

Geochemistry of some ultramafic and gabbroic rocks from the northern Oman Mountains, United Arab Emirates

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ABSTRACT

Ultramafic and gabbroic rocks of the Oman ophiolites crop out northwest of Al-Fujairah. This paper presents the geochemical characteristics of some of these rocks. They are distinctly enriched in MgO and depleted in silica, total iron, total alkalis and titania. Their variation diagrams indicate that they are more closely related to the komatiitic magma type than other magma types. However, the field criteria on which komatiites are primarily defined are completely lacking in the rocks of the present study. Thus, it is believed that they represent a distinct magma type among ophiolite complexes.

INTRODUCTION

The Oman Mountains constitute a distinct geographic and geologic province in the southeastern part of the Arabian Peninsula. The general geology of these mountains has been worked out by several authors, e.g. Lees (1928), Greenwood & Loney (1968), Allemann & Peters (1972), Glennie *et al.* (1974), Welland & Mitchell (1977) and Gealey (1977). Six rock units have been recognized in the Oman Mountains:

- F Maastrichtian and Tertiary non-orogenic sediments
- E The Semail ophiolites
- D The allochthonous Hawasina
- C The parautochthonous Sumeini Group
- B The autochthonous Hajar Super-Group
- A A pre Mid-Permian basement of granitic and metamorphic rocks.

During the Late Cretaceous, units C, D and E were tectonically emplaced above unit B. Unit A represents the continental basement for these sequences, and appears in two windows in the southern part of the mountain range.

The Semail ophiolites (Semail nappe) include six units, with a sheet of metamorphic rocks at the base, which may represent highly metamorphosed parts of Hawasina. These units are (Glennie *et al.* 1974):

- 6 Extrusive rocks, mainly spilites and basalts, with some pelagic sediments.

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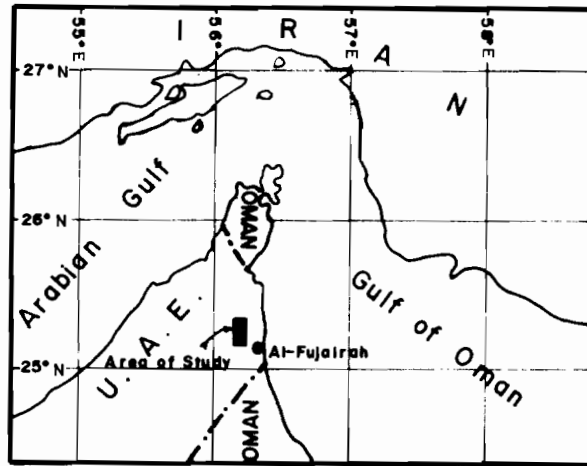


Fig. 1. Index map for the northern part of Oman Mountains showing the location of the studied area.

- 5 Diabase dyke swarms.
- 4 A complex zone of hypabyssal gabbroic rocks with prevalent ophitic texture.
- 3 A layered sequence of coarsely granular gabbroic rocks.
- 2 A complex transition between gabbros and peridotites.
- 1 Various serpentinised peridotites.

This paper presents a geochemical study of some ultramafic and gabbroic rocks from the northern part of the Oman Mountains (Figs 1 and 2), northwest of Al-Fujairah.

FIELD DESCRIPTIONS OF THE AREA STUDIED

In the study area, units 1 and 3 of the Semail ophiolites crop out (Fig. 2), where they are separated by a major fault. The geology of this area has been recently studied by Al-Sulaimi (1978). The ultramafic rocks are mainly composed of harzburgite and dunite, which are variously serpentinized. The gabbroic rocks include gabbro, eucrite, troctolite, olivine gabbro and norite, and uraltised gabbro, with minor amounts of quartz anorthosite and few bands of wehrlite, dunite and amphibolite. These gabbroic rocks are dominantly layered.

GEOCHEMISTRY OF THE ULTRAMAFIC AND GABBROIC ROCKS

The geochemical characteristics of the ultramafic and gabbroic rocks have been studied through the analyses of 20 samples of fresh rocks, comprising 13 gabbroic rocks (including uraltised gabbro and pegmatitic gabbro), six serpentinised peridotites and one quartz anorthosite. The results of the analyses, expressed as weight percent oxides, are given in Table 1.

COMPARISON WITH WORLD AVERAGES

Table 1 exhibits the chemical composition of most of the rock types of the present study, together with world averages of similar rock types (Lemaitre 1976) for compari-

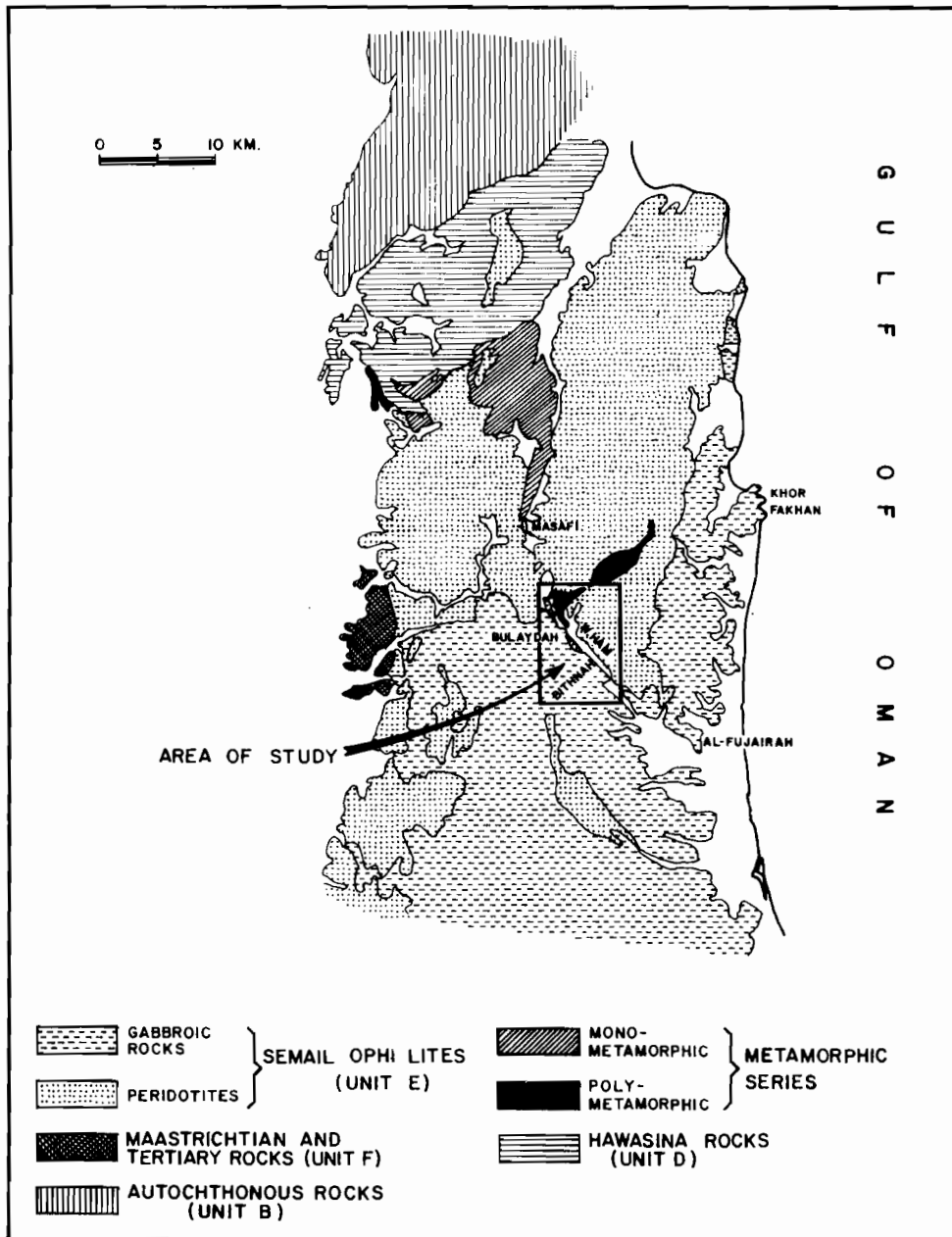


Fig. 2. Generalized geologic map for part of northern Oman Mountains showing the location of the studied area and the main rock units (modified after Allemann & Peters 1972).

Table 1. Chemical analyses of the rocks of the present study, and some world averages of similar rocks, after Lemaire 1976

Major oxides	J7	J18	J55	J57	J58	J59	J28	J30	J31	J39	J41	J42	J43	J25	J49	J40	J37	J26	J44	J45	1	2	3	4
SiO ₂	39.89	38.15	41.29	38.74	39.44	39.72	45.52	45.99	46.54	46.50	44.19	44.63	44.67	40.64	38.49	50.58	47.02	51.15	48.13	69.22	42.26	50.14	50.44	50.28
TiO ₂	0.006	0.005	0.008	0.009	0.009	0.008	0.10	0.094	0.12	0.10	0.063	0.082	0.066	0.045	0.22	0.22	0.13	0.64	0.26	0.53	0.63	1.12	1.00	0.64
Al ₂ O ₃	0.83	0.69	0.98	0.82	0.92	0.55	16.09	13.97	13.07	11.87	12.11	12.58	18.33	12.08	8.02	7.42	5.64	15.89	20.67	15.65	4.23	15.48	16.28	25.86
Fe ₂ O ₃	5.21	6.57	4.36	5.01	4.95	5.05	1.04	1.39	1.62	1.56	3.31	1.14	1.23	4.35	4.67	1.74	4.04	2.57	1.26	0.17	3.61	3.01	2.21	0.96
FeO	3.12	1.46	3.60	3.53	3.50	3.12	2.65	3.03	2.70	3.65	2.70	4.15	2.40	3.41	3.75	6.71	8.50	5.91	3.35	0.74	6.58	7.62	7.39	2.07
MnO	0.11	0.10	0.11	0.10	0.10	0.11	0.07	0.08	0.08	0.09	0.09	0.08	0.06	0.10	0.10	0.61	0.19	0.12	0.08	0.02	0.41	0.12	0.14	0.05
MgO	40.84	36.94	40.51	42.60	42.28	14.16	12.53	14.35	13.15	16.40	17.69	16.94	11.70	20.90	30.89	15.66	24.48	6.72	6.64	0.99	31.24	7.59	8.73	2.12
CaO	0.79	1.20	0.90	0.66	1.00	0.62	16.53	15.83	18.47	15.90	11.99	13.80	15.80	10.73	5.01	15.05	6.09	10.57	15.33	4.51	5.05	9.58	9.41	12.48
Cr ₂ O ₃	0.35	0.41	0.34	0.40	0.31	0.35	0.16	0.15	0.23	0.088	0.11	0.15	0.073	0.07	0.32	0.21	0.29	0.028	0.02	<0.02	—	—	—	—
NiO	0.28	0.28	0.29	0.32	0.29	0.28	0.04	0.04	0.05	0.031	0.054	0.045	0.023	0.06	0.20	0.04	0.12	0.013	0.01	0.006	—	—	—	—
Li ₂ O	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	—	—	—	—
Na ₂ O	0.01	0.02	0.01	0.01	0.01	0.01	0.50	0.41	0.40	0.30	0.25	0.37	0.50	0.22	0.48	0.34	0.17	2.83	1.71	6.60	0.49	2.39	2.26	3.15
K ₂ O	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.04	0.02	0.01	0.02	0.01	0.01	0.02	<0.01	0.01	<0.01	0.08	0.02	0.07	0.34	0.93	0.70	0.65
P ₂ O ₅	0.06	0.08	0.04	0.03	0.03	0.03	0.06	0.02	0.03	0.08	0.01	0.26	0.36	0.19	0.04	0.01	0.07	0.29	0.02	0.19	0.10	0.24	0.15	0.09
CO ₂	0.64	1.43	0.52	0.70	0.58	0.58	0.09	0.11	0.11	0.20	0.11	0.14	0.09	0.16	0.61	0.17	0.14	0.05	0.06	0.03	0.30	0.07	0.18	0.14
Cl	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	—	—	—	—
H ₂ O ⁺	7.57	11.50	6.89	6.68	6.31	6.31	3.69	3.67	3.02	2.60	5.56	4.70	3.57	6.15	6.90	1.46	3.03	2.66	2.36	1.08	3.91	0.75	0.84	1.17
F	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	—	—	—	—
S	0.03	0.03	0.04	0.03	0.03	0.03	0.01	0.01	0.02	0.05	<0.005	0.005	0.01	0.04	0.03	0.10	0.03	0.005	<0.005	<0.005	—	—	—	—
H ₂ O ⁻	0.57	0.92	0.52	0.63	0.59	0.59	0.86	0.52	0.61	0.39	1.50	0.53	0.75	0.66	0.77	0.17	0.46	0.35	0.23	0.24	0.31	0.11	0.13	0.14
Total	100.30	99.78	100.40	100.26	100.35	99.93	99.95	99.70	100.24	99.82	99.75	99.60	99.65	99.82	100.30	100.05	100.40	99.87	100.15	100.04	99.46	99.15	99.86	99.80

Rocks of the present study: J7-J59 peridotites, J28-J43 gabbros, J25 and J49 troctolites, J40 eucrite, J37 olivine norite, J26 unaltered gabbro, J44 pegmatite gabbro, J45 quartz anorthosite.
World averages of similar rocks (Lemaire 1976): 1. Peridotite; 2. Gabbro; 3. Norite; 4. Anorthosite.

son. The table shows that our rocks possess the following geochemical characteristics:
 (a) Their contents of silica, total iron, total alkalis ($\text{Na}_2\text{O} + \text{K}_2\text{O}$) and titania are lower than the average.

(b) The MgO content is distinctly higher than the average.

(c) The alumina content in the peridotites is low, whereas in the gabbroic rocks it is about normal, except in the eucrite and olivine norite where it is low. This low content of alumina is clearly the result of the high content of olivine and orthopyroxene.

(d) The CaO content in peridotites is low while in the gabbroic rocks it is high except in the olivine norite and some troctolites, also because of the high content of olivine.

(e) The MnO is low in the peridotites and varies greatly in the gabbroic rocks.

These general geochemical characteristics show that the rocks of the present study are more mafic than the world averages. They also reflect their high content of olivine

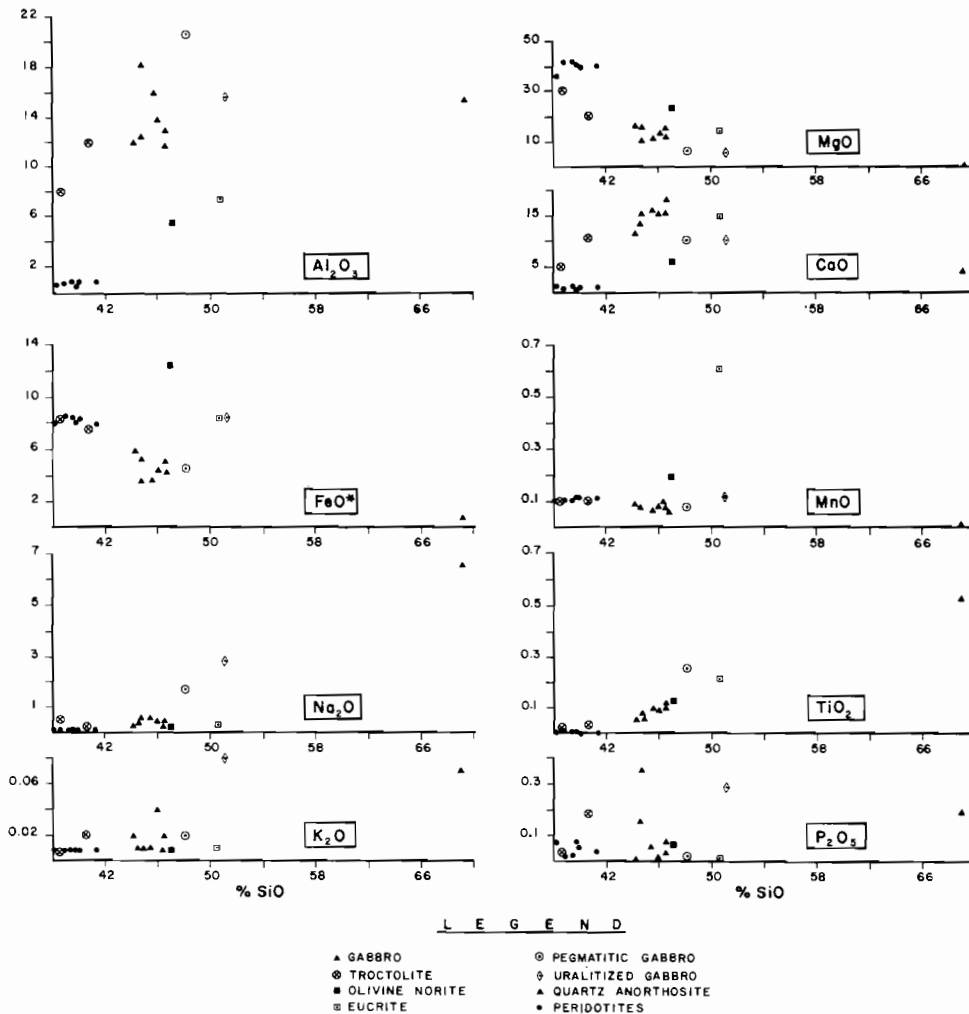


Fig. 3. Diagrams showing the variations in major oxides against the content of SiO_2 of the studied rocks.

and orthopyroxene. This supports the hypothesis of their origin from mantle material (Glennie *et al.* 1974).

VARIATIONS IN COMPOSITION

Since silica is the dominant contributor to the chemical variance, Harker diagrams have been constructed (Fig. 3) to show the variation of the various oxides against silica. FeO and Fe₂O₃ are calculated as total iron FeO*.

The diagrams illustrate that the peridotites show much less variation than the gabbroic rocks. The diagrams further illustrate the following variations: CaO and TiO₂ show positive correlation with silica, especially with respect to the gabbroic rocks; MgO and (FeO + Fe₂O₃) as FeO* show negative correlation; Al₂O₃, K₂O and P₂O₅ show considerable fluctuation without any special trend; Na₂O does not show any variation with silica, except in the pegmatitic gabbro and quartz anorthosite where it is enriched, especially in the quartz anorthosite.

Troctolites show the variation trends of the gabbroic rocks in most cases, although they have a much lower silica content. The quartz anorthosite also shows the same trends if taken as a final fraction.

The variation trends shown in the rocks of the present study are compatible with those expected in a comagmatic rock series except for Al₂O₃ (because of predominance of olivine) and Na₂O + K₂O which are very low to start with. Furthermore, the variation diagrams show a gap in composition between the peridotites and troctolites on the one hand, and gabbroic rocks on the other. Thus, the chemical variations of the rocks under consideration seem to be consistent with the hypothesis of Glennie *et al.* (1974), concerning the origin of these rocks. They originated by partial melting of mantle material, where peridotites represent the refractory residue and the gabbroic rocks are differentiated from the resulting melt. Troctolites represent cumulates of early formed crystals.

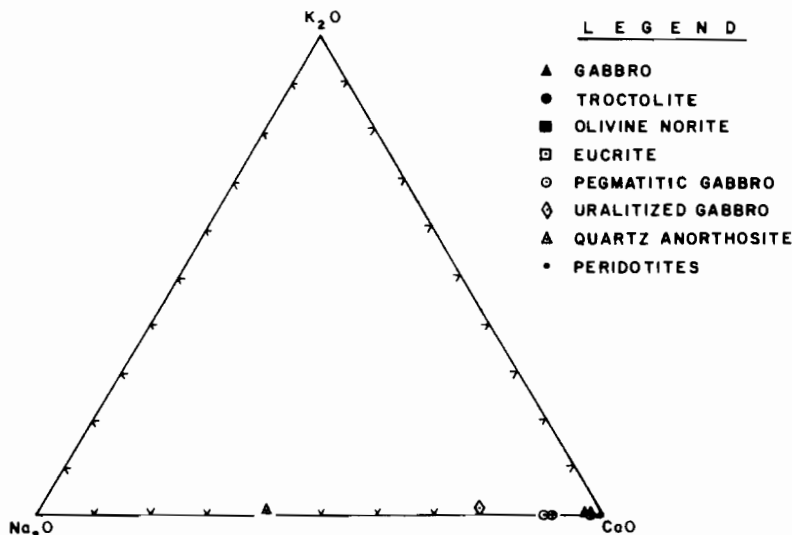


Fig. 4. A triangular diagram showing the relation between K₂O, Na₂O and CaO in the studied rocks.

Olivine norite, eucrite and peridotite plot almost at the CaO corner.

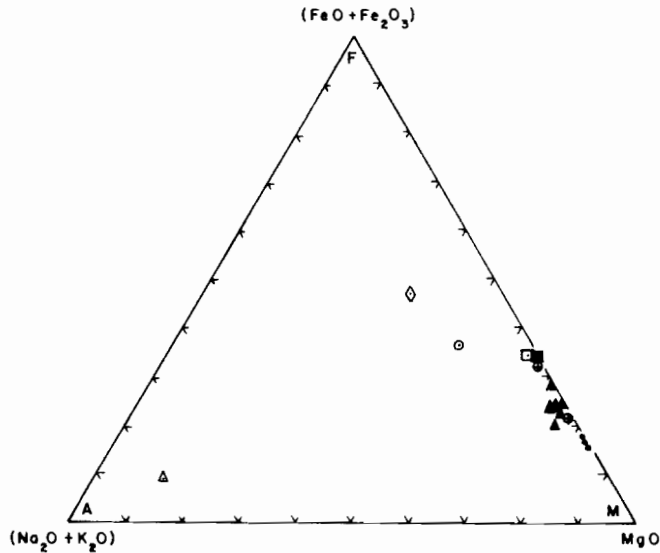


Fig. 5. AFM diagram showing the trend of the studied rocks.

The relationships between Na_2O , K_2O , CaO , MgO and FeO^* are shown in Figs 4 and 5. In Fig. 4 the contents of CaO , Na_2O and K_2O of the analysed samples were recalculated to 100% and plotted on the diagram. The figure shows a high deficiency in the potassium content of all the rocks. The ultramafics and gabbroic rocks are relatively enriched in CaO and impoverished in soda, while the quartz anorthosite shows definite enrichment in soda. This indicates that the original magma was highly deficient in K_2O and that the differentiation trend is towards enrichment in soda.

The contents of $(\text{K}_2\text{O} + \text{Na}_2\text{O})$, $(\text{FeO} + \text{Fe}_2\text{O}_3)$ as (FeO^*) and MgO of the analysed samples were recalculated to 100% and plotted on a triangular diagram (Fig. 5). The deficiency of total alkalis and total iron in the ultramafics and gabbroic rocks is clearly shown in the figure. The uralitised gabbro and pegmatitic gabbro show approximately equal amounts of total iron oxides and magnesia with slight enrichment in alkalis. The quartz anorthosite, on the other hand, is highly enriched in alkalis and impoverished in both magnesia and total iron. The enrichment in total alkalis in the quartz anorthosite is due to enrichment in soda only as shown by Fig. 4. The diagram suggests that the rocks under consideration show enrichment in iron from peridotites to gabbroic rocks first, then decrease in iron towards the quartz anorthosite. However, more analyses are needed to clarify this trend.

CORRELATION WITH SOME OTHER MAGMA TYPES

The chemical analyses of the rocks of the present study are plotted on diagrams which are commonly used to discriminate between various magma types. Fig. 6, after Peccerillo & Taylor (1976), illustrates the relationship and the distinction between four magma series in terms of K_2O and SiO_2 contents. The rocks under consideration lie within the tholeiitic area. Fig. 7, after Macdonald & Katsura (1964), which illustrates the relationship between SiO_2 and the sum of $\text{Na}_2\text{O} + \text{K}_2\text{O}$ has been widely used to distinguish between tholeiitic and alkalic series. All the rocks of the present area lie well

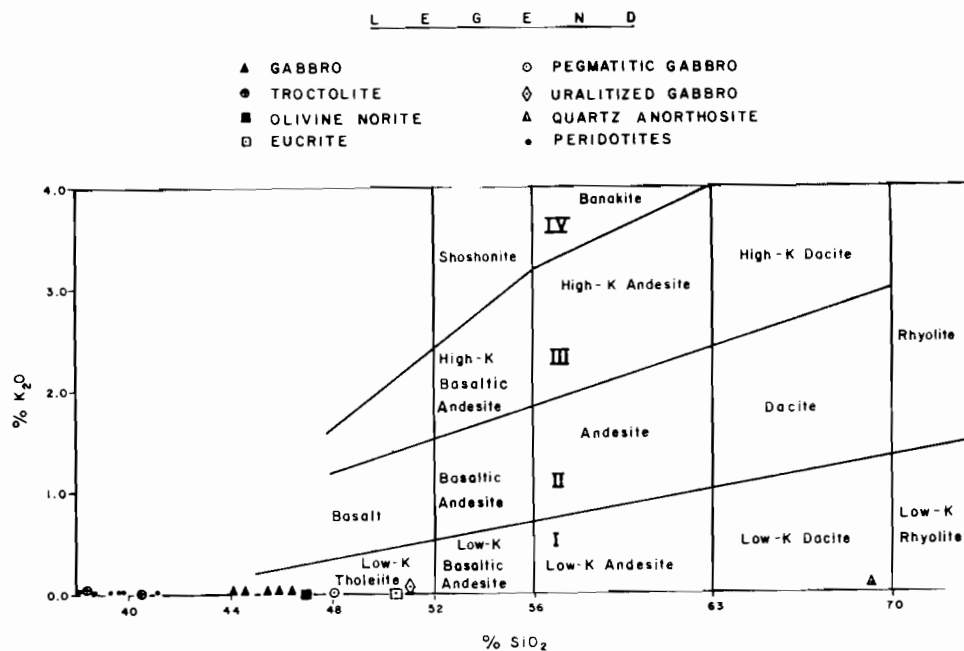


Fig. 6. Relationship between SiO_2 and K_2O contents for various magma series. (I) tholeiite, (II) calc-alkaline, (III) high-K calc-alkaline, (IV) shoshonite (after Peccerillo & Taylor 1976). The plots of the studied rocks are also shown.

within the tholeiitic field, except one troctolite sample which shows some enrichment in Na_2O , probably because of some albitisation. Kuno (1966), presented two diagrams to distinguish between three magma types (Fig. 8a) and their rock series (Fig. 8b). Again, the rocks of the present study fall well within the tholeiitic fields in Fig. 8, except the quartz anorthosite which is caused by the enrichment of feldspars.

CORRELATION WITH SOME OTHER MAFIC AND ULTRAMAFIC ROCKS

The mafic-ultramafic bodies fall into two major classes, based on their tectonic environment. These are: bodies emplaced in non-orogenic areas, which are themselves

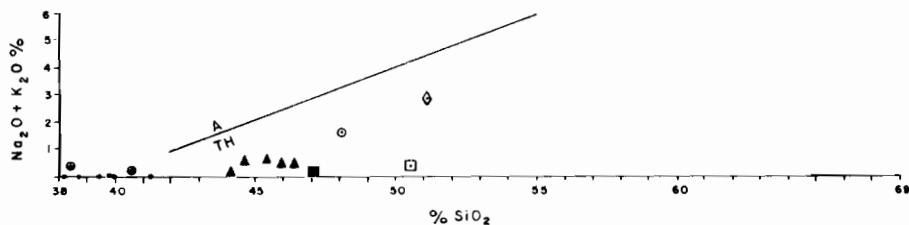


Fig. 7. $\text{Na}_2\text{O} + \text{K}_2\text{O}$ vs. SiO_2 diagram for the studied rocks. The boundary between tholeiitic basalt (TH) and alkaline olivine basalt (A) for Hawaiian rocks (after Macdonald & Katsura 1964) is also shown.

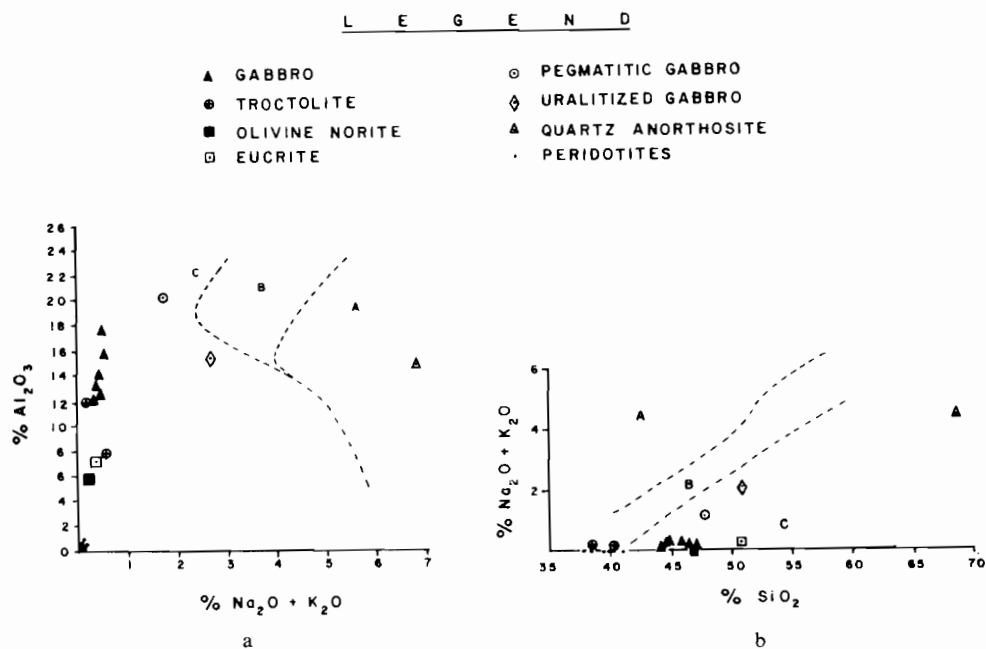


Fig. 8. Variation diagrams comparing the composition of the studied rocks with the composition of different magma types (a) and magma series (b). A, alkali basalt, B, high alumina basalt, C, tholeiitic basalt (after Kuno 1966).

undeformed or weakly so, and bodies which are emplaced in orogenic areas and which are themselves deformed. The first class has been classified by Naldrett & Cabri (1976) into:

- 1 Large stratiform layered complexes (e.g. Bushveld and Stillwater).
- 2 Sills and sheets equivalent to flood basalts (e.g. Palisades sills and Dufek intrusion, Antarctica).
- 3 Medium- and small-sized intrusions (e.g. Skaergaard and Rhum).
- 4 Alkalic ultramafic rocks in Ring complexes and Kimberlite pipes.

The mafic and ultramafic rocks of the Oman Mountains cannot be considered within this class of mafic and ultramafic complexes since they are emplaced within an orogenic belt and they are deformed (Glennie *et al.* 1974). Furthermore they show some salient chemical differences from the various groups of that class:

- 1 The composition of the large stratiform complexes as well as smaller ones like Skaergaard, tend to be mafic rather than ultramafic, although ultramafic zones are present. In the Oman Mountains in general, ultramafic rocks are much predominant over mafic rocks (Glennie *et al.* 1974).
- 2 The sills of plateau basalt are associated with tholeiitic basalts of plateau type which are characterised by a high K_2O content, while the rocks under consideration contain low K_2O and are not associated with tholeiitic basalts of the plateau type. The volcanic rocks in the central and southern parts of the Oman Mountains are pilitic pillow lavas (Glennie *et al.* 1974).

- 3 The last group is alkaline, which is not the case with the Oman mafic and ultramafic rocks.

The second class of the mafic and ultramafic complexes are those emplaced in orogenic areas. These have been classified by Naldrett & Cabri (1976) into two major sub-classes which are:

(a) Synvolcanic bodies: including two types; tholeiitic suite (e.g. Kakagi Lake and Bill River complex) and komatiitic suite (e.g. Munro–Dundonald area, Canada, and East Goldfields, Australia).

(b) Alpine-type bodies: which are portions of ophiolite complexes (e.g. Troodos and New Caledonia).

A third minor group includes the Alaskan type of ultramafics (Naldrett & Cabri 1976). This group is clearly different chemically from the rocks of the Oman Mountains.

The alpine type bodies are portions of ophiolite complexes which are emplaced in the solid state during tectonism. The ophiolites themselves are interpreted as portions of the oceanic crust and upper mantle which are characterised by a certain sequence (Naldrett & Cabri 1976; Glennie *et al.* 1974). In many respects, the mafic/ultramafic rocks of the Oman Mountains are ophiolites as defined by the Penrose Conference participants (1972), Allemann & Peters (1972), Glennie *et al.* (1974), Welland & Mitchell (1977) and Gealey (1977). However, ophiolite complexes display variable chemical characteristics.

In terms of volcanic rock series, Miyashiro (1975) has classified the ophiolite complexes into three main classes: class I, characterised by the presence of volcanic rocks of both calc-alkaline and tholeiitic series; class II, characterised by the presence of tholeiitic series volcanics only; and class III, characterised by the presence of tholeiitic and alkalic series volcanics. This difference between the chemistry of the first two volcanic series, to which the rocks of the present study may be related, can be shown on the plots of SiO_2 vs. $(\text{Fe}_2\text{O}_3 + \text{FeO})/\text{MgO}$ and $(\text{Fe}_2\text{O}_3 + \text{FeO})$ vs. $(\text{Fe}_2\text{O}_3 + \text{FeO})/\text{MgO}$ (Fig. 9 a and b respectively). On the diagrams, the trends of several well-studied series are also plotted. Boundary lines separating calc-alkaline and tholeiitic series in volcanic and related rocks are also shown in these diagrams. The rocks of the present study were plotted in these diagrams. From the plots (Fig. 9 a and b) it is evident that the rocks under consideration cannot be correlated with any of the trends because they plot towards the low $(\text{Fe}_2\text{O}_3 + \text{FeO})/\text{MgO}$ ratio and do not show many variations in that ratio.

Thus, at the present state of knowledge it is difficult to assign the rocks of the present study to any of the two ophiolite types of Miyashiro (1975).

The other major class of the orogenic mafic/ultramafic complexes of Naldrett & Cabri is the synvolcanic bodies, which are bodies contemporaneous with early 'eugeosynclinal' volcanism. They comprise two magma series: komatiites and tholeiites. These two classes have been distinguished on the basis of field occurrence and textures in several areas of the world (e.g. Canada, South Africa and Australia). From the chemical point of view, both magma series will plot in the tholeiitic field of diagrams such as those in Figs 6, 7, 8a and b. However, other chemical parameters distinguish between them.

Komatiitic magma is characterised by a low $\text{FeO}/(\text{FeO} + \text{MgO})$ ratio for a given SiO_2 content as compared to the tholeiitic magma. Furthermore, komatiites are

L E G E N D

- ▲ GABBRO
- ⊙ PEGMATITIC GABBRO
- ⊗ TROCTOLITE
- ◇ URALITIZED GABBRO
- OLIVINE NORITE
- ▲ QUARTZ ANORTHOHITE
- EUCRITE
- PERIDOTITES

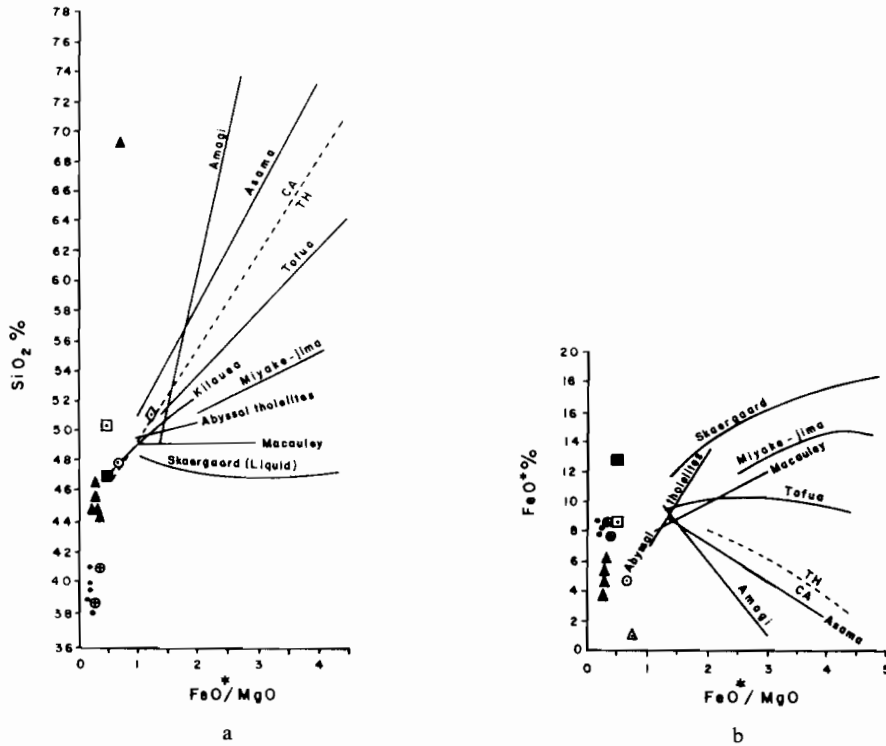


Fig. 9. Plots of the studied rocks on the diagrams which show the distinction between tholeiitic (TH) and calc-alkaline (CA) series in volcanic and related rocks (after Miyashiro 1975). The trends of some rock series are also shown.

usually lower in their TiO₂ content than tholeiites, and this is well shown in plotting TiO₂ versus MgO or SiO₂ respectively. The rocks of the present study are compared with these two magma types from well-documented areas. Fig. 10 shows the plot of Al₂O₃ vs. FeO*/(FeO* + MgO) of the studied rocks as well as the fields of rocks from other areas (Arndt *et al.* 1977). The rocks of the present study are clearly separated from both the tholeiitic and komatiitic fields. Furthermore, the peridotites show deficiency in Al₂O₃ while the gabbroic rocks show some enrichment in Al₂O₃. Figs 11 and 12 show the plots of TiO₂ versus SiO₂ and MgO respectively for the present rocks and those of the tholeiites and komatiites from several places. These also show that the rocks of the present study are well separated from both tholeiites and komatiites of the synvolcanic bodies. However, they are closer to komatiites from the chemical point of view. Therefore from the petrochemical point of view the rocks under consideration are closer to the komatiitic suite than the tholeiitic suite of synvolcanic complexes.

L E G E N D

- + Rocks of the present study
- Komatiites from Canada
- Australia
- ▲ India
- ▼ Radesia
- Barberton Mountain Land
- x Fe-rich Tholeiites associated with Komatiites from Canada & Australia
- u Proterozoic Komatiites from Ungava, Canada
- † Manitoba
- g Lower Palaeozoic Komatiites from Rambler, Newfoundland
- b Tertiary picritic Basalt from Baffin Bay

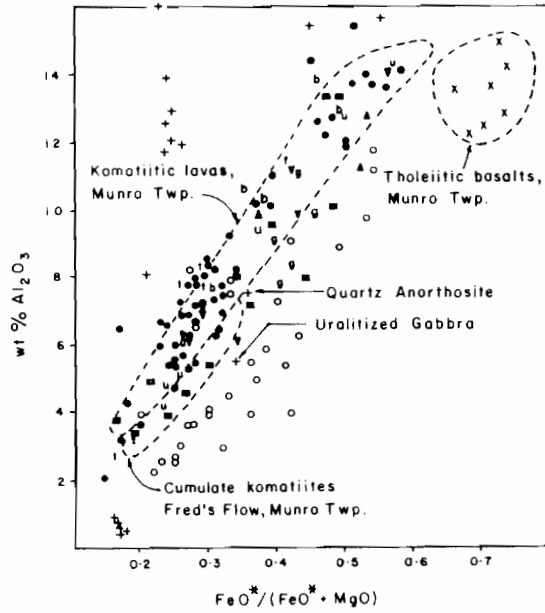


Fig. 10. Relation between Al_2O_3 and $\text{FeO}^*/(\text{FeO}^* + \text{MgO})$ for the studied rocks and rocks from other areas (after Arndt *et al.* 1977).

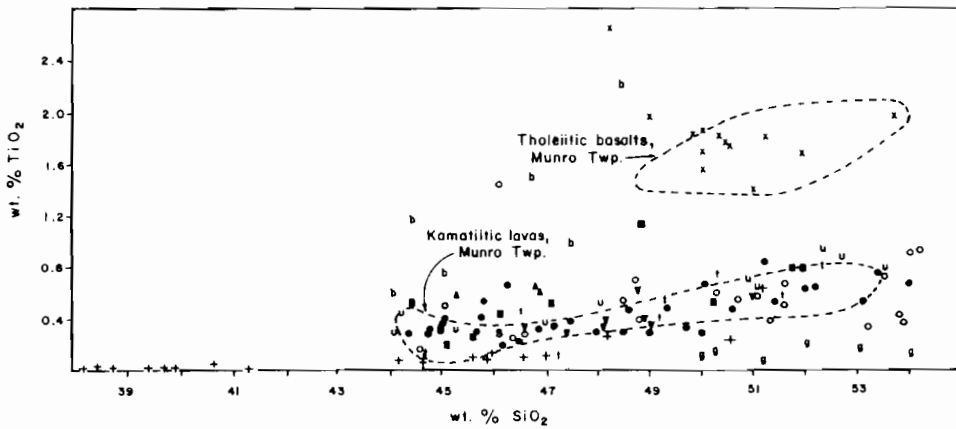


Fig. 11. Relation between TiO_2 and SiO_2 for the studied rocks and rocks from other areas (after Arndt *et al.* 1977). Legend as in Fig. 10.

L E G E N D

- | | |
|------------------|----------------------|
| ▲ GABBRO | ○ PEGMATITIC GABBRO |
| ● TROCTOLITE | ◇ URALITIZED GABBRO |
| ■ OLIVINE NORITE | △ QUARTZ ANORTHOSITE |
| □ EUCRITE | • PERIDOTITES |

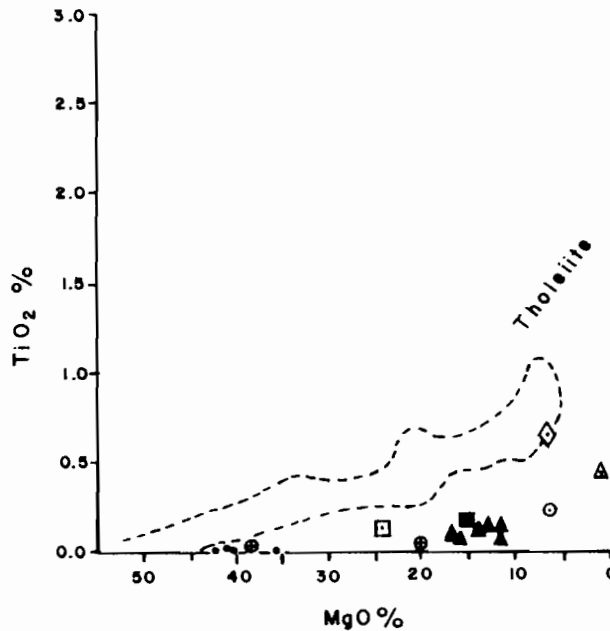


Fig. 12. Plot of TiO₂ versus MgO contents in the studied rocks. The area of komatiites from Yakabindie is shown by a broken line, and the area of some tholeiites is also indicated (after Naldrett & Cabri 1976).

Accordingly, these rocks, which are considered as part of an ophiolite complex, are chemically closer to the komatiitic magma than any other magma type to which they are compared in the present study. However, this is only a chemical similarity. Field criteria on which komatiites are primarily defined are completely lacking in the rocks of the present area. Thus, they probably represent a distinct magma type among the ophiolite complexes.

TRACE ELEMENTS

The content of some trace elements in the analysed rocks are shown in Table 2. These have been correlated with trace element contents of other mafic and ultramafic rocks from different areas (Table 3), where world averages of these elements in the basic and ultrabasic rocks are also included.

Table 3. Trace element contents of rocks from the Oman Mountains (ppm) compared with other mafic and ultramafic rocks. Data of the Skaergaard are from Wager & Mitchell (1951) and data of Caledonian plutonic rocks and the world averages are from papers by Goldschmidt and others which were reported by Wager & Mitchell (1951).

		Ultrabasic	Basic
Cr	Oman Mts.	2120-2804	137-2189
	Skaergaard	1500	230(120)
	Caledonian Average (G)	2500 (5000)	300 (500)
V	Oman Mts.	4-15	15-140
	Skaergaard	120	220(140)
	Caledonian	100	150
	Average (Troger)	(130)	(250)
Ni	Oman Mts.	2201-2515	79-1572
	Skaergaard	1000	120(170)
	Caledonian	700	200
	Average (G)	(4000)	(200)
Co	Oman Mts.	70-100	30-130
	Skaergaard	90	48(53)
	Caledonian	200	70
	Average (G)	(300)	(100)
Cu	Oman Mts.	17-29	10-100
	Skaergaard	100	67(130)
	Average (S & G)	(-)	(150)
	Oman Mts.	<10(245)	<10-180
Sr	Skaergaard	100	600(350)
	Caledonian	20	1000
	Average (Noll)	(-)	(180)

Table 2. Trace element contents (ppm) of the rocks of the present study

Sample no.	V	Cu	Co	Ba	Sr
J7	14	17	100	<10	<10
J18	15	20	86	<10	245
J55	10	25	72	<10	<10
J57	4	25	72	<10	<10
J58	4	29	70	<10	<10
J59	15	17	90	<10	<10
J28	78	52	35	<10	90
J30	140	66	58	<10	60
J31	80	100	40	<10	50
J39	90	66	50	<10	40
J41	72	76	72	<10	50
J42	92	70	66	<10	10
J43	90	66	37	<10	50
J25	18	56	64	<10	<10
J49	15	70	130	<10	15
J40	130	96	50	<10	40
J37	25	43	70	<10	<10
J26	370	19	38	<10	170
J44	140	10	30	<10	180
J45	49	1	19	<10	30

J7-J59 peridotites, J28-J43 gabbros, J25 and J49 troctolites, J40 eucrite, J37 olivine norite, J26 unalutised gabbro, J44 pegmatitic gabbro, J45 quartz anorthosite.

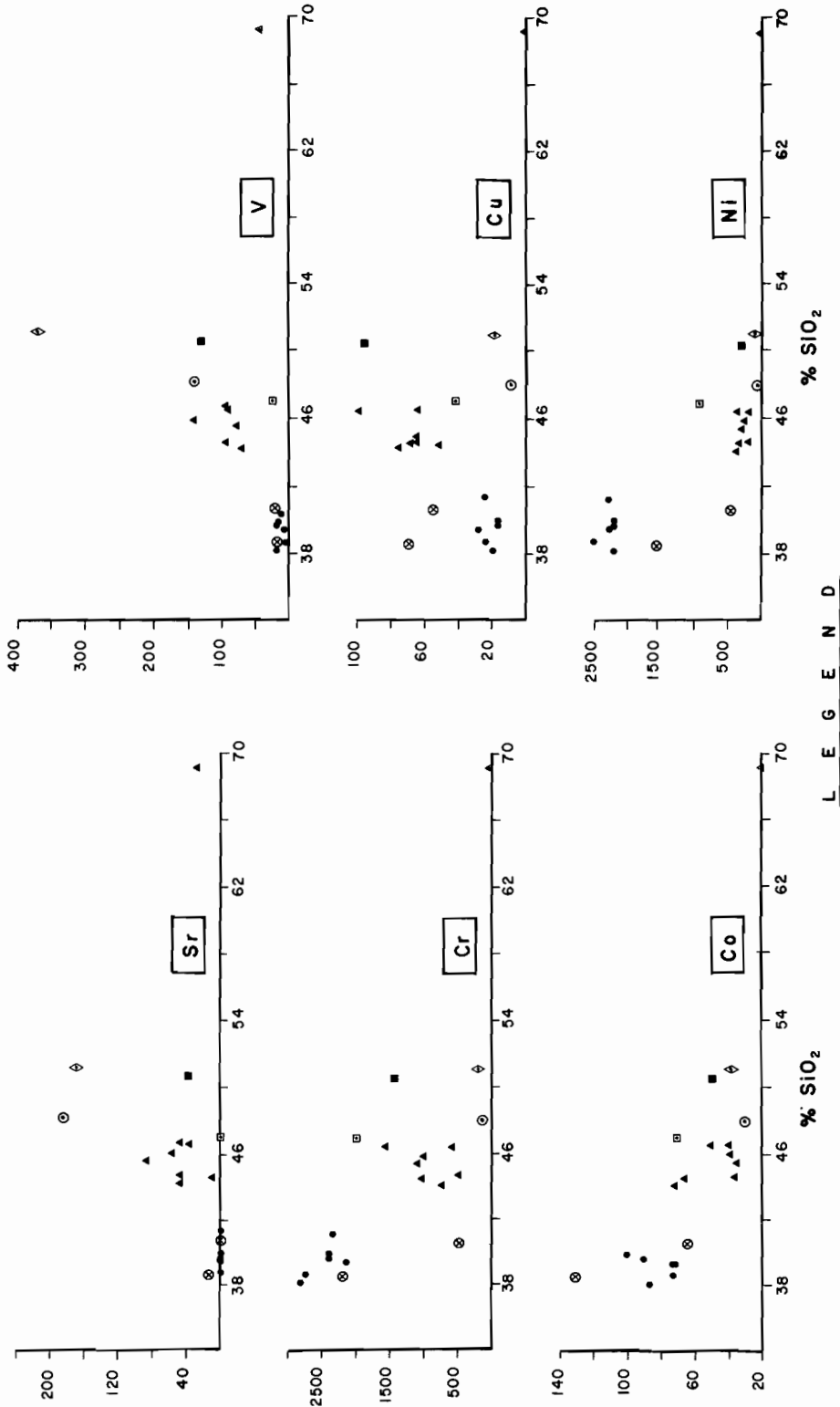


Fig. 13. Diagrams showing the variations in some trace elements (ppm) against the SiO₂ content of the studied rocks.

Variation diagrams have been constructed for the elements Sr, Cr, Co, V, Cu, and Ni vs. SiO₂ (Fig. 13). The diagrams illustrate that variation in peridotites and mostly troctolites is not great while variation is best shown by gabbroic rocks (excluding the uraltitised gabbro and quartz anorthosite). The diagram also shows that V and Cu are positively correlated with SiO₂ whereas Cr, Co and Ni are negatively correlated with silica. Cr shows considerable fluctuations but tends to increase in amount as silica increases.

CONCLUSION

The ultramafic and gabbroic rocks of the present study are a portion of an ophiolite sequence (Oman ophiolites). Their composition indicates that they are more mafic than world averages of mafic and ultramafic rocks, and they exhibit a distinct tholeiitic nature. When compared with other mafic and ultramafic complexes, they are more closely related to the komatiitic suite than the others. However, field criteria on which komatiites are primarily defined are completely lacking in the rocks of the present study. Thus, they probably represent a distinct magma type among the ophiolite complexes.

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جيو كيميائية بعض الصخور فوق المافية
والجابروية من شمال جبال عمان ، الامارات العربية المتحدة

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خلاصة

يختص هذا البحث بدراسة جيوكيميائية لبعض الصخور المافية وفوق المافية التي تشكل جزءا من حزام الايوليت بجبال عمان ، شمال غرب مدينة الفجيرة . تتميز هذه الصخور بأنها غنية بأكسيد المغنسيوم وفقيرة في السيليكا ومجموع الحديد ومجموع القلويات والتيتانيا ، وذلك اذا ما قورنت بالمتوسط العام لتركيب مثل هذه الصخور . ويشير التغير في التركيب الكيميائي لهذه الصخور الى أنها أقرب ما تكون الى الصهار الكوماتيتي من أى صهار آخر ، غير أن هذه الصخور العمانية تفتقر الى الخصائص الحقلية التي تميز الصخور الكوماتيتية ، ولهذا فانه يعتقد أن الصخور العمانية تشكل نوعا مميزا من الصهارات بين مجمعات الايوليت .

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