Recycled volatiles beneath the Western Antarctic Rift

M.W. BROADLEY[1]*, C.J BALLENTINE[1], L. DALLAI[2] AND R.BURGESS[1]

[1]SEAES, University of Manchester, M13 9PL, UK (michael.broadley@postgrad.manchester.ac.uk)

[2]CNR, Institute of Earth Sciences and Resources, Pisa, Italy (dallai@igg.cnr.it)

The Western Antarctic Rift System (WARS) represents an area of long lived extension between East and West Antarctica. The origin of this rift is poorly understood, with both an actively up-welling plume and passive rising of the asthenosphere being championed as the cause [1]. To explore the origin and evolution of the rift, a suite of 11 mantle xenoliths from Northern Victoria Land have been analysed for their halogen and noble gas isotopic signatures.

Noble gas and halogens are excellent tracers of volatiles within the mantle; providing a key source of information on the underlying mantle which is driving the rift. The fluid inclusions present within mantle xenoliths provide the best medium through which magmatic volatiles can be transported to the surface and still be able to retain a pristine magmatic signature. Noble gas and halogens contained within these fluid inclusions are released by in vacuo crushing and analysed through mass spectrometry.

Noble gas signatures extracted from the fluid inclusions show MORB like $^{3}He/^{4}He$ ratio of $7.4R_A$ whilst the $^{20}Ne/^{22}Ne$ ratios are indicative of a deeper primordial mantle source. Halogen analysis has shown the samples to be extremely enriched in iodine with I/Cl ratios ranging from a MORB like 0.09148×10^{-3} to highly enriched value of 54.6×10^{-3}. These values are indicative of mixing between mantle and subduction fluid endmembers.

Halogen ratios indicate that seawater derived volatiles have been incorporated into the mantle during subduction. Volatiles were released from the slab at depth possibly by the breakdown of antigorite. This fractionated the halogens further causing an increase in the I/Cl ratio seen within the xenoliths [2]. Noble gas ratios indicate that the driving force of the rift is the convecting upper mantle, with an addition of a deeper mantle volatile source. Geochemical data, along with seismic evidence [3], suggests that slab detachment during the Cretaceous created localised convection currents which brought some primordial mantle up from depth. The rising mantle would have exerted a force on the bottom of the Antarctic Plate causing it to break apart.

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Phototrophs and ore formation

J. J. BROCKS*,[1] B. J. BRUISTEN[1], A. PAGÈS[2] AND K. GRICE[2]

[1] Research School of Earth Sciences, The Australian National University, Canberra, ACT 0200, Australia. (*correspondence: Jochen.Brocks@anu.edu.au)

[2] WA Organic & Isotope Geochemistry Centre, Curtin University, WA 6845, Australia.

Sediments of the 1.64 Ga Barney Creek Formation (BCF) in northern Australia host one of the largest stratiform Pb-Zn deposits in the world. An early fraction of the zinc sulfide may have formed by discharge of zinc-rich fluids from a proximal fault into sulfidic bottom waters, causing synsedimentary precipitation of ZnS onto the sea floor (SEDEX model).

As the BCF contains the oldest known, thermally well-preserved molecular fossils (biomarkers) in the world, it is the ideal location to study the role of microorganisms and biogenic organic matter in this process. Solvent extracts of the sedimentary rocks yielded aromatic carotenoids produced by phototrophic sulfur bacteria, including extremely high concentrations of okenane from purple sulfur bacteria (Chromatiaceae) and chlorobactane produced by green-pigmented green sulfur bacteria (Chlorobiaceae) [1]. As okenone was exclusively known from planktonic Chromatiaceae, we envisaged a planktonic phototrophic community inhabiting a euxinic deep water system [2], consistent with a SEDEX component to ore formation. However, precursors of almost all fossil aromatic carotenoids have now also been discovered in microbial mats [3]. We present biomarkers from mat facies in the BCF and discuss whether the finely laminated sediments represent phototrophic microbial mats that thrived under a shallow, fully oxygenated water column or benthic mats that formed in a deep sulfidic basin.

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