Complex mineral water well inspection

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József Buránszki senior geophysicist, Geo-Log Ltd., Budapest
Gábor Szongoth senior geophysicist, Geo-Log Ltd., Budapest
András Prohászka geologist, Geo-Log Ltd., Budapest
Sándor Hegedűs geophysical engineer, Geo-Log Ltd., Budapest
Zsófia Kalotai enviromental scientist, Geo-Log Ltd., Budapest

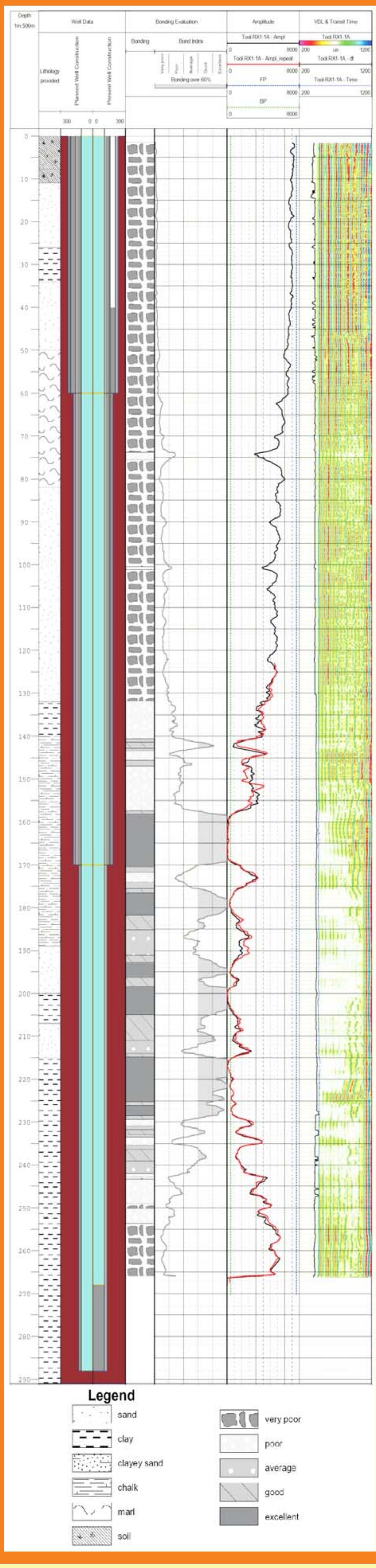
www.geo-log.hu

Summary

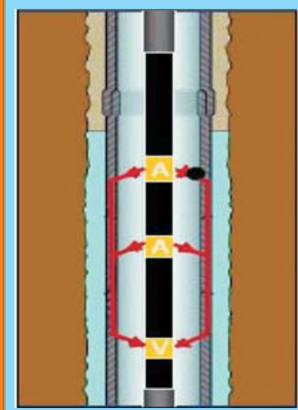
The inspection of water wells by borehole geophysical methods is a very important task, since the major part of the well is underground, hidden for simple visual inspection.
Quality checking of the drinking and the mineral water wells is especially important, since the requirements are the highest for them.
The Geo-Log Ltd. has been inspecting the Central and East-European wells of the Coca-Cola Company for five years in Lithuania, Serbia, Romania, Bulgaria, Ukraine, Cyprus and Greece.

Acoustic cement column investigation (CBL) is especially important in the mineral water and soft drink industry. This is because it is not just about ensuring the excellent drinking water quality, but, furthermore, this water is consumed in bottled form by a large number of people. The mineral water wells are generally not deep (max. a couple of hundred meters), however, the water demand is virtually unlimited, thus wells are usually large in diameter. The construction of wells, especially blocking out of the upper aquifers potentially containing polluted or endangered water, is a great challenge for each contractor regardless the country where the well is constructed.

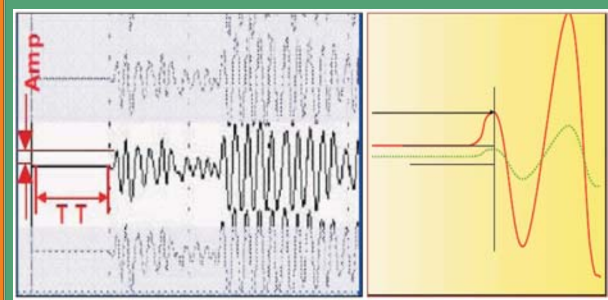
Very low Bond Index values could be observed above the depth of 157 m, especially above 132 m. Fortunately, this zone is above the bottom of surface casing. The bottom of this casing is found in a better zone between 132 and 157 m, in which the Bond Index shows excellent and good bonded zones, with some relatively thin parts of poorer quality. In this interval the better bonded zones tend to accompany the clay beds. After a heterogeneous, but generally average quality bonding interval 229-241 m, the Bond Index is lower than 10% down to the bottom.
Since a thick clay bed is assumed to be between 215 and 292 m, with an excellently bonded zone nearby its upper zone, this interval blocks out any leakage coming potentially from the upper sand beds.
The deepest 25 m of the well were filled by bonded cement, so that there is no information about it.



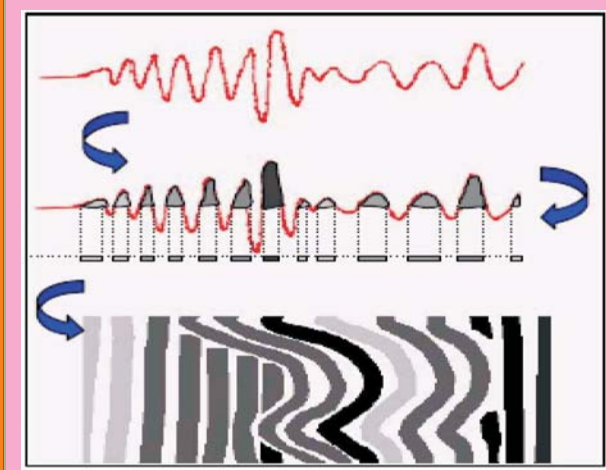
The tool that is used for measuring the bonding is a regular sonic tool, which is carefully centralized in the casing.

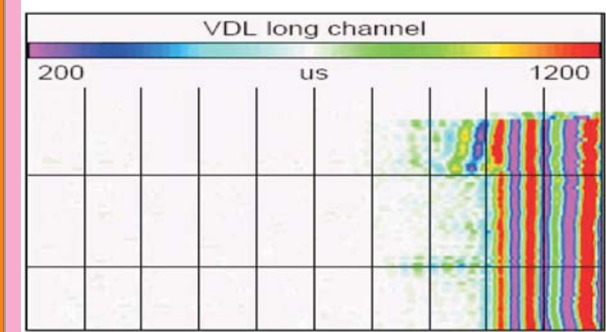


Sonic waves generated by the transmitters (A) of the logging tool travel through the water and the casing then returns to the receiver (V).
The amplitude of the returning signal varies according to the bonding between the cement and the casing.
The time needed for the waves to arrive to the receiver depends on the transmitter-receiver spacing, the diameter of the casing and the type of the fluid.
So-called Travel Time (TT) is generally constant along the casing unless the quality of the fluid changes.

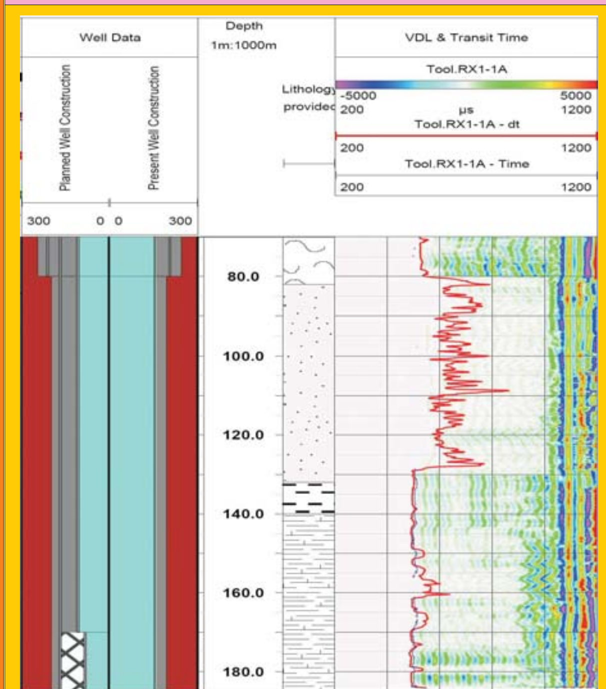


The amplitude of the first peak is used to characterize the bonding. In a free-pipe, which is not cemented at all, the amplitude is high (red curve in the right figure above), while it is small in a perfectly cemented casing (green curve).
The higher is the amplitude, the worse is the bonding. The ratio of the bonded portion to the total circumference is named as Bond Index (BI) and it is usually expressed in percentage.





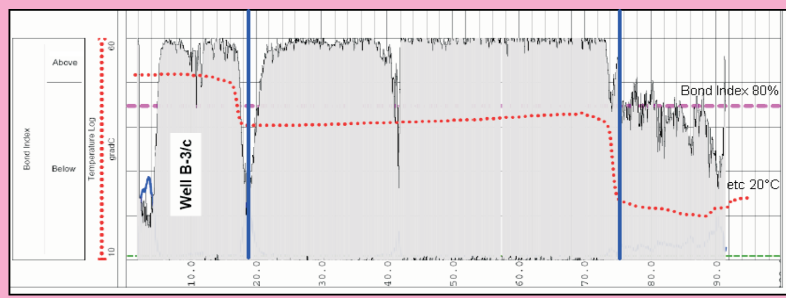
The figure above presents how the so-called Variable Density Log (VDL) is constructed from the individual wave trains (referred to as 'signature' or 'wiggle trace' in some papers).

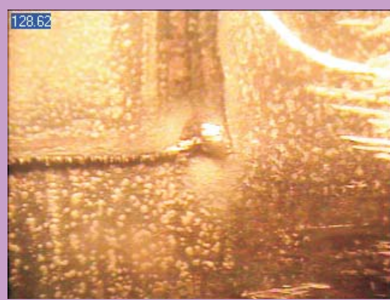


An extraordinary well bonded part is due to the permeable sand bed which is generally invaded excellently by the slurry. In this zone even the formation waves are vanished.

Well structure monitoring with color camera

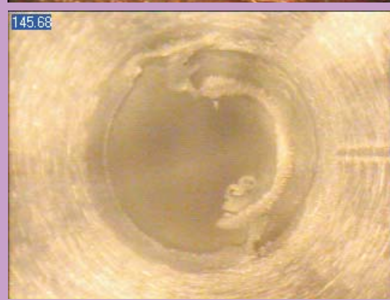
The wide (610/594 mm) PVC pipe deformed considerably due to the heat produced during the consolidation of the cement. The well was professionally sealed and a new well was established a few hundred meters away. The cementing in this later case was already implemented in three consecutive steps, therefore, considerable amount of heat was not produced. The lower figure presents the size of the new well after cementing. The thermal curve and CBL were taken 48 and 72 hours after the latest episode of cementing respectively. The measurements illustrate nicely the episodic nature of cementing, because the uppermost section is still warm due to the consolidation of cement. At ~20 m the contact between the two cement surface is of poor quality based on CBL section - and below 75 m the cementing has, again, weak quality, which is confirmed by the temperature ~20°C that resembles closely the original temperature of the rock. In summary, the good quality of cementing (consolidation is in the excess of 80%) between 21-74 m ensures the blocking of downward flowing pollutions.





Investigation of a steel pipe got damaged during the drilling

During the drilling of a well aimed at producing bottled water, the contractors experienced several challenges, as they had to save several occasions, and consequently their 365/344 mm sized pipe (not a brand new one) got damaged (deformation, sliding off) and at some places the boring tool got stuck. The following images illustrate these damages.
The damaged steel pipe was, however, completed as the contractors saved the stuck instruments and went on with the drilling of the well. The well was successfully completed as yielding 300 l/min good quality water, but to achieve this was a little bit challenging.

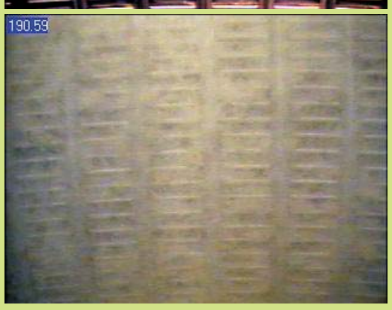


Detection of pollutants in mineral water wells

The water contained white residue in an old well. The aim of the investigation was to localize the place of the precipitation. During the monitoring iron and manganese precipitation could be detected in the filters which also settled down to the base of the well.

Monitoring filters by video camera

It is crucial for a completed well that the entire surface of the filter is clean, because this makes sure that the well gives water without sand and the yield is maximal. In the figures below we demonstrate how a clean filter surface and another surface, which is yet to be cleaned, look like.
The experience tells us that the monitoring of filters with camera is very effective, since we have checked several new wells where the filter surface was entirely clean only after the third occasion. The procurer could only convince the drillman about the need of effective filter-cleaning when presented these images.



Colour video camera inspection in Greece. On the picture above the cable-disinfecting device can be seen.