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Fluid Flow and Gas Hydrate Dynamics at Costa Rica Convergent Margin

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Chloride-depleted fluids expulse at active vent sites at Costa Rica continental margin. Oxygen and hydrogen isotope ratios and thermogenic methane indicate that the fluids originate largely from mineral dehydration in subducted sediments at about 10-12 km depth. Conspicuous differences in the geochemical composition of fluids from various locations allow a general subdivision of a southern (Mound 11) type and a northern (Mound Culebra) type. Fluids of the Mound Culebra type are rich in boron, show a strong component of thermogenic methane and obviously rise at high rates. In contrast, Mound Culebra type fluids are strongly enriched in calcium, barium, and bromine, which points to a significant impact from anoxic diagenesis. Similarly, Cl-depleted fluids are known from deep drilling in upper plate sediments off Nicoya Peninsula (ODP-Leg 170). We applied a reactive–transport model simulating the degradation of organic matter to constrain the rates of methane and gas hydrate formation in upper plate sediments using data from ODP-Site 1040. Our best estimate for the amount of gas hydrate is an average concentration of only 0.75 vol.%, corresponding to about 2.5 Tg CH_4 per km trench within the frontal prism of slope sediments. Hence, observed Cl-depletions may not have originated from dissociating gas hydrates. However, pore water profiles at ODP-Site 1040 give strong indications for the lateral advection of deep-seated fluids and thus, confirm the results obtained from analysis of the vent fluids.