**KELLY WEST IMPACT STRUCTURE, AUSTRALIA, GRAVITY** J. B. Plescia[1], [1]Applied Physcis Laboratory, Johns Hopkins University, 11100 Johns Hopkins Road, Laurel MD 20723, jeffrey.plescia@jhuapl.edu..

**Introduction:** The Kelly West impact structure is one of a several on the Australian continent that have been discovered and studied over the last two decades [1-4]. Kelly West is located in Northern Territory (19° 55.72'S; 133° 56.97'E). Only the central uplift (~2 km diameter) of the structure is exposed; the overall diameter and character beyond the central uplift are unknown. As such, Kelly West is particularly suited for a gravity survey to determine the diameter and other structural aspects [e.g., 5-9].

**Geology**: A detailed geologic map of Kelly West was compiled in 1989 by Eugene and Carolyn Shoemaker [1] building on the earlier work of Tonkin [10] and illustrating much of the structural complexity. The principal bedrock geologic units include the Hatches Creek Group and the Gum Ridge Formation. Two breccia units: an authigenic breccia and a sedimentary breccia, are also mapped. Laterite, colluvium and alluvium cover much of the surrounding plains and low areas within the central uplift. Five units are defined within the Hatches Creek Group: lower red sandstone, white sandstone, conglomeratic brown sandstone, shale, and an upper red sandstone. The Hatches Creek Group, which lies above the Warramunga Group, is also Early Proterozoic in age and includes quartzite and sandstone with interbeds of basaltic and silicic lavas. The Gum Ridge Formation is composed of chert, chert breccia, and limestone and is of Early-Middle Cambrian age. Regional structure in the area consists of a syncline filled with Hatches Creek Group rocks.

**Data Collection**: A gravity survey was conducted over the structure using a Worden gravity meter (Master Model III, #758, meter constant 0.0877 mGal/dial division). Data were collected along a series of roads in the area, along a profile across country extending to the east and on and around the central uplift. Because there were no absolute gravity base stations in the area, gravity values are relative to an arbitrary base station at the site. Base station measurements were made every few hours to account for meter drift. The average meter drift calculated was about 0.07 mGal $hr^{-1}$. Elevations were determined using a laser theodolite and were referenced to the nearby Kelly West trigonometric station. Terrain corrections were not applied as the relief in the area is small and topographic maps with the appropriate resolution are not available. Bouguer reductions were computed using a density of 2.67 g $cm^{-3}$.

**Gravity**: The Bouguer gravity map shows a south-southeast trending (N110°E) low with an amplitude of a few mGal. Marginal gradients into the low are of the order <1 mGal $km^{-1}$. This anomaly is consistent with that observed in the regional gravity survey of the Tennant Creek sheet [11]. The signature from the Kelly West structure is obscured by this larger anomaly and indicated only by a deflection of the contours on the southwest margin of the low. In order to isolate the anomaly associated with the structure itself a residual field was calculated and contoured.

In order to isolate the anomaly due to the structure, various order polynomial surfaces were fit to the Bouguer gravity and residuals calculated. Those residual values were then contoured. Figure 1 illustrates the 3rd order residual gravity field in an oblique 3D representation.

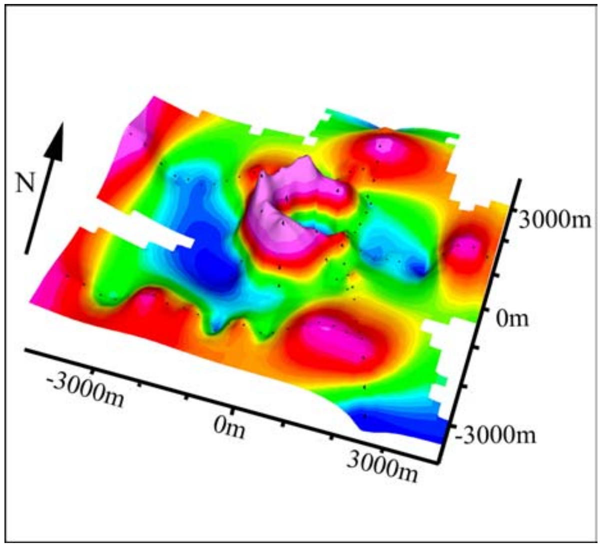


*Figure 1. 3D perspective of residual gravity field showing the central high with interior low and annular low. Small black dots denote station locations.*

The central gravity anomaly is composed of a low and surrounding high over the central uplift. The low reaches –0.5 mGal. Surrounding the central low is a ring high ~1.8 km in diameter with as much as 1 mGal of relief with respect to the central low. The high is best defined to the west and it's definition is clearly controlled by the distribution of stations. Its absence on the east side suggests that it is narrower and of lower amplitude on that side. Coverage on the east side is not as extensive as on the west side, but there appears to be a sufficient number of stations to define the presence of the anomaly.

Surrounding the central anomaly is a more subtle, annular low some 6.6 km in diameter bounded at larger distances by higher values. The annular low is best defined in areas where there is good control: to the east, southwest and northwest. The low is not as well defined on the northeast and southeast margins. Although it appears to have an amplitude that varies with azimuth, it is unclear whether this is real or an artifact of the data distribution. However, the low is considered to be real with an amplitude of about 0.2-0.3 mGal. There is sufficient control to show that the low is not present at greater distance from the structure.

**Discussion**: The gravity anomaly indicates that at the present erosional level, the Kelly West structure has a diameter of 6.6 km. This is smaller than the diameter estimate of [1] of 8-20 km. Given the presence of breccia in the center of the structure interpreted to be alluvial or colluvial in origin [1], significant erosion does not appear to have occurred. Thus, the 6.6 km diameter, although a minimum value, is probably close to the original value.

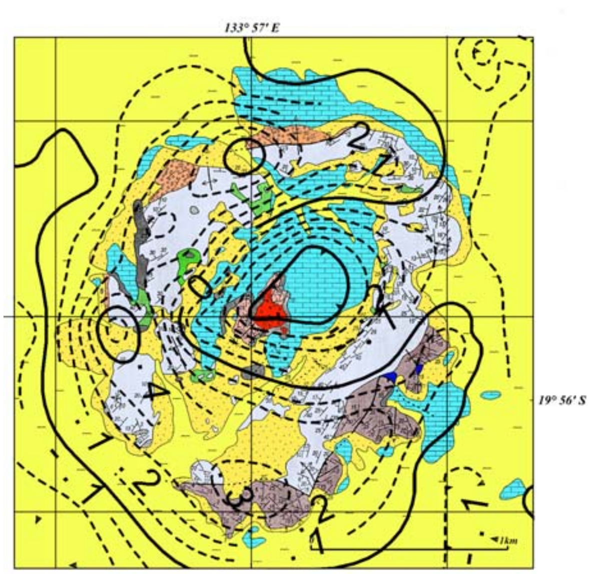


*Figure 2. Residual gravity overlain on the central peak geology showing the correlation of geology and gravity.*

The gravity anomaly can be correlated with the geology. The central low is coincident with exposures of the breccia and extends beyond the exposure to the north and east. Those areas are covered by a thin veneer of the Cambrian Gum Ridge rocks and can be interpreted to overlie a more widespread (thicker?) section of the breccia. The annular gravity high is coincident with the circular outcropping of the White Sandstone and Lower red sandstone of the Hatches Creek Group (around the circumference of the central uplift) and the conglomeratic brown sandstone in the north and northwest. This suite of rocks is structurally complex but the gravity coverage is insufficient to show the correlations with small-scale structure.

The central low thus corresponds to a volume filled with low density breccia. The annular high corresponds to the relatively high-density sandstone. The outer low is, presumably, associated with the crater floor breccia and post impact fill having relatively low density. Modeling of the gravity suggests density contrasts of–0.09 g $cm^{-3}$ for the annular trough, +0.03 g $cm^{-3}$ for the central uplift, and –0.37 g $cm^{-3}$ for the inset into the top of the uplift. These density contrasts are similar to those reported for other impact structures.

Kelly West is one of the few structures in this diameter range with a well-defined central positive gravity anomaly. Most other structures of this size either lack an anomaly or have simple lows. It may be that lack of significant erosion has preserved the density contrast at Kelly West allowing for the preservation of the complete gravity anomaly.

**Summary**: Kelly West is a 6.6 km diameter impact structure on the Australian continent. The diameter is determined from a gravity survey as only the central uplift is exposed. A central gravity anomaly over the central uplift is composed of an annular high and an inset low. An outer annular low defines the remainder of the structure. Gravity over the central uplift is well correlated with the exposed geology.

**References:** [1] Shoemaker E. M. and Shoemaker C. S. (1996) *AGSO J Geo. Geophys., 16*, 379-398. [2] Grieve R. A. F. and Pesonen L. J. (1992). *Tectonophysics, 216,* 1-30. [3] Grieve R. A. F. (2001) Geol Sur. Canada Report 548, 207-224. [4] Grieve R. A. F. *et al*. (1995) *GSA Today, 5,* 189, 194-196. [5] Pilkington M. and Grieve R. A. F. (1992) Rev. Geophys., 30, 161-181. [6] Plado J. *et al.*, (1996) *MAPS, 31*, 289-298. [7] Plado J., *et al.*, (1999) *GSA Spec. Pap 339,* 229-239. [8] Sturkell E. F. F., *et al*. (1998) Tectonophysics 296, 421-435. [9] Plescia J. B. *et al.* (1994) *JGR, 99*, 13167-13179. [10] Tonkin P. (1973). *J. Geol. Soc. Aust., 20*, 99-102. [11] Dodson R. G. and Gardener J. E. F. (1978) Tennant Creek. Bur. Mineral Resources, Geology and Geophys., Commonwealth of Australia, 26 pp.