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The Exotic Composition of Chromitites from the Loma Caribe Ophiolite, Dominican Republic

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INTRODUCTION

Chromitites are monomineralic bodies of chromite usually associated with mafic-ultramafic magmas such as those that form layered or zoned mafic-ultramafic bodies that intrude the continental crust, komatiite lavas and the mantle section of ophiolite complexes. The analysis of the distribution of a suite of major (Cr, Al, Fe, Mg), minor (Ti, Mn, Zn, Co, V), and trace elements (Ga, Sc) in chromite has been revealed as a useful tool to discriminate chromitites from these different geotectonic settings (e.g., Pagé and Barnes, 2009; González-Jiménez et al., 2015). Chromites in chromitites from layered intrusions and komatiite lavas are characterized by high contents of Ti compared with chromites from MORB, whereas those from ophiolite complexes chromitites have Ti contents lower or similar to chromites from MORB. Ophiolitic chromitites can be classified as Cr-rich (Cr# = Cr/(Cr+Al) > 0.6) and Al-rich (Cr#<0.6). The available data show that Al-rich chromitites exhibit a distribution of major, minor and trace element identical to that of chromite from MORB. In contrast, Cr-rich chromitites are depleted in Ti, Ga and Ni and slightly enriched in Co and Mn relative to MORB composition. A third group of ophiolitic chromitite, Cr- and Ti-rich, has been described as a unique case from a single chromitite body in the Dominican Republic (Proenza et al., 2007). The present work provides additional data of this body and two new found bodies in order to better define the nature of their parental melts and their geotectonic setting of formation.

GEOLOGICAL SETTING

The Loma Caribe peridotite body is exposed as a NW-SE oriented Mesozoic belt of 95 km long and 4 to 5 km wide along the Cordillera Central in Dominican Republic (Fig. 1). It is one out of many occurrences of ophiolite-related ultramafic rocks in the northern margin of the Caribbean plate (Lewis et al., 2006). The peridotite body consists of harzburgite, lensoid or tabular bodies (<10 m across) of dunite within harzburgite, and rare lherzolite, all of them with variable degrees of serpentinization (40% to 90%; Marchesi et al., 2016). They crop out as isolated dismembered bodies that strike parallel to the NW trend of the belt.

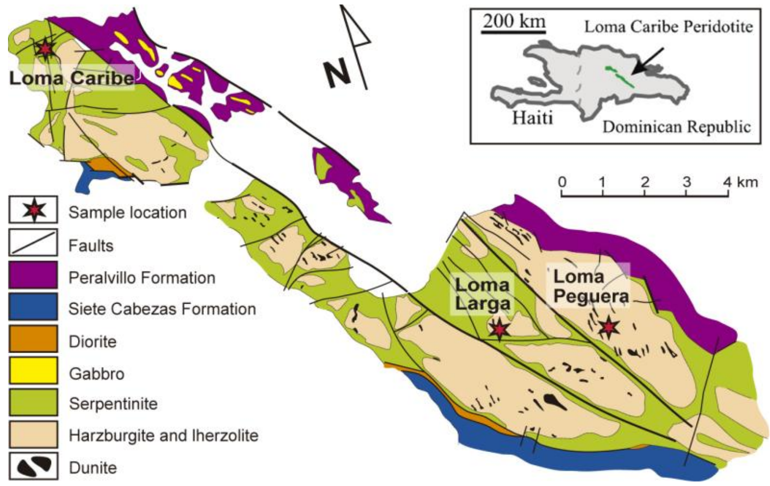

fig 1. Geographical location and geological map of the central section of Loma Caribe peridotite. Modified from Marchesi et al. (2016).

Small pods of massive chromitite (up to 10 m in length and <1 m thick) are enclosed in serpentinized dunites along the peridotitic belt (Proenza et al., 2007). Three of these occurrences are Loma Caribe and Loma Peguera chromitites, included in serpentinized peridotite, and Loma Larga chromitites, occurring mainly as weathered "floating chromitites" within limonite (Fig. 1). They all show typical massive textures (95 vol.% chromite) without the presence of primary silicates in the matrix, except for some interstitial secondary chlorite and serpentine.

SAMPLES AND ANALYTICAL METHODS

Chromitites from Loma Caribe, Loma Larga, Loma Peguera pods (Loma Peguera 1) and veins (Loma Peguera 2; Fig. 1) were sampled to investigate the major-, minor- and trace-element chemistry of chromite. Major element data were collected using the JEOL JXA-8230 electron probe microanalyser, at the Serveis Científics i Tecnològics, University of Barcelona. Chromite Sc, Ti, V, Mn, Co, Ni, Zn and Ga data were collected using a Resolution M-50 Excimer laser coupled to ThermoICap Qc ICP-MS at the Laboratorio de Estudios Isotópicos (LEI) of Centro de Geociencias, UNAM (Mexico). Data reduction was calculated with the software Iolite v2.5.

palabras clave: Cromita, Cromitita ofiolítica, Elementos traza, Loma Caribe

key words: Chromite, Ophiolitic chromitite, Trace elements, Loma Caribe

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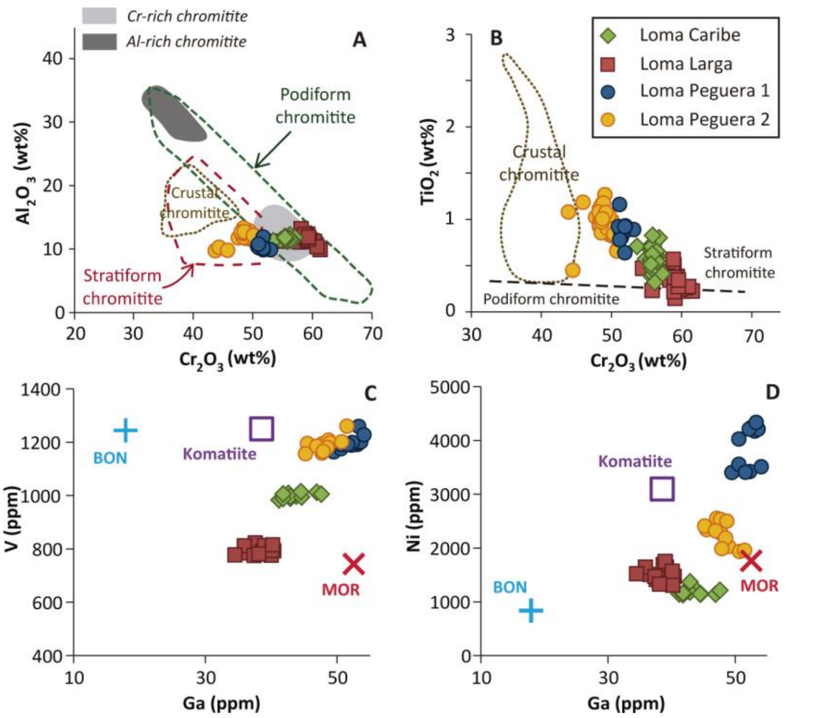

fig 2. *Chromite composition for major (A,B), minor and trace elements (C,D). Cr-rich and Al-rich fields from Zhou et al. (2014); podiform, stratiform and crustal chromitite fields from Lian et al. (2017); BON (boninite) and MOR compositions from Pagé and Barnes (2009).*

CHEMICAL COMPOSITION

All chromitites are Cr-rich in composition (Cr# ~0.75, up to 0.82), with Cr_2O_3 contents slightly heterogeneous among the different bodies (total range from 44.29 to 61.19 wt.%). Aluminum contents are more homogeneous (~11.07 wt.%). The chromitites are systematically enriched in TiO_2, with heterogeneous contents between 0.14 and 1.25 wt.% displaying a negative correlation with Cr_2O_3. The composition of chromite is not restricted to the podiform chromitite field but also overlaps the stratiform chromitite field (Fig. 2 A, B). Minor and trace element composition are also heterogeneous among the different deposits, but all form an array showing positive correlations of V (775–1259 ppm) and Ni (1133–4334 ppm) against Ga (35–54 ppm; Fig. 2 C, D). They present compositions intermediate between boninite and MOR chromite, closer to MOR chromite composition in most of the cases (Fig. 2 C, D). Previous studies describe a negative correlation between Cr# and V and Ga (Pagé and Barnes, 2009), but this relation is not confirmed by our results.

DISCUSSION AND CONCLUSIONS

There is a general positive correlation between Al and Ga contents in chromite. Thus, Ga contents have been proven a useful tool to discriminate between chromitites with varying Al contents formed in the oceanic mantle: in some ophiolite complexes, the oceanic mantle is geochemically segmented, with Ga-poor and Cr-rich chromitites located in the deepest portion of the mantle section and Ga-rich and Al-rich chromites near to the mantle-crust transition zone. However, Dominican Republic chromitite bodies are a unique case, being Cr-rich and Ga-rich. Binary diagrams of Ga against other trace elements present in chromite from the Dominican Republic show a clear positive correlation from Loma Larga to Loma Caribe and Loma Peguera. These data suggest a progressive modification of an evolving common parental melt. Our data also show that the chromitites from Dominican Republic did not crystallize from Mg-rich basaltic melts such as boninite or MORB (Fig. 2). We conclude that chromitites from Loma Caribe peridotite show an unusual composition that could be attributed to their crystallization from liquids extracted from a mantle plume. Therefore, chromitite bodies from Dominican Republic could be the first known case of plume-type ophiolitic chromitite.

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