Mass Transfer During Hydrothermal Mantle Processes within a Serpentinite Mélange

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INTRODUCTION

Extensive fluid-rock interaction and fluid-mediated transfer of chemical elements occur in the subduction environment (Manning. 2004, Breeding et al., 2004, Hermann et al., 2006). Exhumed serpentinite mélanges representing fragments of the slab-mantle interface and containing exotic high-P blocks are perfectly suited for the study of these processes (e.g.. Marschall et al., 2009, Sorensen et al., 2010, Blanco-Quintero et al., 2011)

Serpentinite mélange exposed in Sierra del Convento (S.Cv.), Eastern Cuba, is characterized by tectonic blocks of subducted oceanic material (García-Casco et al., 2008, Lazaro et al., 2009). Jadeitite bodies also occur in the mélange (fig 1), which have been interpreted as the result of precipitation of hydrothermal fluid evolved from the crystallization at depth of hydrated tonalitic-trondhjemitic magmas (García-Casco et al., 2009, Cárdenas-Párraga et al., 2012).

This contribution presents a geochemical characterization of a vein of jadeitite hosted in the serpentinitic matrix of the mélange, and addresses the associated fluid-rock interactions in the slab-mantle interface.

SAMPLING AND ANALYTICAL TECHNIQUES

The vein and wall rocks were sampled across the boundary in order to obtain a cm-scale profile. The samples were ground in a tungsten carbide mill for whole-rock analysis. Major element and trace element compositions were performed by means of XRF (major elements and Zr) and ICP-MS (trace elements) at Centro de Instrumentación Científica (CIC), University of Granada. Mineral abbreviations are after Whitney and Evans (2010).

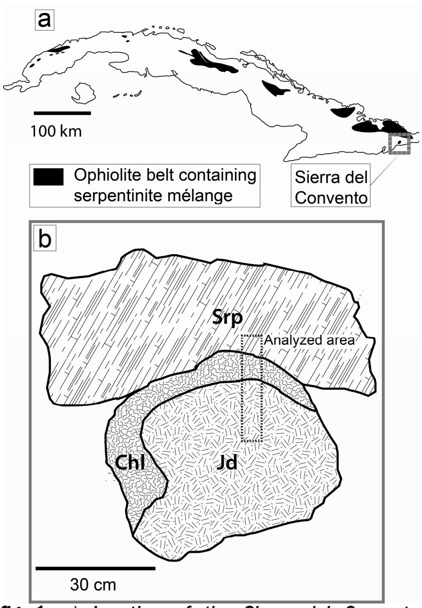

***fig 1.** a) Location of the Sierra del Convento serpentinitic-matrix subduction mélange. b) schematic drawing showing the field relations from a jadeitite body.*

RESULTS

Four types of rock were studied. The jadeitite vein, a mm-sized albite band located in contact with the wall-rock, a black-wall band of chloritite composition representing the metasomatized mantle peridotite, and the host serpentinite.

The analyzed serpentinites display a marked evidence for fluid/rock interactions before vein formation (refertilization) characterized by marked enrichment in mobile elements. This process likely took place during serpentinization. These samples can be identified as subducted serpentinites of harzburgitic protolith and possible abyssal setting of formation prior to subduction (fig 2).

Major element contents are constant across the jadeitite vein. The albite band is however slightly enriched in MgO and Al_2O_3, and slightly depleted in Na_2O with respect to the jadeitite vein. The chloritite black-wall is markedly depleted in SiO_2 and enriched in MgO, and FeO relative to all other bands. Al_2O_3 shows a mild enrichment in the chlorite zone, reaching low values in serpentinite, although slightly higher than in abyssal harzburgitic serpentinites. Both the chloritite and serpentinite bands are depleted in Na_2O.

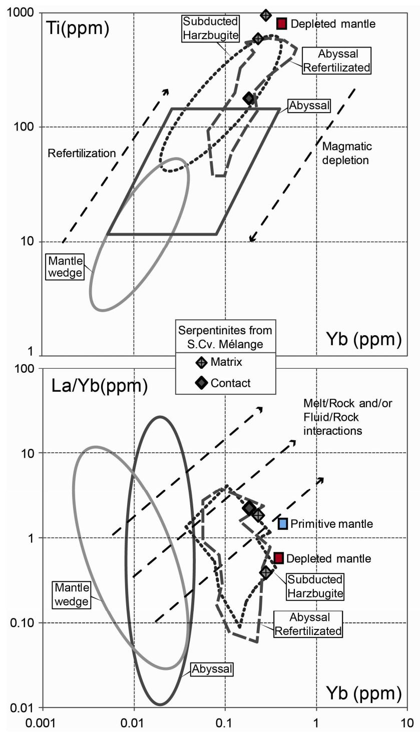

***fig 2.** Ti and La/Yb versus Yb plots of the studied serpentinite samples, including abyssal, abyssal refertilized, subducted and mantle wedge serpentinites for comparision (modified after Deschamps et al., 2013). The composition of the primitive mantle is from McDonough and Sun (1995) and of the depleted mantle is from Salters and Strake (2004).*

Trace element contents in the jadeitite vein are characterized by a slight decrease of large ion lithophile elements

palabras clave: Mélange de Subducción, Jadeitita, Serpentinita, Transferencia de masas.
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(LILE; Sr, Ba, Rb) towards the contact with the albite band and black-wall, though these elements increase close to the albite band. The LILEs show marked decreases in the chloritite black-wall and in the host serpentinite. Rare earth element (REE) contents increase in the jadeitite vein towards the albite band, sharply increase in the chloritite black-wall and decrease in the serpentinite host- rock. High field-strength elements (HFSE: Sc, Y, Nb, Ti, P and Zr) show similar trends as the REE. However, the serpentinite samples have similar or slightly lower values than abyssal refertilized and subducted harzburgite serpentinites (averages from Deschamps et al., 2013), except in Zr contents, which are higher. The siderophile elements (Cr, Ni, Co) and Mg contents are similar to those of abyssal, abyssal refertilizated, and subducted harzburgite serpentinites, showing a decrease from the host serpentinite towards the chloritite band and a local enrichment in the jadeitite vein near the contact between the band of albite and jadeitite. Vanadium displays a trend similar to those of other siderophile elements, but it is enriched in the serpentinites with respect to abyssal, abyssal refertilizated, and subducted harzburgite serpentinites.

DISCUSSION AND CONCLUSIONS

These results suggest that the jadeitite-forming fluids (Na-Ca-Al-Si-rich hydrous fluid) infiltrated and precipitated in veins (i.e., fractures) hosted by mantle serpentinites, transferring significant amounts of REE, LILE and HFSE in a SiO_2 undersaturated environment and triggering the metasomatic replacement of (at least partially) serpentinized peridotite during fluid–peridotite interaction. These processes generated a contact between the host serpentinite and the crystallizing jadeitite vein characterized by two bands. An albite band formed on the jadeitite side where LILEs are concentrated, and a black-wall band of chloritite in the serpentinite side enriched in HFSE and REE by the infiltrating metasomatic fluid. This metasomatic process formed apatite, titanite, rutile, zircon and allanite in the chlorite black-wall, which are the most relevant carriers of these elements. The LILE were mostly incorporated in the Na- and K-bearing minerals (jadeite, omphacite, phengite) in the vein, and are absent in the chloritite band and the host serpentinite (fig 3). Recurrent episodes of infiltration of chemically diversified fluids likely played a role in the formation of the albite band, though a single-stage process is possible.

The siderophile elements (Cr, Co and Ni) and Mg were, in turn, transported from the metasomatic front (chloritite) towards the jadeitite vein, but not from the non-chloritized serpentinite wall rock towards the metasomatic front. This was a likely consequence of the strong focused flux of fluid from the vein towards the wall-rock (fig 3).

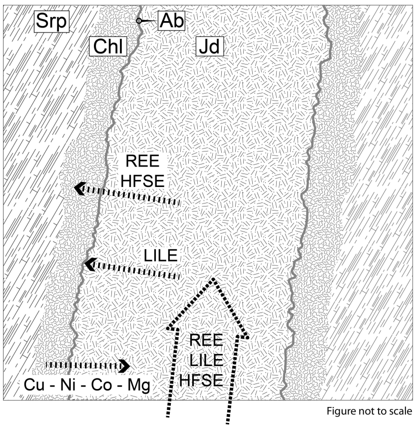

fig 3. *Schematic model showing transfer patterns of chemical elements in jadeitite vein.*

The observed mass transfer processes occurred at moderate-T (550-600 ºC) in the slab-mantle interface. They, however, can shed light on higher temperature subduction-related processes relevant for the transfer of crustal material towards the upper plate mantle and the generation of arc magmas.

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