Ediacaran carbon isotope anomaly records shallow marine event, not entire ocean

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The Ediacaran is one of the most important periods in the history of life when multicellular animals firstly appeared on the earth. However, we still poorly understand the relationship between the abrupt biological evolution and environmental change. Ediacaran sections record the largest $d^{13}C$ arnomaly through the Earth's history, named Shuram excursion [1, 2] . The observed excursion may reflect extensive remineralization of large organic matter in the Ediacaran ocean [2, 3], or merely the result of diagenetic alteration [4]. However, marine sediments must have been globally preconditioned in a unique way, to allow ordinary and local process to produce an extraordinary and widespread response [5]. We analyzed carbon and nitrogen isotopes by using drill core samples from four different depositional settings in South China: shallow marine Three Gorges and Weng'an sections, and deeper Tianping and Shiduping sections. The new results of deeper sections show high carbon isotope ratio and no negative excursion in spites of high spacial resolution. Weng'an section in shalow shelf also shows only smaller negative excursion (>-4‰) compare to that of Three Gorges section in another shallow marine setting. Thus, the limited appearance of the negative $d^{13}C$ excursion in shallow marine settings may suggest that extensive remineralization took place only in shallow part of the organic-carbon-rich Ediacaran ocean. Alternatively, shallow section preferentially suffered from diagenetic alteration possibly in response to sea-level fall, though the regressive trend is not evident. On the other hand, $d^{15}N_{TN}$ in Three Gorges shows long-term gradual decrease from the Shuram excursion to early Cambrian, which may rather reflect change in long-term oceanic signal.

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Elemental partitioning and Eu^{2+}/Eu^{3+} XANES calibration between synthetic KREEP basalt, apatite, and whitlockite vs. T and f_{O_2}

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Apatite, a common accessory phase found in a broad range of rock types, is known to host a number of important trace elements (U, Th, REEs, Sr, etc). The purpose of this research is to synthesize and equilibrate apatite from KREEP analogue melts as a function of temperature (T) and oxygen fugacity (f_{O_2}) in order to calibrate an apatite crystallization redox sensor.

The experimental method incorporates the use of seven different solid-state media buffers (ranging from -magnetite-hematite to graphite-CO-CO_2, representing ($\Delta f_{O_2} \approx 12$ log units) contained within evacuated silica tubes to control f_{O_2}. KREEP glasses are artificially doped with P_2O_5 to ensure apatite saturation [1-2] and enriched in REE (including La, Ce, Sm, Eu, Gd and Lu) in order ensure cocentrations sufficient for x-ray analysis (including EPMA and XANES). Experiments are carried out at 1000 – 1175 ˚C, incorporating conditions ranging from subsolidus to near-liquidus. Crystalline phases co-existing with apatite include olivine, plagioglase and whitlockite.

As indicated in a number of previous works [e.g., 3-4] the spectral components comprising the Eu L_3 XANES region are sensitive to $Eu^{3+}/\Sigma Eu$. Experimental results here show systematic increases from almost no Eu^{2+} in apatite at NNO to almost 45% Eu^{2+} at the graphite-CO-CO_2 buffer. Similar changes in $Eu^{3+}/\Sigma Eu$ are seen the synthetic glasses, thus indicating that Eu valence behaviour can be used as a valence or redox sensor for basaltic source melts that exist at low f_{O_2} (relative to terrestrial environments).

REE partitioning results for apatite (and where possible, whitlockite) are similar to those previously reported within the literature [5], indicating equilibria. The combined results of partitioning and XANES provide the first experimental constraint on redox sensitive geochemical processes that control trace element systematics within phosphates.

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