Acid rock drainage associated with tropical glacier retreat: Nevado Pastoruri, Perú.

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An important glacier retreat has been registered in the Nevado Pastoruri (Huascarán National Park) from 1962 to 2001, reducing its surface a 60% [1]. This process is frequent in glaciers located at Cordillera Blanca. Occasionally, glacier retreat exposed pyrite-rich rock outcrops of the Chicama formation, causing its alteration and the generation of acid rock drainages (ARDs) [2].

In the case of Nevado Pastoruri, the glacier retreat has left exposed to atmospheric conditions the sandstones and lutites with coal enriched in pyrite of the Chimú formation [3].

The proglacial zone presents a lot of lakes, scant vegetation, and intense fluvioglacial erosion. On morphologies typically glacier are abundant the ARDs, revealing like springs of underground water, runoff or forming lakes. ARDs are clearly identifiable for the colour and the morphology (terraced iron formations), which is associated with the oxidation of Fe(II).

The water sampling was carried out in the proglacial zone. After cluster analysis using 23 samples, two groups were established. The first group (n=8) gathered the most acidic samples, pH 3, showing also the highest concentrations of elements such as SO_4, Fe, Al, Ca, Mg, Mn and Zn. These samples were directly related to the pyrite alteration (227 mg/L SO_4, 41 mg/L Fe) and aluminosilicate dissolution (10 mg/L Al), showing especially high values. This group is made up by the ARDs. The average concentration of these samples was an order of magnitude higher than the values showed by second group, which showed a scant mineralize (freshwater).

The ARDs geographical distribution is not disperse. These samples are grouped in a band of 600 m length with N-S direction and 250 m wide, between the elevations of 4925 and 5025 m. The mixing of two water types generates the source of River Pachacoto, showing Fe(III) buffer water (pH 3.1, Fe 0.7 mg/L) and several mg/L of dissolved Al (4.5) that confers mineral acidity to water.

[1] Duran *et al*. (2009) *Investigaciones Sociales* **13**, 59-77. [2] Fortner *et al*. (2011) *Applied Geochemistry* **26**, 1792-1801. [3] INGEMMET (1996) Geología de los cuadrángulos de Huaraz, Recuay, La Unión y Yanahuanca, pp. 292.

Sr and Nd isotope data for arc-related (meta) volcanics (SW Iberia)

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In the southern sector of the Ossa-Morena Zone (Iberian Variscan Chain), along its boundaries with the Beja-Acebuches Ophiolite and the South-Portuguese Zone, Upper Palaeozoic igneous mafic and intermediate rocks, both intrusive and extrusive, are widely represented. The so-called Odivelas Unit (Andrade,1983), include (meta-) basalts and (meta-) andesites, which, according with previous studies, display low-K tholeiitic to calc-alkaline signatures and, therefore, are interpreted as remnants of an active margin volcanic arc. Santos *et al*. (1990) subdivided those volcanics into two groups: in Alfundão-Peroguarda, the tholeiitic nature is dominant; in Odivelas-Penique, the calc-alkaline signature becomes more pronounced. Intercalation of limestone layers provided some age constraints, showing that the subduction-related volcanic activity in the studied area began in the Lower Devonian and continued, at least, through the Middle Devonian (Conde & Andrade, 1974; Machado *et al*., 2010).

In this work, samples previously studied by Santos *et al.* (1990) and Silva *et al.* (2011) were analysed for Sm-Nd and Rb-Sr isotopes. Considering that the volcanics were systematically affected by hydrothermal metamorphism, it is expected that the Sr signatures show significant disturbance. In contrast, Nd isotope ratios probably reflect the primary features. Alfundão-Peroguarda samples show a very limited range of positive initial ε_{Nd}, from +5.1 to +4.3 (assuming 400 Ma), showing no evidence for significant crustal assimilation and, therefore, allowing the attribution of negative Nb and Ta anomalies to arc-related processes On the other hand, $^{87}Sr/^{86}Sr$ varies from 0.7044 to 0.7060 (for 400Ma). These samples rocks define a horizontal trend on the initial ε_{Nd} vs. initial $^{87}Sr/^{86}Sr$ plot, typical of co-genetic rocks that underwent interaction with seawater. On the other hand, Odivelas-Penique volcanics show wide spectra for both initial $^{87}Sr/^{86}Sr$ (from 0.7038 to 0.7066) and ε_{Nd} (from +4.6 to -4.1). Significantly, the highest εNd values for this group are within the narrow range defined by Alfundão-Peroguarda tholeiitic basalts, suggesting a common mantle source (or very similar sources) for the most mafic magmas of both sectors.

The whole set of Nd isotope ratios supports the distinction previously proposed between the two groups of volcanics. In addition, the variation from positive to negative initial ε_{Nd} values in the Odivelas-Penique suite shows that its geochemical features were likely influenced by assimilation of continental crustal material.

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