

## AVO Analysis of Long Offset Seismic Data Using 3-D Graphical Analysis

Fuping Zhu<sup>1</sup> and Richard L. Gibson<sup>2</sup>

<sup>1</sup>Shell International Exploration and Production Inc., 200 N. Dairy Ashford, Houston, TX 77079

<sup>2</sup>Department of Geology and Geophysics, Texas A&M University, College Station, TX 77843

### ABSTRACT

P-wave AVO intercept (A) and gradient (B) crossplotting is widely used for detecting anomalous elastic properties that may be indicative of hydrocarbons, but long offset seismic data are starting to become widely available. It is well known that the two-term AVO equation is only an approximation for angles of P-wave incidence less than 30°. However, long-offset seismic data with P-wave angle of incidence much larger than 30° are sometimes used to extract A and B values using a 2-term AVO equation. And then the extracted A and B values are used for AVO crossplotting and hydrocarbon detection. We show how inaccurate A and B values may result if the two-term AVO equation is used for prestack seismic data with large incident angles.

A linear  $V_p$ - $V_s$  and a Gardner-like  $V_p$ - $\rho$  (rho) relationship explain the linear relationship between A and B for typical brine-saturated sandstones and shales, and this line passes through the origin. However, in the Gulf of Mexico (Hilterman, 1990) and Gulf of Thailand (Zhu,

2000), the sand velocity is sometimes larger than the shale velocity, while sand density is smaller than the shale density. As a result, the A-B trend of some brine-saturated sandstones and shales may not pass through the origin or may not be linear in the A-B plane. Nevertheless, a linear  $V_p$ - $V_s$  relationship holds and the average  $V_p$  across the shale and sand interface does not vary significantly. AVO intercept (A), gradient (B) and curvature (C), which can be extracted from long offset prestack seismic data, are expressible in an equation representing a plane the 3-D A-B-C space. Deviations from this plane suggest abnormal velocities and indicate lithology and fluid variations.

### REFERENCES CITED

- Hilterman, F., 1990, Is AVO the seismic signature of lithology? A case history of Ship Shoal-South Addition, Geophysics: The Leading Edge of Exploration, Vol. 09, No. 06, pp. 15-22.
- Zhu, F., 2000, Shear-wave velocity estimation using multiple logs and multicomponent seismic AVO interpretation: Gulf of Thailand, Ph.D. dissertation, Texas A&M University.

