Invisible gold in arc volcanic glasses

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We present new EMPA major and LA-ICPMS trace element data from submarine basaltic to rhyolitic volcanic glasses recovered from the Kermadec arc volcanic centers Monowai, Brothers, Healy, Cotton, Rumble II West, Rumble III and Clark. During time-integrated analyses, invisible nano-sized nuggets rich in Au, Ag, Mo, Sn, Sb and W—mostly located along microlite or microcrystal-glass boundaries—were identified and then mapped using LA-ICPMS. Field and experimental evidence suggest that hot gases exsolve from magmas and accumulates as bubbles, can act as a carrier for metals, including Au and Ag. Mainly due to changes in temperature, pressure, flow regime and melt characteristics (i.e., viscosity, volatile saturation, and so on) during the ascent of the magma and quenching of the lava during eruption, the bubbles become unstable and may collapse, subsequently depositing metal-rich nano-nuggets in the glass. The localised occurrence of the nano-nuggets indicates a heterogeneity in the metal-contents of the gas phases exsolved from the ascending magma. In addition, imperfections, such as microcrystals, may act as nucleation point for nano-nuggets, which can explain their common occurrence along microcrystal-glass boundaries. Furthermore, these nano-nuggets appear to preferentially occur in basaltic glasses rather than in silica-rich glasses, suggesting there is an influence of magma type on the metal-bearing capabilities of the exsolved gases (bubbles). The formation of nano-nuggets in Kermandec arc glasses most likely represents a syn-eruption metal enrichment, possibly representing an indication of the ore forming capabilities of magmatic sources.

Niobium and Tantalum Mineralization in the Nechalacho REE Deposit, NWT, Canada

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The Nechalacho Layered Nepheline-Aegirine Syenite suite at Thor Lake, North West Territories, situated within the alkaline to peralkaline Blachford Lake Complex, contains substantial researves of Rare Earth Element (REE), zirconium, niobium, tantalum, and gallium in two ore zones (Upper and Basal zones). Pervasive hydrothermal alteration, involving replacement of primary magmatic mineral assemblages by an assemblage comprising K-feldspar, biotite, zircon and magnetite, influenced the upper 300 m of the layered suite, including the niobium-tantalum mineralization, which occurs in both ore zones. This was followed by albitization.

Previous studies of niobium and tantalum mineralization have focused on pegmatites, in which they occur as magmatic columbite group minerals that vary compositionally due to crystal fractionation. Unlike most pegmatites, niobium and tantalum at Thor Lake are hosted mainly by secondary minerals, i.e., fergusonite-(Y) and columbite group minerals, and as minor components in zircon. In the Upper ore zone, columbite group minerals occur within the altered cores of zircon crystals and immediately surrounding these crystals. Fergusonite-(Y) displays similar textural relationships with zircon in the Basal ore zone. Primary magmatic columbite group minerals have been identified only within drill core intervals of unusually high bulk iron content.

We propose a model in which niobium and tantalum were concentrated at the magmatic stage in a zirconium-silicate, such as eudialyte in the Basal ore zone or within zircon in the Upper ore zone. The zirconium-silicate, eudialyte, was decomposed by hydrothermal fluids, resulting in the formation of zircon with yttrium-rich cores. Fergusonite-(Y) then crystallized during hydrothermal alteration of these zircon cores in the heavy REE-enriched, Basal ore zone. Simultaneously, alteration of yttrium-poor zircon in the heavy REE-depleted Upper ore zone led to the formation of fine-grained columbite group minerals. Locally, primary columbite group minerals crystallized and were later metasomatically altered within iron rich horizons of the ore zones. As opposed to other niobium and tantalum-bearing intrusions, the minerals in the Nechalacho Layered Suite that host these two metals are predominantly of secondary origin.

DOI:10.1180/minmag.2013.077.5.20