An Unusual Borehole Temperature Log From Les Mines Selbaie, Northwestern Québec, Canada

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INTRODUCTION

Temperature and temperature gradient logs are routinely collected as part of the borehole logging program being carried out by the Geological Survey of Canada (Killeen, 1991; Mwenifumbo, 1993). Normally, these logs acquire large scale temperature variations that show temperature lows near surface, and show increasing temperatures with increasing depth, that reflect heat flow from the earth's crust. Broad but low amplitude increases in temperature near surface, in logs from the Canadian Shield, identify surface warming conditions over the 10,000 years since the last ice age. The temperature gradient logs show the effects of this surface warming over distances of a few tens of metres, along with short wavelength events of a few metres. These short wavelength events may indicate water flow in faults.

LES MINES SELBAIE TEMPERATURE LOG

Temperature and temperature gradient logs from a borehole drilled from surface at Les Mines Selbaie in northwestern Québec (Reed, 1997) are presented (Figure 1). These show the common features indicated above on both the temperature and temperature gradient logs. Additionally, however, there are two temperature highs at 270 m (anomaly A) and 333 m (anomaly B) in Selbaie hole B1210. Anomaly A shows a peak temperature of 6.0°C, or 1.7°C above a local background of about 4.3°C. The smaller anomaly B shows a peak temperature of 5.6°C, or 0.8°C above a local background of about 4.8°C. Both anomalies reside on a crustal gradient in the temperature, that is increasing with depth locally at a rate of 0.56°C per 100 m. Anomalies like A and B are unusual.

The source of the temperature anomalies was found when the locations of underground workings were plotted with the hole location. Underground access drifts lie within a few metres of the line of hole B1210. Figure 1 shows the locations of the drifts (a and b) closest to the hole. Drifts a and b are about 3 m and 6 m from the hole respectively. The peaks of the temperature highs coincide with the closest approach of the hole to the drifts. Further, an explanation of the widths and peak amplitudes of the anomalies may be found in the time of the opening of the drifts with the time of the logging of the hole.

Hole B1210 was logged on July 11, 1991. Drift a was opened on May 6, 1989 and drift b was opened on March 1, 1991. The temperature of anomaly A has had two years and two months to develop, while the temperature of anomaly B has had only three months and one week to develop by the time of the borehole survey. The longer resident drift a has had much longer to heat up the surrounding rock than drift b.

The air temperature in the drifts is warmer than the rocks. At Les Mines Selbaie air is constantly being pumped underground from surface. In winter this air is heated to 5°C, while in summer, the warmer ambient surface air is pumped underground. While the effects of cooling of the air by the cooler rocks underground are not known, it may be assumed that the underground air is at least at 5°C. A source of additional heat underground is the mining equipment operating in these drifts. The peak temperature of 6°C of anomaly A may be near the average air temperature in drift a. Drift b has not been resident long enough for the temperature in the hole to rise to the average air temperature in the drift.

It might be expected that the temperature in the rocks increases in time along a cylindrical front away from the drift. The drifts here might be assumed to be a tube shape. These cylinders, indicated in section as circles around drifts a and b, and tied to their respective anomalies (Figure 1), fit the anomalies reasonably well, although it seems clear that anomalies A and B are close enough to overlap each other, and cause a misfit of the anomalies along their proximal edges. Anomaly A is broader than anomaly B because of the longer resident time of drift a, and the consequent movement of heat further into the surrounding rocks.

A straight line background has been drawn representing the through going continuity of the crustal gradient ("1" in Figure 1). (Careful observation of the gradient above and below the anomalies in the hole shows however that there has been a step up in to depth, in temperature

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of the crustal background at the anomalies. The slope of the gradient has remained unchanged however. The source of this step is unknown.) There is a suggestion of a broad increase in temperature of about 0.2°C at the anomalies. This underlying anomaly is identified as element 2 on Figure 1. This broad anomaly may arise from underground workings further away from the hole, which are accessed by drifts a and b.

CONCLUSIONS

Two temperature high anomalies have been shown to be caused by underground drifts near to a drill hole in which the temperature measurements were taken. The temperature in the rocks within a few metres of the openings increases in time as the heat disperses away from the warmer underground openings.

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REFERENCES

Killeen, P.G., 1991, Borehole geophysics: taking geophysics into the third dimension, GEOS 1991/2.

Mwenifumbo, C.J., 1993, Temperature logging in mineral exploration, Journal of Applied Geophysics, 30, p. 297-313.

Reed, L.E., 1997, Les Mines Selbaie—25 years of discovery and definition of a polymetallic base metal sulphide ore body, Exploration '97, Fourth Decennial Conference on Mineral Exploration, Toronto, (this volume).

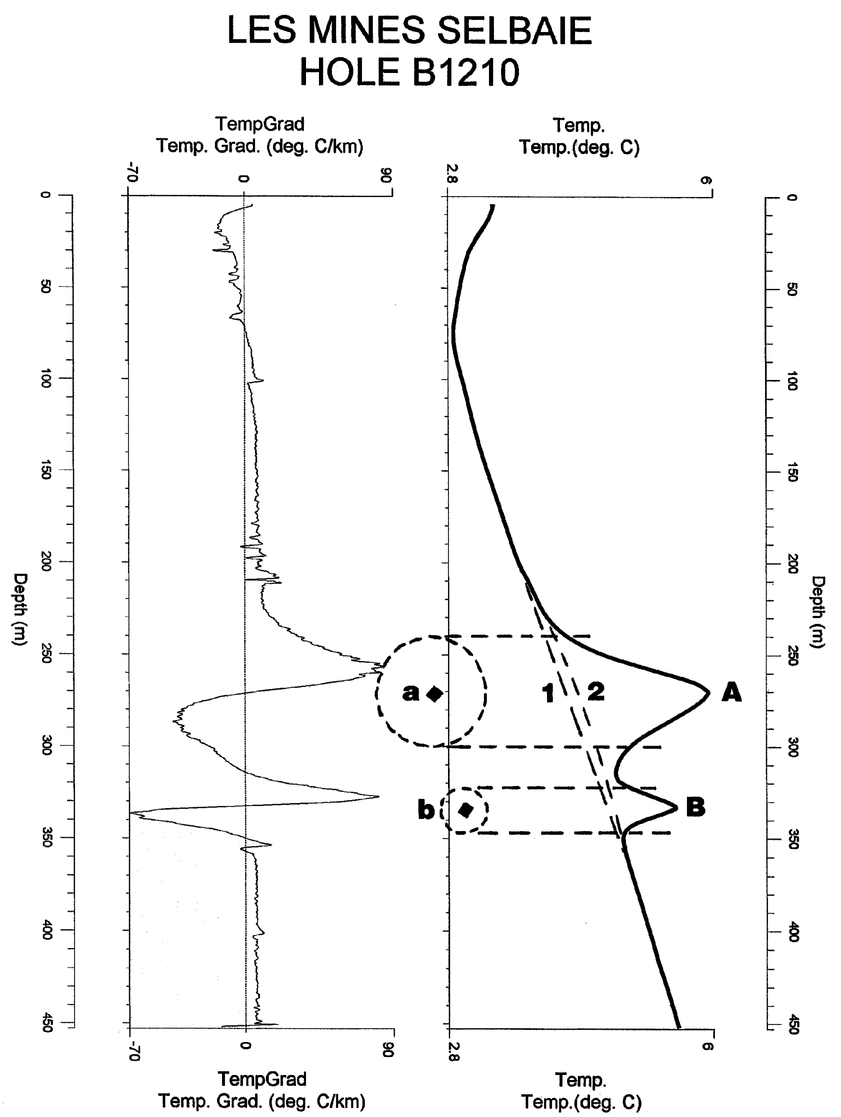

Figure 1: *Logview temperature and temperature gradient profiles for hole B1210. Anomalies A and B associate with underground drifts a and b. Circle represent the anomalous temperature migration fronts as they advance into the rock surrounding the drifts. "1" is the background crustal temperature gra dient seen by the temperature response. "2" is a small departure from the background interpolated from the upper and lower edges of anomalies A and B (Logview is software developed by the GSC, Open File 3055).*