Continental silicic rock composition: A major control of past global chemical weathering?

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The composition of igneous rocks in the continental crust has changed throughout Earth's history. However, the impact of these compositional variations on chemical weathering, and by extension on seawater and atmosphere evolution, is largely unknown. We use the strontium isotope ratio in seawater [$(^{87}Sr/^{86}Sr)_{seawater}$] as a proxy for chemical weathering, and we test the sensitivity of $(^{87}Sr/^{86}Sr)_{seawater}$ variations to the strontium isotopic composition ($^{87}Sr/^{86}Sr$) in igneous rocks generated through time. We demonstrate that the $^{87}Sr/^{86}Sr$ ratio in igneous rocks is correlated to the epsilon hafnium (εHf) of their hosted zircon grains, and we use the detrital zircon record to reconstruct the evolution of the $^{87}Sr/^{86}Sr$ ratio in zircon-bearing igneous rocks. The reconstructed $^{87}Sr/^{86}Sr$ variations in igneous rocks are strongly correlated with the $(^{87}Sr/^{86}Sr)_{seawater}$ variations over the last 1,000 million years, suggesting a direct control of the isotopic composition of silicic magmatism on $(^{87}Sr/^{86}Sr)_{seawater}$ variations. The correlation decreases during several time periods, likely reflecting changes in the chemical weathering rate associated with paleogeographic, climatic, or tectonic events. We suggest that for a large part of the last 1,000 million years, the $(^{87}Sr/^{86}Sr)_{seawater}$ variations respond to changes in the isotopic composition of silicic magma rather than to changes in the global chemical weathering rate. We conclude that the $(^{87}Sr/^{86}Sr)_{seawater}$ variations are of limited utility to reconstruct changes in the global chemical weathering rate in deep times. We further argue that the changing composition of silicic rocks, along with their spatial distrubution and abundance, should influence the sensitivity of the chemical weathering feedback on the long-term carbon cycle.