Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 985

Platinum Group Elements (PGE) Mobility Under Tropical Weathering Conditions

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Introduction

The study of PGE (Ru, Rh, Pd, Os, Ir, and Pt) in geologic settings were initially motivated by their petrochemical applications and economic interest. Moreover, PGE have recently received much attention in regard to studies investigating global elemental fluxes and mobility in surficial/weathering environments. Furthermore, PGE soluble compounds have raised health concerns about their toxicity despite of the relatively inertness of metallic PGE. In spite of all these factors, the partitioning and solubility of PGE in weathering environments is still not well understood. In this study, we assess the mobility of PGE under weathering conditions by analyzing the chemical alteration profile of gabbroic rock samples obtained from a tropical environment.

Materials and Methods

The studied samples were taken from partially weathered gabbroic boulders outcropping at the surface of lateritic soils in southern Venezuela. These soils and boulders are derived from rocks belonging to a mafic-ultramafic layered body of Precambrian age. The gabbro boulders have an inner fresh core, composed predominantly of plagioclase and amphibole, capped by alteration rims (2-10 cm thick) composed of variables proportions of goethite, hematite, gibbsite and kaolinite. The samples selected for this study include the fresh rock (R5) and 5 samples representing increasing degrees of alteration from the innermost (R5-D) to the outermost (R5-A) portions of the rim. This sampling strategy minimizes the problem of sample heterogeneity and guarantees the cogenetic relationship between the unweathered and weathered samples. The samples were ground to less than 74 μm, then fused with sodium peroxide and the PGE were separated by tellurium coprecipitation. Pt, Pd, Ir, Os, and Ru were analyzed by isotope dilution inductively coupled plasma mass spectrometry (ICP-MS). Rh and Nb were analyzed by external calibration ICP-MS. The precision of the analyses relative to absolute concentrations (1σ) was better than 3% (Ru, Pt, Rh, Pd, Nb) and 8% (Os, Ir).

Results and Discussion

In order to assess the mobility of PGE, their loss or gain due to the weathering process was computed by comparing the PGE content with that of Nb, which was assumed to be immobile, according to the following equation:

PGE loss or gain = 100 x [(Rw-Rf)/Rf]

where Rw and Rf correspond to the Nb normalized PGE concentration in the weathered and fresh rock samples, respectively. The calculated PGE gains and losses are shown in Figure 1. With the exception of Os in sample R5-D, a general trend for PGE losses relative to Nb are observed as a consequence of the weathering process. However, PGE losses are significantly lower than that of many other elements. For example, the loss of rare earth elements (REE) was estimated to be as large as 90% (Tapia et al., 1998). The PGE show different behaviors: Pd and Os loss increase from the inner to the outer weathered rim areas while the Ir, Rh, and Ru loss decrease towards the outer rim. This pattern of Ir, Rh, and Rh loss may indicate that the Nb is also partially lost in the more weathered samples. Heterogeneous distribution of PGE in the unweathered sample may explain the irregular Pt loss, as well as the relative Os enrichment in sample R5-D.

The observed sequence of PGE mobility is: Os, Ru > Pd > Ir, Rh, Pt. The higher mobility of Pd relative to Pt in the weathering processes is now well established (Wood et al., 1990; Bowles et al., 1994; Salpéteur et al., 1995). The differences between Pt and Pd mobility is assigned to the higher solubility of Pd in the form of organic and inorganic complexes, and the higher stability of secondary Pt phases. The behavior of Ru, Os, Rh and Ir in the weathering environment is less documented. However, Peucker-Ehrenbrik and Hannigan (2000) found significant losses of Os, Pd, Ir, and Pt for the weathering of black shale.

The results of this work show that even in the conditions of very intense weathering, characterized by the total dissolution of primary gabbroic mineral phases, PGE are only partially mobilized.

Journal of Conference Abstracts
Volume 5(2), 986

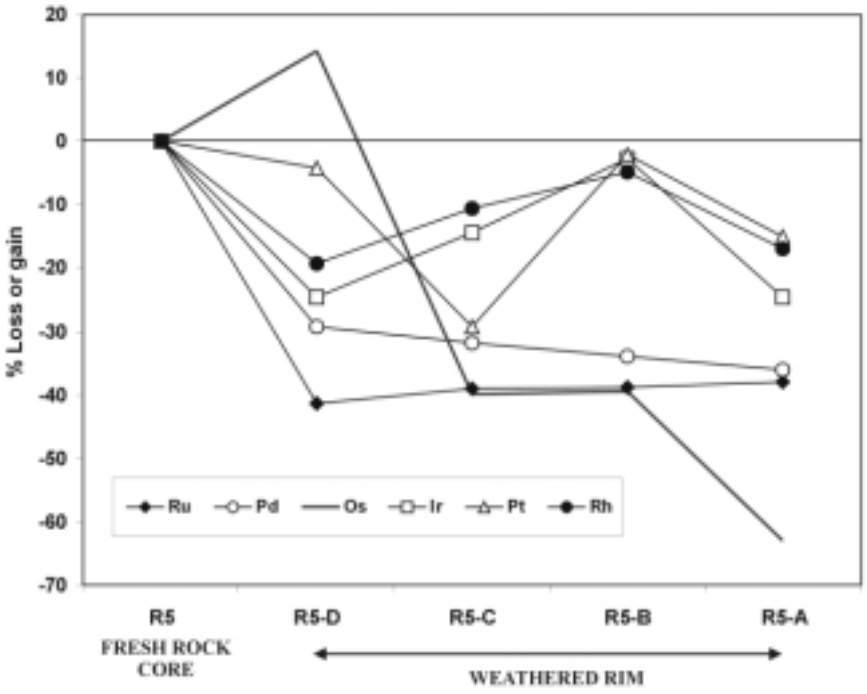

Figure 1: Calculated PGE gains and losses relative to Nb

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