Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12394

Stable and radiogenic isotopes in the Stillwater Complex, Montana: Evidence for contamination by crustal fluids

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In comparison to the geologically similar Bushveld Complex in South Africa, relatively few isotopic investigations have been conducted at the Stillwater Complex in south-central Montana. Isotopic studies at the Bushveld Complex have previously been used to better constrain crustal contamination, identify possible evidence of fluid circulation, and track mineral-scale isotopic disequilibrium. Lack of investigation of radiogenic isotopes at Stillwater has in part been due to prior assumptions that isotope systematics had been disturbed by a regional metamorphic event. New isotopic analyses of Rb-Sr, Sm-Nd, and Pb-Pb isotopes in bulk rock Stillwater samples and country rock/hornfels samples the metamorphic aureole are presented. Models of fluid circulation are investigated by comparison of fluid-associated pegmatoidal bodies to spatially associated host rock samples and underlying hornfels samples. While the hornfels appears to be isotopically similar to the Stillwater Complex (e.g., $^{87}Sr/^{86}Sr_{i,\text{hornfels}}$ = 0.69354-0.70503; $^{87}Sr/^{86}Sr_{i,\text{Stillwater}}$ = 0.69816-0.70933), evidence of resetting of radiogenic isotope systematics during regional metamorphism at 1.7 Ga is not observed. While all three radiogenic isotope systems in Stillwater Complex samples are highly variable at the whole rock scale, samples from the hornfels define isochrons dating to Stillwater Complex emplacement. A regional metamorphic event capable of disturbing Stillwater isotopes should also alter the associated hornfels. Limited diffusion of Rb and Sr may mean that analysis of isotopes at bulk rock scales eliminates any issues of isotopic resetting. Variability in radiogenic isotope signatures in Stillwater Complex samples may thus be suggestive of variable crustal contamination. Models of crustal contamination are discussed. δD in pyroxene separates are analyzed; results suggest higher H_2O contents in pyroxene of the Lower Banded series pegmatoids, which also have δD signatures closer to those of analyzed hornfels samples. This may suggest that circulation of crustal fluids is responsible for isotopic evidence of contamination. These results provide support for hydrothermal models of Pt- and Pd-enrichment in the Stillwater Complex J-M Reef.