

**Temperature and pressure profiles in
Bouillante Wells 4, 5, 6 and 7**

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INTRODUCTION

The geothermal field at Bouillante is located in the town of Bouillante on the western coast on Basse Terra, Guadeloupe. In the 1970's four geothermal wells were drilled in the field by EURAFREP, but only well BO-2 turned out to be economically productive, yielding 8-10 kg/s of high pressure steam (at 6 bar-a). Geothermal development at Bouillante culminated with the construction of a 4.7 MW_e double-flash condensing power plant, which came on line in May 1987 with well BO-2 supplying the steam for the plant. Géothermie Bouillante SA. operates the power plant and the geothermal field. In 1998 well BO-4 was stimulated and is now considered economically productive. As a result of that and due to limited access to land for locating boreholes, new wells BO-5, BO-6 and BO-7 were directionally drilled from the BO-4 platform during the period from December 2000 to May 2001. The three new wells were flow tested in 2001. Two of them, wells BO-5 and 6 turned out to be very good producers yielding 14,6 and 18.5 kg/s, respectively, of high pressure steam. Well BO-7 was on the other hand non productive.

Based on the successful drilling of wells BO-5 and 6, Géothermie Bouillante SA. decided in 2001 to increase the power production by constructing a new 11 MW_e power unit in addition to the existing 4.7 MW_e plant. The construction work for Bouillante 2 is underway and the plant is expected to be on line before the end of year 2003.

Compagnie Francaise pour le developement de Geothermie (CFG) has been responsible for the scientific work for the drilling and utilization of the new wells. It has subcontracted Orkustofnun GeoScience Division (ROS) to give consultancy on relevant reservoir engineering topics and assist in carrying out measurements on both the new and the older wells.

This report describes the activity that the representative Benedikt Steingrímsson participated in during his stay in Guadeloupe in April 2003. The first phase in the work plan was to measure static temperature and pressure in wells BO-2, BO-4, BO-6 and BO-7. These wells were last logged in middle of March 2002 and BO-4, 6 and 7 have been shut in since then and BO-2 since early summer 2002. The objective of the measurements now was to evaluate temperature changes and pressure drawdown during the last year. The logging in wells BO-4, 6 and 7 was carried out on April 15th -17th but well BO-2 was unfortunately not accessible for logging at the time due to construction work of the new power plant next to the wellhead of BO-2 with traffic of trucks and cranes moving heavy items to the plant site.

The second phase of the work plan was to measure pressure recovery after production in well BO-5. This well has been under production for some 8 months (since June/July 2002) and has supplied steam to Bouillante 1. The plan was to close the well on April 22nd and monitor the pressure recovery for two days. The operation of well BO-5 was interrupted few days before the mission due to problems in the automatic controls of the power plant and again on April 14th, the first day of the mission. The operation of the power plant continued to be unstable and production from BO-5 had to be stopped for few hours almost every day. Finally on Saturday morning April 19th, very high water levels were observed in the main separator and the demister. The plant had to shut down for an extended period to overhaul and investigate the steam separator and steam/water pipes to the power plant. Due to these operational problems the pressure recovery measurements in well BO-5 could not be carried out as planned. When this became clear it was decided to measure

instead temperature and pressure profiles in BO-5 few days after closure to evaluate the pressure draw down. This was done on April 22nd and 23rd, 3 and 4 days after closing of the well.

The data for the temperature and pressure profiles of wells BO-4, 5, 6 and 7 is reported, some discussion provided and comparison made to older data, especially the logs in March 2002, for each of the wells. The author thanks the help and support he received from Mr. Bernard Herbrich in performing the measurements and the pleasant company of him, Mr. Herlander Correia, Gerard Gauthier ("le president") and other CFG staff members during these warm April days in Bouillante.

MAIN ACTIVITY IN APRIL 2003

April 13th: Traveled from Iceland to Paris, France and continued to Guadeloupe. Arrived at Point-a-Pietre at around 20:00 local time about one and half hour delayed. Bernard, who was traveling on an earlier flight, was supposed to pick me up when I landed. It turned out that his flight was delayed by some 5 hours and landed more than one hour after my flight. We then took a rental car and drove to Bouillante. Arrived at the hotel at 23:00 after nearly 22 hours of travel.

April 14th: Woke up at 7 and was picked up by Bernard at 8:30. We went directly to the power plant and Bernard showed me the Kuster gauges all very neatly packed after the logging in March 2002. We then went to the BO-4 site and checked the logging unit and the wellheads of wells BO-4, 5 6 and 7. We had the logging unit moved to a convenient location on the platform for the logging of wells 6 and 4, which we hoped to start logging later in the day. The Kuster gauges were assembled (the same elements as used in March 2002) and made ready for the logging. The transformer for the chart reader was dead and could not be repaired. Instead we used a 12 Volt car battery to light up the bulb of the reader. We then went back to the logging site and fixed the wire line connection for the gauges. We started the unit to make sure the engine ran smoothly which it did within few minutes. At that time it was clear that wells 4 and 6 would not be ready for logging until the next morning as the wellheads were being pressure tested. We considered logging BO-7 but a missing top plate stopped us. When BO-7 was logged in March 2002 the top plate of well BO-6 was transferred to the wellhead of BO-7. So it was clear that the logging of BO-7 had to wait until the pressure testing of the wellheads had been completed.

April 15th: The pressure testing was completed at around 11 and we started the logging immediately and completed the temperature and pressure surveys in well BO-4 in the afternoon. The wellhead pressure was 2.8 bar and we logged at 100 m intervals down to 1100 m, as it is not considered safe to go deeper into the well. The logging went fine and all the instruments functioned perfectly.

April 16th: We started early and completed logging well BO-6 shortly after lunch. The wellhead pressure was about 3.6 bar. Bottom was found at 1226 m (was 1228 meters in March 2002). We planned to start the logging of well BO-7 in the afternoon but the forklift was not available to move the top plate from BO-6 to BO-7.

April 17th: We had the forklift at 7 in the morning. After moving the top plate to BO-7 the logging was completed in 4 hours. The wellhead pressure on BO-7 is zero and the bottom was found at 1095 m, which is the same depth as in March 2002. We then looked at the possibilities of logging well BO-2. The well is next to the new power plant and at present there is a hectic activity of cranes and trucks moving equipments for the new power plant. It was therefore not considered possible to carry out the logging. Spent the afternoon in reading the chart of the logs in BO-4, 6 and 7.

April 18th: We were at the power plant by seven to get the forklift to return the top plate to BO-6. It turned out that the forklift had a flat tire. Worked through the day on the well data, plots and started to write this report. Bernard was able to move the top plate back to BO-6.

April 19th: Started the day on the BO-4 platform. Hooked together a simple water level gauge to measure the water level in BO-7. This was easier than thought as the water level was only at 1.5 m depth measured from the top flange (about 80 cm below the edge of the cellar). WHP of BO-6 was 3.7 bar (range of meter 40 bar) and of BO-4 2.8 bar (range 6 bars). The operation of the power plant was stopped at around 10 o'clock due to high water levels in the separator and the demister.

Worked on report. After lunch Herlander took me to La Soufriere and then completed the southern roundtrip of Basse Terre.

April 20th: Easter Sunday. Took the day off and went to Grande Terre with Herlander and Bernard. Heard during the day that the water line from the separator had been opened at the control valves before the LP-separator and that iron pieces and scaling were blocking the pipe.

April 21st: Herlander picked me up and took me to the power plant. We started to look at the deposits and the metal pieces from the water line. The metal seemed to be corroded Chevron sheets from the main separator. Spoke with Sverrir Þórhallsson at Orkustofnun and Kristinn Ingason of VGK. Went to the BO-4 site in the afternoon measure wellhead pressures on BO-4, 5 and 6 and the water level in BO-7. Prepared the wellhead of BO-5 for logging the next day. The WKM-master valve had obviously not been operated for a long time and it took Bernard and me a long time and a lot of sweat to close it.

April 22nd: Began the day with report work while a blind plate was put in the two phase pipe line from BO-5. This was because of security reason as the pipeline was now open down at the power plant. After that a temperature log was run in well BO-5. Bottom was found at 1194 m, which is one meter short of what was measured last year. When pulling out the gauge seemed to scrape against some minor obstruction between 500 and 600 m depth. Decided to run the pressure log the next day. That would be 4 days after closing of the well. Read the chart, tabled and plotted the temperature data. Met Timothy (Tim) Dunford from Power Engineers.

April 23rd: Bernard had to go early in the morning to Pointe-a-Pietre. Worked on the report and when Bernard was back we did the pressure logging in well BO-5. This time the gauge ran smoothly up the well and nothing was found between 500 and 600 m depth. Read the chart, and tabled and plotted the data. It was interesting to see that the pressure had recovered fully during the 4 days elapsed since the closing of the well.

April 24th: Herlander picked me up at 8 o'clock. Looked at the demister that had been opened. Tim and Herlander were happy over what they saw. No corrosion and no scaling problems in the demister. Went to the pumping station. They are now deepening the pit to 5.5 m. The water level was kept high in the pit. Very little geothermal activity was seen in the pit, only minor gas bobbling. Outside the steel walls some activity was observed. Bernard came at 11:30. The plan was to copy the draft of this report on Herlander computer but, unfortunately, Herlander was not in his office and as we had not his password we could not copy the file. I checked out of the hotel and Bernard brought me to the airport where we met the Kinley operator (Billy something) who will run the caliper survey in BO-5. The Air France left for Paris at 5 o'clock.

April 25th: Arrived in Paris early in the morning and continued to Iceland in the afternoon.

WELL BO-4

Well BO-4 was drilled in the 1970's in two stages to a total depth of 2505 m. The well was completed with a 9 5/8" casing to 558 m depth, a slotted 7" liner from 541 m to 1199 m and 4 1/2" slotted liner from 1184 m to 2504 m. The main circulation losses during drilling were attributed to the interval 560 m to 1050 m. Discharge testing performed between July 1978 and June 1979 yielded about 60 t/hr (16.7 kg/s) total flow rate at about 4 bar-g wellhead pressure and with about 17% steam fraction at that pressure. Due to this poor performance the well was not considered economical for utilization at that time. The well was stimulated in 1998. A short discharge test in 1999 confirmed the success of the stimulation as a total flow rate of over 130 t/hr (36 kg/s) was obtained at 14 bar-g wellhead pressure. Furthermore, caliper logging of the well showed that the well was clean and free from obstruction down to 1100 m depth and that obstacles encountered before the stimulation job had completely vanished. Basically no scaling was found in the casing. A long-term discharge test was performed from January to May in the year 2000, but at a relatively small rate around 22.5 t/hr (6.2 kg/s). This test supported earlier findings. Well BO-4 has been closed since May 2000.

Well BO-4 was logged on April 15th. Wellhead pressure was 2.8 bar-g and measurements were made at 100 m interval down to 1100 m depth, as it is not considered safe to go deeper. The temperature and pressure data are printed in the appendix and plotted in blue color on figures 1

and 2 along with some older profiles. The measured values now are very similar to the ones measured in March 2002, as can be seen on the figures where the profiles from 2002 are plotted in red color. The older profiles on figure 1 show higher temperatures especially in the upper cased part of the well. At the production depth the last to profiles are similar to the one from 1996, but no indication of temperature inversion is observed as in the 1996 profile. The temperature gauge used now is the same as the one used in 2002. The temperature values for these two profiles are compared in the appendix. At 100 m the temperature now was 2°C lower than in 2002 indicating that the gauge was not fully stabilized during the 10 minutes waiting time at that depth. The temperature differences of other measuring points are of the order of +/- 1°C, which is well within the accuracy of the gauge. It is therefore the conclusion of the log that the temperature around well BO-4 has not changed during the last year. The log now confirms a reservoir temperature of 246 °C around well BO-4.

The pressure profiles in BO-4 are shown on figure 2, the one of April 15th in blue and the one from 2002 in red. It is clear from the figure that the pressure has decreased slightly during the last year. The same pressure gauge was used in both runs and a direct comparison of the pressure logs show that the pressure drawdown in BO-4 from March 2002 to April 2003 is about 1 bar (see appendix).

WELL BO-5

Well BO-5 was drilled in two stages. It is directionally drilled with kick off point (KOP) at 225 m and with an inclination buildup to about 32° in the direction of N45°E. In the first stage the well was drilled to 610 m (MD) in January 2001. The well was deepened to 1198 m (MD) in May 2001. All depth numbers refer to measured depth unless other is indicated. The well is cased with 9 5/8" casing to 500 m and completed with 7" perforated liner from about 460 m to bottom (1197 m). Not all of the pipes in the liner are perforated. A short discharge test was carried out in June 2001, after that the well was kept closed until July 2002, when it was connected to the power plant.

It was planned to shut-in well BO-5 on April 22nd to monitor the pressure recovery in the well. However, the operation of the power plant was unstable the last week prior to shut-in and the production from well BO-5 was stopped almost every day for few hours until Saturday April 19th when it was stopped for indefinite time. Due to these disturbances and the premature closing of the well, the planned recovery monitoring could not be carried out. Instead it was decided to let the well stand closed and measure a temperature profile and a pressure profile few days after closing of the well. This would indicate the pressure drawdown in the reservoir close to the well and possible temperature changes. The temperature survey was carried out on April 22 and the pressure survey a day later.

Figures 3 and 4 show several temperature and pressure profiles in well BO-5. The profiles now are shown in blue but the ones from March 2002 in red. The same gauges were used in these last two surveys. The measuring values of April 2003 are shown in a table in the appendix and in another table a comparison is made between the measurements in March 2002 and April 2003.

From figure 3 and the tables in the appendix it is clear that the temperature values now are higher than in March 2002. The main difference is in the upper part of the well and is due to the short time elapsed from the closing of the well. At reservoir depth the temperature increase is 1-2°C. This is very small change and probably not significant. It is, however, tempting to look at this as an indication that during production the well is drawing warmer fluids from the productive faults. Highest temperature measured in April is 252.5°C at 900 m depth and a slight (~2°C) temperature inversion is seen below 1000 m. It has been suggested that the well intersects the productive "Faille de Cocagne" fault zone in the depth range 900-1000 m. The temperature appears to have a maximum in the permeable fault, but as the well stretches further away from the fault the temperature decreases.

As can be seen on figure 4, the pressure profile on April 23rd coincides more or less with the profile from March 2002. A more accurate comparison can be seen in the appendix. At the

wellhead the pressure is now 1.5 bar higher than last year but below 100 meters depth most of the pressure values are either identical or deviate by 0.1 bar. Exceptions are the 700 m depth where the pressure now is 0.3 bar lower than in 2002 and the 1100 m depth where the pressure is 0.4 higher than in 2002. These discrepancies are believed to be due to chart reading errors for the 2002 pressure log. Anyway the main conclusion of the pressure log on April 23rd is that the **pressure in BO-5 had fully recovered to initial pressures only 4 days after the well was shut-in.**

WELL BO-6

Well BO-6 was drilled in February 2001 to 1248 m (MD). It is directionally drilled with kick off point (KOP) at 230 m and with an inclination buildup to about 36° in the direction of N20°W. All depth numbers refer to measured depth unless other is indicated. The well is cased with 9 5/8" casing to 498 m and completed with 7" perforated liner from 462 m to bottom. The well was discharged briefly in early March 2001 and again for three weeks in late March and April 2001. The well has been closed since April 2001.

The measured static temperature and pressure profiles from well BO-6 are shown in figures 5 and 6, and measuring values of the logs on April 16th are shown in tables in the appendix. The same gauges were used now as in the measurements in March 2002. For easier comparison the new measurements are plotted in blue color but the ones from 2002 in red. The sharp temperature maximum around 900 m depth is neither observed now nor in 2002 even though it was confirmed by two measurements in 2001. The last two static temperature profiles reach a maximum (~251.5-7°C) around 1000 m and below that depth a slight (~1-1.5°C) decrease in temperature is observed. A comparison of the temperature values now and of March 2002 is shown in the appendix. The temperatures now are slightly higher than last year. In the upper part the "heating up" is of the order of 2-3°C but less than 0.5°C below 700 m depth. This temperature change is not considered to be significant at least not at the reservoir depths.

The pressure profiles are shown on figure 6. A pressure drawdown is observed during the last year. A comparison of the measured values in March 2002 and in April 2003 is shown in the appendix. There is some scattering in the pressure differences but on the average the pressure change below 500 m depth is of the order of 0.7-0.8 bar. This is a little less drawdown than observed in BO-4.

WELL BO-7

Well BO-7 was drilled in April 2001 to 1400 m (MD). It is directionally drilled with kick off point (KOP) at 230 m and with an inclination buildup to about 37° in the direction N130°W. The inclination drops off below 1000 m and is 23° at 1300 m. All depth numbers refer to measured depth unless other is indicated. The well is cased with 9 5/8" casing to about 500 m and completed with 7" perforated liner from 463 m and to 1100 m. The liner shoe is supposedly closed, hindering possible flow from deeper parts of the well. The well was only discharged for few hours in June 2001 with total discharge rate of 50 t/hr (14 kg/s) and wellhead pressure lower than 5 bar-g. The well has been closed since then.

Figures 7 and 8 show the measured static temperature and pressure profiles from well BO-7. The profiles of 17th of April 2003 are shown in blue color but the ones of March 2002 in red. The measuring values for the surveys on April 17th are tabled in the appendix. Also in the appendix a comparison is made between the surveys now and the ones in March 2002. In 2002 some obstacles were found below 1000 m depth and the temperature gauge stopped at 1019 m depth. Now in April, no obstacles were found and both the temperature and the pressure gauge went without any hesitation to bottom at 1095 m.

Figure 7 shows very similar temperature profile now as in March 2002. **The temperature above 500 m is, however, significantly higher now** as can be seen in the comparison table in the appendix. In the uppermost 200 meters the heating is about 10°C and at 300 and 400 m depth the

measured temperature is now about 4°C higher than in March 2002. This is considered to be temperature recovery after the drilling, which was completed in April 2001. Below 500 m the temperature differences in BO-7 between 2002 and 2003 are insignificant.

The pressure profiles on figure 8 show slightly higher pressure now than in March 2002, especially in the uppermost few hundred meters. The pressure increase is, considered to be, caused by the heating of the upper part of the well. The pressure change at, 100 m depth, suggests a 4.2 m rising of the water table in BO-7 from March 2002 to April 2003. This is believed to be due to the heating of the upper part of the well. At reservoir depth (below 500 m) the pressure increase is of the order of 0.1-0.2 bars, which is within the accuracy of the measurements. It is, however, very interesting to note that **no significant pressure drawdown is seen in well BO-7** despite almost a one year of production from the nearby well BO-5. During the present mission the water table in BO-7 was measured at 1.5 m below the top flange. During the 4 days after closing of well BO-5 the water level in BO-7 rose only 15 cm.

CONCLUSIONS AND RECOMMENDATIONS

Static temperature and pressure profiles were measured in the Bouillante wells BO-4, 5, 6 and 7 in April 2003. Well BO-2 was not accessible for logging at this time due to construction work of the new Bouillante 2, 11 MW power plant, next to the BO-2 well site.

Wells BO-4, BO-6 and BO-7 have been closed for the last few years but BO-5 has been under production since July 2002 when it replaced well BO-2 in supplying steam to the Bouillante 1 power plant. Pressure recovery in BO-5 could not be monitored, as the well had to be closed earlier than planned due to operational problems in the Bouillante 1 power plant.

The results of the logging in April 2003 are described in previous chapters and compared with previous logs in the wells, especially the static profiles measured in March 2002. However, the main conclusions and recommendations are the following:

- 1) The logging operation was carried out without any problems and no obstacles were found in the wells. Well BO-4 was measured to 1100 m, as it is not considered safe to go deeper. Other wells were measured to "bottom", which was found at same depth as in March 2002.
- 2) The measured temperature profiles now are similar to the profiles measured in March 2002. The temperature differences below 500 m depth are of the order of 1-2°C, which is not considered significant. Near surface temperatures are now considerably higher in BO-7 than in 2002. It is suggested here that the heat recovery after drilling of the well in 2001 was not completed in March 2002. Future temperature logs in the well will determine if this is correct interpretation or not. High temperatures shallow in well BO-5 are on the other hand due to the production from the well, which was stopped only three days before the temperature log was made.
- 3) The measured pressures at reservoir depths show that the 8 months production from BO-5 has lowered the pressures in BO-4 by about 1 bar and in BO-6 by 0.7-0.8 bar. However, the pressure recovery is fast when BO-5 is shut-in. The pressure log in BO-5, 4 days after shut-in shows that the well has recovered to the pressures in March 2002.
- 4) Well BO-7 is poorly connected to BO-5 and shows little or no pressure response when BO-5 is in production. During the 4 days after closing of well BO-5 the water level in BO-7 rose only 15 cm. Comparison of the pressure logs in BO-7 in April 2003 and in March 2002 shows no pressure drawdown deep in the well. At shallow depth the pressure in BO-7 has increased in agreement with the heating of the upper part the well. The pressure change suggests that the water level in the well has risen some 4-5 m during the 13 months between the pressure logs.

The temperature and pressure logs in the Bouillante wells in April 2003 show that the present production from the reservoir has little effect on the Bouillante reservoir. Future monitoring of the reservoir should include regular measurements of the temperature and pressure profiles. The

logging should be carried out when the capillary tubing is pulled out of the wells for maintenance. I understood from Bernard Herbrich that this would be done after approximately 6 months operation of the wells. Well BO-4 is likely to be a standby well in the future. If so it should be considered to use the capillary tubing to monitor reservoir pressures in BO-4.

More effort should be put into the maintenance of the wellhead equipment. This will become more important after installment of the capillary tubing in the wells for inhibitor injection. The operational safety of the wellhead equipment is maintained by keeping the equipment clean and free of leaks. Valves needs to be operated regularly (about once a month) greased and leaks must be stopped immediately by tightening or repacking the seals.

Reykjavík on May 6th 2003

Benedikt Steingrímsson and Ómar Sigurðsson
Geothermal Reservoir Engineers

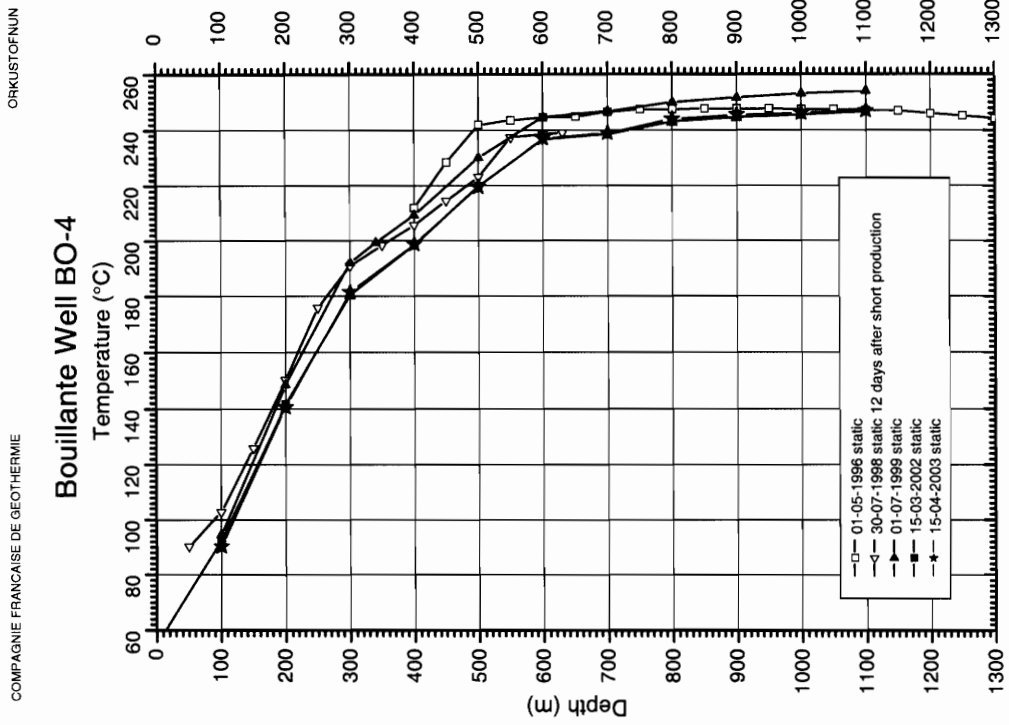


Figure 1. Static temperature profiles measured in well BO-4.

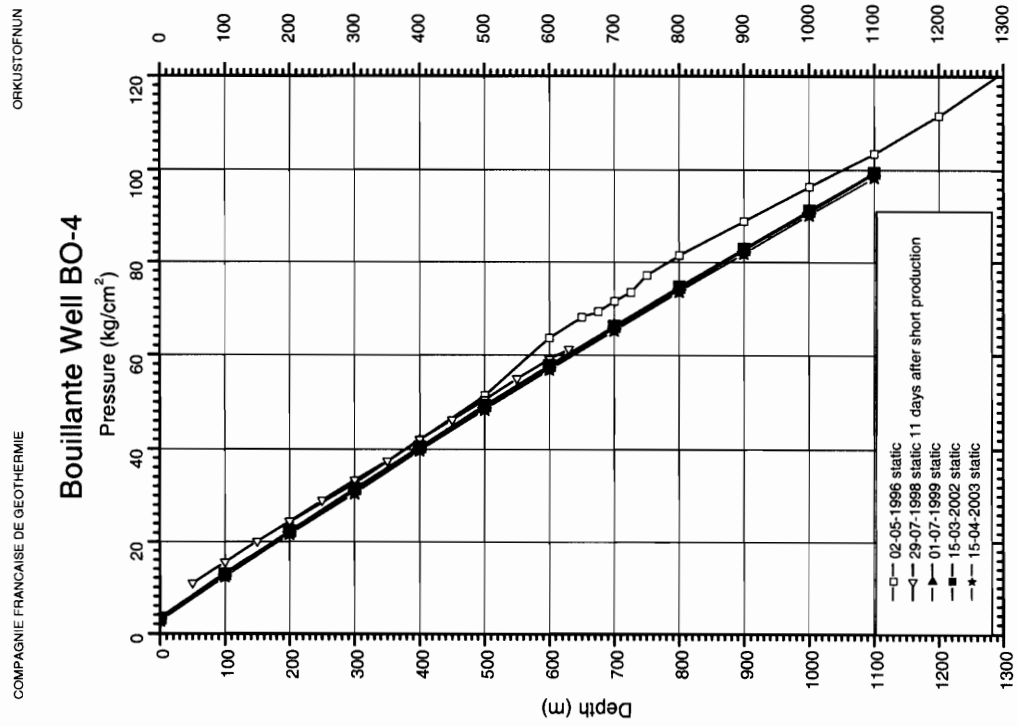


Figure 2. Static pressure profiles measured in well BO-4.

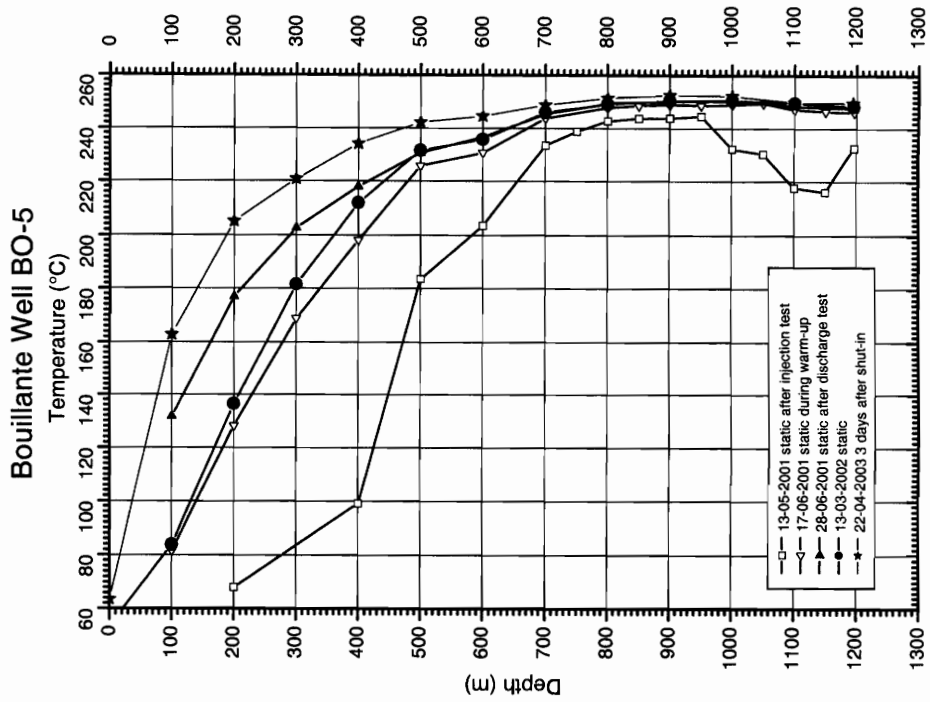


Figure 3. Static temperature profiles measured in well BO-5.

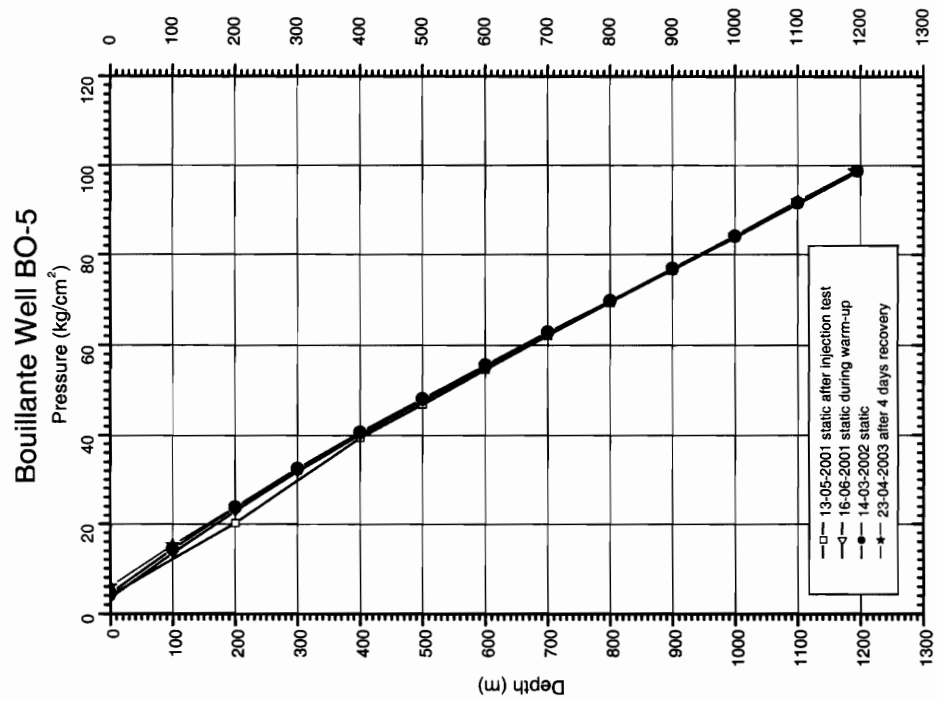


Figure 4. Static pressure profiles measured in well BO-5.

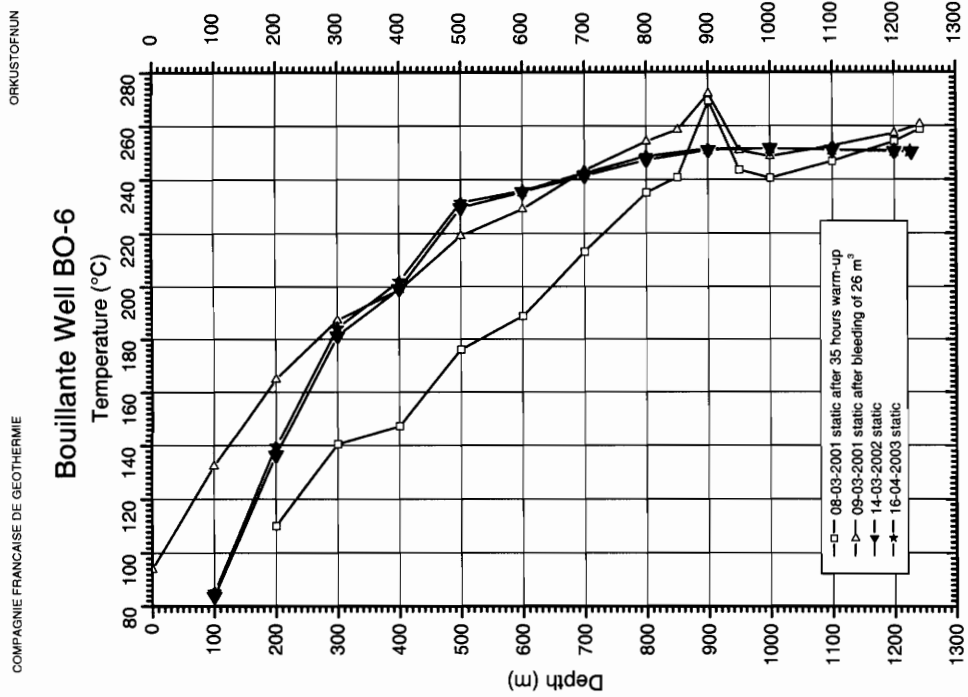


Figure 5. Static temperature profiles measured in well BO-6.

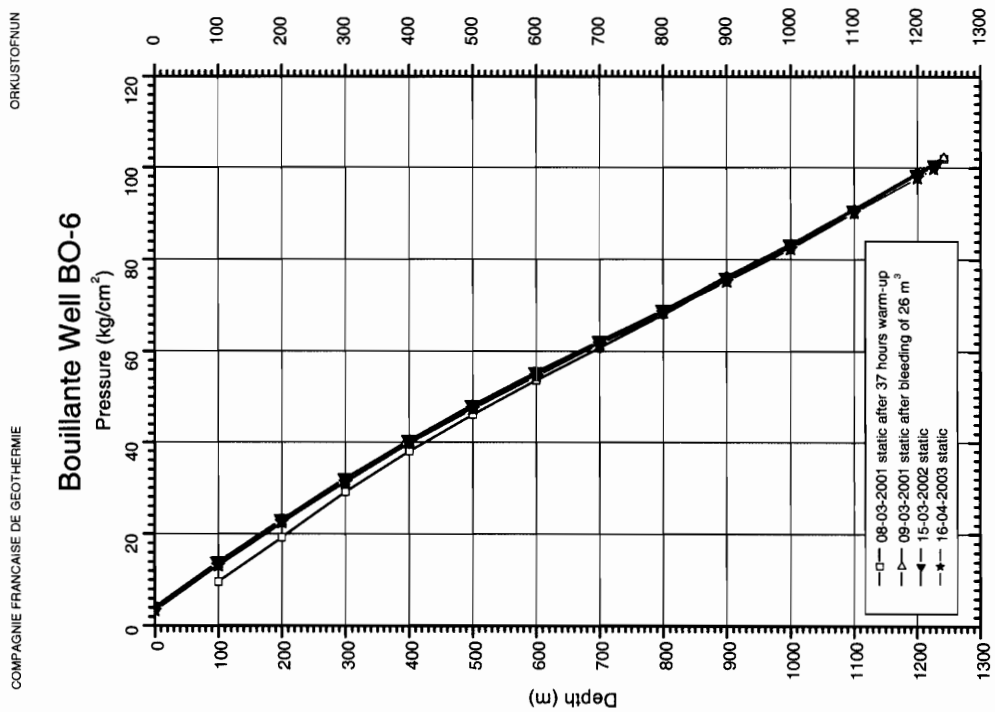


Figure 6. Static pressure profiles measured in well BO-6.

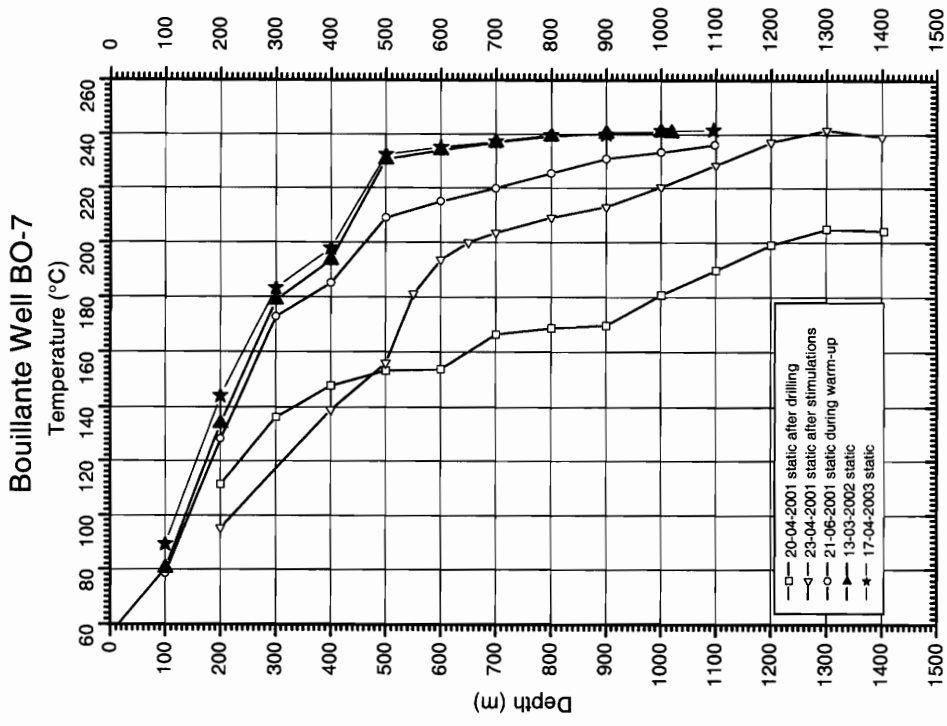


Figure 7. Static temperature profiles measured in well BO-7.

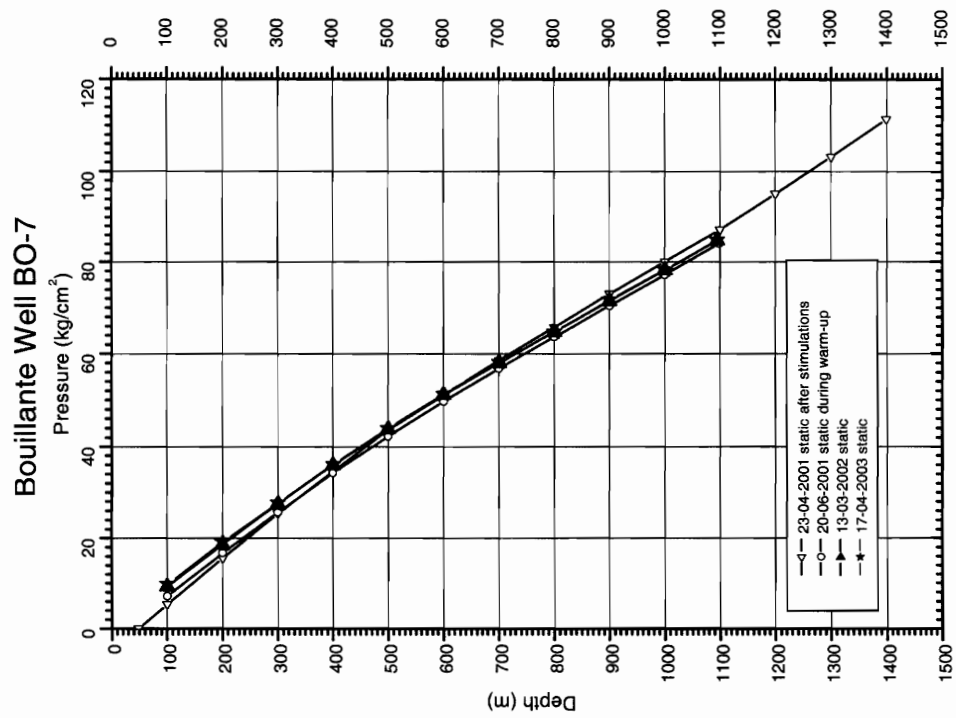


Figure 8. Static pressure profiles measured in well BO-7.

Figure 9.

APPENDIX

- BO-4.** Static temperature and pressure logs in April 2003.
Comparison between March 2002 and April 2003.
- BO-6.** Static temperature and pressure logs in April 2003.
Comparison between March 2002 and April 2003.
- BO-7.** Static temperature and pressure logs in April 2003.
Comparison between March 2002 and April 2003.

STATIC TEMPERATURE AND PRESSURE PROFILES IN WELL BO-4

Date: 15-4-2003

Temperature gauge KT-10073; Clock 3h, serial no. V4284; Time 11:00-13:30
 Pressure gauge KP-K8238; Clock 3h, serial no. V4184 (OS-clock); Time 13:30-15:30
 Zero reference about 1m above cellar.

Depth (m)	TEMPERATURE			PRESSURE			
	Deflection (cm)	Temperature (°C)	Observations (Temp. Logging)	Deflection (cm)	Pressure (bar)	Pressure (kg/cm ²)	Observations (Press. Logging)
0			WHP 2,8 bar-g	0,096	2,58	2,63	
100	0,630	90,3		0,454	11,99	12,23	
200	1,458	140,4		0,816	21,26	21,68	
300	2,132	181,3		1,145	29,80	30,39	
400	2,414	198,6		1,490	38,89	39,66	
500	2,753	219,4		1,817	47,47	48,40	
600	3,036	236,9		2,134	55,79	56,89	
700	3,067	238,9		2,440	63,93	65,19	
800	3,148	243,9		2,751	72,18	73,60	
900	3,174	245,5		3,054	80,24	81,82	
1000	3,183	246,1		3,360	88,41	90,15	
1100	3,197	247,0		3,664	96,51	98,41	

Remarks: Only measured to 1100 m depth, which has been determined as safe depth.
 Depth at 0 m when gauges back at top.

Well BO-5 was closed 16:11 to 16:50 and 17:10 to 17:45 on April 15th

STATIC TEMPERATURE AND PRESSURE PROFILES IN WELL BO-4

Comparison of logs of March 2002 and April 2003

Depth (m)	TEMPERATURE 2003 and 2002			PRESSURE 2003 AND 2002		
	15.3.2002 (°C)	15.4.2003 (°C)	Temperature 2003-2002 (°C)	15.3.2002 (kg/cm ²)	15.4.2003 (kg/cm ²)	Pressure 2003-2002 (kg/cm ²)
0				3,23	2,63	-0,60
100	92,3	90,3	-2,0	12,84	12,23	-0,61
200	141,5	140,4	-1,1	22,35	21,68	-0,67
300	180,4	181,3	0,9	31,43	30,39	-1,04
400	198,3	198,6	0,3	40,40	39,66	-0,74
500	219,7	219,4	-0,3	49,30	48,40	-0,90
600	236,6	236,9	0,3	57,79	56,89	-0,90
700	238,4	238,9	0,5	66,21	65,19	-1,02
800	242,9	243,9	1,0	74,59	73,60	-0,99
900	244,5	245,5	1,0	82,82	81,82	-1,00
1000	245,5	246,1	0,6	91,16	90,15	-1,01
1100	246,5	247,0	0,5	99,37	98,41	-0,96

STATIC TEMPERATURE AND PRESSURE PROFILES IN WELL BO-5

Dates:

22-4-2003

Temperature gauge KT-10073; Clock 3h, serial no. V4284; Time 11:00-13:30

23-4-2003

Pressure gauge KP-K8238; Clock 3h, serial no. V4284; Time 11:30-13:30

Zero reference about 1m above cellar.

Depth (m)	TEMPERATURE			PRESSURE			
	Deflection (cm)	Temperature (°C)	Observations (Temp. Logging)	Deflection (cm)	Pressure (bar)	Pressure (kg/cm ²)	Observations (Press. Logging)
0	0,190	63,7	WHP 6 bar-g	0,224	5,96	6,08	WHP 5.8 bar-g
100	1,828	162,8	Not stabilized	0,579	14,98	15,27	
200	2,520	205,1	Not stabilized	0,912	23,42	23,88	
300	2,775	220,8		1,233	31,88	32,51	
400	2,990	234,1		1,536	39,86	40,64	
500	3,120	242,2		1,815	47,24	48,17	
600	3,158	244,5		2,084	54,39	55,46	
700	3,225	248,7		2,346	61,34	62,55	
800	3,267	251,3		2,609	68,34	69,68	
900	3,285	252,5		2,873	75,38	76,86	
1000	3,281	252,2		3,142	82,66	84,29	
1100	3,242	249,8		3,429	90,13	91,90	
1194	3,238	249,5		3,675	96,78	98,68	
				0,244	6,25	6,37	

Remarks: Depth at -3 to 4 meters when gauges at top.

STATIC TEMPERATURE AND PRESSURE PROFILES IN WELL BO-5

Well shut-in on April 19th at about 10 in the morning.

Comparison of logs of March 2002 and April 2003

Depth (m)	TEMPERATURE			PRESSURE		
	13.3.2003 (°C)	22.4.2003 (°C)	Temperature 2003-2002 (°C)	13.3.2003 (kg/cm ²)	23.4.2003 (kg/cm ²)	Pressure 2003-2002 (kg/cm ²)
0		63,7		4,62	6,08	1,5
100	83,8	162,8	79,0	14,43	15,27	0,8
200	136,3	205,1	68,8	23,81	23,88	0,1
300	181,6	220,8	39,2	32,54	32,51	0,0
400	211,9	234,1	22,2	40,71	40,64	-0,1
500	231,5	242,2	10,7	48,17	48,17	0,0
600	235,7	244,5	8,8	55,59	55,46	-0,1
700	246,0	248,7	2,7	62,87	62,55	-0,3
800	249,1	251,3	2,2	69,81	69,68	-0,1
900	250,4	252,5	2,1	76,91	76,86	-0,1
1000	250,5	252,2	1,7	84,09	84,29	0,2
1100	249,5	249,8	0,3	91,48	91,90	0,4
1195	248,4	249,5	1,1	98,69	98,68	0,0

STATIC TEMPERATURE AND PRESSURE PROFILES IN WELL BO-6

Dates:

16-4-2003

Temperature gauge KT-10073; Clock 3h, serial no. V4284; Time 8:45-11:15

Pressure gauge KP-K8238; Clock 3h, serial no. V4184 (OS-clock); Time 11:30-13:00

Zero reference level with cellar.

Depth (m)	TEMPERATURE			PRESSURE			
	Deflection (cm)	Temperature (°C)	Observations (Temp. Logging)	Deflection (cm)	Pressure (bar)	Pressure (kg/cm ²)	Observations (Press. Logging)
0			WHP 3.6 bar-g	0,122	3,28	3,34	WHP 3.6 bar-g
100	0,546	85,2		0,485	12,83	13,08	
200	1,445	139,6		0,845	22,04	22,47	
300	2,178	184,1		1,173	30,50	31,10	
400	2,472	202,1		1,491	38,90	39,67	
500	2,948	231,5		1,778	46,34	47,25	
600	3,018	235,8		2,045	53,42	54,47	
700	3,124	242,4		2,309	60,41	61,60	
800	3,225	248,7		2,566	67,21	68,53	
900	3,268	251,4		2,815	73,83	75,28	
1000	3,272	251,7		3,072	80,68	82,27	
1100	3,265	251,2		3,364	88,47	90,21	
1200	3,257	250,7		3,641	95,87	97,76	
1226	3,253	250,5		3,716	97,84	99,77	
0							

Remarks: Depth at -2m when gauges back at top.

Well BO-5 was closed 9:08 to 12:43 and 15:42 and 17:43 April 16th

STATIC TEMPERATURE AND PRESSURE PROFILES IN WELL BO-6

Comparision of logs of March 2002 and April 2003

Depth (m)	TEMPERATURE 2003 and 2002			PRESSURE 2003 AND 2002		
	14.3.2002 (°C)	16.4.2003 (°C)	Temperature 2003-2002 (°C)	15.3.2002 (kg/cm ²)	16.4.2003 (kg/cm ²)	Pressure 2003-2002 (kg/cm ²)
0				4,13	3,34	-0,79
100	83,7	85,2	1,5	13,95	13,08	-0,87
200	136,3	139,6	3,3	23,18	22,47	-0,70
300	181,1	184,1	3,0	32,05	31,10	-0,95
400	199,1	202,1	3,0	40,47	39,67	-0,81
500	229,5	231,5	2,0	48,22	47,25	-0,97
600	235,3	235,8	0,5	55,43	54,47	-0,96
700	241,3	242,4	1,1	62,34	61,60	-0,74
800	247,2	248,7	1,5	69,14	68,53	-0,61
900	250,8	251,4	0,6	76,13	75,28	-0,85
1000	251,5	251,7	0,2	83,36	82,27	-1,09
1100	250,9	251,2	0,3	90,76	90,21	-0,55
1200	250,3	250,7	0,4	98,44	97,76	-0,68
1228	250,2	250,5	0,3	100,58	99,77	-0,82

STATIC TEMPERATURE AND PRESSURE PROFILES IN WELL BO-7

Date: 17-04-2003

Temperature gauge KT-10073; Clock 3h, serial no. V4284; Time 7:45-10:00
 Pressure gauge KP-K8238; Clock 3h, serial no. V4184 (OS-clock); Time 10:00-11:30
 Zero reference about at top of cellar.

Depth (m)	TEMPERATURE			PRESSURE			
	Deflection (cm)	Temperature (°C)	Observations (Temp. Logging)	Deflection (cm)	Pressure (bar)	Pressure (kg/cm ²)	Observations (Press. Logging)
0							
100	0,613	89,3		0,364	9,62	9,81	
200	1,519	144,1		0,722	18,78	19,15	
300	2,163	183,2		1,049	27,22	27,76	
400	2,400	197,7		1,360	35,43	36,13	
500	2,963	232,4		1,658	43,13	43,98	
600	3,007	235,1		1,930	50,36	51,35	
700	3,040	237,2		2,182	57,07	58,19	
800	3,078	239,6		2,427	63,58	64,83	
900	3,083	239,9		2,681	70,35	71,73	
1000	3,105	241,2		2,923	76,80	78,31	
1095	3,109	241,5		3,163	83,20	84,84	

Remarks: Depth at 0 m when gauges back at top.
 Well BO-5 was shut during 0:34 to 10:53 on April 17th

STATIC TEMPERATURE AND PRESSURE PROFILES IN WELL BO-7

Comparison of logs of March 2002 and April 2003

Depth (m)	TEMPERATURE 2003 and 2002			PRESSURE 2003 AND 2002		
	13.3.2002 (°C)	17.4.2003 (°C)	Temperature 2003-2002 (°C)	13.3.2002 (kg/cm ²)	17.4.2003 (kg/cm ²)	Observations (Press. Logging)
0						
100	80,4	89,3	8,9	9,39	9,81	0,42
200	133,8	144,1	10,3	18,67	19,15	0,48
300	178,9	183,2	4,3	27,57	27,76	0,18
400	193,4	197,7	4,3	35,99	36,13	0,13
500	230,6	232,4	1,8	43,83	43,98	0,15
600	234,1	235,1	1,0	51,20	51,35	0,15
700	236,9	237,2	0,3	58,08	58,19	0,11
800	239,2	239,6	0,4	64,81	64,83	0,02
900	240,3	239,9	-0,4	71,54	71,73	0,19
1000	240,9	241,2	0,3	78,23	78,31	0,08
1019	240,6					
1095		241,5		84,79	84,86	0,07