Comparison of Eastern Ross Sea with Campbell Basin

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The Ross Sea embayment is thought to be extended continental crust that may have undergone as much as 100% extension (Lawver and Scotese, 1987; Cooper et al., 1991). Marie Byrd Land, Campbell Plateau, Lord Howe Rise, and both North and South New Zealand may also be extended crust. Campbell Plateau and Lord Howe Rise are still below sea level while Marie Byrd Land may have been uplifted by a mid-Cenozoic mantle plume (LeMasurier and Rex, 1989) and New Zealand is again subaerial due to late Cenozoic compression (Bradshaw, 1989). Marine magnetic anomalies found between Campbell Plateau and the eastern Ross Sea/Marie Byrd Land indicate initiation of Pacific-Antarctic seafloor spreading at ~85 Ma (using the timescale of Kent and Gradstein, 1986). Before that time, the Ross Sea, Marie Byrd Land, Campbell Plateau, New Zealand and Lord Howe Rise were contiguous. Prior to ~100 Ma, these landmasses, with the Antarctic Peninsula (including the Thurston Island block), were arranged along the actively subducting Pacific margin of cratonic East Antarctica and Australia (Cawood, 1984). As evidenced by the complex history of New Zealand (Bradshaw, 1993), some if not most of these pieces were accreted during Permian to Cretaceous time.

GEOSAT satellite gravity data [positive anomalies] and GEBCO bathymetry [<_2000 m waterdepth] are used to define the ocean/continent boundary [OCB] for Campbell Plateau. Recent ERS-1 satellite gravity data (Sandwell, pers. comm.) are used to define the OCB along the eastern Ross Sea margin (Fig. 1). In figure 1, the edges of the deep sedimentary basins of the Ross Sea, taken from Cooper et al. (1991), are superimposed as thick white lines on the ERS-1 satellite gravity data. The Campbell Plateau OCB outline with the sediment isopach...

Fig. 1 - ERS-1 satellite gravity data south of 72°S merged with the Geosat satellite gravity data from north of 72°S (Sandwell, 1992) courtesy of David Sandwell. Heavy off-white line marks the presumed ocean-continent boundary along the Ross Sea margin. The thin white lines are the edge of the Campbell Plateau (CMP) as picked from the Geosat gravity data and the sediment thickness contours of the basins on the Campbell Plateau taken from Carter (1988a). The Campbell Plateau has been rotated closed to Marie Byrd Land (MBL) in its pre-85 Ma position. Hatched thick white lines in the Ross Sea embayment mark the edges of the sedimentary basins taken from Cooper et al. (1991). CB=Campbell basin, CH=Central high, CT=Central trough, EB=Eastern basin, NVL=North Victoria Land, TR=Terror rift. A-A' is the location of the seismic line shown in figure 2.
lines from Carter (1988a) are reconstructed onto the Ross Sea ERS-1 gravity map and are shown as thin white lines. There is an extraordinary fit (Fig. 1) between the OCB of the Campbell Plateau and the OCB of the West Antarctic margin from just east of Iselin Bank (176°W) to well along Marie Byrd Land (145°W). There is also an excellent alignment of the eastern margin of the Campbell basin with the eastern edge of the Eastern basin. The close fit suggests that most of the extension in the eastern Ross Sea, Marie Byrd Land and Campbell Plateau occurred prior to break-up at approximately 85 Ma. Since there is no overlap of the two OCBs in the eastern Ross Sea/western Marie Byrd Land region with the conjugate Campbell Plateau margin, we presume that this break was not preceded by an interval of crustal stretching parallel to it.

Reconstruction of Australia with East Antarctica (Royer and Sandwell, 1989) places Tasmania and the South Tasman Rise along the North Victoria Land/western Ross Sea continental margin with little room between the reconstructed pieces and Iselin Bank, an assumed continental “back-stop” block. Seismic reflection and refraction work on the South Tasman Rise (Hinz et al., 1985) indicate that it is a continental fragment that has been stretched during the Mesozoic and Cenozoic and it presumably fit between Australia/Tasmania and East Antarctica prior to seafloor spreading. Seismic reflection work across the western margin of Iselin Bank (Davey and Cooper, 1987) suggest that it was the conjugate rifted margin of the South Tasman Rise. The fit of the South Tasman Rise continental fragments into the Iselin Bank backstop along with Tasmania and a tight fit of Australia to East Antarctica, preclude much post break-up extension in the western Ross Sea.

Support for the hypothesis that the Ross Sea Embayment underwent the majority of its extension prior to 85 Ma include the observations that 1) the Ross Sea is underlain by basement grabens filled with up to 8 km of high velocity presumed Mesozoic strata that are unconformably overlain by up to 6 km of flat-lying Cenozoic rocks (Cooper et al., 1987), 2) a similar seismic stratigraphy in Campbell basin (Anderton et al., 1982), and 3) the remarkable match (Fig. 1) in the 85 Ma reconstruction that brings sedimentary basins found on Campbell Plateau (Carter, 1988a) into alignment with those in the eastern Ross Sea (Cooper et al., 1991). In the western Ross Sea, broad and deep basement grabens lie below a regional unconformity, U6 (Hinz and Block, 1984), that can be traced in multichannel seismic reflection data as a high-amplitude reflector (Fig. 2). U6 is mostly undeformed and planes the tops of basement blocks. All major basin downfaulting (i.e. major regional extension) occurs below U6, with principally broad regional subsidence above U6 (Cooper et al., 1991). From drilling and regional considerations, U6 may separate overlying Eocene and younger glacial strata from underlying late Mesozoic (?) strata and Paleozoic basement rocks (Cooper et al., 1991). Because in situ rocks below U6 have not been sampled, the age of U6 is uncertain and other explanations are entirely possible (Busetti and Cooper, 1994).

The Anderton et al. (1982) report shows that the Paleocene in Campbell basin has a uniform thickness of 200-350 m and slopes southwest basically parallel to the sea floor, which deepens from 200 m in the northeast to 850 m in the southwest. The inferred Cretaceous section shows great variation in thickness across horsts and grabens, and in the deep part of the basin in the south is 1500-4000 m thick. There is a strong suggestion that faulting is confined to the Cretaceous (Bradshaw, personal communication). The Great South basin, which lies north of the Campbell basin, also has thick drilled Cretaceous sections that grade upward from non-marine sandstones and coal measures (mid-Cretaceous) to fluvial and shallow marine strata (late Cretaceous) that overtop the main horst blocks. Since the Cretaceous, this basin has remained tectonically quiet with regional subsidence and marine transgression (Cook and Beggs, 1990).

The use of satellite data more tightly constrains plate reconstructions between the Campbell Plateau and Ross Sea (Figure 1; Lawver and Gaither, 1994) than possible in prior comparisons of these areas (e.g. Cook and Davey, 1990 and Cooper et al. 1990). The new reconstructions may help explain the late Mesozoic structural evolution of the formerly conjugate extensional basins, in particular, knowledge of the timing of New Zealand extension should provide insight into the history of Ross Sea extension.

REFERENCES

Busetti M. & Cooper A.K., 1994, Possible ages of unconformity U6 in the Ross Sea, Antarctica. This volume