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# A Prospective Deep Basin in Southern Papua New Guinea?

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## SUMMARY

ExxonMobil's development of the Hides area to the northwest, and Inter Oil's giant gas discoveries at Elk and Antelope to the east, have revitalized exploration in the intervening area of PPL 319-PRL 13, southern Papuan Basin. With only limited seismic and well data available, the most time- and cost-efficient exploration option for the permit holder was to fly and interpret an airborne gravity and magnetic survey covering the permits and the adjacent surround.

After completion of acquisition and processing, the gravity/magnetic data were analysed both qualitatively and quantitatively. Existing seismic data were reprocessed and reinterpreted. We then integrated the results by means of 2D structural models incorporating surface geology, seismic, and subsurface data in order to reach solutions compatible with all data sets.

The final interpretation revealed what appeared to be a large, deep Jurassic basin which we have named Kikori Basin. If confirmed, it could be a hydrocarbon kitchen feeding both internal and surrounding prospective fold and fault structures. Several target leads in and around the deep basin were selected for detailing by a new seismic program which is not yet completed.

**Key words:** South Papuan Basin, airborne gravity/magnetics, Jurassic basin

## INTRODUCTION

The area of Permits PPL 319- PRL 13 ranges from the Papuan Basin lowlands north of the Gulf of Papua, across the Darai Platform, and northward to the Papuan Fold Belt. Prior to 2010, exploration was limited, in part because the terrain and weather made seismic work slow and expensive and in part because any potential Tertiary or Mesozoic plays were considered high risk. Following ExxonMobil's development of the Hides area to the northwest and Inter Oil's major gas discoveries at Elk and Antelope to the east, a new look at the permit areas could be justified by their proximity to both.

In order to high-grade target areas before committing to slow and costly seismic work, the operator opted to cover the permits and adjoining acreage with high resolution airborne gravity and magnetic surveys. The survey was flown and processed in 2010 and the data were analysed both qualitatively and quantitatively before finalizing an integrated seismic/gravity/magnetic/subsurface interpretation that was compatible with all data sets.

An early expectation that the program might reveal basement structures amenable to Miocene reef build-up was not realized. However, an unexpectedly favourable result of the survey was our interpretation of a large, deep Jurassic basin in the southern portion of PPL 319.

## GEOLOGY AND GEOPHYSICS

The geology of the Papuan Basin is well-covered by many published papers whose authors have studied the area in depth. Its geologic provinces range from a low, swampy foreland basin in the south to a hilly frontal thrust belt in the north. Important formations in the permit area are the Miocene Darai Limestone, which varies from a low-density chalky facies to a high-density karstified facies, the Cretaceous Ieru/Toro, and the Jurassic Koi-Iange/Barikewa.

The area to be evaluated exceeded 700,000 acres. However, legacy seismic coverage within the permit consists of only 8 lines totalling 125 km of 1988-vintage 20-fold dynamite data. A new 27 km line was shot in 2010 just west of the PPL 319-PPL 237 border and quality of the new data is much improved over the older data collected over and around the Darai outcrop.

Reconnaissance aeromagnetic surveys have been used in PNG for over 20 years and at least one other permit holder has used airborne gravity/magnetic surveys in the southern Papuan Basin. The survey covering PPL 319-PRL 13 was flown in 2010 and consists of 15,261 line-km. Because terrain variations ranged from 0 m MSL to 1500 m MSL, it was more practical to fly a terrain-clearance survey than to fly one with several constant-elevation blocks. Traverse lines were flown north-south at 800 m spacing and control lines were flown northeast-southwest at 3200 m. The line directions were designed to be normal to estimated geologic trends and also to reduce anomaly distortion due to the low magnetic latitude.

## INTERPRETATION METHODS

The overall interpretation relied heavily on quantitative magnetic analysis coupled with integration of seismic and known geology. I calculated magnetic depth estimates along each flight line using Werner, 2D Euler, spectral, and slope analysis algorithms and evaluated them for quality and consistency. I also made line-to-line and cross-line depth ties for further quality assurance. Caution was required when interpreting short-wavelength gravity anomalies, especially in areas with relatively shallow Darai limestone. Our evaluation showed that the anomalies could have non-unique sources, either from structures in or under the Darai, facies/density changes within the Darai, thinning or thickening of the Darai interval, or Karst features within the high-density matrix.

Although we initially made separate seismic, geologic, and gravity/magnetic interpretations, the key to a cohesive final product was the integration, with limited adjustments, of the separate interpretations which could then be tested and demonstrated by sets of 2D structural models. After the models were evaluated for consistency and geologic plausibility, we were able to extend those results to basement surface contour maps and geologic play maps.

## INTERPRETATION RESULTS

Magnetic anomalies associated with the volcanic mountains of Mt. Murray, Mt. Duau, and Mt Favenc dominate the magnetic map north of the permit areas. These large subcircular anomalies give way to elongate short-wavelength anomalies representing shallow folds and thrusts of volcanoclastic sands which trend west toward the Papuan Thrust belt. The Thrust Belt, which includes the economically important Hides area, is in turn represented by elongate magnetic anomalies which trend southeast into PPL 319. We interpret the elongate basement structures in northern PPL 319 as a deep extension of the trust trend.

Magnetic anomaly character changes across PPL 319 from northwest to southeast. We attribute this change to the presence of a northeast-southwest left-lateral shear zone which terminates or offsets several basement structural trends.

We interpret the broad, predominantly east-west magnetic anomalies in southern PPL 319 as sourced by deep basement structures. The broad trough-like minimum is of special interest because our interpretation shows it as a deep Jurassic basin with up to 8000 m of nonmagnetic fill. This Kikori Basin, as we have named it, could be a hydrocarbon kitchen capable of charging the embayments, high blocks, and pinchouts to the north and east.

## CONCLUSIONS

The interpretation we developed for the PPL 319- PRL 13 could not have been made in a time- and cost-effective way without the use and effective integration of all the methodology described. The final interpretation has provided target lead areas for a new seismic program, a structure map of the magnetic basement surface, and has predicted the presence of a previously unmapped deep Jurassic basin and potential hydrocarbon kitchen.

The magnetic basement interpretation is in local agreement with basement interpreted from the limited seismic coverage. The lack of one-to-one correlation between many magnetic basement features and gravity anomalies emphasizes the complexity of the sedimentary section. Sets of 2D structural models using geophysical and geological data constraints demonstrate the power and value of integrated interpretation methods for arriving at geologically reasonable solutions.

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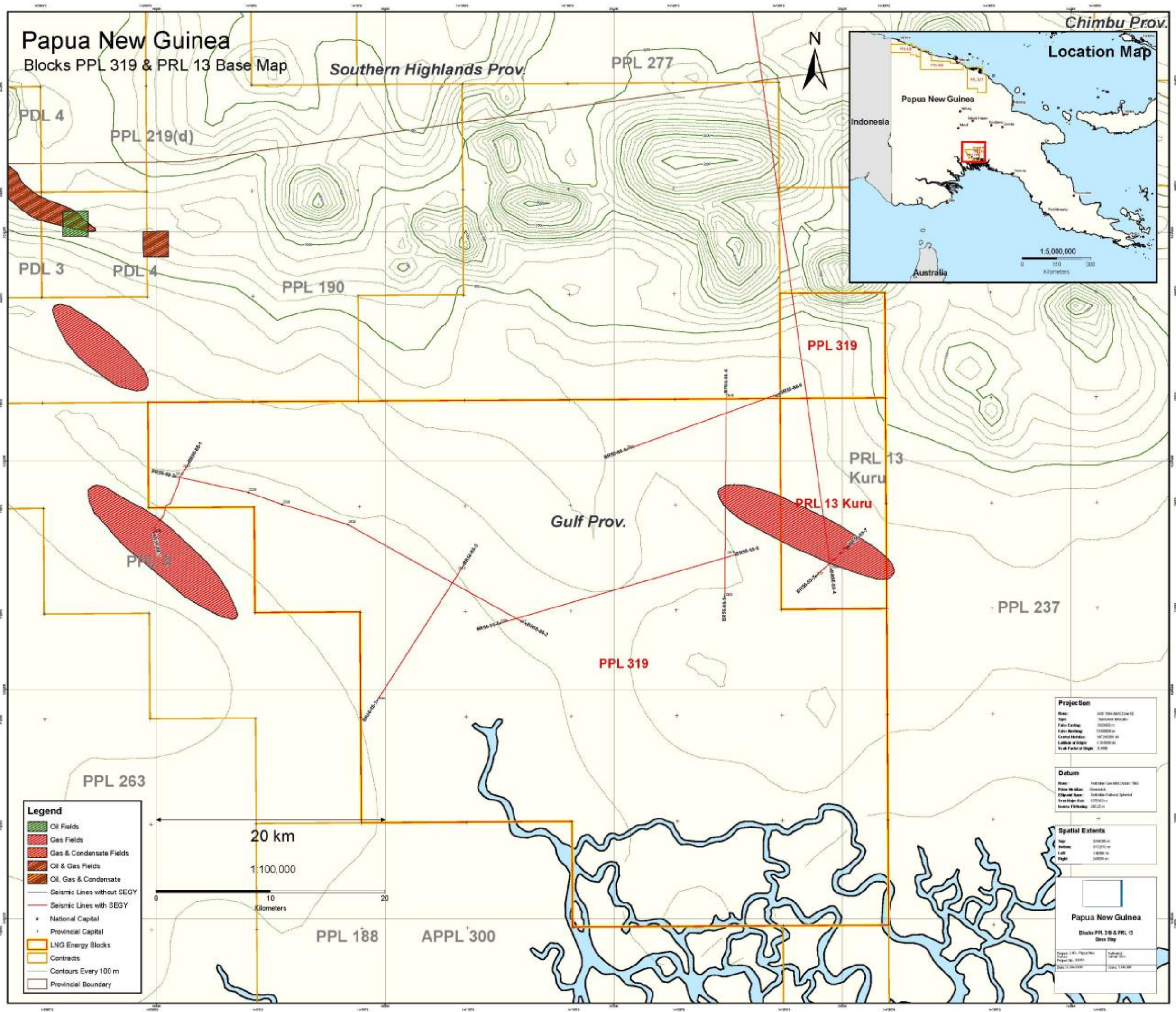


**Figure 1 Location of PPL 319-PRL 13, existing gas fields, wells, and legacy seismic lines**