Locating oil under ice

This project demonstrated that finding oil under ice can be achieved fairly simply with existing technologies. Finding oil spilled under several feet of ice and snow is a daunting task. Rather than trying to detect oil by looking through the ice and snow, a novel and simple approach is to look from below using instrumentation mounted on an autonomous underwater vehicle (AUV) or remotely operated vehicle (ROV) (Fig.1). To test the capability to detect oil from below the ice, the Oil Spill Recovery Institute sponsored a test of potential underwater oil detection sensors. The work was performed by Dr. Jeremy Wilkinson of the Scottish Association for Marine Science and Drs. Hanumant Singh and Ted Maksym of Woods Hole Oceanographic Institution.

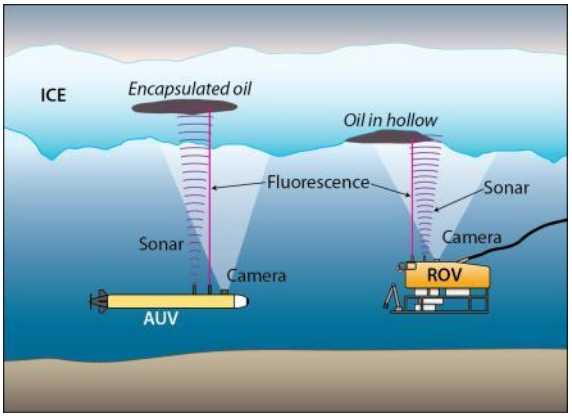

Fig. 1. Can we find oil under ice using existing oceanographic technology?

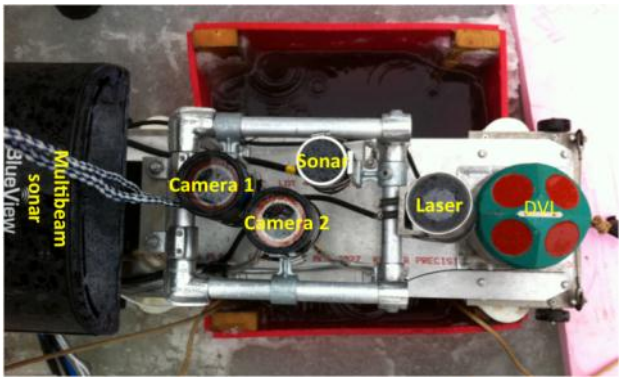

Fig. 2. Sensor suite mounted on trolley

Test configuration A continuous sheet of sea ice was grown at the Geophysical Research Facility at the Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, New Hampshire. Sea ice was grown to a thickness of about twenty inches, with several small, thinner regions to simulate the complex under-ice topography likely to trap oil. An instrumented trolley (Fig. 2) was pulled along a track on the bottom of the tank. The instruments included high-dynamic range cameras, a laser light source, a single-beam sonar (basically a depth sounder), multi-beam sonar unit and DVL. The trolley allowed the sensor suite to be moved underneath regions with and without oil, simulating an AUV or ROV mission. An inexpensive submersible camera mounted in the tank to view the injection of oil quickly demonstrated that visual detection of oil from below is not a problem (Fig. 3).

Fig. 3. Oil under ice and the instrument trolley as seen using an inexpensive camera and natural light.

Detection of Oil The high-dynamic range camera system provided clear and distinct delineation of the oil during both day and night tests (Fig. 4). The single-beam sonar reliably detected oil under the ice (Fig. 5), for both cold and warm oil (which will melt into the ice). Clear and distinct acoustic reflections were detected from the oil and sea ice, allowing a straightforward determination of the thickness of the oil, even for oil as thin as one inch. There was also evidence in the acoustic signature that it may be possible to find oil encapsulated within the ice.

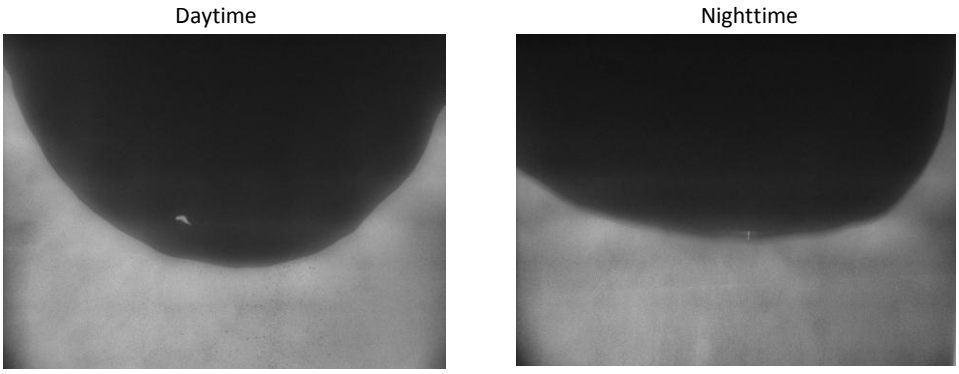

Fig. 4. High-dynamic range camera images of the edge of an oil slick under ice in daylight (left) and night (right) conditions. Oil can easily be detected and mapped due to sharp changes in brightness. Illumination at night was provided by a sheet laser on the instrument trolley.

The sensors used in this experiment are inexpensive, function during day or night, and have a long history of use on ROVs and AUVs in ice environments. The experiment showed the ability to measure both the presence and thickness of oil under ice. This research team has successfully used these platforms under sea ice in the Arctic and Antarctic on a number of occasions so we are confident in the ability to deploy the sensors under the ice.

These are preliminary results and we expect more information from this experiment to be available in the future. Future efforts are expected to focus on detecting oil encapsulated in the ice. We are also looking at potential development of additional sensors that may enhance our capabilities beyond the sensors used in this test.

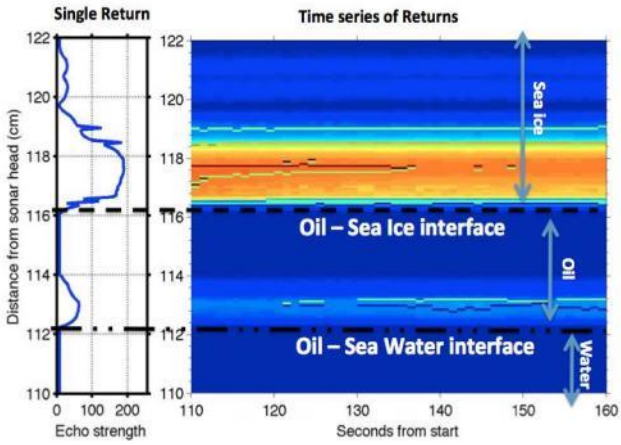

Fig. 5. The raw returns from the sonar altimeter clearly show a strong return from the oil-ice interface and a slightly weaker return from the oil-water interface. The difference between the two gives the oil thickness (two inches here).

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