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Understanding gas hydrate dissolution

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In order to understand the role gas hydrates play in climate change or their potential as an energy source, we must first understand their basic behaviors. One such behavior not well understood is their dissolution and the factors that control it. Theoretically, hydrates are stable in areas of high pressure, low temperature, moderate salt concentrations, and saturated methane. Yet in nature, we observe hydrate to outcrop seafloor sediments into overlying water that is under-saturated with respect to methane. How do these hydrates not dissolve away? To address this question, we combine both field and laboratory experiments. In the field, we have collected pore-waters directly surrounding gas hydrate outcrops and measured for in situ methane concentrations. This gives us an understanding of the concentration gradients, and thus methane flux, directly from the hydrate to the surrounding environment. From these samples, we found that methane concentrations decreased further from hydrate yet are always under-saturated with respect to methane hydrate. The resulting low methane gradients were then used to calculate low dissolution rates. This result suggests that hydrates are meta-stable in the environment. What controls their apparent meta-stability? We hypothesize that surrounding oils or microbial slimes help protect the hydrate and slow down their dissolution. To test this hypothesis, we conducted a series of laboratory experiments where hydrate was formed at in situ pressure and temperature and the source gas removed; first with no oils, then with oils. Dissolved methane concentrations were then measured in surrounding fluids over time and dissolution rates calculated. To date, both methane and mixed gas hydrate (methane, ethane, and propane) have similar dissolution rates of 0.12 mM/hr. Future experiments will add oils to determine how different hydrate dissolves with such contaminants. This study will further our understanding of factors that control hydrate stability in nature.