An experimental approach to high-temperature iron isotope fractionation

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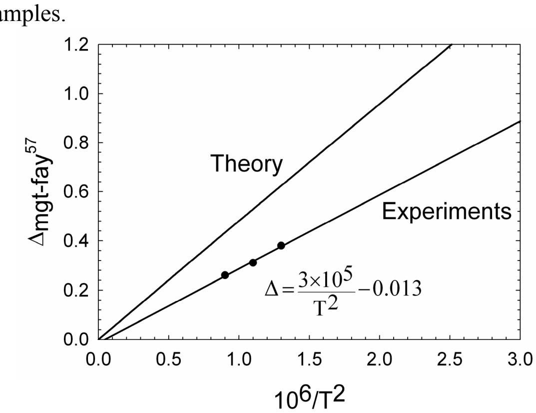
There is considerable variation in $^{57}Fe/^{54}Fe$ among igneous minerals but the cause is uncertain. A central problem in interpreting natural iron isotope data is that equilibrium fractionation factors among coexisting minerals are poorly known. We performed experiments to establish the iron isotope equilibrium partitioining between fayalite and magnetite at a range of temperatures. These minerals are surrogates for mantle spinel and olvine. Experiments were performed in a piston cyldiner apparatus at 1 GPa and at 600, 700, and 800°C. Starting synthetic magnetite was spiked with ^{54}Fe to track the approach to equilibrium (e.g., Matsuhisa *et al*., 1978). The experiments were conducted with added quartz to ensure that oxygen fugacity was fixed at the quartz-fayalite-magnetite equilibrium.

The results show that there is a resolvable fractionation between the fayalite and magnetite and that it decreases with increasing temperature: at 600°C $\Delta_{mgt\text{-}fa}$ = 0.45‰, at 700°C Δ = 0.31‰, and at 800°C Δ = 0.28‰ +/- 0.017‰. The figure below shows our data compared with the predicted fractionation factors (Polyakov and Mineev, 2000). At higher temperatures the theory and experiments are in fair agreement, but as temperature decreases there is a more substantial difference. This study has experimentally determined for the first time inter-mineral $^{57}Fe/^{54}Fe$ equilibrium fractionation at high temperature. The results show that the magnitudes of these fractionations are large and require consideration when interpreting iron isotope ratios observed in natural igneous samples.



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Coeval Pan-African granitization and migmatization of the north Sudan Basement

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We have carried out geochronological and isotopic investigations (zircon U-Pb and Pb evaporation and Nd isotope analyses of North Sudan Basement granitoids and migmatites to characterize sources and to find comprehensive answers to the apparently misleading field chronology, where granitoids (quartz-monzonite, granodiorite, tonalite and granites) intrude (quartz-monzonite, granodiorite, tonalite and granites) migmatite-gneisses; thus suggesting post migmatization emplacement. Whole rock and biotite separates were also analysed for Rb and Sr isotope composition, to determine migmatization-reheating and/or cooling ages.

Zircon U-Pb isotope dilution analyses for representative granitoid that intrude or form lenses and pods interbeded with migmatites, yield ages of 602 ± 3.1 Ma and 602 ± 28 Ma, while zircon $^{207}Pb/^{206}Pb$ evaporations data give similar mean ages of 602 ± 3.5 Ma and 599 ± 3.8 Ma. U-Pb analyses for migmatite zircon fractions from representative samples yield ages of 599 ± 12 Ma to 606 ± 7 Ma and zircon $^{207}Pb/^{206}Pb$ evaporation analyses give similar mean ages of 603.8 ± 2.1 Ma and 603.5 ± 3.7 Ma. We interpret these identical zircon age data as crystallization ages for the North Sudan basement granitoids and migmatites Both rock types have crustal signatures (εNd = -3.5 to -4.8 for migmatites and εNd = -2.4 to -8.9 for granitoids). These basement rock types are different from the older (717.6 ± 0.61 Ma and 707.3 ± 0.97 Ma) mantle sourced (εNd = +5.6 to +6.9) granitoid Ring complexes. Rb/Sr whole rock isochron for migmatites give an age of 583 ± 21 Ma, being identical within error limits to basement rock zircon ages. Biotite Rb/Sr cooling ages for both migmatites and granitoids are younger and very similar, (566 ± 11 Ma to 570 ± 17 Ma) with a mean age of 567.5 ± 2.8 Ma and are interpreted as the metamorphic-cooling ages.

While isotope data indicate crustal sources for North Sudan basement migmatite and associated granitoid melt, their similar Pan-African zircon age data and identical biotite cooling ages suggest concomitant crystallization, with inference for coeval indicate coeval crystallization, which together with identical biotite cooling ages, suggest concomitant granitization and migmatization of the North Sudan basement.