ANTIQUITY OF EDIACARAN FOSSILS, EARLY SHELLED ORGANISMS, RECENT RADIOMETRIC AGE-DATES FROM INDIA AND ANCESTRAL BIOTA**.** Abhijit Basu, Department of Geological Sciences, Indiana University, 1001 E 10th Street, Bloomington, IN 47405; basu@indiana.edu

Introduction: The Ediacaran (~600 Ma – 543 Ma), now synonymous with the Vendian Period of the Neoproterozoic Era, is of particular interest because life-forms of this epoch apparently experienced explosive metazoan diversification and ended the realm of non-shelled organisms ushering in the "Cambrian Explosion'. Assemblages of fossils of diverse soft-bodied biota and traces in rocks of this age, found in all continents, are considered by many to be exclusive and hence a biostratigraphic marker if not indicative of the age as well [cf. 1]. Indeed, several Ediacaran units have been dated using robust radiometric techniques. An example would be the U-Pb dating of magmatic zircons (580 Ma) from volcanic ash beds of the Doushantuo Formation in China, and bracketed at the top by large negative excursion of $\delta^{13}C$ values in carbonate rocks at 551 Ma [2]. However, history of paleontological research is replete with discoveries and extension of age-ranges of biota [e.g., 3,4]. Bengtson et al. [4] and Rasmusen et al. [5] especially show that the Stirling Formation of Australia, with Ediacaran biota and previously considered to be Ediacaran in age, is actually 1800 Ma to 2100 Ma old. We report recent age dates of a few Proterozoic strata from India (fig. 1), which suggest that considerable revision of chronostratigraphic implications of the reported biota is necessary.

Data: In peninsular India, virtually undeformed, unmetamorphosed, and 'unfossiliferous' mostly marine sedimentary rocks have been traditionally considered Neoproterozoic in age. These rocks are found in large and small basins on Archean cratons. The Vindhyan and the Chhattisgarh Supergroups comprise the two largest basins and the rocks are considered to be approximately coeval [6-8]. From the Tarenga Formation in the upper part of the Chhattisgarh Supergroup, De [9] reports the occurrence of stromatolites, filamentous algae, coccoidal forms in clusters, and notably of *Zinkovioides* spp. rather akin to *Zinkovioides inclusis*. The occurrence establishes an Ediacaran age for the Tarenga Formation with "possible correlation with the Zinkov Beds of Podolia" [9]. SHRIMP ages of magmatic zircon from interstratified volcanic tuff, however, range from 990 Ma to 1020 Ma [10].

Many have studied the biota from the uppermost units (Lakheri Limestone; Sirbu Shale) of the Vindhyan Supergroup, which De [11, 12] summarizes well. The assemblage including *Spriggina*, and highly ordered symmetry of *Cyclomedusa* and *Hiemalora*, for example, is typically Ediacaran. Negative excursions of $\delta^{13}C$ and Sr-isotope-stratigraphy of the sequence coincide well with worldwide excursions in the Neoproterozoic [13]. Malone et al. [14, 15], however, based on U-Pb age dates of detrital zircons and paleopole position contend that the uppermost age of the Vindhyan Supergroup is about 1000 Ma.

Azmi et al. [16] and Joshi et al. [17] insist that typical Ediacaran assemblages and lowermost Cambrian shelly fossils occur in the Rhotasgarh Formation in the Semri Group of the Vindhyan Supergroup. Bengtson et al. [4] generally corroborate the occurrence but do not necessarily agree with the assigned ages. SHRIMP and TIMS ages of magmatic zircons from a volcanic ash bed, and Pb-Pb dates of three limestone units, however, place the age of the Semri Group between a little older than 1721 Ma and not much younger than 1514 Ma [13, 18-21]. The fossil-bearing horizon is older than 1514 Ma and could be as old as 1601 ± 130 Ma.

Inference: We infer that sedimentation of the Vindhyan and Chhattisgarh Supergroups occurred between approximately 1750 Ma and 950 Ma. Fossils in these sediments are much older despite their biological Ediacaran affinity.

Discussion: Given that many stratigraphers, paleontologists and geochronologists have studied the same units at various times and in various laboratories using different methodologies, the data presented above can be safely assumed as trustworthy. The seeming contradiction between biostratigraphy and chronostratigraphy needs resolution. One strong possibility is to consider, if not conclude, that the antiquity of fossil assemblages described from the Vindhyan and Chhattisgarh Basins go back to about 1750 Ma or older and are not younger than about 950 Ma. This conclusion provides two major corollaries.

First, complicated life forms including shelled organisms had already evolved in the Paleoproterozoic. The dearth of unmetamorphosed sedimentary rocks, paucity of limestone that escaped diagenetic resetting of carbon isotope and $^{87}Sr/^{86}Sr$ ratios, and the lack of reliable depositional ages, for example from magmatic zircons in coeval volcanic units, have prevented the community from coming to such a conclusion. Instead, the community relied and concentrated more on the strata immediately below the Cambrian (defined on the basis of first preservation of shelled organisms) where a rich diverse assemblage of soft-bodied organisms and traces are preserved [cf. 22]. Current data suggest that understandable obliteration of fossil record in Paleoproterozoic and Archean rocks and the absence of explosive diversification of metazoans during that time describe biological evolution more accurately. It follows that there is no need to call upon events of explosive evolution to explain the fossil record.

Second, because ancestral biota on Earth is that old and that evolved, origin of life in simple bacterial or other forms very likely dates back to before 4 Ga. If so, search for fossils in meteorites, such as the morphology reported from ALH 84001 [23], remains a fruitful endeavor.

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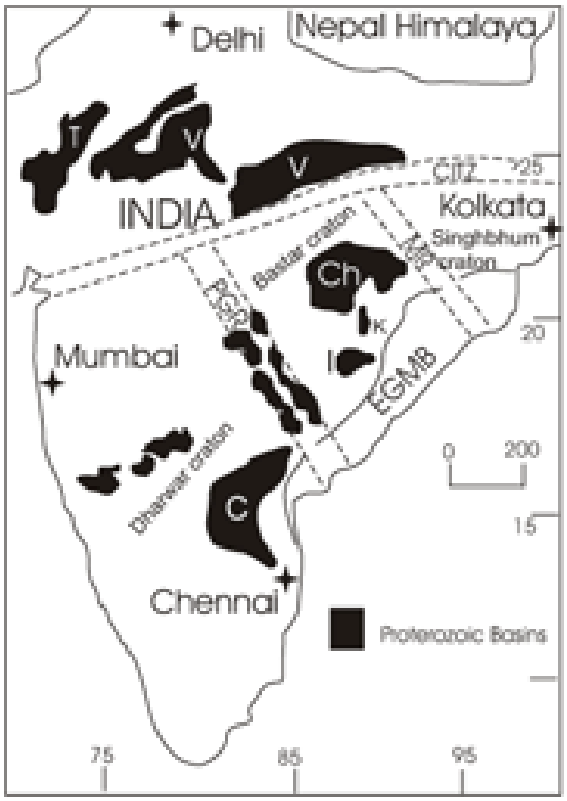

Fig.1. Location of the Proterozoic Vindhyan (V) and Chhattisgarh (Ch) Basins in India.