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Forearc Ophiolite in Havana-Matanzas, Western Cuba: Evidence from Serpentinized Mantle Peridotite REE Geochemistry and Cr-spinel Composition

LLANES CASTRO Angélica Isabel[1,*], PROENZA Joaquín Antonio[2] and CRUZ GÁMEZ Esther María[3]

1 Department of Mineralogy and Petrology, Institute of Geology and Paleontology, Havana, Cuba
2 Department of Mineralogy, Petrology and Applied Geology, Barcelona University, Barcelona, España
3Department of Geology, Pinar del Río University, Pinar del Río, Cuba / University of Nuevo León, México

1 Introduction

Habana-Matanzas ophiolites (HMO) form part of the western segment of the Northern Cuban ophiolites, extending for more than 1000 km along the island, the largest ophiolite outcrops in the Caribbean (Khudoley and Meyerhoff, 1971). The upper mantle peridotites in HMO are composed mainly of refractory serpentinized harzburgites with tectonite textures (Fig. 1), hosting small chromitite bodies. They occur tectonically intermingled with the Cretaceous volcanic arc sequences.

Here we present mineral chemistry of Cr-spinels and bulk rock REE compositions of the mantle peridotites from HMO with the aim of constraining tectonic setting of formation.

2 Bulk rock REE and Cr-spinel compositions

According to chondrite-normalized REE patterns (Fig. 2), two groups of peridotites are distinguished: (i) group-A display higher REE concentrations with respect to those belonging to the group-B, exhibiting a nearly linear increase from LREE to HREE, that indicates fertile abyssal affinity; (ii) group-B is characterized by LREE enrichment relative to MREE/HREE, they have been interpreted to result from partial melting and mantle interaction with ascending melts at a suprasubduction zone, documenting melt metasomatism in mantle wedge regions by slab-derived.

The unaltered Cr-spinel composition allows identifying three groups of mantle peridotites in HMO:

(1) Group A peridotites, which contain spinels with low Cr#[100Cr/(Cr+Al)] = 21–25 and high Mg#[100 Mg/(Mg + Fe)] = 69–75, (2) Group B peridotites, which contain spinels with intermediate Cr# (39–50) and Mg# (54–68), and (3) Group C peridotites with high Cr# (63–73) and low Mg# (40–52).

Low Cr# spinel Group A peridotites are genetically related to (i) group-A (fertile abyssal peridotites). Group B intermediate Cr# spinels plot within abyssal peridotites as result of 15 to 20 % of partial melting of a fertile mantle (Fig. 3). Group C peridotites, with high Cr# spinel, show Cr# versus TiO_2 relationships of forearc affinity, itcorresponds to (ii) group-B LREE enriched peridotites (Fig. 3).

3 Tectonic setting implications

Within forearc ophiolites can be recognized mantle wedge and abyssal peridotites, although the former are typically dominant (Parkinson and Pearce 1998; Batanova and Sobolev 2000; Pearce et al. 2000; Choi et al., 2008; Marchesi et al.,

* Corresponding author. E-mail:isa@igp.minem.cu

2011; Deschamp et al., 2012). SSZ peridotites are characterized by spinels with much higher Cr#s than abyssal peridotites and low Ti content (Arai 1994) which signifies higher degrees of partial melting in the SSZ peridotites compared to abyssal peridotites (Chois et al., 2008).

Attending to Cr-spinel and REE compositions, Group A peridotites with fertile abyssal affinity may represent trapped abyssal paridotites from the Proto-Caribbean lithosphere that did not subduct. The intermediate Cr# spinel Group B peridotites could signify abyssal peridotites that subducted to shallow depths and were transferred to fore-arc/arc environment during an intraoceanic collision event, alternatively they may be considered relicts of the mantle wedge originated during a moderate proto-forearc extention. Group C peridotites with higher Cr# spinels and LREE enriched have geochemical characteristic consistent with melt reactions between refractory peridotite and boninitic melts like magma generated during subduction–initiation process.

Although the discussion continues regarding the origin and evolution of the Caribbean realm (Iturralde-Vinent and Lidiak, 2006; Pindell et al., 2006, 2011), the recent plate tectonic models of the Caribbean suggest that the origin of most Caribbean ophiolites is related to the Aptian initiation of southwest-dipping subduction of the Proto-Caribbean oceanic lithosphere below the Pacific Plate lithosphere that would become the Caribbean Plate.

The tectonic relationship of Havana-Matanzas mantle peridotites with volcanic arc rocks combined with their SSZ and abyssal peridotite geochemical signatures, and the Cr-spinel composition (low to high Cr#) allow to propose that in the Habana-Matanzas ophiolite coexist fragments of abyssal peridotites from a downgoing oceanic lithosphere (Proto-Caribbean oceanic domain) and peridotites formed by partial melting of a mantle source which was later modified by fluids and melts in a suprasubduction zone mantle wedge (Caribbean/Pacific Farallon-derived lithosphere).

The preservation of abyssal peridotites together with those of the forearc affinity should be associated to the latest Cretaceous-Paleocene collision between the leading edge of the Caribbean plate with the southern margin of North America, when the Proto-Caribbean and Caribbean oceanic mantle relicts were accreted into Bahamas continental paleomargin.

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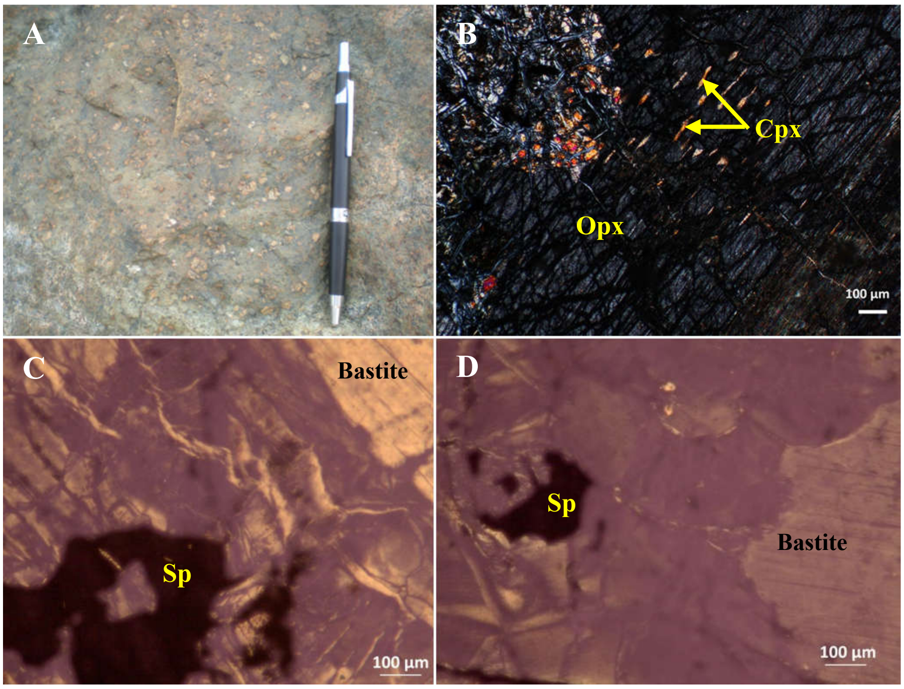

Fig. 1. Field photo and photomicrographs from Habana-Matanzas mantle peridotites: **(A)** Serpentinized harzburgite with pseudoporfiric bastite; **(B)** Vermicular shape dark brown spinel (Sp) in abyssal serpentinized harzburgite (Sp); **(C)** reddish brown spinel in forearc serpentinized harzburgite; **(D)** Exsolution lamellae of clinopyroxene (Cpx) in orthopyroxene (Opx) in serpentinized harzburgite.

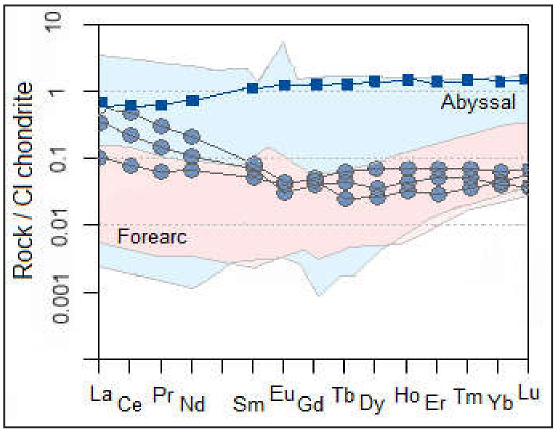

Fig.2 Chondrite-normalized bulk rock REE patterns for HMO mantle peridotites. Patterns from abyssal mantle peridotites (blue field; modified after Paulick et al., 2006; Proenza et al., 2016) and forearc (pink field; after Parkinson and Pearce, 1992) are shown for comparison.

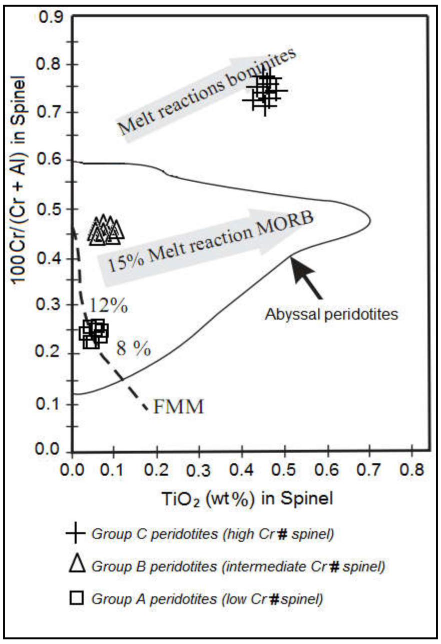

Fig.3 TiO_2 versus 100Cr/(Cr + Al) in Cr-spinel of HMO mantle peridotites. Dotted line field of abyssal peridotite spinels and gray arrows are from Choi et al. (2008).

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