

Platinum Group Minerals (PGM) in Ni-Laterites from Falcondo (Central Dominican Republic)

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INTRODUCTION.

Previous studies have suggested that lateritic weathering could play an important role in the neo-formation of platinum group mineral (PGM), and that laterites have a potential for PGE research (Bowles, 1986; Grey et al., 1996). The behaviour of PGE in this environment is not yet completely understood, although some examples of well documented remobilization and precipitation/enrichment of PGE in lateritic environments already exist (Salpeteur et al., 1995; Traoré et al., 2008).

In this study, one saprolite sample from a Ni-lateritic profile (Central Dominican Republic) have been investigated using innovative Electric Pulse Disaggregation (EPD) and hydroseparation (HS) techniques (Rudashevsky et al., 2002) with the aim of determining the occurrence of the platinum group minerals (PGM).

GEOLOGICAL SETTING.

The Loma Caribe peridotite, in the Median Belt, in central Hispaniola is about 4-5 km wide and extends for 95 km from La Vega to Cerro Prieta north of Santo Domingo (Lewis et al., 2006). Most of the body is serpentinized harzburgite but dunites, and lherzolites also occur (Proenza et al., 2007). The Loma Caribe peridotite was emplaced first as early as the late Albian. Ni-laterite is well-developed over the Loma Caribe serpentinized harzburgites. Most

of the nickel is found in the saprolite zone and these deposits are classified as silicate-type deposits (highest-grade Ni laterite deposits). The main ore consists of hydrated Mg-Ni silicates (serpentine and "garnierite") occurring deeper in the profile (zone C to D). These zones account for 40% of the total ore reserves, while zone B (limonite ore) is 25% of the reserve (Lewis et al., 2006).

THE ANALYZED SAMPLE.

The analyzed sample (3.3 kg), was taken from the saprolitic zone (horizon D, according to mining operation). This horizon consists of predominantly hard fragments of serpentinite from 5-25 cm in diameter set in a matrix of soft serpentine minerals. The fragments are a pale yellow ochre or dark grey color and often show concentric alteration zones.

ANALYTICAL TECHNIQUES.

EPD liberates accessory minerals from many rock types in a pristine condition without damaging them. The basic components of the unit are a high voltage power source fed to a voltage-increasing circuit, which discharges the current to the sample chamber (see Rudashevsky et al., 1995 for details).

The HS process solid water-insoluble powdered samples to produce representative "heavy-mineral concentrates" of particles that follow Stokes' law when settling in a carefully controlled upward pulsating water stream (Rudashevsky et al., 2002). HS is very efficient in separating trace

amounts of PGM from the fine fractions of powdered samples (e.g. Cabri et al., 2005). The 40, 63, 80 and 125 m μ fractions prepared for HS were treated separately until the purest concentrates were achieved.

The concentrates were mounted with resin and 2.5 cm polished sections were prepared for SEM and electron microprobe analyses. The analyses of the PGM were done with a four-channel CAMECA SX50 electron microprobe at the Serveis Científicotècnics of the University of Barcelona.

RESULTS.

PGM grains were found in the 40, 63 and 80 m μ fractions HS concentrates of the analyzed saprolite sample. The PGM assemblage comprises Ru, Os, and Ir-rich phases, including laurite [(Ru,Os,Ir)S₂] and undetermined Ru-Fe, Ru-Fe-Ir-Os, and Ru-Pt-Fe-Os-Ir alloys/oxides, and Rh-Ir sulfide.

The heavy concentrate also included chromite, magnetite, goethite and awaruite grains, as well as metals: Fe, (Fe,Cr), Ni, Cu, Sn and Pb. The silicate minerals consist predominantly of serpentine, and minor olivine and quartz.

The PGM can be divided into two categories:

i) PGM included in fresh chromite grains. They were found in 63 and 80 m μ fractions, and form single-phase euhedral grains (fig. 1). They consist of

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laurite and an undetermined Rh-Ir-S phase, corresponding to the formula $(\text{Rh},\text{Ir})_3\text{S}_4$. The shape and composition of PGM enclosed in fresh chromite grains suggest a primary origin.

ii) Free PGM grains (only found in 40 μm fraction), that mainly consist Ru-Os-Ir-Fe oxides, undetermined Pt-Ir-Fe-Ni and Ru-Os-Ir-Rh alloys (fig. 2). These PGM are characterized by an irregular shape, rugged surface and high porosity. In some case, the PGM grains consist of two phases intimately intergrown, one containing an oxide and the other composed of PGE alloy.

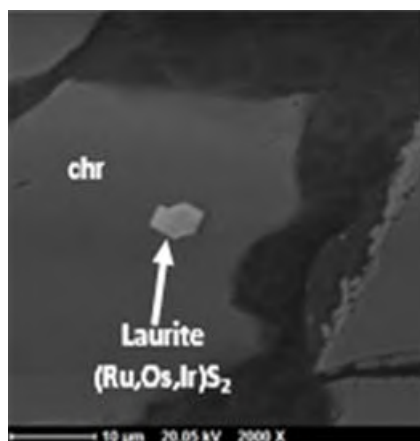


fig 1. PGM grain (laurite) in heavy concentrate of the sample LP-4 (63 $\text{m}\mu$ fraction). chr: chromite.

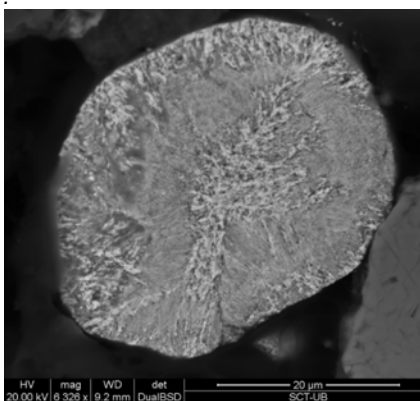


fig 2. PGM grain (Ru-Fe-Os-Ir) in heavy concentrate of the sample LP-4 (fraction < 40 $\text{m}\mu$ in size).

The compositions of the main PGM are plotted in fig. 3. The composition of the laurite plot close to the Ru apex in the Ru-Os-Ir ternary, and is similar to most of the magmatic laurite, containing Os and Ir in solid solution, up to 19 wt% and 9.8 wt% respectively.

Electron-microprobe data (at. %) plotted in fig. 3 reveal that the compositions of

the Ru-Os-Ir-Fe oxides/alloys are very similar to that of the sulfides of the laurite-erlichmanite series. Their chemical composition in terms of Ru-Os-Ir ratios strongly suggests an origin of these oxides by a progressive desulfuration and further oxidation of primary laurite. However, all our analyzed oxide/alloy grains are sulfur-free, suggesting complete desulfuration or the possibility that they were not generated by the desulfuration process. Also, some Ru-Os-Ir-Fe phases contain Si and Mg, suggesting that some of them represent mixture of PGM and silicates, probably serpentine.

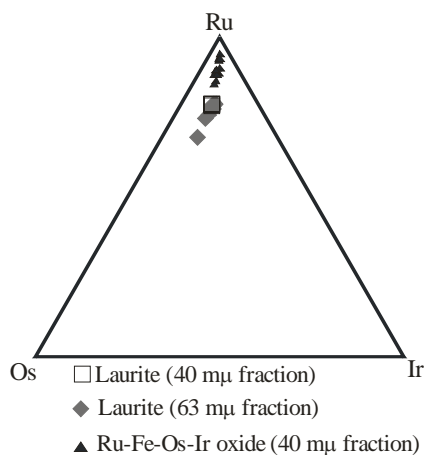


fig 3. Composition (atom %) of laurite and Ru-Fe-Os-Ir oxides in terms of Ru-Os-Ir ternary diagram.

CONCLUSIONS

To the best of our knowledge, the PGM found in this work represent the first record of in situ PGM in a Ni-laterite profile derived from ophiolite-related mantle peridotites.

PGM included in unaltered chromite grains are primary in origin, formed in the high-temperature magmatic stage. In contrast, the free grain of PGE alloys/oxides present in saprolitic zone at Loma Peguera may represent the product of alteration of pre-existing PGM, or may result from precipitation under lateritic conditions. The irregular shape and high porosity of oxide/alloys suggest that they result from a dissolution process. The occurrence of PGM as free particles in the weathering profiles of southern New Caledonia has been interpreted as derived from the supergene dissolution of PGM-bearing chromite (Traoré et al., 2008).

In any case, the occurrence of PGM in saprolite zone suggests the existence of

mechanisms of alteration, remobilization and crystallization of PGE in lateritic environments. The abundance of encountered PGM makes the investigated Ni-laterites potentially important also for the economic recovery of PGE.

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