

A note on the geology of Nubra-Shyok area of Ladakh, Kashmir, Himalaya

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Abstract

The Nubra-Shyok area lying between Ladakh range in the north and Karakoram range in the south, differs tectono-stratigraphically from the Indus Suture zone. It is characterised by acid to intermediate volcanics with interbedded sediments of Lower Cretaceous age (Khardung volcanics) and an ophiolitic melange consisting of low to medium grade metasediments, lava flows alternations of sandstone, shale conglomerate and bodies of serpentinite, pyroxenite, hornblendite and diorite (Shyok Formation). These are intruded by a tonalite body in the northwestern part of the area. The tectono-stratigraphy of the Nubra-Shyok area suggests that they probably represent the components of a marginal basin in an island-arc system.

Introduction

The regional geology of the Central Ladakh along the Indus Suture zone has been described by various authors (Tewari, 1964; Shankar *et al.*, 1976; Shah *et al.*, 1976; Frank *et al.*, 1977). Geological information is however lacking in the Nubra and Shyok valleys lying north of the Indus Suture zone between Karakoram range in the north and the Ladakh range in the south. Stoliczka (1865) gave a brief account of the geology along the Indus-Tibetan-Yarkand route while Norin (1946) made explorations in southwestern Tibet including parts of the Shyok valley. In recent years contributions have been made by Bhandari *et al.* (1978) and Gupta and Sharma (1978). An expedition was sent by the Wadia Institute of Himalayan Geology in 1978, and the present communication is based on the geological observations made by the team in the area between Panamic, Thoise and Shyok villages.

GEOLOGY OF THE AREA

A preliminary geological map of the area has been prepared (Figure 1). The regional geological set-up of the area is summarised in Table I. The southern most unit is the Indus Formation. The northern margin of the Ladakh batholith is enveloped by a thick succession of Khardung Volcanics in Nubra and Shyok valleys which are apparently different from those of the Indus Suture zone. These volcanics are overthrust by the rocks of the tectonic ophiolitic melange of the Shyok Formation. The rocks of Karakoram Batholith have intrusive junction with the Shyok Formation, but at places the contact appears to be sharp and tectonised.

Indus Formation

The main lithological units of the Indus Formation include the flyschoidal sediments (Cretaceous-Eocene) and molasse deposits (Miocene-Pliocene). The molasse unit lies unconformably over the Ladakh Batholith and the flyschoid sediments have a thrust contact with the molasse.

Ladakh Batholith

The batholith, which forms an elongated body about 600 km long with width varying from 25-30 km, consists mainly of granitoid rocks of tonalitic composition.

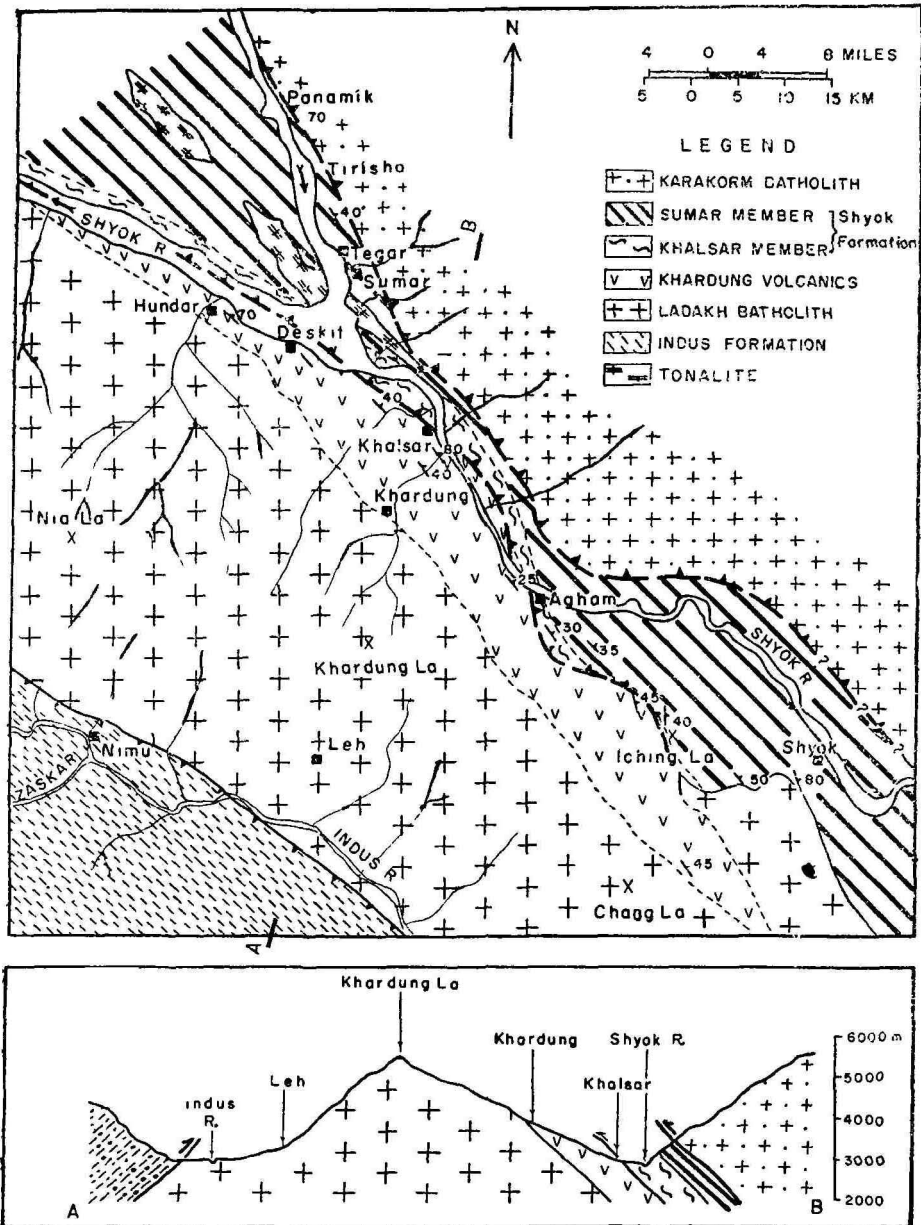


Figure 1

The association of basic rocks throughout the body is quite marked. The units of the batholith have intruded into the Dras Volcanics along its southern border as well as into the Khardung Volcanics along its northern margin. The most significant character of the rocks of this batholith is that they are poor in potash and total alkalis. The batholith has intruded the volcanics of Upper Cretaceous to Lower Eocene age and is overlain in places by Mio-Pliocene Molasse sediments, indicating an age ranging from Middle-Eocene to Oligocene.

TABLE I

Karakoram Batholith : Mica granite, tonalite, gneisses and migmatites	
<i>Intrusive junction, Locally tectonised</i>	
Shyok Formation	Summur Member : crystalline limestone, amphibolite, micaschist, basic lavas, serpentinite, shale, sandstone, conglomerate ; garnet-kyanite schist and amphibolite
	Khalsar Member : Chlorite schist, quartzite, limestone, amphibolite, hornblendite, pyroxenite, and diorite
<i>Khalsar Thrust</i>	
Khardung Volcanics	Rhyolite, dacite, andesite, ignimbrite, tuff, agglomerate, volcanic breccia, chert, limestone, sandstone and conglomerate
<i>Intrusive Junction</i>	
Ladakh Batholith	Mainly granite and tonalite, with some diorite, gabbro, aplite and pegmatite
<i>Thrust or unconformity</i>	
Indus Formation	Alternations of sandstone, shale, conglomerate with limestone

Khardung Volcanics

The volcanics which were earlier termed as Shyok Volcanics (Gupta and Sharma, 1978) have been named as Khardung Volcanics after the type locality where these are best exposed. They overlie the Ladakh Batholith, the latter showing intrusive contact to the former. The volcanics are made up of a few kilometer thick succession of acid and intermediate volcanics, volcano-clastics, tuffs and sediments. The interbedded limestone and shale have yielded *Orbitolina parma* and *Orbitolina discoidea* indicating a Lower Cretaceous age. The intrusions of Ladakh batholith into the Khardung Volcanics have been observed near Hunder, and also the xenoliths of Khardung Volcanics have been recorded within the batholith near the marginal zone.

Shyok Formation

It consists of a sequence of sediments, metasediments, volcanics, mafic and ultramafic rocks sandwiched between the Karakoram Batholith in the north and the Khardung Volcanics or the Ladakh Batholith in the south. The Shyok Formation is divisible into a northern, Sumur Member and the southern, Khalsar Member. The Sumur Member is composed of crystalline limestone, amphibolite, mica-schist, basic lavas, serpentinite lenses, green and red sandstone, shale and conglomerate. In the upper reaches of the Shyok valley, east of Agham, it shows increase in the grade of metamorphism resulting in the formation of higher grade rocks of amphibolite facies such as garnet mica-schist, kyanite schist and garnet amphibolite which are well exposed at Chummer Nala section. The Khalsar Member consists of chlorite schist, quartzite, limestone, amphibolite with bodies of hornblendite, pyroxenite and diorite. This unit has irregular distribution and is absent at places like Agham and Sati Villages. The limestone in both the units have yielded stems and oscicles of crinoids, corals and algae from localities around Agham and 2 km

NE of Trisha. A few transverse sections of corals belonging to *Lolsdaleia tibatica* Reed indicating Upper Carboniferous to Lower Permian age have been identified (personal communication R. J. Azmi). The lithological units of the Shyok Formation generally do not show regular stratigraphic continuity. They occur as thrust slices and large lenses forming a tectonic melange. The melange has ophiolitic components, and hence can be described as ophiolitic melange (Gansser, 1974). An intrusive body of tonalitic composition occurs within the Shyok Formation exposed at localities south of Tirit and junction of Nubra and Shyok rivers.

Karakoram Batholith

The Karakoram Batholith is an important petrographic province and occupies the major part of the Karakoram range. Its northwestern part has been studied in some detail by Desio (1979) and his co-workers. Igneous activity in the Karakoram occurred in two main phases, viz., Late Cretaceous to Eocene and Neogene. The southeastern extension of the batholith exposed in the Shyok valley is essentially composed of granitoid rocks ranging in composition from granite, granodiorite to tonalite. The batholith has intruded into the Shyok Formation. Its contact at places is tectonised showing the development of mylonites.

Discussion

The Nubra-Shyok area differs tectono-stratigraphically from that of the Indus Suture zone forming a separate tectonic zone. The presence of acid to intermediate volcanics (Khardung Volcanics) and the occurrence of sediments of Upper Carboniferous to Lower Permian age in the tectonic ophiolitic melange of the Shyok Formation are important elements. This zone is also characterised by the absence of flyschoid sedimentation of Triassic to Lower Eocene age and an extensive andesitic volcanism of Upper Cretaceous to Lower Eocene age and the molasse deposit of Mio-Pliocene of the Indus Suture zone. It is now widely accepted that the Himalaya originated as a result of continent-continent collision (Dewey and Bird, 1970; Gansser, 1977) and the Indus Suture is the site of an old subduction zone along which a large segment of the Tethyan ocean was consumed during the northward drift of the Indian plate. This is confirmed by the presence of a full sequence of ophiolites and ophiolitic melange as well as glaucophane schist metamorphism in the southeastern extension of the Indus Suture zone (Virdi *et al.*, 1977, Thakur and Virdi, 1978). Gansser (1977) proposed the possibility of another suture in the Shyok valley. On the basis of geological data obtained from the present investigation it is difficult to say whether another suture or subduction zone is located in the Nubra-Shyok area. However, the Khardung Volcanics can be interpreted as volcanic activity associated with an island-arc and the Shyok Formation may represent the components of a marginal basin, probably a back-arc basin of an island arc system.

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