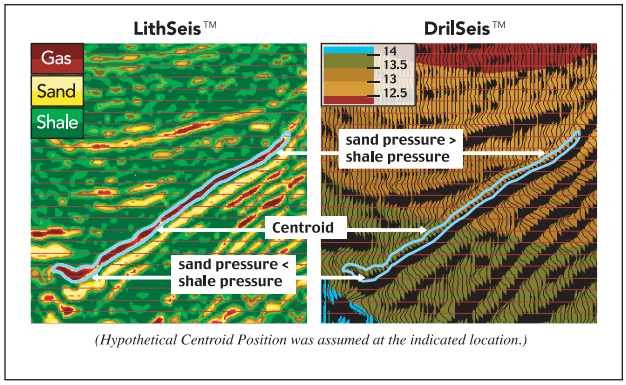
Pore Pressure Prediction Solves Jimba Problems

Pemex's Jimba *exploration and production block in Veracruz, Mexico, has presented the company and its partners with some thorny exploration and drilling issues.*

By Rhonda Duey, Exploration Editor, Hart's E&P

Jimba is a gas-prone area where high pore pressures and steeply dipping beds combine to make for some attractive exploration targets but some tricky drilling.

eSeis, Inc., in cooperation with Pemex and Jaguar Exploration Inc., applied its proprietary new pore pressure prediction technology along with other proprietary technologies to help solve these issues. The results were presented in a poster session yesterday morning.



Centroid effect illustrated on Jimba data set.

The greater Jimba Survey covers about 170 sq miles (445 sq km). The present study was confined to a 10-sq mile (25-sq km) area around a hypothetical location with some previously drilled wells that provided calibration. The sediments range in age from Recent to Mesozoic, and the primary exploration target is in the Middle Miocene.

To tackle the various exploration and drilling issues, eSeis applied its DrilSeis™ pore pressure prediction technologies to calculate pore pressures for the entire 3-D volume. The pore pressure results were combined with lithologies and fluids, as predicted by the LithSeis™ process, to identify potential gas-bearing reservoirs and calculate the magnitude of potentially dangerous centroid-effect pressure variations.

Information about pressure variations is contained in and may be extracted from an analysis of the velocity of shales in an over-pressured environment. This analysis relies on empirically established relationships between pore pressure and shale velocity and is performed routinely on well logs where the shale points can be easily identified. Variations on the analysis also are commonly applied to seismic data and, in the best case, a reasonable approximation of shale velocities can be calculated and used to estimate shale pore pressures; this approach is incorporated in eSeis's V-based™ pore pressure prediction.

An alternative approach to pore pressure prediction is incorporated in eSeis's Q-based™ pore pressure prediction technology. This approach, for which eSeis has a patent pending, relies on the more fundamental relationship between effective stress and the transmission of various frequencies. Because effective stress plus pore pressure is equivalent to overburden, pore pressure is easy to calculate in normally compacting sediments.

The V-based and the Q-based pore pressure prediction technologies are combined in DrilSeis, which eSeis offers as a commercial service. The two approaches are independent of each other and thus offer a more robust approach to pore pressure prediction than the more traditional approaches based on velocity analyses alone.

Because of the centroid effect, sand pore pressures cannot be assumed to be equal to the pressure of the encasing shales when the shales are over-pressured (see graphic). This is true even where the shale pore pressure is known with a high degree of certainty. The effect becomes strong in over-pressured areas with any appreciable dip and continuity of the sands. The result may be an abrupt increase in pressure when a sand bed is encountered at a relatively high structural position; or, conversely the pressure may abruptly drop if the sand is encountered further downdip.

Calculating the centroid pressure requires knowledge of the shales' pressure and the sands' geometry, which may be encountered. Appropriate use of the information contained in the unstacked seismic gathers allows lithologic solutions to be combined with pressure solutions, resulting in a complete analysis of the entire volume of data for pore pressure, seal capacity and fluid gradient.

Lithologic solutions are derived by eSeis using proprietary algorithms in its LithSeis service. Prestack data are used in the LithSeis technology to derive estimates of shear and compressional acoustic impedance; the analysis is predicated on a petrophysical approach and utilizes a 10-fold classification of amplitude vs. offset types. The analysis also yields good estimates of porosity and the presence of compressible fluids. All results are reported in 3-D volumes, which facilitates the mapping of interesting reservoirs.

Analysis of the Jimba seismic data reveals pressure variations in the vicinity of well control, which are consistent with pressures calculated from well logs and reflected by mud weights used during drilling. In the example at left, below a dipping, gas-filled sand reservoir, as indicated on LithSeis, extends through a range of shale pore pressures, as indicated by DrilSeis.

Calculations of the centroid effect on this particular sand suggest it will contain pressures about 1 lb/gal to 1.5 lb/gal higher than the surrounding shale in its updip reaches and will be under-pressured relative to the shale in the downdip portions.

For more information, visit Booth No. 1708 or *www.e-seis.com*. ●