Depth Control - The MWD Challenge

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Accurate depth control while drilling has always been a difficult task. It falls into two categories, the absolute depth measurement and the relative depth measurement (thickness). The subject of absolute depth measurement has been analyzed successfully by Kirkman and Seim (1990), we have used their recommendations with success in the North Sea.

However, there is another depth control problem that is as serious, perhaps more serious, and to date unsolved. This is the measurement of thicknesses or keeping the depth readings accurate continuously.

Gryphon Field

Kerr-McGee operates Gryphon Field in the U. K. North Sea with partner's Clyde Petroleum, Aaron Energy, and Fisherman's Petroleum. The reservoir is composed of a very high permeability (1 to 10 Darcies) unconsolidated sandstone. The sandstone contains both a gas-oil contact at -5541 feet subsea and an oil-water contact at -5731 feet subsea. Figure 1 lists the wells that have penetrated the contacts. The MWD penetrations and the wireline penetrations are listed separately.

The boreholes (both MWD and wireline) were drilled with 12.25" bits and oil-based mud was universally used. Sticking was not a problem for either the MWD collars or the wireline tools.

In general, the absolute depth measurement by both the MWD logs and the wireline logs, is good. The maximum error, as measured against the average of the wireline measurements, is 1 foot per 1,000 feet which is the industry accepted accuracy of wireline depth measurements. With the exception of one well, the 24Y, the wireline logs were within 0.5 feet per 1,000 feet.

Seven wells penetrated both contacts, four of these wells were logged with wireline logs and the average oil column thickness from these wells is 190 feet which is the assumed oil column thickness. This thickness was also measured (to within one foot) by one of the MWD logs, the 9/18B-A7. While the maximum error in measuring this thickness with wireline is about 0.5 feet (also the sampling interval) the MWD error is three feet for the A2 and four feet for the A8.

These thickness measurement errors are not unusual and their cause is unknown, but must be related to the depth to time computation done by the MWD companies. We have seen these "rubber band" depth shifts in every well where both wireline logs and MWD logs are available.

Figures 2 and 3 show examples. In both figures the wireline logs are shown as solid lines and the MWD logs are shown as dashed lines.

In Figure 2 a section of log from the 9/18B-17Z is shown, no depth adjustment has been made by the author, and if one was made by the MWD company or the wireline company it was not reported. The depth shift between the two GR logs at the top and base (points A & B) of the sand is 17 feet. The depth shift between markers at (wireline depth, point C) 6364 feet and 6384 feet is 14 feet. This is a loss of 3 feet in thickness in 70 feet.

Figure 3 is from the 9/18B-19Y. The logs appear to be on depth at 5678 feet (point A) but are three feet off at 5712 feet (point B).

As stated above, this author has no explanation for these common and perplexing depth problems. He does, however, understand the economic consequences. In large fields, one foot of pay can represent millions of barrels in reserves. This is a problem that should take a high priority in MWD research laboratories.

Reference

Kirkman, Matthew and Seim, Per, "Depth Measurements with wireline and MWD Logs," SPWLA (London Chapter) MWD Seminar, 23 April, 1990.

Captions

Figure 1: Gryphon Field Oil/Water and Gas/Oil Contacts.

Figure 2: A section of the MWD (dashed) and wireline (solid) logs for the 9/18B-17Z. Three correlatable points are labeled A, B, and C. Points A and B require a 17 foot depth shift and point C requires a 14 foot depth shift.

Figure 3: A section of the MWD (dashed) and wireline (solid) logs for the 9/18B-19Y. Two correlatable points are labeled A and B. Point A requires no depth shift and point B requires a three foot depth shift.