EEIG
Route de Kutzenhausen
F-67250 Soultz

Stimulation Test 03May27

GPK3

Correction of Downhole Pressure

Calculation with HEX-B

Technical Note
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Ref. TN17.2/TM

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1. Measured data – Calculated data (HEX-B)

For the stimulation test 03may28 at GPK3 the downhole pressure has been recalculated with HEX-B. The calculated pressures for the first 312'500 s at 4544 m depth show significant deviations from the measured values (Figure 2). Therefore a corrected pressure data set (Figure 7) has been worked out based on the calculated values. An additional data set solely for the depth of 4544 m is given in Figure 8.

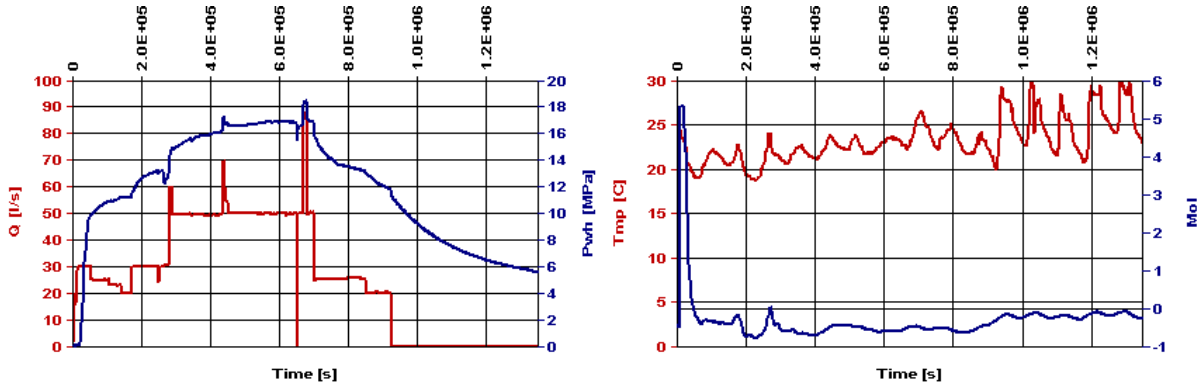


Figure 1: *Injection values for flow rate, wellhead pressure, fluid temperature and the smoothed NaCl-molality derived from the measured density during the stimulation test 03may27 at GPK3, used as input values for the calculations with HEX-B.*

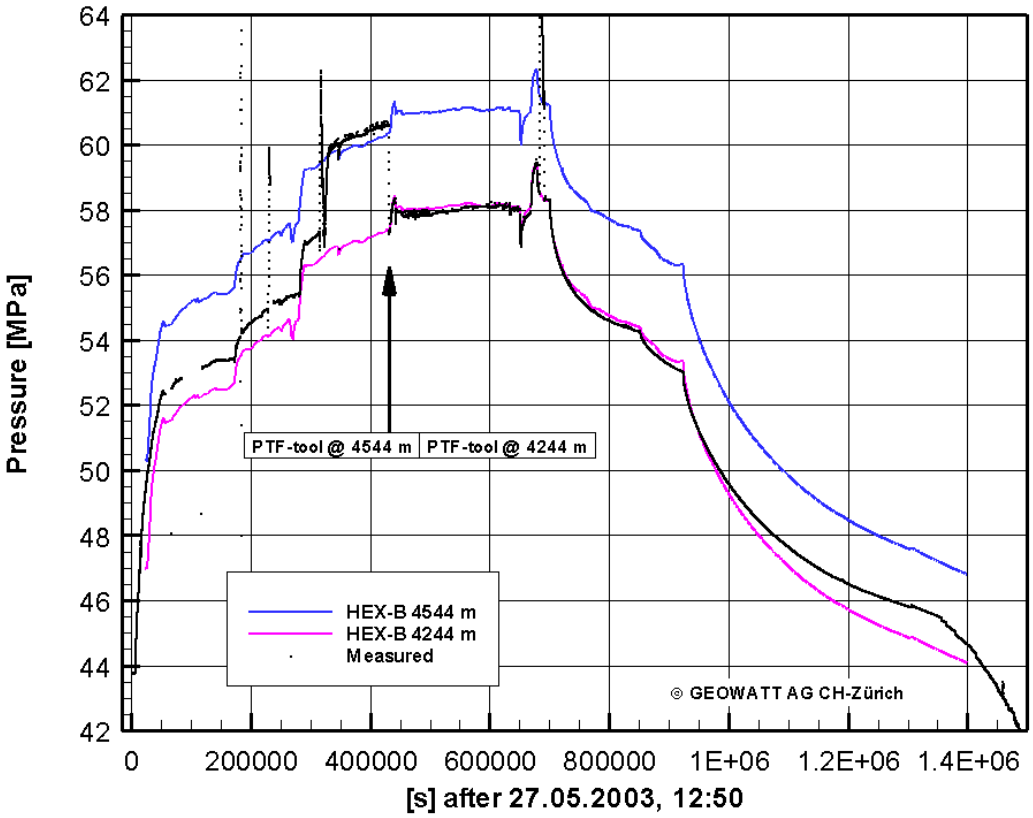


Figure 2: *Measured and calculated (HEX-B) pressure at depth of 4544 m and 4244 m in GPK3 during the injection test 03may27*

2. Data correction

2.1. Overview

The following time periods have been considered:

Period [s]		*Comments*	*Data Correction*
Start	*End*		
0	5'046	No injection	Calculation of the initial pressure
5'046	19'086	1. Phase of injection with no increase of the wellhead pressure. During this period the water level in the borehole was below the wellhead, HEX-B cannot treat this situation so far.	None
19'086	**312'499**	The measured values are up to 2 MPa below the calculated values. It can be assumed that the tool had an offset.	Pressure-dependent
312'499	327'859	The measured values start to increase to the calculated values without any change of the injection rate.	Dropped
327'859	1'350'000	The values seem to be correct, with exception of the period between 680'000 and 691'000 which will be dropped.	None

2.2. Initial pressure calculation

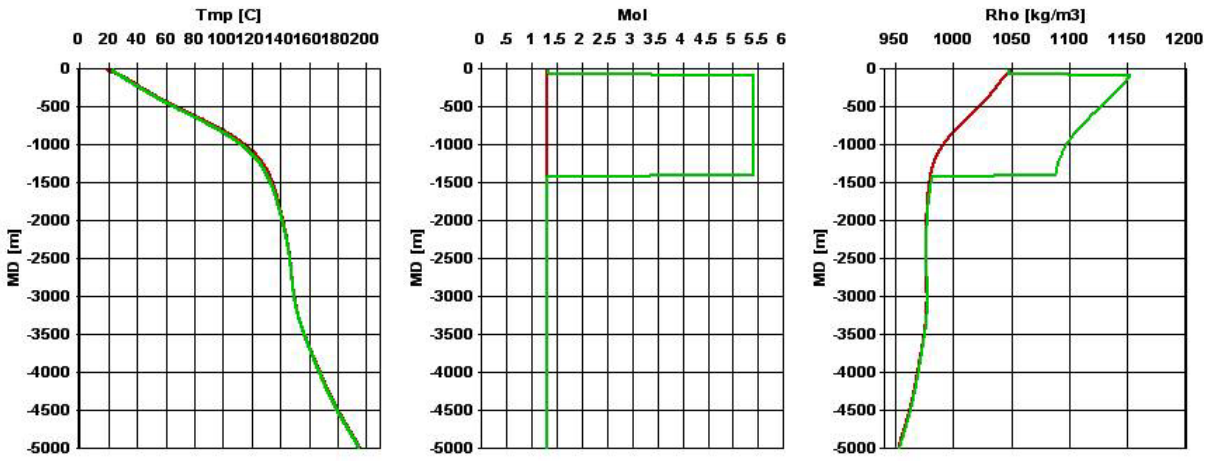
The aim is to calculate the initial pressure at 4544 m depth immediately before the stimulation test started and to compare this value with the measured pressure. The initial density of the fluid in the borehole has been determined as 1050 kg/m^3 under surface conditions (T = 20°C, p_{amb} = 0.1 MPa). Before the stimulation test 03may27 started the well has been killed with brine of density 1160 kg/m^3. The water-level in the well was –100 m below surface. In the following the density values are expressed as NaCl-molalities.

Two situations have been considered here:

A. The brine pushed down the initial fluid in the well and remained at its position

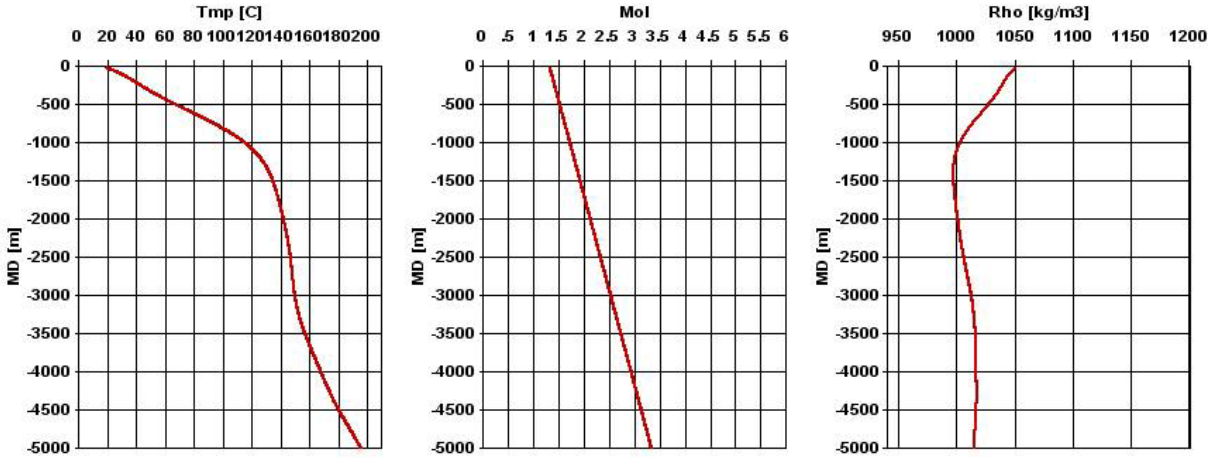
B. The injected brine had mixed with the initial fluid and a linear density gradient was present in the well before the test started.

A. Injected brine remained at its position in the well (green line)



The pressure at 4544 m was calculated as **43.65 MPa**.

B. Injected brine is mixed with the fluid in the well



The pressure at 4544 m was calculated as **43.45 MPa**.

The difference in the downhole pressure at 4544 m depth between the two considered states of the injected brine in the well is only minor. The measured pressure value seems to be correct.

2.3. Correction 19’086-312’499 s

The correction for this period have been made in three steps:

1. Dropping of the failures and the values during the move of the tool (Figure 3)

2. Development of a pressure-dependent function for the correction (Figure 4)
   Function: $dp(p) = -109.366 + 4.040*p - 0.03657*p^2$

3. Correction of the measured values with the function dp(p) (Figure 5)

An alternative way to correct the values would be a shift by the average dp calculated from 50’000 s – 312’499 s (see Figure 4, left) = +2.13 MPa. The deviation between these two types of correction is minor except for the period before 50’000 s (Figure 6).

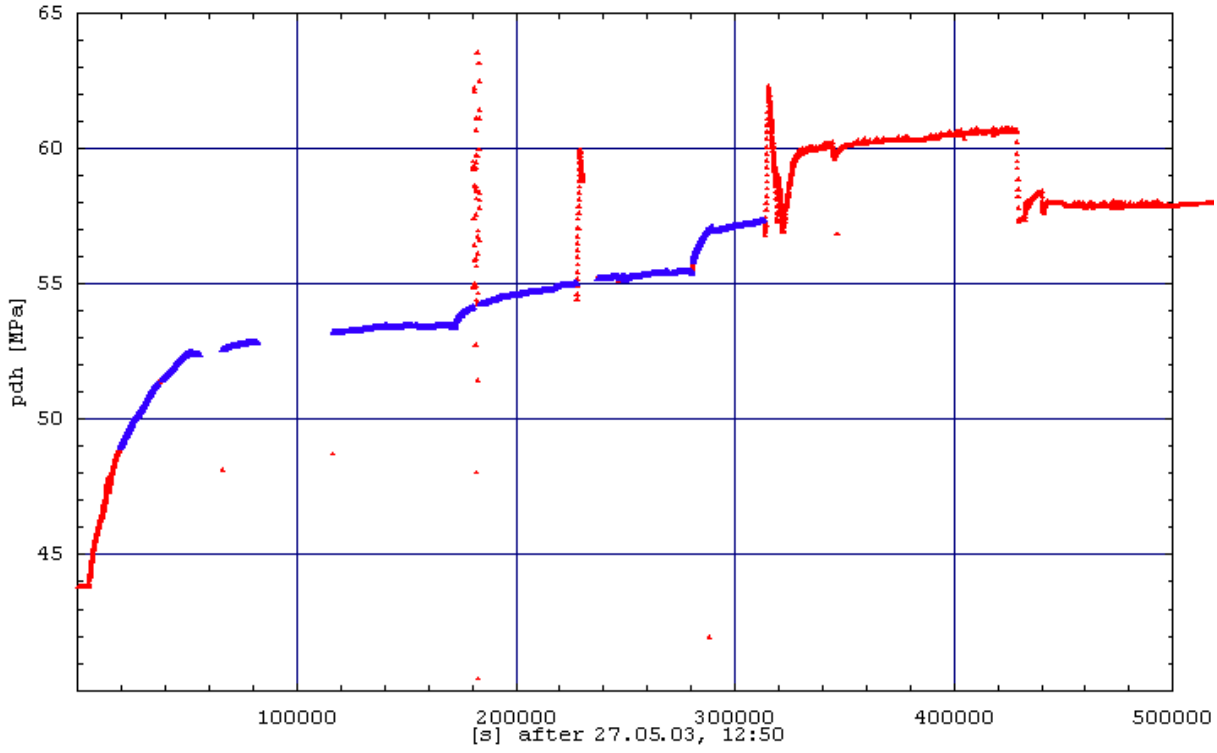


Figure 3: Red: Measured data; Blue: Filtered data used for the correction

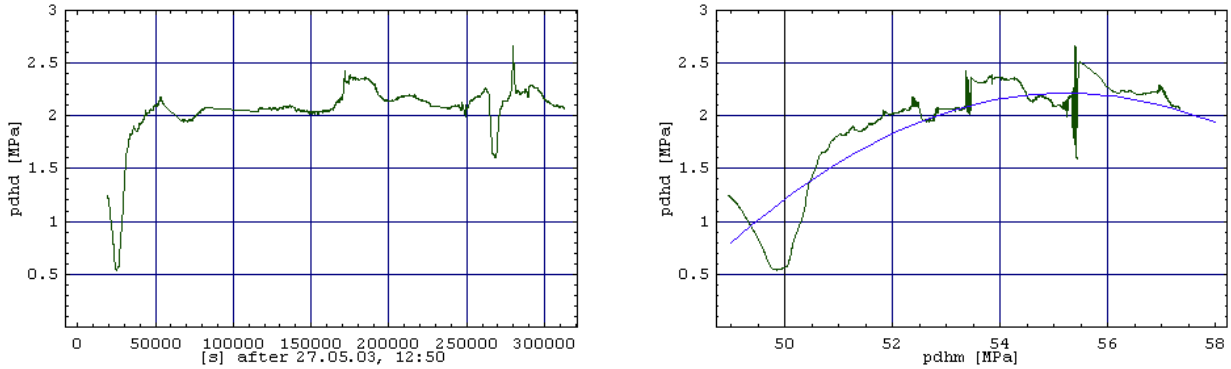


Figure 4: *Left: Difference between the calculated and the filtered measured values; Right: Difference as a function of the pressure, blue the fitting function*

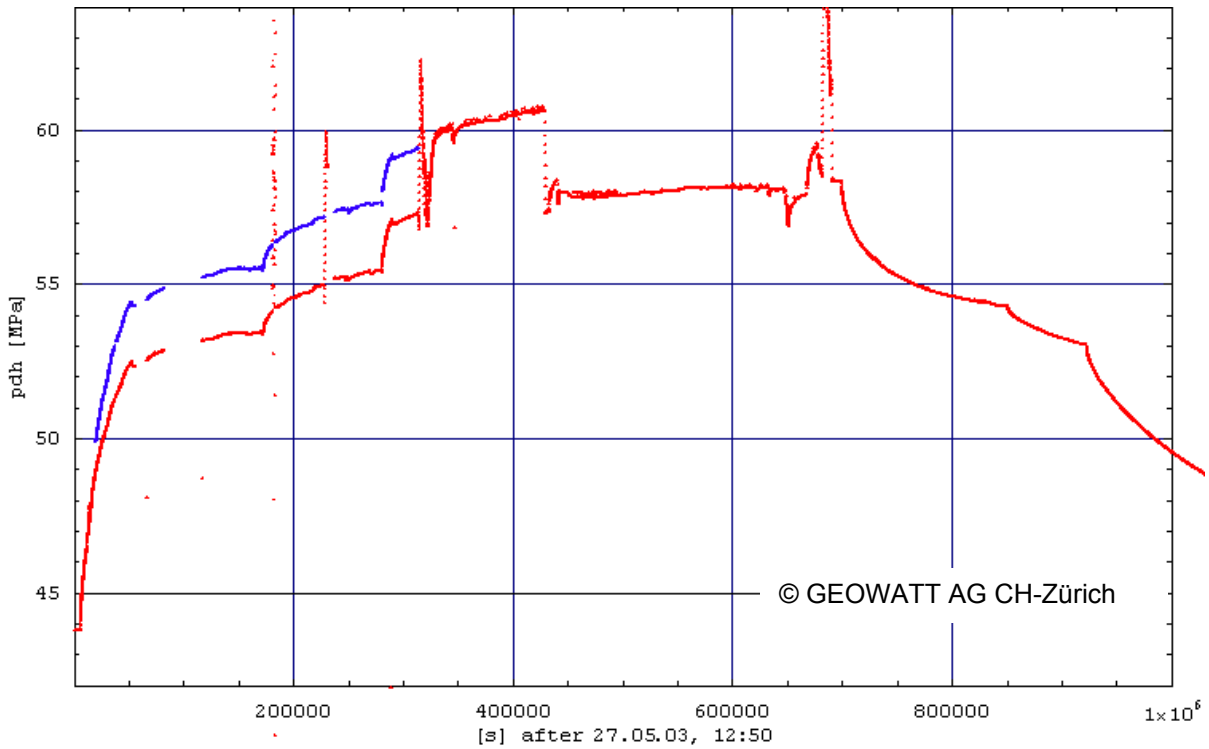


Figure 5: *Red: Measured values; Blue: Corrected values*

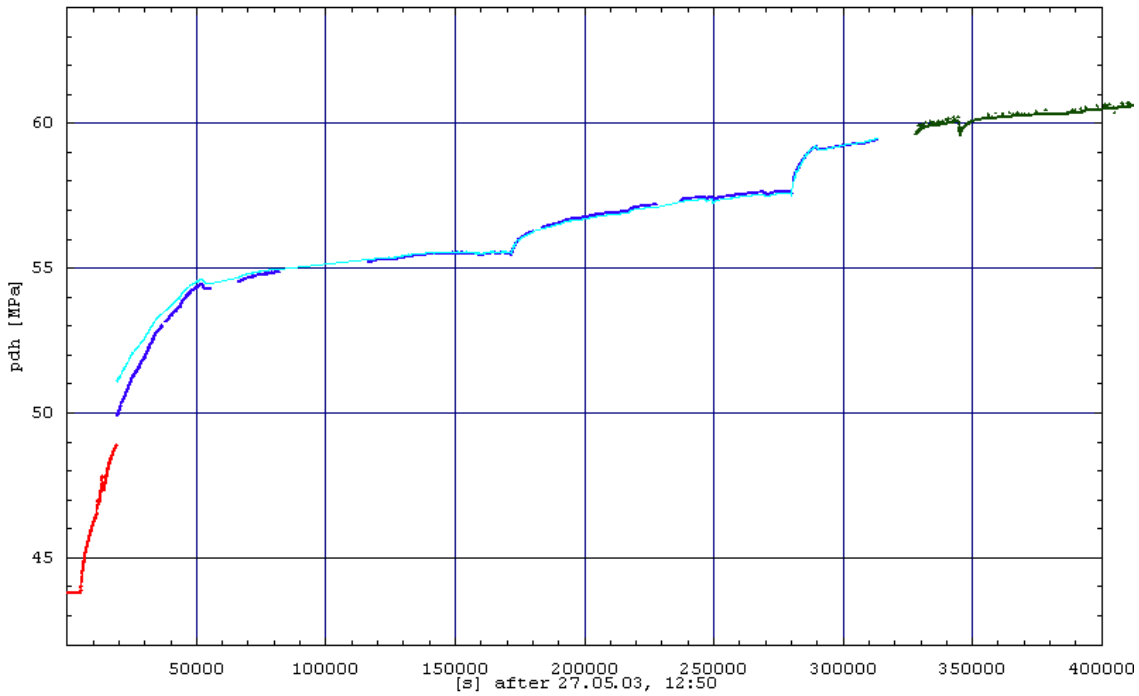


Figure 6: *Comparison between pressure-dependent and constant correction*
Red: Initial values (uncorrected);
Blue: pressure-dependent corrected;
Cyan: constant corrected with +2.13 MPa
Green: uncorrected

2.4. Corrected data set

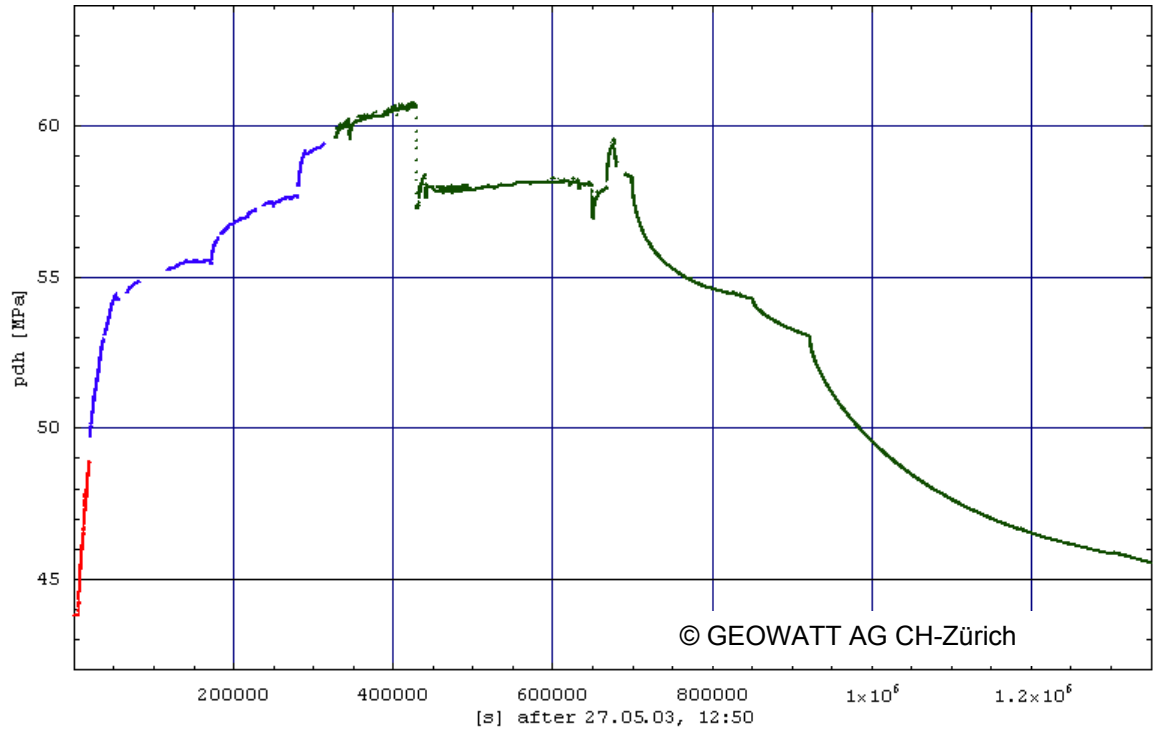


Figure 7: *Complete data set for the downhole pressure in GPK3 at 4544 m and 4244 m during test 03may27; Red: Initial values (uncorrected); Blue: Corrected values; Green: uncorrected (680'000-691'000 s dropped)*

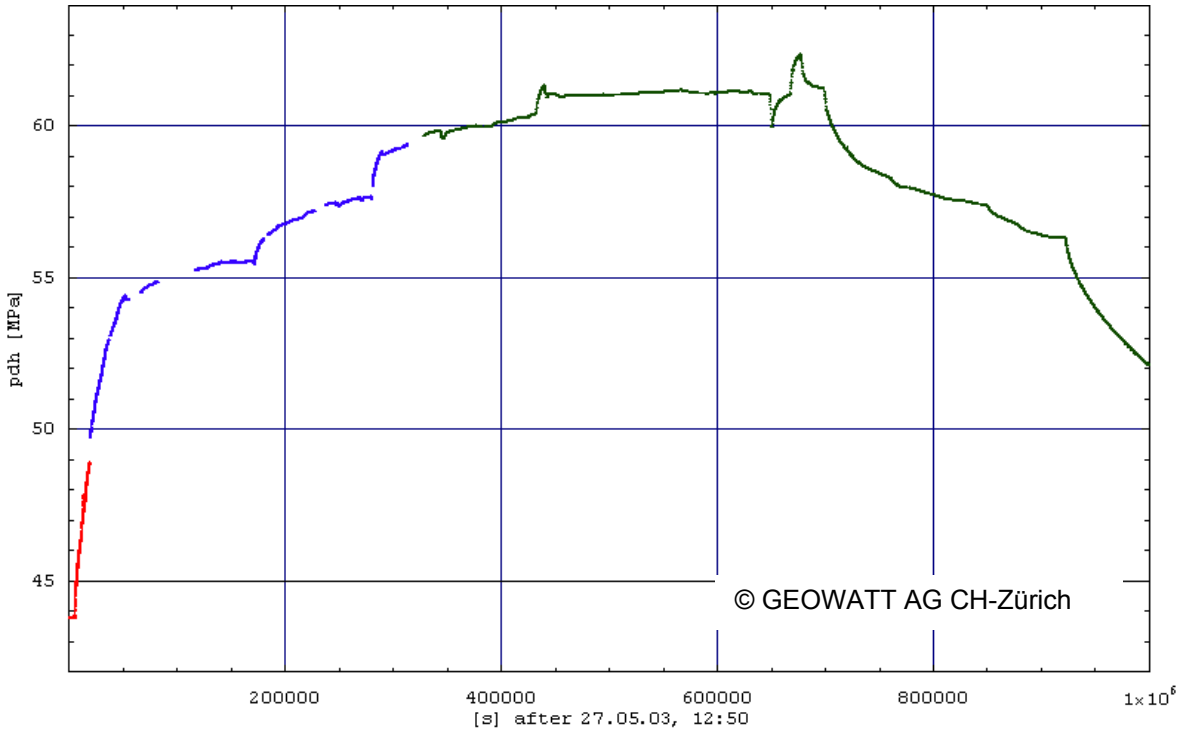


Figure 8: *Complete data set for the downhole pressure in GPK3 at 4544 m during test 03may27; Red: Initial values (uncorrected); Blue: Corrected values; Green: calculated with HEX-B*

2.5. Comments

Summarised comments to Figure 7:

1. The measured initial pressure value seems to be correct.

2. The first part of the curve (red) has not been corrected since the wellhead pressure was below surface and therefore calculations with HEX-B are not possible so far.

3. The second part (blue) has been corrected with a pressure-dependent correction. Since the initial value seems to be correct, this pressure dependency of the deviations is reasonable.

4. The third part (green) was left unchanged since the values measured at 4244 m depth fit with the calculations. The data between 680'000 s and 691'000 s have been dropped.

Summarised comments to Figure 8:

1. The first and the second part of the curve are identical with Figure 7.

2. The third part (green) corresponds to the HEX-B calculations until 10^6 s. After 10^6 s the calculated pressure at the depth 4244 m drops faster than the measured values. For this shut-in period the calculated temperature is at maximum 6 K below the measured values. This should lead to a calculated pressure around 0.25 MPa over the measured values. Since a contrary effect can be observed this pressure deviation can not be explained and the data set for the depth of 4544 m is clipped at 10^6 s.

2.6. Files

Two files are available:

1. GPK3_Pdh_corr_geowatt.dat: Data corresponding to Figure 7

2. GPK3_Pdh_corr4544_geowatt.dat: Data corresponding to Figure 8