Seismic Imaging under the Darai Limestone in the PNG Thrust-belt

Greg Beresford
Frank Nicholson

Seismic exploration in the PNG Highland's has experienced a 'mini renaissance' over the last few years where the permit Operators have engaged a group of independent contractors to acquire several hundred kilometres of 2D seismic. The cost of acquisition is upwards of US$ 50,000 per kilometre which generally rules out in-field experimentation and places a greater emphasis on processing and pre-survey modelling. Many of the seismic programs have traversed thick, (massive, from 500m->1000m) karst Darai Limestone at surface. The karst limestone, combined with the structural complexity of the thrust belt produces seismic images which range from clear to undecipherable. Full waveform elastic modelling based on wells at Gobe, Gobe-1X and Hides provides insights into seismic propagation through the limestone and lead to better acquisition design. In turn this may improve data quality to the point where pre-stack migration can be applied successfully.

Elastic seismograms computed using the method of Kennett (1979) reveal that thick columns of buried limestone typical of the Gobe area do not in themselves produce a serious barrier to imaging targets underneath. The models use a simple replacement velocity from the depth at which reliable logs exist in the limestone. In all cases this depth is below the water table. Transmission loss through the limestone can be as little as 10dB depending on the degree of karsting. The composite wavelet produced by both short period multiples and mode conversions will produce useable reflections off target out to offsets as high as 5km. These large offsets are important to include as the near offsets are more contaminated by multiples generated by the limestone.

The S/N estimated from the elastic modelling is higher than what we might guess it to be from the field data. From this we conclude that many of the problems for exploration in PNG arise in the first 100m (or even less) below the surface. The limestone above the water table may be producing most of the transmission problems due to scattering. It is critical for the success of future exploration to measure the elastic properties of the shallow limestone and determine the mechanism by which the data are being degraded.