of (— ve) character, has an extinction angles of 6°-8°, and a refractive index greater than balsam but less than quartz. It is about Ab_{75}. It includes apatites, and occasionally biotite.

The orthoclase is very subordinate in quantity, and generally sericitized. It forms smaller and later crystals.

The quartz forms large allotriomorphic plates free from bubbles.

The biotite is fresh or partially chloritized and contains numerous pleochroic haloes about zircons. Muscovite is present in smaller quantity than the biotite. Occasional large euhedral apatites are seen, and one elongated crystal of sphene is present.

A large and very distinct myrmekite growth was seen at the junction of oligoclase and orthoclase crystals with quartz. It was developed in an albite-oligoclase zone of the plagioclase, and was convex towards the quartz.

The probable order of crystallization is—apatite and zircon, etc., biotite, oligoclase, muscovite, orthoclase and quartz, and deuteric alterations giving rise to chloritization and sericitization preceded final consolidation.

Rosiwal Analysis: —

Quartz	41·3
Plagioclase	41·1
Orthoclase	8·1
Biotite	6·4
Muscovite	3·1
	100·0

Rock No. 749, obtained *in situ* at Penguin Point B is a variant of 747. In the small hand specimen available for examination the principal minerals are noted to be felspar and biotite, but occasional small garnets are also observable.

Rock No. 1298, obtained *in situ* at Penguin Point A, is that of a dark fine-grained exogenous inclusion. The inclusion at contact with the granite is surrounded by a coarse biotite-rich zone. Specimen No. 748 is another exogenous inclusion in the Penguin Point granodiorite. It is a fine-grained, light coloured, recrystallised rock surrounded at contact with the granite with a coarse biotite-rich zone.

(c) *GRAPHIC GRANITE AND APLITES*:

Rock No. 604, erratic Cape Denison. The rock is an allotriomorphic *sodic graphic granite* consisting essentially of albite and quartz (Plate IV., fig. 2), together with minute patches of microcline, and a small amount of interstitial muscovite.

The albites occur as large allotriomorphic plates, of very irregular outline. The edges of the crystals are generally finely reticulated. The refractive index is > Canada Balsam (as prepared by Mr. Mann, as used in mounting it, namely, 1·525—30) and is < Quartz. The figure is always (+ ve). Very fine lamellar twinning characterises most of the crystals, suggesting that they are cut more or less parallel to the (001) face. The extinction angle varies from 2° up to 8°, the mean of the most examples being about 4°.

Some crystals cut parallel to (010) extinguish at 15° to the cleavage.

The felspar appears to be very close to pure albite or between Ab_{100}-$Ab_{95}An_5$.

Wavy extinction occurs locally, combined with a roll in the twin lamellae, and quite commonly the crystals are locally sheared and warped. Irregular lines of varied extinction are set up by incipient fracturing and straining by microscopic quartz stringers, and occasionally minute flakes of muscovite appear along the cleavage.

The albites appear in places to include patches of albite of different orientation to the host. Examination shows these to be crystal overlying or underlying the main crystals, and not inclusions.

An effect of the quartz intrusion into the albite is to develop minute patches of microcline in the latter. These patches are rare, marginal and invariably associated with intrusive quartz veinlets. They show cross hatching, and a refractive index less than that of the original, and enclosing albite. The figure is (+ ve), so that the amount of potash introduced cannot be great.

The quartz also shows two habits ; (a) Large allotriomorphic, much cracked plates of quartz, generally traversed by strings of minute bubbles. These crystals are generally smaller than the felspars in size, more rounded and equally reticulate of edge. They sometimes enclose felspar crystals. Undulose extinction is a frequent phenomenon.

(b) Granular interstitial quartz occurs commonly between the large quartz of crystals, but is far from general. It may also occur as veins in the felspar, or interstitially between felspar and quartz.

Small patches of muscovite occur associated with the granular quartz mozaics : It is always interstitial. Apatite appear to be practically absent. There is no trace of myrmekite.

A Rosiwal volumetric analysis gave the following figures :—

Albite	65·15
Quartz	30·07
Granular Quartz	4·66
Muscovite	0·12
	100·0

From this, the chemical composition was calculated approximately as follows :—

(a) the muscovite was ignored.

(b) the felspar was assumed to be Or, $Ab_{98}An$,

(c) the volume per cent of quartz was multiplied by 1·011, representing the ratio *sp. gr. quartz* to sp. gr. felspar (albite) $\frac{2{\cdot}65}{2{\cdot}62}$

(d) the resulting percentages were recalculated to a total of 100% giving

Quartz ... 35·0 }
Or, $Ab_{98}An_1$ 65·0 } % by weight.

	Calculated Composition	Chemical Analysis
SiO_2	79·9	77·95
Al_2O_3	12·8	14·04
Fe_2O_3	——	0·36
FeO	——	0·13
CaO	0·13	trace
MgO	——	0·35
Na_2O	7·5	6·33
K_2O	0·11	0·38
H_2O+	——	0·25
H_3O-	——	0·08
	100·0	99·87

In the Quantitative Classification this rock falls into 1. 3. 1. 5. Westphalose. Several analyses in this sub-rang are close to that given above, but none has as high a percentage of Al_2O_3.

Rock No. 1229, occurs *in situ* as a vein in the granodiorite at Rookery Cove, Penguin Point B, King George Land. This specimen consists essentially of quartz, with subordinate felspar (orthoclase with a very little plagioclase), and two micas—a little chloritized biotite, and a little muscovite. It is an *aplite*, with a very quartz rich graphic intergrowth structure. The felspar is interstitial.

The quartz shows a tendency to develop free faces where not in contact with quartz. The actual crystals have a very irregular shape, and numerous crystals show equal polarization colours and simultaneous extinction, suggesting granophyric relations.

The felspar is generally sericitized, except for the rather small quantity of plagioclase. Muscovite and chloritized biotite make up the remainder of the rock.

Rosiwal Analysis:—

Quartz	74·25
Felspar	22·19
Muscovite and Biotite	3·55
	100·0

i.e., 85% of the rock is SiO_2.

V. APPENDIX.

Petrographical notes on certain additional *types including granite (833A), Adamellite (690 and 469), Granodiorite (859) and aplite (472 and 221).

Rock No. 690 (*adamellite*), erratic, Cape Denison. This is a pink even-grained rock in which can be seen clear vitreous quartz, white plagioclase, pink orthoclase and a little biotite. The grain-size in hand specimen is about 3 to 4 mm.

The quartz is unstressed and contains many strings of gas-liquid inclusions.

The plagioclase is not weathered to any great extent. Many of the crystals are clear but others have a weathered nucleus surrounded by an unweathered exterior. The composition is $Ab_{75}An_{25}$. It is usually twinned on the Albite Law and occasionally on the Carlsbad Law. The albite twinning is regular but very closely spaced.

The potash felspar is microcline-microperthite. The microcline twinning is very well developed but as in the plagioclase it is on a fine scale. The crystals are also twinned on the Carlsbad Law. The sodic phase is scattered through the host as many fine parallel veinlets. The microcline is very slightly weathered and the sodic phase slightly more so.

Biotite is the only ferro-magnesian. It is now almost entirely altered to chlorite with epidote in the cleavage planes. Some less altered pieces show the pleochroism from light straw yellow to dark brown.

Magnetite is fairly abundant for an accessory. It is usually associated with the biotite but in large idiomorphic crystals which show it to be original.

An unusual feature is the presence of fluorite. It is easily distinguished by its low birefringence and its isotropic nature. Several of the grains are tinged with the purple colour which is so characteristic of fluorite. It is almost invariably associated with the biotite which is probably a fluorine bearing variety.

Apatite is not uncommon as small crystals enclosed in the biotite and plagioclase and more rarely in the other minerals. Many of the larger crystals contain long irregular inclusions running down the vertical axis.

There are in the rock some grains of a dark mineral with a high relief. They differ from zircon in being coloured and from monazite in extinction and closely resemble zenotime of other rocks.

Sphene is also present as large irregular grains and as wedge-shaped crystals.

The structure is allotriomorphic granular, although many of the plagioclase crystals show a tendency towards idiomorphism. The grain-size averages about 1·0 to 1·5 mm. with the quartz nearer the lower limit and the felspar about the higher.

*There were culled from the Expeditions extensive rock collection subsequent to the completion of the original report by Summers and Edwards. [Ed.]

A Rosiwal Analysis gave the following mineral composition:—

Quartz	32·7%
Plagioclase	31·1%
Microcline-Microperthite	34·3%
Biotite	1·0%
Magnetite	0·7%
Fluorite	0·1%
Apatite	0·1%

The rock is therefore an *Adamellite* or according to Johannsen's system* a Leuco-Granite, 126″P.

Rock No. 469 (*adamellite*), erratic, Cape Denison. This is a medium to coarse grained rock composed of clear vitreous quartz, white plagioclase, brownish pink orthoclase and a little black biotite.

The quartz extinguishes evenly and shows no sign of stress. It contains many strings of gas-liquid inclusions.

The potash felspar is slightly perthitic orthoclase. It is in large crystals which contain included grains of quartz and more rarely plagioclase, as well as the irregular veinlets of plagioclase which constitute the sodic phase of the perthite. It is slightly weathered.

The plagioclase is in this rock clearer and less altered than the orthoclase. It is commonly twinned on the albite law and gives an extinction angle of $-7°$ which indicates a composition of $Ab_{85}An_{15}$. Some of the crystals are zoned but the difference in composition is not great enough for measurement.

Biotite is the only ferro-magnesian. It is in short thick idiomorphic crystals with X = light straw yellow, Y = Z = dark greenish brown. It contains inclusions of apatite and zircon, the latter with fairly good pleochroic halos.

The accessories are magnetite, sphene, apatite and zircon. The magnetite is in idiomorphic crystals and is the most common of the accessories. The sphene is in irregular grains associated with the biotite and magnetite. Apatite is in small elongated grains and is not common. There are only a few crystals of zircon present.

The structure is allotriomorphic but differs from that typical of granites in one important respect. The orthoclase forms crystals which in the section attain lengths of from 3 to 5 mm. The plagioclase is in hypidiomorphic crystals which, although there are some big crystals, average only half the size of the orthoclase. The felspars are not dispersed evenly through the rock but are aggregated together to form a mesh. The areas between the mesh, 30% of the total rock, are filled with the quartz grains. These areas are from 5 to 8 mm. across and the quartz grains are 1 to 2 mm. in diameter. One result of this structure is that owing to the large orthoclase crystals and the large quartz aggregates the grain-size appears coarser and much more even in hand specimen than it really is. Also it is very difficult to get a representative section of the rock.

* Johannsen, A. "Petrography," University of Chicago Press.

The Rosiwal Analysis of the rock is as follows:—

Quartz	33·7%
Plagioclase	30·6%
Orthoclase	34·9%
Biotite	0·6%
Magnetite	0·1%
Sphene	0·1%

The rock is therefore an *Adamellite* or a Leuco-Granite, 126″P.

Rock No. 833A (*Granite*), erratic, Cape Denison. This is a rock even coarser in hand specimen than the preceding rocks. Pink orthoclase and quartz make up the bulk of the rock with subordinate white plagioclase and scattered rather small flakes of biotite. In one or two instances crystals can be seen with narrow rims of plagioclase.

The quartz is again free from all effects of strain but contains a large number of gas-liquid inclusions arranged in two sets of mutually perpendicular planes. The orientation of these planes is the same in every part of the rock.

The orthoclase is only very slightly perthitic and is rather difficult to distinguish from the untwinned plagioclase. As a rule it forms bigger crystals and is allotriomorphic whereas the plagioclase forms smaller crystals with a tendency to idiomorphism. It contains included crystals of quartz and plagioclase. It is not much weathered.

The plagioclase is in many places considerably weathered. It forms hypidiomorphic crystals which are often twinned on the Carlsbad Law in addition to fine lamellar twinning. Its composition is about $Ab_{75}An_{25}$.

The biotite is brown and pleochroic from X = light straw yellow, to $Y = Z$ = brown. The colour is not very intense even in the position of maximum absorption. It contains inclusions of lawsonite interlaminated with the biotite and of grains of apatite. Much of it has now altered to chlorite.

Sphene, magnetite and apatite are accessories. Magnetite is in crystals and grains and contains included crystals of apatite. The sphene is in grains associated with the biotite and as wedge-shaped crystals scattered through the rock. The apatite is in small crystal included in the felspar and biotite.

The structure is similar to that of 469 above although the grain-size is somewhat larger. It is impossible to judge the size of the felspars from the section but in hand-specimen the orthoclase is seen to average 8 × 4 mm. and to range up to 20-25 mm. in length. The plagioclase is of a smaller size and averages 2 to 3 mm. The quartz grains are again largely aggregated into certain areas which contain 10 to 20 grains from 1·5 to 2·5 mm. in diameter. The structure in this rock is very similar to that of a granite from South Australia that was described by the writer and which the present rock closely resembles.* A similar structure has been described by L. Hawkes† and he has suggested the term "Glomero-granular Structure."

* "The Murray Bridge Granite," Trans. Roy. Soc. S. Aus., vol. lviii, 1934.

† Min. Mag., vol. xxi., 1929, p. 163.

The Rosiwal Analysis gave the following result :—

Quartz	28·0%
Plagioclase	21·2%
Orthoclase	46·8%
Biotite	2·7%
Magnetite	0·7%
Sphene	0·5%
Apatite	0·1%

The rock is a *Granite* or in Johannsen's system a Leuco-Granite, 126″P.

Rock No. 859 (*Hornblende granodiorite*), erratic, Cape Denison. This is a medium grained reddish brown rock in which the black ferro-magnesians stand out. It is weathered to a fair degree as the felspar is greasy and opaque in appearance and light pink to very light green in colour.

The minerals visible in thin section are plagioclase, microcline, quartz, hornblende and biotite.

The plagioclase is all weathered and is in striking contrast to the unaltered microcline. Much of the alteration product appears to be micaceous but there is some epidote in recognisable grains. This alteration has not involved more than 10% of the substance of the felspar but has the effect of clouding it completely in most instances. The composition as made out from the less altered crystals is about $Ab_{55}An_{45}$.

The microcline is clear and fresh. It is twinned on the microcline and albite laws but the twinning is not so regular nor so conspicuous as is usual.

The quartz is clear and unstressed. It contains quite a few strings and planes of liquid-gas inclusions.

The hornblende is the more abundant ferro-magnesian. It has X = light greenish yellow, Y = green, Z = bluish green, $X < Y \leqslant Z$, The extinction angle $Z \wedge c$ is 25° and the mineral has the properties of pargasite.

The biotite is ragged and is in places slightly weathered to chlorite. It is pleochroic from light yellow brown to dark brown. There is some lawsonite interlaminated with the biotite in many instances.

The accessories are epidote, apatite, zircon and magnetite. The epidote is mostly associated with the hornblende and is apparently of secondary origin. The apatite is in small hexagonal crystals included in the hornblende and felspar.

The structure is a remarkable one in several ways. The plagioclase and hornblende both form idiomorphic crystals of from 1 to 3 mm. in length in the case of the felspar and from 0·3 to 0·6 mm. in the case of the hornblende. The quartz is subidiomorphic and is in crystals about a millimetre in diameter. The microcline is interstitial

between these minerals and is in optical continuity over large areas. Where the microcline is more abundant the structure is poecilitic (see plate IV., fig. 6) but in other places the microcline makes up only 10% of the rock, though still in optical continuity over considerable areas. The order of completion of crystallisation is zircon, apatite, hornblende and plagioclase, biotite, quartz and lastly microcline. The microcline seems to have commenced crystallisation after the plagioclase and hornblende had finished.

The mineral composition in volume percentages is as follows:—

Quartz	21·7%
Plagioclase	46·6%
Microcline	20·5%
Hornblende	6·1%
Biotite	4·9%
Magnetite	0·2%

The rock is therefore a *Hornblende Granodiorite.*

Rock No. 472 (*aplite*), erratic, Cape Denison. This is an aplite or a fine-grained granite. The bulk of the rock is fine grained but there are porphyritic crystals of pink orthoclase 2 to 5 mm. across set in a light pink holocrystalline groundmass of average grain-size about 0·4 to 0·6 mm. There are a few crystals of biotite scattered through the rock.

The quartz is in allotriomorphic crystals which are free from strain effects. It contains a considerable number of gas-liquid inclusions.

The potash felspar is a rather indefinite microcline. It is in the most instances so much weathered as to obscure the structure of the twinning. It is not perthitic but contains included grains of plagioclase.

The plagioclase is all weathered and clouded with minute micaceous flakes. The composition is about that of oligoclase but the degree of alteration precludes any precise determination.

There is both muscovite and biotite present in the rock. The biotite forms small flakes scattered through the rock and is now almost entirely altered to chlorite. The muscovite is in bunches of radiating crystals which belong to a late stage of crystallization as the muscovite is always xenomorphic against the felspar. It differs from the normal muscovite in that it is faintly pleochroic from colourless (X) to light golden yellow (Z).

There is in the rock a yellow mineral which cannot be determined. It is biaxial negative with a low optic axial angle. It is pleochroic from colourless (X) to rich golden yellow (Z). It forms bunches of prismatic crystals with a fair cleavage parallel to the elongation and with positive elongation. The refringence is high and the birefringence about 0·025. The extinction is inclined at a small angle to the long axis of the crystal.

The rock is also made notable by the presence of fluorite. This mineral is not common but there are one or two large grains. It has in one crystal the purple spots so characteristic of fluorite.

The other accessories are magnetite, haematite and calcite. The magnetite is primary but the other two are secondary. The haematite is in dendritic growths probably derived from the weathering of the felspar.

The structure is not the saccharoidal structure typical of aplites but is more like that of a fine grained granite. The quartz is of an average grain-size of 0·5 to 0·6 mm. The bulk of the felspar is of the same size but quite a few of the crystals are of a larger order and range up to 3 to 4 mm. in length. The structure is similar to that of 469 but is modified by the fact that the size of the quartz and felspar grains are more nearly uniform.

The Rosiwal Analysis is as follows:—

Quartz	36·4%
Plagioclase	29·4%
Orthoclase	32·2%
Biotite	0·6%
Muscovite	0·3%
Iron Ores	0·5%
Fluorite	0·1%
Accessories	0·5%

The rock is an *Aplite.*

Rock No. 221 (*aplite* intersecting *adamellite*), erratic, Cape Denison. This is a specimen showing an aplite vein in contact with adamellite. The adamellite is pink and coarse grained. The essential minerals are pink felspar and quartz. The aplite is fine grained and light pinkish brown. The aplite is obviously a vein intruded into the granite and although the rocks are most probably related they are dissimilar enough to warrant separate descriptions.

(1) The granite is seen in thin section to be composed of quartz, orthoclase-perthite, plagioclase and biotite.

The quartz is in large allotriomorphic crystals which show slight undulose extinction. It contains a few inclusions of small muscovite flakes and a considerable number of gas-liquid inclusions.

The potash felspar is an orthoclase-microperthite. The sodic phase is dispersed through the host as irregular branching veinlets. The orthoclase is weathered and slightly clouded by decomposition products. It contains included grains of quartz.

The plagioclase is weathered with the production of many small mica flakes. The exact nature of these flakes is indeterminable because of their minute size but it is probable that they represent some of the potash phase which although in solid solution at the time of crystallisation is now no longer in equilibrium under conditions of stress and low temperatures. This potash separating out crystallises in the form stable under the conditions—sericite. There are also included in the plagioclase many small irregular grains of fluorite about 0·01 to 0·02 mm., in diameter. Larger crystals are developed at the edges of the plagioclase crystals. It is notable that this fluorite is only developed (in this form) in the plagioclase and to a less extent in the orthoclase. The composition of the plagioclase is near that of pure albite as the extinction angle in the symmetrical zone is — 17°.

The biotite is now entirely changed to chlorite and haematite. The biotite was not regularly distributed through the rock but had grouped together in synneusis structure. The clots contain a dozen or so flakes. The chlorite is pleochroic from light yellow to a bright green and has a birefringence of about 0·010.

Associated with the biotite are fluorite and zircon. The fluorite is in large irregular masses often tinged with purple and showing the characteristic cleavage and relief. It is primary and has not resulted from the alteration of the biotite. The zircon is associated with pleochroic haloes which are as intense in the chlorite as they normally are in the biotite.

There are also a few grains of fluorite in the rest of the rock as well as the minute grains so plentiful in the felspars. The other accessories are magnetite and apatite, but neither mineral is at all abundant. The apatite is in small grains in the biotite and the felspar.

The structure is typically granitic, coarse allotriomorphic granular. This rock differs markedly from some of the other granites such as 833A and 469 in the fact that the quartz is of the same order of grain-size as the felspar. The average size of the grains as seen in the hand specimen is from 5 to 6 mm. and this is confirmed by the microscopic examination. The fluorite is in grains 0·2 to 0·4 mm. in diameter.

The order of abundance of the minerals is Orthoclase, Quartz, Plagioclase, Biotite, Fluorite, Magnetite, Apatite and Zircon.

The rock is an *Adamellite* or in Johannsen's system an Alaskite.

(2) The aplite shows intrusive relations towards the granite. In the hand specimen the contact appears to be a straight line but the thin section shows a contact that is far from straight. The granite apparently was already solid when the fissuring took place and so broke unevenly along the cleavage planes of the felspar and lines of weakness in the quartz. This resulted in a zig-zag line of contact. The figure, Plate IV, fig. 5, shows the contact of the aplite with a large perthitic orthoclase of the granite and serves to illustrate the difference in grain-size of the two rocks. It also shows the

quartz and felspar of the aplite moulded on and penetrating cracks in the felspar. Where the aplite is in contact with the quartz in the granite it has penetrated down cracks to a depth of several millimetres. In some places it is difficult to determine the exact junction of the two rocks. In several places the aplite appears to be of a slighter finer grain near the contact than it is further away.

The quartz is in allotriomorphic grains which show slight undulose extinction. It contains a moderate number of small gas-liquid inclusions.

The orthoclase is perthitic and similar to that of the granite. It is not much weathered.

The plagioclase is slightly more calcic than that of the granite and the maximum extinction angle of — 13° in the symmetrical zone gives a composition $Ab_{95}An_5$. It is not altered as is the plagioclase of the granite nor does it contain the minute inclusions of fluorite. It is less weathered than the orthoclase.

The biotite is, like that of the granite, completely altered to chlorite. It is in clots that are similar to, but smaller than, those in the granite.

Fluorite is again conspicuous and is usually associated with the biotite although it is also sporadically distributed through the rock.

The structure of the rock is not typically aplitic but resembles that of 472. The orthoclase is often large and ragged and tends to be poecilitic. The plagioclase is usually hypidiomorphic and the quartz is often aggregated together rather than evenly spread through the rock. The average grain-size is about 0·03 to 0·05 mm.

The Rosiwal Analysis gave the following mineralogical composition:—

Quartz	30·8%
Orthoclase	39·0%
Plagioclase	23·0%
Biotite	0·9%
Fluorite	0·3%

The rock is an *Aplite* or an Alaskite-Aplite 116'D.

DESCRIPTION OF PLATE IV.

Fig. 1. Granite, No. 200, showing quartz fractured and displaced: × 88, crossed nicols (J. S. Mann photo).

Fig. 2. Albite graphic granite, No. 604, showing quartz and albite: × 49, crossed nicols (J. S. Mann photo).

Fig. 3. Granodiorite, No. 746, showing myrmekite growth in granite: × 275, crossed nicols (A. B. Edwards photo).

Fig. 4. Granite, No. 223, showing microcline, quartz and chlorite: × 49, crossed nicols (J. S. Mann photo).

Fig. 5. Showing the contact of aplite and granite in rock No. 221. The portion of the figure to the left shows a large perthite individual of the granite: × 20, crossed nicols (H. E. E. Brock photo).

Fig. 6. Hornblende granodiorite, No. 859. The whole of the field of view is occupied by one individual of microcline loaded with poecilitic inclusions of quartz, plagioclase (speckled by alteration) and hornblende: × 14, crossed nicols (H. E. E. Brock photo).

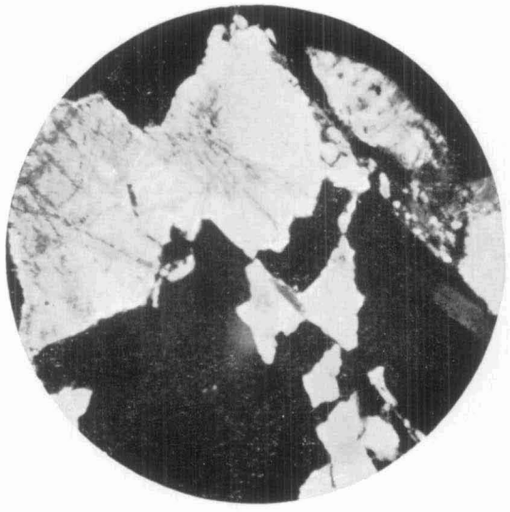

Fig. 1.

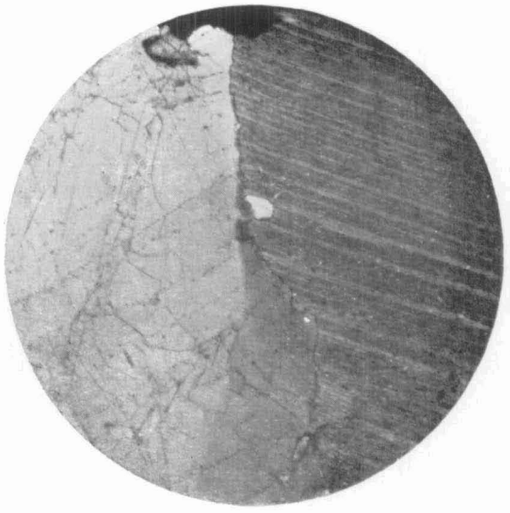

Fig. 2.

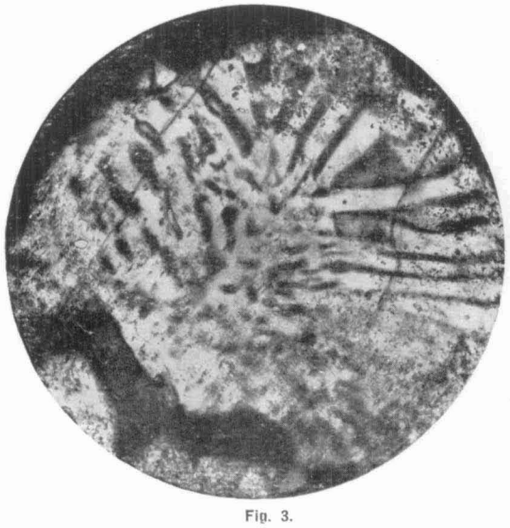

Fig. 3.

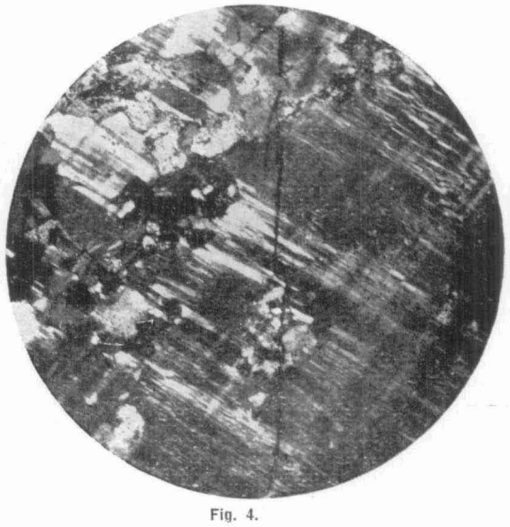

Fig. 4.

Fig. 5.

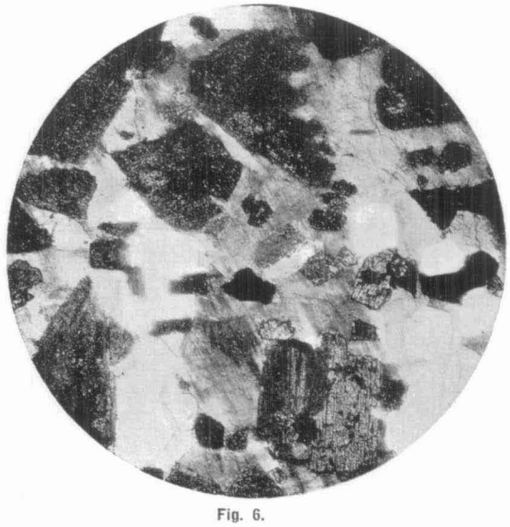

Fig. 6.

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