Measuring the speciation of iron in hydrothermal plume particles

BRANDY M. TONER[1*], JOHN A. BREIER, JR.[2], KATRINA J. EDWARDS[3], SIRINE C. FAKRA[4], CHRISTOPHER R. GERMAN[5], MATTHEW A. MARCUS[4], AND OLIVIER J. ROUXEL[6]

[1]Department of Soil, Water, and Climate, University of Minnesota, St. Paul, MN, USA, toner@umn.edu (* presenting author)

[2]Department of Applied Ocean Engineering, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, jbreier@whoi.edu

[3]Departments of Biological Sciences and Earth Sciences, University of Southern California, Los Angeles, CA, USA, kje@usc.edu

[4]The Advanced Light Source, Lawrence Berkeley National Laboratory, Berkeley, CA, USA, sfakra@lbl.gov

[5]Department of Geology and Geophysics, Woods Hole Oceanographic Institution, Woods Hole, MA, USA, cgerman@whoi.edu

[6]Europole Mer, Universite de Bretagne Occidentale, Brest-Iroise, Plouzane, France, orouxel@univ-brest.fr

Abstract

The global mid-ocean ridge (MOR) system is a 60,000 km submarine volcanic mountain range that crosses all of the major ocean basins on Earth. Along the MOR, sub-seafloor circulation of seawater exchanges heat and elements between the ocean crust and seawater. The amount of iron (Fe) released by hydrothermal venting to the ocean per year is similar in magnitude to that of global riverine runoff. Until recently, measurement and modeling activities to understand the contribution of hydrothermal Fe to the ocean budget have been largely neglected.

The goal of the present research is to identify and quantify the forms of Fe present in hydrothermal plume particles to better understand the bioavailability, geochemical reactivity, and transport properties of hydrothermal Fe in the ocean. Direct Fe speciation data in hydrothermal plume precipitates has been reported only twice. This lack of data reflects how difficult it has been to obtain high quality samples and measure Fe speciation in the complex physical-chemical mixtures that compose hydrothermal plume particulates. These challenges have slowed our understanding of hydrothermal Fe speciation and transport, as well as the potential contribution of hydrothermal Fe to the global ocean budget.

On-going sediment trap deployments and new *in situ* filtration equipment are making it easier to obtain great samples. Improved synchrotron-radiation X-ray microprobe instruments and data analysis tools are making measurements of Fe speciation accessible and hold promise for quantitative research applications. In this contribution, the application of synchrotron-radiation X-ray microprobe to the mapping and quantification of Fe valence states and species will be discussed for hydrothermal plume particles collected by sediment trap and *in situ* filtration at the East Pacific Rise 9-10 N.

Timing and source of cold seeps at the northern slope of South China Sea: Evidence from U/Th dating and Sr isotopes

HONGPENG TONG[1], DONG FENG[2], HAI CHENG[3, 4], SHENGXIONG YANG[5], HONGBIN WANG[5], ANGELA M. MIN[4], R. LAWRENCE EDWARDS[4] AND DUOFU CHEN[1, 2*]

[1]CAS Key Laboratory of Marginal Sea Geology, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou, China, cdf@gig.ac.cn

[2] CAS Key Laboratory of Marginal Sea Geology, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou, China, fd@gig.ac.cn

[3]Institute of Global Environmental Change, Xi'an Jiaotong University, Xi'an, China

[4]Department of Geology and Geophysics, University of Minnesota, Minneapolis, USA

[5]Guangzhou Marine Geological Survey, Guangzhou, China

Methane-rich fluid and gas expulsion often leads to authigenic carbonate formation close to the seafloor along continental margins. These carbonates represent excellent geochemical archives of methane emanation and possibly gas hydrate destabilization. Here, we report U/Th dating and Sr isotopes of seep carbonates from Shenhu area and Dongsha area on the northern continental slope of South China Sea. The obtained data will be used to discuss the timing of cold seep activity and potential driving processes involved and the source of fluids as well. The U/Th ages of the carbonates span a long time interval. Especially, carbonates from Shenhu area show a wide range of U/Th ages, between 152 ka and 330 ka. In contrast, carbonates from Dongsha area reveal U/Th ages between 42 ka and 77 ka. However, most of the carbonates revealed U/Th ages that point to formation during sea level lowstand. In addition, some of the studied carbonates, for example, samples from Site 3 of the NE Dongsha area have positive $\delta^{18}O$ isotopic signatures, presumably caused by gas hydrate dissociation. The results suggest that enhanced fluid flow during these time intervals closely related to sea level variations associated with glacial/interglacial cycles and possibly environmental change that affected the stability of gas hydrate reservoirs. The $^{87}Sr/^{86}Sr$ ratios of the carbonates range between 0.709025 and 0.709259. Specifically, samples from SW Dongsha display less radiogenic values, that are lower than that of modern seawater (0.709175). The carbonates must have formed either at or near the seafloor in contact with less radiogenic pore fluids, presumably deeper in the sediment. In contrast, samples from all the other areas are characterized by more radiogenic Sr values, suggesting that the seep fluids in contact with more radiogenic terrigenous material such as basinal brine and/or meteoric water.

This study was funded by the NSFC (91028012), CAS (KZCX2-YW-GJ03), and 973 Program (2009CB219508).