Scarce industrial commodities: a glance at the possible rhenium availability in mining residues from the exploitation of Portuguese ore deposits

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Rhenium (Re) is one of the last naturally occurring elements to be discovered about a century ago. It is a singular metallic element for many reasons – high melting point (3180 ºC, only exceeded by tungsten and carbon/diamond), and high density; high modulus of elasticity and electrical resistivity; low friction, no ductile-to-brittle transition and high resistance to creep – and nowadays it is highly demanded for various industrial fields, ranging from the assembling of catalysts used in the fabrication of lead-free high-octane gasoline to the production of high-temperature super-alloys for aircraft engines. However, rhenium does not occur specifically mineralized, being carried essentially by molybdenite (natural molybdenum disulphide, Mo52) and its global availability in the Earth's crust amounts to a single-digit parts-per-billion. World reserves of rhenium are then primarily encircled in, or attached to, molybdenite from porphyry copper deposits. As a result, rhenium is currently a by-product in the copper mining industry, being oxidized when roasting molybdenite-rich ores and being subsequently recovered from the resulting flue dusts under the form of ammonium perrhenate (APR).
Rhenium is nowadays one of the most expensive commodities due to its very low availability comparative to actual industrial demand. Recycling of Re-containing materials (mainly alloys and catalysts) therefore configures an important secondary supply of this very scarce element and the sustainable appraisal of Re-containing mining wastes gains today a relevance that will certainly increase in next years.
A brief primary glance at the possible rhenium availability in mining residues from the exploitation of Portuguese ore deposits is presented starting with São Domingos abandoned mine (southern Portugal). The massive sulphide deposits from the Iberian Pyrite Belt (IPB) were exploited there since the Roman occupation of Iberia and elemental analysis recently carried out on these mine wastes under the EU-FP7 research project PROMINE has disclosed the occurrence of quite impressive Re contents, up to 3.4 ppm; a subsequent X-ray absorption spectroscopy study performed at the European Synchrotron Research Facility (ESRF, Grenoble/France) has shown that rhenium is attached to oxygen in São Domingos mine wastes. The same methodology was recently applied to assess the binding state of Re in selected rhenium-rich molybdenite samples from various provenances and the spectroscopic results point to a disordered replacement of Mo by Re, without forming new Re-Mo-S phase(s). Molybdenite occurrences in Portugal were studied in relation with tungsten exploitation but their Re contents were never addressed; the high values now recognized for mine wastes from IPB massive sulphide ore deposits encourage the implementation of a suitable analytical and quick methodology to ascertain rhenium content of molybdenite - a work now in progress and which preliminary results will be described.