

Amphibole compositions as indicators of deep crustal and mantle processes in subduction zones: case study – Tso Morari metamafics, Ladakh, Himalaya

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Amphiboles have large number of cationic sites where substitution by various elements is a rule in response to changes in environmental conditions (Veblen 1985). The environmental conditions include hydrostatic pressure, temperature, $\mu_{\text{H}_2\text{O}}$, f_{O_2} etc. Experimental and empirical data are available to correlate these factors with mineral compositions for many amphibole species. These criteria have been utilized to study a natural example of ultra-high pressure metamorphism from the Himalaya.

A small area in SE Ladakh, just south of the Indus Suture Zone has been a subject of intense study recently (de Sigoyer et al. 2000, 2004, Guillot et al. 2000, 2008, Jain et al. 2003) because of the implications of geologic and geochronologic studies on the tectonic nature of Plate Subduction mechanism. Singh and Verma (2006) have shown for this area how compositions of phengite and biotite of metamafics (forming boudins in the host feldspar gneisses) and the host rocks respond to various stages of subduction and exhumation of plates.

Amphiboles are also important constituents of the metamafic boudins present in the Tso Morari region. From the point of view of phase relationships Verma et al. (2008) have shown that the metamafics are characterized by five assemblages. Two of these five assemblages are UHPM indicators while one belongs to HPM.

In the present study, a large dataset of chemical composition data through EPMA on relevant phases including amphiboles has been utilized to fine-tune the P-T- $\mu_{\text{H}_2\text{O}}$ - f_{O_2} values of the P-T-t path (subduction as well as exhumation components). Na-amphibole including glaucophane (Amphibole nomenclature after Leake et al. 1997) is present in cores of the zoned garnets in assemblage i) where it coexists with epidote and paragonite (HPM assemblage). Assemblage ii) is UHPM assemblage without any amphibole. Na-Ca amphiboles, taramite and magnesiokataphorite form assemblage iii), where these occur with garnet and phengite (UHPM assemblages). These amphiboles also occur as inclusions in some garnet grains. A continuous progressive reaction has even generated barroisite and rare winchite compositions in amphiboles that form part of this assemblage in the matrix. Ca-amphiboles occur as part of assemblages iv), and v) which contain albite, chlorite and biotite with another continuous reaction

sequence in amphiboles, chlorites and biotite. These assemblages are correlated with different stages of subduction and exhumation on the basis of textures as well as thermobarometry.

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