GRAVITY INVESTIGATION OF THE CONNOLLY BASIN IMPACT STRUCTURE, WESTERN AUSTRALIA; E. M. Shoemaker, U.S. Geological Survey, Flagstaff, AZ 86001, C. S. Shoemaker, U.S. Geological Survey, Flagstaff, AZ 86001, and J. B. Plescia, Jet Propulsion Laboratory, Pasadena, CA 91109.

The Connolly Basin is a 9-km-diameter impact structure [1] in Western Australia. Geologic mapping of the basin [2] indicates that the center of the basin is occupied by a steep-sided structural uplift--a central peak. The mapping has been used to control the geophysical modeling reported here. Further control for the modeling is provided by a north-south seismic reflection line that completely crosses the structure. The line is slightly offset from the center of the basin, crossing along the eastern edge of the central uplift [2]. Strong, nearly horizontal reflectors are present at depths of about 0.7 to 0.8 sec beneath the basin rim and interior; these same reflectors are inclined and offset a few hundredths of a second beneath the central uplift. Reflectors at depths <0.7 sec are strongly disrupted and are offset by inward-dipping normal faults beneath the basin.

During the 1985 and 1986 field seasons, two gravity profiles, one oriented north-south and one east-west, were measured across the crater. The north-south profile corresponds to the location of the seismic section. Topographic control was obtained by alidade, theodolite and tape survey. Stations were spaced 176.17 m apart and the profiles are 11.3 km long. Gravity measurements were made using a Worden Master Model meter. Both the gravity values and topographic control are relative, as these data are not yet tied to a preexisting network. The Bouguer gravity values include drift, free air, Bouguer (assumed density 2.67 g cm^{-3}), and latitude corrections. No topographic correction was made as the correction is negligible (<<0.01 mgal).

The regional gravity field in the Connolly Basin area is defined by a sparse gravity network (about 1 station/150 km^2) [3]. A broad northeast-oriented gravity high strongly influences the regional gravity gradient in the vicinity of the crater. The regional gradient is about 0.4 mgal/km along the north-south profile and and 0.8 mgal/km along the east-west line. The residual (regional removed) gravity shows that the central uplift is marked by a pronounced gravity high (half-wdith about 1.6 km) having about 1.6 to 2.0 mgal of relief relative to the gravity values outside of the crater (Figure 1). Surrounding the uplift at a distance of 1.8 to 4.0 km is a gravity high exhibiting about 0.3 to 0.5 mgal of relief. This high is separated from the central uplift by an annular gravity low (a moat) about 0.5 km across having about 0.3 mgal of relief.

Figure 1 illustrates a possible relative density model for the Connolly Basin along the north-south and west-east gravity lines. The density model includes a high-density region corresponding to the central uplift and two shallow thin layers of material filling the basin. The central uplift is composed of material brought from depth (possibly the Patterson Formation), which has a positive density contrast of about 0.06 to 0.07 g cm^{-3} relative to the surrounding country rock. This contrast is derived from the observed gravity on the assumption that the structural amplitude of the uplift is 1 km, about that expected for a 9-km impact structure. The gravity data indicate that the margins of the uplift have variable dip.

We have postulated two shallow layers of diverse density contrast on the basis of geologic units mapped on the basin floor. The deeper layer is a ring of material with a density contrast of about -0.08 g cm^{-3}, which we interpret as impact breccia. This low-density layer has a maximum thickness of the order of 100 m and is required to explain the low-gravity moat. The upper layer, which we correlate with an exposed unit of crater-fill sandstone, has a positive density contrast of about 0.1 to 0.13 g cm^{-3} and a maximum thickness of 100 m. We infer that this positive density contrast arises from the presence of low-density shales in the country rock in which the crater was formed. A tradeoff can be made between the thicknesses of the two layers and their density contrasts in modeling the gravity anomaly.

REFERENCES: [1] Shoemaker, E.M., and Shoemaker, C.S. (1986) Connolly Basin, A probable eroded impact crater in Western Australia: L.P.S.C. XVII, p. 797-798. [2] Shoemaker, E.M., and Shoemaker, C.S. (1989) Geology of the Connolly Basin, Western Australia, this volume. [3] Crowe, R.W.A. (1979) Bureau Mineral Resources, Geology and Geophysics, Western Australia Geologic Survey, 1:250,000 Geological Series Explanatory Notes, Morris, Western Australia, 12 p.

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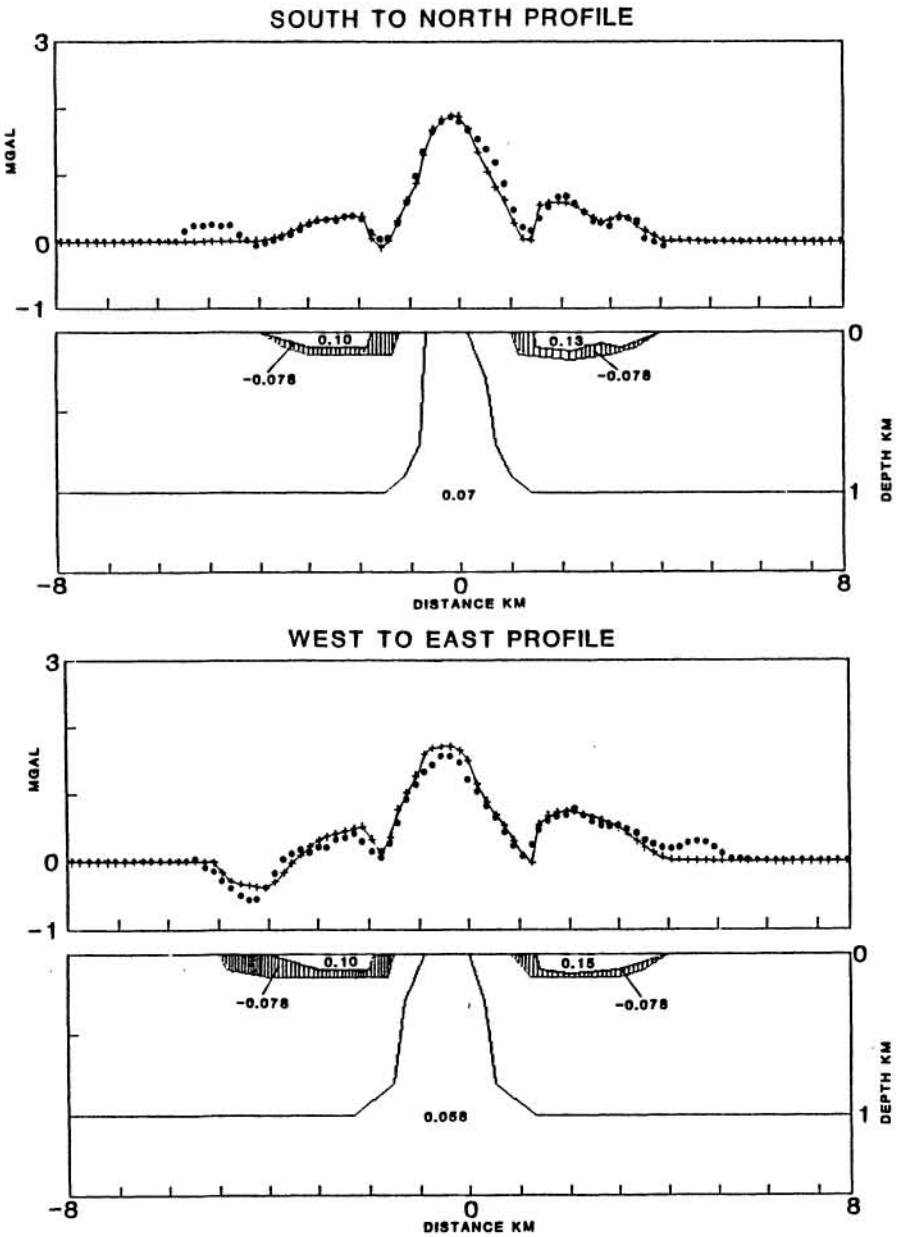

Figure 1. Gravity profiles and relative density models for the Connolly Basin. Dots show residual Bouguer anomaly; lines with + marks are modeled residual gravity corresponding to relative density models below profiles. Density is shown in g cm^{-3} relative to main unit above 1 km depth (which is unlabeled).