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Significance of the basin wide reverse polarity reflector in the Offshore Sydney Basin, East Australian Margin

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The Offshore Sydney Basin is located between latitudes 32°30'S and 34°30'S between the coastal cities of Newcastle in the north and Wollongong in the south, covering a total area of ∼15,000 squire km. The structural framework of the offshore portion of the basin comprises five principal elements: the Offshore Syncline, an extension of the New England Fold Belt, an offshore extension of the Newcastle Syncline, the Offshore Uplift and the Outer Continental Shelf. The present easterly extent of the basin is the result of Cretaceous rifting and commencement of seafloor spreading in the adjacent Tasman Sea. The continental shelf is approximately 50 km wide offshore Sydney and is edged by relatively steep continental slope. This study has been carried out with 2D multichannel seismic data covering the northern half of the offshore basin.

The Cenozoic sedimentary cover of the basin is characterized by two regional unconformities: one at the base of Cenozoic and another intra-Cenozoic. The unconformity at the base of Cenozoic is known as the Top Sydney Basin unconformity. In places the surface is displaced by faults and also characterized by possible mounds producing an overall highly irregular topography. Though most of the faults remained buried beneath the surface some continued up to seafloor. They seem to have NW-SE direction with significant lateral extension.

The intra-Cenozoic unconformity forms a prominent reflector at about 80 to 200 msbs (TWT). It is characterized by an angular unconformity with the reflectors terminating onto it from beneath. It is also associated with prograding sequences beneath, terminating with toplap geometry, suggesting that it forms the boundary between a transgressive and regressive phase. This is interpreted as a prograding carbonate dominated shelf-edge. The most interesting aspect of this seismic reflector is that the major part of it presents reverse polarity with respect to the seafloor reflection. The amplitude of the reflector changes laterally and is characterized by patches of high amplitude (bright spots). Contour mapping shows that this reverse polarity reflector is continuous and regionally distributed. The depth of the reflector with respect to the sea surface is too shallow to be a BSR, typically caused at the interface between hydrate containing sediments above and free gas below. Reverse polarity is a common indicator of the accumulation of hydrocarbons. However, alternatively in such shallow depth it can also be caused by the presence of a soft sediment layer. Another important point to note is that no chimney or any other gas escape features have been observed in the vicinity originating from the reverse polarity reflector. However, in the adjacent continental slope, giant pockmarks have been observed on the bathymetry data. They most probably originated from gas sources in Permian coal measures. In order to understand what is causing this reverse polarity further quantitative analysis such as AVO and inversion has been done.

AVO analysis and subsequent inversion of selected seismic lines show that some parts of the reversed polarity are characterized by bright spots, especially on the hanging wall side of the major faults, caused by the presence of gas. The stratigraphic position of the reflector suggests that the anomalous horizon could have been formed during the low-stand that followed the high-stand progradation event seen on dip sections. The gas accumulation could then be associated with "back reef" carbonates that during the low stand have been subjected to karstification causing the gas entrapment in vugular pore spaces.