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Faults and Fractures Characterization of Granitic Basement, Cuu Long Basin, Offshore Vietnam

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Summary

The fractured granitic basement of Cuu Long Basin is Vietnam's most prolific oil and gas reservoir. In Cuu Long basin of Vietnam, large accumulations of hydrocarbons are discovered in the heavily faulted granitic basement. However, it is quite difficult to identify faults and fractures because of lack of layered strata within the granitic rocks. The seismic reflections of the faults usually depend on the width and fluid fill of the fault planes.

The fault likelihood and innovative basement fault likelihood algorithms made it possible to identify natural lineaments in the basement and to correlate them to the younger fault systems. Conventional fault detection methods rely on the layered reflectivity within the overburden but fail in the basement as there are no coherent reflections other than faults themselves. Basement fault detection method finds the lineaments in the basement that are reflective due to the presence of fluids.

In addition, compartmentalization of basement reservoir and the impact of basement faults on the tectonics of the shallower portion of the 3D is discussed.

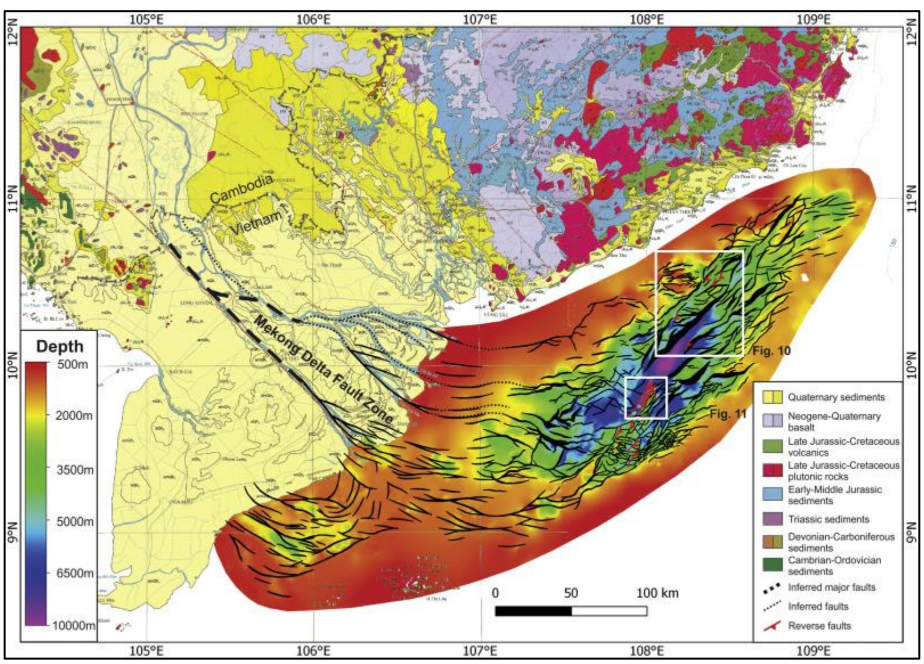


Figure 1: Basement Map of Cuu Long Basin showing regional tectonic fabric

Introduction

Hydrocarbon deposits in the basement occur in many parts of the world. The reserves range from as small as one or two million barrels of oil or gas equivalent to as much as almost two billion barrels of oil (Libya's Augila-Naafora field). The basement reservoirs include fractured and weathered granites, quartzites, carbonated, metamorphic and volcanics.

The Cuu Long Basin is one of the major Cenozoic marginal sedimentary basins of the continental shelf of Vietnam (Fig.1). This basin consists of highly fractured Mesozoic basement and overlying Cenozoic strata of different age and origin. Basement composes mostly of felsic intrusive and sedimentary rocks undergone numerous tectonic events and as a result is highly fractured. The basement rocks were exposed to weathering before subsidence and covered by Cenozoic sedimentary units during subsequent rifting and basin formation processes. These processes created local significant structural variability such as horst and grabens, a network of fractures with sufficient pore space and permeability within the basement complexes. All of these events have contributed to the formation of a unique type of hydrocarbon reservoirs within the basement granitic rocks of the Cuu Long Basin, which became primary targets for oil and gas exploration in Vietnam.

A 600 sq km 3D is used in the analysis. The 3D is shot over a basement high with reverse faulting aligned in NE-SW direction.

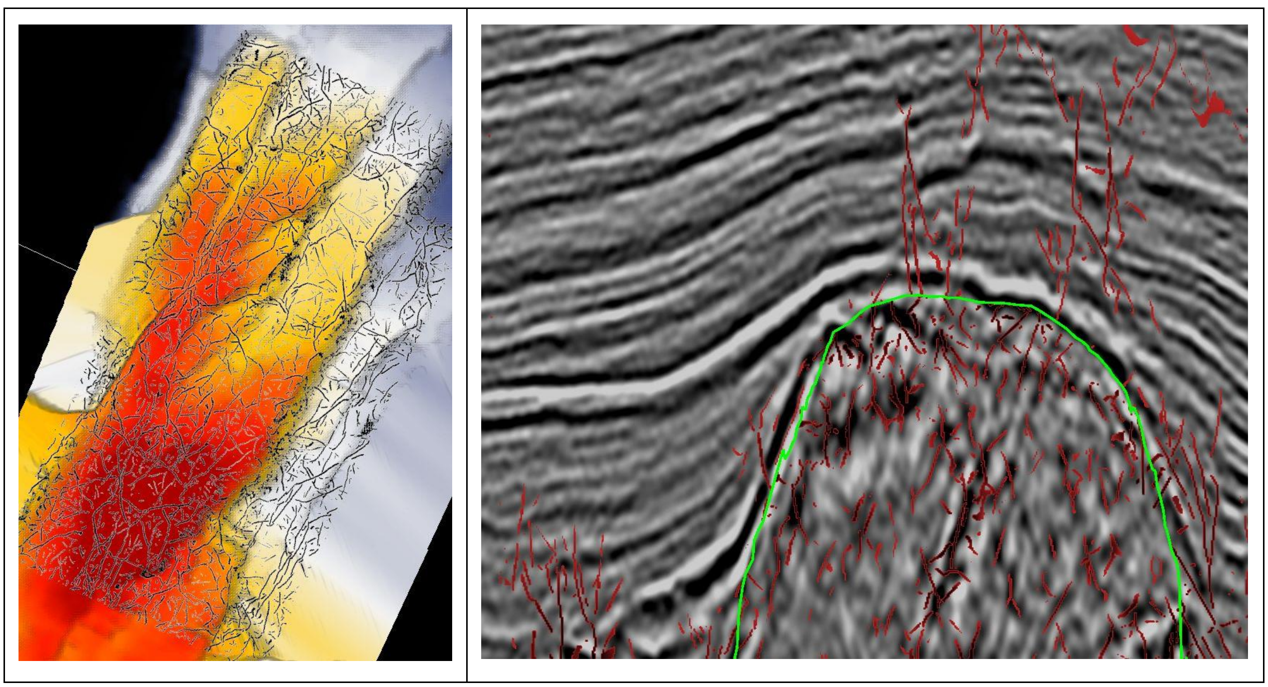


Figure 2: Results of fult likelihood and basement fault likelihood merged together and displayed over in-line and map view.

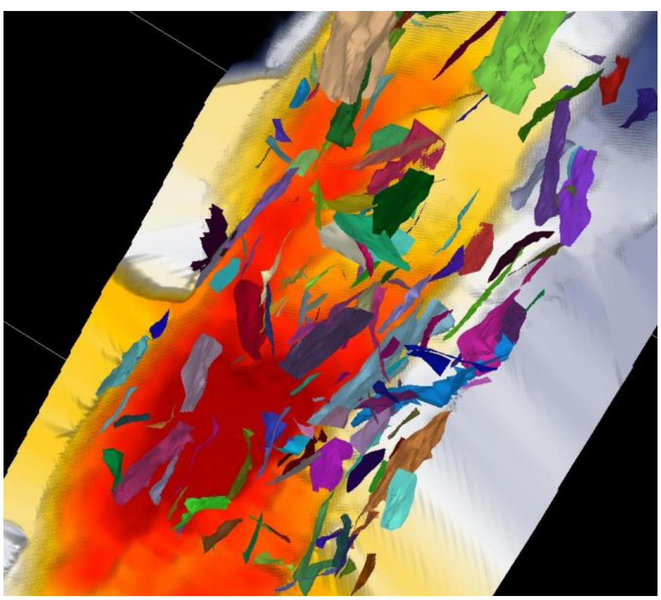
Workflow

Within this work, we applied fault likelihood algorithm to the most productive reservoir – fractured granitic basement, in Cuu Long basin, southern offshore of Vietnam to fulfill the following tasks:

- Fault Lineaments – automatically picked for shallow and basement parts separately, using different algorithms,
- Separation of lineaments according to tectonic events (rifting, compression, and thermal sagging),
- Faults proximity and density are calculated,
- Visual correlation between FMI logs and Fault attribute volumes,
- Faults main azimuths are identified and grouped according to the thinned fault likelihood results.

Basement fault likelihood algorithm is a modification of fault likelihood algorithm strictly following peaks or troughs instead of dissimilarity between the reflectors. The data is processed for basement faults likelihood. In addition, another volume is generated using regular thinned fault likelihood process.

Basement interpretation is added to the volume and used as an interface to combine the two above mentioned volumes. The combined volume thus depicts the actual fault propagation from basement to the shallow horizons (Fig. 2). It is interesting to see that the areas where the shallow faults interact with deeper faults have less prospectivity than the areas where older fault systems do not continue into the shallow zone.



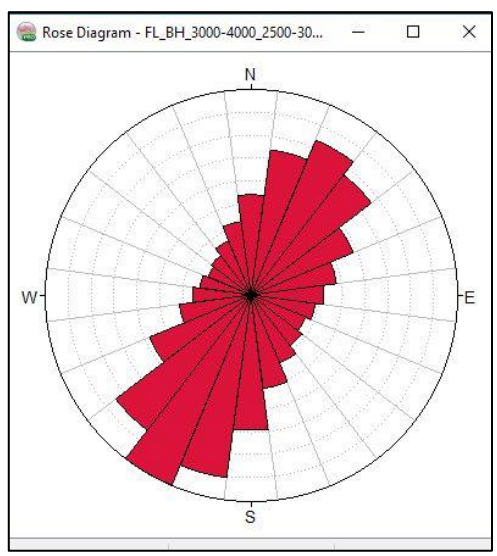


Figure 3: Extraction of major fault system displayed in 3D (left) with fault density histogram showing NE-SW direction.

From the combined volume the fault planes are detected and extracted over the whole 3D. The faults are then characterized based on the dips and azimuths (Fig. 3). The dominant azimuth for all fault planes is NE-SW and that is very consistent with what is observed through the FMI log data.

Conclusions

Application of basement fault likelihood allows the full characterization of basement faulting and its relationship to the younger fault extensions. Re-activation of basement faulting could cause breach of reservoirs and thus a complete understanding of tectonic history is required. Faults' dip and azimuth provide the vital information for geologists to create the structural framework with higher confidence.

Acknowledgements

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