Temperature measurements during the 6000 m logging campaign in the KTB-Oberpfalz HB

G. Zoth

During the 6000 m logging campaign six temperature logs were run at irregular time intervals taking into account recommendations of the task group on geothermics. First measurements started when temperature readings were taken at the depth of 2400 m, well above the neutral or cross over point between warming and cooling, which has been estimated to be at about 2875 m depth. Logging speed was 15 m per minute down to the bottom of the well. The thermal load due to drilling operations is given in table 1:

Table 1:

circulation	interval:	51 hours	(drilling)
round trip	interval:	21 hours	
circulation	interval:	19 hours	(reaming and circulating off bottom)
circulation	interval:	2 hours	(drilling)
roundtrip	interval:	46 hours	
circulation	interval:	2 hours	(coring)
roundtrip	interval:	19 hours	
circulation	interval:	41 hours	(circulating without drilling, Z = 6018 m)
round trip	interval:	10 hours	

In fig. 1 all six temperature logs are presented as well as bit size, maximum and minimum caliper and gamma ray (left column). The curve drawn from 0 m to 4000 m shows the temperature measured 19 months after circulation stop in the KTB pilot borehole, which is situated 200 m to the west of the KTB superdeep borehole, briefly called the "Hauptbohrung". This temperature curve represents almost the equilibrium formation temperature. The dots at 760 m, 1720 m, 3000 m and 4500 m correspond to the temperatures extrapolated from bottom hole measurements during the previous logging campaigns in the Hauptbohrung.

The first of the six temperature runs, as indicated in Table 2, was made already 14 hours after circulation stop. Obviously, the last circulation block without drilling caused a stronger cooling than expected.

Author's address:
Niedersächsisches Landesamt für Bodenforschung, KTB-Projekt, P.O. Box 510153, 30631 Hannover, Germany

Table 2:

date	time	time since end of the circulation	temperature (°C)
15.03.	14:10	14 h 10′	113.5
15.03.	11:50	59 h 50′	141.5
16.03.	11:31	83 h 31′	148
18.03.	04:18	124 h 18′	153.5
19.03.	13:00	157 h	159
20.03.	20:38	188 h 30′	162

Using a numerical simulation model (Kessels, 1987, unpublished)) the temperature readings given in table 2 yield a value of 172 ± 2 °C for the equilibrium temperature. This value agrees well with the result obtained by applying the Horner Plot technique (Dowdle & Cobb, 1975).

Alltogether there are now five reliable bottom hole temperature values available for the Hauptbohrung. Out of these BHT-values temperature gradients have been calculated starting with an average annual surface temperature T_o = (7.7 ± 0.5) °C at the location. Results are summarized in Table 3.

Table 3:

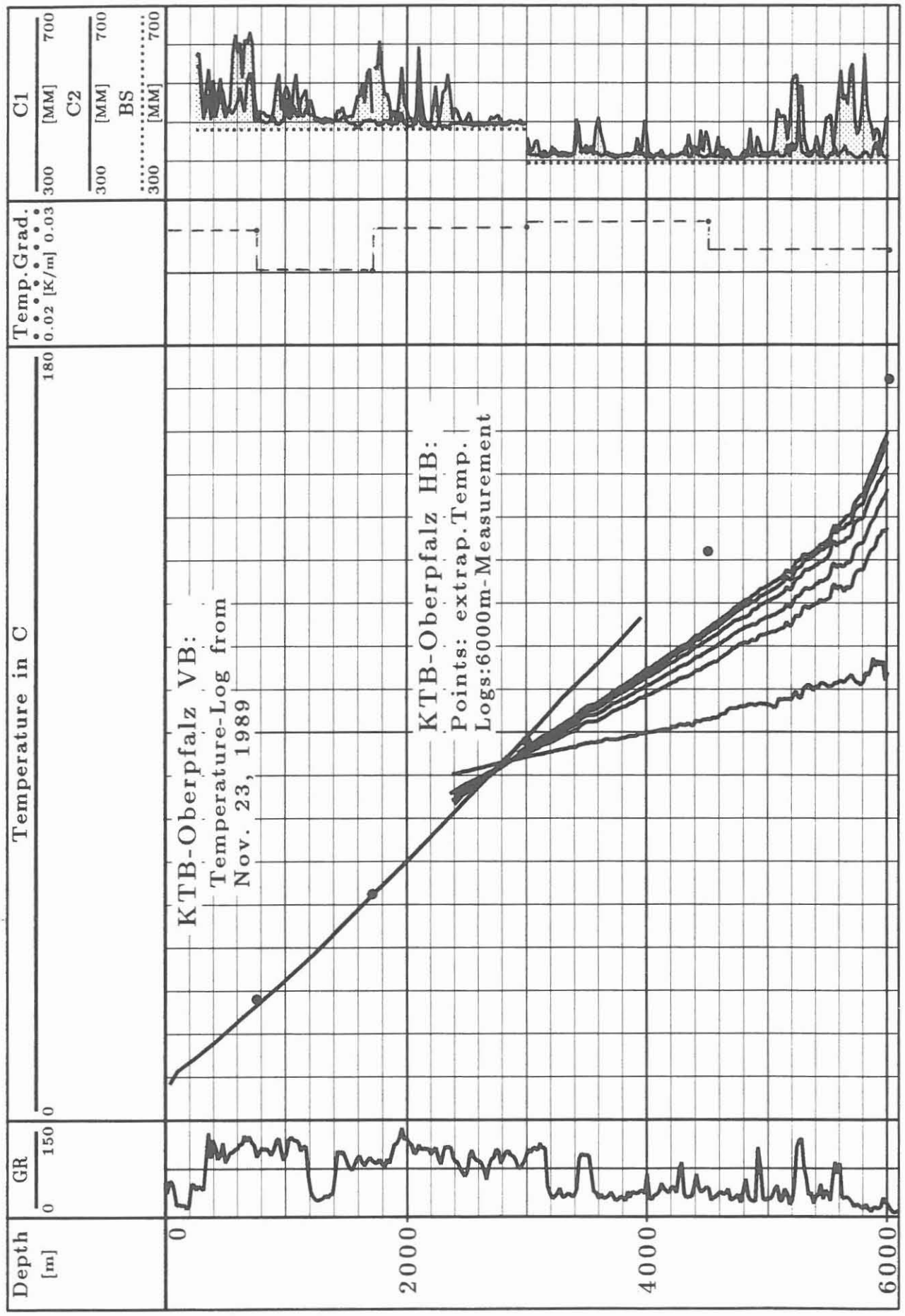
depth (m)	temperature T (°C)	temperature gradient Γ (Km^{-1})			
0	7,7				
		> 0.0279			
762	29 ± 0,5				
		> 0.0251			
1720	53 ± 1		0.0263		
		> 0.0281			
3003	89 ± 1			0.0271	
		> 0.0285			
4512	132 ± 1				0.0276
		> 0.0265			
6024	172 ± 2				0.0273

Apparently, the temperature gradient tends to decrease slightly below 4512 m. It is reminded, however, that the depth intervals are very large and further temperature measurements beyond 6024 m have to be made in order to confirm this observation.

Reference:

DOWDLE, W.L. & COBB, W.M. (1975): Static formation temperature from well logs - An empirical method. - J. of Petr. Techn., 27: 1326-1330.

Fig. 1



5-MAR-1993 12:46 / ZOTH