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Petrography of the Alkaline-Igneous Complex from Michni (Mohmand Agency), N.W.F.P, Pakistan

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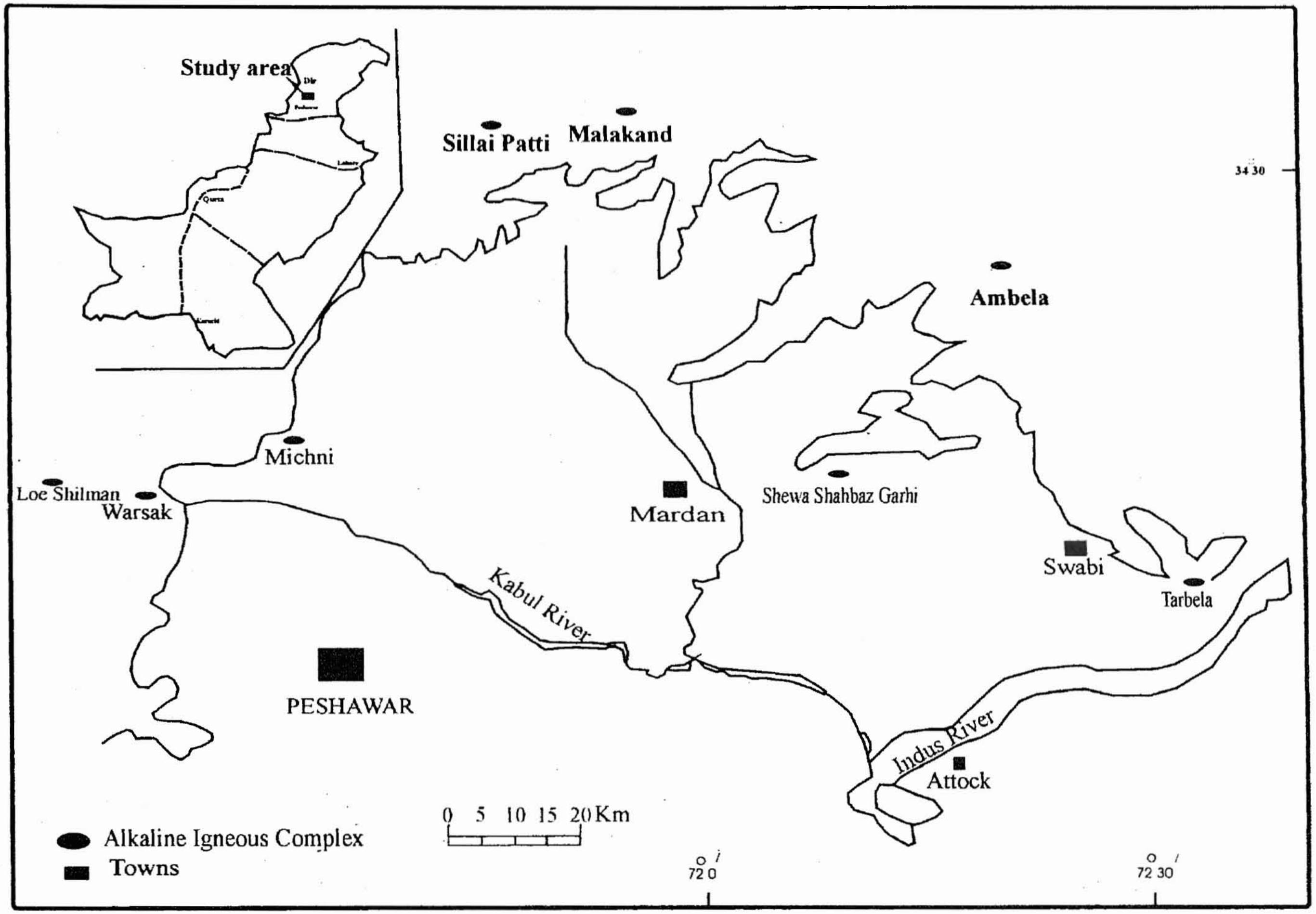
ABSTRACT: *This paper documents the occurrence of alkaline-igneous complex, which is exposed 30 km northwest of Peshawar, near Michni (Mohmand Agency), N.W.F.P. The complex appears to be the eastern extension of the Warsak alkaline rocks and is considered to be the part of the alkaline igneous province of the Peshawar plain. It shows a series of rock associations, such as mica-pyroxenite, melteigite and ijolites occur in the inner horizon, whereas the outer sequence contians nepheline-syenite and alkali-syenite. The foidal syenite and alkali syenite occur as lensoidal bodies within the inner horizon. Petrographic study of these rocks clearly show reaction rims in and around pyroxene and foidal minerals indicating metasomatism and/or alteration.*

INTRODUCTION

The Permo-carboniferous alkaline igneous complexes, emplaced into the lower to middle Paleozoic metasediments, are exposed along the northeastern to northwestern part of the Peshawar Plain (Fig. 1). These complexes comprise:

a) Gabbroic rocks, grading from pyroxenite to leuco-grabbro; albitites and albite-carbonate breccia; granites and carbonatites (Jan et al., 1981) and hornblende melteigite. (Siddiqui, 1973) exposed at the western bank of the Tarbela Dam.
b) Granite, foidal syenites, ijolites, carbonatites and dykes of dolerite exposed as Ambela granitic complex (Martin et al., 1962, Siddiqui et al., 1968, Rafiq, 1987). In addition, with alkaline acidic to basic volcanics in Swabi area including Shewa-Shahbazgarbi complex (Chaudhry & Shams, 1983; Rafiq et al., 1997).
c) Alkali granites and carbonatites at Malakand (Ashraf & Chaudhry, 1977).
d) Carbonatites and basic igneous rocks of Sillai Patti and Loe-Shilman northwest of the Peshawar (Majid, 1976).
e) Granites, micro-porphyries and basic rocks at Warsak (Ahmad et at., 1969).

Reconnaissance sampling in the eastern extension of the Warsak indicates that ijolite and syenite rocks are intruded into the metasediments of the Paleozoic age. This recently investigated alkaline silicate complex is exposed at Shine-Ghundai near Michni (Mohmand Agency), NWFP (Fig. 1). The area is located 28 kilometers northwest of Peshawar and lies between 71° 28′E longitude and 34° 12′N Latitude (Fig .2). Administrative inaccessibility limited geological work in the Mohmand Agency. Earlier workers (e.g., Coulson, 1936; Ahmad et al., 1969; Kempe & Jan, 1970; Kempe, 1973) described the alkaline granites and micro-porphyries and gabbroic rocks from the Warsak area. The Warsak alkaline igneous complex is exposed west of the Michni alkaline silicate complex.



. Fig. 1. Location map of Alkaline Igneous province of Peshawar plain NWFP Pakistan.

FIELD ASPECTS

The alkaline igneous complex of the Michni area comprises mica-pyroxenite, melteigite ijolite series rocks on one-hand and feldspathoidal syenites to alkali-syenites on other. Various lithologic units of the complex are presented (Fig. 2). The complex is structurally characterized as sills, sheets and plugs striking nearly east-west and dipping 60°-70° towards north. The northern contact with the pelitic to psammatic schist (Marghazar Formation) of early Paleozoic age is sharp, while the southern contact is poorly exposed and mostly covered with alluvium. East-west extension is also not clear because of alluvium cover. The complex extends for at least 2 kilometers in the east-west and more than 1.5 kilometers in the north-south direction. The complex consists of two sub-parallel mica-pyroxenite sheets about 50 meters apart in the central part with close association of multiple sheets of melteigites and ijolites. The outer sheets / sills and plugs of feldspathoidal syenite and alkali-syenite along with rocks of ijolites series are more extensive, and can be followed for a distance of more than a kilometer oblique to the strike along the road.

PETROGRAPHY

The following brief petrographic account is based on reconnaissance rock samples collected from the roadside. Field relationship and petrographic study of the rocks of the area indicate that these rocks are ranging in composition from mica-pyroxenite to melteigite and ijolite with major exposures of feldspathoidal syenites and alkali-syenite as felsic associates.

Mica-pyroxenite

Massive sheets of dark-green color mica-pyroxenite are very coarse-grained and can be easily identified due to the presence of 2-5 cm euhedral shiny golden dark brown grains of mica (phlogopite). In addition, the pyroxenite consists largely of euhedral to subhedral pale green augite (diopsidic-augite) with interstitial fine-grains of mica and apatite. Texturally, the diopsidic-augite is granular and small amount of nepheline occurs mainly along intergranular boundaries. Apatite forms anhedral to polygonal crystals, generally free of inclusions. Tiny subhedral grains of garnet (melanite) are present in traces. Modal composition of the mica-pyroxenite is given in (Table 1).

Mica-melteigite and Melteigite

With increasing nepheline content, the mica-pyroxenite grades into mica-melteigite and melteigite (Table 1). Texturally, the rocks consist of medium to coarse-grained varieties, with subhedral pale-green pyroxene (diopsidic-augite). Tiny grains of greenish to bluish green amphibole and neobiotite occur as alterations. Fine grains of aegirine-augite are also noticed in and around diopsidic-augite. Nepheline generally occurs within the interstices of pyroxene. Apatite is relatively coarser and more than in mica-pyroxenite. Garnet is very fine grained and occurs in traces. Traces of sphene are also noticed (Table 1).

Ijolite

Ijolite forms the bulk of the outcrop in the central part of the complex (Fig. 2). Melteigite and ijolites are much similar and indistinguishable at the outcrop. These rocks show variability in grain size and texture both in the outcrop and in the microscope. Microscopic study shows a textural variation of nepheline from interstitial irregular grains to larger subhedral grains (Table 1). The increase in nephline content in ijolites closely correlates with an increase in aegirine content (see also Lehijarvi, 1960).

TABLE 1. MODAL COMPOSITION OF SOME ALKALINE ROCKS FROM MICHNI AREA MOHMAND AGENCY, N.W.F.P. PAKISTAN

	Mica Pyroxinite (6A1)	Mica Pyroxinite (6A2)	Mica Pyroxinite (7A3)	Melteigite (7A1)	Melteigite (7A2)	Ijolite (7A4)	Nepheline Syenite 3G	Nepheline Syenite 5B	Nepheline Syenite 3H	Nepheline Syenite (21A)	Nepheline Syenite (15A)	Nepheline Syenite (2A)
Alkali Feldspar	---	---	---	---	---	---	32^{++}	55	$40^{\dagger\dagger}$	62	58^{*}	50^{++}
Nepheline	7	6	8	18	11	14	28	21	20	17	15	15
Pyroxene	60	55	70	70	82	68	14	6	4	18	20	25
Soda-Amphibole	---	---	Tr	6	2	10	15	3	18	1	5*	5
Sphene	---	---	---	---	---	Tr	7	Tr	15	2	Tr	Tr
Apatite	2	3	5	4	5	5	1	15	2	1	2	5
Garnet	---	---	---	Tr	---	---	3	Tr	1	---	Tr	1
Neo-biotite	Tr	1	1	Tr	Tr	1	---	Tr	---	Tr	Tr	---
Biotite	30	35	15	---	Tr	2	---	---	---	---	---	---
Ore	1	Tr	1	1	---	Tr	Tr	---	---	---	---	Tr

(Table 1 continued)

	Nepheline Syenite (0)	Alkali Nepheline Syenite (17A)	Nepheline Syenite 5F	Syenite V.Course 5C	Nepheline Syenite 2B2)	Syenite 3FI	Syenite porphyry 3A	Alkali Syenite 3FII	Alkali Quartz Syenite porphyry	Syenite porphyry 3A
Alkali Feldspar	42	78++	40	65	54++	40††	67††	65++	75	67++
Nepheline	12	12	10	8	5	5	5	---	---	5
Pyroxene	12	6	3	20	20	1	25	16	7	25
Soda-Amphibole	23	1	41	2	18	17	Tr	15	8	Tr
Sphene	5	Tr	---	Tr	Tr	30	---	Tr	1	---
Apatite	2	1	2	3	2	2	1	Tr	3	1
Garnet	3	---	4	2	1	3	---	2	Tr	---
Neo-biotite	Tr	---	Tr	Tr	Tr		Tr	Tr	1	Tr
Biotite	---	Tr	Tr	Tr	---	Tr	2	Tr	5	2
Ore	Tr	Tr	Tr			3	Tr	2	Tr	Tr

Tr = Trace * = some carbonate
†† = Secondary Quartz ++ = With Quartz and Albite

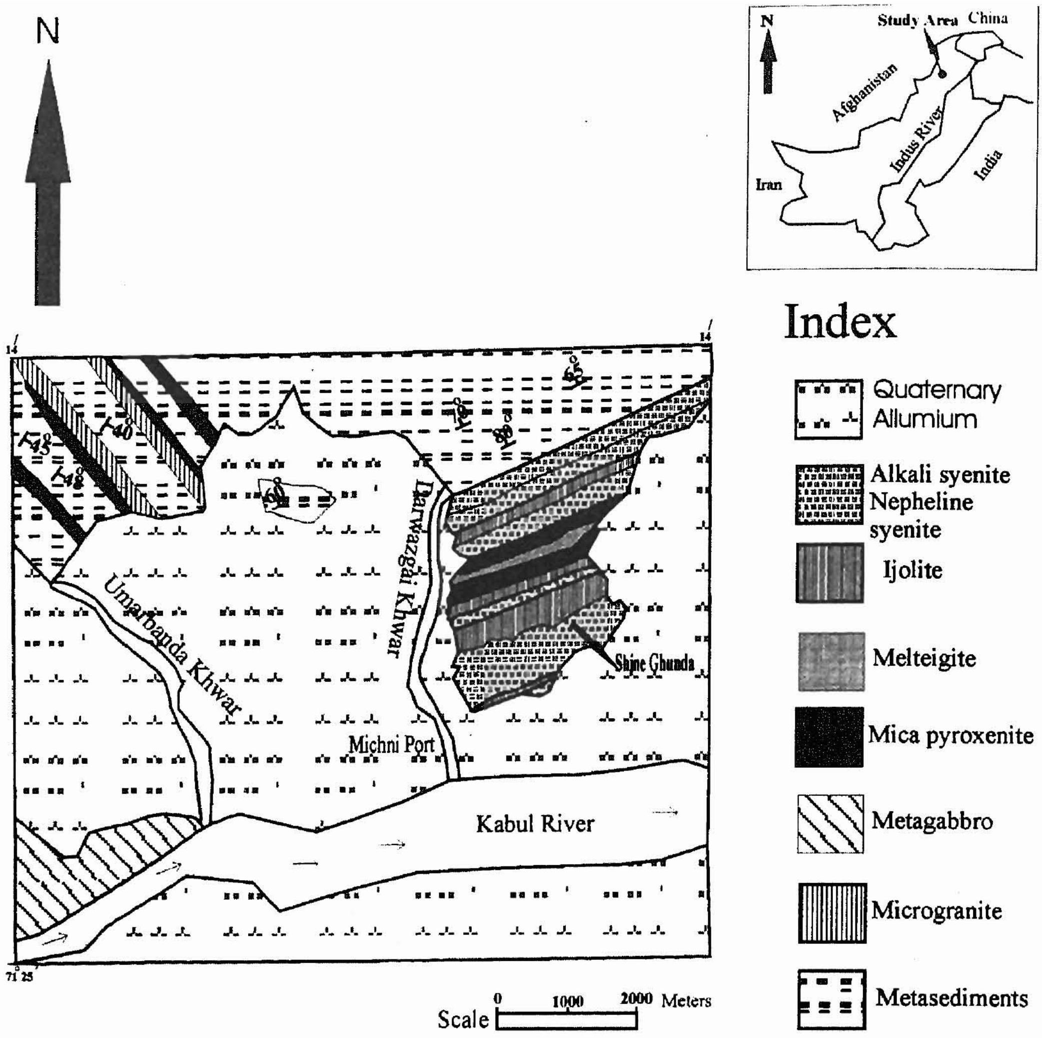


Fig. 2. Geological map of Michni Alkaline Igneous Complex, Mohmand Agency NWFP, Pakistan.

The coarser ijolites contain 5-8mm long grains of pyroxene consisting of Pale-green (diopsidic-augite) core and deep green rims (aegirine-augite) with intergranular nepheline and mica. Apatite is in the form of polygonal crystals with more concentration than in melteigite. Garnet is found in traces. Secondary biotite after pyroxene and secondary opaque mineral occur in traces.

Nepheline Syenites and Alkali Syenites

The great bulk of the complex is composed of nepheline syenite and alkali syenite (Fig.2). These are interlayered and associated with the rocks of ijolite. These rocks occur in the from of sheets/sills and are essentially parallel to ijolite. However, their thickness is variable and ranges from two to tens of meters. Similarly, their grain size shows variation from coarse-grained (5-8mm grain size) to micro-porphyries.

Nepheline syenites show variable color. The coarser variety is greenish-grey, while the medium and fine-grained and fine varieties are light to dark-grey. The three principal constituents of nepheline-syenite are alkali-feldspar, nepheline and pyroxene. The alkali-feldspar is variable in amount and distribution (Table 1). In thin-section alkali-feldspar is mostly fresh, but in few sections it is crowded with tiny small inclusions of nepheline and pyroxene simulating a poikilitic texture in a matrix of coarser crystals. Nepheline occurs as subhedral to anhedral crystals with inclusions. The phenocrysts of nepheline show some alteration (natrolite). Pyroxene varies from colorless to pale-green diopsidic-augite core to bluish-green aegirine augite rims/margin. The medium to fine variety of nepheline syenite shows the same modal composition. The alkali-feldspar, nepheline and pyroxene occur as a group or clusters in some of the rocks, with zoned aegirine-augite. Garnet and sphene set in a groundmass of the same minerals together with apatite and rare ore. Reaction rims around pyroxene and association of sodic-amphibole as cluster in and around aegirine-augite might be due to the metasomatic effect in these rocks.

Texturally the alkali-syenite is very much similar to nepheline-syenites. Modal composition reveals an increase of alkali-feldspar (with albite), aegirine-augite, riebeckite and sphene from alkali-syenite to nepheline-syenites (Table 1). Some rocks show very high amount of sphene (i.e., sample No. 3F, upto 30%). Tiny needles of riebeckite arranged parallel to the cleavage plane in alkali-feldspar might also be due to metasomatism in these rocks.

DISCUSSION

Field relationship and petrographic study of the alkaline-igneous complex under discussion reveal extensive occurrence of foidal-syenite, alkali-syenite and rocks of ijolite series. Before studying the mineral and whole rock chemistry, it is difficult to comment on the genesis of these rocks. However, the repeated emplacement and presence of whole rock sequence from mica-pyroxenite through melteigite to ijolites (with some urtite rocks) indicates the existence of ijolite magma, which may have followed an igneous differentiation trend. Petrography also reveals the differentiation, as we see enrichment of diopsidic-augite with traces of nepheline in mica-pyroxenite to enrichment of aegirine-augite and nepheline in the rocks of ijolite series.

The exposed volume of the various rock units of the complex, such as the mica-pyroxenite, melteigite and ijolite represent only a small portion (probably 20-25% of the outcrop), while the rest are nepheline-syenite and alkali-syenite. Taking into account the Warsak micro-porphyries and alkali-granite exposed to the northwest of the study area, it is difficult to explain the rocks are derived from ijolite magma by differentiation. Rafiq (1987) and Rafiq and Jan (1989) have discussed the disilicification trend for the syenites, foidal-syenite, alkali-syenite and ijolite of the Koga complex (a part of the Ambela granitic complex). Here also the presence of larger bodies of foidal syenite and alkali-syenite and their field relationship as compared to rocks of ijolite series provides some evidence and favor disilicification trend for the formation of foidal syenite and alkali syenite rocks.

Absence of carbonatite body in the near vicinity and an almost total absence of any carbonate mineral in these rocks, does not favor a metasomatic origin for the nepheline-syenite and alkali-syenite. However, mineral chemistry, particularly of feldspars and feldspathoids, needs to be obtained which help in distinguishing the processes involved.

REFERENCES

Ahmad, M., Ali, K.S.S., Khan, B., Shah, M.A. & Ullah, I., 1969. The Geology of Warsak area, Peshawar, West Pakistan. Geol. Bull. Univ. Peshawar, 4, 44-72.

Ashraf, M. & Chaudhry, M.N., 1977. A discovery of carbonatite from Malakand. Geol. Bull. Univ. Punjab, 14, 91-94.

Chaudhry, M.N. & Shams, F.A., 1983. Petrology of the Shewa porphyries of the Peshawar Plain Alkaline Igneous Province, NW Himalayas, Pakistan. In: Granites of Himalayas, Karakorum and Hindukush. (F.A. Shams e.d.) Geol. Bull. Univ. Punjab, 171-181.

Coulson, A.L., 1936. A soda-granite suite in the North-West Frontier Province. Proc. Nation. Inst. Sci. India, 2, 103- 111.

Jan, M.Q., Asif, M. & Tahirkheli, T., 1981. The Geology and petrography of the Tarbela Alkaline Complex. Geol. Bull. Univ. Peshawar, 14, 1-28.

Kempe, D.R.C. & Jan, M.Q., 1970. An alkaline igneous province in the North-West Frontier Province, West Pakistan. Geol. Mag., 107, 395-398.

Kempe, D.R.C., 1973. The petrology of the Warsak alkaline granites, Pakistan and their relationship to other alkaline rocks of the region. Geol. Mag., 110, 385-404.

Lehijarri, M. 1960. The alkaline district of Livaara Kuusamu, Finland. Bull. Comm. Geol. Finland, 185, 62.

Majid, M., 1976. Mineralogy and petrology of the Shilman carbonatite complex, Khyber Agency, NWFP. Geol. Bull. Univ. Peshawar, Inf Rel., 7.

Martin, N.R., Siddiqui, S.F.A & King, B.H., 1962. A geological reconnaissance of the region between the lower Swat and Indus River of Pakistan. Geol. Bull. Punjab. Univ., 2, 1-14.

Rafiq, M., 1987. Petrography and geochemistry of Ambela Granitic Complex. NWFP Pakistan. Unpublished Ph.D. thesis, Univ. Peshawar, 272p.

Rafiq, M. & Jan, M.Q., 1989. Geochemistry and Petrography of the Ambela granitic complex, NW. Pakistan. Geol. Bull. Univ. Peshawar, 22, 159-179.

Rafiq, M., Shah, A., Hamidullah, S. & Sayab, M., 1997. Classification and genesis of late Paleozoic volcanic rock from Peshawar Plain, North West Pakistan. Geol. Bull. Univ. Peshawar, 30, 251-271.

Siddiqui, F.A., 1973. Alkaline rocks of ijolitic affinity from Tarbela Dam area (Hazara district). Geonews, 111, 17.

Siddiqui, S.F.A., Chaudhry, M.N. & Shakoor, A., 1968. Geology and petrology of the feldspathoidal syenites and associated rocks of Koga area, Chamla valley, Swat, West Pakistan. Geol. Bull. Univ. Punjab, 7, 1-30.

Sutherland, D. 1966 b. Intrusive complexes and volcanism in eastern Uganda. Proc. Geol. Soc.