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PETROLOGY OF PRICES SPRINGS "GRANITE", N.T.

by

S. M. Hasan

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INTRODUCTION

Prices Springs "Granite" occupies an area of about 50 square miles. The granitic rocks crop out two miles west of Grove Hill, Northern Territory, on the North Australian Railway (Grove Hill is about 110 miles south of Darwin). Prices Springs "Granite" has an intrusive relationship with the Lower Proterozoic Golden Dyke and Burrell Creek Formations. The contact is invariably sharp. Hornfels has developed on the northern and western margins of the mass. The effects of thermal metamorphism on the sediments are rather limited, both in intensity and spread; only low grade metamorphic rocks are developed at or near the contact.

PETROGRAPHY

The Prices Spring "Granite" is medium to coarse grained pale grey rock. No directional structure or foliation has been noticed in the handspecimen or in the thin section. The rock is even grained, though at times some of the feldspars tend to be porphyritic. Commonly grainsize ranges between medium to coarse, but occasionally fine-grained types have also been noticed, as for example Specimen No. 3991.

Xenolithic materials are present; these are usually ellipsoidal and between one and two inches long. Under the microscope they show even-grained allotriomorphic texture. They are composed of potash feldspars (microcline and microcline-perthite), some amounts of plagioclase and quartz, hornblende and biotite. The accessories are apatite, zircon and sphene. Micrographic structure between quartz and feldspars is quite common. The xenoliths appear to be of igneous origin.

The granitic rocks from Prices Spring range in composition from adamellite to granodiorite, though adamellite is the most common type. Under the microscope these rocks show the typical hypidiomorphic texture and are found to consist of quartz, potash feldspars, plagioclase and biotite, with minor apatite, zircon, and sphene, and accessory muscovite, chlorite, fluorite, allanite, epidote, and iron oxides. Hornblende can also be included in the list of accessories, though it is present in only four out of seven thin sections examined.

Quartz occurs as medium- to large-sized anhedral grains. Undulose extinction is quite common. Some quartz grains have been cracked and granulated. In one section (3975) there is evidence that some recrystallisation has also taken place. Inclusions of feldspars, mica and hornblende are present. Besides there are also some minute needle-like inclusions and minute grains which are arranged in lines, without any parallelism. These minute inclusions appear like dust and are opaque under low magnification, but seen under higher magnification these inclusions are transparent; some of them have a pale violet colour. The needle-like inclusions are apatite, and the dust-like inclusions are probably liquid and gas.

Potash feldspars occur as orthoclase, microcline, microcline-perthite, and microperthite. Microcline and microcline-perthite phenocrysts have also been noticed. They occur as subhedral to euhedral crystals, measuring up to 6.25 x 3.22 mm. These phenocrysts have suffered very little alteration, and are usually fresh. Inclusions of plagioclase, quartz and mica are present.

Potash feldspars of the groundmass occur as medium- to large-sized anhedral to subhedral grains. Microcline is the most common type. These potash-feldspars have also suffered very little alteration. Microcline shows the typical cross-hatching, and the micro-perthites are usually vein or film perthites. At times slight undulose extinction is also seen. Common inclusions are quartz, plagioclase, and mica.

Plagioclase is oligoclase-andesine, and occurs as medium- to large-sized anhedral to subhedral grains. Plagioclase has generally suffered a moderate degree of alteration, but in some cases, even the traces of polysynthetic twinning are obscured. Traces of normal zoning have been noticed. Zoned crystals are heavily altered in the centre, and the more albitic outer zones are less altered. The usual alteration-products are sericite, kaolin and epidote, though rarely calcite has also been found in the fine alteration material. Inclusions of potash feldspars, quartz and mica are quite common. Myrmekitic intergrowth with quartz has been noticed, but is not very common.

Biotite occurs in medium- to large-sized flakes, which are strongly pleochroic, with X = pale straw yellow, Y = dirty brown, and Z = deep brownish red, with absorption X<Y<Z. Pleochroic haloes are common, and are strongly developed around inclusions of zircon. Biotite is usually fresh, but in some instances it has been chloritised. Inclusions of zircon, apatite, iron oxide, quartz are quite common. Epidote also occurs as inclusions, usually between lamellae of the biotite, where it forms elongated lense-like patches. Very thin films of opaque materials are commonly included along cleavage planes.

Hornblende occurs as small- to medium-sized anhedral to subhedral grains. Hornblende crystals are at times prismatic, but usually they are of very irregular form. The hornblende is moderately pleochroic, with X = dirty green, Y = bottle green, and Z = pale bluish green. Simple twinning has been noticed, and in some cases this simple twinning has been repeated several times, and resembles the polysynthetic twinning seen in plagioclase. Common inclusions are sphene, apatite and magnetite.

Apatite occurs either as small prismatic crystals and as hexagons, or as medium-sized irregular grains. It is mostly colourless, but a coloured variety has also been noticed, as in Specimen No. 3989. These coloured varieties are distinctly pleochroic from pale brownish grey to darker grey, with O greater than E.

Zircon occurs as small subhedral to euhedral crystals, usually as inclusions in biotite, where it is surrounded by pleochroic haloes.

The sphene is a coloured variety, and is moderately pleochroic from pale grey to honey coloured. It occurs in medium-sized grains, which are irregular in form. Some of these grains are as large as 2.22 x 2.02 mm. Inclusions of apatite, biotite and feldspar are present.

Occasional euhedral crystals of allanite are also seen. Fluorite usually occurs as small-sized irregular grains, both colourless and coloured (amethyst), are present.

Muscovite, chlorite, sericite, epidote, and calcite are of secondary origin, and occur as inclusions in other minerals.

The opaque accessories are magnetite, hematite, and ilmenite, and they occur as irregular grains, usually as inclusions in other minerals. Of the three ore minerals, magnetite is most common.

MODAL ANALYSIS

Six thin sections of the granitic rocks were selected for modal analysis, and the results together with the mean of the six analyses are given in Table 1. It will be noted from this table that hornblende is not present in all the thin sections examined, though it is present in a majority of them. The other point which is quite noticeable is the variation shown in the proportions of the major constituents, as, for example, quartz ranges between 18 and 35%, potash-feldspar between 15 and 47%, plagioclase between 20 and 41%, and biotite between 6 and 14%. The accessories show very little variation.

CHEMICAL DATA

Two specimens (1 and 2) of the granitic rock from Prices Springs were selected for chemical analysis, and the results, together with comparable analyses of McKinlay Granite (3 and 4), Cullen Granite (5 and 6), and Daly's (7) average of 47 Precambrian granites, are given in Table 2. It will be seen from Table 2, that the adamellites from Prices Springs and the McKinlay adamellites are very similar in chemical composition. Compared with the Cullen Granites, the adamellites from Prices Springs are lower in SiO_2, and higher in Al_2O_3, FeO, CaO, Na_2O and K_2O. Compared with Daly's average, these adamellites are low in SiO_2 and Fe_2O_3, and high in FeO and MgO.

ORIGIN AND CORRELATION

Field evidence and thin section examination suggest that Prices Springs "Granite" is of magmatic origin.

It has already been noted that the Prices Springs "Granite" can be chemically correlated with the McKinlay "Granite", and to a certain extent with the Cullen batholith. In Table 3 the modes of six analysed rocks from Table 2 are given.

It will be seen from this table that the percentages of quartz range between 25 and 38, potash feldspar between 23 and 42, plagioclase between 11 and 35, and biotite between 4 and 12. However, the variations in the mineralogical composition, as seen in the thin section, are no greater than might be expected in a rock of such coarse grain size.

TABLE 1.

	A.	B.	1.	C.	2.	D.	E.
Specimen No.	3990	3989	B3276	3991	3975	B0946	Mean
Colour Index	7.71	17.99	13.06	6.88	13.37	7.54	11.09
Quartz	17.82	25.75	27.84	28.49	30.93	35.01	27.64
Pot. Feldspar	47.62	15.40	33.30	30.43	35.28	29.38	31.90
Plagioclase	26.85	40.85	25.81	34.20	20.42	28.07	29.37
Biotite	6.58	13.79	10.28	5.91	12.04	6.08	9.11
Hornblende	0.49	1.67		0.32	Present		0.41
Non. Op. Acc.	0.51	1.92	2.09	0.58	1.23	0.68	1.17
Opaque Acc.	0.13	0.61	0.69	0.07	0.10	0.78	0.40
Total	100.00	99.99	100.01	100.00	100.00	100.00	100.00
Name and symbol according to Johannsen.	Adamellite 226'	Granodiorite 227'	Adamellite 226'	Adamellite 227'	Adamellite 226'	Adamellite 226'	Adamellite 226'

TABLE 2.

	1.	2.	3.	4.	5.		7.
SiO_2	67.90	69.92	67.04	67.72	72.94	71.30	71.06
Al_2O_3	15.81	15.08	16.42	15.51	13.70	14.57	14.10
Fe_2O_3	0.63	0.91	0.29	0.96	0.51	1.19	1.46
FeO	3.20	2.20	2.61	2.58	2.10	1.43	1.63
MgO	0.86	1.14	0.96	1.09	1.08	0.69	0.59
CaO	1.78	1.64	1.91	1.51	0.66	0.76	1.97
Na_2O	3.16	2.65	3.07	3.05	2.54	3.13	3.24
K_2O	4.19	5.18	5.31	5.37	4.93	5.68	4.50
H_2O+	0.91	0.77	1.40	1.08	0.90	Nil	0.69
H_2O-	0.02	Nil	0.02	0.03	0.04	0.87	
TiO_2	0.40	0.45	0.50	0.48	0.03	0.08	0.48
P_2O_5	0.16	0.18	0.22	0.19	0.09	0.08	0.10
MnO	0.08	0.05	0.10	0.09	0.04	0.06	0.18
Total	99.10	100.17	99.85	99.96	99.56	99.84	100.00

1. (3276), Adamellite, 3 miles east of Grove Hill, 200 yd. south of the track to Burrundie (Prices Springs "Granite"), Analyst: S. Baker.
2. (3975), Adamellite, Burrundie, Run 1. Ph. 54, Pt. 5. (Prices Springs "Granite"), Analyst: S. Baker.
3. (3968), Adamellite, Burrundie, Run 2, Ph. 75, Pt. 1, (McKinlay "Granite"), Analyst: S. Baker.
4. (3970), Ademallite, Burrundie, Run 2, Ph. 75, Pt. 3. (McKinlay "Granite"), Analyst: S. Baker.
5. (1133), Granite, Edith Creek crossing on Stuart Highway, (Cullen batholith), Analyst: S. Baker.
6. (3283), Granite, $\frac{1}{4}$ mile west of Goodparla track, 1 mile past the turn off. (Cullen batholith), Analyst: S. Baker.
7. Daly's average of 47 analyses of Precambrian Granites.

TABLE 3.

	1.	2.	3.	4.	5.	6.
Colour Index	13.06	13.37	12.69	14.47	6.61	5.15
Quartz	27.84	30.93	25.34	27.67	38.30	32.84
Pot. Feldspar	33.30	35.28	30.72	22.70	44.08	42.14
Plagioclase	25.81	20.42	31.25	35.15	11.01	19.86
Biotite	10.28	12.04	10.66	12.17	5.01	4.45
Hornblende	-	Present	-	-	-	-
Non. Op. Acc.	2.09	1.23	1.57	1.96	0.97	0.18
Op. Acc.	0.06	0.10	0.46	0.34	0.63	0.52
Total	100.01	100.00	100.00	99.99	100.00	99.99
Name and symbol according to Johannsen.	Ad. 226'	Ad. 226'	Ad. 227'	Ad. 227'	Granite 226'	Granite 226'

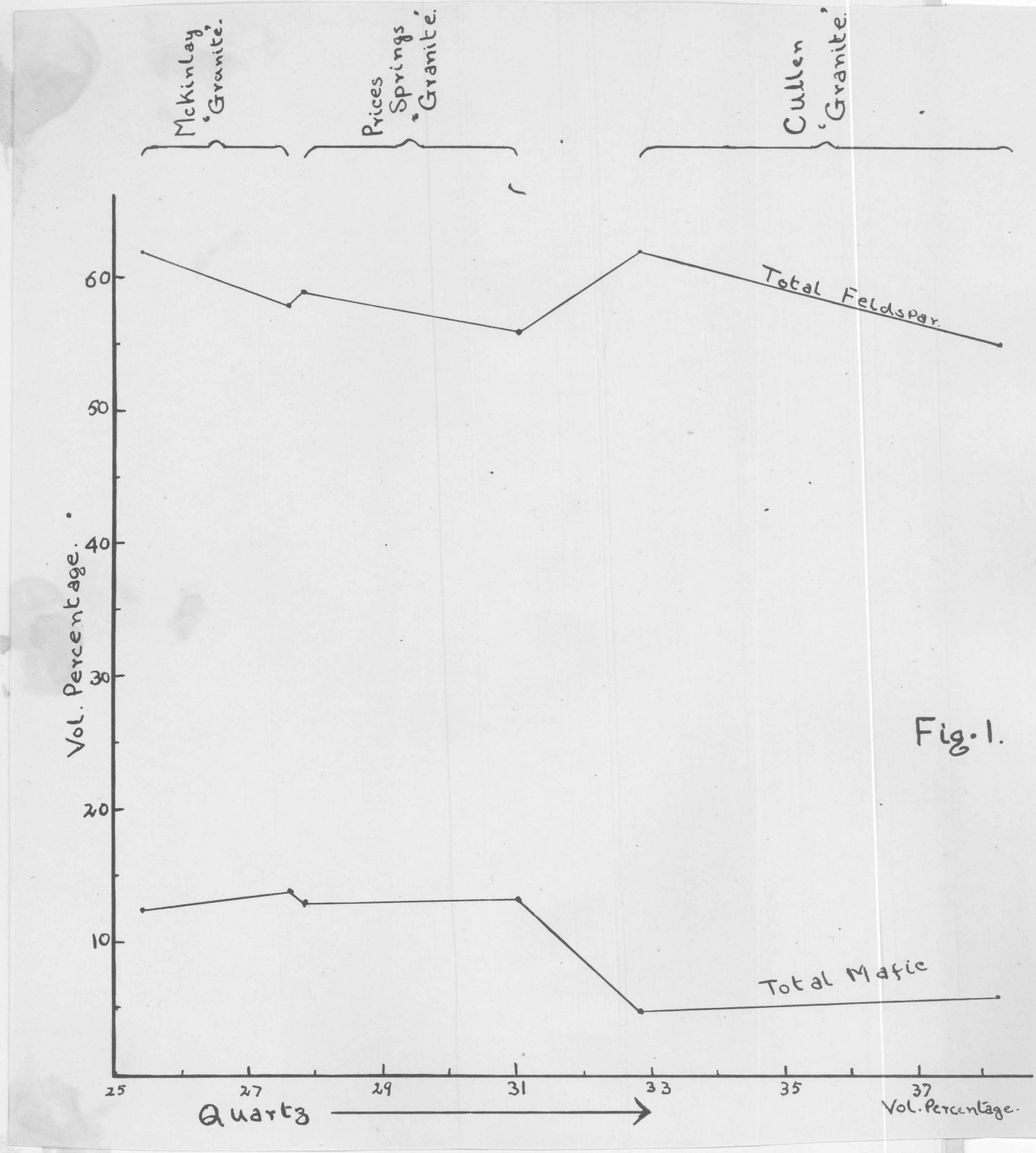

Fig. 1.

Fig. 1 - Mineral relationships.

Fig. 1 is drawn from data given in Table 3, and it is apparent from Fig. 1 that an inverse relationship exists between the total feldspar content and the total mafic content of the three "granite" masses.

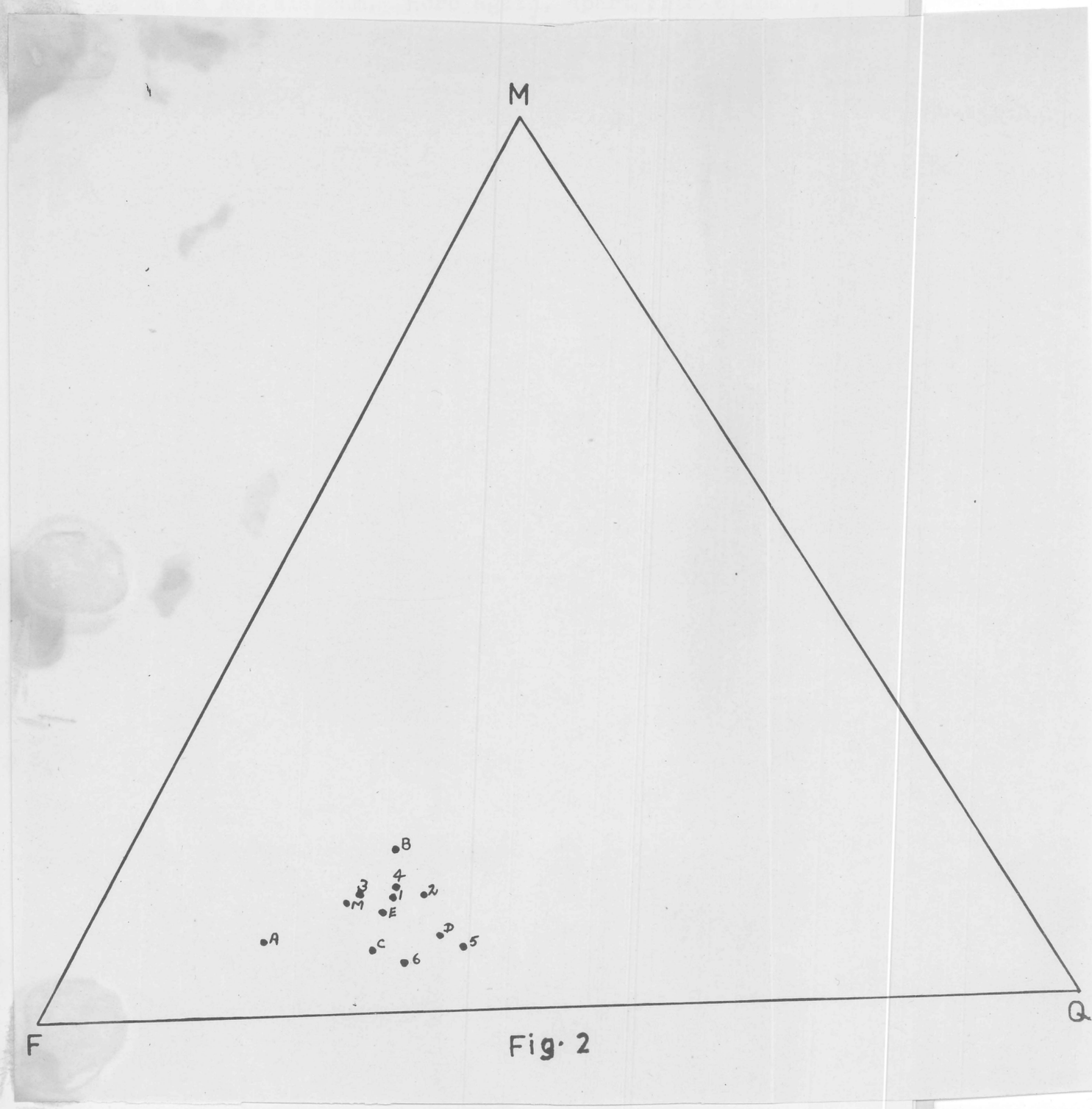

Fig. 2

Fig. 2 - Mineral composition diagram.

In Fig. 2, the six analyses from Table 3 are plotted in a M.F.Q. diagram (M = total mafic, F = total feldspar, and Q = quartz), together with other analyses of Prices Springs "Granite" (A, B, C, D, and E) for Table 1, and M the mean of six analyses of McKinlay "Granite".* The concentration of all the points (except A) in one corner of the triangle is quite noticeable.

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* "McKinlay Granite", S. M. Hasan, March 1958, in File No. 120NT/2.

The chemical analyses (Table 2) have also been plotted in Fig. 3 on an ACF diagram. Here again, apart from 6 and 7, all the rest of the analyses are very close to each other. No. 6 is the analysis of Cullen Granite and No. 7 is Daly's mean of 47 analyses of Precambrian granites, these two are also not very far away.

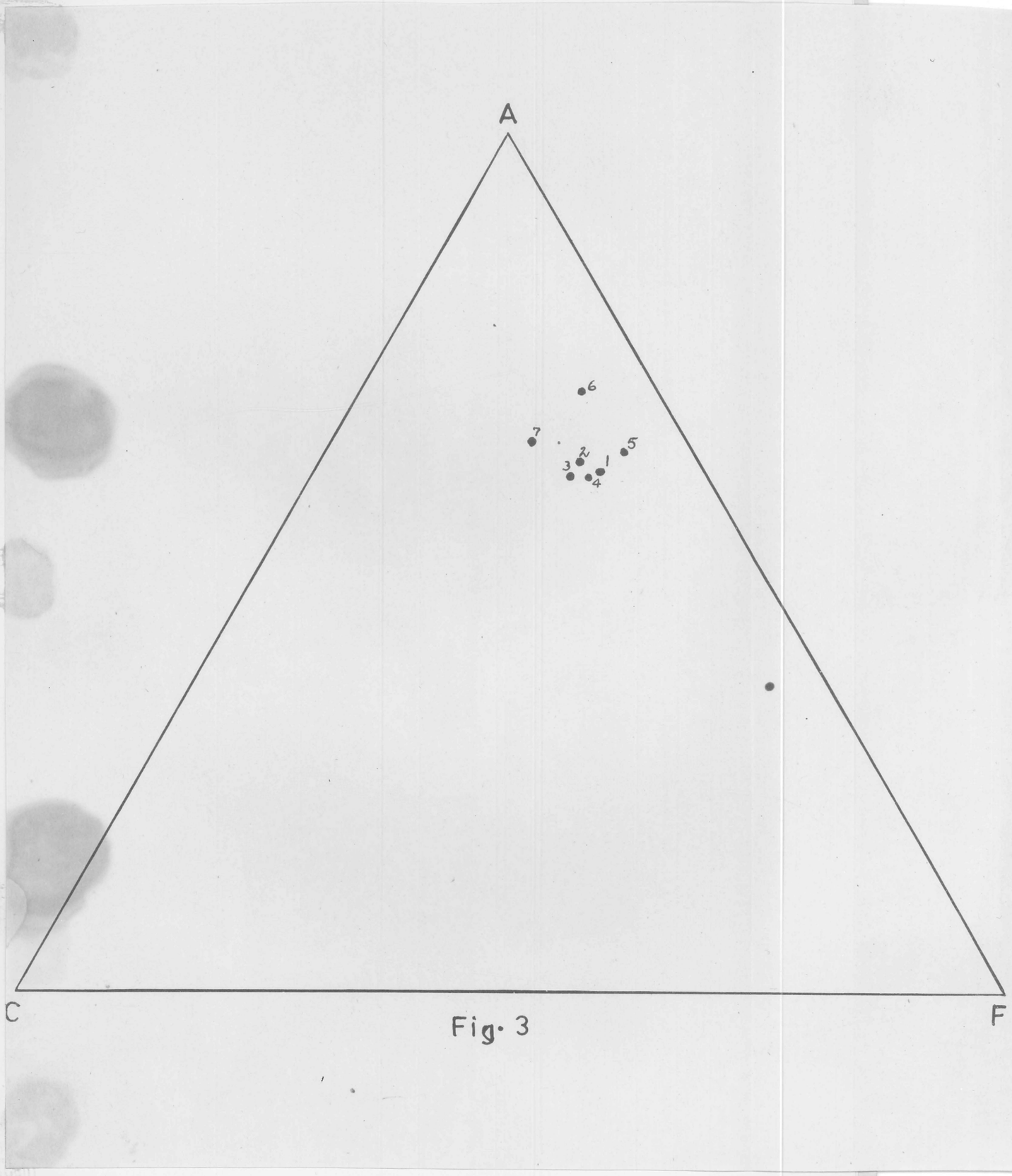

Fig. 3

Fig. 3 - Chemical composition diagram.

The above evidence together with field observations suggests that the Prices Springs "Granite" and McKinlay "Granite" are genetically related to each other, and furthermore that these two granite masses are in turn genetically related to the Gullen batholith.