Natural Methane Hydrates: Energy Resource and Climate Implications

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Methane hydrate is an ice-like compound formed when methane (CH_4) combines with water at relatively low temperatures and moderate pressures. Such conditions are common in shallow sediments on marine continental margins below waters at least 350-550 m deep and within and beneath thick, continuous permafrost. Gas hydrates are widespread, nominally concentrate methane by ~160 times compared to STP, and sequester a significant fraction of the carbon available for near-surface cycling. For these reasons, hydrates are often mentioned as a potential unconventional energy source and invoked as a contributor to global atmospheric CH_4 emissions and thus greenhouse warming. This talk reviews the state-of-the-art for methane hydrate energy and climate studies.

Energy. Methane hydrate traps natural gas in a concentrated form and at shallower, more accessible depths than conventional gas. Currently, there are no proved gas hydrate reserves, in part because no long-term production test (e.g., 18 months) has been completed to document sustained gas release from hydrates. Such a test is likely to occur by 2020. To date, short-term production tests have been carried out in permafrost areas in the US and Canada and offshore Japan in a deepwater marine setting. The locations of these tests highlight a challenge for rapid adoption of gas hydrate as an energy resource, namely the need to transport the gas long distances under harsh conditions between the production area and markets.

Climate: Up to 2% of annual atmospheric CH_4 emissions has been attributed to dissociating gas hydrates, but evidence suggests that actual emissions are far lower. On contemporary Earth, gas hydrate dissociation occurs mostly on upper continental slopes, where warm intermediate waters perturb the updip extent of gas hydrate stability. Methane released at these water depths mostly dissolves or oxidizes to CO_2 before reaching the atmosphere. This alters ocean chemistry, but has minimal direct impact on the atmosphere. Where thick permafrost is thawing rapidly, particularly on shallow (< 100 m) circum-Arctic Ocean shelves, direct emission of CH_4 from gas hydrates to the atmosphere is in theory possible. Permafrost-associated methane hydrate is not that common and occurs mostly at depths > 225 m in petroleum basins with particular cooling histories. Emissions from such hydrates have probably been significantly overestimated.