Textural Relations and Mineral Compositions of Garnierite Ores Using X-Ray Images

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INTRODUCTION.

"Garnierites" are significant ore minerals in the saprolitic horizons of Falcondo nickel laterite deposits in the Dominican Republic. The garnierite mineralization mainly occurs as millimetric to centimetric-thick veins. Other occurrences include tension fracture-fillings, anastomizing veins, boxwork fabric, coatings on joints, often displaying slickensides and breccias (Proenza et al., 2008). These authors have concluded that Falcondo garnierite ores consist of fine-grained mixture of three solid solutions: (i) lizardite-nepouite, (ii) talc-willemseite, and (iii) sepiolite-falcondoite. However, the garnierite ores are compositionally variable on a fine scale and exhibit heterogeneous textures.

In this study, using X-ray images, we provide new data on textural relations and mineral compositions of garnierites ores from Falcondo Ni lateritic profile (Central Dominican Republic).

ANALYTICAL AND COMPUTATION TECHNIQUES.

Elemental (Si, Ni, Mg, Fe, Al, Na, Ca, Co, and Mn) X-ray images were obtained with a CAMECA SX–50 microprobe at the Serveis Cientificotècnics of the University of Barcelona operated at 15 keV and 200 nA, a focused beam, step (pixel) size of 3 μm, and counting time of 25-30 ms/pixel. These images were processed with DWImager software (Torres-Roldán and García-Casco unpublished). García-Casco (2007) has documented that high beam current combined with short counting time (milliseconds) avoids problems of beam damage to silicate minerals. Analyses of the mineral compositions were made with the same electron microprobe operated at 15 KeV and 10 nA.

RESULTS AND DISCUSSION.

X-ray maps revealed the spatial distributions of Ni and associated elements. They show that textures and mineral compositions are variable and complex at the μm-scale (Fig. 1), suggesting a complex history of deposition of the garnierite minerals.

The maps show discrete localization of high Ni contents (bright white in X-ray image of figure 1), and regions with typical colloform fabric characterized by alternating light and dark bands. Ni-rich phases are iron-poor, indicating a secondary (neoformed in lateritic conditions) origin. In contrast, areas of elevated Fe indicate that relict primary silicates (e.g. oceanic serpentine) are partially preserved.

Si-rich areas correspond to a later generation of microcrystalline quartz or colloidal silica filling voids and fractures. On the other hand, Si- rich areas containing small quantities of Ni represent the cryptocrystalline variety of quartz, poorly defined, named "chrysoprase".

Chemical variations mainly occur as changes in Si, Mg and Ni content. The amounts of Al, Cr, Ti, Ca, Na and K are very low. Quantitative electron microprobe analyses, and X-ray diffraction, indicate that the studied garnierite ores are composed dominantly of Ni-rich talc-willemseite (the so-called kerolite-pimelite series) and Ni-serpentine. Many EMPA in figure 2 lie close to or just below the talc-willemseite join, and probably are intimate mixtures of two mineral phases, known as the 10A° garnierites or kerolite-pimelite series (where tlc > srp) as defined by Brindley et al. (1979).

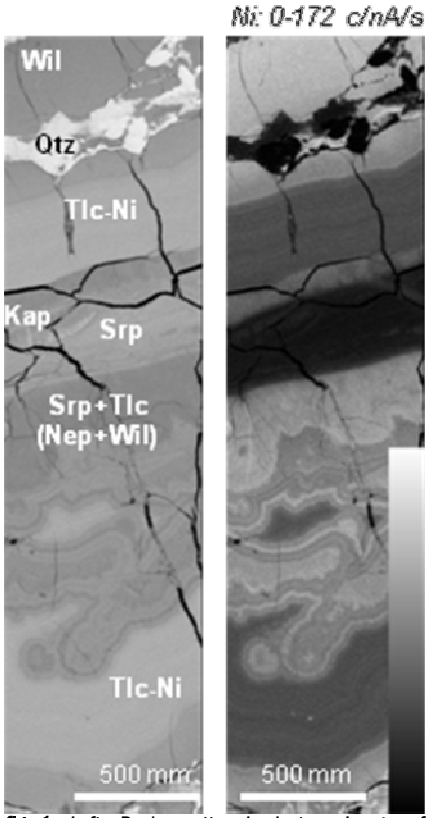

fig 1. *Left: Back scattered electron image of selected area of garnierite sample GAR-4. Right: X-ray image corresponds to Ni (Kα) of the same area of the sample.*

palabras clave: Garnieritas, Níquel, Lateritas, Falcondo, República Dominicana, Caribe.

key words: Garnierites, Nickel, Laterites, Falcondo, Dominican Republic, Caribbean.

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Also, our results suggest the presence in garnierite ores of karpinskite [$(Mg,Ni)_2Si_2O_5(OH)_2$)(?)] in close association with serpentine and Ni-bearing talc. Karpinskite is a valid species (Pre-IMA, 1956), but questionable, reported only as veinlets in "kerolitized" serpentinite from Nizhni Tagil massif (Urals, Russia).

Falcondo karpinskite has an intermediate composition between talc (high Si/(Mg+Ni ratio) and serpentine (low Si/(Mg+Ni ratio) (see figure 2).

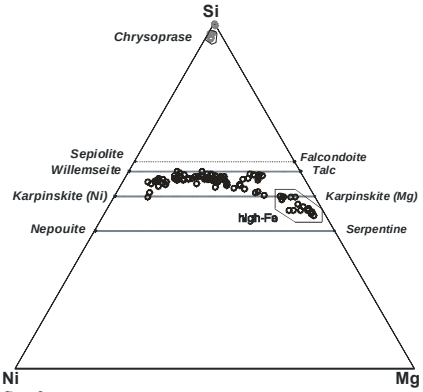

fig 2. *Projection of garnierite ores composition (at.%) in Si-Ni-Mg ternary diagram. The figure also indicates the positions of the solid solution series between Ni-sepiolite-falcondoite, talc-willemseite, karspinskite (Mg) – karspinskite (Ni) and lizardite-nepouite.*

Probably, karpinskite corresponds in a general way to the minerals often termed as deweylites, or may correspond to poorly crystalline material reported in garnierites and identified as mixtures of talc-like minerals and serpentine (Brindley and Hang, 1973).

Finally, X-ray maps suggest that the so-called chrysoprase consists of fine-grained mixture of cryptocrystalline variety of quartz (chalcedony) and trace amounts of Ni-rich talc. This Ni-rich phase is responsible of their characteristics green colour.

ACKNOWLEDGMENTS.

This research has been financially supported by the Spanish project CGL2006-07384. JAP and JFL gratefully acknowledge the help and hospitality extended by the staff of Falcondo mine (XSTRATA).

REFERENCES.

Brindley, G.W., Bish, D.L., Wan, H.M. (1979): Compositions, structures, and properties of nickel-containing minerals in the kerolite-pimelite series. Am. Mineral., 64, 615-625.

Brindley, G.W., Hang, P.T. (1973): The nature of garnierite-I Structure, chemical compositions and color characteristics. Clays and Clay Mineral., 21, 27-40.

García-Casco, A. (2007): Magmatic paragonite in trondhjemites from the Sierra del Convento mélange, Cuba. American Mineralogist, 92, 1232-1237.

Proenza, J.A., Lewis, J.F., Galí, S., Tauler, E., Labrador, M., Melgarejo, J.C., Longo, F., Bloise, G. (2008): Garnierite mineralization from Falcondo Ni-laterite deposit (Dominican Republic). Macla, 9, 197-198.