

Single Probe Borehole Temperature Logging

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The technology for measuring temperatures in deep boreholes (>20 m) involves a single sensor on a cable. The system shown here is capable of measurements up to about 150 m. The sensor is attached with a four-wire connection to a high quality multi-meter. The multi-meter can be attached to a computer for automatic data recording, although for this type of measurement the computer is not usually used. Boreholes are typically cased with $\frac{3}{4}$ inch steel pipe, and filled with ????. It is more convenient to take measurements in summer, but in fact these measurements could be taken at any time of year. The system is compact enough for one person to carry to any site.

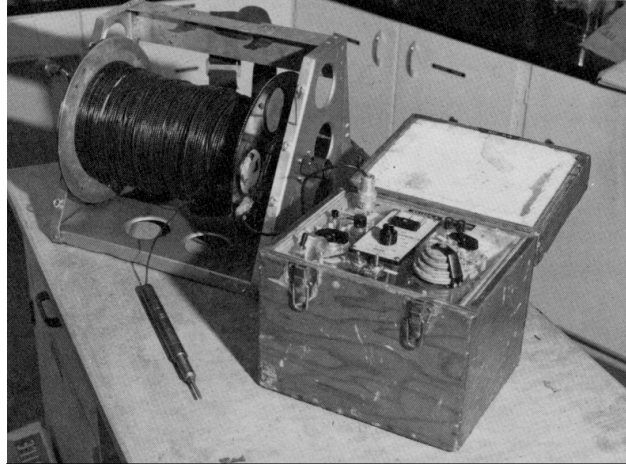


Figure 1. A single-sensor system used by Terrain Sciences

The procedure is straightforward. The sensor probe is dropped into the borehole and is stopped about every meter on the way down for a measurement. This typically yields about 100 measurements in a single hole, which are easily recorded in a notebook. A computer is convenient in this situation because it can convert the thermistor resistance to temperature. Distance down the borehole is measured by recording revolutions of a pulley that feeds the sensor cable into the borehole. Equilibration time at each depth is about 2 minutes near the surface, and somewhat less at greater depths (where the temperature change between depths is smaller). Equilibration time in air would be approximately 2 hours, so it would not be practical to use this arrangement in larger diameter air-filled boreholes. We don't see any influences of the probe movement on the temperature field because we take measurements on the way down the hole.

It is important to measure both temperature and depth very precisely to get a useful temperature profile. This system has a precision in temperature of about 0.002°C , and less than 2 cm in depth. The thermistor calibration is checked at 0°C in an ice-water bath before and after going into the field. One sensor that we have been using since 1993 has not changed its calibration within the precision of the measurement system, which is about 1 ohm. An advantage of having a single sensor used for measurements at all depths for a number of boreholes is that errors due to differences in calibration are eliminated. Special cables are needed for very deep boreholes, as the stress on long cables is higher.