J. Univ. Kuwait (Sci.) **11**, 1984

Petrographical and geochemical studies of small granitic intrusions in the peridotite sequence of Semail ophiolite, United Arab Emirates

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ABSTRACT

Small granitic intrusions occur in the peridotites of Al-Fujayrah, United Arab Emirates. They have been classified petrographically into two types: granodiorite, and granite which includes granitic rocks intermediate between granodiorite–biotite–muscovite granite and biotite–muscovite granite. The chemical analyses of these granitic rocks indicate that they have the composition of continental calc–alkaline suites and that they are characterised by high K_2O content. K/Ar dating indicates that they have an age of 92 ± 4 million years. It is believed that these granitic intrusions have intruded the base of the Semail ophiolite before the ophiolite emplacement.

INTRODUCTION

The Oman Mountains represent a distinct geological province. They comprise the world's largest and best exposed ophiolite complex known as the Semail ophiolite. The stratigraphy and general geology of these mountains have been investigated by many authors such as Lees (1928), Greenwood & Loney (1968), Allemann & Peters (1972), Glennie *et al.* (1973, 1974), Welland & Mitchell (1977), Gealey (1977), Smewing *et al.* (1977) and Searle & Malpas (1980). Seven rock units have been recognised in the Oman Mountains:

(a) A pre Mid-Permian basement of granitic and metamorphic rocks.
(b) The autochthonous Hajar Super-Group.
(c) The parautochthonous Sumeini Group.
(d) The allochthonous Hawasina.
(e) The allochthonous Haybi Complex.
(f) The Semail ophiolites.
(g) Maastrichtian and Tertiary non-orogenic sediments.

Units (d), (e) and (f) are tectonically emplaced above units (b) and (a) which are considered to belong to the autochthonous Arabian continent. Each allochthonous unit is separated by major thrust contact.

In the Al-Fujayrah area, complete ophiolite sequence of the Semail nappe and metamorphic rocks could be observed (Fig. 1). The geology of the area marked on the

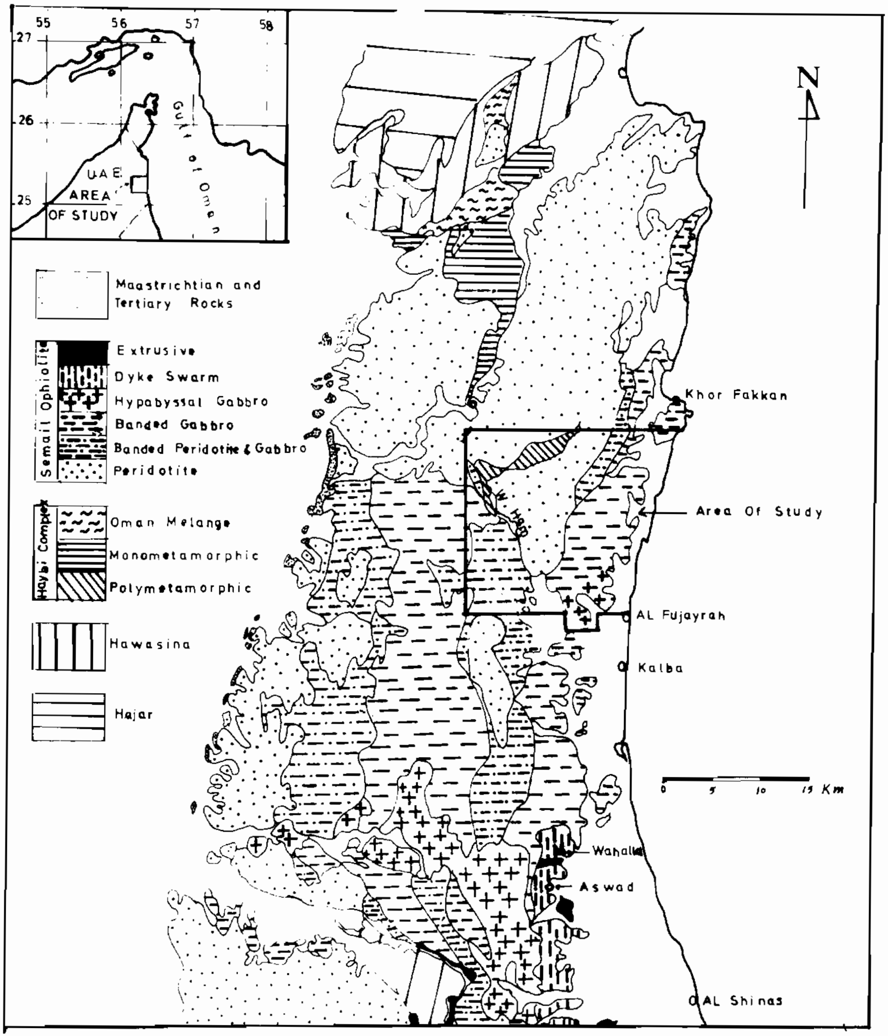

Fig. 1. Geological map of northern Oman Mountains showing location of the area of study and the different rock units (modified after Glennie *et al.* 1974).

map has been recently studied by Al-Sulaimi (1981). Granitic intrusions of different sizes and shapes occur in the peridotite of the Semail ophiolite east of Wadi Ham (Fig. 1). The purpose of this paper is to study the petrology and geochemistry of these granitic intrusions.

Small masses of granitic rocks of different shapes and sizes and with sharp contacts have been intruded into the peridotites (Fig. 2). These granitic intrusions or pods are distributed randomly in the ultrabasic rocks from the zone above the banded dunite harzburgite near the contact with the metamorphic rocks up to the zones near the gabbro-peridotite contact. The highest granite outcrop observed in the ophiolite sequence of the area of study is between the peridotite and the overlying gabbro contact. However, Greenwood & Loney (1968) recognised some of these granitic

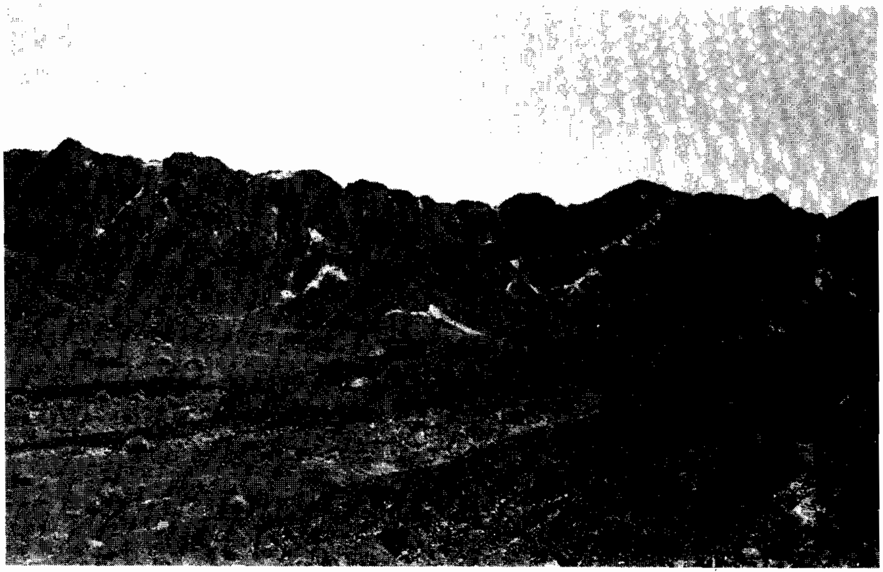

Fig. 2. A photograph showing the occurrence of granite intrusions in the peridotite sequence.

outcrops within the gabbroic rocks, and Abbotts (1978) described granitic intrusions in Masirah Island (S.E. coast of Oman) which cut all the ophiolite sequence of that island.

The granitic intrusions in the area of study are mainly distributed in an area of about 32 km^2 and form less than two volume per cent of the outcrop of that area. They occur as veins, dykes, sheets and irregular pods, cutting the ultrabasic rocks of the peridotite sequence. Moreover they range in width from a few decimetres up to 10 m and have lengths ranging from less than one metre up to 60 m. Some of these granites are locally zoned with quartz in the core of the intrusion surrounded by a feldspar–quartz zone, granitic rock and a selvage zone in contact with the peridotites.

PETROGRAPHY OF THE GRANITIC ROCKS

The granitic rocks in the area of study are characterised by small variations in mineralogical composition. They are composed mainly of quartz which ranges from 10 to 35 volume per cent, microcline from 15 to 35 volume per cent, sodic plagioclase from 10 to 30 volume per cent, biotite from 5 to 20 volume per cent and muscovite up to 10 volume per cent. All these minerals usually occur in the same rock in various amounts, with accessory minerals including epidote, chlorite, apatite, rutile, zircon and iron oxide. Undeformed granite usually shows coarse-grained equigranular to inequigranular texture in which the microcline forms large phenocrysts. Pegmatitic varieties are also observed in some zoned granites and these are composed only of quartz and feldspar minerals. Sheared and deformed granites show fine-grained textures. Petrographically and mineralogically, the granitic rocks can be classified according to Streckeisen (1976) (Fig. 3) into two main types. The first type can be regarded as granodiorite composed of quartz, biotite, predominant sodic plagioclase with a smaller amount of microcline. Muscovite occurs in accessory amounts in these rocks

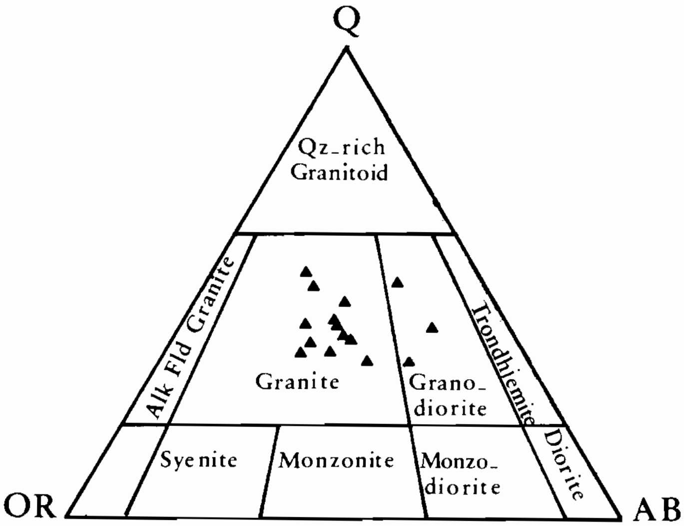

Fig. 3. Normative OR–Q–AB triangular diagram for the classification of the granitic intrusions in the peridotite of Al-Fujayrah (after Streckeisen 1976).

and usually never reaches more than one volume per cent. The second type is granite which is divided into two classes. Intermediate granite includes rocks composed of quartz, sodic plagioclase, microclines which usually form large phenocrysts, biotite and muscovite. In these rocks potash feldspar is usually more abundant than sodic plagioclase. The second granite class can be regarded as biotite–muscovite granite, composed of microcline phenocrysts with lesser amounts of sodic plagioclase, and rather more muscovite and biotite. Some of the granitic rocks show strong foliation indicated by the parallel orientation of micas and usually the foliation is parallel to the peridotite contact. The colour of the granitic rocks ranges from white leucocratic granites to grey coloured rocks depending on the amount of micas present.

The alkali feldspars occur as essential minerals in the granitic rocks and they are represented by microclines. The microclines in the granodioritic rocks show higher potassium content (Or 91·7–Or 96·5 mol%) than that in the granites (Or 86·4–Or 89·4 mol%) (Table 1). BaO was detected only in the granitic rocks and may reach up to 0·42 wt% in some microcline crystals of these rocks.

Microcline generally forms irregular crystals in the granodiorites with an average grain size of about 4 mm across. The microclines in the granites form large phenocrysts set in a coarse matrix of quartz, microcline, sodic plagioclase together with flakes of biotite and muscovite resulting in a porphyritic texture. The microcline phenocrysts either occur as large equidimensional crystals or as elongated polygonal grains up to 8 mm in length. Also in some cases, the microclines occur as small irregular crystals in equigranular granitic rocks. The microcline phenocrysts often include numerous small stringers and grains of rounded or irregular quartz crystals, small euhedral laths of plagioclase, small flakes of micas and minute prismatic apatite crystals resulting in poikilitic texture. In the pegmatites of some zoned granites the microclines form crystals of more than 1 cm in length. They are mainly intergrown with quartz forming graphic textures. Perthitic intergrowth, which is indicated by the occurrence of films of

Table 1. Potash feldspar composition in the granitic intrusions

	Granodiorite 75*			Mica granite 290			
	1†	2	3	1	2	3	4
SiO_2	64·77	64·80	65·14	64·82	65·11	65·07	65·33
Al_2O_3	17·94	18·39	18·33	18·46	18·31	18·42	18·18
Na_2O	0·37	0·90	0·72	1·32	1·14	1·26	1·46
K_2O	15·67	15·08	15·30	15·47	14·70	14·56	14·09
Ba_2O	0·00	0·00	0·00	0·24	0·28	0·42	0·36
	98·75	99·17	99·49	99·41	99·54	99·73	99·42
0 = 32							
Si	12·077	12·012	12·039	11·993	12·031	12·012	12·059
Al	3·945	4·021	3·994	4·027	3·988	4·008	3·958
Na	0·134	0·325	0·259	0·475	0·410	0·452	0·524
K	3·729	3·568	3·608	3·439	3·465	3·428	3·318
Ba	0·000	0·000	0·000	0·018	0·021	0·031	0·027
	19·887	19·928	19·902	19·955	19·917	19·931	19·888
Na	3·50	8·30	6·70	12·10	10·60	11·60	13·60
K	96·50	91·70	93·30	87·90	89·40	88·40	86·40

* = Sample no.
† = Analysis no.

oriented layers of sodic plagioclase in the microcline crystals, is also observed in the granitic rocks. In addition, most of the alkali feldspars show very well developed cross-hatch microcline twinning, although carlsbad twinning is not uncommon.

Sodic plagioclase occurs as a major mineral in the granitic rocks and is more abundant in the granodiorites. The plagioclase crystals in the granodiorites are more sodic than those in the granites and have the composition of oligoclase with An content ranging from 15 to 24 mol%. The granites have plagioclase crystals ranging in composition from oligoclase up to andesine with An content ranging from 20 to 39 mol% (Table 2). On the other hand, the pegmatitic granite contains more sodic plagioclase of albite composition with An content ranging from 9 to 11 mol%.

The plagioclase crystals occur in subhedral polygonal grains but due to recrystallisation they form irregular crystals in some granitic samples. They range in grain size from minute crystals of less than 0·5 mm in length mainly enclosed in microclines up to large crystals of more than 6 mm in length. In some pegmatitic varieties, the plagioclase is more than 1 cm in diameter. Sometimes small quartz and mica crystals are enclosed in the large plagioclase crystals. Very often quartz inclusions, which are curved and vermicular, are intergrown with the plagioclase crystals resulting in myrmekitic texture and usually these myrmekites penetrate the microcline phenocrysts in some granitic rocks. Kaolinisation and clouding of the sodic plagioclase crystals are common in the granitic rocks. The plagioclase in the granitic rocks is strongly zoned.

Both biotite and muscovite occur in the granitic rocks of the area of study and they form the only ferromagnesian minerals in these rocks. Muscovite is uncommon in the granodioritic rocks but they form essential minerals in the granites. Biotite is present in all the granitic rocks but is more common in the biotite–muscovite granites. The micas

Table 2. Plagioclase composition in the granitic intrusions

	Granodiorite 75*					Mica granite 290				Pegmatite 257				
	1†	2	3	4	5	1	2	3	4	1	2	3	4	5
SiO_2	62·46	62·05	62·73	64·74	61·69	58·12	58·47	59·71	63·54	65·54	65·84	66·50	65·92	66·69
Al_2O_3	23·47	22·37	23·47	22·15	23·73	26·25	26·12	24·77	22·46	21·05	21·14	20·95	20·68	20·80
CaO	4·92	4·12	5·00	3·17	5·18	8·28	7·98	7·00	4·10	2·29	2·43	1·89	1·97	2·02
Na_2O	8·98	8·96	8·84	10·04	8·71	7·11	7·07	7·72	9·17	10·21	10·23	10·53	10·46	10·68
K_2O	0·16	0·26	0·22	0·00	0·26	0·07	0·16	0·23	0·14	0·77	0·17	0·19	0·17	0·08
	99·99	97·76	100·26	100·10	99·57	99·83	99·80	99·43	99·41	99·86	99·81	100·06	99·20	100·27
							0 = 32							
Si	11·073	11·223	11·090	11·397	10·998	10·421	10·475	10·713	11·286	11·578	11·596	11·657	11·670	11·679
Al	4·906	4·770	4·891	4·597	4·988	5·550	5·517	5·240	4·704	4·385	4·391	4·330	4·317	4·296
Ca	0·935	0·799	0·948	0·598	0·990	1·592	1·532	1·346	0·780	0·434	0·459	0·356	0·374	0·379
Na	3·086	3·142	3·028	3·428	3·010	2·472	2·454	2·687	3·156	3·498	3·493	3·577	3·591	3·625
K	0·038	0·061	0·050	0·000	0·059	0·017	0·036	0·054	0·033	0·175	0·040	0·043	0·039	0·018
	20·040	19·997	20·009	20·023	20·048	20·053	20·016	20·042	19·961	20·071	19·980	19·965	19·991	19·999
Ca	23·10	20·00	23·60	14·90	24·40	39·00	38·10	32·90	19·70	10·60	11·40	9·00	9·30	9·40
Na	76·00	78·50	75·20	85·10	74·20	60·60	61·00	65·70	79·50	85·20	87·50	90·00	89·70	90·10
K	0·90	1·50	1·20	0·00	1·40	0·40	0·90	1·40	0·80	4·20	1·10	1·00	1·00	0·50

* = Sample no.
† = Analysis no.

range in size from small flakes of less than 0·2 mm in length up to large prismatic crystals 4 mm long. Usually, muscovite appears to have replaced biotite, especially in the late granitic rocks. In some cases the two mica crystals may be interlayered in the same grain. Sometimes biotite shows strongly pleochroic haloes especially in the granodiorites. The micas often show preferred orientations which result in foliated granites. The biotites show strong pleochroism from light brown to reddish brown. Moreover the biotites are commonly altered into green pleochroic chlorite, where the alteration usually takes place along the cleavage of the crystals.

Quartz is a very abundant mineral in the granitic rocks and sometimes it forms more than 30 volume per cent of the rock. It occurs mostly as anhedral crystals with irregular boundaries interlocked together. Quartz is characterised by undulose extinction in some sheared granites. In the pegmatitic varieties, simultaneous crystallisation of quartz and feldspar has produced graphic textures. Moreover quartz usually includes numerous clusters of hair-like needles of rutile crystals.

DEFORMATION OF THE GRANITIC ROCKS

Some of the granitic rocks show strong tectonic fabrics indicated by the elongation and the parallel orientation of quartz crystals. The micas are crushed and also oriented parallel to the plane of shearing. Large microcline crystals which poikilitically enclose small crystals of micas and quartz, are still observed. These large microclines are also elongated parallel to the shearing direction and occur as augen in a groundmass of fine grains of feldspars, quartz and mica. More shearing and granulation result in mylonitic rocks which are characterised by a preferred orientation of rock fragments parallel to the plane of shearing. Large crystals of plagioclase which show kink and deformation bands occur in a matrix of fine grained and crushed crystals. Late quartz veins also cut the sheared granitic rocks.

GEOCHEMISTRY OF THE GRANITIC ROCKS

Fifteen granitic samples have been selected for the geochemical analyses, to represent the granitic intrusions in the area of study. Five of these samples (J70, J71, J80, J83 and J85) have been analysed by Robertson Research International, Llandudno, Gwyned, N. Wales, while the rest of the samples have been analysed at the Department of Geology, University College of Wales, Aberystwyth. The rocks have been analysed for major and some trace elements. The granitic rocks are characterised by high normative Qz–Ab–Or (usually more than 80%) and high SiO_2 content ranging from 71 to 77·1 wt%. They are also characterised by a relatively low Na_2O content averaging 2·9 wt% and of high K_2O content (especially in the granite rock types) averaging 4·4 wt%. The average Fe_2O_3/FeO ratio is 0·81.

Silica variation diagrams have been constructed in Fig. 4 and they show typical trends for cal–alkalic rocks (Nockolds & Allen 1953; Smith 1970; Mueller & Saxena 1977) with Al_2O_3, TiO_2, FeO (Fe_2O_3+FeO), MgO, MnO, P_2O_5 and CaO showing negative correlation with SiO_2. Na_2O and K_2O show no definite trends. The Sr values are variable but the Rb content is related to the K_2O content (Fig. 5).

Total alkalis have been plotted against the SiO_2 content of the granitic rocks in Fig. 6 and all the rocks fall in the calc–alkali field of the diagram.

The data, when plotted on an AFM diagram on Fig. 7, show a trend produced by

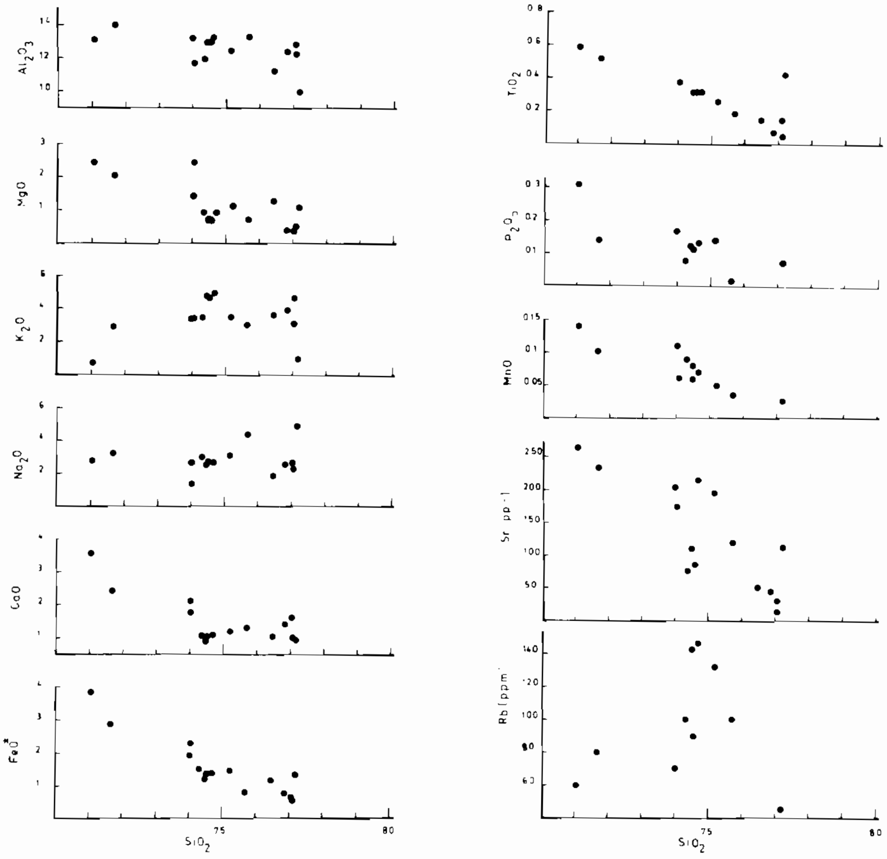

Fig. 4. Silica variation diagrams for the granitic intrusions.

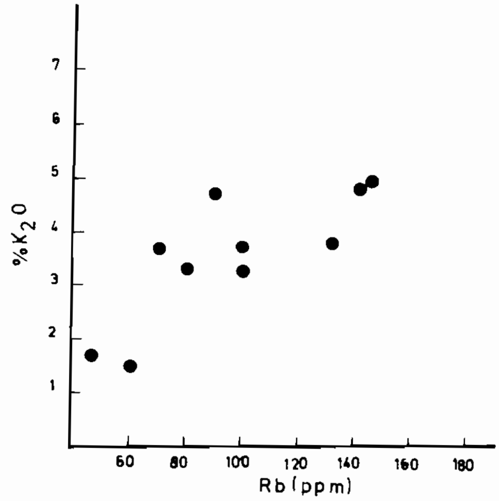

Fig. 5. K_2O/Rb relationship for the granitic rocks of Al-Fujayrah.

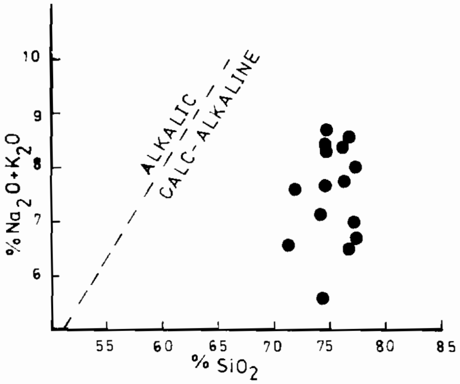

Fig. 6. Alkali/silica variation diagram for the granitic rocks; field boundary after Irvine & Baragar (1971).

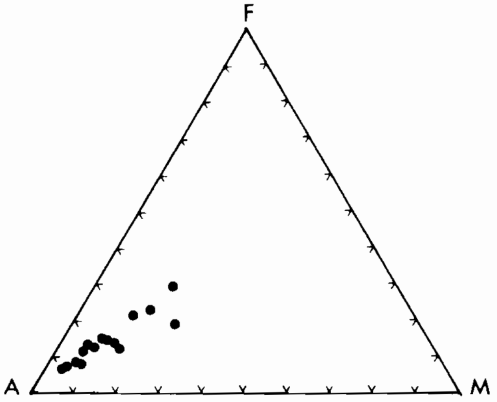

Fig. 7. AFM triangular diagram for the granitic rocks.

decreasing contents of MgO and total iron because the alkali values are approximately constant.

The analysed granitic rocks are plotted on Na_2O–K_2O–CaO diagram on Fig. 8. The trend of these granitic rocks is toward increasing K_2O content (from granodiorite to granite).

The analysed granitic rocks are plotted in the normative Q–Or–Ab triangular diagram (Fig. 9) where the minimum melting field of the granitic rocks and isobaric minimum (after Tuttle & Bowen 1958) are also shown in the diagram. It appears from this diagram that the granitic rocks had a maximum P_{H_2O} of about 2·5 kb. The three granodiorite samples are plotted close to the Q–Ab joining line.

K/Ar dating of some of the muscovite crystals in the granitic rocks of the area of study gives an age of 92 ± 4 million years (M.Y.) which is close to the age of Semail ophiolite (Glennie *et al.* 1974). Tilton *et al.* (1981) show that zircon from an amphibolite aureole beneath the Semail ophiolite is 95 ± 2 M.Y. old. Also K/Ar dating of these amphibolites give an age of 90 M.Y. (Lamphere *et al.* 1981). Therefore it appears that these granites must have been intruded before the ophiolite emplacement. Also field and petrographical studies of these granites indicate that they have been

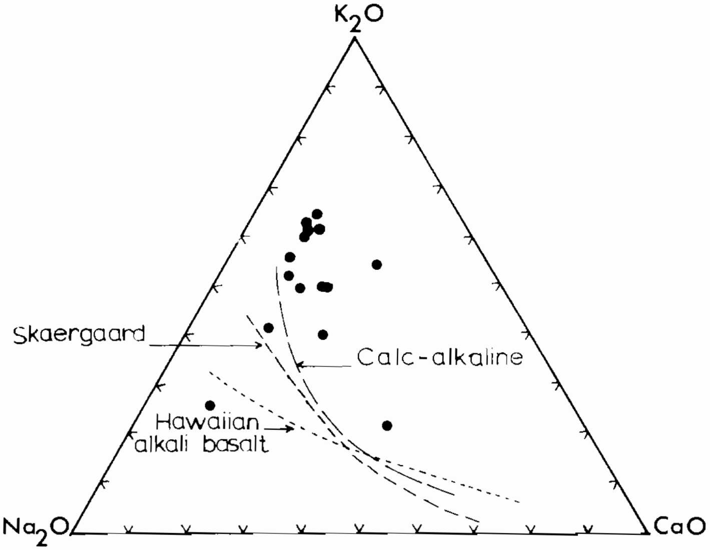

Fig. 8. Na_2O–K_2O–CaO triangular variation diagram for the granitic rocks. Trends of other magmatic suites are also presented in the diagram.

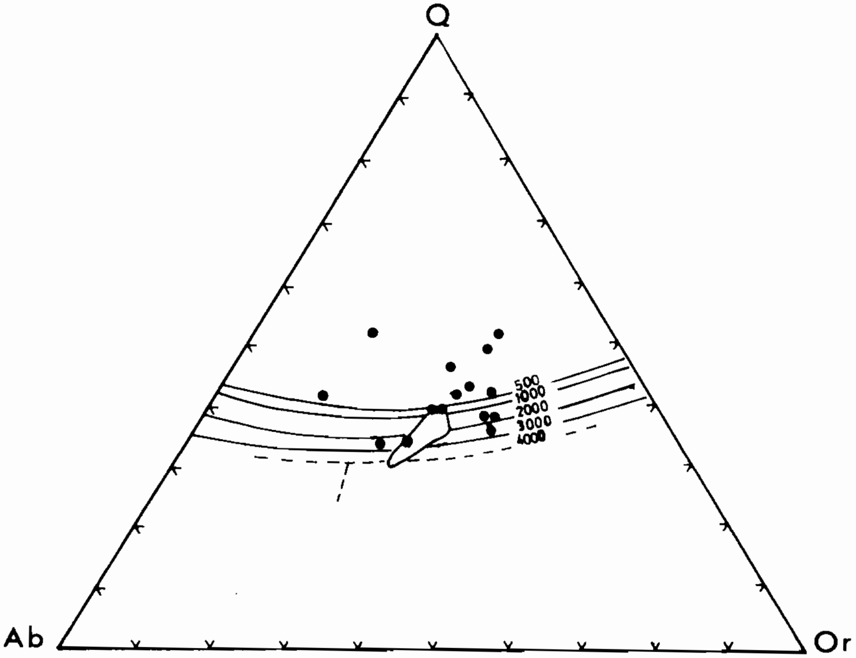

Fig. 9. Q–Ab–Or ternary diagram for analysed granitic rocks. Isobaric minima from Tuttle & Bowen (1958).

affected by the tectonic emplacement of the Oman ophiolite in that they are characterised by a strong tectonic fabric.

CONCLUSION

Small granitic intrusions occur in the peridotite of the Oman ophiolite in Al-Fujayrah. Petrologically, they are divided into two main rock types: (1) Granodiorite which is composed of quartz, biotite, perdominant sodic plagioclase of oligoclase composition and smaller amounts of microcline with Or of more than 91 mol%. Muscovite occurs in

Table 3. Whole rock analyses of the granitic intrusions

	Granodiorite			Granite			
	74*	75	258	113	205	252	76
SiO_2	77·10	75·64	71·00	74·40	74·25	74·45	71·60
TiO_2	0·44	0·19	0·60	0·32	0·25	0·32	0·52
Al_2O_3	10·00	13·45	13·15	13·00	12·02	13·00	14·05
Fe_2O_3	0·40	0·15	1·43	0·58	0·65	0·76	1·66
FeO	0·92	0·60	2·42	0·65	0·88	0·62	1·22
MnO	0·03	0·04	0·14	0·08	0·09	0·06	0·10
MgO	1·16	0·72	2·42	0·65	0·93	0·67	2·00
CaO	0·92	1·30	3·56	0·92	1·05	1·00	2·40
Na_2O	5·00	4·40	2·78	2·58	3·18	2·66	3·60
K_2O	2·00	4·00	1·79	5·80	4·50	5·68	3·98
P_2O_5	0·08	0·00	0·31	0·12	0·08	0·11	0·14
H_2O	1·30	1·22	1·20	1·00	1·20	0·63	0·70
Total	99·35	101·71	100·80	100·10	99·08	99·96	101·97
Cr	–	–	22	–	–	–	–
Ni	0	13	13	13	13	0	16
Co	51	88	57	30	36	36	48
Cu	24	10	147	78	65	113	75
Zn	28	45	122	61	38	47	95
Sr	113	118	265	110	75	85	236
Rb	45	100	60	142	100	90	80
Li	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–
Pb	*v*	*v*	*v*	*v*	*v*	*v*	*v*
Ga	*v*	*v*	*v*	*v*	*v*	*v*	*v*
K/Rb	369	332	248	339	273	523	413
C.I.P.W. Norms							
Q	37·99	30·84	36·48	34·44	34·74	34·36	27·73
Or	11·82	23·64	10·58	34·27	26·59	33·56	23·52
Ab	40·31	37·23	23·52	21·83	26·91	22·51	30·46
An	–	5·14	15·64	3·78	4·69	4·24	10·43
C	–	–	0·91	1·09	0·20	0·92	–
Di	3·24	1·00	–	–	–	–	0·44
Hy	2·35	2·05	8·52	1·95	3·15	1·76	4·97
Mt	–	0·22	2·07	0·84	0·94	1·10	2·41
Il	0·84	0·36	1·18	0·61	0·47	0·61	0·99
Ap	0·19	0·02	0·73	0·28	0·19	0·26	0·33

Table 3 (*cont.*)

	Granite						
	287*	289	290	J70	J71	J80	J83
SiO_2	74·60	73·95	75·10	76·40	74·00	77·00	77·00
TiO_2	0·32	0·38	0·26	0·15	0·40	0·15	0·05
Al_2O_3	13·35	13·25	12·59	11·30	11·60	12·90	12·30
Fe_2O_3	0·48	0·46	0·42	0·52	1·22	0·31	0·40
FeO	0·92	1·84	1·06	0·61	0·70	0·35	0·27
MnO	0·07	0·11	0·05	0·02	0·06	0·02	0·02
MgO	0·93	1·40	1·12	1·30	2·40	0·50	0·40
CaO	1·05	1·76	1·20	1·00	2·10	1·60	1·00
Na_2O	2·70	2·70	3·18	1·90	1·42	2·62	2·35
K_2O	6·00	4·43	4·57	4·60	4·20	4·10	5·70
P_2O_5	0·13	0·17	0·14	–	–	–	–
H_2O	0·98	0·54	0·78	2·05	1·80	0·35	0·33
Total	101·53	100·99	100·47	99·83	99·90	99·60	99·82
Cr	–	–	–	–	–	–	–
Ni	53	130	27	*s*	*s*	*v*	*v*
Co	27	44	42	*v*	*v*	–	–
Cu	117	198	54	*s*	*s*	*v*	*v*
Zn	62	76	31	–	–	–	–
Sr	216	205	198	50	175	30	15
Rb	146	70	132	–	–	–	–
Li	–	–	–	10	25	5	5
V	–	–	–	*v*	*s*	*v*	*v*
Pb	–	–	–	*v*	*v*	*v*	*v*
Ga	–	–	–	*v*	*v*	*v*	*v*
K/Rb	341	526	287				
C.I.P.W. Norms							
Q	32·25	34·74	34·69	43·42	41·59	11·79	38·69
Or	35·45	26·18	27·00	27·18	24·82	24·23	33·68
Ab	22·85	22·85	26·91	16·08	12·01	22·17	19·88
An	4·36	7·62	5·04	4·96	10·42	7·94	4·69
C	0·82	1·22	0·57	1·38	0·90	1·25	0·45
Di	–	–	–	–	–	–	–
Hy	3·21	6·06	4·05	3·77	5·98	1·48	1·17
Mt	0·70	0·67	0·61	0·75	1·29	0·45	0·58
Il	0·61	0·72	0·49	0·28	0·76	0·28	0·09
Ap	0·31	0·40	0·33	–	–	–	–

	Altered granite	
	J85*	101
SiO_2	76·80	63·10
TiO_2	0·07	0·57
Al_2O_3	12·50	14·73
Fe_2O_3	0·27	1·35
FeO	0·48	3·80
MnO	0·02	0·28
MgO	0·40	3·54
CaO	1·40	4·00

Table 3 (*cont.*)

	Altered granite				
	J85*	101		J85	101
Na_2O	2·62	6·18	C.I.P.W. Norms		
K_2O	4·95	2·52	Q	38·73	4·75
P_2O_5	–	0·26	Or	29·25	14·89
H_2O	0·35	1·30	Ab	22·17	52·29
Total	99·86	101·63	An	6·95	5·02
			C	0·29	–
Cr	–	36	Di	–	10·70
Ni	*v*	40	Hy	1·63	9·04
Co	–	25	Mt	0·39	1·96
Cu	*v*	85	Il	0·13	1·08
Zn	–	121	Ap	–	0·62
Sr	45	442			
Rb	–	40			
Li	5	–			
V	*v*	–			
Pb	*v*	–			
Ga	*v*	–			

* = Sample no.
v = <0·005% *s* = 0·005–0·05% – = not detected.

accessory amounts in the granodiorite. (2) The second rock type is the granite which has been divided into two classes. The first granite class is intermediate in composition between granodiorite and biotite–muscovite granite. The second granite class is the biotite–muscovite granite which is composed of microcline phenocrysts (Or 86·4–Or 89·4 mol%) with lesser amounts of sodic plagioclase ranging in composition from oligoclase up to andesine and rather more muscovite and biotite. Deformation and shearing of the granitic rocks are common. Chemically, the granitic intrusions have the composition of calc–alkaline suits with a tendency of increasing K_2O content from granodiorite to granite. K/Ar dating of these granitic intrusions gives an age of 92 ± 4 M.Y. Field and petrographical studies and K/Ar dating of the granitic rocks indicate that they have been intruded before the ophiolite emplacement.

ACKNOWLEDGEMENTS

This work has been financially supported by the Kuwait Institute for Scientific Research, which is greatly appreciated. Special thanks are due to Dr W. J. Phillips for his assistance in field work, reviewing the paper and constructive discussions.

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(Received 4 June 1983, revised 30 November 1983)

دراسات بتروجرافية وجيوكيميائية لصخور جرانيتية متدخلة صغيرة في تكوينات البريدوتيت في سماعيل افيوليت بدولة الامارات العربية المتحدة

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خلاصة

يقدم هذا البحث دراسة بتروجرافية وجيوكيميائية لصخور جرانيتية متدخلة في البريدوتيت في الفجيرة . قسمت هذه الصخور الجرانيتية بتروجرافيا إلى مجموعتين : الأولى صخور الجرانوديوريت والثانية صخور الجرانيت . وتنقسم صخور الجرانيت إلى نوعين : صخور لها تركيب معدني ما بين الجرانوديوريت وجرانيت البيوتيت ـ مسكوفيت ، وصخور من جرانيت البيوتيت ـ مسكوفيت . ولقد اتضح من التحاليل الكيميائية لهذه الصخور انها تتبع مجموعة الصخور فوق القلوية القارية . ومن تقدير عمر هذه المتدخلات الجرانيتية بواسطة البوتاسيوم/ارجون اتضح أن عمرها ٩٢ (± ٤) مليون سنة . ويعتقد بأن هذه الصخور تدخلت في الجزء السفلي لسماعيل افيوليت (البريدوتيت) قبل ازاحة الجسم الافيولوتي إلى مكانه الحالي .