A global review on the origin of agpaitic rocks and their relation to miaskitic peralkaline rocks

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Peralkaline igneous rocks are defined by a molar (Na + K)/Al ratio > 1 and are subdivided into miaskitic and agpaitic varieties based on their mineralogy. In the more common miaskitic types, HFSE and REE are largely stored in zircon and titanite, while agpaitic varieties contain a wealth of mostly halogen-bearing Na-Ca-HFSE minerals instead. Agpaitic rocks represent the most evolved stages of peralkaline systems. They are, however, notably rare compared to miaskitic rocks (about 100 vs. several thousand occurrences world-wide). Therefore, their formation requires special conditions that are not generally met during the evolution of peralkaline rocks. In spite of their rarity, agpaitic and hyper-agpaitic rocks form important deposits of critical metals such as REE, Zr, Nb, U and are interesting targets for otherwise rare elements such as F, Be, Sn, Zn and Ga.

The relative timing when peralkaline magmas reach their agpaitic stage is variable. Magmatic agpaitic assemblages can only form if early magmatic crystallization conditions were reduced enough (low f_{O2}) to enable subsequent Fe-enrichment, increase in peralkalinity, retention of halogens and extreme enrichment of HFSE in the evolving magmas. Late-magmatic agpaitic assemblages indicate that the required enrichment levels of the above-mentioned constituents were only reached during the final differentiation stages of magmas. Hydrothermal agpaites precipitate from highly saline brines released from peralkaline magmas and capable of transporting HFSE.

The presently used classification scheme for peralkaline rocks does not account for the variable processes acting during the evolution of peralkaline rocks. Variable processes may produce sequences of mineral assemblages that belong to different groups of this classification. Therefore, we suggest that rather than assigning peralkaline rocks to a specific subgroup, careful textural studies that distinguish early magmatic, late magmatic and hydrothermal phase assemblages are warranted. This is the only way to understand the impact of various physico-chemical parameters during different evolutionary stages of these mineralogically and texturally diverse rocks.