

Sr isotopes in Banded Iron Formation carbonates: Disequilibrium with ancient seawater

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Introduction

Constraining the isotopic composition of ancient seawater can give insight into past geologic and oceanic processes. Here we analyzed Rb-Sr isotopes on the same samples previously analyzed for Fe, C, and O isotope compositions by Heimann *et al.* 2010 [1] of banded iron formation (BIF) carbonates (siderite/ankerite) from the Kuruman Iron Formation and underlying platform carbonates (calcite/dolomite) from the Gamohaam Formation, Transvall Craton, SA.

Isotopic Results and Interpretations

Isotopic analysis revealed large Fe isotope variability ($\delta^{56}\text{Fe}=+1$ to -1%), low $\delta^{13}\text{C}$ values (-12 to -1%), and $\delta^{18}\text{O}$ values of $\sim 21\%$ [1]. Sr isotope analysis revealed a large range of initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios, with calcite at or near the $^{87}\text{Sr}/^{86}\text{Sr}$ ratio of ~ 2.5 Ga seawater (~ 0.705) [2], whereas the iron-rich carbonates have initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios that range from at or near seawater to very high ratios of ~ 0.745 . Combining the initial $^{87}\text{Sr}/^{86}\text{Sr}$ with the $\delta^{13}\text{C}$ shows Fe-poor carbonates (calcite and dolomite) have both Sr and C isotopic composition close to or at sea water composition, whereas the Fe-rich carbonates (siderite and ankerite) are farther from equilibrium with seawater. Because these Fe-rich carbonates are bounded by shale layers, the radiogenic $^{87}\text{Sr}/^{86}\text{Sr}$ ratios likely reflect small-scale fluid interaction during authigenic mineral formation in the soft sediments during microbial iron reduction.

[1] Heimann *et al.* (2010) EPSL in press. [2] Veizer (1989) *Ann. Rev. Earth Planet. Sci.* **17**, 141–167.

Marine-terrestrial linkages associated with Early Cretaceous (Aptian-Albian) global change

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A calcrite succession from the Cedar Mountain Formation (CMF) of Utah is calibrated by detrital zircon U-Pb dates spanning from ~ 131 to 105 Ma, overlapping Oceanic Anoxic Events OAE1a and OAE1b. Coupled chemostratigraphic profiles of calcite & organic carbon $\delta^{13}\text{C}$ data show parallel structure, and capture records of the early Aptian Ap7 and late Aptian-early Albian Ap12-A11 features [1] in long-ranging positive Carbon Isotope Excursions (CIEs). CIEs are expressed in profiles with background calcrite $\delta^{13}\text{C}$ values of $\sim -6\%$ VPDB ($\delta^{13}\text{C}_{\text{org}}$ values of $\sim -30\%$), and peak calcrite $\delta^{13}\text{C}$ values of $\sim -3\%$ VPDB ($\delta^{13}\text{C}_{\text{org}}$ values of $\sim -27\%$). The Ap7 peak is calibrated by a 119.4 ± 2.6 Ma U-Pb date on calcrite. Coordinated $\delta^{13}\text{C}$ data show Aptian-Albian CIEs coincide with atmospheric pCO_2 changes following conventional methodology [2]. Moreover, the Ap7 and Ap12-A11 CIEs coincide with changes in calcrite $\delta^{18}\text{O}$ values, ranging from $\sim -8\%$ VPDB in background positions up to -4 to -3% at the peaks of the Ap7 & Ap12-A11 CIEs. Diagenetic studies of selected calcrites in the CMF consistently yield *Meteoric Calcite Line* values with $\delta^{18}\text{O}$ of -8% VPDB, showing that $\delta^{18}\text{O}$ of zonal paleoprecipitation changed little over time. Some components in CIE calcrites show evidence for evaporative enrichments of early diagenetic porewater $\delta^{18}\text{O}$ values by $\geq 4\%$. Along with dramatically-reddened siliciclastic mudstone strata from the Ap7 & Ap12-A11 intervals, diagenetic studies suggest that the CIEs were episodes of continental aridification.

[1] Herrle *et al.* (2004) *Earth & Planet. Sci. Letters* **218**, 149–161. [2] Ekart *et al.* (1999) *Amer. Jour. Sci.* **299**, 805–827.