Ximu Liu liuximu@outlook.com

Borehole logging and in-situ observatories

Poster

A Pressure-Resistant Self-Contained Offline Temperature Measurement Device for Various Polar Ice Borehole Environments

|  |  |
| --- | --- |
| Ximu Liu1, Da Gong1, Yazhou Li2, Bo Han1, Yuchen Sun2, Pavel Talalay1, Ziyan Wu1, Zhipeng Deng1, Xianzhe Wei1, Xiaopeng Fan1, \* | 1Polar Research Center, Institute for Polar Science and Engineering, Jilin University, Changchun, China;  \*Polar Research Center, Institute for Polar Science and Engineering, Jilin University, Changchun, China;  2School of Engineering and Technology, China University of Geosciences, Beijing 100083, China; |

Accurate measurement of temperature within Antarctic ice holes is crucial for understanding the thermal state of ice sheets and subglacial environments, especially for the study of ice sheet dynamics, subglacial heat flux, and the broader Antarctic thermal environment. However, conventional temperature-measuring devices become inapplicable in ice boreholes due to extreme cold, high pressure, and the corrosiveness of drilling fluids. We have developed a new device, named iBOLT (ice Borehole Offline Logger of Temperature), that provides a simpler, portable, and efficient solution for downhole temperature measurement in the Antarctic. The iBOLT device can measure temperatures in various environments within the range of -45℃ to +85℃ (±0.1℃ accuracy), withstand pressures up to 40 MPa, and can be used in a Φ80 mm borehole, thus highly suitable for temperature measurement in Antarctic ice holes, subglacial lakes, and other liquid environments requiring temperature monitoring. It is powered by a self-contained power supply and can continuously record temperature for more than 50 days with a data interval of 1 minute. All the recorded data can be read, exported, and stored via Bluetooth after being recovered to the surface. Laboratory tests and field borehole applications of iBOLT show that temperature readings stabilize within 10 minutes in liquid environments. Therefore, surface personnel only need to record the time and the corresponding depth. In this study, we present the development process of the iBOLT temperature measurement device, including structural design, simulation analysis, testing procedures, and results from field borehole applications.

References

Talalay, P.G., Leitchenkov, G., Lipenkov, V. *et al.* Rare ice-base temperature measurements in Antarctica reveal a cold base in contrast with predictions. *Commun Earth Environ* **6**, 189 (2025). <https://doi.org/10.1038/s43247-025-02127-1>

Talalay, P., Li, Y., Augustin, L., Clow, G. D., Hong, J., Lefebvre, E., Markov, A., Motoyama, H., and Ritz, C.: Geothermal heat flux from measured temperature profiles in deep ice boreholes in Antarctica, The Cryosphere, 14, 4021–4037, <https://doi.org/10.5194/tc-14-4021-2020>

Hills, B. H., Harper, J. T., Humphrey, N. F., & Meierbachtol, T. W. (2017). Measured horizontal temperature gradients constrain heat transfer mechanisms in Greenland ice. Geophysical Research Letters, 44, 9778–9785. <https://doi.org/10.1002/2017GL074917>

Engelhardt H. Ice temperature and high geothermal flux at Siple Dome, West Antarctica, from borehole measurements. *Journal of Glaciology*. 2004;50(169):251-256. [doi:10.3189/172756504781830105](http://dx.doi.org/10.3189/172756504781830105)

Miles, K.E., Hubbard, B., Quincey, D.J. *et al.* Polythermal structure of a Himalayan debris-covered glacier revealed by borehole thermometry. *Sci Rep* **8**, 16825 (2018). <https://doi.org/10.1038/s41598-018-34327-5>

Fudge, T. J., B. R. Markle, K. M. Cuffey, C. Buizert, K. C. Taylor, E. J. Steig, E. D. Waddington, H. Conway, and M. Koutnik (2016), Variable relationship between accumulation and temperature in West Antarctica for the past 31,000 years, Geophys. Res. Lett., 43, 3795–3803, doi:[10.1002/2016GL068356](https://doi.org/10.1002/2016GL068356).

Scambos, T. A., Campbell, G. G., Pope, A., Haran, T., Muto, A., Lazzara, M., et al. (2018). Ultralow surface temperatures in East Antarctica from satellite thermal infrared mapping: The coldest places on Earth. Geophysical Research Letters, 45, 6124–6133. <https://doi.org/10.1029/2018GL078133>

Yang, J.-W., Han, Y., Orsi, A. J., Kim, S.-J., Han, H., Ryu, Y., et al. (2018). Surface temperature in twentieth century at the Styx Glacier, northern Victoria Land, Antarctica, from borehole thermometry. Geophysical Research Letters, 45, 9834–9842. <https://doi.org/10.1029/2018GL078770>