Utility of apatite trace-element for tephrochronology

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Apatite is a common accessory mineral in intermediate and felsic igneous rocks. Because apatite has a wide range of trace-element compositions as well as strong resistance to diagenetic alteration, the trace-element composition of apatite has been used for tracing petrogenetic processes of plutonic bodies as well as the tephrochronology of Paleozoic tephras. We studied apatite trace-element compositions of representative Quaternary ignimbrites and their corresponding co-ignimbrite ashes in Japan. The results demonstrated following three points.
1. Trace-element compositions of apatite phenocrysts are useful for discriminating and correlating tephras and ignimbrites. Even different tephra deposits and ignimbrites derived from the same caldera can be distinguished.
2. Trace-element compositions of apatite phenocrysts are not affected by welding, making them valid for correlations between densely welded and non-welded tuffs.
3. In successive ejecta of each eruption cycle, the Cl, Mg, Mn, Y, and Ce contents of apatite phenocrysts generally are constant throughout successions except for the uppermost parts, whereas Fe contents vary from horizon to horizon. This compositional stratigraphy makes it feasible to identify the eruptive stage at which co-ignimbrite ash was ejected by correlating apatite trace-element compositions between ignimbrite successions and co-ignimbrite ashes.
Given the resistance of apatite to diagenetic alteration, this correlation method is a promising tool for correlating pre-Quaternary volcanic and volcaniclastic rocks and identifying their source volcanoes. In order to apply this method to tephrochronology of pre-Quaternary tephra, we examine Miocene and Cretaceous tuffs in Japan (Kinone Formation in Chiba and the Yezo Group in Hokkaido). Our result demonstrated that pre-Quaternary tuffs can also be used for wide-correlation of tephra as well as identification of source caldera.

Keywords: apatite, tephrochronology, caldera

