REVEALING HIDDEN INFORMATION; HIGH RESOLUTION LOGGING-WHILE-DRILLING SLOWNESS MEASUREMENTS AND IMAGING USING ADVANCED DUAL ULTRASONIC TECHNOLOGY

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Abstract:

A new logging while drilling (LWD) acoustic tool has been developed with novel ultrasonic pitch-catch and pulse-echo technologies. The tool enables both highresolution slowness and reflectivity images, which cannot be addressed with conventional acoustic logging. Measuring formation elastic-wave properties in complex, finely layered, formations is routinely attempted with sonic tools that measure slowness over a receiver array with a length of 2 ft or more depending upon the tool design. These apertures lead to processing results with similar vertical resolutions, obscuring the true slowness of any layering occurring at a finer scale. If any of these layers present significantly different elastic-wave properties than the surrounding rock, then they can play a major role in both wellbore stability and hydraulic fracturing but can be absent from geomechanical models built on routine sonic measurements.

Conventional sonic tools operate from approximately 0.1 kHz to 20 kHz and can deliver slowness information with approximately 1 ft or more depth of investigation. This is sufficient to investigate the far field slowness values but makes it very challenging to evaluate the nearwellbore region where tectonic stress redistribution causes pronounced azimuthal slowness variation. This stress-induced slowness variation is important because it is also a key driver of wellbore geomechanics. Moreover, in the presence of highly laminated formations there can be a significant azimuthal variation of slowness due to layering that is often beyond the resolution of conventional sonic tools due to their operating frequency. Finally, in horizontal wells, multiple layer slownesses are being measured simultaneously because of the depth of investigation of conventional sonic tools. This can cause significant interpretational challenges.

To address these challenges, an entirely new design approach was needed. The novel pitch-catch technology operates over a wide frequency range centered at 250 kHz and contains an array of receivers having a 2 in. receiver aperture. The use of dual ultrasonic technology allows the measurement of high-resolution slowness data azimuthally as well as reflectivity and caliper images. The new LWD tool was run in both vertical and horizontal wells and directly compared with both wireline sonic and imaging tools. The inch-scale slownesses obtained show characteristic features that clearly correlate to the formation lithology and structure indicated by the images. These features are completely absent from the conventional sonic data due to its comparatively lower vertical resolution.

Bio:

Matthew Blyth is the LWD Geophysics, Acoustics and Geomechanics Domain Head with the Schlumberger Well Construction division. Since joining Schlumberger in 1997, he has filled a variety of roles, all within the field of logging while drilling. He is currently involved in the long-term technical development plan for LWD acoustic and seismic technology within Schlumberger and their applications. He has authored and coauthored multiple papers on LWD technology and its uses. Matthew graduated in 1996 from Cambridge University with a Bachelors and a Masters in Engineering. He is a member of the SPWLA, SPE, SEG, and ASA and has served as both a VP and as President of the Houston SPWLA chapter. He is on the board of the SPWLA Sonic SIG, was on the committee organizing the 2019 SPWLA Symposium and was a 2016/2017 SPWLA Distinguished Speaker.