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Occurrence of a melange along the Malakand pass north of Dargai, northern Pakistan

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Abstract

An ophiolitic mélange has been identified along the Malakand pass north of Dargai. The mélange is characterized by exotic blocks of talc-carbonate, talc actinolite schist, greenschist and plagio-granite in a matrix of graphitic schist of the Saidu formation. It has an northeast southwest extension. The mélange is considered as imbrication of the MMT zone along the Kishora thrust.

1. Introduction

In Swat area north of Malakand, the Indus suture zone (also known as the Main Mantle thrust zone) consists of discontinuous, strongly imbricated, ophiolitic mélange slices which are wedged between the Indian plate to the south and Kohistan island arc to the north. Kazmi et al. (1984) subdivided the Indus suture zone into the Mingora ophiolitic mélange, Charbagh greenschist mélange and the Shangla blue schist mélange. Similarly south of Malakand, ophiolitic and ultramafic rocks occur and known as Harichand Ultramafic Complex (Uppal, 1972), Sakhakot-Qila Ultramafic Complex (Rafiq, 1984), Kot-Prang Ghar mélange (Hussain et al., 1984) and the Dargai klippe (Tahirkheli et al., 1979; Malincanico, 1982; Lawrence et al., 1989).

This paper documents the occurrence of an ophiolitic ménage from the Malakand pass north of Dargai (Fig. 1) which is extending to the Kot area in the west and Jowar in the east.

2. Field and petrographic features of the blocks and matrix of the ophiolitic mélange

The area north of Dargai comprises metasedimentary rocks of the Indian shelf marked as an Alpurai group. It is consisted of the basal unit as the Marghazar formation followed by Kashala and the upper unit as the Saidu formation. The ophiolitic mélange occurs in a sheared matrix (graphitic phyllite) of the Saidu formation with a northeast southwest extension (Fig. 1). The mélange is comprised of blocks of greenschist, talc-carbonate schist, plagio-granite and talc-actinolite schist. In the following section field and petrographic features of the blocks and the matrix are described.

2.1. Greenschist

Foliated, grayish-green, chlorite-rich greenschist occurs as blocks in the melange zone. Most of the rocks are schistose and have elongated porphyroblasts of feldspar and quartz in a matrix dominated by chlorite. Feldspar porphyroblasts range from 1 mm to 5 mm in length, and are more clearly visible on weathered surfaces. Pyrite cubes are common. The greenschist comprises the mineral assemblage chlorite + plagioclase + epidote + quartz + muscovite as major constituents while calcite + hematite + pyrite and ilminite as accessories. Chlorite occurs as flakes as well as laths and defines the foliation. It is pleochroic from colourless to light green. Plagioclase occurs as porphyroblasts with inclusions of epidote, quartz and chlorite. Twined grains are also common. Plagioclase is albite in composition and is determined both under the microscope and by XRD. Xenoblastic strained quartz is very common.

Epidote occurs as xenoblastic to idioblastic grains in a fine matrix of chlorite, quartz, and plagioclase. Calcite occurs as patches in the matrix and also as a secondary vein mineral. Some calcite veins crosscut the foliation.

The mineral assemblage of chlorite + albite + quartz + muscovite + epidote is representative of greenchist facies metamorphism. The protolith of these rocks are most likely mafic to intermediate volcanic flows or tuffs.

2.2. Talc-carbonate schist

Brownish to brownish-gray talc-carbonate schist occurs as blocks in the melange zone. The talc shine and its soapy character are easily distinguished. The brown color is due to weathering of the metallic minerals probably magnetite. Fuchsite (green mica) is common. South of the Malakand pass the talc-carbonates make a chain of blocks and brecciated contact can be seen (Fig. 2). These talc-carbonate rocks were earlier reported by Jan and Shah (1987) and regarded from ultramafic precursors based on high Cr and Ni contents.

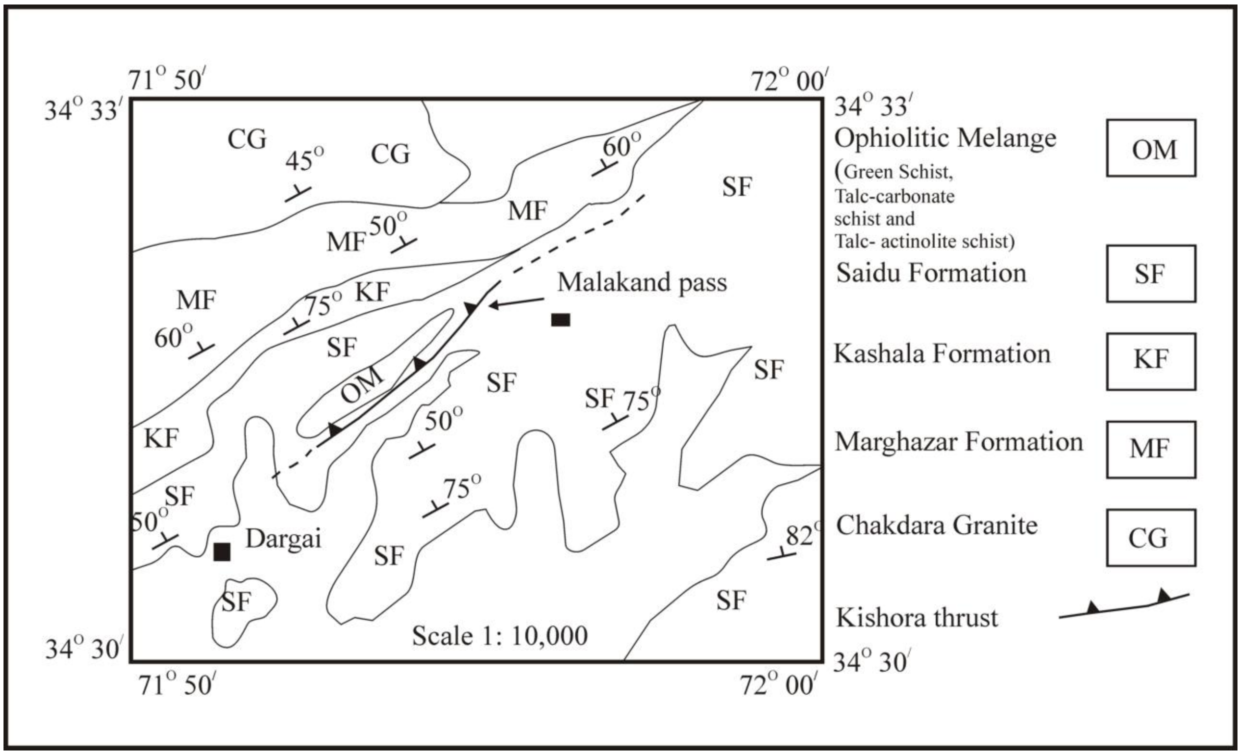

Fig. 1. Geological map of the Malakand pass area.

Fig. 2. Faulted contact (black line) of the talc-carbonate (left) with the graphtic phyllite (right), along the Malakand pass.

The talc-carbonate contains dolomite + talc as essential minerals. Accessory minerals include calcite, siderite, quartz, plagioclase, magnetite, fuchsite, chlorite, sericite, and epidote. Dolomite occurs as xenoblastic as well as idioblastic grains. Few dolomite xenoblasts have inclusions, which are quartz, plagioclase and talc. Siderite occurs as subhedral grains stained by iron alteration on the margins.

Quartz and plagioclase occur as patches and layers of fine aggregates that are probably later veins or formed during the emplacement of the blocks into the matrix rock. Most of the grains are subangular. Talc and chlorite occur as flakes and shreds throughout the matrix that define the foliation. Talc is mostly after dolomite. The mineral assemblage dolomite + talc + chlorite is representative of low grade greenschist facies metamorphism. The protolith of the rock may be an impure dolomite.

2.3. Plagio-granite

In hand-specimen and outcrop this is a pinkish white rock with dark cluster and patches of biotite. Altered magnetite spots are also common. The rock is medium-grained and weakly foliated. The rock contains the mineral assemblage feldspar (plagioclase, orthoclase) + quartz + biotite + magnetite with minor clinopyroxene, epidote, muscovite, sericite. The texture is granoblastic with weak foliation.

Plagioclase occurs as fine- to medium-grained xenoblasts, sericitized on the margins and showing undulatory extinction. It is albite in composition and determined by XRD. Twined grains are common. Quartz grains occur as xenoblast and have inclusions of biotite and rare muscovite. Very few grains are flattened along the foliation.

Biotite occurs as clusters and thin tabular grains along the intersticies of the quartz and feldspar grains. Some of the biotite grains are kinked. Clinopyroxene occurs as subhedral grains which are mostly deformed. Magnetite clusters can be seen along the cleavages.

The mineral assemblage is compatible with greenschist facies metamorphism. The modal proportion of the minerals (65% feldspar; plagioclase much more than the potash feldspar, 25% quartz, and 10% mica) indicates that the rock is trondhjemitic in composition.

2.4. Talc-actinolite schist

The talc-actinolite schist is a whitish rock with green radiating actinolites. It occurs as thin sheets in association with the greenschist in the melange zone. Under the microscope it is composed of talc, actinolite and chlorite which are strongly foliated. The rock is probably derived from an ultramafic protolith.

2.5. Graphitic schist

The graphitic schist of the Saidu formation serves as the matrix. It is a fine- to medium-grained rock with grain-size of quartz and feldspar ranging from about 0.2 mm to 2 mm. The graphitic schist has a well-developed segregation banding defined by alternating quartzo-feldspathic microlithons 1 mm to 4 mm in thickness, bounded by white mica and graphite cleavage domains of about 1 mm or less in thickness.

Under the microscope the rock contains the mineral assemblage quartz + plagioclase + muscovite + chlorite + graphite + zoisite. Accessory minerals include opaque ore, biotite, pyrite, and calcite. Xenoblastic quartz is the major phase in most of the sections and constitutes 40 to 45% of the modal volume. It exhibits undulatory extinction and sutured boundaries in the pressure shadows around the feldspar porphyroblasts. Plagioclase also occurs as xenoblasts and exhibits undulatory extinction. Together, quartz + plagioclase make greater than 60% of the modal volume. Muscovite, biotite, and chlorite constitute 15-20% of the modal volume. Mica flakes with graphite dust define the foliation. They have been folded. Crenulation lineation and cleavage is also observed. Relict of the earlier foliation exists in the microlithons of the later foliation.

Zoisite occurs as elongated tabular grains along and across the foliation. It makes about 1% of the modal volume. Those lying across the foliation are pre- to syn-kinematic with respect to the foliation, because foliation truncates against these grains.

The texture shows at least three fabrics, the relict of the earlier foliation S_1 in the later foliation S_2 and the crenulation lineation L_2. In some sections two sets of lineation are present. The mineral assemblage quartz + plagioclase + muscovite + zoisite is typical of greenschist facies rocks. The protolith of these graphitic schist is probably quartzo-feldspathic with organic and silt-clay constituents.

3. Discussion

The association of metabasic and ultramafic rocks in the melange complies with current definitions of the ophiolite suite (Coleman, 1977; Dewey and Bird, 1971; Moores and Vine, 1971). The present melange is regarded as imbrications of the ophiolitic melanges of the Indus Suture (MMT) Zone.

The MMT was identified as the continuation of the Indus Suture Zone by Tahirkheli et al. (1979). They placed the MMT fault contact variably above or below rocks of the Indus Suture Zone. Just northwest of Dargai, the Dargai mafic and ultramafic complex was considered to be a klippe underlain by the MMT (Tahirkheli et al., 1979; Kazmi et al., 1984, 1986; Lawrence et al., 1989). Kazmi et al. (1984; 1986) revealed that the MMT (Indus Suture) zone contained faults of different age and tectonic history. The basal fault of the MMT (Indus Suture) zone which separates the suture zone from the Indian shelf rocks is known as the Kishora thrust. The roof fault which separates the suture from the Kohistan rocks is known as the Kohistan fault. DiPietro et al. (1998) subdivided the Indus Suture Zone (MMT) into three internally imbricated mélange slices (Fig. 3). These include the "Swat" mélanges (Shangla, Charbagh and Mingora); the "Dargai" mélange including Sakhakot Ultramafic Complex and the "Nawagai" mélange characterized by marble. The basal fault of each slice is the Kishora, Dargai and Nawagai fault respectively.

Our best guess is that the Kishora thrust can be followed as a continuous fault from east of Shangla to the Mingora (Kazmi et al., 1984) where the transition from Saidu to melange is sharp. There is an imbrication of Saidu and other units of Alpurai Group, but in general, there is very little of the Saidu formation (an Alpurai Group) within the melange itself. Additional slices of melange are found within Saidu formation further west at Chakdarra, north of where the Kishora fault seems to disappear such that the Saidu formation with melange slices is in direct contact with Kohistan fault (Ahmad and Lawrence, 1992). The mélange slices along Kishora thrust north of Chakdara bend southward and disappear in the alluvium north of the Swat River (Fig. 3). It reappears along ridges north of Dargai. These mélange blocks (slices) north of Dargai represent part of an imbricate fault system related to Indus Suture Zone (MMT).

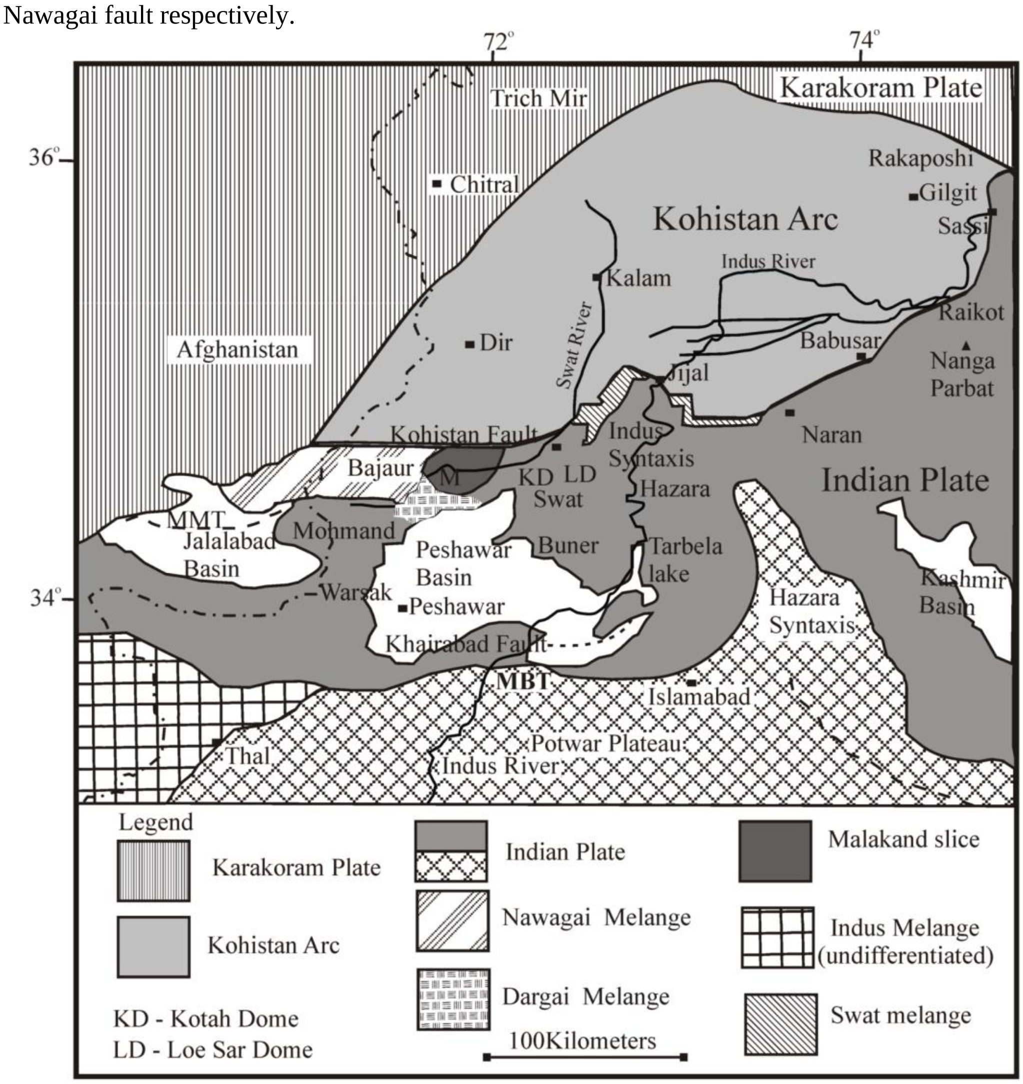

Fig. 3. Map showing the mélanges and structure of the northern hinterland of the Indian plate (After DiPietro et al., 1998).

References

Ahmad, I., Lawrence, R.D., 1992. Structure and Metmorphism of the Chakdara area NW of Swat River, Pakistan. Geological Bulletin University of Peshawar, 25**,** 95-112.

Dewey, J.F., Bird, J.M., 1971. Origin and replacement of the ophiolite suite: Appalachian ophiolites in Newfoundland. Journal Geophysical Research, 76, 3179-3206.

DiPeitro, J.A., Ahmad, I., Hussain, A., Isachsen, C.E., 1998. Tectonics of the Indus suture zone in Northwest Pakistan. Geological Bulletin University Peshawar, 31**,** 53-55.

Hussain, S.S., Khan, T., Dawood, H., Khan, I., 1984. A note on Kot-Prang Ghar mélange and associated mineral occurrences. Geological Bulletin University Peshawar, 17, 61-68.

Jan, M. Q., Shah, M. T., 1987. Cr, Cu, Zn, Co, Ag, and Au content of some talc-carbonate rocks from N.W.F.P., Pakistan. Geological Bulletin University of Peshawar, 20, 215-216.

Kazmi, A.H., Lawrence, R.D., Dawood, H., Snee, L.W., Hussain, S.S., 1984. Geology of the Indus suture zone in the Mingora Shangla area of Swat, N. Paksitan. Geological Bulletin University of Peshawar, 17, 127-144.

Kazmi, A. H., Lawrence, R. D., Anwar, J., Snee, L. W., Hussain, S. S., 1986**.** Mingora emerald deposits (Pakistan): Suture associated gem mineralization. Economic Geology, 81, 2022-2028.

Lawrence, R.D., Kazmi, A.H. Snee, L.W., 1989. Emerald deposits of Pakistan: In: Kazmi, A. H., Snee L.W., (Eds), Geology, Geomology, and Genisis, Van Nostrand Reinhold, New York, New York.

Malinconico, L.L. Jr., 1982. Structure of the Himalayan Suture Zone of Pakistan interpreted from gravity and magnetic data. PhD Thesis, Dartmouth College Hanover, New Hampshire, 128.

Moore, E.M., Vine, J.F., 1971. The Troodos massif, Cyprus and other ophiolites as oceanic crust: evaluation and implications. Royal Society London Philos, Transaction, Series, A., 268, 443-466.

Rafiq, M., 1984. Extension of Sakhakot-Qla ultramafic complex in Utmankhel, Mohmand Agency, N.W.F.P., Pakistan. Geological Bulletin University of Peshawar, 17, 53-59.

Tahirkheli, R.A.K., Mattauer, M., Proust, F., Taponier, P., 1979. The India-Eurasia suture zone in northern Pakistan: Synthesis and interpretation of recent data at plate scale. In: Farah A., Dejong, K. A., (Eds), Geodynamics of Pakistan, Geological Survey of Pakistan, 125-130.

Uppal, I. H., 1972. Preliminary account of the Harichand ultramafic complex, Malakand Agency, N.W.F.P. Pakistan. Geological Bulletin University of Punjab, 9, 55-63.