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Mineral chemistry of accessory phases in a High Ba-Sr suite: Scottish Caledonian appinites and granites

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Crustal evolution is currently governed by plate tectonics and it has been shown that between the Archean and the Phanerozoic major changes in subduction styles occured. Among others, the chemistry of different plutonic rocks through time and the understanding of their petrogenesis have helped to define different stages in the evolution of plate tectonics. An important change around 2.7 Ga led to the genesis of rocks that are the result of a metasomatized mantle wedge: the sanukitoids. This event is interpreted as the result of the evolution from a shallow to a steep subduction style. Modern plate tectonics is now generally generating calc-alkaline suites but exceptions can occur such as the Caledonian (Palaeozoic) high Ba-Sr plutons in northern Scotland. The latter have been interpreted as a modern analogue of the sanukitoids [1].
In this contribution, we aim to study this Caledonian sanukitoid-like suite from northern Scotland. Whole rock chemistry (trace elements and stable isotopes) of these rocks ranging from appinitic to granitoid in composition are well constrained [1] but it has been argued that careful study of accessory phases can give more information on the petrogenesis of the plutons [2]. The incorporation of trace elements and more particularly rare earth elements (REE) into their structures make them ideal to understand petrogenetic processes. Here, we present a detailed petrographic study and systematic analysis of trace elements of apatite, titanite and zircon in a range of plutonic rocks from appinitic to granitoid compositions. Trace elements in these accessory phases give direct access to the crystallisation history of these plutons. With these data, we suggest that apatite and titanite record in-situ crystal fractionation and mixing processes. Whole-rock reverse modelling, using single grain apatite or titanite trace element compositions, give reliable results. These results also highlight the relationship between the appinite and granitoid rocks and their petrogenetic history.

[1] Fowler et al. (2008) Lithos 105, 129-148. [2] Hoskin et al. (2000) Journal of Petrology 41, 1365-1396.