info@geophex.com
+1 (919) 839-8515

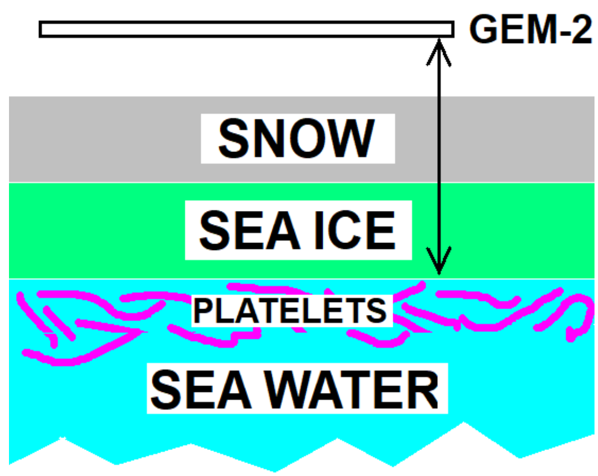
Newsletter – April 2020

GEM-2 in the Antarctic

Because of the versatility of our GEM-2 instrument, our customers are constantly finding new ways to use it. One application is the measurement of sea ice thickness in the polar regions. Both airborne and ground-based EMI (ElectroMagnetic Induction) have been used before to estimate sea ice thickness. Because of its moderate length (<2 metres) the GEM-2 can easily be mounted in a kayak or sled for towing.

GEM-2 ON A TOWED SLED

There many parallels between ice measurements and a traditional ground conductivity survey. The simplest assumption for data analysis is a layered model, with the seawater conductivity much greater than that of the sea ice, snow and air above it. (> 2,000 mS/m vs. < 100 mS/m). But the picture is more complicated when ice-platelet clusters form under the ice. These are clumps of crystalline ice which float in the seawater on the underside of the ice layer; their density and depth, and hence bulk conductivity, are highly variable. They will cause errors in ice thickness measurements if not taken into account.



Scientists from the Alfred Wegener Institute of the Helmholtz Centre for Polar and Marine Research in Germany (www.AWI.de) have developed calibration and deployment methods for characterizing sea ice shelves in the Antarctic. In particular, they have been able to exploit the GEM-2's advanced capabilities to perform more complex characterizations than simply measuring ice thickness.

Scientists conducted expeditions to various locations with and without platelet formations. They used the GEM-2 to record response at several frequencies, for different heights and correlated these results with physical measurements at that location, the 'ground truth'. They found that having independent measurements for both in-phase and quadrature at each frequency reduced the ambiguity of the recorded signal, leading to more accurate calibrations. Also they found the higher frequencies (63 kHz and 93 kHz) most useful in characterizing the platelet layer. These types of measurements are not available from more primitive single-frequency/fixed frequency instruments.

In this undersea photo, platelet ice is the cloud-like ice on the "ceiling"; the ice coming off the seafloor is called anchor ice

Many free-air calibrations were carried out to estimate any long-term drift and temperature dependency of the GEM-2; temperatures ranged between -10 C and -24 C . They did not observe a strong temperature dependence of the zero-level offsets for any frequency, and the instrument performed well. The cold affected the capacity of GEM-2 batteries; this was solved by keeping a spare battery inside someone's coat while the other battery was in use. The GEM-2 comes with a spare battery, and a battery change takes less than a minute, so near-continuous surveying is easy.

CALIBRATION AT VARIOUS HEIGHTS

The GEM-2 itself is made of industrial-grade components rated from -40 C to +85 C, so operating temperatures are not normally an issue.

This newsletter is based partly on the paper "Towards an estimation of sub-sea-ice platelet-layer volume with multi-frequency electromagnetic induction sounding" by Priska A. Hunkeler, Stefan Hendricks, Mario Hoppmann, Stephan Paul And Rüdiger Gerdes. The paper is at https://epic.awi.de/id/eprint/36936/

Undersea photo courtesy of John Weller Photography (http://www.johnbweller.com/)
Other photos courtesy of Alfred Wegener Institute (www.awi.de)

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Geophex Ltd. 605 Mercury street, Raleigh NC 27603, USA info@geophex.com

Tel: +1 (919) 839-8515 www. geophex.com