Spatial Variations in the Salinity of Pore Waters in Northern Deep-Water Gulf of Mexico Sediments: Implications for the Stability of Methane Hydrates

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It is known that elevated pore water salinities reduce the pressure-temperature stability range of methane hydrates, a potential energy resource in the deepwater Gulf of Mexico (GOM). Although there have been numerous studies of brine seeps in the GOM, much less is known about salinities in the vast areas between seeps. A study has been made of spatial variation in pore water salinities in sediments in an approximately 500-km by 200-km area of the northern GOM to document salinities in the upper 500 m of the sedimentary section, the approximate depth range in which methane hydrates may be stable. Salinities were calculated from borehole logs using a dual electrical conductivity model. A total of nearly 1000 salinity calculations were made for 84 boreholes from 6 protraction areas. Depending on where logging began and the total depth of the hole, salinity measurements extended from within a few hundred meters of the seafloor or less to depths of 3 or 4 km or more. The salinity-depth curves thus obtained were extrapolated upward to provide an estimate of pore water salinities just below the seafloor. Even though much of the northern GOM is underlain by allochthonous salt and numerous seafloor brine seeps have been documented, most of the shallow sedimentary section has not been permeated by hypersaline waters. These waters are limited to areas near brine seeps. Most of the sedimentary section, at least in the boreholes studied, is characterized by pore waters having apparently normal seawater salinities (ca. 35 g/L) to moderately elevated seawater salinities (< 60 g/L) to a subseafloor depth of a kilometer. Some of the moderately elevated salinities may be the result of hydrate formation, which removes free water. Hypersaline waters having salinities in excess of 100 g/L become more common at subseafloor depths of 2 km and greater. No obvious relation could be developed between salinity and subseafloor depth to top of salt. A previous field study at Green Canyon 65 and published numerical simulations of fluid flow above tabular salt bodies suggest that brines produced by salt dissolution pond above salt and/or within minibasins and that the dominant mechanism of vertical solute transport is a combination of compaction or pressure-driven advection and diffusion and not large-scale thermohaline overturn. Superimposed on this diffuse upward flux of dissolved salt is the more focused and localized expulsion of saline fluids up faults.