RADWASTE

RESULTS FROM THE INITIAL SERIES OF GEOTHERMAL LOGS OF BOREHOLE URL-1, LAC DU BONNET

Malcolm J. Drury and Dzintars K. Tomsons*

INTERNAL REPORT 81-12

Geothermal Studies Group,
Division of Seismology and Geothermal Studies,

Earth Physics Branch

Energy, Mines and Resources Canada

Ottawa

1981

TM 303426 M03/81

* Division of Gravity and Geodynamics, on secondment from AECL

Borehole URL-1 at the proposed underground research laboratory site near Lac Du Bonnet, Manitoba, was drilled to a downhole depth of 678 m between February 18th and March 29th 1981. The hole has been geothermally logged by the standard technique, as described by Judge (1980), on three occasions since completion of the hole, on 1st, 7th and 30th of April, 3, 9 and 32 days after the end of drilling. This initial series of logs represents the first phase of a well-defined schedule, designed to gain maximum scientific benefit from borehole geophysics and hydrogeology. The purpose of this report is to make the results and interpretation of the logs available quickly for other workers planning experiments in the borehole. As in previous reports, depths will be given as true vertical depth followed by the downhole length in parenthesis.

Geothermal logging is performed in order to detect water flow within the borehole and in fractures from a study of thermal anomalies. The techniques for extracting such information from temperature logs have been presented in a previous report (Drury, 1980). Subsequently, a class of thermal anomaly with examples from CR-1, Chalk River, ATK-3 and ATK-4, Atikokan, has been described (Drury and Jessop, 1981). This type of anomaly is associated with fractures that fill with fluid during drilling, but otherwise have no water flowing through them. The thermal anomaly resulting from this phenomenon decays with time in a characteristic manner.

Figure 1 shows the results of the three initial temperature logs of URL-1. The data for consecutive logs have been separated for clarity. The most striking characteristic of the temperature profiles is the absence of any major thermal anomaly. There is no downhole water flow, such as was observed in WN-2; nor is there any regional flow across fractures that intersect the borehole, as is seen in WN-4 (Drury, 1980); nor are there any of the major anomalies such as those observed on successive logs at 69 m vertical depth in ATK-3 (Drury, 1981).

Some points can, however, be made. Bottom-hole temperatures have decreased only very slightly by 3 mK between the first and third log, whereas the hole has cooled significantly at shallower depths (for example, by 0.18K at 100m). This is the normal behaviour of the temperature distribution as the thermal disturbance from drilling decays. The first log shows small temperature disturbances, as is expected for a log so soon after the end of drilling. A number of minor thermal anomalies are seen but most have disappeared by the time of the second log six days later. A small anomaly at 459 m (482 m) persists in the second log but has disappeared by the third log. A surprising aspect of the temperature logs is the lack of a pronounced anomaly to coincide with the large fracture at 312 m (325 m). A small anomaly at this depth in the first log has virtually disappeared six days later.

The only anomaly that is seen in all three logs is one centred on 111m (115m). This anomaly is clearly decaying with time, although its amplitude, approximately 50 mK in the first log, is approximately ten times less than an anomaly in CR-1 observed the same period of time after the end of drilling (Drury and Jessop, 1981). Attempts to model the URL-1 anomaly as arising from a passive, i.e. non-flowing, crack that has filled with warmed drilling fluid were reasonably successful, considering the difficulty involved in manually extracting such a small anomaly from the normal temperature field. The modelling technique is described by Drury and Jessop (1981). A model of a uniform source strength of 0.1 μK ms^{-1} for the drilling period yields temperature anomalies that vary both spatially and temporally in much the same way as the observed anomaly. Assuming that the density and heat capacity of the rock into which URL-1 is drilled are 2.64 Mgm^{-3} and 950 J kg^{-1} respectively (Jessop et al,1981; Drury and Jessop, 1981), the amount of heat passed into the fracture is calculated to be approximately 7×10^5 Jm^{-2}.

The anomaly centred on 111m (115m) is probably the expression of a fracture that has filled with drilling fluid, but through which there is no regional water flow. The amplitude of the anomaly is much less than similar ones seen in CR-1 and ATK-3 and ATK-4, suggesting that less fluid has entered the URL-1 fracture. This implies a lower permeability for this crack than in the Chalk River or Atikokan cracks. The smaller anomalies seen in the URL-1 logs that decay with time also probably represent minor fractures into which there is relatively very little penetration of drilling fluid.

In summary, the initial temperature logs of URL-1 have not revealed any major thermal disturbance arising from water flow either within the borehole or across fracture planes. A number of small anomalies are present in the first log, but they have all either disappeared or substantially decayed one month later. A fourth geothermal log is planned for August, after the hydro-geological testing. Any effects of such testing on the thermal regime around the borehole should then be detectable.

References

Drury, M.J., 1980. Thermal studies at Pinawa, Manitoba. Geothermal Service of Canada, Internal Report 80-12, 15 pp.

________________ 1981. Temperature measurements in the Atikokan boreholes, 1979-1980. Geothermal Service of Canada, Internal Report 81-5, 10 pp.

______________ and Jessop, A.M., 1981. The effect of a fluid-filled fracture on the temperature profile in a borehole. Geothermal Service of Canada, Internal Report 81-10, 18 pp.

Jessop, A.M., Judge, A.S. and Drury, M.J., 1981. Existing data on specific heat and thermal diffusivity of rocks and minerals. Geothermal Service of Canada, Internal Report 81-11, 14 pp.

Judge, A.S., 1980. Thermal studies at Chalk River - August 1977 to February 1978. Geothermal Service of Canada, Internal Report 80-3, 13 pp.

(Note - Copies of all of the above reports are available from the RADWASTE Data Base, Division of Gravity and Geodynamics, Earth Physics Branch)

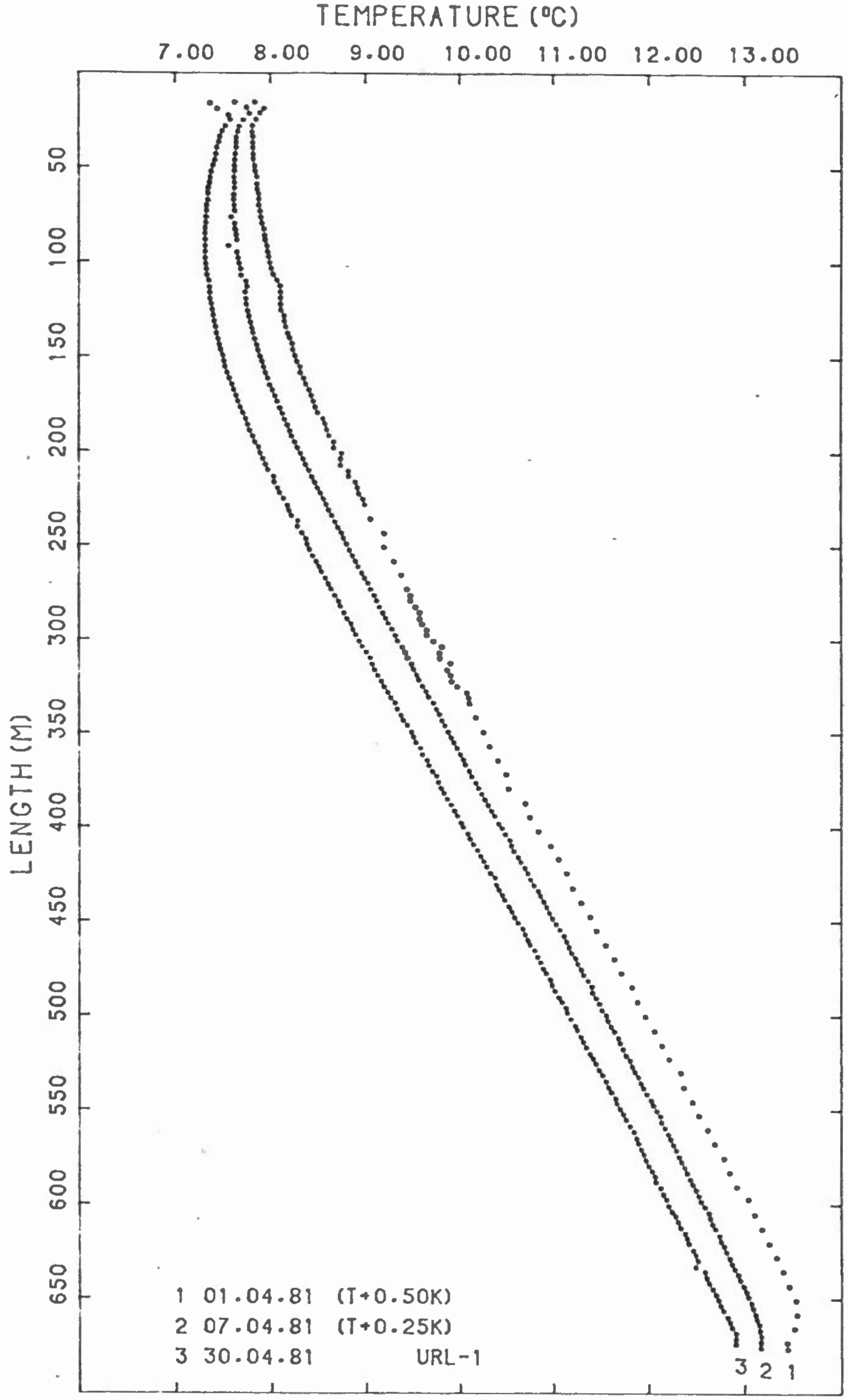

Fig. 1. Temperature logs of URL-1 taken 3, 9 and 32 days after the end of drilling.