GEOLOGY OF THE BARAUL VALLEY, DIR

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ABSTRACT

Over 520 sq. km. of the Baraul Valley has been investigated geologically and mapped on 1 : 63, 360 scale. Quartzite are the oldest rocks, exposed in the eastern part of the valley, and overlain by the mixed series of Palaeocene-Eocene age which covers the central part of the area. The series includes interbedded volcanics (andesite, dacite, rhyolite, tuff and agglomerates) and metasedimentary/sedimentary rocks (pelitic, calcarious and arenaceous) intruded by small post-Eocene dioritic rocks. A large part of the valley, in the north as well as the south, is occupied by (?)Creto-Eocene diorites, quartz diorites, granodiorites and leucodiorites. The northern contact between the diorites and the mixed seeries is probably faulted.

INTRODUCTION

Northern Dir District is occupied by a vast variety of igneous and metamorphic rocks. Amphibolites and diorites are amongst the most abundant rocks and form a part of the Upper Swat hornblendlc group of Martin *et, al*. (1962) which covers many thousand square kilometers ares between Nanga Parbat and Eastern Afghanistan. Due to an abundance of noritic rocks (now considered pyroxene granulites by Jan, 1977), the group was renamed the Kohistan basic complex by Jan and Mian (1971), the Middle Indus norite group by Desio (1974) and the Kohistan Complex by Tahirkheli (this volume). The Complex, apparently, is more basic in the east (Swat and Indus valleys, where noritic rocks are more nbundant) than in the west (Dir, where diorites and quartz diortites are more abundant).

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To the immediate south, in Jandul Velley, the following four major rock units have been distinguished by Kakar *et al.* (1971) :

4. Late Tertiary phases of granite and diorite stocks, dykes, quartz and pegmative veins.

3. Tertiary volcanic rocks (dacites, andesites, and tuffs interbedded with metasedimentary rocks.

2. (?) Mesozoic plutonic igneous rocks (diorites, granites, norite, pyroxenites, peridotites, hornblandites).

1. (?) Palaeozoic rocks of amphibolite facies.

Similar rocks as those exposed in Baraul Valley have been described to the east and southeast of the area by Arbab and Khan (1973) and Choudhry and others (1974). However, here in contrast to Baraul, amphibolites and granitic rocks also are common whereas volcanic rocks are rare or absent.

The following is a summarised account of the detailed geology, petrography and structure of the Baraul Valley presented in the form of a M. Sc. thesis to the Department of Geology, University of Peshawar (Khan, 1972).

STRATIGRAPHY AND GEOLOGY OF THE BARAUL VALLEY

On the basis of detailed mapping, the following rocks succession has been worked out in the area:

Dioritic Intrusions	Early to Middle Tertiary.
Mixed series	Early Tertiary.
Dioritic Rock	Cretaceous to Early Tertiary.
Quartzites	(?) Palaeozoic.

The Quartzites

These rocks appear near Taus village and cover the eastern part of the Baraual Valley. They appear to have a wedge shaped relationship with the rocks in the west, broadening out eastwards across the Punjkora river. They are moderately- to thickly- bedded and strike NE-SW with NW dip. The rocks are well-jointed, commonly in three directions the most prominent of which is along the bedding. The quartzites underlie the mixed series and appear to be older that the latter; however, the contact between the two has been shown by Arbab and Khan (1973) and Tahirkheli and Jan (this volume) to be faulted. The quartzites have been named Shau Quartzites by Tahirkheli (this vol.).

The rocks are blackish but turn dark grey on weathering; they are hard, compact, medium- to fine-grained, with some linear arrangement of minerals, especially mica. Quartz and biotite are their dominant constituents with subsidiary muscovite and ore. Iron oxide leaching occures along the grains contacts.

The Mixed Series

The mixed series consists of sedimentary/metasedimentary rocks (shales, sandstone, limestone, slate, phyllite, quartzite, schist, amphibolite) and interbedded, weakly metamorphosed volcanic rocks (andesite, dacite, rhyolite, tuffs, agglomerates). The series covers the central part of the area and has a general NE trend and NW inclination, and is thinner in the central than in the eastern and western parts of the valley. In the latter part it reaches a few thousand metres in thickness.

Both vertical and lateral variation in lithology is common; from Chutiatan to Shehikot the sedimentary material is dominant but volcanic rocks increase westwards at their expense and become the dominant rocks in the western part of the valley.

Age and Correlation. The mixed series can be assigned an Early Tertiary age on the basis of fossils. A fine-grained arenaceous limestone of clastic nature, exposed 1.5 km north of Mian Banda, contains Nummulites and Lockhartia. A graphitic calcareous shale near Skhokas contains Aktinocyclina or Discocyclina. Lockhartia has been found in a shaley bed at Shahi (Kakar *et al*., 1971). These fossils suggest an Eocene age for the sedimentary and interbedded volcanic rocks. The series has been called Dir group by Tahirkheli (this volume) and has been divided into Baraul Banda Slates and Ultrot Volcanics.

Dioritic xenoliths are found in the volcanic matrix and vice versa. The diorites of the area can be correlated with those of the Late Cretaceous to the south of Kalam (Jan and Kempe, 1973); it would, thus, seem that the volcanic activity started in the Late Cretaceous and ended in Eocene. The Utrot volcanics of Swat, which have been correlated with those of Dir on the basis of general trend, colour, texture and lithology, have also been considered to be post-Cretaceous and Early Tertiary (Jan and Mian, 1971). Tahirkheli and Jan (this volume) have shown that the Swat and Dir volcanic rocks form a continuous belt.

Volcanic Rocks. A characteristic feature of the volcanic rocks, like those of the Upper Swat (Martin *et al.*, 1962; Sultan 1970; Jan and Main, 1971) is their colour variation-green, red, brown, yellow, grey, white. Thegreenish colour is due to chlorite and epidote and the red/brown to oxidized/hydroxidized iron ore granules. In general, volcanoclastic rocks are more abundant than flows. They are usually fine-grained and more or less homogeneous tuffs or contain larger lithic fragments (usually volcanic but locally also dioritic) in a tuffaceous or lava matix. The fragments are angular to subrounded, variable in texture, composition, colour and, usually, up to several centimetres in size. They are generally distributed at random but in Landai Khwar they are lense-shaped and arranged parallel to bedding. Microfolding is common in the marix as well as in the pebbles. In a few places, fragments of andesite, quartzite and phyllite are set in a groundmass of quartz diorite.

The flows are essentially crystalline but some glassy material, partly altered, is also abserved in most of the thin sections. Many of the rocks are porphyritic and, in some, the feldspar phenocrysts many be more than 2.5 cm in length. Quartz, calcite, and feldspar veins, filling fractures and joints, are common. The rocks can be classified into andesites, dacites, rhyolites and their tuffs; the distinction being based on the amount of quartz and K-feldspar phenocrysts. They appear to be randomly distributed in the field in short distances. Detailed mapping and petrography are needed to find out the changes in composition in space and time.

Andesites. The andesites seem to be more abundant than other rocks and are generally green to greenish pink and locally pilotaxitic. The phenocrysts are mostly of andesine and hornblende, locally of ore and pyroxene, and very rarely of quartz. The groundmass is also composed of these minerals, with epidote, chlorite, sericite, calcite and, in some, traces of sphene—all secondary in origin, mainly after plagioclase and hornblende. The calcite may also form large patches or veins with quartz. Hematitic dust is abundant in the groundmass.

Dacites. These rocks are also porphyrttic and the groundmass, locally, appears to have a schistose fabric due probably to metamorphism. The rocks contain andesine, K-feldspar, hornblende, quartz and ore. Plagioclase is partially or completely saussuritized and hornblende altered to chlorite, biotite, carbonate and (?) actinolite. The groundmass is cryptocrystalline to glassy and rich in hematite dust.

Rhyolites. These rocks contain plagioclase, quartz, K-feldspar, and hornblende phenocrysts in altered glassy to microcystalline groundmass containing minor ore dust. The plagioclase is mostly sericitized whilst hornblende is altered to chlorite, biotite and carbonate. Also ohserved are secondary epidote, and sphene (after ore).

Tuffs. The tuffs, like the flows, are weathered, variable in colour, and may be very similar to some of the interbedded sedimentary rocks in appearance. As these tuffs were laid in marine shelf conditions, sorting is generally poor. The tuffs of the Utror volcanics (Swat) appear to be mostly air borne and welded (Jan and Mian, 1971). It is possible that some of the tuffs in Baraul area are also air borne (Jan, personal communication). The tuffs have calcite veins and are mainly composed of plagioclase, quartz, ore grains and lithic fragments set in a finer grained matix of sericite and hematite, with snbsidiary and probably secondary epidote, calcite and chlorite.

Sedimentary and Metasedimentary Rocks. These include shales, slates, phyllites, and quartzite in main, with some arenaceous limestones, calcareous schists, amphibolites, and sandstone. The rocks are intimately associated and interbedded with the volcanic rocks and the two could not be separately mapped on the scale used (1 : 63, 360). The pelitic rocks are more abundant than the other types.

Shales, Slates, and Phyllites. These rocks are grey, black, brown, reddish or light green (like the associated volcanic rocks), moderately bedded and profusely jointed. They are "altered and crushed", particularly near the diorite contacts. They become more micacieous and talcosic towards the NW. Epidote, calcite and quartz veins carrying ilmenite, tourmaline and, occasionally, Cu-minerals are common. Like the country rocks, these veins are also microfolded. The phyllites may carry red volcanic material parallel to bedding; it seems that simultaneous deposition of volcanic and sedimentary material took place. The rocks show two directions of schistosity suggesting two tectonic episodes.

The shales, slates and phyllites are similar in composition, containing clay/sericite, iron ore (both opaque grains and reddish leaching), carbonate, quartz, biotite and some felspar. Graphite, tourmaline, opidote and pyrite may also occur in the slates and phyllites. Fluctuation in amount of the various minerals is not uncommon in the rocks. The slates usually also have chlorite, talc and occassionally bigger pyrite crystals. Opaque ore is comparatively more common in the dark grey variety.

Calcareous and Silliceous Rocks. The fossilifeous Mian Banda rock is a marmorized arenaceous limestone of fine-grained clastic nature. It contains calcite, quartz and ore with a few fine-grained calcareous fragments and fossils. Sericite, epidote and biotite are the accessories. The fossiliferous shale at Skhokas is rich in carbonate and graphite with lesser amount of quartz and feldspar. In Shaltalu Khwar, almost parallel to the trend of the stream, are found fine- to medium-grained marble bands which are hard, massive, and pinkish white.

Small bands of sandstone are exposed 1.5 km NW of Mian Band and at Skhokas. Rocks in the former occurrence show somewhat parallel orientation of the minerals. They contain quartz, sericite, feldspar and ore, cemented by hematite (hence the reddish fresh or darker weathered colour of the rocks). Calcite, graphite, sphene and amphibole are the other minerals. Quartzitic bands have been found in Shaltalu, Ghingara and Biur. Those of the latter area are fractured, jointed, red-stained and interbedded with phyllites. Those in Shaltalu are white, fine-grained and extremely fractured with N45° E trend.

Amphibolites. These rocks are exposed in Nusart Khwar near Pak-Afghan border and at several other localities as xenoliths in the diorites. They are usually medium-grained but textural variations in the streaky bands are found. Plagioclase, hornblende and quartz are their main constituents, accompanied by ore, biotite, chlorite, epidote and locally calcite which may also occur along the fractures.

The Plutonic Igneous Rocks

The northern and southern parts of the area are occupied by large masses of (?) Cretaceous to Early Tertiary diorites. They locally grade into leucodiorites, granodiorites, quartz diorites, pyroxene-quartz diorites and micro-diorites. The rocks are granular in character but may be gneissic near to contacts. They are medium- to coarse-grained, equigranular to subsequigranular but the mircrodiorites are porphyritic to subporphyritic and contain small veins of quartz and calcite. Poikilitic development of hornblende and biotite and myrmekitic intergrowths are observed in a number of rocks. In addition to the main masses, small intrusions of Early to Middle Tertiary diorite have also been found in the Mixed series such as those near Mian Banda and Sunai.

The southern diorites are in continuation with the dioritic girdle of the Jandule Valley in the southwest. Here they are intruded by a number of porphyritic dykes which are related to the later volcanic activity in the area (Kakar *et. al.*, 1971). Pegmatitic veins ranging from one centimeter to 1½ m in thickness are common, at places abundant, in the northern dioriies. They have a general NE-SW trend and are composed of alkali feldspar and quartz. However, some of them also contain hornblende, tourmaline and, rarely, mica.

The diorites are composed of plagioclase, hornblende, and biotite with minor quartz, epidote, ore, sphene, apatite, pyroxene (both ortho and clino) and muscovite. Quartz $\pm$ K-feldspar are more abundant in some of the rocks (*e. g.* granodiorite, quartz diorites). The leucodiorites are mainly composed of plagioclase with minor quartaz; the accessory minerals make up less than 5%. Veins of quartz and feldspar have been noted in some cases.

The plagioclase (andesine) commonly shows granulation, undulatory extinction and twisting due to deformation. It is zoned, cloudy (in some pseudomorphed by epidote/sericite) and locally contains hornblende inclusions. Myrmekitic intergrowth, deyeloped better at the contact of orthoclase, is also observed. The K-feldspar, mostly kaolinized, is either orthoclase or perthite, the former may have plagioclase inclusions.

The hornblende is light to deep green pleochroic and is tabular in metadiorites. Replacement of hornblende by chlorite, sphene and epidote is common and, locally accompanied by calcite and ilmenite. In a few cases, its cores alter to bluish green actinolite and the margins to chlorite. Biotite is present in almost all the rocks, increasing along with quartz diorites and granodiorites. It is brown to yellow pleochroic and is associated with bornblende and chlorite.

The quartz occurs as minute grains or, along with feldsper and calcite, in the form of small veins. Its amount and grain size increases in the more silicic rocks. In the vicinity of Shahi, it becomes distinctly coarse- grained and has a pinkish-red stain. In some rocks it is poikilitic in character. The opeque ore may be in independent grains, localized along fractures; included in the other minerals; or associated with sphene and hornblende.

Both augite and bronzite/hypersthene, often uralitized green, are present in the pyroxene-bearing diorites. In the rest of the rocks they are either absent or in minor quantity. They are weekely zoned, locally twinned, carry ore inclusions and may be marginally chloritized. At places, the hypersthene, distinctly pleochroic, is surrounded by hornblende, biotite and, rarely augite.

The dioritic rocks are similar to those found to the south (Kakar et al, 1971) and south-east of the area (Chaudhry and others, 1974) and perhaps with those of the Laikot-Kalam area (Jan and others 1971, 1973). However, Jan (personal communication) thicks that a number of dioritic rocks of Dir valley to the south of Chutiatan appear to be amphibolitised basic and intermediate platonic rocks and are not similar to those of the Laikot area.

STRUCTURAL GEOLOGY

The area is structurally complex; it has gone through severe tectonic movements, producing a number of folds (overturned, isoclinal and tight folds) and faults. The whole area may be interpretted as an overturned isoclinal fold as suggested by the succession of rock units in the extreme eastern part of the valley near Taus and the general dip and strike of the rocks. Here, the quartzities may be making the core, whilst the metasedimentary rocks on either side are succeeded by volcanics. The general trend of all these rocks is NE-SW with NW dip, locally modified by minor folds and faults. However, further data is needed before a final assessment can be made about the structure of the area The contact between the quartzites and Mixed series has been shown by Arbab and Khan (1973) to be a probable fault.

The northern contact between the diorites and the Mixed Series is puzzling. It is in the form of the letter Z and the lower NE-SW contact is very much deformed and weathered. Presence of small dioritic bodies in the mixed series may suggest that the northern diorites are also younger than the Mixes Series. However, absence of contact metamorphism and of dykes, sills and veins in the latter in the vicinity of contact do not favour this idea. It may be noted here that similar dioritic rocks to the southerest of the area have been regarded by Chaudhry and other (1974 a, b) to be younger than the Palaeocene sediments.

The Z-shaped contact may actually be a product of faulting at different times. The diorites may originally have been brought in contact with the Mixed series due to faulting, followed by an approximately NS hinge fault perallel to Binr Khwar. A N-S fault, running for many kilometres along Binr Khwar in the Mixed Series may possibly be related to this hinge fault. The shear zone between the Mixes Series and northern diorites, according to Arbab and Khan (1973), may be due to an upward thrust of the diorite body in a mobile state, followed by cooling and later movement.

The southern diorite contact is either a fault or unconformity since the diorites are older than the volcanics.

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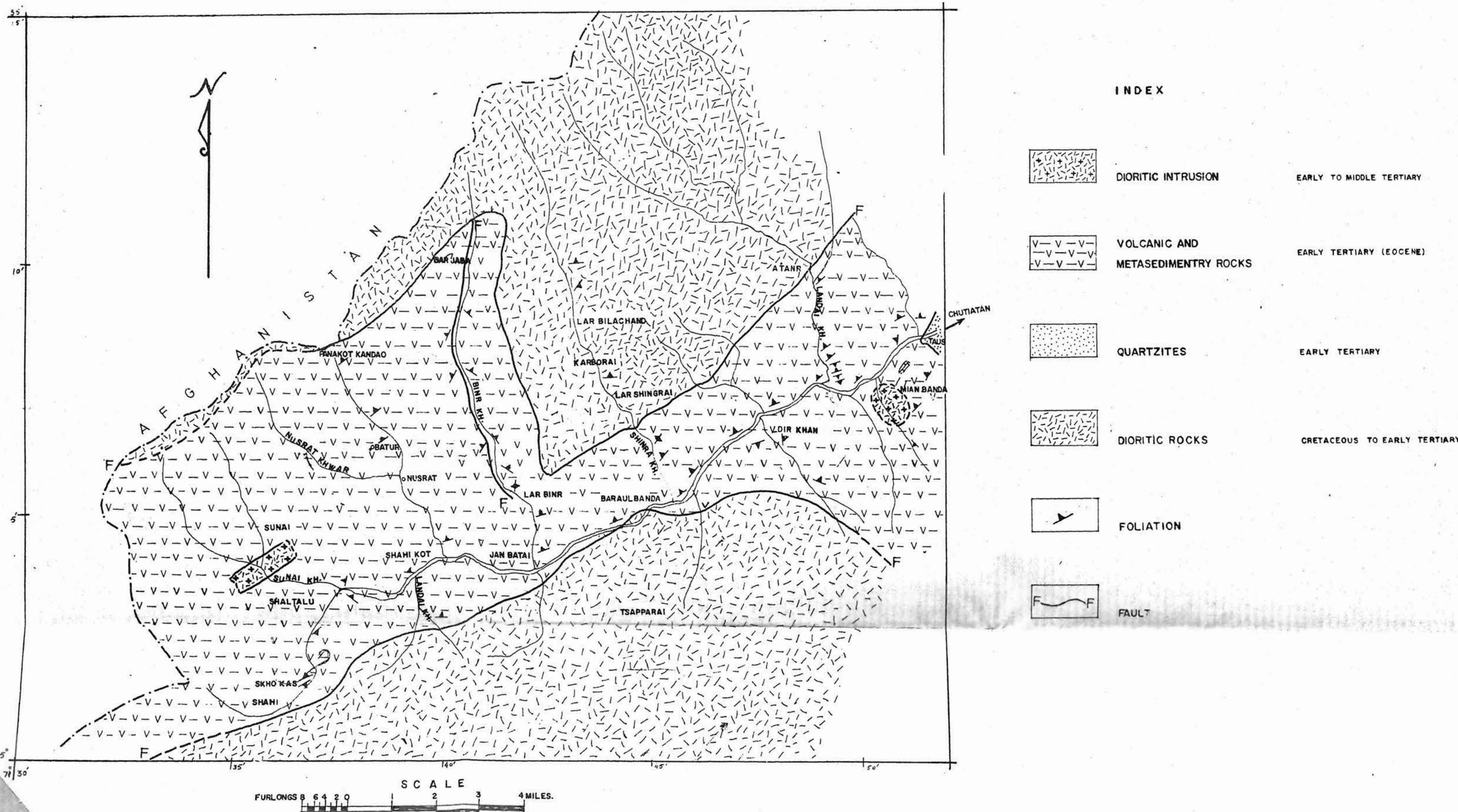

GEOLOGICAL MAP OF BARAUL VALLEY (DIR)

(FAZAL AHMAL)