A New Approach for Characterizing Rock Closure Stress From Borehole Images; Honoring the High-Resolution Mechanical Facies of Unconventional Reservoirs

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Abstract

Many different methodologies have been introduced and applied to better understand the rock behavior and the closure stresses that affect hydraulic stimulation of lateral wellbores in unconventional reservoirs. The intensively laminated nature of unconventional reservoirs imposes a unique challenge during the evaluation and stimulation life cycle of pilot wells and infill well drilling plans. Borehole acoustic tools, through axial, azimuthal and radial information from monopole and dipole measurements, provide a clear understanding of mechanical properties within the near wellbore region. Intrinsic anisotropy, also known as Vertically Transverse Isotropy “VTI”, presents a specific challenge over stress-induced anisotropy. Intrinsic anisotropy is well known in shaley, highly laminated formations. These thin bed laminations, characteristic of many unconventional reservoirs, present a challenge in adequately evaluating intrinsic anisotropy, due to the limited resolution of existing acoustic tool measurements. Such acoustic measurements generate an average response over a two to three feet interval, at best. However, borehole measurements of higher resolution, most notably borehole images, and core data clearly reveals the true nature of these thin bedded reservoirs with laminae on the scale of inches and below. It is therefore clear that acoustic measurements are not adequately characterizing the high-resolution mechanical properties of these reservoirs. Borehole images provide the unique ability to resolve this high-resolution stratigraphic and mechanical variability and more

accurately characterize intrinsic anisotropy. This abstract proposes a novel, new methodology for understanding and evaluating thin bedded reservoirs through the integration of existing acoustic measurements and borehole images. The method will introduce high-resolution quantitative outputs (generated from the electrical contrast of thin bed laminae), a ‘sharpened’ closure gradient and also a stress image that will honor the depositional facies; introducing a mechanical facies with quantitative values that can be extracted all around and along the wellbore. It is envisaged that this new approach will provide the opportunity to address the current limitations of resolving high-resolution mechanical properties that are common to unconventional reservoirs.

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