OS51C-04: Methane Hydrate Formation from Enhanced Organic Carbon Burial During Glacial Lowstands: Examples from the Gulf of Mexico

Friday, 15 December 2017
08:45 - 09:00
New Orleans Ernest N. Morial Convention Center - 278-279

Methane hydrates in fine-grained marine sediments are often found within veins and fractures occupying discrete depth intervals that are surrounded by hydrate-free sediments. As they are not connected with gas sources beneath the base of the methane hydrate stability zone (MHSZ), these isolated hydrate-bearing intervals have been interpreted as formed by in situ microbial methane. We investigate here the hypothesis that these hydrate deposits form in sediments that were deposited during glacial lowstands and contain higher amounts of labile particulate organic carbon (POC), leading to enhanced microbial methanogenesis. During Pleistocene lowstands, river loads are deposited near the steep top of the continental slope and turbidity currents transport organic-rich, fine-grained sediments to deep waters. Faster sedimentation rates during glacial periods result in better preservation of POC because of decreased exposure times to oxic conditions. The net result is that more labile POC enters the methanogenic zone and more methane is generated in these sediments.

To test this hypothesis, we apply an advection-diffusion-reaction model with a time-dependent deposition of labile POC at the seafloor controlled by glacioeustatic sea level variations in the last 250 kyr. The model is run for parameters estimated at three sites drilled by the 2009 Gulf of Mexico Joint Industry Project: Walker Ridge in the Terrebonne Basin (WR313-G and WR313-H) and Green Canyon near the canyon embayment into the Sigsbee Escarpment (GC955-H). In the model, gas hydrate forms in sediments with higher labile POC content deposited during the glacial cycle between 230 and 130 kyr (marine isotope stages 6 and 7). The corresponding depth intervals in the three sites contain hydrates, as shown by high bulk electrical resistivities and resistive subvertical fracture fills. This match supports the hypothesis that enhanced POC burial during glacial lowstands can result in hydrate formation from in situ microbial methanogenesis. Our results have implications for carbon cycling during glacial/interglacial cycles and for hydrate accumulation in the MHSZ. In particular, once hydrate-bearing intervals formed during glacial periods are buried beneath the MHSZ and dissociate, gas bubbles can rise and recycle microbial methane into the MHSZ.

Plain Language Summary

Natural methane hydrates, ice-like compounds of water and methane, are widespread in continental margin sediments. We show here evidence for the hypothesis that methane hydrates form preferentially in sediments deposited during glacial periods, which contain more organic matter that is converted to methane by microbes.

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