MAPPING SUB-SURFACE GEOLOGY FROM MAGNETIC DATA IN THE HIDES AREA, PAPUAN FOLD BELT, PAPUA NEW GUINEA

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INTRODUCTION

The use of potential field data is valuable in the exploration for hydrocarbons in volcanic provinces such as the Papuan Fold Belt. By applying Energy Spectral Analysis (ESA) and Automatic Curve Matching (ACM) methods to magnetic data, a test was conducted to determine the possibility of mapping sedimentary horizons and faults in part of this region lacking volcanic cover. A relatively simple anticline structure near Hides, without volcanic cover, was chosen.

A horizon mapping technique (ESA) was used to detect magnetic interfaces corresponding to geological horizons. The ACM technique was used to delineate major fault structures. The magnetic data was used to successfully map the Hides anticline structure and major thrust faults were mapped in 3D. The complex overthrust structure, intersected at the Karius 1 well, was defined using a combination of the horizon mapping and structural interpretation.

A magnetic marker within the upper, weakly magnetic Dari Limestone was mapped, showing the trend of the top of the Dari. The Top of the Ieru Formation and Toro Formation were mapped and five deeper sedimentary interfaces were also mapped. The results from the interpretation of magnetic data are consistent with structures mapped from seismic and well data.

GEOLOGICAL SETTING

The Papuan Fold Belt is 100km wide and 1000km long and in places up to 3km high and consists of complex fold and thrust structures, including vertically overturned beds, creating thrust repeats of Miocene Formations (Hill et al, 2004).

The study area covers the Hides Anticline, which generally trends north-west to south-east, plunging to the south-east, with fault traces in this orientation mapped at the surface (Figures 1 & 2). The region is surrounded by three volcanoes, Mounts Sisa, Kerewa and Doma.

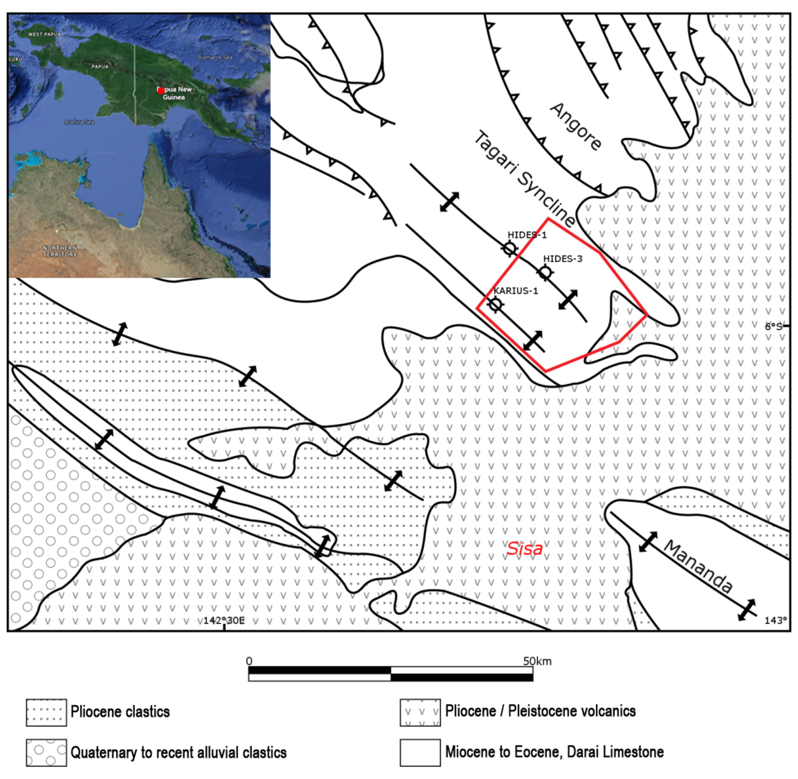


Figure 1 Location of Hides study area, Western Papuan Fold Belt, PNG. (after Hill et al 2004).

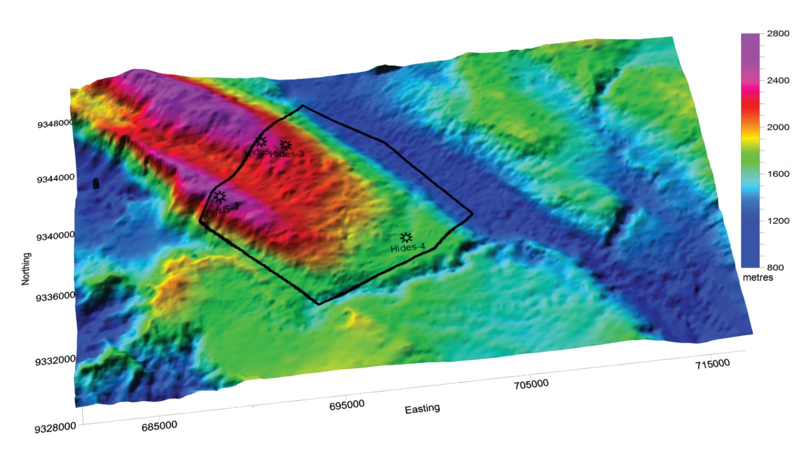


Figure 2 Hides Topography in 3D with study area and wells.

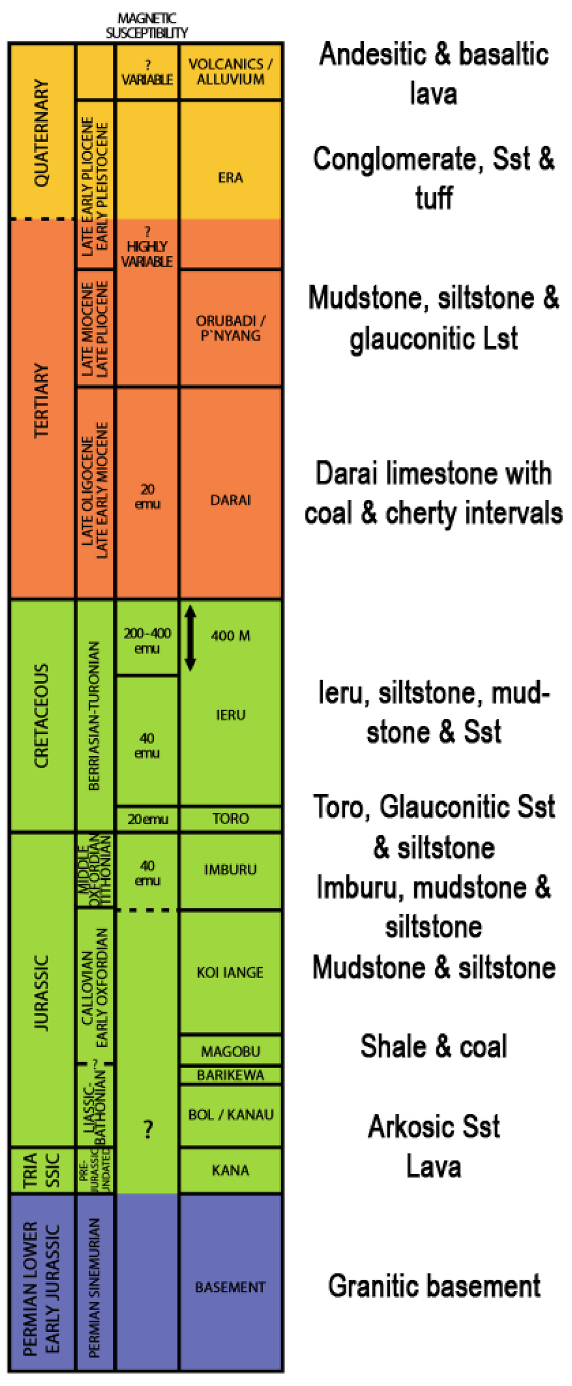


Figure 3 Litho-stratigraphy of the Hides Anticline.

The majority of the region is covered in highly magnetic lavas and volcaniclastics. The local topography ranges from 2.8km in the centre, to 1.2km along the north-eastern edge of the Hides Anticline. Four wells have been drilled within the study area; Hides-2, 3 and 4 and Karius-1. The anticlinal structure of Hides results in Darai Limestone outcrop (or subcrop) and includes thrust faulting from the southwest.

The litho-stratigraphy of the area comprises the Miocene Darai Limestone which includes multiple sedimentary layers of strongly magnetic materials. The Cretaceous Ieru Formation consists of Upper Ieru, a more magnetic sandstone, and lower Ieru, a marine siltstone and mudstone. The Toro Sandstone of Lower Cretaceous age is shallow marine glauconitic sands (indicator of increased magnetic properties). The Upper Jurassic Imburu Formation consists of mudstone and siltstones (Figure 3).

DATA DESCRIPTION

The magnetic data used for the study was from an airborne survey acquired in 2006 and 2007 over a large part of the Papua New Guinea Highlands. The traverse spacing for the survey was 400m. The Total Magnetic Intensity (TMI) data was gridded with a 100x100m mesh and was Reduced To Pole (RTP) (Figure 4). Existing down-the-hole magnetic susceptibility logs from the four wells show that there are multiple magnetic markers within the sedimentary section. Average susceptibility values from Hides 2 are high in the Darai limestone.

Hides 1, to the north of the Hides Anticline, also has layers near the top of Darai with high magnetic susceptibility units, suggesting there are likely volcaniclastic units within the Darai Limestone. The Ieru Formation has a higher magnetic susceptibility in the section close to the Base Darai.

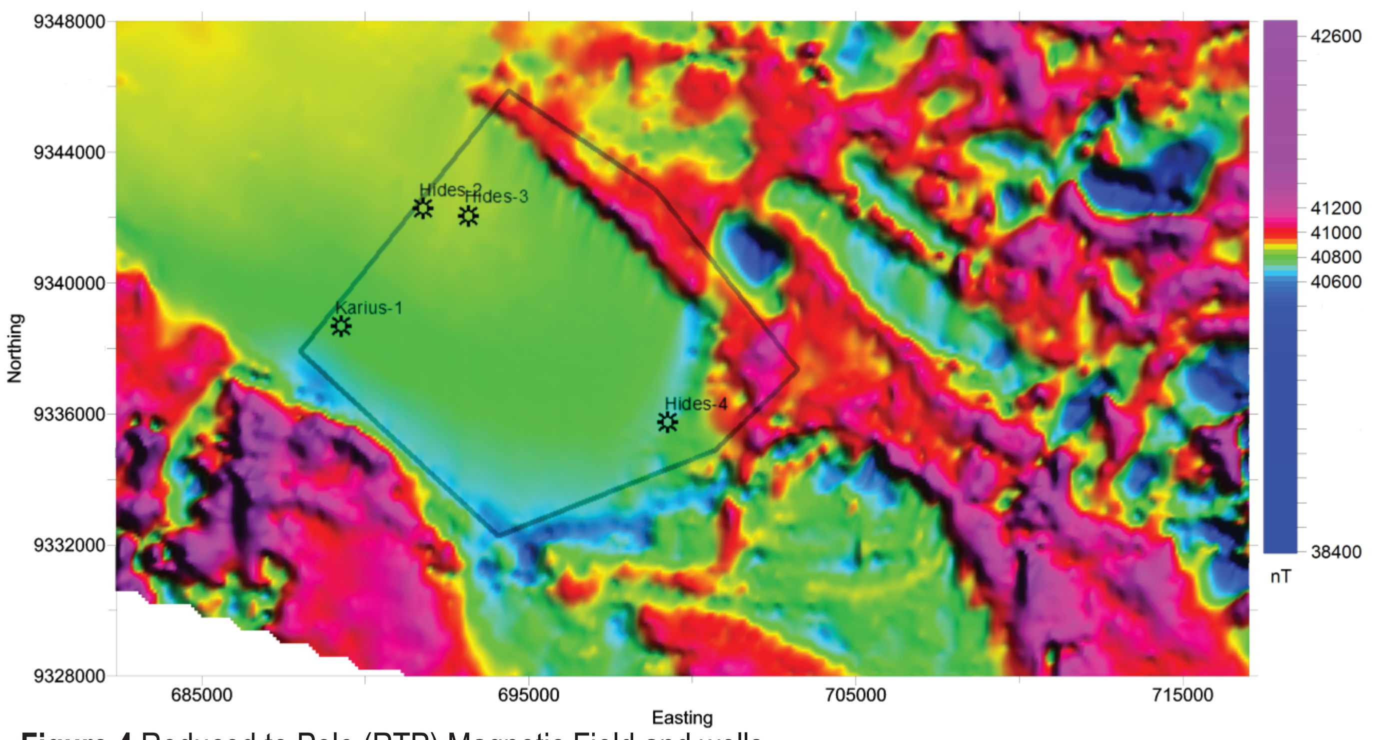
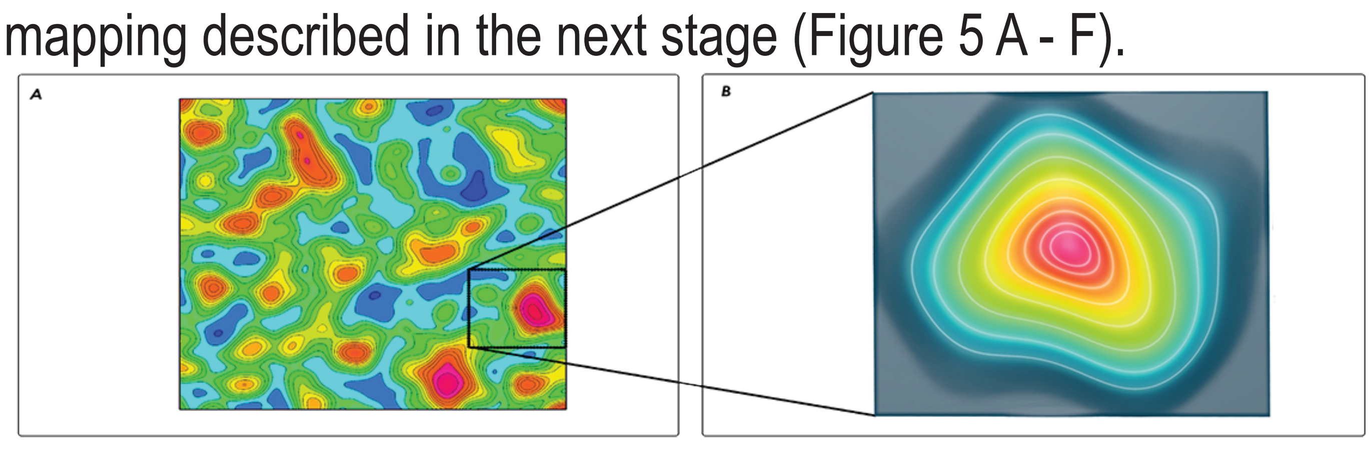


Figure 4 Reduced to Pole (RTP) Magnetic Field and wells

METHODOLOGY

Horizon Mapping: The Energy Spectral Analysis "Multi-Window Test" (ESA-MWT) procedure (Kivior et al., 2011) was applied to detect the depth to magnetic heterogeneities. At each MWT-station, multiple spectra were computed and interpreted over increasing window sizes and a graph of the depth values versus window size was plotted. When the window covers the anomaly properly, the depth stabilises forming a depth-plateau. By further increasing of the window size, deeper depth-plateaus can be detected. Depth-plateaus were laterally merged with those depth-plateaus from surrounding MWT-stations, building a skeleton map of magnetic interfaces corresponding to the Top Darai and Ieru as well as other deeper interfaces. Each depth-plateau provided the optimal window size for higher resolution depth mapping described in the next stage (Figure 5 A - F).



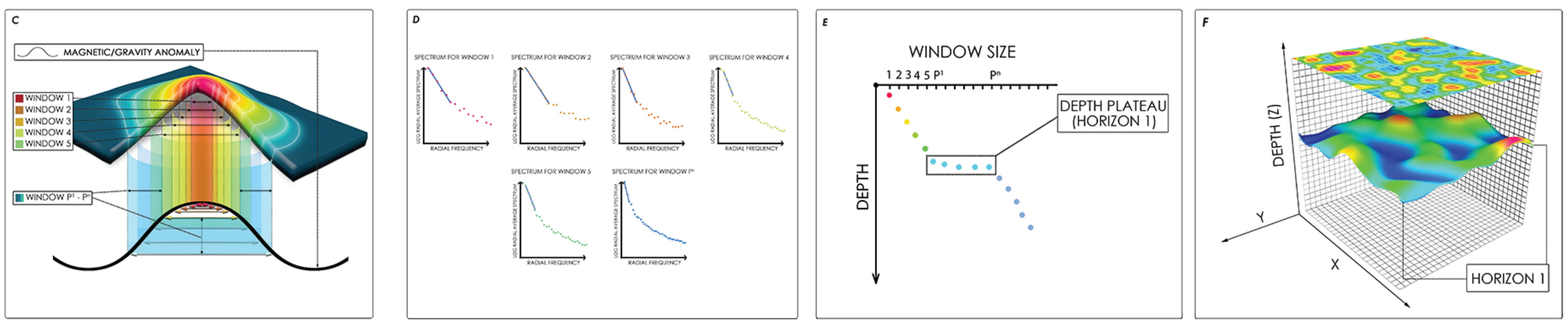


Figure 5 (A & B) A simplified representation of the ESA-MWT horizon mapping procedure; beginning with a magnetic/gravity anomaly map, (C) over a statistical layer of an ensemble of multi-prisms, (D) ESA-MWT, applied through interpretation of spectra computed from windows of increasing size, (E) identifies a depth-plateau; (F) analysis of depth-plateaus detected over a coarse mesh of ESA-MWT stations covering the study area produces a skeleton map of a magnetic/gravity horizon.

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