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 δ53Cr records associated with intense climatic changes during Neoproterozoic glaciations.

We present a δ53Cr record of late Neoproterozoic marine carbonates stretching from the Chuos (746±2 Ma [2]) to the Ghaub Fm (635.6±0.5 Ma [3]), exposed in northern Namibia, covering shallow water sedimentation during the Cryogenian glaciations. The δ53Cr stratigraphy was complemented with δ13C_carb as well as major and trace element concentrations. The Chuos δ53Cr 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, δ53Cr values are positively fractionated (+0.12±0.02‰) and correlate to δ13C_carb, while in post-Ghaub carbonates δ53Cr values decrease to ~-0.08‰, similar to drops observed in post-Chuos sediments, and accompanied by increased Cr, Sc, and Ti concentrations. These δ53Cr results suggest increased continental-derived detrital input as a consequence of enhanced weathering periods related to rapid climate change, elevated post-glacial pCO2 [5], proximity to the continent and/or increased hydrothermally-derived Cr input.

The observed δ53Cr 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 pCO2 render the δ53Cr signal unfractonated, also potentially indicating the predominance of accumulated hydrothermally-derived Cr in the shallow seawater pool during the Ghaub aftermath.


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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