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# [EA]An Integrated Structural Interpretation and Modelling Workflow for the Barikewa Field, Papua New Guinea*

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## Abstract

Compression since the Late Miocene has resulted in highly folded and faulted Mesozoic to Tertiary strata within the Papuan Basin, making exploration and development of hydrocarbon resources a challenging proposition. A structural interpretation based on a variety of data sources is required to confidently quantify the potential range of resources associated with a field. This presentation describes a novel approach to strontium isotope analysis used by Santos to more accurately predict top reservoir in the recent Barikewa-3 well. Due to highly variable topography, including extensive limestone karstification, compounded by dense forest coverage, seismic acquisition and processing is challenging and expensive in the PNG Highlands. The result is often poor seismic images and hence other data sources are utilised in an integrated workflow to interpret the sub-surface.

The Darai Plateau is interpreted as a large scale inverted half graben extending approximately 150 km in strike from Mt Bosavi in the northwest to the Barikewa Gas Field (Figure 1) in the southeast (Hulse and Harris, 2000). In comparison to the adjacent highlands, it is structurally benign in nature and contains the more gently folded foreland margin of the foldbelt. Whilst this might suggest that seismic acquisition could produce better results in the area, this has not necessarily been the case. Similarly to the highlands, the extensive limestone karstification and dense forest coverage result in poor imaging.

The Barikewa Gas Field in the foreland margin area of the Papuan Basin is interpreted by Santos to be a low relief inversion anticline towards the southern end of the Darai Plateau. Barikewa was discovered in the 1950's, drilled on the extrapolation of surface data which defined the trap and gave an estimated vertical closure of 170 m over an area of 90 square kilometres. There was no seismic definition pre-drill.

Barikewa-1 drilled to a total depth of over 4000 m MD and intersected gas bearing reservoirs in the Toro Formation and Hedinia Member, with flow potential of 108 MMCFD. Very high mud weights in Barikewa-1 damaged the deeper sands (Koi-Iange and Magobu) preventing a proper logging and testing program (Bird and Seggie, 1990). Barikewa-2 was drilled in 1981 up-dip of Barikewa-1 at Base Darai level, but was wet at both the Toro and Hedinia levels. The current model suggests it was drilled in a separate, uncharged fault block, however it is also possible that the structure is lacking closure to the NW of this separate fault block.

Seismic was shot over the field in 1997 with generally poor results despite several reprocessing efforts. As a consequence, a 2016/17 re-evaluation of Barikewa involved a structural interpretation workflow to model the Barikewa Gas Field in an attempt to prognose the then upcoming Barikewa-3 appraisal well. The workflow involved the integration of surface geology, surface and well dip measurements, palynology, strontium isotope data, and fault analysis along with 2D seismic interpretation. Strontium isotope analysis in the Darai Formation can be used to define the age of a limestone sample with unique accuracy. This is because deposition of the Darai Formation occurred during a period of rapid and monotonic change in the 87Sr/86Sr composition of sea water in the Miocene, with diagenetic fluid mobility interpreted to be minimal post-deposition thus preserving the original strontium isotope composition of the limestone during burial diagenesis (Hornafius and Denison, 1993). Given this ability to accurately date samples from the Darai Formation, strontium isotope analysis provides a more robust guide for seismic interpretation away from well penetrations. Strontium isotope data was collated over the area from both field samples and well data with calculated Oslick ages used for this workflow. This data was used to interpret a surface that represents an age of 15 Ma (Figure 2). This surface was then projected down to the approximate Base Darai, using a transform derived from Barikewa-1 and -2 well data and well velocities, providing constraint for the interpretation of Base Darai form away from well data.

This projected Base Darai surface was then used to guide seismic interpretation in TWT to produce two versions of a Base Darai TWT map. The first (V1) assumed a constant TST from the 15Ma surface to Base Darai, adjusted to nearest seismic pick. The second (V2) placed greater reliance on seismic character and assumes the Darai thins to the North West.

Using a combination of palynology, velocities and well derived true stratigraphic thicknesses (TST's), these Base Darai surfaces were projected down to Top Toro to provide guidance for seismic interpretation away from well data (Figure 3), resulting in a high case (shallow, V2) and a low case (deep, V1) pick at Top Toro for the upcoming Barikewa-3 drill.

These surfaces were converted to depth using a constant interval velocity model and the high and low picks for the Top Toro were predicted to be 1500 m TVDSS and 1587 m TVDSS respectively at the Barikewa-3 drilling location. Ultimately, Top Toro was intersected within an accuracy of several meters to the pre-drill prediction using the strontium isotope workflow described above.

Using these surfaces, a fault framework model incorporating an en-echelon NE bounding fault system, which honours well data, was built and QC'd in trap-tester (t7) for structural plausibility. Juxtaposition analysis conducted in T7 also identified key spill points at the reservoir level. Results from Barikewa-3 were incorporated into the interpretation before the model was exported for volumetric analysis conducted in Petrel.

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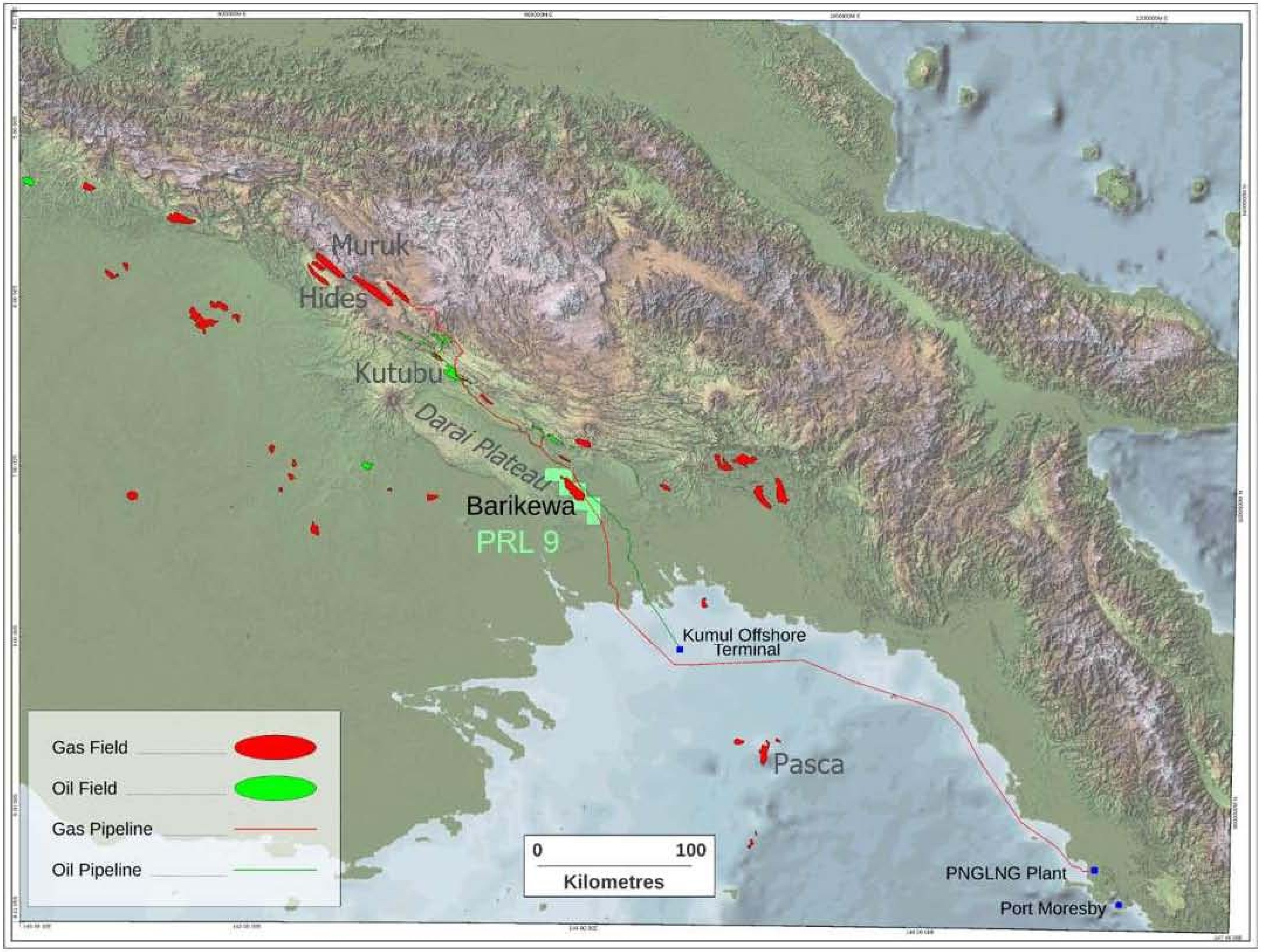


Figure 1. Location of Barikewa Gas Field.

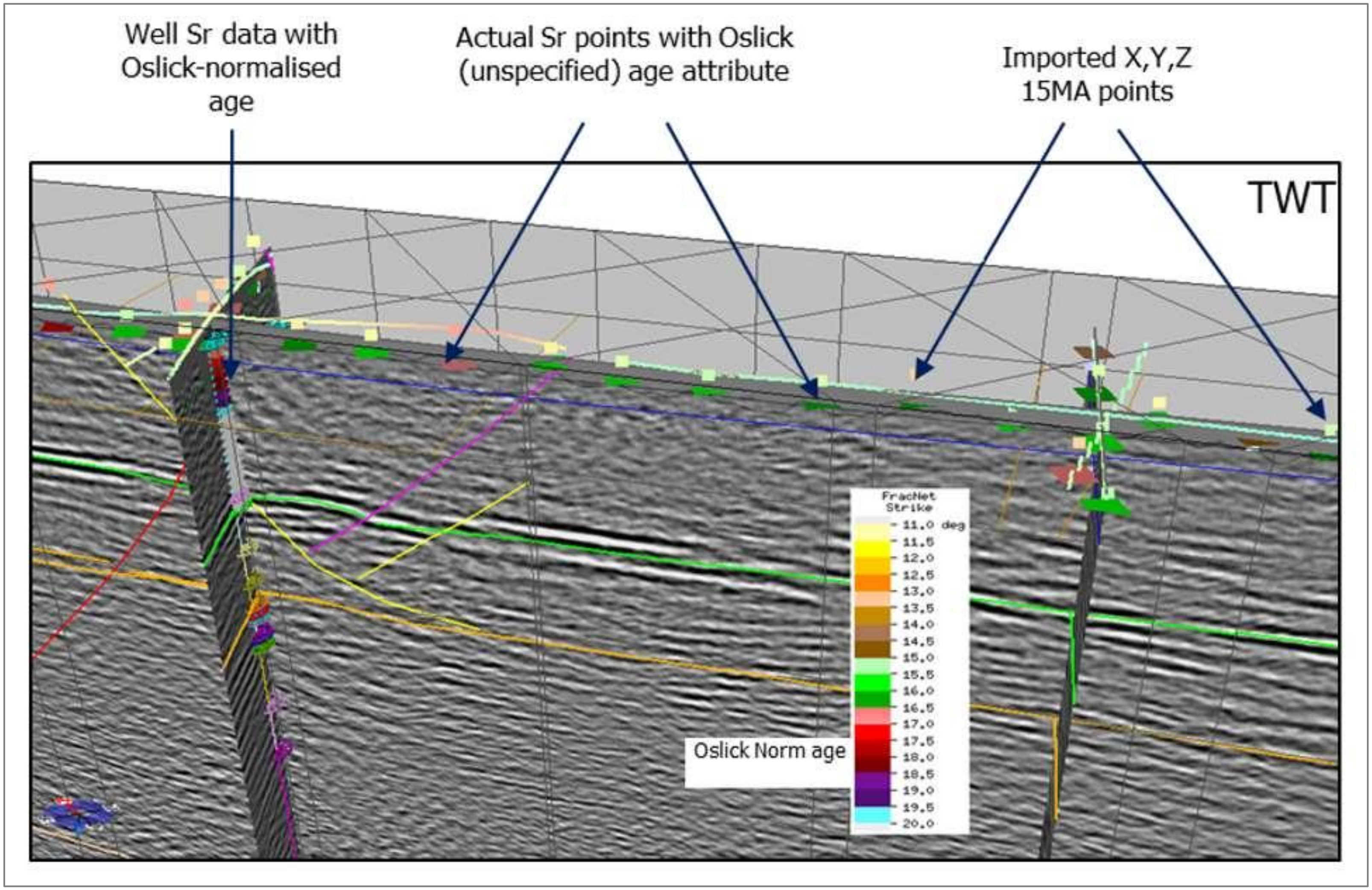


Figure 2. Strontium data points and resulting 15 Ma surface posted on a TWT line in Trap Tester.

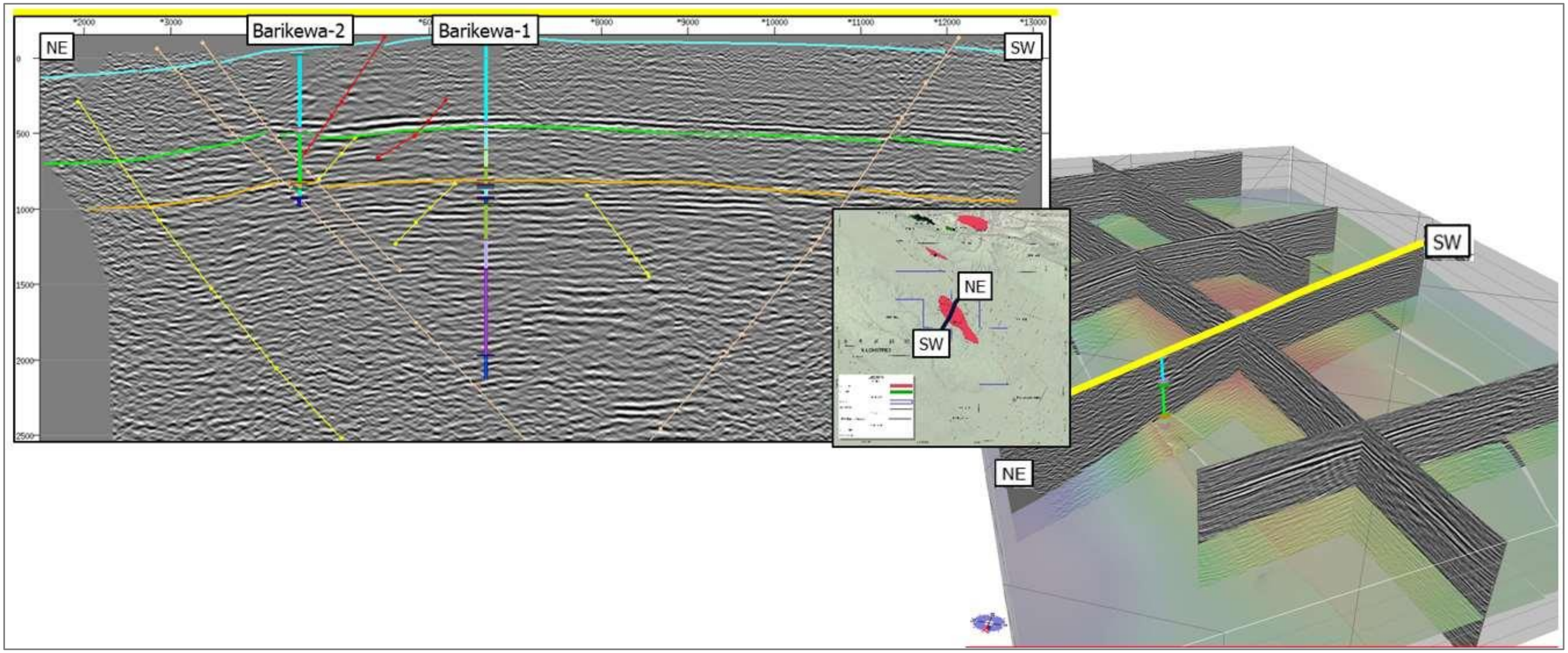


Figure 3. Seismic line example showing interpretation guided by the 15Ma and Base Darai surfaces, along with the 2D seismic coverage over the area.