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A New Constraint for the Age of Unconformity U6 in the Ross Sea

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Abstract - In the Eastern Basin of the Ross Sea there is seismic evidence of a very strong and clear reflectors (U6) that marks a very important event whose age and origin are under debate.
A new constraint on the age of U6 has been identified by the reprocessing of multichannel seismic data. We show that unconformity U6 onlaps a structural high (Central High) before reaching DSDP site 270. So U6 is older than the sediments found at DSDP site 270, whose age at the bottm of the hole is older than 26 Ma, according to the previous correlation by Hinz and Block, (1984).

INTRODUCTION

In the eastern Ross Sea (Fig. 1), U6 is an erosional unconformity clearly onlapping against the main basement highs. It is at the top of subparallel horizons filling the grabens in the basement, separating them from the upper aggradational - progradational regional sequences. It has a very characteristic seismic signature, with high amplitude and continuity (Fig. 2). In the eastern Ross Sea, U6 is the youngest deformed horizon, and is locally onlapped by the overlying sequence which is mainly undeformed. In the western Victoria Land Basin, U6 is a very strong angular unconfomity, separating underlying deformed strata from the upper sequences, thus distinguishing two phases of rifting (Cooper et al., 1987).

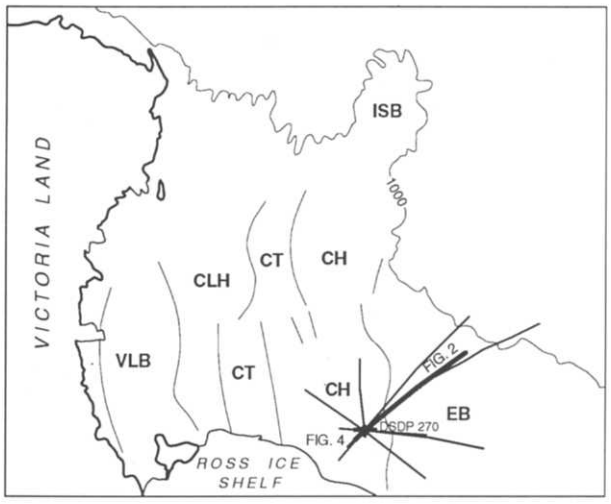

Fig. 1 - Position map of the Ross Sea showing the seimic lines crossing DSDP site 270 and the main structural elements. (CH = Central High, CLH = Coulman High, CT = Central Trough, EB = Eastern Basin, ISB = Iselin Bank, VLB = Victoria Land Basin)

Various ages and origins have been proposed for U6.

In the Eastern Ross Sea the erosional unconformity U6 was first identified by Hinz & Block (1984). In their interpretation, U6 reaches DSDP site 270. At site 270, drilled on the flank of a small basement graben, below a Holocene - Miocene glacial - marine sequence (385 m), calcareous greensand (1 m) dated at 26 Ma (Late Oligocene), and carbonaceous sandstone (1.8 m) and breccia (25.5 m) dated probably Oligocene have been found lying on the Paleozoic basement (Hayes & Frakes, 1975), (Fig. 3). Using this site, Hinz & Block (1984), and Hinz & Kristoffersen (1987) attributed to U6 a Late Oligocene age, with a hiatus between 22 and 30 Ma. They thought that this hiatus is linked to the climatic and enviromental changes caused by the onset of the circum - Antarctic current due to the opening of the Drake Passage beginning at 29 Ma (Barker & Burrell, 1977).

Bartek et al., 1991, assuming a Late Oligocene age, also, attribute the origin of U6 to the first ice sheet grounding event.

Cooper et al. (1990) gave unconformity U6 an older age (Eocene), relating it to the tectonic phase that produces grabens in the basement. Therefore in their interpretation the unconformity doesn't reach site 270.

METHODS AND RESULTS

Seismic lines crossing DSDP site 270 have been reprocessed at the Osservatorio Geofisico Sperimentale in order of understand whether or not U6 can be traced across the site. Data contained in the SCAR Seimic Data Library (1992, 1993) were used. Seven lines collected by MAGE, JNOC, BGR and OGS were filtered and displayed at appropriate scale and plotting parameters.

The result is that U6 followed the Eastern Basin onlaps the basement high just before the well (Fig. 4). Thus U6 must be considered older than 26 Ma.

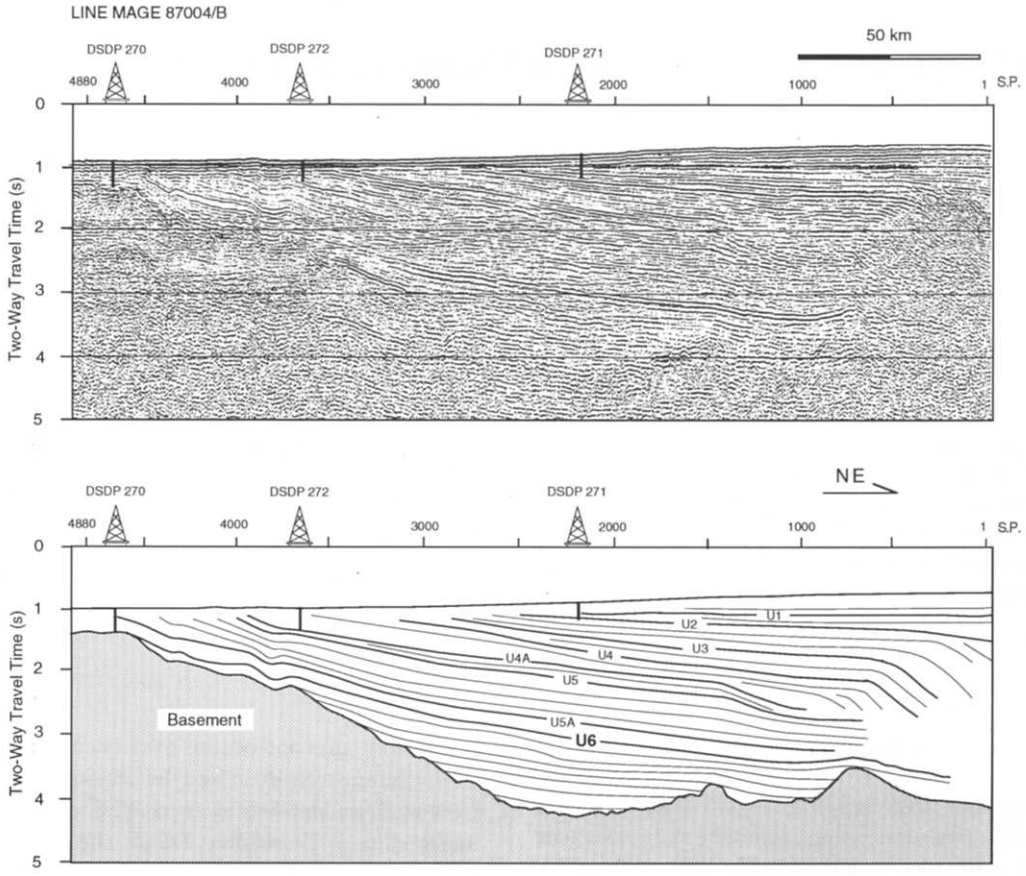

Fig. 2 - Seismic line MAGE 87004/B crossing the Eastern Basin (modified after Cooper et al., 1991). U6 is a strong amplitude horizon onlapping the basement high. See figure 1 for location.

DISCUSSION

It is not clear if the origin of U6 is related to sea-level change, tectonics, or a sum of both. Erosion below and onlap above the unconformity can justify both causes.

Some of the seismic characteristics in the eastern Ross Sea indicate U6 as a break - up unconformity. From marine magnetic isochrones the beginning of drift between the Campbell Plateau and the Marie Byrd Land - Eastern Ross Sea is at isochron 34, dated at 84 Ma (Lawver et al., 1992). Even though from well data U6 appears older than 26 Ma, it is very difficult to consider it as a break - up unconformity dated at 84 Ma (Late Creataceous), because there is no evidence of such a large stratigraphic gap.

Considering that by overlaying on our lines the stratigraphic horizon dated 26 Ma at site 270, we obtain a thickness above of no more than 300 m, the age of the unconformity cannot be too far from Late Oligocene; resonably we consider it older than Late Oligocene but no older than Eocene.

Because in this time span the global paleoceanographic 30 Ma sea level lowstand occurs (Vail et al., 1977), we propose that U6 be correlated with this event.

Since in the eastern Ross Sea U6 is the youngest deformed horizon, and the upper sequence is mainly undeformed, it is possile to suppose a stress field change.

Cloething et al., (1989) modelling a lithosphere with depth-dependent rheology (brittle upper layer and ductile lower layer), found that even during post break-up evolution of the margin, intraplate stress can play an important role in modulating the subsidence of the margin. Cloething & Kooi (1992) say that the tectonic stress field within lithospheric plates shows a causal relationship between processes affecting the plate boundaries and intraplate deformation.

So U6 could be a consequence of changes in the stress regime due to plate readjustments. This can be verified by looking at the geomagnetic chronology south of Campbell Plateau (Fig. 5), which shows a parallel trend between chrones 32 (71 Ma) and 18 (42 Ma), contrary to the other

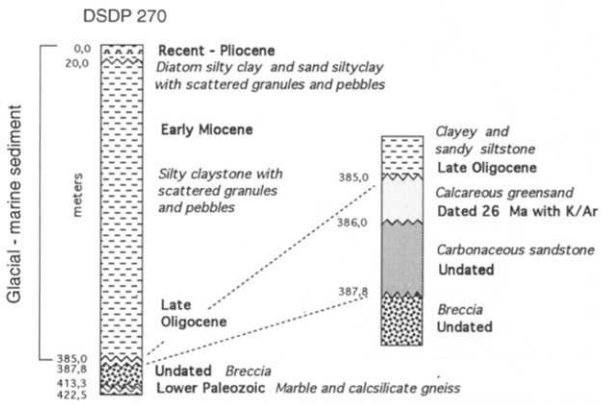

Fig. 3 - Stratigraphy at DSDP site 270 from Hayes and Frakes, (1975), modified. The column to the right is an enlargement of the lower part of the site.

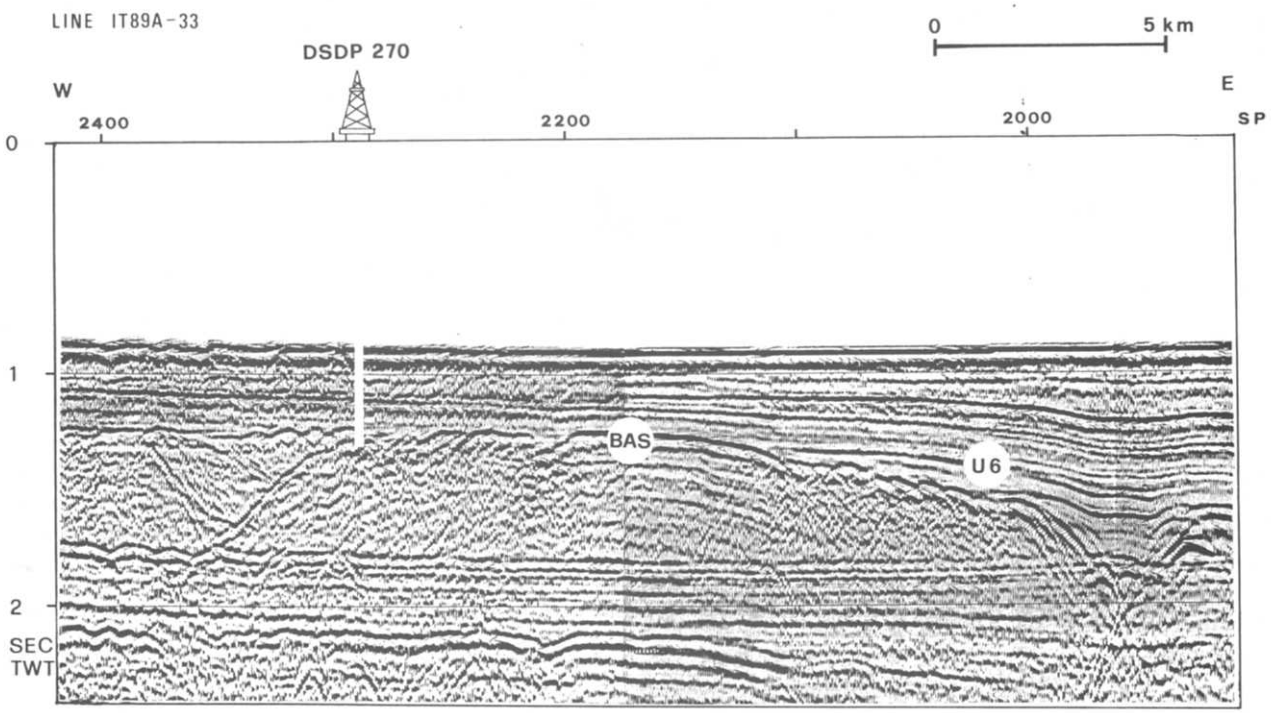

Fig. 4 - Result of reprocessing seismic line IT89A-33 showing that U6 onlaps the basement high just before reaching DSDP site 270. See figure 1 for location.

geomagnetic chrones in the south-west Pacific; after a data gap due to unrecognizable chrones, the trend between chrone 6 (21 Ma) to the present one is rotated eastward with the same direction as the other anomalies in the area (Stock & Molnar, 1987). During the period of unrecognizable chrones between 18 and 6, the spreading rate was very slow (Molnar et al, 1975). Many interpretations have been given to explain this anomalous trend, such as changes in direction and velocity of the spreading. Stock and Molnar (1987) suggest that until chrone 18 there was a triple junction among the Pacific, Antarctic, and a third plate corresponding to the

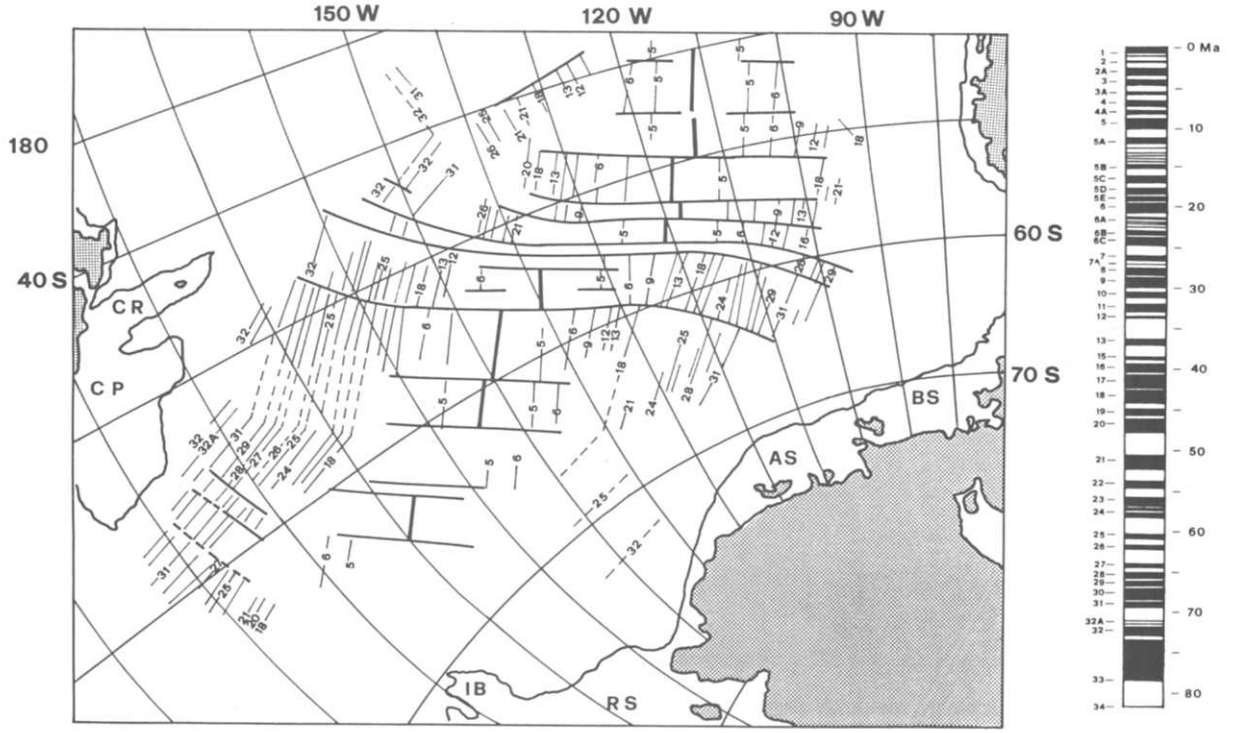

Fig. 5 - Geomagnetic chrones in the south-west Pacific area. Below the Campbell Plateau the isochrones between 32 and 18 are rotated with respect to the other coeval chrones in the area. After a gap, the chrones younger than 6 have the same orientation as the other coeval chrones in the area. (Modified after Stock & Molnar, 1987). (CP = Campbell Plateau, IB = Iselin Bank, CR = Chatman Rise, RS = Ross Sea, AS = Amundsen Sea, BS = Bellinghausen Sea).

Bellinghausen and Amundsen seas. Between the Antarctic and the Bellinghausen plates, they assume the existence of a spreading center whose activity started at chrone 31 and stopped at chrone 18.

As processes affecting the plate boundary produce stresses that propagate over large distances in the intraplate areas, and that can modulate the subsidence of the passive margin (Cloething & Kooi, 1992), we propose a correlation between this geodynamic event of plate readjustment which started in the Late Eocene (42 Ma) with unconformity U6.

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