

Geology, Mineralogy and Geochemistry of the Loma Ortega Ni Laterite Deposit, Dominican Republic

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INTRODUCTION.

Loma Ortega deposit is one of the seven mining areas of Falcondo mine in Dominican Republic. This deposit is one of the strategic areas of exploration at this time. Despite their importance, no previous investigations have been carried out on the mineralogy, geochemistry and origin of the deposit.

In this paper, we report the results of a geological, mineralogical and geochemical investigation of Loma Ortega Ni-laterite deposit. The aim of the study is compare the mineralogy and geochemistry of two lateritic profiles (one Ni-rich and other Ni-poor).

Samples were investigated using X-ray fluorescence (XRF), X-ray diffraction (DRX), scanning electron microscopic (SEM-EDS) and electron probe microanalysis (EPMA).

GEOLOGICAL SETTING.

The Ni laterite deposits of the Dominican Republic occur over a belt of serpentinized peridotite (Loma Caribe) that is about 4-5 km wide, and extends for 95 km from La Vega to Loma Sierra Prieta north of Santo Domingo (Lewis et al., 2006). Most of the ultramafic bodies consist of harzburgite with subordinate clinopyroxene-rich harzburgite, dunite and lherzolite. The lateritization began in the early Miocene, when serpentinized peridotites were exposed to weathering and erosion. Haldeman et al. (1979) recognized at least four physiographic cycles as judged from different surface levels and benches on hill slopes. The lateritization process continues today but it is not suggested that optimum conditions for lateritization have necessarily been continuous since the Early Miocene.

THE LOMA ORTEGA LATERITIC PROFILE.

According to the criteria used by Falcondo geologists in their mining operation, several zones of ore-grade material have been recognized, based on Ni and Fe contents, texture, and proportion of rocky fragments (Haldemann et al., 1979). Zones D to E represent the lower saprolitic horizon, and zone C the upper saprolitic horizon. Zone B correspond to ferruginous saprolite or yellow-red limonite (above of the Mg discontinuity), whereas zone A corresponds to the upper limonite or red laterite zone that has been recognized in Ni-laterite deposits in other parts of the world.

Profile 1 (lower Ni grade) is 30 m deep. Three zones have been recognized from bottom to top: peridotitic protolith (> 10 m) → saprolite (17.5 m) → ferruginous saprolite (2.5 m). The limonite zone s.s. is totally eroded.

The protolith is represented by non-weathered serpentinized dunite and harzburgite. The saprolite zone is characterized by the preservation of the primary fabric and contains remnants of the protolith. This zone is dominated by lizardite, which replaces olivine grains (Fig. 1). Goethite becomes more abundant toward the top of this zone, and small amounts of chromite and maghemite are also present. Veins of siliceous material mainly consist of microcrystalline quartz. Aggregates of smectites are present in these veins.

The overlaying ferruginous saprolite zone is comprised of disaggregated yellow-red limonitic blocks. The mineralogy of this zone consists of lizardite, chromite, goethite and maghemite enveloping forsterite relict grains totally dissolved and silicified with

a thick film of goethite (Fig. 2). Silica veinlets and boxwork, are abundant within smectites.

Profile 2 (high Ni grade) is 50 m deep. Four zones are recognized from bottom to top: peridotite protolith (> 15 m) → coarse saprolite (18 m) → soft saprolite (15 m, the ore horizon) → ferruginous saprolite or yellow-red limonite (2 m).

The peridotite protolith from profile 2 is broadly similar to that of profile 1 and can be classified as predominantly harzburgite-dunite with weathering only along fracture plans.

The coarse saprolite zone, with preserved primary texture, consists of olivine grains altered to lizardite and weathering silicate minerals locally transformed into goethite. Veins are filled by iron oxides and asbolane (Fig. 3).

The coarse saprolite grades vertically into the soft saprolite zone, which is the ore horizon. In this zone, relict silicified grains, Ni-poor lizardite and a second generation of Ni-rich lizardite (Fig. 4) are the major crystalline phases, occurring with minor magnetite, chromite, goethite and Mn-Ni-Co oxihydroxydes.

The overlaying ferruginous saprolite zone is red to ochre, and consists of hard 2-5 cm blocks of goethite rich material. This zone is dominated by pseudomorph forsterite grains completely altered to goethite surrounded by microcrystalline quartz. Groundmass is altered to goethite, maghemite and hematite. Fractures are filled with quartz forming a boxwork texture.

WHOLE-ROCK CHEMISTRY.

In profile 1, there is a strong increase in

palabras clave: Laterita, Lizardita, Esmectita, Níquel, República Dominicana, Caribe.

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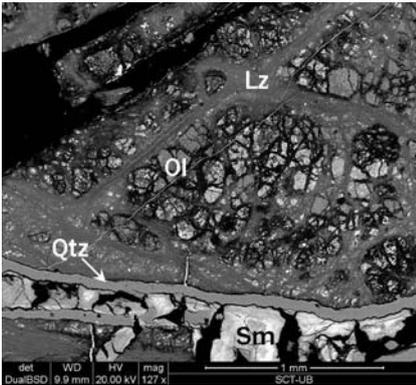


fig 1. Back-scattered electron image of saprolitic horizon in profile 1.

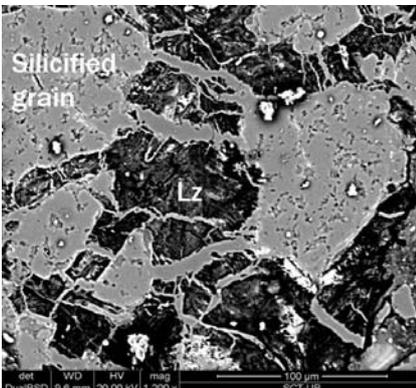


fig 2. Back-scattered electron image of strongly silicified ferruginous saprolite zone in profile 1.

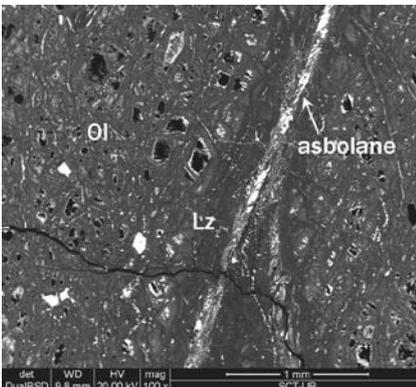


fig 3. Back-scattered electron image of saprolite horizon with relict grains of olivine replaced by lizardite, and fracture filling by asbolane in profile 2.

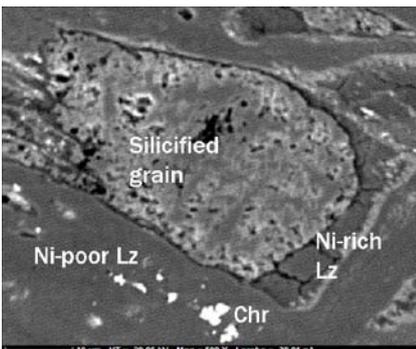


fig 4. Back-scattered electron image of lizardite horizon surrounding silicified grains in saprolite horizon in profile 2.

the Si, Fe, Mn and Ni content from the parent rock to the top of the weathering profile, whereas MgO content decreases. In profile 2, FeO, MnO, contents increase up the profile as opposed to MgO. Ni concentrations strongly increase in the profile 2 from the peridotite protolith through to the soft saprolite and then sharply decrease in the ferruginous saprolite. Ni is highly enriched in soft saprolite zone (up to 3.16 NiO wt.%) (Fig. 5).

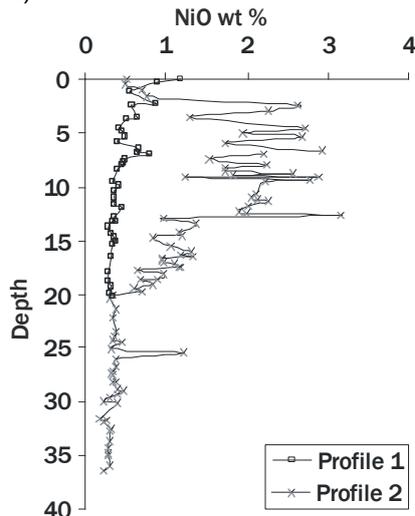


fig 5. Variation in NiO wt.% as a function of depth in the two profiles.

MINERAL CHEMISTRY.

Primary lizardite is Ni-poor (< 0.4 wt.% NiO), and is no more enriched in Ni than in olivine. The second generation of lizardite is the major Ni-bearing phase. Ni content in Ni-rich lizardite ranges from 1.16 to 2.44 wt.% NiO.

The average chemical composition of the smectite with 0.85 wt.% NiO in profile 1 is similar to that of trioctahedral plasma-smectite in the Murrin Murrin lateritic profile (Gaudin et al., 2004). Ni content in the analyzed asbolane varies from 12.53 to 16.06 wt.% (average value = 14.30 wt.%), whereas the cobalt content ranges from 0.48 and 4.06 wt.%.

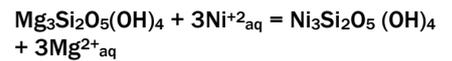
DISCUSSION AND CONCLUSIONS.

In the Loma Ortega Ni-laterite most of the nickel is found in the saprolite zone and these deposits are classified as the silicate-type deposits (highest-grade Ni laterite deposits).

The geochemistry and mineralogy of the studied profiles suggest that, ore grade mineralization is mainly controlled by topography, drainage and position of the water table. The profile 2 has higher grade ore (up to > 3 wt.% NiO), and is

associated with more freely drained parts of the saprolite. The altitude of the profile 2 is 367 m, whereas profile 1 is at 263 m. In the area of the profile 2, the relatively high relief allows free draining with a deep water table. This condition results in the high water flow, maximum rates of leaching and significant supergene Ni enrichment. Also, profile 1 is more silicified, causing dilution in the bulk Ni content.

The second generation of lizardite is the major Ni ore in saprolite. Ni is derived by the leaching of olivine, primary lizardite and Ni-bearing goethite. Primary lizardite results from the serpentinization of olivine prior to weathering. The second generation of lizardite results from the exchange of Ni for Mg in partly weathered primary lizardite (Golightly, 1981; Freyssinet et al., 2005):



At equilibrium in this reaction, Ni is far more stable in lizardite and Mg in the soil water (Golightly, 1981).

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