MULKARRA IMPACT STRUCTURE, SOUTH AUSTRALIA: A COMPLEX IMPACT STRUCTURE. J. B. Plescia, U. S. Geological Survey, 2255 N. Gemini Drive, Flagstaff, AZ 86001

Introduction: Flynn **(1)** identified a structure in the subsurface of the western Eromanga Basin that he interpreted as a buried impact. The structure, based on seismic reflection and gravity, was considered a simple bowl shaped crater 9 km in diameter. Residual gravity data showed a circular anomaly 6-7 km in diameter having a central low and a surrounding high; total gravity relief IS ~1 mGal (residual gravity over the remainder of the region was not illustrated). The nature of a disturbed zone surrounding the suggested 9 km structure was not addressed.

The question of the diameter remains. **(1)** concluded the diameter was 9 km and the structure was that of a simple crater. However, the seismic deformation encompasses a region 17 km in diameter. Thus, two models may be suggested: a 9 km diameter structure whose formation disturbed the surrounding sediment, or a larger feature with a central pit or peak ring.

Geologic Context: The stratigraphic section consists of fluvio-lacustrine sediments (Hutton Sandstone, Birkhead Fm., Mooga Fm.) overlain by a shallow marine and marginal marine sequence (Cadna-Owie Fm., Bulldog Shale, Coorikiana Sandstone, Oodnadatta Fm., and Winton Fm.). Unconformities separate the sedimentary section from underlying basement and from overlying Tertiary and Recent sediments. The only post-Jurassic regional deformation in the area is the Tertiary age northeast-trending Birdsville Track Ridge Anticline of Tertiary age to the northwest.

Seismic reflection data indicate reflectors are flat lying and undeformed outside the structure. Within the interior, reflectors are broken up and somewhat chaotic. A series of horsts and grabens (~ 500 m wide) and normal faults with perhaps 50-100 m of offset occur. The deformed zone is ~ 17 km across. At the center is a bowl shaped depression 9 km across overlying incoherent reflectors. Deformation occurs below the Coorikiana Sandstone (750 m deep), but extends through the remaining section and possibly into the basement (1400 m deep).

Gravity Survey: To better constrain the crustal structure, data were collected in September 1993 using a Lacoste Romberg meter; elevation control was established using a laser theodolite. Data were collected along four diagonal profiles centered on the gravity anomaly defined by **(1)**. The new data were combined with data presented by **(1)** that were collected in 1988 **(2)**. The combined set consists of >600 stations.

The uppermost part of the stratigraphic section at Mulkarra is characterized by a seismic velocity of 2.4 km sec^{-1}, thus a density of 2.1 g cm^{-3} was used in the reduction. The more detailed gravity survey reported here defines a Bouguer gravity field decreasing to the west-southwest, consistent with the broader gravity field **(3)**. Removal of 2nd and 3rd order surfaces produces residual maps that isolate the anomaly directly associated with the Mulkarra structure.

The third order residual gravity map (Figure 1) shows a central low surrounded by a high ~8 km in diameter having ~1 mGal relief. This feature is again surrounded by a low having a diameter of 15-16 km (measured to the axis of the outer low) or 20 km (measured to the outer edge of the low).

Interpretation: Gravity and seismic data suggest that the Mulkarra structure is not a 9 km simple crater. Rather, it is a 20 km complex crater with a 9 km central pit or peak ring. The stratigraphic context of the structure suggests it was formed in a shallow marine environment in unconsolidated sediments. A 20 km diameter structure is within the complex size range, although the diameter is smaller than the transition diameters for central pits (22 km) and peak rings (25 km) **(4)**. However, as the final form of the crater is controlled by the strength of the material **(5)**, a low cohesion and low viscosity target (i.e., unconsolidated marine sediments) could result in the onset of a central pit or peak ring at smaller diameters.

The Marquez structure in Texas shows similar limited deformation in seismic profiles across the feature. Marquez is a 13 - 20 km diameter complex impact crater **(6)**. Seismic reflection data **(7)** show a central peak (characterized by chaotic and incoherent reflectors) and a surrounding annulus where the strata is only mildly deformed. Concentric inward dipping normal faults with <100 m of displacement sur-

round the structure. A well defined rim does not occur. The suggestion has been made **(8)** that as the Marquez structure formed in a marine environment in unconsolidated sediments, the classic bowl shaped structure with a central peak and well defined rim did not form. Rather the energy was expended in a more chaotic disturbance of the stratigraphy.

A similar situation may have occurred at Mulkarra. Impact into a marine section of largely unconsolidated sediments may have produced a crater lacking the well defined structural elements of impacts into more competent rock. As a result, the gravity signature is similarly less well developed

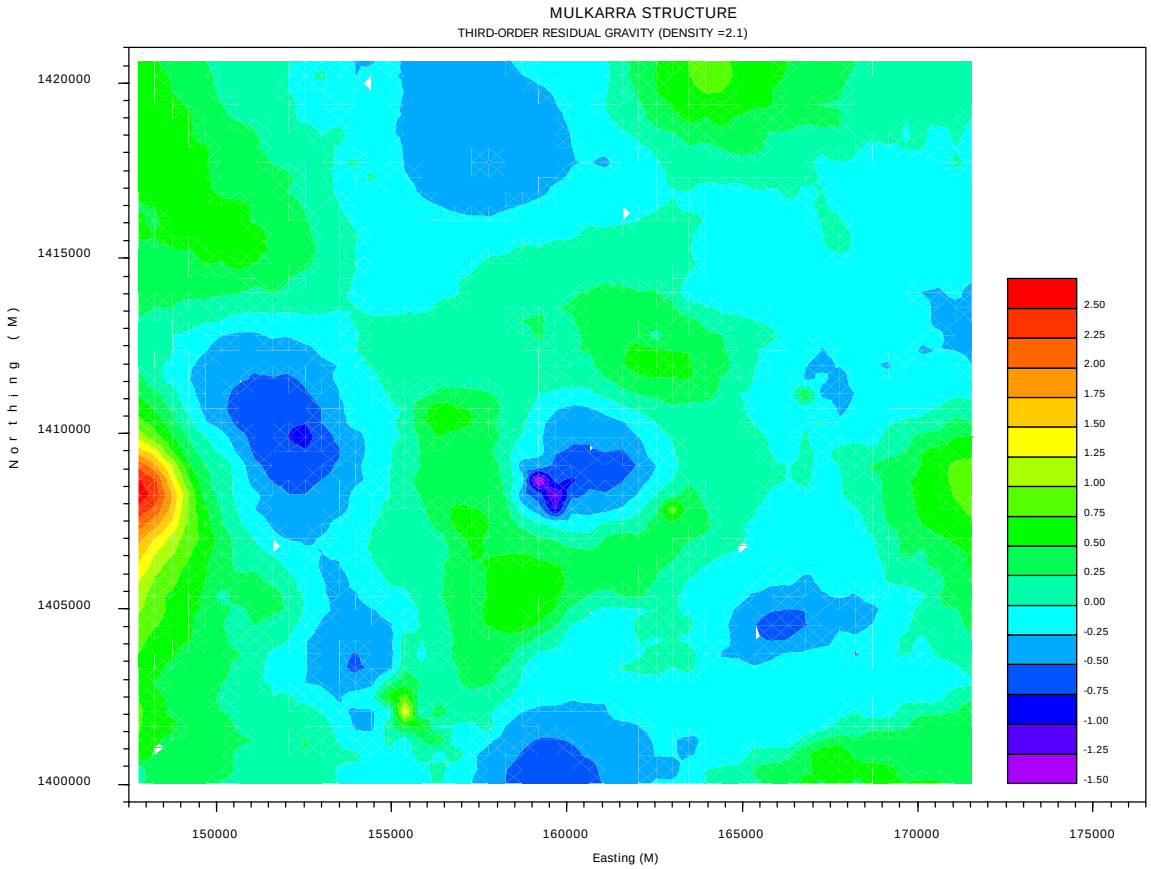

Figure 1. Color coded contour map of the third order residual gravity. Reduction density was 2.1 g cm^{-3}. A 50 x 50 grid was calculated and contoured. Contour interval is 0.25 mGal.

References: **(1)** Flynn, M., 1989, The Cooper and Eromanga Basins Australia, B. O'Neil ed., Australian Society of Exploration Geophysicists, p. 431-439. **(2)** Busuttil, S., 1988, SANTOS Ltd. Unpublished Report. **(3)** Williams, A., 1975, Geological Survey South Australia. **(4)** Pike, R., 1983, J. Geophys. Res., **88**, 2500-2504. **(5)** Melosh, H., 1989, Oxford University Press, 245 pp. **(6)** Sharpton, V., and Gibson, J., 1990, LPSC 21, 1136-1137. **(7)** Gibson, J., 1990, M. Sc. thesis, University of Houston, 65 pp. **(8)** Buchanan, P., et al., 1998, Meteoritics, **33**, 1053-1064.