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A Spatial and Temporal Record of the Hydrothermal Plume at Rainbow, 36ºN on the MAR

Rachel R. Cave (rrc@soc.soton.ac.uk), **Christopher R. German** (cge@soc.soton.ac.uk), **Alexis Khripounoff** (alexis.khripounoff@ifremer.fr), **Robert W. Nesbitt** (rwn2@soc.soton.ac.uk) & **John Thomson** (jth@soc.soton.ac.uk)

Southampton Oceanography Centre, European Way, Southampton, SO14 3ZH, UK

Accurate estimates of the impact of hydrothermal venting on the geochemical budget of the oceans require a detailed knowledge of both the distribution and the nature of hydrothermal activity world-wide. Until now a major gap in our knowledge has been the understanding of the flux from any given vent site over a geologically relevant time-scale.

The most active vent site yet discovered in the N. Atlantic is at Rainbow, at 36ºN on the MAR. It is situated on the flank of a raised block of ultramafic basement in the discontinuity between two segments of the ridge, and produces a strong and persistent hydrothermal plume. Because sediments along ridge axes are often found to be enriched in hydrothermally derived elements compared to open ocean sediments, they may contain the best records of local and regional hydrothermal activity. In 1998, therefore, a series of four sediment cores were collected from under the path of the Rainbow plume at increasing distance from the vent site, out to a maximum distance of 25km. The cores represent continuous accumulation, with the longest core spanning the period from the last glacial maximum (LGM) to the present day. The sediments comprise predominantly calcium carbonate (>80%), with the remainder being made up of a combination of detrital material and hydrothermal plume fallout. Material from a year-long deployment of 5 sediment traps at Rainbow was also recovered. Sediment trap particles were collected both within and without the plume, and the influence of venting is reflected in the chemistry of the within-plume samples. One pair of traps was located close to one of the core sites.

Geochemical data is presented here showing the apparent influence of near and far field hydrothermal venting on the chemistry of all four pelagic sediment cores from the Rainbow area. These data, averaged over thousands of years due to the slow sediment accumulation rate, are compared both with the present day sediment flux near the vent site, and with the downstream plume geochemistry from stand-alone-pump (SAP) data. Downcore variation in hydrothermal input provides temporal information on the activity of the Rainbow vent site since the last glacial maximum. Cu/Fe ratios in the core tops decrease from 0.02 at less than 2km from the vent site to 0.004 at 25km distance downplume, and are in close agreement with the Cu/Fe ratios from the SAP data taken at similar distances downplume. V/Fe ratios are constant in the core tops, at 0.0042 ±0.0002 , and in the samples from the nearby sediment traps, but are more variable in the plume data. Both Cu/Fe and V/Fe reduce downcore. The presence of a small amount of local ultramafic basement in the detrital fraction of the cores is indicated by Cr/Ni/Mg ratios, but is not sufficient to affect the concentrations of elements introduced by hydrothermal fallout.