

Ophiolites in the North Himalayan nappes and Indus Suture Zone in Eastern Ladakh (NW Himalaya, India)

Nicolas Buchs¹ & Jean-Luc Epard¹

¹ Institut des sciences de la Terre, University of Lausanne, Switzerland

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Introduction

The Ophiolitic rocks of Eastern Ladakh are subdivided into two main groups, based on the geodynamic setting during their formation: the supra-subduction zone ophiolite and their ophiolitic "mélanges", corresponding both to the Indus Suture Zone.

Recent detailed studies North-East of the Tso Morari area revealed a large diversity of ophiolitic rocks and associated sediments. We identified three distinct tectonic units containing ophiolites: The Nidar Ophiolite, the Drakkarpo nappe and the Karzok-Ribil nappe (Fig. 1)

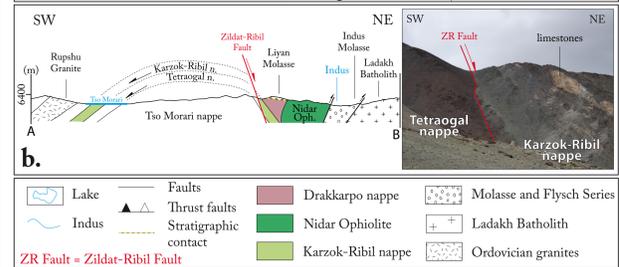
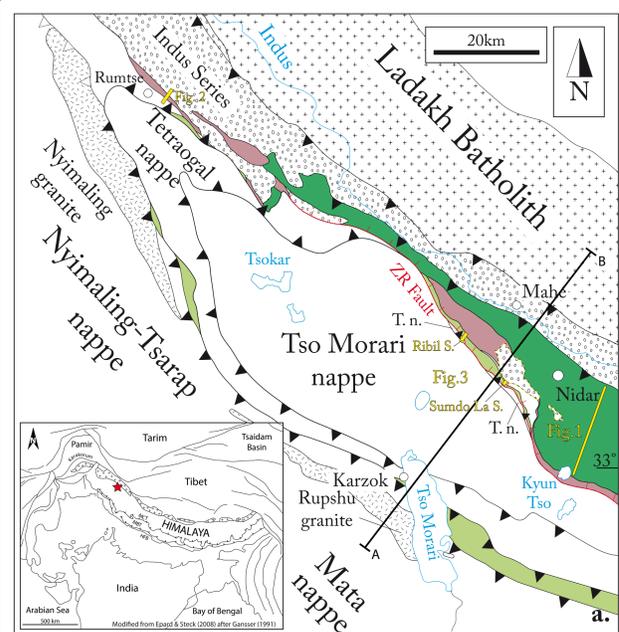


Fig. 2: Synthetic lithostratigraphic profile of Nidar Ophiolite a) 130±2 Ma plagiogranite (albite + quartz + zircon ± amphibole) in Intrusive Complex Type II.

Drakkarpo nappe - Rumtse Profile

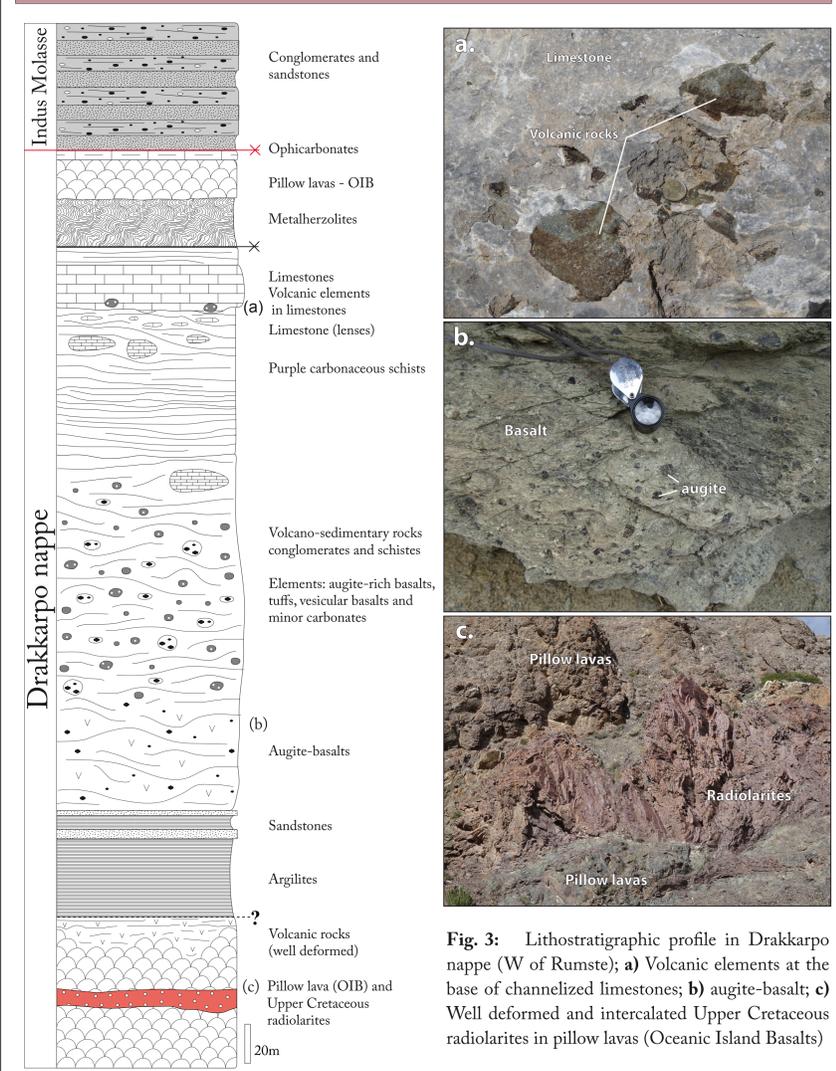


Fig. 3: Lithostratigraphic profile in Drakkarpo nappe (W of Rumtse); a) Volcanic elements at the base of channelized limestones; b) augite-basalt; c) Well deformed and intercalated Upper Cretaceous radiolarites in pillow lavas (Oceanic Island Basalts)

Karzok-Ribil nappe - Ribil Chu profile

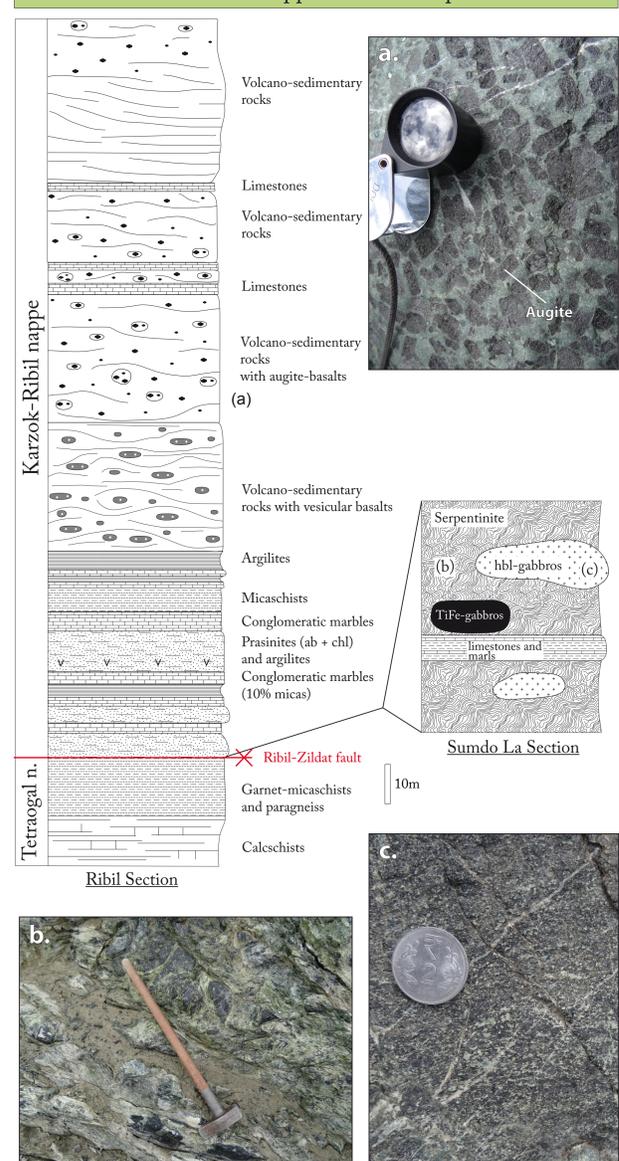


Fig. 4: Lithostratigraphic profiles of Karzok-Ribil nappe in Ribil Chu valley north-western part of Tso Morari nappe (Fig.1a); a) Augite-basalt (OIB); b) Serpentinite of Sumdo La; c) Hbl-gabbro cumulate.

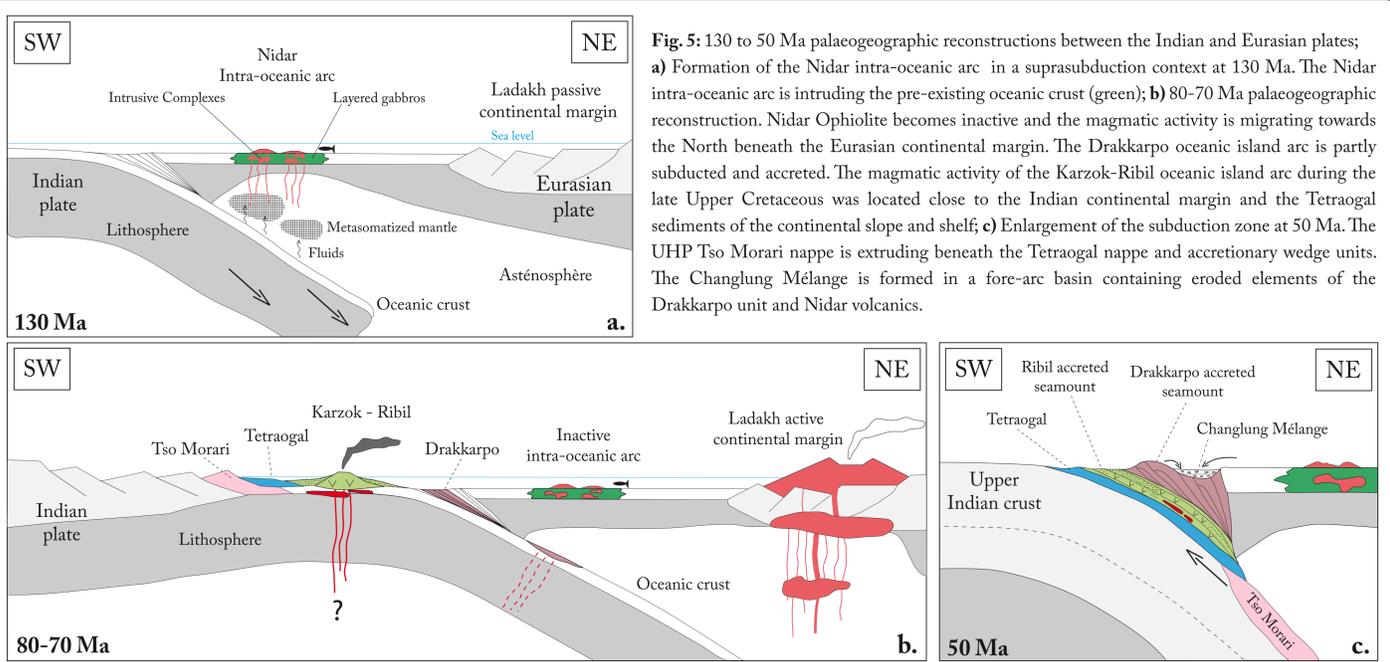


Fig. 5: 130 to 50 Ma palaeogeographic reconstructions between the Indian and Eurasian plates; a) Formation of the Nidar intra-oceanic arc in a suprasubduction context at 130 Ma. The Nidar intra-oceanic arc is intruding the pre-existing oceanic crust (green); b) 80-70 Ma palaeogeographic reconstruction. Nidar Ophiolite becomes inactive and the magmatic activity is migrating towards the North beneath the Eurasian continental margin. The Drakkarpo oceanic island arc is partly subducted and accreted. The magmatic activity of the Karzok-Ribil oceanic island arc during the late Upper Cretaceous was located close to the Indian continental margin and the Tetraogal sediments of the continental slope and shelf; c) Enlargement of the subduction zone at 50 Ma. The UHP Tso Morari nappe is extruding beneath the Tetraogal nappe and accretionary wedge units. The Changlung Mélange is formed in a fore-arc basin containing eroded elements of the Drakkarpo unit and Nidar volcanics.

Discussion and conclusion

The Nidar supra-subduction zone Ophiolite (Mahéo et al. 2004; Ahmad et al. 2008) represents a complete ophiolitic sequence, from mantle to sediments (Fig. 2), which underwent a low greenschist facies metamorphism. Nidar Ophiolite recorded a first magmatic event in a fore-arc spreading center related to subduction roll back, generating the thick layered gabbros. Slab roll back slowed down due to young oceanic lithosphere and a second magmatic phase occurred in the pre-existing oceanic crust at 130 Ma, producing Intrusive Complexes and volcanic rocks (Fig. 5a)

The Drakkarpo nappe is a "mélange" unit composed of thick polygenic conglomerates with channelized limestones (Fig. 3a) and volcano-sedimentary rocks (Fig. 3b), mainly consisting of tuffs and oceanic island augite-basalts, serpentinites, pillow lavas and radiolarites (Fig. 3c). This unit is suggested to be part of an accretionary wedge containing slices of oceanic islands arc (Fig. 5bc). This island arc was developed during Upper Cretaceous on the Indian plate. The Drakkarpo nappe marks the Indus Suture Zone. A new "Changlung Mélange" has been characterized in the northern part of the Drakkarpo nappe. This mélange is made of Upper Ypresian age limestones based on the presence of benthic foraminifera (nummulites). It contains blocks and smaller clasts deriving from the underlying Drakkarpo nappe and volcanic rocks from the overlying Nidar Ophiolite and Batholith (Fig 5c). This mélange is interpreted to be a shallow sedimentary basin dominated by detrital sediments developed in a fore-arc context.

The Karzok-Ribil nappe is a newly defined tectonic unit involved in the North Himalayan nappe stack. It can be followed at the top of the Tetraogal nappe and around the Tso Morari dome (Fig. 1b). The Karzok-Ribil nappe is composed of segments of an ophiolitic sequence (serpentinites (Fig. 4b), hbl-gabbros (Fig. 4c) and pillow lavas), radiolarites, polygenic conglomerates, agglomeratic slates from the Indian margin, augite-basalts (OIB) (Fig. 4a) and limestones. It is suggested to represent an oceanic island (Fig. 5b), located close to the Indian passive margin in an ocean-continent transition zone. This unit was accreted below the Drakkarpo "mélange" in the accretionary wedge (Fig. 5c).

These new data on the Ophiolitic units define the pre- and synorogenic geometry of the North Indian margin and the Ladakh volcanic arc at the Southern part of Asian plate. Nidar Ophiolite and the Drakkarpo nappe represent the Indus Suture Zone (s. s.) and the Karzok-Ribil nappe belongs to the North Himalayan nappes and was involved in the nappe stack with the Tetraogal and Tso Morari nappes.

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