Petrology and Geochemistry of Mafic Intrusive Rocks from the Sapi-Shergol Ophiolitic Mélange, Indus Suture Zone, Western Ladakh: Constraints on Petrogenesis and Tectonic Setting

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ABSTRACT

This article reports the existence of subduction-related tholeiitic, normal mid-ocean ridge basalt (N-MORB)-type mafic intrusives emplaced within the Sapi-Shergol ophiolitic mélange of the Indus Suture Zone, western Ladakh. The Shergol mafic intrusives show Fe enrichment with basalt to basaltic-andesite composition. Based on their mineralogy and textures, these mafic rocks can be identified as fine- to medium-grained gabbros that have undergone greenschist-grade metamorphism. These rocks have N-MORB-type geochemical characteristics, exhibiting nearly flat to depleted light rare earth element patterns ($(La/Sm)_N = 0.66–1.05$). Petrogenetic modeling suggests <20% partial melting of a depleted MORB-type mantle source, within the spinel peridotite stability. The presence of slightly negative anomalies of high field strength elements like Nb, Zr, and Ti in multielement patterns reflect the influence of subduction zone magmatism. The presence of low-Ti clinopyroxene ($En_{38–50}Fe_{11–25}Wo_{31–43}$; enstatite-ferrosilite-wollastonite), Ca-rich plagioclase ($An_{2–36}$; andesine), and pargasitic amphibole also reflects their subduction-related depleted-mantle origin. The MORB–island arc tholeiite signature displayed by the Shergol gabbros intrusive in Shergol peridotites reflect their generation in a mantle wedge associated with the Early Cretaceous intraoceanic subduction within the Neo-Tethys Ocean. They are similar to Spongtang ophiolite gabbros intrusive in the Spongtang ophiolite mantle peridotites from south Ladakh, ophiolitic mélange gabbros from southern Tibet, and Muslim Bagh ophiolite gabbros from Pakistan. Based on this study, we offer a geodynamic model suggesting that the Sapi-Shergol ophiolitic slice was intruded by mafic intrusive rocks that represent the relict of the intraoceanic substratum of the Cretaceous Dras arc complex.

Online enhancements: appendix tables.

Introduction

Ophiolites may originate either at mid-ocean ridges (Thayer 1969) or at intraoceanic island arcs (Miyashiro 1973, 1975; Gass et al. 1975; MacLeod et al. 2013). Subduction-influenced lavas are common in worldwide ophiolites (Miyashiro 1973, 1975; Shervais 1982), which has led to the concept of suprasubduction zone (SSZ) ophiolites, defined as those forming above subduction zones (Pearce et al. 1984). SSZ ophiolites may be generated in a forearc setting immediately following subduction initiation (Dilek and Flower 2003; Dilek and Furnes 2011); however, a feasible alternative is a backarc setting (Meffre et al. 1996). SSZ ophiolites of forearc origin are apparently more common than backarc basin derived ophiolites (Shervais 2001; Shervais et al. 2004). At present, the Izu-Bonin-Mariana (IBM) and Tonga-Kermadec arc-trench rollback systems are the most exciting sites for the study of SSZ ophiolite genesis (Bloomer 1983; DeBari et al. 1999; Hawkins 2003; Reagan et al. 2010, 2013, 2015, 2017, 2018; Ishizuka et al. 2011). Forearc basalts from the Mariana forearc, derived from more depleted mantle sources faintly influenced by subduction (Reagan et al. 2010), were apparently erupted immediately after subduction initiation (Ishizuka et al. 2011; Reagan et al. 2013, 2017).

The Jurassic to Cretaceous ophiolite remnants of the Neo-Tethys Ocean extend from the Betic Rif and

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