NEW TOPOGRAPHIC MODELLING OF THE >45 km DIAMETER SIMLIPAL RING STRUCTURE, SINGHBHUM CRATON, ODISHA, INDIA- WORLD'S OLDEST IMPACT STRUCTURE. Sharad Master[1,2] and Gordon R. J. Cooper[2], [1]EGRI, [2]School of Geosciences, University of the Witwatersrand, Johannesburg, South Africa, sharad.master@wits.ac.za.

Introduction: The Simlipal Basin consists of a 2-3 km-thick sequence of basaltic lavas and pyroclastics interbedded with three quartzite units, deposited on 3.44 Ga TTG gneisses, and 3.3-3.12 Ga granites and greenstone belts of the Archaean Singhbhum Craton, in NE Odisha, India [1,2]. The detrital zircons in the lower quartzite give provenance U-Pb ages of 3.55 to 3.08 Ga [3]. The basin outcrops in the form of a concentric ring structure (centered on 21°52'07.66" N; 86°20'08.75" E), with a diameter of c. 45 km, situated within a NNE-SSW trending plateau (Fig. 1). Three inward-dipping topographic rings are defined by the resistant quartzites. The centre of the Simlipal Structure is occupied by an 800m-thick differentiated ultramafic-mafic intrusion, the Amjori Sill, covering an area of 130 km^2 [4]. The basalts of the Simlipal ring structure are intruded by the Mayurbhanj suite of gabbros, granophyres, and pyroxene granites, dated at c. 3.08 Ga [2]. Later events are dated at 2.37, 2.08 and 1.96 Ga (Rb-Sr) [2], and at 1.2-1.0 Ga (Pb-loss) [3]. Because it is a large ring structure with inward-dipping layers, in a cratonic setting, with a central gravity high and an undeformed layered intrusion in the middle, having macroscopic evidence for shock deformation, Simlipal is regarded as a large ancient complex eroded impact structure [5].

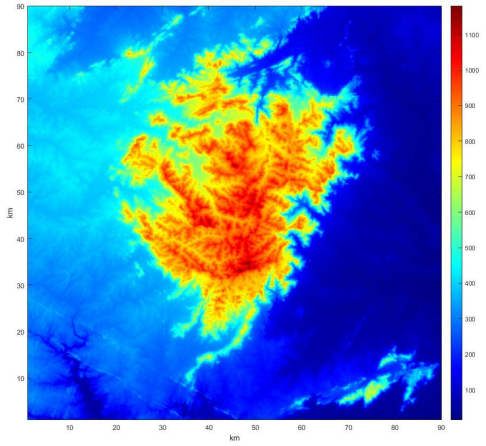

Figure 1: DEM, derived from SRTM data, of Simlipal structure and surrounds, in 90 x 90 km box.

Evidence for impact origin of Simlipal structure. The best macroscopic evidence for an impact origin has been found at Uski Falls, ~6 km NW from the structure's geometric center, where numerous examples of partial shatter cones, and clusters of amalgamated shatter-cone-type striated and curved, corrugated surfaces are present on basalt boulders [5]. The partial shatter cones consist of conical striated surfaces, with striations radiating out from the cone apex. Some shatter cones have the appearance of being twisted or almost braided (Fig. 2). Breccias are also found in the basalts at other localities (Fig. 3).

Figure 2: "Braided" shatter cones in basalt from Uski Falls in the Simlipal Structure- macroscopic evidence for high shock pressures. Scale bar divisions in cm.

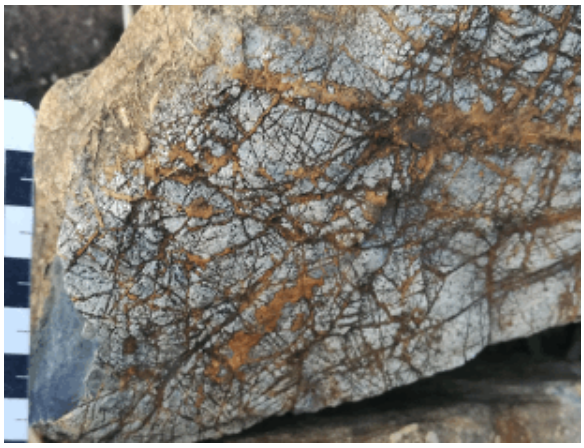

Figure 3: *In situ* brecciated basalt, with carbonate veins.

Topographic modelling: Our new study has utilised Digital Elevation Models (DEMs) derived from Shuttle Radar Topographic Mission data. We have used image processing techniques for shape and topographic analysis [6, 7], and centrally-illuminated sun-shading [8] (Fig. 4) to enhance concentric circular features of this complex impact structure. The shape S of a surface f can be calculated from the following equation [6, 7]:-

$$S = \frac{2}{\pi}\tan^{-1}\left(\frac{-\frac{\partial^2 f}{\partial x^2}-\frac{\partial^2 f}{\partial y^2}}{\sqrt{4\left(\frac{\partial^2 f}{\partial x \partial y}\right)^2+\left(\frac{\partial^2 f}{\partial x^2}\right)^2+\left(\frac{\partial^2 f}{\partial y^2}\right)^2-2\frac{\partial^2 f}{\partial x^2}\frac{\partial^2 f}{\partial y^2}}}\right)$$

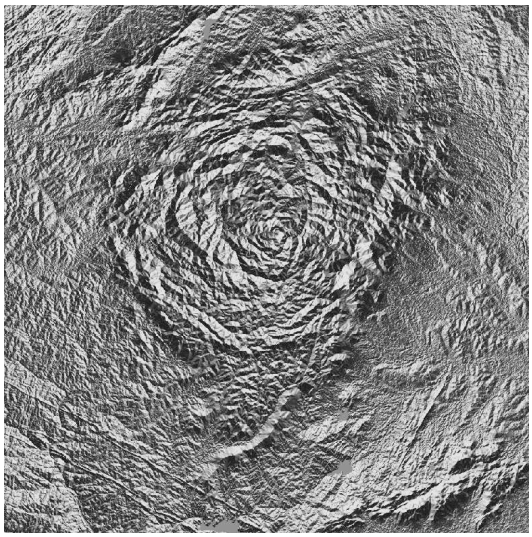

Figure 4: Centrally-illuminated DEM of Simlipal structure, revealing several roughly concentric rings. Width of box is ~ 90 km across.

Results: Our processed centrally-illuminated DEMs (e.g., Fig. 4) indicate that deformation in the Western Sighbhum Craton (Iron Ore Group) is not concentric with the Simlipal ring, and is unrelated to it- so Simlipal is probably not the central part of a much larger impact structure. Shape analysis of the DEM (Fig. 5) shows Simlipal is surrounded by a broad moat or trough, and with three roughly concentric but non-circular rings defined by ridges, separated by troughs. The central part of the structure is occupied by an undeformed subhorizontally-bedded ultramafic to mafic layered intrusion [4, 5]- here interpreted as a differentiated impact melt sheet, similar to the ones in the Sudbury, Manicouagan and Morokweng structures, occupying a central peak ring [e.g., 9].

The Simlipal basalts are intruded by the undeformed mafic-ultramafic Amjori intrusion, as well as by the Mayurbhanj granitoids, dated at c. 3.08 Ga [2]. The age of the Simlipal Structure is thus constrained to be c. 3.08 Ga, making it the oldest known impact structure on Earth. At >45 km diameter, it is the largest impact structure in Asia, larger than the recently postulated 31 km crater under the Bolaven volcanic field in Loas [10].

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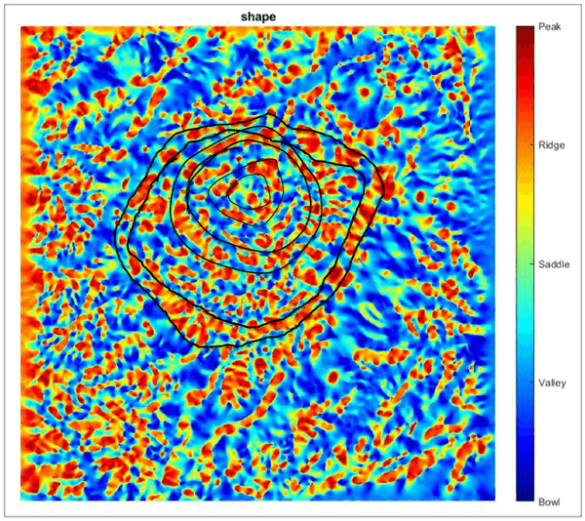

Figure 5. Shape of the topography of the Simlipal structure showing a broad moat or trough surrounding the structure (in shades of blue), and three roughly concentric rings, corresponding to quartzite ridges interbedded with basaltic volcanic rocks (reddish colours), outlined in black. Width of box is ~ 90 km across.