EVIDENCE FOR A MAJOR IMPACT STRUCTURE IN THE NORTHWEST PROVINCE OF SOUTH AFRICA - THE MOROKWENG IMPACT STRUCTURE; [1]**B. Corner,** [2]**W.U. Reimold,** [2]**D. Brandt,** and [3]**C. Koeberl**, [1]Corner Geophysics Namibia Pty. Ltd., P.O. Box 11474, Klein Windhoek, Namibia; [2]Dept. of Geology, Univ. of the Witwatersrand, P.O. Wits 2050, Johannesburg, RSA.; [3]Inst. of Geochemistry, Univ. of Vienna, Althanstr. 14, A-1090 Vienna, Austria.

Summary: Evaluation of gravity and aeromagnetic data for the region of the Northwest Province of South Africa has revealed the presence of a circular structure of about 340 km in diameter. Together with our findings of shock metamorphism in the form of planar deformation features (PDFs) in quartz of quartzite and of brecciated Banded Iron Formation (BIF) from this region, as well as a report of shock metamorphism and a melt rock from drillcore from the central part of this region by Andreoli et al. [1], this geophysical evidence is strongly indicative of a large, previously unknown, impact structure, termed the *Morokweng impact structure*.

Extensive mapping of the suboutcrop geology of the Kaapvaal Craton, based on aeromagnetic and gravity interpretation coupled with published geological data, has been undertaken by BC since 1986. At that early stage, a circular magnetic structure in the vicinity of Morokweng in the Northwest Province of South Africa (Figs. 1 - study area - and 2, area studied and sampling sites) was identified and interpreted as an intrusion termed the 'Morokweng intrusion' [2]. This pear-shaped feature has a diameter of ca. 30 km and is located on the central-western portion of the Kaapvaal Craton. In the N, E, and S it is flanked by a concentric, magnetically quiet, zone of about 70 km diameter, which is characterized by the loss of amplitude of the anomalies of a NE striking dyke swarm (cf. Figs. 3a - Total-Field Magnetic Data - and 3b - Residual Shadow Image of the Total-Field Data [MRS encircled and labelled 'M'; 'K-K' = Kalahari Trend of Anomalies; 'B-B' = anomalies related to Transvaal age BIF; the outer circular structure has a diameter of 170 km centered on 'M'], and Fig. 4). Refinement of this early interpretation, after application of image processing techniques, has now revealed the presence of a much larger, circular structure centred on the so-called 'Morokweng intrusion', with a diameter of about 340 km. This larger structure (Figs. 3a,b) manifests itself as a series of arcuate faults along its perimeter, displacing *inter alia* banded iron formation of the ca. 2.5-2.25 Ga Transvaal Supergroup, as well as deforming the Kraaipan greenstone belt of $\geq$ 3 Ga age along its eastern flank. The southern flank is characterised by long-wavelength arcuate magnetic anomalies interpreted as the signatures of deep crustal faults. The western flank abuts against the Kalahari Trend of magnetic anomalies. Figure 4, showing the circular Morokweng features (the central MRS and the larger ones) in relation to the major structural elements of the Kaapvaal Craton [stippled areas are major magnetic anomalies thought to be due to magnetisation of granitoid crust], was discussed by Corner [3], who first proposed that the combined Morokweng features constituted one of the largest terrestrial impact structures, possibly of early Proterozoic age. According to Stettler [4], the central Morokweng structure could be a low-density, plug-like body, such as a magnetic syenite or granite. Andreoli et al. [1] have since reported the presence of charnockitic rocks from a drillcore into the so-called 'Morokweng intrusion'. These authors stated that their findings suggest the presence of a 30 km wide impact melt body, which was surrounded by a 70 km wide zone of fractured, demagnetised, and shock, as well as thermally, metamorphosed basement rocks. They proposed the name 'Morokweng Ring Structure' (MRS) for this feature.

We have recently performed detailed surface geological studies of the central part of the Morokweng structure. While outcrop is scarce in this largely Kalahari sand- and calcrete-covered terrane, it was possible to obtain an extensive sample suite of autochthonous (mainly Black Reef Quartzite, BRQ, from the base of the Transvaal Supergroup) and allochthonous quartz-bearing rocks. Samples (a quartzite and a BIF breccia, resp.) from localities FR9 and NC23 (Fig. 2) exhibit shock metamorphism in the form of single or multiple sets of PDFs in quartz (Fig. 5a), with up to 5 optically visible orientations in some grains. To date, orientations for 22 sets in 18 quartz grains of 2 samples were determined with a universal stage. Fig. 5b shows that the orientations of these PDFs, as determined by U-stage work, correspond to crystallographic planes that are diagnostic of shock. Eighteen of 22 measured sets could be reliably indexed. All our samples of basement granite and of autochthonous BRQ are unshocked. Lack of deformation of the Archean granitoid basement indicates a very deep erosion level in this region, and lack of shock deformation in BRQ could be suggestive of a pre-Black Reef age (ca. 2.25 Ga) of the Morokweng impact event.

A number of other, associated, features are evident on the aeromagnetic images of Figs. 3a and b: the NE trending dyke swarm, which shows the highest frequency of dykes within the larger structure; a prominent E-W dyke passing through the center of the structure (called the 'Machavie Line' by [3]); and a number of radial faults. The dyke swarm has possible implications for the age of the impact event, as several dykes of this direction have been mapped to the SW as cutting through Transvaal BIF. The loss of amplitude of the dyke anomalies in the vicinity of the MRS could suggest a post-Transvaal age for the impact. However, Stettler [4] noted that this dyke swarm is constituted of dykes of different ages. A further factor of structural interest is that the larger Morokweng structure forms the focus of a major change in structural direction within the Kaapvaal Craton, i.e., from predominantly NS in the southwestern portion to ENE in the eastern portion. This suggests that the Morokweng impact structure played a fundamental role in the tectonic evolution of the Craton.

We conclude that the existence of a large impact structure in the region around Morokweng, the *Morokweng impact structure*, is confirmed. Further detailed studies, particularly of the drillcore described by [1] and concerning the age of the structure, are necessary. During further geological studies and exploration activity in this part of the Kaapvaal Craton, the existence of this large impact structure must be born in mind.

Refs.: [1] Andreoli, M. *et al.*, 1995, Cent. Geocongress, GSSA, JHB, ext. abstr., 541-544; [2] Corner, B., 1986, Geocongress '86, GSSA, JHB, ext. abstr., 27-30; [3] Corner, B., 1994, *Crustal framework of the Kaapvaal Province from geophysical data*. In: *Abstr., Proterozoic Crustal and Metallogenic Evolution Conf.*, Windhoek, p.9; [4] Stettler, E., 1987, in: *Current Res. in Afr. Sci., 14th Coll. on Afr. Geol.*, ext. abstr., 339-342.

MOROKWENG IMPACT STRUCTURE: Corner, A. et al.