FIRST EVIDENCE FOR AN IMPACT ORIGIN OF THE >45 km DIAMETER SIMLIPAL RING STRUCTURE, SINGHBHUM CRATON, ODISHA, INDIA

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Introduction: The Simlipal Basin consists of a 2-3 km-thick sequence of supracrustal rocks deposited on 3.44 Ga TTG gneisses, and 3.3 to 3.12 Ga granites and greenstone belts of the Archean Singhbhum Craton, in NE Odisha, Eastern India [1,2]. Lithologically, the Simlipal Basin is made up mainly of basaltic lavas and pyroclastics interbedded with three quartzite units, the lowest of which also contains conglomerates [1,2]. 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 with a long axis of about 70 km (Fig. 1A). The beds within the ring structure dip inwards at angles varying from 18 to 76° towards the centre. Three topographic rings are defined by the resistant quartzites (Fig. 1B). 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. The layers consist, from bottom to top, of dunite, peridotite, picrite, gabbro, and quartz norite [1,3]. The basalts of the Simlipal ring structure are intruded by the Mayurbhanj suite of gabbros, granophyres, and pyroxene granites, dated at 3.09 Ga [2], thus the age of the structure is constrained between 3.12 and 3.09 Ga. There is a gravity high in the centre of the structure, with a bouguer anomaly rising steadily from -25 mgal at the edge of the structure, to about -10 mgal at 5km from the centre [4]. Then there is a change in slope, with the central part of the structure having a sharper increase in the gravity anomaly, to -2 mgal at the centre, modeled as being due to a thick mafic volcanic unit [4].

Evidence for Impact Origin- shatter cones: Few processes on earth, aside from impact cratering, can form a large circular structure with inward dipping beds, in a cratonic setting, such as the Simlipal Structure. The first evidence for an impact origin of the Simlipal Structure has been found at a locality called Uski Falls, ~6 km NW from the geometric center of the ring structure. Outcrops here consist of massive basalts, some containing large unfilled vesicles and lithophysae. Numerous examples of partial shatter cones, and clusters of amalgamated shatter-cone-type striated and curved, corrugated surfaces are present on the loose basalt boulders at the foot of the Uski Falls. In some boulders, there are multiple examples of shatter cones, in different orientations. 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. The largest shatter cone measured 14 cm in length (Fig. 1C). The apical angle is typically 35 degrees or less. In the NW, outer parts of the structure, centripetally-dipping crossbedded quartzites young normally, and are not overturned, and *in situ* brecciated basalt has been observed.

We consider the presence of shattercones as the best macroscopic evidence for shock metamorphism in the Simlipal Structure, which we regard as being of impact origin. The gravity profile [4] indicates a 3 km-thick central intrusion, which we regard as an undeformed, horizontally bedded differentiated impact melt sheet occupying the inner part of a central peak ring within a large complex impact structure, similar to the differentiated melt sheet in the Sudbury structure. *In situ* brecciated and slickensided felsites are present in the older basement rocks on the outside of structure, to the north. At a radius of 84 km from the center, there is an outer arc of greenstone belt rocks, but they are not concentric with, and are probably unrelated to, the Simlipal Structure. Further field, petrographic, geochemical and remote sensing studies are planned on the Simlipal Structure and surrounding areas. The location of the Simlipal Tiger Reserve (and future National Park) wholly within the Simlipal Structure will ensure that these rocks will be conserved and protected in the future, and they may also serve as a drawcard for scientific studies, geotourism, ecotourism, and earth and planetary science education.

References: [1] Iyengar, S.V.P., et al., 1981. Indian Journal of Earth Sciences, 8, 61–65. [2] Mishra, S., et al., 1999. Precambrian Research, 93, 139-151. [3] Chennakesavulu, N., Sahu, K.C., 1985. The Indian Mineralogist, 22(2), 231. [4] Verma, R.K., et al., 1984. Tectonophysics, 106, 87-107.

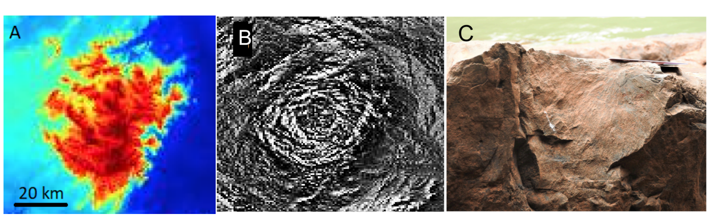

Figure 1. (A) Digital Elevation Model of Simlipal Structure, derived from SRTM data (B) Centrally-illuminated sunshaded DEM of (A), showing concentric topographic rings (C) Large (14 cm radius) partial shattercone in basalt, Uski Falls