Origin of laminations in BIF deciphered from N and Fe isotopes

K. HASHIZUME[1]*, D.L. PINTI[2], B. ORBERGER[3], C. CLOQUET[4], M. JAYANANDA[5] AND H. SOYAMA[1]

[1]Dept. of Earth & Space Sci., Osaka Univ., Toyonaka 560-0043, Japan (*kohash@ess.sci.osaka-u.ac.jp)
[2]GEOTOP, H2X 3Y7, Montréal, Qc, Canada
[3]Groupe ERAMET, 75755 Paris, France
[4]CRPG-CNRS, BP 20, 54501 Nancy, France
[5]Dept. of Geology, Univ. of Delhi, Delhi 110 007, India

Elucidation of the formation process of banded iron formations (BIF) is the major purpose of this study. Not only the iron oxidation process itself, but the alternation between the quartz- and iron-rich layers may provide important clues on the emergence of the oxygen in the early atmosphere.

A >2.72 Ga old BIF from Dharwar Craton, southern India, was studied. Compositions of N, Fe and Ar isotopes, major and trace elements including REEs were analyzed among 10 qz- or Fe-oxide-rich bands from the sample. REE and trace element compositions of the samples indicate a minimal influence from the continental crust, allowing us to propose a relatively simplified view of the water column from which constituents of the BIF sample precipitated. Qz- and Fe-rich layers showed contrasting compositions of N, Fe and Ar isotopes and of REEs. A positive correlation between $\delta^{15}N$ and $\delta^{56}Fe$ values, which range from +2 to +12‰ and +0.9 to +2.2‰, respectively, is the major finding of this study. Qz-rich layers exhibit higher Eu anomalies correlated with $^{40}Ar/^{36}Ar$ ratios. This trend is explained by the contribution of a constant amount among all bands of a hydrothermal component, added to Y-rich REE and ^{36}Ar-rich Ar components, which possibly represent Archean oceanic and atmospheric air compositions, respectively, carried by Fe-bearing minerals. The lower $\delta^{56}Fe$ values observed among the Fe-rich bands could be explained either by anoxygenic photosynthetic oxidation or O_2-mediated abiotic oxidation from an oceanic ferrous iron with a mantle origin. We explain the higher $\delta^{56}Fe$ values among the qz-rich bands by dissimilatory iron reduction (DIR) by which lighter iron isotopes are consumed faster. The qz-rich bands are N-rich, in concentrations and C/N ratios, and ^{15}N-rich, in the isotope ratio. We propose that formation of the qz-rich bands may correspond to periods when the photosynthetic biological productivity at the surface of the ocean was active. The DIR could have been enhanced during this period by supply of abundant organic matter to the iron particles. The biological activity at the ocean surface could be the switch producing the laminations in BIFs.

Net community and gross primary production in the Southern California Bight based on carbon export, dissolved O_2/Ar and triple oxygen isotopes: Exploration of how the magnitude and timing of upwelling events may influence export efficiency

W.Z. HASKELL II [1], M.G. PROKOPENKO [1], D.E. HAMMOND [1], R.H.R. STANLEY [2], W.M. BERELSON[1]

[1]Dept. of Earth Sciences, University of Southern California, 3651 Trousdale Pkwy, Los Angeles, CA, 90089, USA whaskell@usc.edu
[2]Dept. of Marine Chemistry, Woods Hole Oceanographic Institution, 266 Woods Hole Rd., Woods Hole, MA, 02543, USA

Biologically driven deviation of dissolved O_2 from equilibrium concentrations, determined from O_2/Ar ratios, has long been used as a tracer of net community production (NCP) in the oceans, as O_2 is a counterpart of carbon in photosynthesis and respiration. Over the last decade, a technique using the triple oxygen isotope composition (TOI) of dissolved O_2 has been applied in many regions of the ocean to estimate gross biological oxygen production (GOP) in the surface mixed layer. The TOI approach rests on using the deviation from mass dependent fractionation of the three oxygen isotopes (^{16}O,^{17}O,^{18}O) in the mixed layer to distinguish between photosynthetic *in situ* produced O_2 and atmospheric O_2 supplied through gas exchange. This “dual-tracer” approach of simultaneous measurements of Net Community and Gross Production provides estimates of NCP/GOP ratios, which reflect efficiency of carbon export. However, applications of this *in-situ* technique have been limited in productive coastal upwelling zones because the mixed layer O_2 mass balance is altered by upward advection of water from the oxygen deficient zone, which has both O_2 concentration and TOI composition out of equilibrium with the atmosphere. The Upwelling Regime In-situ Ecosystem Efficiency (Up.R.I.S.E.E.) time-series study is an ongoing effort to expand the application of the O_2-based dual-tracer approach to the upwelling regimes. In this study, O_2/Ar and TOI measurements through the upper thermocline are combined with estimates of upwelling rates, constrained by a mass balance of ^{7}Be in the surface mixed layer and upwelling indices from wind stress curl. Accounting for the contribution of the deep water O_2 signal to the mixed layer O_2 and TOI inventory, we test whether the timing and/or magnitude of upwelling events affect an ecosystem's efficiency in exporting organic carbon from the surface ocean in this highly productive setting. Sediment trap deployments and budgets of DIC, DOC, and ^{234}Th are used to further constrain export estimates, and compared to NCP. Preliminary results from the first six months of a two-year study will be presented.

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