

Fig. 2 – Burning Ice



(Adapted from Ir. M.M. Mooijer-van Heuvel & Dr. Ir. C.J. Peters)

The active surface layer of permafrost is a thin top slice of tundra vegetation that thaws every summer and freezes hard during the arctic winter. Vegetable material is locked each year into the permafrost, which gets thicker and thicker. Methane gas from the rotting vegetable material collects and reacts with water to form methane hydrate - that frozen lattice-like substance. Permafrost has acted as a carbon sink, locking away carbon and other greenhouse gases for tens of thousands of years. Permafrost underlies an estimated 20-25 percent of the world's land surface. It occurs over almost 50 percent of Russia and Canada, 20 percent of China, and probably all of Antarctica. Permafrost in northern Siberia is about 1,600 meters, (5,250 feet) thick and about 650 meters (2,133 feet) thick in northern Alaska. Permafrost lies beneath about 80 percent of Alaska, and a yet higher percentage of Siberia.

The greatest volumes of natural gas hydrates are hosted in deep-sea sediments. These gas hydrates exist within a pressure-temperature limited volume often called the gas hydrate stability zone (GHSZ) (Collett, 2004). Across a typical continental margin, the GHSZ creates a lens-shaped outline beneath the seafloor (Fig. 3 and Fig. 14). These lenses begin in about 250 to 500 meters (820-1,640 feet) of water depth because, depending on local conditions, this is where the pressure is high enough and the water temperature low enough to create gas hydrates. From this depth down, the seafloor marks the top of a lens because gas hydrates, like ice, float and cannot accumulate in water. The bottom of the lens lies within the sediment, where temperatures are too warm for gas hydrates, and where the gas dissociates from its host. With current engineering and scientific capabilities, finding and extracting methane from hydrate accumulations in the earth seem to be within reach. Hydrate crystals are most stable under cold conditions. For example, at 86° Fahrenheit, the crystals must be kept under nearly 15,000 psi (pounds per square inch) of pressure to keep them from decomposing. At 32° Fahrenheit, the pressure requirement is just 442 psi.

Some deposits of methane hydrate, layered with seafloor sediments, are believed to be 3,000 feet thick, but these veins exist at water depths of at least 10,000 feet.

Under the enormous pressures and cold temperatures at the bottom of the ocean, methane gas dissolves. The molecules of methane become locked in a cage of water molecules to form crystals. These crystals, having the likeness of ice, cement together the surrounding ocean