Gas on the rocks
Cold facts about methane hydrate

The gas-bearing potential of frozen methane hydrate deposits beneath the Arctic permafrost may take the chill out of future Canadian winters.

It's one of those classic good news/bad news situations. According to many experts, a vast supply of natural gas, up to twice our known current reserves, may lie frozen solid beneath the crust of Canada's permafrost. The energy equivalent of this untapped storehouse could be over four billion tons of coal.

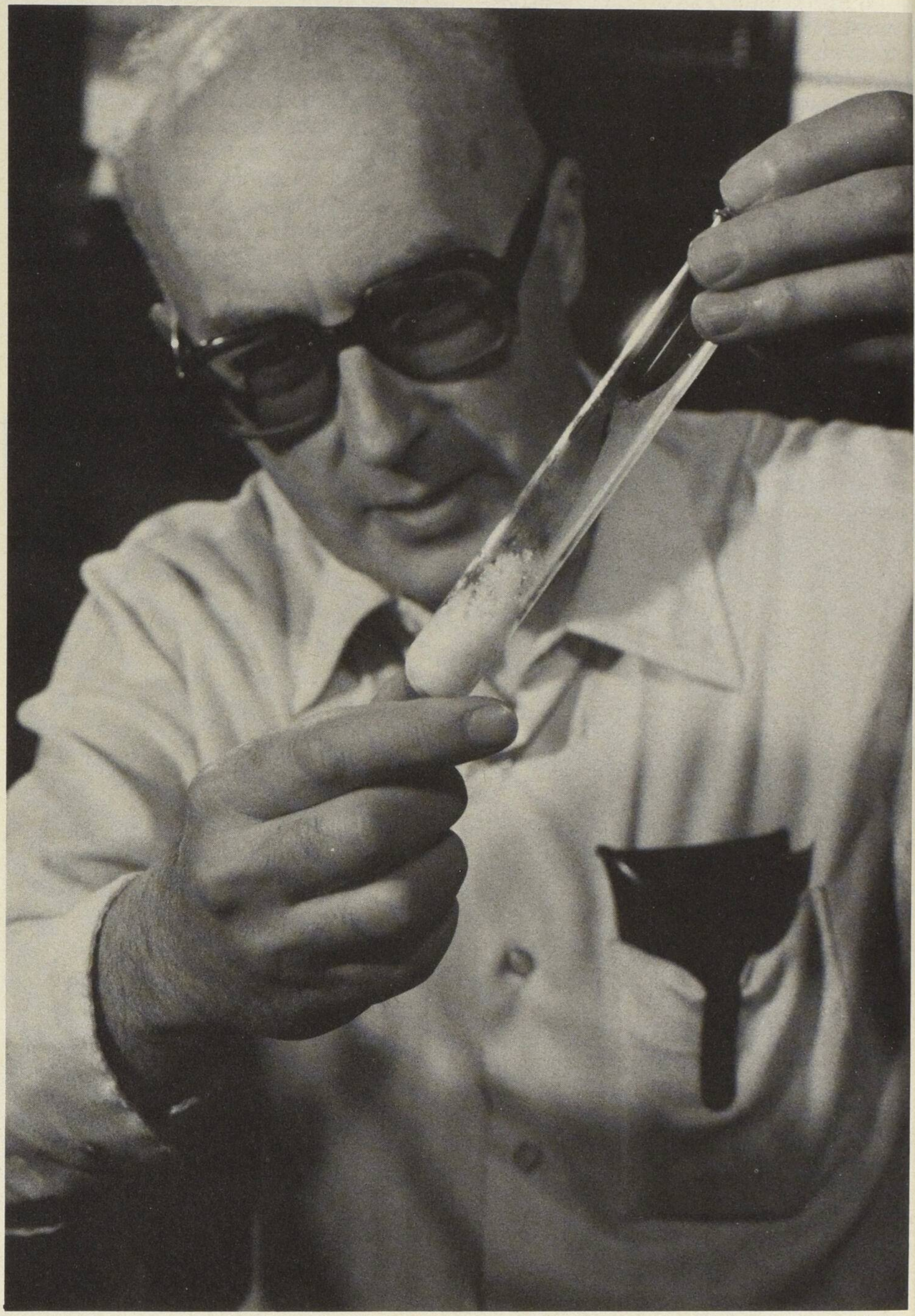
But that's cold comfort. Predictably, there's a "bad news" angle to the story too. "No one's found an easy way to get the gas out," explains NRC chemist Don Davidson.

The problem is that the gas is locked up in a little-understood solid form, a frosty mixture of ice, methane (natural gas) and small amounts of other light gases. That's where Davidson and his colleagues come in. They're learning more about how frozen gas hydrates behave in the laboratory — electrically, magnetically and in response to heat — and hoping to make these substances less of a mystery.

"Imagine a large frozen sponge," explains Davidson, "with single molecules of gas plugged into all the emply spaces. That's the kind of thing we're talking about. Of course, the structure is actually more regular and orderly than that, but either way the molecules are trapped in their own icy cells." By all estimates, 1 m^3 of this material could release over 160 m^3 of methane.

Deposits of frozen hydrate, most likely formed during intensely cold periods of the earth's evolution, are normally found in layers below the permafrost (or even beneath the cold ocean floor). They're accessible, but not easy to work with. At first glance, prying the gas loose would seem to be a taxing but not insoluble engineering problem... like extracting oil from Alberta's tar sands. But there's a catch. Frozen gas is chemically unstable and explosive, making it somewhat unpredictable under pressure or heat. Imagine trying to handle something that can expand rapidly to over a hundred times its original volume.

This same explosive tendency also poses an unseen hazard to exploration crews probing the Arctic landscape for natural gas. Dangers arise as drillers punch through the unstable hydrate layer to a gas pocket below. To minimize such risks, geologists must learn how to predict where the frozen gas occurs and then to recognize the subtle differences between the hydrate and normal ice. Unfortunately, instruments sensitive enough to do this haven't been built yet.



A sample of non-explosive frozen hydrate releases bubbles of gas as the substance warms up. *(Photo: Bruce Kane, NRC)*

Cet échantillon non explosif d'hydrate gelé dégage des bulles de gaz à mesure que sa température augmente. *(Photo: Bruce Kane, CNRC)*

"We're looking at minute differences between the properties of plain ice and frozen gas," says Davidson. "I guess it's a case of walking before you can run. Once we know enough about these substances at a molecular level, maybe instruments can be designed to distinguish between them in the field."

The NRC chemists have studied hydrate complexes of methane as well as safer and more stable relatives containing propane and butane gas. These carbon-containing molecules caged in their icy structures are examined with a comparatively new technique using nuclear magnetic resonance spectroscopy. Solid samples (previously only liquids or solutions could be used) are cooled and whirled in a strong magnetic field while a radio frequency signal extracts vital data. Other experiments include in-