Global cooling forced increase in marine $^{87}Sr/^{86}Sr$ ratios

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Late Cenozoic increases in marine $^{87}Sr/^{86}Sr$ ratios have been frequently used in the climate-weathering-tectonics connections, although many basic issues of how the changes in marine $^{87}Sr/^{86}Sr$ ratio reflect global biogeochemical processes remains the topic of recent debate.

Here we concern the possible influence of global cooling on marine $^{87}Sr/^{86}Sr$ ratios in a kinetic way. The importance of biotite weathering is emphasized due to its low activation energy in weathering reaction (~27 KJ/mol). Since activation energy (E_a) determines the temperature sensitivity of reaction rate, minerals with low E_a will have less weathering rates response to temperature change than those with high E_a. Thus, decrease in global temperature will be particularly beneficial to raise $^{87}Sr/^{86}Sr$ ratios of continental flux by increasing the fraction of Sr derived from biotite weathering. A 6 Myr record of continental weathering preserved in the eolian deopsit in Chinese Loess Plateau are employed to test this hypothese. Preferential weathering of biotite was observed due to gradual cooling climate since ~2.6 Myr B.P.

Based on Arrhenius temperature dependence of reaction rates, a model is established to survey the response of $^{87}Sr/^{86}Sr$ ratios of continental flux to global temperature change (figure, A). Mean $^{87}Sr/^{86}Sr$ ratio of 0.71095 for the continental flux in 5 to 3.4 Myr B.P. is suggested by the paleo temperature estimates. By using this value, steady state of oceanic $^{87}Sr/^{86}Sr$ since 3.4 Myr B.P can be modeled when adopting a Sr flux of 4.8×10^{10}mol/yr (97% of modern value, curve a). Keeping this Sr flux as constant, following increases in $^{87}Sr/^{86}Sr$ of continental flux responding to global cooling can explain most of the increase in marine $^{87}Sr/^{86}Sr$ since 3.4 Myr B.P. (curve b). The result suggests that weathering kinetics may be another mechanism that relating the global climate change to marine $^{87}Sr/^{86}Sr$ curve.