Fractionation processes in the granite-related ore system of the Karagwe-Ankole Belt (Rwanda)

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Primary mineralisation in the Karagwe-Ankole Belt (KAB) of Central Africa occurs in Nb-Ta-Sn rare-element pegmatites, Sn greisenised pegmatites and peribatholitic Sn or W hydrothermal quartz veins which are all spatiotemporally related to the regional "Kibara tin", peraluminous leucogranite intrusions of 986 ± 10 Ma (Tack et al., 2010). This study focuses on the deposits located in the central part of the KAB, i.e. in Rwanda and presents the status quo of the observed fractionation mechanism in this composite ore system. Elemental geochemistry and quantitative distribution models have been used 1) to quantify the mechanisms behind the regional formation of the pegmatite- and quartz vein-hosted deposits from the parental Kibara tin granites, 2) to examine the distribution and enrichment of Nb, Ta, Sn and W in the different metallogenetic subsystems (i.e. pegmatites and veins) and among different phases (i.e. minerals, fluids and melts) and 3) to evaluate the role and extent of mixing between magmatic-hydrothermal and metamorphic fluids in the formation of the peribatholitic quartz vein deposits.

We demonstrate that Rayleigh-type fractional crystallisation acted as the main mechanism by which the pegmatitic magmas differentiate from the parental leucogranitic melt. However, early aqueous fluid exsolution and W fluid-fractionation and late borosilicate melt immiscibility have been identified to occur during differentiation of this B-rich, F-poor melt system. The very high degrees of fractional crystallisation induced magmatic disseminated Nb-Ta and accessory Sn mineralisation in the rare-element class pegmatites. Lithological-controlled precipitation conditions in combination with fluid mixing and dilution form the key processes responsible for the decoupling of W and Sn. More specific, the Sn-W fractionation is responsible for the formation of relatively early hydrothermal W mineralisation in black shale-hosted quartz veins, and of relatively late hydrothermal/metasomatic Sn mineralisation in feldspar-rich quartzites/sandstones and greisenised rare-element class pegmatites.

Tack et al. (2010). Precambrian Research 180, 63-84.