EVIDENCE FOR SHOCK METAMORPHIC ORIGIN OF MULTIPLY-STRIATED JOINT SURFACES (MSJS) IN SANDSTONES OF THE SINAMWENDA METEORITE IMPACT STRUCTURE, ZIMBABWE.
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The Sinamwenda Structure (17°11'42" S, 27°47'30"E) is a 220 m-diameter postulated impact crater situated in western Zimbabwe [1] (Fig. 1). Although the surrounding rocks are flat-lying unjointed Middle Triassic (Karoo) sandstones, the rocks of the crater rim are characterised by steep or overturned bedding, abundant multiply-striated joint surfaces (MSJS), and widespread microbrecciation. We show that the MSJS are the result of shock metamorphism of the coarse sandstones in the crater rim, because of the rare occurrence, at the striated surfaces only, of isolated grains of shocked quartz containing Planar Deformation Features (PDFs). The presence of shocked quartz with PDFs is regarded as proof of the impact origin of the Sinamwenda crater.

The crater rim of the Sinamwenda Structure is elevated a few metres above the level surface of the surrounding flat-lying, unmetamorphosed, trough crossbedded Karoo sandstones and grits of the Escarpment Grit Fm (K^6) [1]. During the original investigation of the structure in 1970, C.W. Stowe found, in the NW rim, steeply-dipping or overturned outcrops of sandstone, which were overlain by stratigraphically underlying shales [1]. Numerous sets of joints containing variably-oriented parallel striations [Fig. 2], which were found in the N and E rim of the structure during the 1994 investigation, were interpreted to be shock produced features similar to the Multiply-Striated Joint Surfaces (MSJS) of the Vredefort and Sudbury structures [1]. These striated joints are entirely absent from the surrounding flat-lying sandstones.

The striated joints are of three main types: (a) smooth, planar joints with polished surfaces, (b) rough, planar joints, and (c) rough, curviplanar joints. In outcrop, the joints occur in many different orientations, and contain striations in different directions. Each individual joint has only one direction of striations. Many striated joint surfaces are stained reddish-brown with iron oxides- these appear to be similar to coated striated surfaces in fragments around experimentally produced [2] and lunar craters (Apollo 14 sample 14047) [2,3]. In hand specimen S3, there is a set of 4 sub-parallel planar joints, with a spacing of 6 to 8 mm, which contain striations with the same orientation. In the same specimen, however, there are other curviplanar striated joints, two of which meet along a curved edge, where the striations appear continuous from one joint to the other. This is similar to the way in which sets of shatter cones, with oppositely oriented cone apices, meet. In sample S3, the measured radii of curvature of curviplanar joint surfaces are 19, 53 and 151 mm.

Initial petrographic investigation of crater rim and surrounding sandstones failed to reveal characteristic shock-induced features (such as PDFs); however, crater rim samples were found to have abundant microdeformation in the form of fractured and shattered grains, intricate deformation bands, and narrow (<2 mm) zones of cataclastic breccias [1]. A more thorough search revealed the presence of rare isolated quartz grains containing single sets of Planar Deformation Features (PDFs), situated only along striated surfaces [Figs 3-5]. The presence of PDFs in quartz grains along MSJS in the Sinamwenda structure indicates the shock-metamorphic origin of the striated joints. These may be analogous to striated surfaces in lunar samples which are preferential loci for shock-produced glass [2]. The discovery of quartz with shock-induced PDFs is regarded as proof of the impact origin for the Sinamwenda Structure, which is the smallest proven impact crater in Africa (cf [4]).

References: [1] Master,S., Robertson,D.J., Stowe,C.W., Walsh,K.L., Reimold,W.U. & Brandt,D. (1994). *Lunar Planetary Science*, **XXVI**, 905-906. [2] Moore,H.J. (1976). *USGS Prof. Pap.* **812-B**, 47 pp. [3] Swann,G.A. et al. (1971). *In*: Apollo 14 preliminary science report. *NASA Spec. Publ.* **SP-272**, 39-85. [4] Koeberl,C. (1994). *J. Afr. Earth Sci.*, **18(4)**, 263-295.

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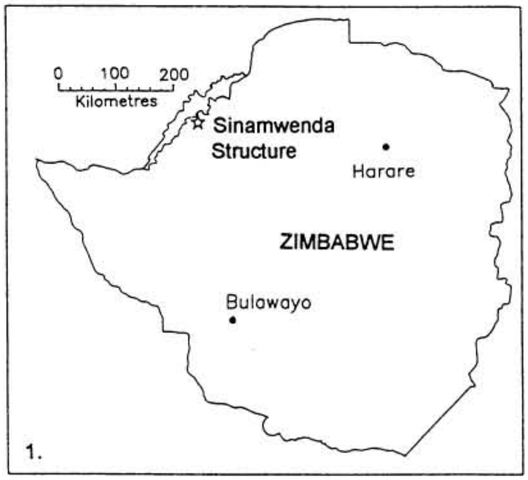

Figures:

1. Locality map of Sinamwenda Structure, W. Zimbabwe
2. Multiply-striated joint surfaces (MSJS) in coarse-grained sandstone, E rim of Sinamwenda structure. The striations are arrowed.
3. Planar Deformation Features in quartz grain, Sample S3, N rim of Sinamwenda Structure.
4. Microbreccia on striated joint surface, showing quartz grain A with a single set of PDFs, Sample S3a, N. rim.
5. Close up of quartz grain A in Fig. 4, showing PDFs.