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# Partial melting as an efficient mechanism to produce rare metal granite?

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Rare metal (HFSE such Sn, W, Ta, Nb and LILLE such Li, Rb) granite represent the most enriched magmatic rocks on Earth. This is especially true for some elements that belongs either to the European list of critical raw materials and/or the conflict minerals (eg. Li, Sn, W, Nb, Ta). Rare metal granites generally emplace in the vincinity of S-type granites during late orogenic stages. The fraction crystallisation mechanism is postulated to be the unique way to produce enriched silicate melt that later leads to ore deposits due to a combination of magmatic/hydrothermal processes. However, some problems persist in the explanation of the genesis of rare metal granite: crystal fractionation alone does not lead to the very high rare metal concentrations; field discrepancies exist between rare metal granites and their supposed parent peraluminous granites that in some cases are unknown. An alternative model - based on the integration of geochemical, experimental, paleogeographical and structural studies – suggests that low degree partial melting could be an efficient mechanism to produce critical metals enriched silicate melts enriched. To test whether this hypothesis makes sense, we present a study of the behaviour of W, Sn, Nb and Ta in metamorphic minerals from various metapelitic rocks. The selected samples do not present anomalous bulk concentrations of these elements with respect to an average continental crust. They formed at different pressure temperature conditions, in different orogenic belts. The rock collection comprises (i) amphibolite-facies staurolite bearing rocks, (ii) sillimanite-bearing rocks and (iii) granulite-facies orthopyroxene-bearing rocks. These samples represent the three main stages of the classical evolution of a collisional gradient leading to partial melting: they respectively belong to the muscovite + biotite domain, the muscovite-out reaction and the biotite-out reaction. We first estimate pressure-temperature conditions of formation of the rocks using pseudosection modelling. We then expose a set of LA-ICP-MS data to identify the critical metal carriers minerals in our samples. Meanwhile, we investigate the behaviour of W, Sn, Nb and Ta during the muscovite out reaction with two piston cylinder experiments (a partial melting experiment and a crystallization experiment). The protolith consists of a staurolite-bearing metapelite that did not suffer partial melting. In the light of these new data, we discuss the framework of the production of critical metal enriched silicate melts. We show that the main carrier of W is muscovite (up to 30 ppm) and that biotite handle Sn at high temperature (up to 40ppm). Using both the data from the natural sample and the experiments, we highlight that muscovite releases W during its destabilisation ant that Sn enters in biotite until the mineral breaks. We finally discuss the implication of multiple low degree partial melting / melt extraction as efficient way to produce

enriched silicate melts.