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THE GRANITOID ROCKS OF THE DAILEKH AND THE JAJARKOT REGIONS IN THE LESSER HIMALAYA OF CENTRAL WEST NEPAL

Toran Sharma *
Koshiro Kizaki **

ABSTRACT

Two types of granitoid bodies are found. More or less concordant, leucocratic to sub-leucocratic two mica granitoids of the Dailekh and the Marma Khola-Pasgar Nala, showing diverse textural types are the plutonic granitoid intrusives predating thrusting episodes. During the thrust movements these granitoids were mobilised along the thrust planes and have undergone considerable mineralogical and textural changes depending upon the intensity of shearing and the degree of metamorphism accompanying thrusting.

The small localised Ramolagaon Granitoid in the brecciated zones showing lateral gradation from the brecciated country rocks to the granitoid rocks are the thrust related Alpine granitoids essentially of metasomatic origin.

INTRODUCTION

Granitoid rocks represent quite distinct lithological types in the unfossiliferous metasedimentary sequence of the Lesser Himalaya. The occurrences of granitoid rocks in the Lesser Himalaya, though limited in space are not so uncommon as was thought. With the more detailed field studies in the Lesser Himalayan belt, we have been able to know their distribution more preciesly. Their association with resembling lithological types and in the areas of assumed tectonic disturbences has led to a number of controversial thoughts reegarding the significance and origin of these granitoids among the geoscientists (Hashimoto et al, 1973; Pecher and Le Fort, 1977; Arita, 1983; Kano, 1984 etc). Recent isochron age dating has provided more knowledge, however, do not seems to lead towards an unified conclusion. In this paper, the authors present the field and laboratory studies of the granitoids of the Dailekh and the Jajarkot regions in the Lesser Himalaya of Central West Nepal.

GEOLOGICAL SETTING AND FIELD RELATIONSHIP

The Dailekh Granitoid

The Dailekh Granitoid occurs as a sheet like body in the low grade phyllites and quartzites sequence comparable to the Kuncha Unit (Sharma, 1984). From the north of Dabada Village along the western flank of the Dailekh hill, the granitoid body descends down to the Lohore

* Department of Mines and Geology, Kathmandu, Nepal.
** Department of Marine Sciences, University of the Ryukyus, Okinawa, Japan.

Khola in the south (Fig. 1). At the confluence of the Lohore Khola and the Parajul Khola, because of the weakly developed Parajul Syncline, the body is folded and extends along the Lohore Khola in the west and along the Parajul Khola through the northern flank of the Ranimata hill range beyond the Bhimhula in east. The thickness of the granitoid body is highly variable from nothing to 1200m around the confluence of the Parajul Khola and Lohore Khola. In the southern part around the Parajul Khola and the Bhimchula a number of amphibolite instrusives are found within the granitoid body and in the associated country rocks. The amphibolite intrusions show distinct discordant relationships. The Dailekh Granitoid has been thought to be the sheet like granitic intrusion in the undisturbed quartzite and phyllite succession of the region (Fuchs, 1977 ans Sharma, 1973). The recent geological mapping (Sharma, 1984) has revealed that many of the lithological units overlying the Dailekh Granitoid gradually disappsear along the granitoid body and could not be followed across the granitoid body in the underlying succession (Fig. 1). This clearly indicates that the base of the Dailekh Granitoid marks a thrust involving some 10s of kilometre displacement.

Though for most part, the plnner fabric of the Dailekh granitoid is in conformity with the underlying and overlying sequences, the granitoid body at places shows discordant intrusive relationship with the overlying succession (Fig.1). Besides, a number of lensoidal layers of phyllites and quartzites measuring upto 100m in thicknesses are seen embedded in the granitoid rock masses. Small aplitic apophysis and epiphesis are found injecting the phyllites and quartizites succession of the overlying sequences and the lenticular horizons of phyllites and quartzites in the granitoid masses.

In the field various textural types could be recognised. A complete gradation from the less tectonised porphyritic granitoids to highly tectonised phyllitic phyllonitic gneisses exists (Fig. 2a). The granitoids near the contact with the country rocks are strongly foliated, phyllitic and show small deformed eye like augens of feldspars warped by the fine clusters of micas. Away from the contact zone, the feldspars become larger, silvery fine mica proportion decreases, large flakes of muscovite and biotite start appearing and the rock becomes perfect augen gneisses. These two textural types are the common and very easily distinguisable varities of the Dailekh Granitoid. However, in the lower reaches of Parajul Khola a non-foliated coarse porphyritic granitiod mass with randomly oriented euhedral feldspar phenocrysts surrounded by the weakly folitated augen gneisses occurs. In the foliated phyllitic gneisses and the augen gneisses a strongly developed mineral and striation linear fabric is well developed.

The Jajarkot Granitoid

In the region of Jajarkot, granitoid rocks occur in different structural levels of the metasedimentary and metamorphic sequence of the Jaljala Synclinorium. On the basis of their structural positions, textural and mineralogical types and the field characters, the granitoids of the Jajarkot region are divided into two groups viz, (a) Marma Khola Pasgar Nala Granitoids and (b) Ramolagaon Granitoids (fig 3).

(a) Marma Khola-Pasgar Rala Granitoid:— The granitoids occurring along the Marma in the south and Pasgar Nala in the north, forming the northern and southern limb of the Jaljala Synclinoriim (Fig. 3) belong to this group. The granitoid rocks occur as a continuous marker horizon in this region. However, in the east,north of Piuthan,it occurs as a discontinuous lenticular body almost in the similar structural position (Arita et al, 1982). The thickness of these granitoid bodies are highly variable from nothing to as much as 250m. Occasionally in some localities e.g. Bagdiya Khola, Tatke and Pasgar Nala, layers, lenses and islands of quartzites and garnetiferous schists are found within the granitoid horizon. In the outcrop scale, they show very conformable contacts with underlying and overlying rocks. The detailed geological mapping in this region (Adhikari and Sharma, 1983) have shown that the granitoid rocks do not occur in the same sratigraphic level (Fig. 3), but instead mark the thrust zone separating overlying Jaljala Unit from the underlying Kuncha Unit. Like in the Dailekha granitoid rocks, mineral lineation and mullion structures trending NNE or SSW are prominantly developed.

The granitoid rocks are very strongly foliated and those in contact with the country rocks are phyllitic, feldspars augens are small and deformed, fine clusters of muscovite and biotite give shinning lustre. In the thicker part of the granitoid body, a coarse varitey with big augens of feldspars and some big flakes of biotite and muscovite is found grading from the outer phyllitic gneisses. The phyllitic gneisses and augen gneisses are the only two textural types (Fig 2b). Except for the coarse nonfoliated porphyritic variety, the Marma Khola Pasgar Nala Granitoid and Dailekh Granitoid show similar field and petrographic characters.

(b) Ramolagaon Granitoide:— Texturally and otherwise, the granitoids ocurring in the Kuncha Unit around the Ramolagaon in the south and upstream of the Pasgar Nala in the north (Fig. 3)., are very much different from the above described granitoids of the Dailekh and the Marma Kholapasgar Nala. They have been developed in a considerably sheared and brecciated zones along which various lithological types of the Kuncha Unit have been shifted laterally and vertically. The brecciated zones vary in thickness from few meters to 30 m and can be followed for long distances along the strike. It is within this brecciated zone that a complete transition from brecciated and pulverised country rocks with few impregnations of feldspars in the greyish indeterminable matrix to rocks with very well developed (upto 1.5cm long) feldspar porphyroclasts embedded in the fine matrix have been observed (Fig. 2c). In the well developed locality as in the upstream Pasgar Nala and the Ramolagaon, they appear as mylonitised granitoids with angular breccia of feldspars in the indeterminable powdery weathering greyish matrix.

From the field characters, it seems that these granitoids have been formed synchronous with the brecciation of the country rocks. The possible mechanism leading to the formation of the Ramolagaon granitoids will be discussed later.

PETROGRAPHY

The Dailekh Granitoid and the Marma Khola-Pasgar Nala Granitoid:— The granitoids of the Dailekh and the Marma Khola Pasgar Nala are the fine, medium to coarse-grained largely leucoratic to sub-leucoratic two mica granitoids which show variation in textures and mineral constituents depending upon the degree of metamorphism subjected. The textural types ranging from mylonitised phyllitic gneisses, augen gneisses to coarsely crystalline porphyritic variety with little effect of mylonitisation are recognised. The last texural type is seen only in the Dailekh Granitoid.

Under the microscope, these granitoids are mainly made up of quartz, k-feldspars, plagioclase, biotite and muscovite. Small granules of garnet are present in the granitoids of the Marma Khola Pasgar Nala. The chief accessory minerals are apatite, zircon, tourmaline, epidote/clinozoisite and occasionally sphene. chlorite occurs as altered product of biotite in most of the granitoids. The ground mass is constituted of recrystallised hypidiomorphic quartz, microcline, albite and clusterous fine micas. The lepidoblastic aggregates of muscovite and biotite define the schistosity.

Quartz:– Quartz is the chief constituent mineral forming the ground mass and phenocryst. The grain size in the ground mass is variable depending upon the textural types . In the mylonitic phyllitic gneisses it froms the small (less than 0.15mm) aggregate whereas in the augen gneisses the size increases reaching upto 0.35mm or more in average . In the coarsely crystalline graniotoids,the porphyritic quartz grains could even be recognised in the hand specimens . In the tectonised phyllitic gneisses and augen gneisses, the blastoporphyritic quartz showing strong strain shadow, warped in tne form of augen by the fluidal lepidoblastic micas occur.

K-feldspars:- It forms the most common feldspar in the granitoids of these areas. It occurs as large blastoporphyritic grain. Deformed, more or less rounded and elongated parallel to the foliation direction. The k-feldspars are warped by the fine clusters of lepidoblastic micas giving an augen structure. The size of the k-feldspars is variable depending upon the textural types. In the phyllitic gneisses. they occur as relatively small (0.6mm to 6mm) rounded and ovoidal augens. The size increases in the augen gneisses exceeding over a centimetre. In the porphyritic granitoids of Dailekh, they often show intergrowth with plagioclase and quartz and are usually large (upto 5cm) sub-hedral to rectangular euhedral in shape.

All most all the k-feldspars show a complex perthitic intergrowth with the plagioclase. Most common perthitic intergrowth are string, bead, rod, ribbon and patch type. The k-feldspars are charged with the inclusions of fine micas, quartz, epidote/clinozoisite etc, occasionally showing sieve texture. In the ground mass they form small irregular grains and are mostly microcline with distinct cross-hatched twinning.

Plagioclase feldspar:- The modal content of the plagioclase is less than the k-feldspars. It occurs as blastoporphyritic grains and also in ground mass as small subhedral grains. The composition of the plagioclase is found to vary according to the textural types in the Dailekh Granitoids. The coarse porphyritic granitoids and some of the augen gneisses show zoned plagioclase with calcic core rimmed by a thin margin of albitic composition. In the rest of the granitoids of the Dailekh and Marma Khola Pasgar Nala the plagioclase is dominantly albite. Most of the plagioclase show fine scattering of calcitic dust in their surfaces along with the inclusions of micas, quartz, epidote/clinozoisite etc.

Biotite:- Texturally two types of biotite could be recognised.
Biotite I :- It occurs as big blastoporphyritic grains showing pre-kinematic relationship with the general foliation. It contains the inclusions of quartz, zircon and opaque minerals. Its margins are corroded. It is strongly pleochroic in tones of brown to light yellowish colours. This biotite is the commonest type in the porphyritic granitoids of the Dailekh. In the phyllitic gneisses and the augen gneisses, it occurs as fractured and deformed grain. In the phyllitic gneisses, this type is relatively less common. It is this biotite which has undergone chloritization.
Biotite II:- It occurs as a small syn-kinematic lepidoblastic laths in association with the muscovites. It is pleochroic in tones of brown to light yellowish green colours. This type is the most common in the phyllitic gneisses and augen gneisses but is rare in the porphyritic

granitoids of the Dailekh.

Muscovite:- Like biotite two types of muscovite have been observed in all the textural types of the Dailekh Granitoid. In the granitoids of Marma Khola Pasgar Nala, except in one or two samples which also contain large blastoporphyritic deformed muscovites, the dominant muscovite is the lepidoblastic syn-kinematic small aggregate type.

Chlorite:- Chlorite occurss mostly as secondary mineral after the blastoporphyritic biotites. Pleochroic in tones of green to white colours, it is seen replacing the margin and lamellae of the biotites.

Garnet:- In the Marma Khola Pasgar Nala Granitoids, allthetextural types show granules of ganet. Garnet occurs as aggregates of small granules (less than 0.15mm). However, in some cases it reaches a size of 0.4mm to be called as small porphyroblast. The garnets are more or less euhedral in shape with inclusions of quartz and opaque minerals at the core. The Dailekh Granitoid, howerve, does not contain garnets. [As compositionally the Marma Khola-Pasgar Nala Granitoid are similar, this difference in the mineral constituents is because of the difference in the metamorphic change associated with the thrusting.] The Marma Khola-Pasgar Nala Granitoid and associated country rocks have suffered higher grade metamorphism (above garnet isograd) than the Dailekh Granitoid and associated country rocks (above biotite isograd).

Among the accessory minerals of apatite, zircon, tourmaline, opaques and epidote/clinozoisite, the last mineral show a very unique feature. Epidote/ clinozoisite are abundant in the phyllitic gneisses and strongly foliated augen gneisses.

The Ramolagaon Granitoid :- The Ramolagaon Granitoid is mylonitic in texture. The main mineralogical constituents are quartz, k-feldspar, albite and muscovite, only opaque minerals are seen as the accessory minerals.

Cryptocrystalline quartz forms the main ground mass with little amount of fine lepidoblastic clusters of sericitic white muscovite defining the weakly developed foliation. Irregular rounded to elongated lobate margined, fractured and granulated k-feldspars and occasionally albite forms the porphyroclasts. Along the fractures of the porphyroclasts fine cryptocrystalline quartz and white micas have been recrystallised. The k-feldspars rarely show perthitic texture. Most common variety of the k-feldspar is the microcline showing cross-hatched twinning. The large rounded to angular granulated and partially polygonised, strongly strain shadowed quartz grains are often present in the ground mass of cryptocrystalline quartz. Unlike the granitoids of the Dailekh and the Marma Khola-Pasgar Nala, two types of muscovites are not seen. Biotite is absent in the Ramolagaon Granitoid.

MINERAL CHEMISTRY

The mineral chemistry of muscovite, biotite, garnet, k-feldspars and plagioclase is determined by the Electron Microprobe Analysis (EPMA). In total 22 samples were selected for the EPMA study that include 12 samples from the Dailekh Granitoid, 5 from the Marma Khola Pasgar Nala Granitoid, and 4 from the Ramolagaon Granitoid representing various textural types. The sample locations are shown in Fig. 1 and 2 repectively.

Muscovite :- The muscovite composition is plotted on the Al203 - Fe0+2 diagram (Fig. 4) of

Miyashiro (1973). A remarkable difference is observed in the composition of the coarse (pre-kinematic) and fine (syn kinematic) muscovites of the granitoids of the Dailekh and Marma Khola-Pasgar Nala. The coarse pre-kinematic muscovites show high Al203 and low Fe0+2 weight percentage. In contarast, the finer lepidoblastic muscovites showed the inverse relation. The study of the muscovite composition in metamorphosed pelitic and semipelitic rocks of comparable chemical composition with the acidic igneous rocks have shown that the muscovite assumes its near ideal composition only in the high temperature condition such that the Al203 content increases with the corresponding decrease of Fe0+2 content with the rise of temperature during the formation of muscovite. This relationship of the muscovite composition with the temperature of their formation clearly indicates that the coarse-grained muscovites in the granitoids of the Dailekh and Marma Khola-Pasgar Nala are the relict primary muscovites of the plutonic rocks formed at the higher temperature. Whereas the fine-grained muscovites are the product of later matamorphism which all these granitoids have suffered during the thrusting. This sevidence on the mineral chemistry of muscovites is also supported by the textural types of the muscovites, the large one show pre-kinematic relationship in contrast to the syn-kinematic relationship of the fine muscovites.

A similar compositional difference between the coarser and finer muscovite is also observed in the Na - Fe - Mg diagram (Fig. 5). The coarser muscovite show higher paragonite component than the finer muscovite indicating contrasting difference in their temperature of formation.

The fine sericitic muscovites of the Ramolagaon show very low Al203 content against very high Fe0+2 reflecting their formation in a very low temperature regime.

Biotite:- The composition of the biotites from the Dailekh and the Marma Khola-Pasgar Nala granitoids plot lies in the field between phlogopite and annite showing higher annite component (Fig. 6). But coarse and fine-grained biotites do not show any significant difference in their chemistry and even the phenocrysts of biotite from the porphyritic granitoids of Dailekh show nearly the same composition.

A number of studies on the composition of biotite from the acidic igneous rocks (Deer et al, 1961) have indicated that the biotite from the acidic igneous rocks show a composition very similar to the those of the low grade metamorphic biotites of pelitic and semi-pelitic rocks. In other words, the plutonic biotites show very high Fe0+2 content and correspondingly lower Mg0 content similar to the composition of the low grade biotites. From this, it is inferred that the coarse-grained biotites analogous to muscovites are the igneous "relicts" of primary biotites and the fine-grained lepidoblastic biotites are the secondary biotites essentially of metamorphic origin.

Garnet :- The garnets from the Marma Khola-Pasgar Nala Granitoid are analysed at three points across the garnet crystal representing the composition of core and rim. The Mg0, Fe0+2, Mn0 and Ca0 show considerable variation from core towards the rim part of the garnet, while the rest of the component Al203, Si02 and Ti02 are found consistent within the crystal.

The garnets of the Marma Khola-Pasgar Nala are the grossular garnet with more than 45% mol fraction of grossular component at the rim of the garnet while almandine component vary from 40 to 27%, pyrope component range from 0 to 0.7% and spessartine component fluctuates between 8 to 20% mol fraction at the rim of the garnet.

All the garnets analysed show the normal zoning pattern (Fig. 7). The decreasing Mn0 content is sympathetically compensated by the increasing Fe0+2 content from core towards the margin of the garnet. In many of the analysed garnet Mg0 content is absent at the core part of the garnet, but is present at the outermost rim of the garnet indicating a general increase of the Mg0 from core towards the margin. The Ca0 component do not show any significant variation, however, in some of the analysed crystals the Ca0 content is found to increase from core towards the margin.

The study of the zoning in garnet (Banno, 1964; Hollister, 1966; Atherton, 1968; Banno and Chii, 1976 etc) have shown that the garnet showing normal zoning pattern are characteristic of the low grade metamorphic terrians. As the granitoid rocks of the Marma Khola-Pasgar Nala occur in the country rocks showing garnet isograd of metamorphism, the garnets of the Marma Khola-Pasgar Nala granitoids are essentially of metamorphic origin. This might be the reason why the Dailekh Granitoid occuring in the metamorph ic terrian not exceeding biotite isograd of metamorphism are devoid of garnets.

Because of the high degree of error involved by the presence of very high Mn0 and Ca0 in these garnets, the temperature estimation by using the KD (Fe - Mg) geothermometry between garnet and biotite could not be implied. But from their chemical compositions, i t is assumed that they represent the low temperature garnets f ormed at the temperature range of 350°C to 450°C (Winkler, 1977).

Feldspars :- Feldspar composition are measured wi th the elelectron microprobe. Only the compositionally zoned plagioclase feldspars are analysed at the rim and the core part. In the rest of the grains showing no compositional zo ning analyses are aquired only from the core part.

The k-feldspars show a consistent compositional range (Fi g. 8). The Ab content varies from 5 to 15 wt% and An content is around 1 wt%. The measurements made in the perthitic pla gioclase always show albitic composition An 0–3. Th e narrow range of the Ab content in the k-feldspar together w i th the various types of perthitic intergrowth of albites indicate that the composition of k-feldspars have been re-equilibrated in the lower temperature taking the textural and mineralogical changes suffered by the granitoids of the Dailekh and Marma Kholạ-Pasgar Nala into consideration during the thrusting episode, it is likely that the major compositional change in the k-feldspar must have taken place during thrusting.

Compositionally Zoned plagioclase have been observed in the least effected augen gneisses (sample. 5, 8) and porphyritic granitoid (sample 7) of the Dailekh. In the rest of the granitoids the plagioclase is slbitic in composition An 0–5 (fig 8). The zoned plagioclase exhibit normal zoning pattern. In the porphyritic granitoid of the Dailekh the central core part is most calcic An An 20–50., the rim has a oligoclase-albite composition An 3–20. In the augen gneisses of the Dailekh, the most calcic core has oligoclase composition An 8–15 adn the rim part is exclusively albitic in composition An1–5. Thus in the Dailekh Granitoid, the compositional variation of plagioclase according to textural type is very distinctive. The common occurrences of the fine calcitic dusts over the plagioclase feldspars of these granitoids suggest that the plagioclase has been pseudomorphically albitised by the expulsion of Ca during the thrusting episode. The is also supplimented by the abundence of Epidote clinozoisite in the phyllitic and augen gneisses.

In the Ramolagaon Granitoid, feldspars show a similar composition to those of the phyllitic gneisses of the Dailekh and the Marma Khola-Pasgar Nala Granitoid.

BULK ROCK CHEMISTRY

The bulk analyses of 7 Dailekh Granitoid, 2 Marma Khola Pasgar Nal a Granitoids, and 2 Ramolagaon Granitoid samples are given to gether with their respective CIPW normatives in the Table 1. The analysis are acquired by using the EPMA for Sio2, Tio2, Fe0 (total), Mg0, Ca0 and K20. The Na20, Mn0 and Fe0 is determined by flame photometry, atomic absorption spectrometry and wet method respectively.

The granitoids show wide range of chemical composition ranging from granite to granodiorite (Fig. 10). In the Al203 - (Na20 + K20)- Ca0 diagram (Fig. 11), the granitoids of the Dailekh and the Marma Khola Pasgar Nala show pseraluminous character whereas those of the Ramolagaon Granitoid are peralkaline to metaluminous in character. A plot of CIPW norms in Q - Ab - Or system (Fig. 12) shows that the granitoids of the Dailekh and Marma Khola-Pasgar Nala lie in the field of plutonic granites (Tuttle and Bowen, 1985) whereas those of Ramolagaon fall outside the plutonic granite field. This also indicates that the granitoids of the Ramolagaon are formed by some processes of fseldspathisation of the country rocks.

ORIGIN

The field characteristics, mineralogical constituents and textural characters of the Ramolagaon Granitoid are different from those of the Dailekh and the Marma Khola-Pasgar Nala Granitoid which show a greater degree of similarity with each other. All these differences indicate that the Ramolagaon Granitoid has different history of their genesis than those of the Dailekh and the Marma Khola-Pasagar Nala Granitoid and should be treated differently while discussing their petrogenesis and origin.

The Dailekh and the Marma Khola Pasgar Nala Granitoids :- From the petrography and mineral chemistry, it is seen that the textural and mineralogical variations within the Dailekh and the Marma Khola Pasgar Nala granitoids are probably due to the variation of degree of metamorphism associated with shearing during their thrusting with which these granitoids are so intimely associated. This fact is also reflected in the metamorphism of the terrian . The Dailekh Granitoid is associated with the rocks which have suffered metamorphism not exceeding the biotite isograd. It is, therefore, the changes in the Dailekh Granitoid are mainly cataclastic textural accompanying minor mineralogical changes. Except some lepidoblastic muscovite and biotite formation, the rocks show relicts of the original igneous minerals and even textures in various state of destruction . On the orher hand, the Marma Khola-Pasgar Nala Granitoid occurring in the country rocks metamorphosed above garnet isograd has undergone considerable mineralogical and textural changes with very scarse relict of the original igneous minerals and textures . The development of predominant lepidoblastic micas and small garnets etc. in these granitoids also supports this view .

All these field, textural, mineralogical and chemical evidences point that the Dailekh and the Marma Khola-Pasgar Nala granitoids are largely concordent intrusives in the overthrusting rock masses. It will be hypothetical to envisage a volcano-sedimentar origin for these granitoids. Their association with the similar lithological types might reflect their similarity in age. Their occurrences along the thrust Zones is accidental. It is highly probable that the differences in the rheological properties between the granitoid rocks and the country rocks enclosing them the interface between the granitoid rocks and the country rocks might have acted as failure plane for the thrust movements. In view of the present authors, there could be number of granitoid bodies in the Lesser Himalaya not related with the thrusts. Such cases have been reported in the Lesser Himalayan metasediments of Kumaon and Himanchal Pradesh (Valdiya, 1983).

In light of the present geochronological Knowledge of the granitoid rocks (Table 2), the authors consider the granitoids of the Dailekh and the Marma Khola-Pasgar Nala to be the pre-thrusting intrusive sheets which in the later period mobilised during thrusting-and were subjected to considerable textural and mineralogical changes depending upon the degree of associated metamorphism. The high water activity, which is usually the case in the thrust zone, might have envolved some exchange of materials between the country rocks and the granitoid body along the contact zones ultimately giving rise to a very conformable and gradational contact between the two.

Ramolagaon Granitoid:- The chemical, textural, and field characteristics of the Ramolagaon Granitoid suggests their origin by some kind of granitization processes of the country rocks. The lateral as well as vertecal transition of the country rocks into the granitoid body by the progressive development of feldspars along and across the strike of brecciated shear zone amply suggests the existence of granitization. The K - Na metasomatism is the likely exp-lanation for the origin of the Ramolagaon Granitoid. It is widely accepted that the brecciated zones, like in the present case, provide the constant pathways for vatious types of gaseous and liquids enriched in different elements. Under favourable conditions such emanations such emanations could bring metasometic change.

For the Ramolagaon Granitoid, it is assumed that the initiation of the brecciation of the country rocks along a shear zone provied the pathways for the K - Na emanations. These emanations brought a metasomatic changes in the pulverised country rocks by forming the porphyroblasts of the K-feldspars and albite finally giving rise to a transformed rock of more acidic and or alkaline granitoid composition. This process of feldspathization and brecciation seems to have undergone hand in hand. As most of the feldspars of the Ramolagaon Granitoid show porphyroclastic textures and granulation along their boundaries, it is presumed that the shearing processes remained active even after the dominant feldspatization event.

The alkali metasomatism are very conspicuous in the vicinity of granitic and granodioritic bodies. considering the present geological set up, it is hard to figure out the likely source of alkali emanations.

COMPARABLE GRANITOIDS OF THE NEPALESE LESSER HIMALAYA

The Ulleri augen gneisses (Le Fort et al, 1974; Kano, 1982, 1984; Arita, 1983 and others) in central Nepal, Phaplu augen gneisses (Maruo and Kizaki, 1983) and Melung augen gneisses (Hashimoto et al, 1973) in eastern Nepal show comparable mineralogy and textural varieties with the Dailekh and the Marma Khola-Pasgar Nala granitoids. Le Fort et al, (1974), on the basis of some bulk rock analyses and the association of the granitoid body with some lithological types, proposed a volcano-sedimentary origin for the Ulleri augen gneisses of central Nepal. They extended their view to the granitoids of eastern Nepal occurring in the similar lithotectonic environment. While others considereed these granitoids to be the Precambrian Basement Gneisses (Hashimoto et al, 1973; 1983). More recently Kano (1983, 1984) opined these granitoids to be thrust related Alpine granitic intrusions.

Kano (1983, 1984) pointed out two texturally different muscovites, coarse and fine-grained in most of the granitoid rocks of central and eastern Nepal. Similar texturally different muscovites are also found in the Dailekh and Marma Khola-Pasgar Nala granitoids. The mineral chemistry of the muscovites show contrasting difference in their mineral chemistry indicating that the coarse muscovites are the relict of the original igneous granitic rocks, while the finer muscovites are the newly formed muscovites comparable to the muscovites of the associated country rocks. On this basis, it is assumed that the comparable granitoids of central and eastern Nepal are also the plutonic concordant sheet like intrusives predating thrusting.

The age of the various granitoid bodies is very difficult to predict. The whole rock Rb/Sr and K/Ar radiometric dating of many of the Lesser Himalayan granitoids (Table 2) show a wide range of the scattering of ages ranging from Mesozoic to Precambrian. It points to the fact that the granitoid intrusions have taken place in different geological periods in the Lesser Himalaya. Since these granitoids occur in different lithological types of the Lesser Himalaya cautions should be taken before generallising them to one granitic phase of the Lesser Himalaya. It is more likely that there could be granitoid bodies belonging to different episodes of granitoid generation in the Lesser Himalayes.

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Table 1: Whole rock chemistry of various granitoids

	DAILEKH GRANITOID							MARMA KHOLA PASGAR NALA		RAMOLAGAON GRANITOID	
	1	3	7	9	11	12	13	4	6	1	9
SiO2	73.11	72.79	71.93	73.27	71.25	73.84	73.80	71.41	74.68	65.46	69.48
TiO2	0.09	0.39	0.51	0.37	0.43	0.28	0.41	0.17	0.18	1.39	0.72
Al2O3	14.38	14.88	14.35	14.39	15.36	14.51	14.19	16.21	13.88	16.63	13.86
Fe2O3	0.48	0.37	0.07	0.59	0.75	0.23	0.06	0.76	0.46	2.48	1.23
Fe0	0.88	1.83	2.68	1.62	2.31	1.50	2.40	0.49	0.73	0.40	0.92
MnO	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.05	0.06	0.11	0.08
MgO	0.24	1.30	0.49	0.33	0.89	0.60	0.31	0.26	0.15	–	–
CaO	1.33	0.46	1.89	0.74	0.45	0.93	0.89	0.53	0.87	0.62	0.21
Na2O	3.04	3.10	2.34	2.27	2.90	2.86	3.09	2.28	3.04	5.49	3.11
K2O	4.79	3.36	4.73	4.39	3.79	3.53	3.36	6.73	4.95	6.91	8.88
I.G.	1.66	1.51	0.98	2.00	1.87	1.69	1.46	1.11	0.96	0.50	1.50
Total	100.01	100.00	99.99	99.99	100.02	99.99	99.99	100.00	100.00	99.99	99.99
CIPW NORMS											
Q	33.40	37.86	33.59	40.28	36.24	39.84	38.89	30.83	35.36	6.58	20.67
Or	28.30	19.88	27.96	25.96	22.42	20.88	19.84	39.78	29.27	40.32	51.26
Ab	25.69	26.23	19.77	19.25	24.53	24.19	26.18	19.26	26.08	48.66	22.67
An	6.61	2.28	9.38	3.66	2.22	4.61	4.42	2.63	4.30	0.30	0.00
Ac	–	–	–	–	–	–	–	–	–	–	3.14
Ns	–	–	–	–	–	–	–	–	–	–	0.11
Ru	–	–	–	–	–	–	–	–	–	0.01	–
Ti	–	–	–	–	–	–	–	–	–	2.06	–
Di	–	–	–	–	–	–	–	–	–	–	0.77
Hy	1.69	5.65	5.29	2.74	5.14	3.61	4.49	0.74	1.14	–	0.15
Mt	0.69	0.54	0.10	0.86	1.09	0.34	0.09	1.11	0.67	–	–
Il	0.17	0.74	0.98	0.70	0.81	0.54	0.78	0.32	0.34	0.99	1.22
Hm	–	–	–	–	–	–	–	–	–	1.06	–

Sample locations are shown in Fig.1 and 3 respectively

TABLE 2: Some of the absolute age determinations of the Lesser Himalayan grantitoids

Name of the granitoid	Rb/Sr age Whole rock m years	Sector	Author
Dalhouse granite	456 ±60	Himanchal	Bhanot et al. 1980
Jispa granite	495 ± 16	Himanchal	Frank et al, 1977
Mandi granite	500 ±100	Himanchal	Jaeger et al, 1971
Mandi granite (Aplite)	545 ± 12	Himanchal	Mehta, 1977
Mandi granite (Aplite)	311 ± 6	Himanchal	Mehta, 1977
Rohtang granite	581 ± 9	Himanchal	Bhanot et al, 1980
Rohtang granite	612 ± 10	Himanchal	Bhanot et al, 1980
Garh Kulu gneisses	500 ± 8	Himanchal	'Bhanot et al, 1980
Garh Leucogranite	467 ± 45	Himanchal	Bhanot et al, 1980
Chandra Valley granite	495 ± 16	Himanchal	Bhanot et al,
Southern Lahul granite	476,517,519	Himanchal	Powell et all 1979
Almora granitic body	577 ± 23	Kumaon	Trivedi et al, 1982
Mansehra granite	516 ± 16	Kumaon	Le Fort et al, 1980
Palung granite	486 ± 10	Nepal	Mitchell et al, 1983
Simchaur-Palung granite	493 ± 11	Nepal	Le Fort et al, 1983
Bandal granite	1840 ± 70	Himanchal	Frank et al, 1977
" "	1220 ±100	Himanchal	Bhanot et al, 1980
Baragaon-Nirath granite	1430 ±150	Himanchal	Bhanot et al, 1980
Koidal gneisses	1170 ±120	Kumaon	Bhanot et al, 1980
Brijanigad gneisses	1139 ± 46	Kumaon	Bhattacharya et al, 1981
Ramgarh group porphyry	1860 ± 65	Kumaon	Trivedi et al,1982
Didikot-Askot	1983 ± 77	Kumaon	Bhanot et al, 1980
Askot	1620 ± 90	Kumaon	Powell et al, 1979
Dangoli-Gwaodam	1307 ± 19	Kumaon	Bhanot et al, 1980
Dadeldhura granite	265	Nepal	Talalov, 1972
Trisuli granite	126	Nepal	Talalov, 1972
Metasomatic augen gneisses (27°48′,87°38′,)	120	Nepal	Talalov, 1972
Para augen gneisses	185 ± 7	Sikkim	Acharya, 1973
Para augen gneisses	214 ±10	Sikkim	Acharya, 1973
Para augen gneisses	190 ± 8	Sikkim	Acharya, 1973

K/Ar age determinations in muscovites, biotites and K-feldspars mostly give Alpine ages.

GEOLOGICAL MAP OF THE DAILEKH REGION

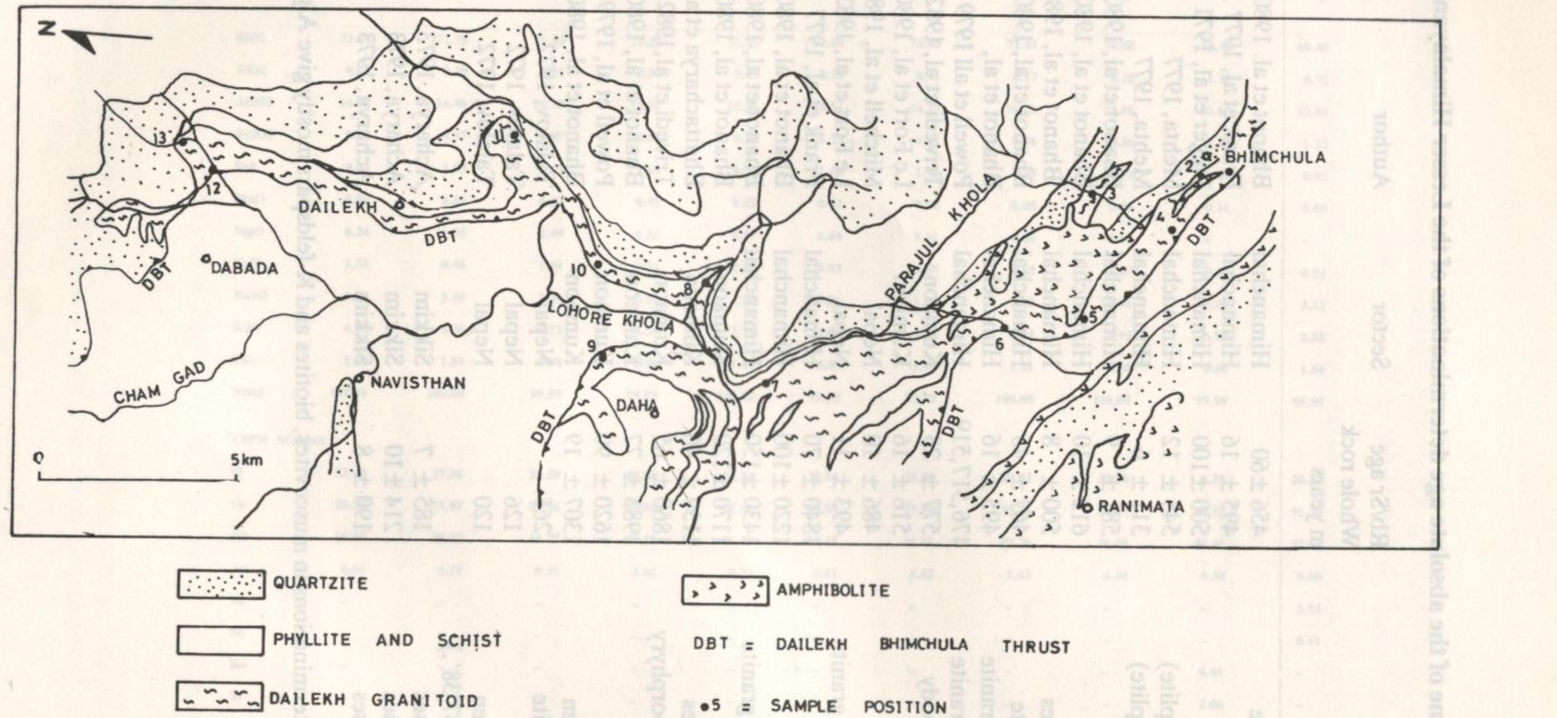


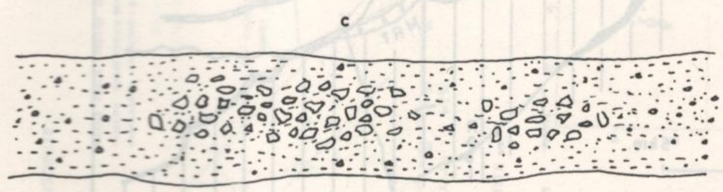
FIG. 1.

DAILEKH GRANITOID

MARMA KHOLA PASGAR NALA GRANITOID

PHYLLITE GNEISS AUGEN GNEISS PORPHYRITIC GRANITOID
COUNTRY ROCK

SCHEMATIC SKETCH ACROSS THE GRANITOID BODY SHOWING DIFFERENT TEXTURAL TYPES

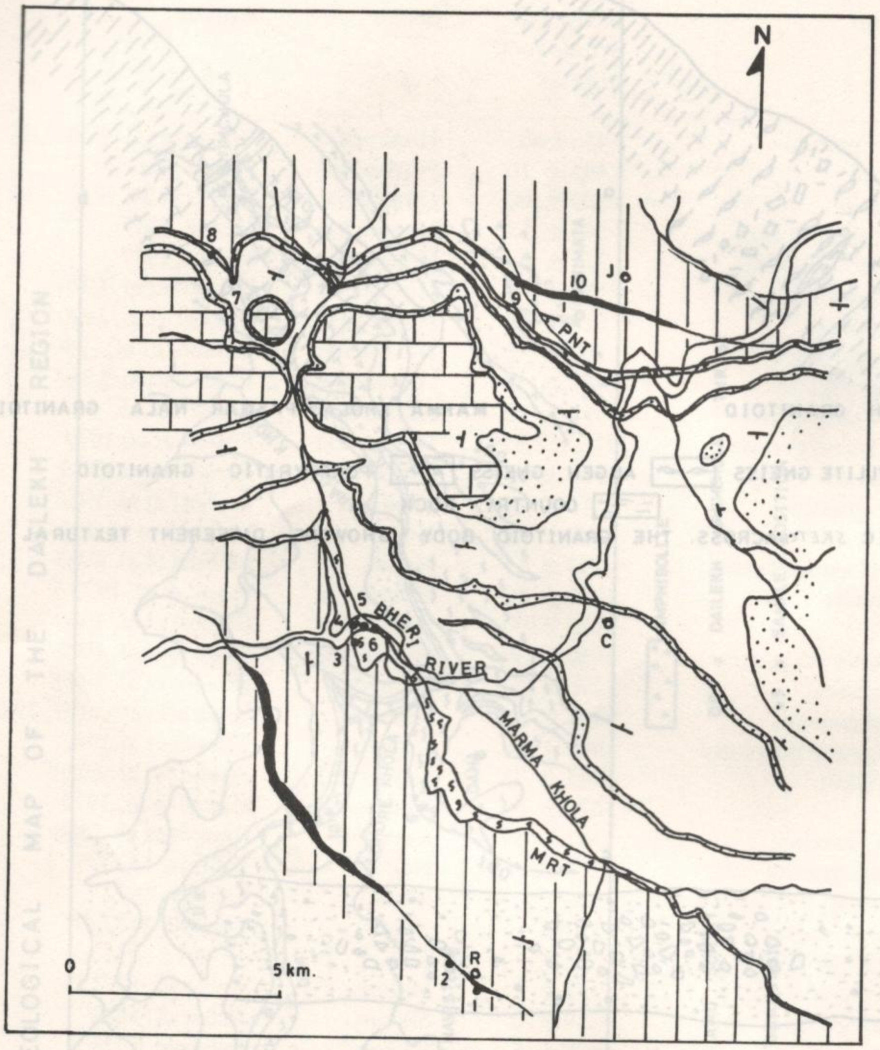


BRECCIATED COUNTRY ROCKS FELDSPAR PORPHYROCLASTS

SCHEMATIC SKETCH SHOWING TRANSITION FROM BRECCIATED COUNTRY ROCKS TO THE GRANITOID ROCKS ALONG THE STRIKE IN THE RAMOLAGAON GRANITOID BODY

FIG. 2.

GEOLOGICAL MAP OF THE JAJARKOT REGION



JALJALA UNIT

MARBLE AND SCHIST

QUARTZITE

SCHIST

KUNCHA UNIT

PHYLLITE SCHIST AND QUARTZITE

MARMA KHOLA PASGAR NALA GRANITOID

BRECCIATED ZONE WITH RAMOLAGAON GRANITOID

J= JAJARKOT, C= CHAURJHARI, R= RAMOLAGAON

MRT= MARMA KHOLA THRUST

PNT= PASGAR NALA THRUST

•5 = SAMPLE LOCATION

FIG. 3.

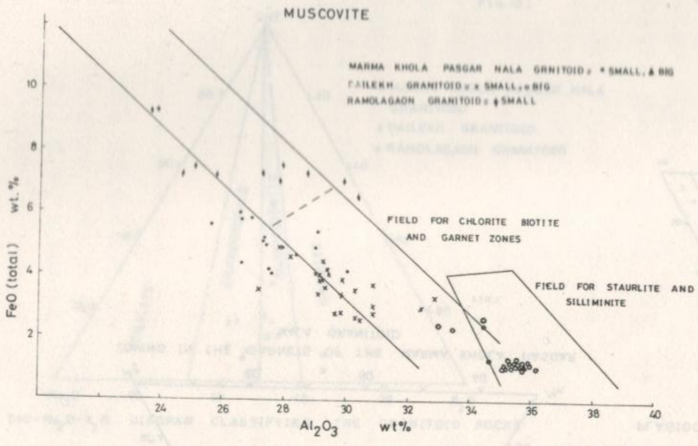


FIG. 4.

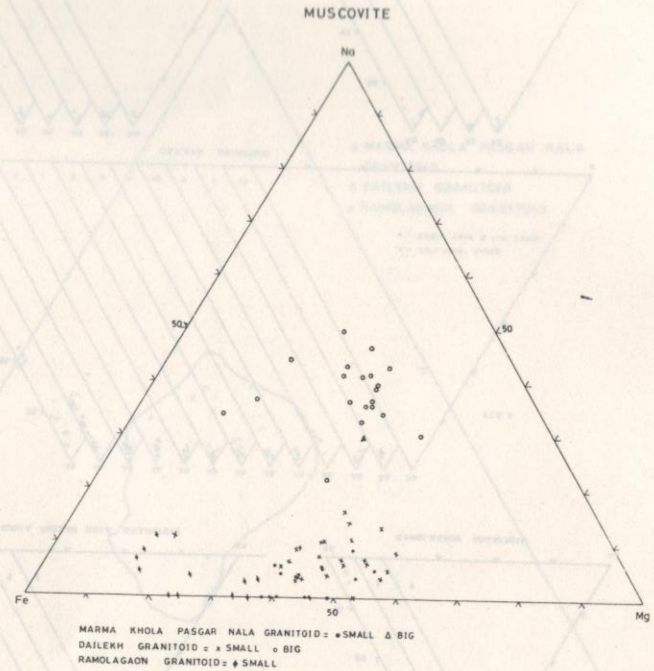


FIG. 5.

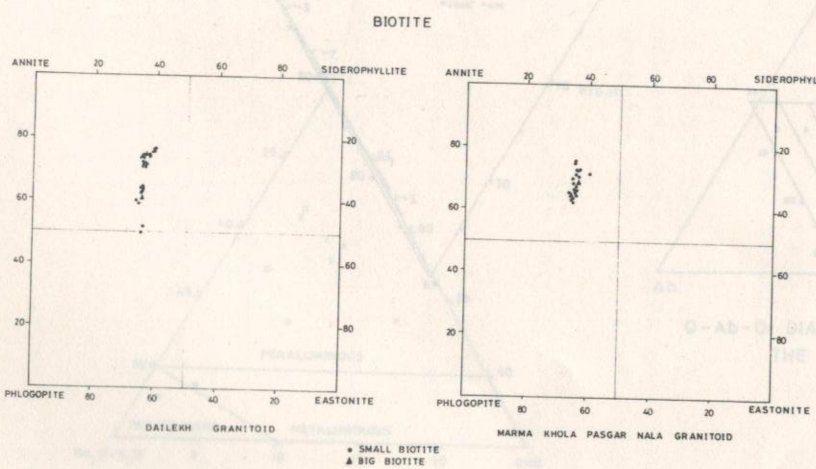
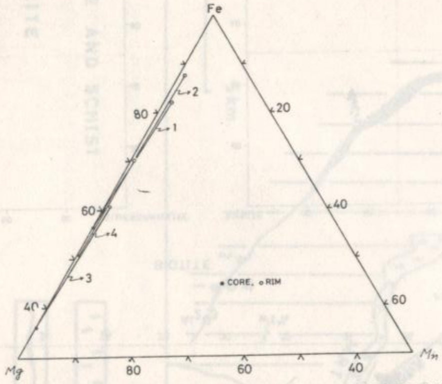


FIG. 6.



ZONING IN THE GARNETS OF THE MARMA KHOLA PASGAR NALA GRANITOID

FIG.7.

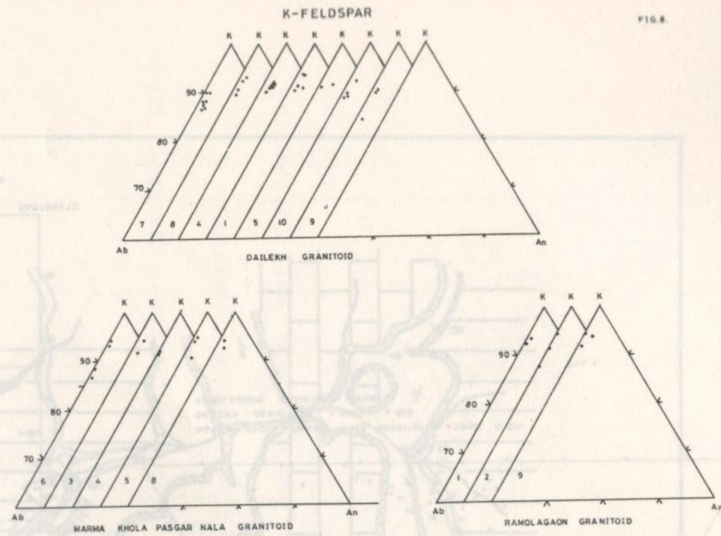


FIG.8.

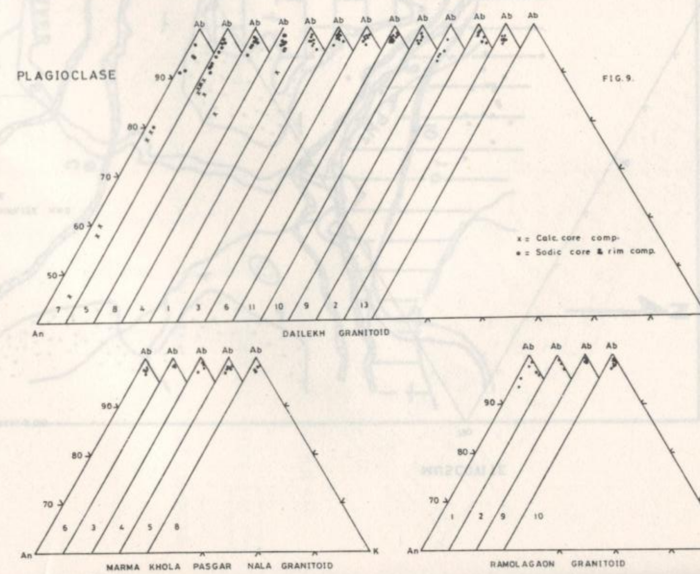
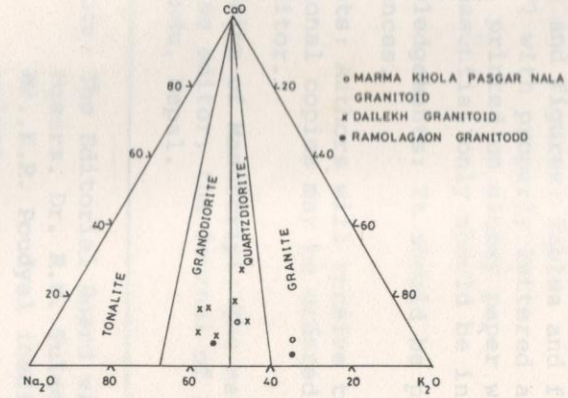


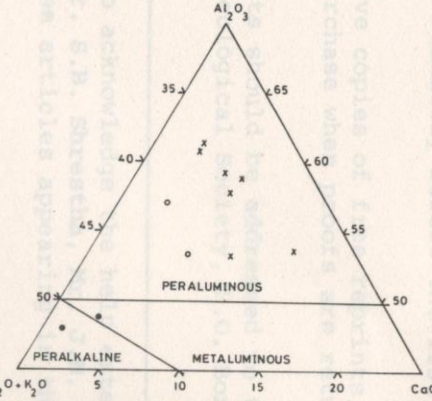
FIG.9.

FIG.10.

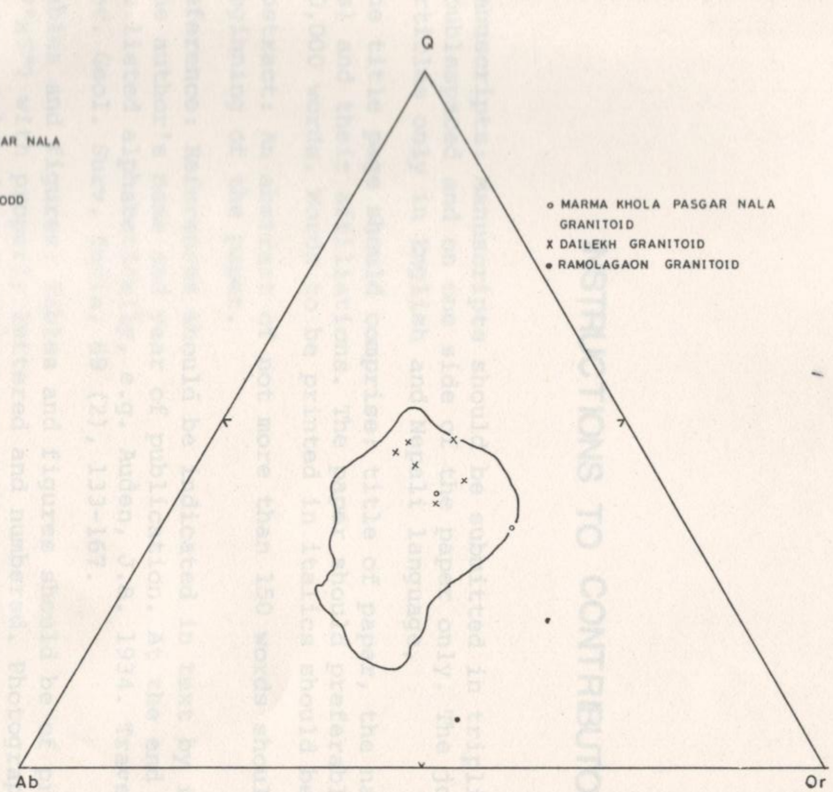


: $CaO-Na_2O-K_2O$ DIAGRAM CLASSIFYING THE GRANITOID ROCKS

FIG.11.



: MOLAR PLOTS OF GRANITOID ROCKS ON $Al_2O_3-(Na_2O+K_2O)-CaO$ DIAGRAM



Q-Ab-Or DIAGRAM OF THE GRANITOID ROCKS, SOLID LINE ENCLOSES THE FIELD FOR THE PLUTONIC GRANITES

FIG.12.