The role of source processes in the origin of rare metal magmas – Insights from micas in granites and pegmatites

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Magmatic micas record the trace element contents of granitic melts during their crystallisation. In two micas bearing leucogranites, biotite is a liquidus phase while muscovite crystallises later. The presence of both micas offers access to compositions of both primary and more residual melts. Using adequate mica-melt partition coefficients, trace element (in this study: Li, Be, Cs, Nb, Ta, Ba, Rb and F) contents of melts can be calculated from trace element contents in micas.

Field observations in the variscan St Sylvestre Leucogranite Complex (Limousin, France) and the Mont d'Ambazac pegmatite field that is intrusive in the complex, suggest progressive differentiation from granites to pegmatites, with melts becoming more enriched in rare metals with time. That is in agreement with the variable enrichments in trace elements of melts at equilibrium with biotite. However, melt concentrations in the most differentiated granite and the less differentiated pegmatite are similar. This shows that textural differences (such as between granite and pegmatite) are not necessarily related to differences in melt composition.

The evolution from biotite to muscovite equilibrium melts is inconsistent with pegmatite representing residual melts from granite crystallisation. On the contrary, cristallisation preserves compositional specificities that are acquired early prior to magma cristallisation.

We suggest that magma differentiation results from source processes and that rare metal enrichment is related to melting and extraction rather than to differentiation by cristallisation at the emplacement level. Trace elements can fractionate through various source-related processes which include: variable degrees of melting; near-source crystallisation during melt extraction; disequilibrium melting or successive melting of an heterogeneous source. Each of these process is viable and may generate successive batches of magma with varying rare metal contents. We also suggest that the textural differences between granite and pegmatite is related to the dynamics of crystallisation rather than to volatile enrichments.