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A Geologic Record of Competing Sulfate-depletion Processes Within Continental-rise Sediments Overlying Methane Gas Hydrates of the Blake Ridge Region (Continental Rise, Offshore Southeastern United States)

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A geologic record of competing sulfate-depletion processes within continental-rise sediments overlying methane gas hydrates of the Blake Ridge region (continental rise, offshore southeastern United States)

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Geochemical signals locked within sediments and sedimentary rocks record geochemical processes through geologic time. Sulfide minerals (elemental sulfur, iron monosulfides, and pyrite) are formed within marine sediments as dissolved sulfide is produced by various geochemical processes, which include sulfate reduction and anaerobic methane oxidation (AMO). The concentration and sulfur isotopic composition ($\delta^{34}S$) of sulfide minerals gives clues about the relative importance of these competing geochemical processes, and consequently about sedimentation rates and upward methane transport.

Marine sediments of the Blake Ridge (offshore South Carolina and Georgia) contain sulfide minerals that point to AMO as an important diagenetic process both today and in the recent geological past. At the present-day methane-sulfate interface, upward-diffusing methane is consumed by reaction with downward-diffusing sulfate, producing a geochemical environment that promotes the authigenic precipitation of sulfide minerals. These sulfide minerals, mainly pyrite, are enriched in the heavy isotope of sulfur (^{34}S), whereas solid-phase sulfide higher in the sulfate reduction zone contains more ^{32}S. This result is consistent with larger fluxes of methane in the region derived from underlying methane gas hydrate deposits.

The sedimentary record of a portion of the Blake Ridge (ODP Site 995) back to the Late Miocene (~6.2 Ma) shows that changing depositional conditions seem to emphasize sulfate reduction over AMO in progressively older sediments. Sulfide mineral concentration changes from low baseline values (0.2 weight percent) in youthful sediments to higher values (0.4 to 0.6 wt %) in older sediments. Baseline values of $\delta^{34}S$ also increase from -45‰ to -30‰ with increasing depth and sediment age. Geochemical conditions today favor more sulfide mineralization in association with AMO, whereas conditions in the past likely responded to higher delivery rates of sedimentary organic matter – conditions necessary to ultimately produce the amount of methane gas hydrates occurring within the Blake Ridge region.

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