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Chromium isotope record of the Otavi Group, Namibia

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Due to its redox-sensitivity, the chromium isotope system is an interesting paleoclimatic tracer particularly powerful in recording fluctuations of atmospheric oxygenation and continental weathering [1]. Here we seek to investigate detailed $\delta^{53}Cr$ records associated with intense climatic changes during Neoproterozoic glaciations.

We present a $\delta^{53}Cr$ record of late Neoproterozoic marine carbonates stretching from the Chuos (746±2Ma[2]) to the the Ghaub Fm (635.6±0.5Ma[3]), exposed in northern Namibia, covering shallow water sedimentation during the Cryogenian glaciations. The $\delta^{53}Cr$ stratigraphy was complemented with $\delta^{13}C_{carb}$ as well as major and trace element concentrations. The Chuos $\delta^{53}Cr$ signal is close to mantle inventory [4], but recovers rapidly to positive values after the glacial sequence, indicating a sufficiently oxygenated atmosphere. Prior to the Ghaub glaciation, $\delta^{53}Cr$ values are positively fractionated (+0.12±0.02‰) and correlate to $\delta^{13}C_{carb}$, while in post-Ghaub carbonates $\delta^{53}Cr$ values decrease to ~-0.08‰, similar to drops observed in post-Chuos sediments, and accompanied by increased Cr, Sc, and Ti concentrations. These $\delta^{53}Cr$ results suggest increased continental-derived detrital input as a consequence of enhanced weathering periods related to rapid climate change, elevated post-glacial pCO_2[5], proximity to the continent and/or increased hydrothermally-derived Cr input.

The observed $\delta^{53}Cr$ fluctuations indicate sufficiently high atmospheric oxygen levels to oxidize and mobilize Cr during weathering processes on land prior and after the major Neoproterozoic glaciations. Increased weathering due to rapid post-glacial rise of pCO_2 render the $\delta^{53}Cr$ signal unfractionated, also potentially indicating the predominance of accumulated hydrothermally-derived Cr in the shallow seawater pool during the Ghaub aftermath.

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A new experimental approach to silicic magma differentiation

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The separation of fluid and crystals from melt at diverse stages in the evolution of magmatic systems is inferred on the basis of thermomechanical modelling [1], geochemical relations of zoned silicic plutonic bodies [2] and phase equilibrium studies [3]. However, experimental tests dealing with magmatic differentiation of natural magmas at real pressures and temperatures are very scarce [4, 5].

In our laboratory experiments, gravity effects are separated from those imposed by thermal gradients, which simulate natural conditions of crystallization in a cooling magma chamber. Major and trace element distribution profiles result from the thermal gradient for water-bearing magma systems. The observed profiles are exclusively explained by diffusion in the liquid and boiling-assisted crystal-liquid separation, without invoking gravity crystal settling. These experiments confirm the key role of fluids in silicic magma differentiation and their implications on explosive volcanism and ore deposit generation.

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