Prediction of Pore Fluid Pressures in Frontier Basins

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ABSTRACT

Pore fluid and fracture pressures are required in advance of drilling a well, and some of the greatest challenges are in frontier exploration where the main input requirements are only seismic data and a geological model. The traditional approach for pore pressure prediction (PPP) relies on shale-based porosity trends applied to seismic interval velocity, implicitly linking velocity to shale compaction. The "normal compaction trend" (NCT) cannot be determined from seismic data, nor from well data where there is none, and hence must be assumed. Unless the expected sediments are smectite-rich shales with 40-60% clay-grade particle size, a Gulf of Mexico shale NCT is not helpful. Rather an average of more typical shales from a global database is more likely to suffice, and will be reviewed. Quantification of the pore fluid pressures is achieved by use of standard algorithms (e.g. Eaton, Bowers) applied to the seismic interval velocities and NCT. It is now possible to compare these results with an independent assessment of shale pore fluid pressure using sedimentation rate and expected clay-grade, although only after careful consideration of the reservoir distribution which has the potential to enhance (by lateral transfer) or deplete (by lateral drainage) the reservoir pressures relative to the shale pressures. Sedimentation rate is determined from the anticipated age of the seismic markers and the depth converted depth section at the future well location. Finally, all the uncertainties associated with the reservoir and shale estimates must be captured in the spread of PPP - from minimum thru expected to maximum PPP over the entire planned drilling depth of the well. This approach, combining shale-based predictions from seismic (and well) data with a sedimentation rate model to deliver a meaningful range of PPP, will be reviewed using data from several basins. The limitations of this approach, especially as it relates to basin-type, and depth and temperature range, will be reviewed. Fracture pressures are also required to define the pre-drill "drilling window". The part that PPP contributes to a meaningful range of expected fracture strength will be briefly reviewed, incorporating new evidence for the magnitude of pore fluid pressure-stress coupling. The coupling values are shown to be less than half previous published estimates.