

FIRST OBSERVATIONS OF SHATTER CONES IN THE DIRECT VICINITY OF THE BUSHVELD COMPLEX. W.U. Reimold¹ and R.C.A. Minnitt^{1,2}; ¹E.G.R.U., Dept. of Geology, Univ. of the Witwatersrand, P.O. Wits 2050, Johannesburg, R.S.A.; ²Cons. Geol., GEOBASEcc, P.O. Box 1423, Florida 1710, RSA.

Findings of shatter cones are reported for the first time from two localities in the Nooitgedacht (Klapperkop) Member of the 2.25-2.35 Ga Timeball Hill Formation near Lydenburg in the Eastern Transvaal - about 25 km from the eastern margin of the Bushveld Complex. Spatial distribution of cone fractures in these river-bed exposures and cone appearances favor their interpretation as true shatter cones and not as sedimentary percussion (impact) marks. An origin by bolide impact has been suggested in the past for the Bushveld Complex (B.C.), however to date no firm evidence in support of this hypothesis has been offered. It may now be speculated whether the Klapperkop shatter cones are related to the formation of the Bushveld Complex, or, alternatively, to a local impact structure in the Proterozoic rocks of the Eastern Transvaal. Be it as it may, further search for such rock deformation around the perimeter of the Bushveld Complex is clearly indicated.

Several workers suggested earlier that the expansive and ore resource-rich Bushveld Complex in South Africa (Fig. 1) could be the result of one or more large impact events [e.g., review by 1]. However, to date no firm evidence in the form of shock metamorphic effects or of macroscopic impact indicators, such as shatter cones that are widely, but not uniformly believed to be diagnostic of impact, could be obtained in support of this hypothesis [2]. The main arguments in favor of Bushveld impact stem from morphological interpretation. It is believed that diagnostic shock effects should not be recognizable, because all exposures of "fragments" of pre-Bushveld crust are distal with respect to impact sites or completely annealed [1].

In 1992, one of us (R.M.) during a hiking-trip accidentally came across an exposure of the Nooitgedacht (also known as Klapperkop) Quartzite Member [3] of the ca. 2.2-2.3 Ga old Timeball Hill Formation of the Transvaal Sequence. He recognized unique near-circular, sometimes raised and cone-shaped fractures (Figs. 2,3) in this riverbed pavement exposure and suggested [4] a possible relationship to similar deformation in shatter-coned Hospital Hill quartzite (Fig. 4) that had just been mapped by him. The Klapperkop exposure is located in the bed of the Houtbosloop streamlet on farm Kantoorbos 263JT, some 27 km SSE of the town of Lydenburg (Fig.1). Individual cones or abraded cone fractures generally measure between 2 and 12 cm in diameter. Poles to striations (Fig. 5) for several well-preserved cones plot along a circle (Wulff net, lower hemisphere) defining a (master) conical angle of 125°. However, some data (small circle in Fig. 6) are clearly not reconcilable with this projection of a master-cone trace. Orientations of apical axes (Fig. 6) scatter widely between near-vertical and subhorizontal attitudes. This scenario is similar to our observations in the Vredefort structure. Close comparison of Figures 3 and 4 reveals that the cone features in both cases are produced by intersecting multiple sets of curvilinear fractures (MSJS [5], cf. Fig. 6).

Exposures of Klapperkop quartzite are rare in this difficult, mountainous terrane and are generally restricted to high, inaccessible cliff-faces and to pavements in river-beds that are often only accessible just above water-falls. Despite these unfavorable circumstances we discovered a second exposure of 'coned' Klapperkop quartzite in the bed of the Beestekraalspruit on the forest farm Uitzoek 260JT, only 3 km NE of the first site. Subsequent surveys failed to yield other accessible outcrops in this area. No cone features could so far be discovered in under- or overlying argillaceous units. The fact that both coned exposures are in river-beds and near water-falls prompted the critique that our 'cones' could represent sedimentary percussion (impact) marks. However, literature studies on this topic provided no support for this suggestion, as our cones are regularly shaped, are sometimes still recognizable as definite 3D, cone-shaped features (Fig. 2), are generally much larger than percussion marks, and are, just like Vredefort and Sudbury shatter cones, related to MSJS. For these reasons we conclude that true shatter cones have been discovered < 25 km from the eastern margin of the Bushveld Complex. Currently it can only be speculated whether these shatter cone occurrences can be linked to the B.C. or are perhaps the result of a local impact event. Only further fieldwork in the environs of the B.C. will potentially resolve this problem. We hope that this report will not trigger a flood of speculative contributions related to the origin of the B.C., but will generate awareness amongst field-workers along the > 1500 km periphery of the Complex of the possibility that shatter cones could occur in their study areas.

Refs.: [1] Elston, W.E., 1992, LPI Contr. No. 790 (Sudbury 92), 23-24; [2] French, B.M., 1990, *Tectonophys.* 171, 287-301; [3] S. Afr. Comm. for Stratigr., 1980, *Geol. Surv. Hdb.* 8, p.192-194; [4] Minnitt, R.C.A. et al., 1992, *Geocongr.* 92, GSSA, Bloemfontein, 274-277; [5] Nicolaysen, L.O. and Reimold, W.U., 1987, *Contrib. to Cryptoexpl. and Catastr. in the Geol. Rec. Worksh.*, Section N2, 8pp.

SHATTER CONES NEAR THE BUSHVELD COMPLEX: Reimold W.U. and Minnitt R.C.A.

