High Lakes Expedition Report: Drilling into Arctic Permafrost

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[摘要] November 16, 2006 NAI investigators, led by T.C. Onstott and S.M. Pffifner of the IPTAI Team, along with scientists from the Geological Survey of Finland and University of Waterloo, Canada, and Michigan State University recently completed a scientific drilling expedition into deep permafrost of the Canadian Arctic.

[关键词] Geological Survey;permafrost;the Canadian Arctic

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The drill site was in the High Lake mining property (67?

2'N, 110 50'W) located in an Archean, mafic volcanic belt and frozen to a depth of ~400 meters. The properties contain significant Cu/Zn sulfide deposits that form surficial gossans of brightly pigmented iron oxides (Figure 1). Mineralogical and microbiological samples of the surface gossan deposits were collected for comparison with subsurface samples.

The goal of the drilling project was to delineate gradients in salinity, gas concentration, pH, pe, microbial abundance, diversity and activity across the permafrost/subpermafrost front and to isolate pristine subpermafrost brine for future studies. Using a 75 mm diameter, triple barrel wire line tool and following aseptic QA/QC protocols 200 meters of core were collected from the lower bou

Fresh water heated to 80oC was used to remove cuttings and from keeping the drill rods from freezing to the uncased frozen rock (Figure 2). At 400 PSI bit pressure the rate of penetration was ~30 m/day. Anomalies in water conductivity or gas concentrations in the drilling water were absent during penetration of the permafrost.

Various measurements including the rate of freezing at the bit were used to indicate the down-

hole temperature and when the permafrost zone had been traversed. The cores and drilling water were processed on site in an anaerobic glove bag (Figure 3) and stored refrigerated or frozen until transport back to labs.

Core samples were collected for lipid, DNA, sulfate reducing activity, geophysical, geochemical, physical, isotopic, and pore water and gas chemical and isotopic analyses. Once coring reached 485 m depth, the drill rods were removed and casing was set to a depth of 290 m to protect the borehole from melt water draining from above. Water was bailed from the hole in order to lower the

After bailing, the borehole water salinity increased, the water level was at 446 m depth and the influx of subpermafrost brine was ~1 L/hour. Within 24 hours the borehole iced closed at 125 m depth capturing the down

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hole probe. An attempt to drill out the ice failed. Vapor condensation either from the subpermafrost water and/or from atmospheric moisture caused the ice plug.

Technical plans are in progress for a drilling campaign in Spring, 2007 to attempt removal of the ice plug. If ice drilling is successful then the borehole will be isolated with a packer system and long

-term monitoring of the subpermafrost microbial community will be possible.