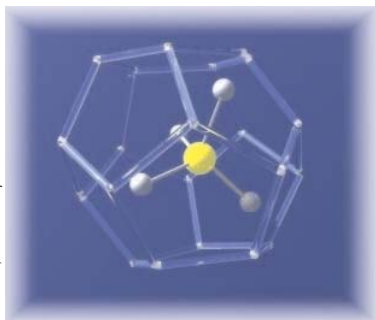


GAS HYDRATES



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J.S. Boehl, USGS with permission



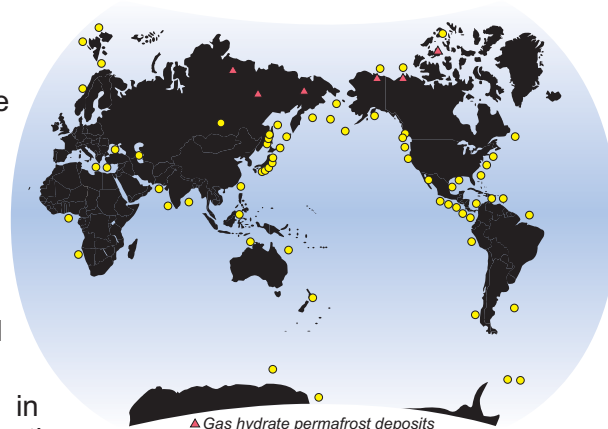
Gas hydrate molecule

Ice That Burns

Gas hydrates are crystalline compounds that belong to a group of ice-like solids called clathrates. In a clathrate, a water molecule forms a cage that traps a gas molecule. Conditions of low temperature and high pressure, such as those found in areas of permafrost and in sediments at the bottom of deep oceans and lakes, are needed for the water cages to form. Methane and carbon dioxide are the common gases found in gas hydrates, but hydrogen sulphide and small hydrocarbon molecules such as propane are also trapped.

Energy and Industry

Once the technologies for separating and producing the gas are perfected, we may be able to use gas hydrates as a source of energy. Gas hydrates are concentrated: they contain about five times more energy than the same volume of conventional natural gas. Gas hydrates occur around the world, and probably have more carbon than all other fossil fuel sources combined: conventional oil and gas reservoirs, oil sand, coal, coal bed methane, and oil shale.



▲ Gas hydrate permafrost deposits
● Gas hydrate deep water deposits



Courtesy of Pacific Northwest National Laboratory, U.S. Department of Energy

Ice that burns

Hydrates also have potential uses in industry. As a hydrate crystal forms, the cage size acts to exclude certain ions and compounds. This means hydrate formation might be used, for example, to remove carbon dioxide from flue gases, or to purify water. Crystallization could also be used for novel energy storage and transportation methods. For example, it may be more economical in some cases to ship natural gas as hydrate pellets (stored at around -15°C) instead of as liquefied natural gas (LNG).

Hazards

Seafloor sediments are like concrete when cemented with hydrates, but if the hydrates melt, the sediments could suddenly move as debris flows (underwater landslides), with the potential to create tsunamis. Gas hydrates can also be a drilling hazard, and sometimes plug up natural gas pipelines.

Climate Change

There are important environmental issues associated with gas hydrates. Methane is about 30 times more effective as a greenhouse gas than carbon dioxide (CO_2). It has been suggested that at least one warming period in the recent glacial past has been due to a release of methane from hydrates. Global environmental changes could melt hydrates, causing methane release and more warming.

GAS HYDRATES



2

In Canada, natural gas hydrates occur in permafrost, and in offshore sediments on all three coasts. The potential for this gas resource is comparable in scale to the oil in the Athabasca oil sands. The Mackenzie River delta contains some of the most concentrated deposits of gas hydrates in the world.

Mallik

Scientists from the Geological Survey of Canada (GSC) and several universities have been studying gas hydrates in the Arctic for many years. This research led to the drilling of the Mallik gas hydrate field in the Mackenzie Delta in 2002. This program was a major international science and engineering study, and it demonstrated that production of gas from hydrate is technically feasible.

The remote location of most gas hydrates means there are constraints to their economic development. Luckily, the Beaufort-Mackenzie region is also an area of major natural gas fields. The proposed Mackenzie Valley natural gas pipeline could be used to transport gas from hydrates.

Hydrate (white) and pebbles in drill core



S. Dailimore, NRCan



S. Dailimore, NRCan

Mallik drill site, February 2002



Great Lakes CO₂

Concern about the impact of carbon dioxide on global climate has led to studies on ways to dispose of industrial CO₂. One way is called sequestration – storing the gas underground in porous rock reservoirs. Another way is to lock it into hydrates. This involves storing frozen CO₂ in deep reservoirs. Research by the GSC has shown that Lake Superior and Lake Huron have potential as CO₂ hydrate reservoirs, as do extensive portions of the Beaufort-Mackenzie region.

Did You Know?

After being lit with a match, gas hydrate burns like a candle

Decomposing hydrate feels like cold Alka-Seltzer fizzing and popping on your skin

Bacteria found in hydrate mounds in the deep, cold waters of the Gulf of Mexico get their nourishment from the methane – these bacteria live together with ice worms and mussels, which attract fish and other animals