North Atlantic Oscillation record from deep-sea corals

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Specimens of the deep-sea gorgonian coral Primnoa resedaeformis were collected live by the remotely-operated vehicle ROPOS from 450m in the Northeast Channel, off the southern tip of Nova Scotia. Chronology was established by analyses for excess ^{210}Pb, coupled with counting annual growth bands in thin section. Elemental analyses (precision 10%) were performed with a magnetic sector ICP-MS equipped with an online 193ηm UV laser ablation unit. These coral skeletons consist of an inner organic layer, in which elemental analysis is questionable, and an outer dense calcite layer, the cortex. Samples of coral cortex were lased with 150 micron diameter spots at increments of 200 micron (approx. annual resolution). The three oldest specimens each had about 40 years represented by the outer cortex. Mg/Ca, Sr/Ca and Ba/Ca profiles agree among these three colonies. The Mg/Ca profiles track the instrumental records at that depth, and record prominent decreases coinciding with cold Labrador Current incursions in 1998, and in the 1960's. Mg/Ca values were converted to temperatures using an empirical formula previously determined for this species (J.M. Heikoop), and match the instrumental record to within 2°C. Values of Sr/Ca and Ba/Ca also increase during the cold-water intrusions, by about 30% and 100%, respectively. Elemental abundances in the cortex of this and related corals may be a valuable record of ocean climate: these organisms have a depth range of 50 to 5000m, and a potential age span of centuries.

Hydrogen and Hydrocarbon Gases in Crystalline Rock: Implications for the Deep Biosphere

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Since the discovery of abiogenic methane in vent fluids at the East Pacific Rise, reports of abiotic methane dissolved in fluids and trapped in fluid inclusions have proliferated, renewing debate about the origin of hydrocarbon-rich fluids in the crust. Large volumes (1-30 L/min) of hydrocarbon gas and hydrogen gas discharge from fractures and exploration boreholes in hard rock mines operating in the Precambrian rocks of Canada, Finland and South Africa. Based on 17 samples from Kidd Creek Mine, Timmins, Ontario Canada, an abiogenic origin for hydrocarbons in Precambrian Shield rocks has been demonstrated[1].

In contrast to the trend of increasing isotopic enrichment in 13C from methane to ethane to propane and butane typical of thermogenic gas, hydrocarbon gases in the Precambrian rocks show a significant depletion in 13C for C2-C4 with respect to methane. Analogous to n-alkanes for the Murchison meteorite[2], the Shield gases have a C1-C4 isotopic depletion pattern consistent with formation by an abiogenic polymerisation reaction. Significantly, hydrogen and carbon isotopic values of these gases vary inversely between C1-C4 homologues – with carbon isotope depletion correlating with hydrogen isotope enrichment. The trend of carbon isotope depletion and hydrogen isotope enrichment reflects the fact that polymerisation of higher hydrocarbons through stepwise addition of the individual monomers involves the addition of a C-C bond, but elimination of C-H bonds.

In this paper, the isotope depletion and enrichment trends used to identify the abiogenic gases at Kidd Creek Mine are applied to a number of new sites (Copper Cliff South Mine, Canada and the Witswatersrand Basin , South Africa) to distinguish abiogenic hydrocarbon end-members from more conventional sources of hydrocarbons. At all of the above sites, microbial communities have been discovered deep in the subsurface. Isotopic and compositional data will be utilized to determine the extent to which hydrocarbon and hydrogen gases may support these deep subsurface microbial communities.

References

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