Rapid and precise Pb isotope analysis of K-feldspar: A new tool for tephrochronology

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The ability to correlate accurately dated volcanic air fall deposits for use in stratigraphic studies is limited by the techniques available to uniquely identify them. The chemical composition of juvenile glass is widely used because of the wide dispersal of glass fragments and the large range in chemical compositions; however it is highly reactive and therefore only present in young, fresh samples. Here, we show that LA-MC-ICPMS Pb isotope analysis of K-feldspar – a common mineral, often used for ^{40}Ar-^{39}Ar geochronology – is a powerful complementary or alternative tool for tephrochronology. Potassium-feldspar typically contains on the order of 10^1 μg/g Pb, and has high Pb/U, making it an attractive target because it contains enough Pb for high-precision analyses, and does not require correction for radiogenic ingrowth. Lead isotopes have three unique ratios, permitting a wider range of compositions than other radiogenic isotopes, and can readily be analyzed. At the BGC, using standard techniques and sample-standard bracketing to NIST 612 glass for mass bias correction, the repeatability, at 2 standard deviations, of single spot analyses of Alder Creek sanidine (~ 30 ug/g Pb) is better than 1.0 ‰ for ^{204}Pb-normalized ratios and better than 0.5 ‰ for $^{208}Pb/^{206}Pb$ and $^{207}Pb/^{206}Pb$.

To establish this as a useful tephrochronological tool, we have applied it to two settings of geological importance, the terrestrial K-Pg boundary sections in the Williston Basin of Montana, and representative Pleistocene tephra from southern Kenya/northern Tanzania rift volcanoes. The former contain the best studied terrestrial record of the end-Cretaceous extinction and subsequent ecological recovery, and the latter form the chronological infrastructure that establish the tempo of early Hominid and faunal evolution in that region. Both contain tephra that can be dated to high-precision, but exhibit rapid lateral facies variations that challenge accurate correlation. Results from most tephra in both areas indicate that they tend to have unique Pb isotope compositions, and are therefore amenable to correlation using this technique.