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LITHOSTRATIGRAPHY OF THE KARAKAR PASS SECTION, SOUTH OF THE MAIN MANTLE THRUST, SWAT, N.W. PAKISTAN

IMTIAZ AHMAD,[1] PAUL S. ROSENBERG,[2] ROBERT D. LAWRENCE,[2] ARIF A.K. GHAURI[1] and MOHAMMAD MAJID[1]

1. NCE and Department of Geology, University of Peshawar, Pakistan.
2. Department of Geology, Oregon State University, Corvallis Oregon, 97331, USA.

ABSTRACT

The Karakar Pass section marks the northern edge of Indo-Pakistan plate. It is predominantly composed of highly deformed and metamorphosed Cambrian and Tertiary (?) granitic rocks and Paleozoic (?) metasediments. The granitic rocks of the area are divided into augen gneisses and tourmaline granites, each belonging to a different age group. The metasedimentary rocks are grouped into Alpurai schists and Nikanai Ghar Marbles.

The augen gneisses are unconformably overlain by the Alpurai schists and tourmaline granites occur as an intrusive sill-like body into the augen gneisses and the surrounding quartzose metasediments. The Alpurai schists includes three members: (1) quartz-mica schist and amphibolites, (2) calc-schists and schistose marbles, and (3) graphitic schist. The whole sequence is terminated in the southeast by the Nikanai Ghar Fault which juxtaposes these units against the Nikanai Ghar Marbles.

INTRODUCTION

The Karakar Pass section is located approximately 95 km. northeast of Peshawar, in the Buner region of Swat District. It is bounded by long. 72°15' to 72°22.5'E and lat. 34°00 to 34°36'N (toposheet No. 43B/6 Survey of Pakistan). Rocks of the area belonging to the Lower Swat-Buner Schistose Group and Swat Granitic Gneisses (Martin, *et al.*, 1962) are interpreted as a marginal slice of the Indian plate, bounded in the north by the Main Mantle Thrust (MMT), and in the south by a series of northward dipping thrust faults of Hill Ranges (Yeats and Lawrence, 1984) *(Fig. 1)*.

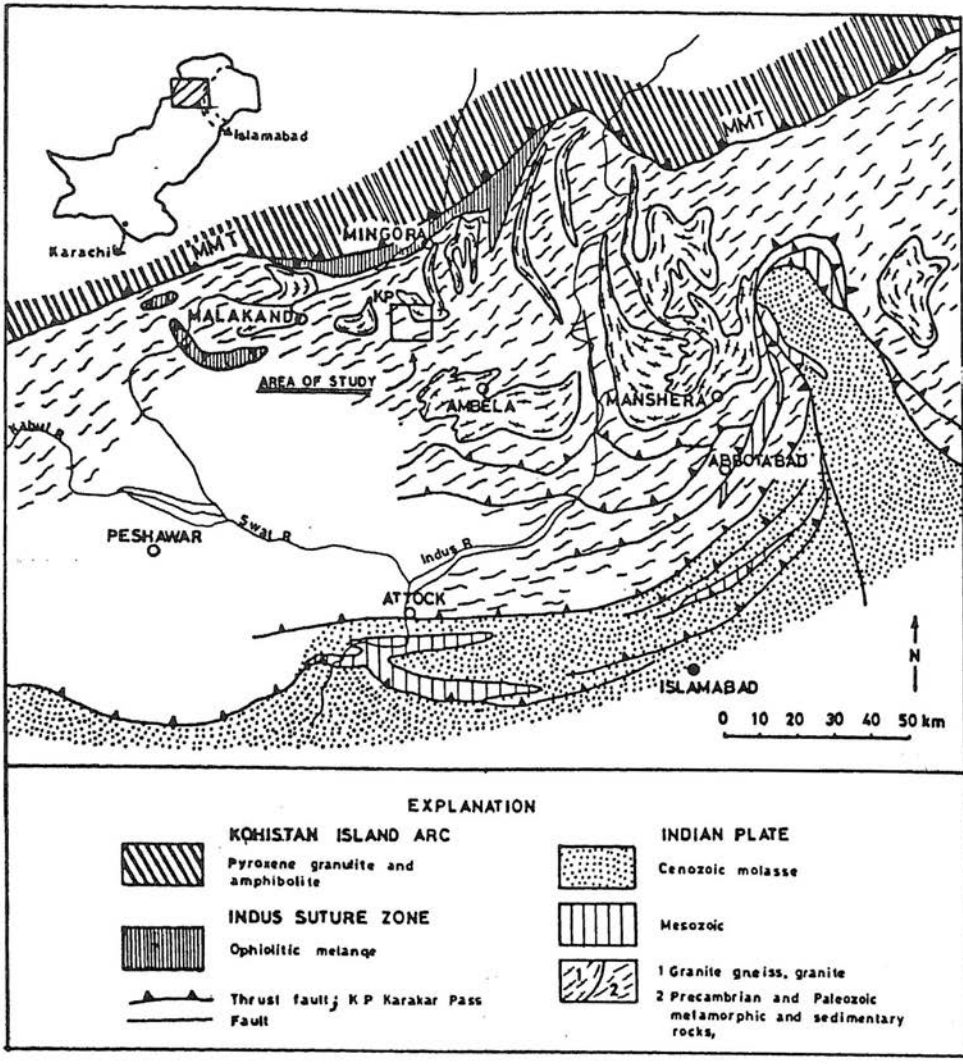


Fig. 1. Generalized geologic map of the Himalayan mountains of northern Pakistan south of the Main Mantle Thrust, (modified after Maluski and Matte, 1984).

According to Martin *et al.*, (1962), the Lower Swat-Buner Schistose Group includes siliceous schist, amphibolite, marble and calcareous schist, phyllite, and green schist. These rocks are intruded syntectenically by Swat Granitic Gneisses, forming parallel bedded sheets within the siliceous schist unit. Schists, marbles, amphibolites and underlying gneisses are considered as a crystalline thrust sheet of the Indian plate, which moved southwards on a thrust plane exposed as a zone of recrystallized mylonites at the base of Swat gneisses (Humayun, 1985).

Kazmi *et al.*, (1984) subdivided the Lower Swat-Buner Schistose Group into lower Manglaur schists, unconformably overlain by the Alpurai schists and

suggested that the Swat gneisses intrude only the lower Manglaur schists (Table I). However, in the Karakar pass section, the Manglaur schists are not clearly identified. As a result the stratigraphic sequence consists of Swat augen gneisses, unconformably overlain by the Alpurai schists. Younger tourmaline granites are present as an intrusive body within the Swat augen gneisses and the metasedimentary rocks. The entire sequence exhibits a probable faulted contact with the Nikanai Ghar Marbles (Fig, 2). From the present study it is concluded that the stratigraphic sequence present in the Karakar Pass section is upside down. Presence of the large recumbent fold in the lower Swat-Buner region (Rosenberg, 1985; Ahmad, 1986) is inferred from this conclusion.

STRATIGRAPHIC SET-UP

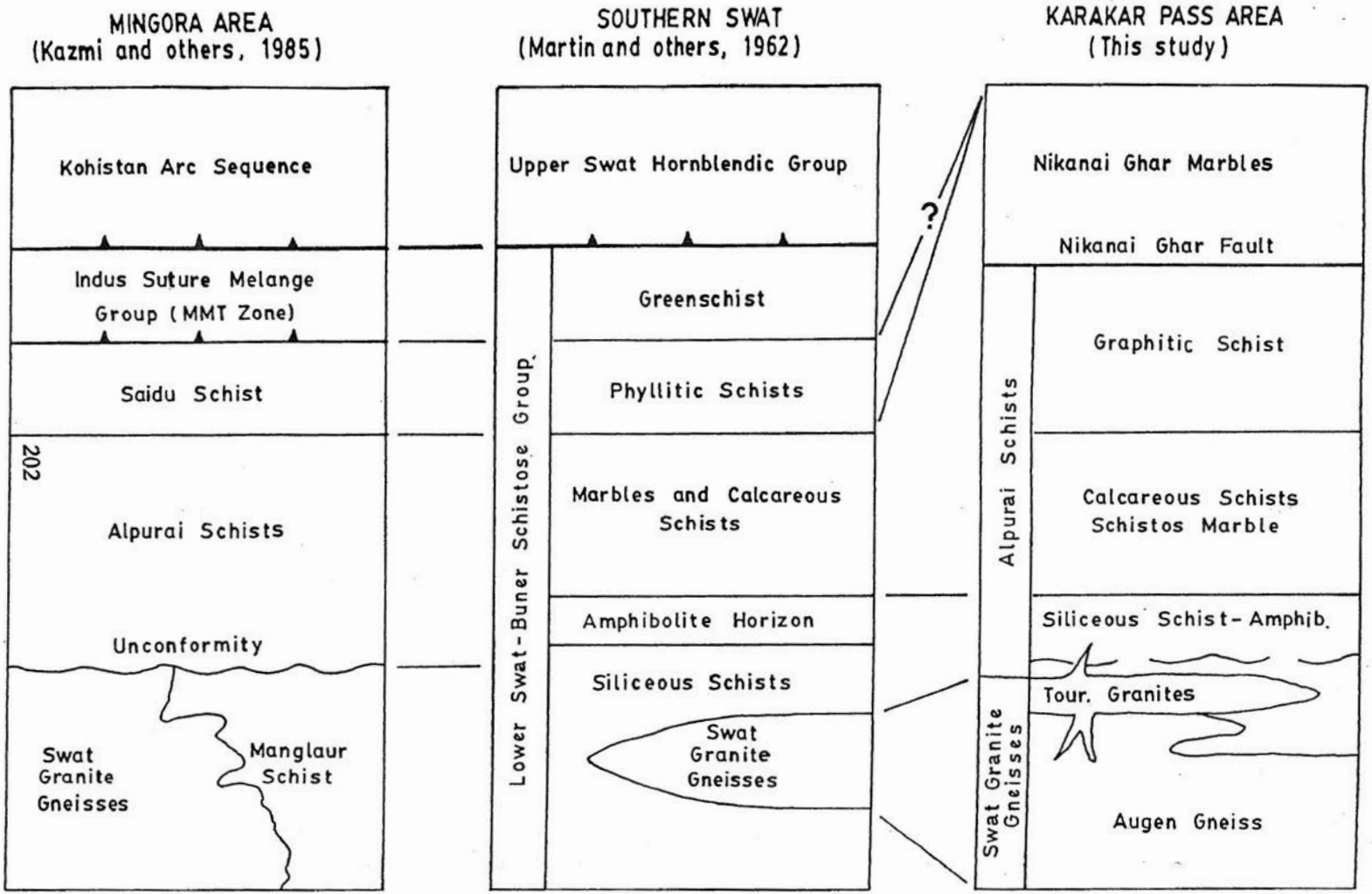
1) Swat granitic rocks

This unit includes the augen gneisses and the tourmaline granites. The augen gneises are characterized by the presence of large potassium feldspar augen in a groundmass of quartz, feldspar, and biotite, while the tourmaline granites are characterized by the presence of black tourmaline crystals, and absence of biotite and feldspar augen.

Augen gneisses: The augen gneisses form deeply weathered, buff to brown outcrops that typically exhibit spheriodal weathering. In handspecimens and outcrops, these gneisses usually contain about 20% to 30% augen formed of lensoidal or rarely spheroidal potassium feldspar megacrysts. Very locally these are euhedral, indicating that they are remnant igneous porphyroclasts. They reach in size up to 6 cm in length. These megacrysts are set in a medium- to coarse-grained groundmass of quartz, potassium feldspar and plagioclase. Flaser (phacoids) of medium to coarse-grained, granular aggregates of quartz and feldspar surrounded by a cataclastic matrix are common. In many places these are so abundant that the rock is described as a flaser gneiss. Medium-grained biotite and muscovite are present in subequal amounts and together make up about 10% by volume of the rocks. These form micaceous layers, oriented parallel to the streaks and layers of quartz and feldspars. Minor amounts of garnet, epidote, sphene, and opaque minerals are also present.

In thin section the augen gneiss exhibits coarse crystals of quartz, potassium feldspar, and plagioclase feldspar, in a finer matrix. Larger crystals of quartz, orthoclase, and microcline display undulose extinction and deformation bands. Some of the deformation is clearly related to strain, induced by the movement along grain-to-grain contacts. Occasionally, biotite and muscovite crystals are bent and kinked. Cataclastic gneissic foliation, defined by the alternating and discontinuous quartzo-feldspathic and micaceous layers, is well developed near the margins. It gradually diminishes toward the interior within the study area; but appears in a more random distribution elsewhere (Carter, Dipetro, pers. com., 1987). It is parallel to the regional foliation in the enclosing metasedimentary

TABLE 1. COMPARATIVE STRATIGRAPHIC COLUMNS FOR SOUTHERN SWAT.



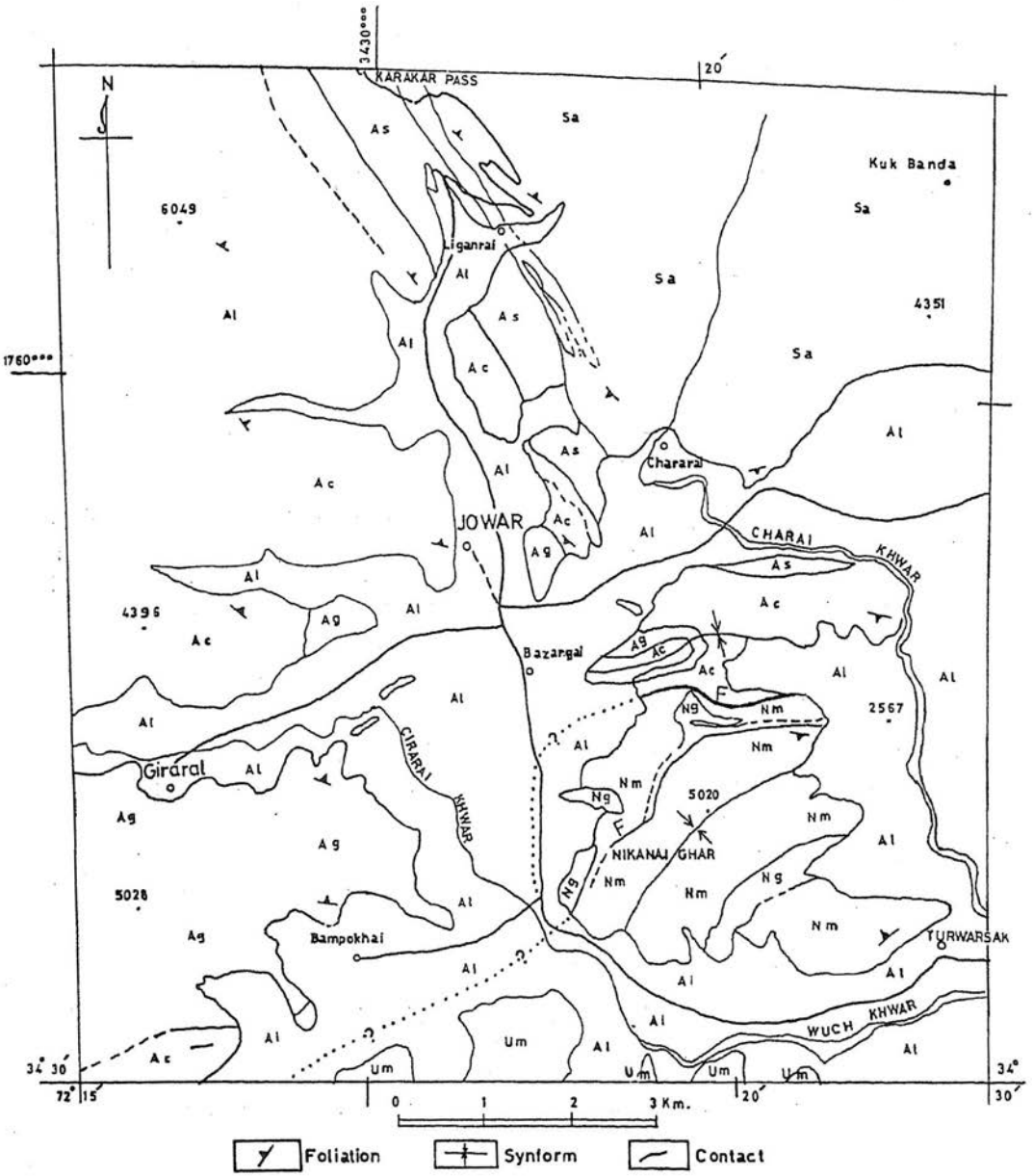


Fig. 2. Geologic map of Karakar Pass, south of the Main Mantle Thrust, Swat District, N.W.F.P., Pakistan. Sa: augen gneisses; Tg: tourmaline granites; As: siliceous schist and amphibolites; Ac: calc-schists and schistose marble; Ag: graphitic schist and lesser calc-schist and schistose marble; Nm: marbles and dolomitic marbles; Ng: undiff. graphitic schist, calc-schist, schistose marble; Um: unmapped; Al: alluvium.

rocks. At some places along the margins, augen gneisses grade into a zone of fine-grained mylonitized augen gneisses up to several meters in thickness.

The augen gneisses at Karakar Pass are part of the loop-shaped body that extends upto Mingora. Similar bodies of augen gneisses crop out at Chakdarra, Kotah, Alpurai, Karora, and Mansehra (Fig. 1), which are described as part of peraluminous granite gneisses of Late-Precambrian to Cambrian age, that extend along the northern margin of the Indian plate (Jan *et al.*, 1981; Le Fort *et al.*, 1980, 1983).

Tourmaline granites: The tourmaline granites crop out at the margin of the augen gneisses and form a sill-like body ranging in thickness from less than 0.5m to over 300m. This unit also forms dykes within the augen gneisses and in the surrounding metasediments.

The tourmaline granites are generally medium-grained and moderately foliated. They are composed of potassium feldspar, quartz, plagioclase, muscovite, and 3% to 15% black tourmaline. The tourmaline grains are scattered throughout the rock or concentrated in thin bands parallel to the regional foliation.

In thin section, the texture of the tourmaline granites is granoblastic-elongate. Quartz, microcline, orthoclase, and plagioclase grains are elongated in one direction. Muscovite and tourmaline are randomly dispersed within the rock, but in some section they display preferred orientation, parallel to the foliation.

Tourmaline granites are widely distributed as small plutons and minor intrusions in the metamorphic rocks of the northern part of the Indian plate (Shams, 1983).

2) Alpurai Schists

The term Alpurai Schists was introduced by Kazmi *et al.* (1984) for the lower three units of Lower Swat-Buner Schistose Group of Martin *et al.* (1962). In the present study, a thick sequence of graphitic schist having a conformable contact with the underlying Alpurai schists, has been included in this formation. The Alpurai schists consists of the following units :

a. Quartz-mica schist and amphibolites.
b. Calc-schists and schistose marbles.
c. Graphitic schist.

Quartz-mica schist and amphibolites: This unit consists of feldspathic quartzite, quartzite, quartz-mica (garnet) schist, biotite schist, biotite-zoisite schist, quartz-muscovite schist, quartz-hornblende schist, and amphibolites. The amphibolite

beds are 1–20 meters thick and become more abundant up section toward the contact with calc-schists and schistose marbles unit. Near the contact, it contains coarse massive epidote, and epidote-amphibolite lenses. This unit always crops out along the margin of the Swat granitic rocks, and has sills and dykes of tourmaline granites. The estimated thickness of the unit is 500–750 meters at Karakar Pass section. The chemical composition of the amphibolites suggest that they are developed from tholeiitic basalt magma (Ahmad, 1986).

Calc-schists and schistose marbles: This is the thickest unit of the formation, and crops out over a large area. It consists of calc-schist, garnet-actinolite calc-schist, and schistose marble with minor amount of massive, white to grey marble. The schistose marbles are thinly-laminated with interbeds of calc-schist. They are light to dark-grey, sometimes banded (white and grey coloured), and consist of calcite, graphite, quartz, and muscovite. The silicate minerals often form layers which are 1–3 centimeters apart. The calc-schists vary from light grey to brownish-grey in colour, and consist of calcite and silicate minerals which sometimes form alternating layers ranging in thickness from 1 to 5 cm. The garnetiferous schists are characterized by the presence of garnet porphyroblasts, and acicular actinolite grains. The calc-schists and schistose marbles have a sharp contact with the underlying amphibolites, which is a major and abrupt lithologic change in the area. The apparent thickness of the unit is 4000 meters, but this is presumed to be greatly modified by internal folding and high strain the unit has undergone.
Graphitic schist: This unit overlies the calc-schists and schistose marbles sequence with a conformable contact. The contact with underlying rocks is mostly sharp but an interbedded sequence with the calc-schists and schistose marbles is not uncommon. The unit is dark-grey in colour and consists of graphite-quartz-muscovite schist, which is phyllitic in character. It is strongly folded and crenulated with one major and another minor lineation, marking at least two episodes of deformation.

The whole sequence of the Alpurai schists is interpreted to be abruptly terminated by a fault, designated as "Nikanai Ghar Fault" (Ahmad *et al.*, this volume), juxtaposing these units against a thick, white, massive and dolomitic marble unit described as "Nikanai Ghar Marbles".

3) Nikanai Ghar Marbles

The "Nikanai Ghar Marbles" is here distinguished as a separate formation for the first time. Previously it was included in the marble and calc-schists unit of the Lower Swat-Buner Schistose Group (Martin *et al.*, 1962). Lithologcially, the formation consists of marbles, with minor amounts of quartzite, calc-schist, and graphitic schist. The marbles are massive to thick-bedded, coarsely crystalline, and partly dolomitic, with poorly preserved fossils. These are white, light-grey to dark-grey in colour. The degree of internal deformation could not be determined due to the massive nature of the marbles and lack of compositional layering or

platy silicate minerals. Quartzite, graphitic schist, calc-schists and schistose marble are present either as tectonic slices or as interbedded layers within the massive marbles. The upper contact of the formation is not exposed, while the lower contact with the Alpurai schists is marked by the "Nikanai Ghar Fault".

DISCUSSION ON THE INTRUSIVE CONTACT RELATIONSHIP

The contact relationships of the Swat granitic rocks with the surrounding metasediments are difficult to interpret because of intense deformation, possible high strain rates, metamorphism, and later intrusion of the tourmaline granites. However, in the Karakar Pass section, the observed contacts are between :

a. Augen gneisses and tourmaline granites, and
b. Tourmaline granites and Mangular schists(?) or Alpurai schists.

Effects of tourmalinization, and occurrences of sills and dykes of tourmaline granites are common in the augen gneisses near their contact with the tourmaline granites in the lower Swat-Buner region.

In the Karakar Pass section, the contact between the augen gneisses and tourmaline granites is occupied by a wedge shaped, thin slice of metasedimentary rocks. The intervening rock is intensely sheared and highly deformed. However, a direct contact has been observed at Suknu Kandao, near Liganrai village. The contact in this section appears gradational due to the tourmalinization and intense shearing, where biotite and feldspar augens increases and tourmaline decreases toward augen gneisses.

The contact between tourmaline granites and adjacent metasediments is mostly sharp and concordant with the regional foliation and bedding planes. However, the presence of numerous sills and veins of tourmaline granites in the metasediments establishes an intrusive contact.

On the basis of regional mapping, Kazmi *et al.* (1984) suggested the occurrence of an unconformity between the Alpurai chists and the Swat Granitic Gneisses. This idea is strongly supported by the presence of the same stratigraphic sequence (Alpurai schists) all over the lower Swat area from Alpurai in the north to Malakand in the south. The work reported here shows that the tourmaline granites intrude the lower part of the Alpurai schists and are, therefore, substantially younger than the augen gneisses.

CONCLUSION

On the basis of field relations, existing regional mapping, stratigraphy, and correlation, the rock units of the Karakar Pass section can be summarized as under :

Tourmaline Granites	....	Tertiary (?)
Nikanai Ghar Marbles	....	Middle Paleozoic
——————Nikanai Ghar Fault——————		
Alpurai Schists	....	Paleozoic (?)
—————— Unconformity ——————		
Swat augen gneisses	....	Late Precambrian to Cambrian
Manglaur Schists (?)	....	Precambrian

The Swat augen gneises are generally considered to be Late Precambrian to Cambrian in age on the basis of their correlation with the Mansehra pluton (Jan *et al.*, 1981). The Mansehra Granite has Rb/Sr whole-rock isochron age of 515 ± 16 m.y. (Le Fort *et al.*, 1983).

The Swat augen gneisses show no intrusive relationship, at least with Alpurai schists, which overlies unconformably the Manglaur schists (?) and the Swat augen gneisses (Kazmi *et al.*, 1984). However, the presence of an unconformity cannot be confirmed within the Karakar Pass area. It may be obscured by intense deformation and metamorphism and later intrusion of tourmaline granites. The rock units present in the Alpurai schists are similar to those present in the Paleozoic sequence of Nowshera and Swabi area (Stauffer, 1968, Pogue, *et al.*, in prep.). Therefore, the Alpurai schists may be Paleozoic in age.

The associated tourmaline granites intrude the Swat augen gneisses and the Alpurai schists. They were deformed during Himalayan metamorphism (Rosenberg, 1985). This suggests that they are younger than Paleozoic and older than Cenozoic Himalayan orogeny. Therefore, the tourmaline granites may be early Tertiary (?) in age.

King (1961) assigned a probably Silurain-Devonian age to the Lower Swat-Buner Schistose Group on the basis of fossils found in marbles unit at Torwarsak. During the present study, fossils were observed in the Nikanai Ghar Marbles from the massive dolomitic marble unit. These fossils have been described by Dr. William A. Oliver at National Museum of Natural History in Washington D.C. (Per. comm. 1986) as "apparently some type of colonial metazoans". According to his observation they are massive bryzoans of Paleozoic age, but the possibility that they belong to any one of several Mesozoic-Cenozoic groups, including bryzoans, corals, hydrozoans, or sponges can not be ruled out. In any case they are not Precambrian and are probably Ordovician or younger. The Nikanai Ghar Marbles and the Alpurai schists show some lithologic similarities, which suggest that both of these are from the same depositional basin. However, the stratigraphic position of the Nikanai Ghar Marbles with respect to the Alpurai schists shows that the former may be younger in age.

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