Marine sediments as an archive of the evolution of volcanism on Montserrat

P. JOHNSON[1], E. INGLIS[1], I. MARCHANT[1], M. CASSIDY[1], M.R. PALMER[1*], P.J. TALLING[1], T.M. GERNON[1], S. WATT[1] AND SHIPBOARD SCIENTISTS OF IODP LEG 340[2]

[1]School of Ocean & Earth Science, University of Southampton, European Way, Southampton SO14 3ZH,UK (*correspondance: pmrp@noc.soton.ac.uk)

[2](http://iodp.tamu.edu/scienceops/expeditions/antilles_volcanism_landslides.html)

Island arc crust has a bulk composition that is approximately basaltic, but continental crust has a bulk andesitic composition. It is has been suggested, however, that island arc crust is layered, with an upper portion that has a silicic composition similar to bulk continental crust, and a lower, mafic portion, that may be lost during transition from arc crust into continental crust. Testing of this model requires observations of clear trends in time and space that reflect the growth, evolution and differentiation of island arc crust.

Evolution of an arc centre also has geohazard implications. For example, if early activity is characterised by mafic volcanism and an absence of shallow magma storage, large-volume explosive eruptions are less likely to occur. The probability of tsunami-forming flank collapses may also increase as the crust thickens and a large, composite edifice forms. Large collapse events may also feedback into volcanic activity by releasing the confining pressure above a magma chamber, leading to the ascent of fresh, less evolved magmas, and a period of increased activity.

It is difficult, however, to test these and other models of the life cycle of an arc centre because erosion, collapses, later eruptions, etc., all obscure and destroy the subaerial record; e.g., ~75% of erupted material on Montserrat (Lesser Antilles) since 1995 has been transported to the Caribbean Sea. The best records of the evolution of arc centres are, therefore, preserved in nearby marine sediments. During IODP340 we recovered a complete sedimentary record from site U1396. This site (~30 km SW of Montserrat) comprises hemipelagic carbonate interspersed with >150 visible tephra layers extending back ~4.5 Myr (the oldest dated rocks on the island are only 2.6 Ma). We also obtained high-recovery records of collapse events from the east of the island at sites U1394 and U1395.

We present preliminary data from these IODP sites that reveal new information concerning the evolution of this arc volcanic centre.

Neoproterozoic ocean chemistry and redox evolution as inferred through sulfur isotope records

DAVID T. JOHNSTON[1]

[1]Dept. of Earth and Planetary Sciences, Havard University, 20 Oxford St., Cambridge MA 02138: johnston@eps.harvard.edu

The classic geochemical approach to reconstructing the net oxidation state of the ocean-atmosphere system is via tracking changes in the C, S and Fe cycles. Rebuilding the Neoproterozoic ocean-atmosphere and searching for the presumed second great rise in atmospheric oxygen has appropriately employed a similar approach. For example, work on the carbon cycle documents large perturbations in the marine DIC, however the interpretation of these anomalies and the links to redox budgets remain contraversial. In parallel, great success has been gained through the pervasive application of Fe-based methods, which now appropriately serve as a backdrop to Neoproterozoic storylines, but record a more basinal and less globally integrated signal. Parallel work on the sulfur cycle ($^{34}S/^{32}S$) carries interest, but often suffers from a lack uniqueness in its interpretations—that is, biological and abiological processes can be hard to distinguish from one another and quantifying seawater sulfate concentrations remains elusive.

Similar to changes in global oxidation state, the role for the S cycle in Neoproterozoc ocean is not clear. A dominant electron acceptor in modern seawater, there is a thermodynamic expectation for sulfate to play a major role in anaerobic remineralization, especially given persistent anoxia in Neoproterozoic deeper water masses. However, thousands of shale analyses reveal strikingly low pyrite contents from both oxic shelves and deeper water facies, and only fleeting indications of euxinia associated with elevated organic carbon loading mark the Neoproterozoic. Viewed in parallel with pre-Sturtian sulfate evaporites and beautiful Marianoan barite cystal fans, the role of the S cycle gains added mystery. In hopes of gaining insight into the Neoproterozoic S cycle, here I present multiple sulfur isotope data from sulfides and sulfates from numerous Neoproterozoic basins. With ^{33}S, the opportunity exists to 1) differentiate between primary and burial diangenetic signals, 2) discern distillation from changes in biological isotope effects, and 3) uniquely track changes in classic measures of pyrite burial over long-timescales. This dataset is further viewed in light of new microbial data and modern marine sediment analyses, which together provides an independent perspective on later Proterozoic ocean-atmosphere oxygenation.

www.minersoc.org
DOI:10.1180/minmag.2013.077.5.10