Observations of Intrinsic Anisotropy in Varied Geologic Settings

Hathon, Lori [1]; Myers, Michael T.[1] (1) Shell International E & P, Inc., Houston, TX.

Acoustic anisotropy in unconsolidated sediments and sedimentary rocks is a function of both the intrinsic character of the material and variability in the externally applied stress field. This paper reports measured intrinsic, acoustic anisotropy in unconsolidated sands and mud rocks from fold-thrust belts, from sub-salt settings, and for sands in typical extensional basin settings. In the latter, the vertical effective stress has been the principal stress throughout the sand's burial history. This is in contrast to thrust belt settings in which the principal stress is non-vertical for some portion of the burial history, or to sub-salt settings in which horizontal stress gradients arise due to rapid changes in salt thickness. Both polar and azimuthal acoustic properties were measured. Laboratory measurements were made under isostatic stress conditions at the estimated in situ stress. Analysis of grain contact length and orientation, and of grain fracture and intergranular pore bodies was performed on thin sections from fast and slow orientations. The influence of layer parallel compaction in the thrust belt samples (and to a somewhat lesser extent in the sub-salt samples) is evidenced by the rotation of grain contacts out of the bedding plane and into a direction perpendicular to the fast azimuthal velocity. Intrinsic azimuthal anisotropy in the thrust belt sands averaged 15% in both crestal and flank structural positions. Anisotropies as high as 30% were observed locally, in proximity to deformation bands and minor faults. In this setting, polar anisotropies tend to be substantially lower than the azimuthal values, averaging about half the azimuthal anisotropy. This observation suggests that a TI medium assumption would be inappropriate in fold and thrust belt settings. In contrast, interbedded mud rocks showed azimuthal anisotropies on the order of 7-8%. In sub-salt settings the degree of azimuthal anisotropy in sands ranged from 5-10% at in situ stress. In extensional basin settings, measured azimuthal anisotropy ranged from 0-3%. In these samples the polar anisotropy is larger than the azimuthal value, and varies depending upon the compaction state of the sands. In all cases this level of anisotropy measured in the core plugs could be directly tied to textural changes observed in thin section.