DISCUSSION

EDIACARAN FOSSILS IN MESO- AND PALEOPROTEROZOIC ROCKS IN PENINSULAR INDIA EXTEND DARWIN by Abhijit Basu. Jour. Geol. Soc. India, v.73, April 2009, pp.528-536

Himanshu Sabot, *Email: sabothk60@live.com* comments:

Professor Basu's hypothesis about pre-Neoproterozoic origin of Ediacaran fossils helps in assigning the age of Kurnool and Bhima Groups. However, the view that Vindhyan, Chhattisgarh, Kurnool, Bhima Basins are approximately coeval is debatable. Available data so far indicate Ediacaran-Tommotian and Mesoproterozoic ages respectively for Kurnool Group (KG) and Bhima Group (BG) with no physical continuity (cf. Dongre et al. 2008*).

The gradational conglomerate/quartzite-limestone-shale sequences (~195-660 m thick) in once contiguous Kurnool and Palnad sub-basins (with westerly provenance) unconformably overlie the granitic basement, as evident from field relations (Nagaraja Rao et al. 1987), paleo-magnetic and geochemical data. The lower conglomerates of Banganapalle Quartzite (BQ)—diamondiferous (and oligomictic) overlying the 980±110 Ma pre-Kurnool dykes and with 840±30 Ma to ~1100 Ma Wajrakarur kimberlite pipes (Scott Smith, 2007) as their source in Kurnool sub-basin and uraniferous (and polymictic with basic pebbles) overlying the 644±18 Ma dyke (Padmakumari and Dayal, 1987) in Palnad sub-basin—constrain the maximum age of BQ. No distinct Palnad (Kurnool) sedimentary xenolith in such basic dykes (traversing the basement) was observed so far, corroborated also by borehole data.

Reliable paleomagnetic data (Goutham et al. 2006) and plotting of paleopole positions showing overlapping of BQ-Normal (74.57°N, 247.33°E) and ~590 Ma Ediacaran magnetic overprint (76.5°S, 68.8°E) on Harohalli dyke (Pradhan et al. 2008) vis-à-vis clear separation of SQ (~1330-1270 Ma); diagnostic occurrence of: (a) trilobite trace fossils (FAD of trilobites ~524.4 Ma) in Nandyal Shale, (b) Paleozoic-aspect palynotaxa (*Dictyotidium*, *Priscogalea*) and calcified cyanobacteria/algae (*Renalcis*, *Tarthinia*, *Korilophyton*, *Spirellus shankari*), *Gemma*, besides *Coleolella*, *Gordia* in Koilkuntla Limestone, c) trace fossils (*Phycodes pedum* and trilobitic *Rusophycus*, cf. *Rusophycus avaloensis* of 543.9±1 Ma age) in Paniam Quartzite (Gururaja et al. 2000); magnetic polarities and paleolatitudes of BQ (5.50N) and Narji Limestone (50S) compatible with paleogeographic setting of Indian plate during 570-530 Ma (Collins and Pisarevsky, 2005); and imprints of ~520-500 Ma Pan-African orogeny (Eastern Ghat deformation evident from neighboring 530±25 Ma Markapur slates and related to Gondwana amalgamation) in Palnad sediments indicate an Ediacaran-Tommotian age (~570-524 Ma) for Kurnool Group.

U-Pb and Sm-Nd isotopic dating indicated a ~1270 Ma minimum age for Bhima sediments (Pande et al. 2008). Paleomagnetic studies of Bhima Group (15 sites) show widely scattered directions in NW and SE quadrants, implying remagnetisation possibly caused by Deccan lavas (Goutham et al. 2008) besides younger/ Recent overprints, vis-à-vis the well-grouped directions in Srisailam Quartzite (SQ), BQ and Narji limestones. This is supported by petrography and chemical dating of pitchblende and coffinites in Bhima limestones and associated granitoids (Dhana Raju et al. 2002) showing large spreads of age (1146 Ma, ~862-798 Ma, Pan-African 480-533 Ma, post-Deccan 62 Ma and younger/ Recent 12-1 Ma), which indicate younger, episodic causative/ hydrothermal fluids oxidise Fe-minerals resulting in remagnetisation.

The reverse faulting in Kurlegare-Gogi area and average RL (~450 m, cf. Pandit et al. 2002) implies that while ~230 m thick Bhima sediments was preserved towards northwest, a minimum of 75 m (Kale and Peshwa, 1995) sedimentary-pile was eroded from the southeastern uplifted block.

Furthermore, attributes of BG like exposed basinal area, lesser thickness, higher RL vis-à-vis those in Palnad Sub-Basin (KG), when considered from denudation rates of siliceous and carbonate rocks (2 to 100 m/ Myr), point to protracted denudation of substantial Bhima sediments (supported also by geophysical estimates) during ~1270 Ma (Mesoproterozoic) to ~65 Ma (time of Deccan trap covering).

A number of dated basic dykes (1326±47, 1480±50 Ma) underlying SQ, lamproites (1384±18 Ma) and kimberlites (~1100-1400 Ma; Gopalan and Kumar, 2008), alkaline magmatism (1350-1250 Ma), hydrothermal copper-lead-zinc and fracture-controlled uranium mineralization (1327±170 Ma; Sinha, 1997) and hydrothermal overprint (1474±176 Ma) on Mehboobnagar dykes were recently found (Sabot et al. in preparation) along major, E-W trending (Nayak et al. 2001) older, reactivated, structurally weak corridor along Kurlegare–Gogi–Kotakonda–Ramadugu–Lambapur–Rallavagu Tanda– Ramannapeta tract. It indicates that Bhima Basin (~1400-1330 Ma) is older than Srisailam Sub-Basin (~1330-1270 Ma), pending finer correlation.

Non-occurrence of diamonds in BG, despite NW paleoslope and SE granitic provenance with ~1100 Ma Wajrakarur-Narayanpet kimberlites; the underlying dykes (1650-1600 Ma) and neighboring Mehboobnagar dyke swarm; presence of microbiota like *Schismatosphaeridium, Vavosphaeridium, Gloeocapsomorpha, Costatosphaerina, Laminarites, Menneria, Oodium* (reported also from 1900-2100 Ma lower Cuddapahs) in BG; absence of *Dictyotidium*, *Priscogalea* (Viswanathiah and Venkatachalapathy, 1987), *Obruchevella* and trilobite trace fossils in BG and their presence in KG— all support above Mesoproterozoic age for BG.

Thus, careful stratigraphic evaluation by constraining first the age of individual basins and then their correlation with relevant homotaxial basins may be attempted.

Abhijit Basu, Department of Geological Sciences, Indiana University, Bloomington, IN-47405, USA replies:

It is gratifying to read and respond to a gracefully sobering discussion of a dare-the-devil paper (Basu, 2009a). Let me point out a possible misunderstanding. That several Proterozoic basins in peninsular India (Vindhyan, Chhattisgarh, Kurnool, Indravati, Bhima, etc) are approximately coeval is not an inference or conclusion of the paper. Rather, it is a restatement of the general consensus as available in the literature up to about 2007. I respond briefly to argue that the absolute age bracket of the deposition of the Kurnool Group cannot be established with current data.

Direct determination of absolute ages of deposition of sedimentary rocks is the hardest problem in geochronology. U-Pb dating of magmatic zircons in volcanic rocks interbedded with the sediments provide the most robust ages. Additionally, maximum and minimum ages of sedimentary rock units can be obtained from dating igneous intrusives and igneous bodies overlying the units under consideration, respectively. The dating methods vary with varying degrees of precision and accuracy, but are strongly dependent on closed-system behavior of the specific isotope system (e.g., no reheating of the strata above closure-temperatures and no resetting of the radiogenic clock). Ages of authigenic minerals (e.g. glauconite, white mica) are not depositional ages. The discussant cites Scot Smith (2007) for ages of pre-Kurnool dykes (the field relations may be debatable), who cites literature data that straddle variously between ~840 Ma and ~1505 Ma. But the discussant does not tell us why the 840 Ma age (K-Ar whole rock) is any more reliable than the 1505 Ma age (Rb-Sr whole rock).

All ages ‘determined’ from paleopole positions, strontium isotope stratigraphy aka SIS, $\delta^{13}C$ excursions, body-fossils, trace fossils, etc. are proxies for absolute ages. Argument put up by the discussant can at best claim that the Banganapalle Quartzite (BQ; base of Kurnool) and the Baghain Sandstone (upper Kaimur, Vindhyan) are paleomagnetically coeval (Goutham et al. 2007). We trust the combined evidence of detrital zircon ages, provenance relations, and paleomagnetism (Malone et al. 2008) placing the near-top of the Vindhyans to be no younger than ~1000 Ma. If so, BQ is clearly much older.

The least trustable of proxy ages are those from trace fossils especially in the Precambrian. The discussant names a number of “diagnostic” trace fossils and calcified algae claiming an Ediacaran-Tommotian age for the Kurnool Group. It does not appear that the identifications are backed up by independent experts. Because misidentification of Proterozoic trace fossils in India is not rare (e.g., Banerjee et al. 2009; Bengtson et al. 2009; Hofmann, 2005; Kulkarni et al. 2004; Bagla, 2000; Conway-Morris et al. 1998, Sharma et al. 1992), I would rather err on the conservative side and not accept results that have not been reproduced in multiple laboratories (identifications of “diagnostic” trace fossils in this case). Regardless, are these fossils remains of life-forms that did not exist either before or after the Ediacaran-Tommotian time bracket at locations where the time-bracket has been authenticated by robust geochronology? Or, are these fossils “diagnostic” only because they occur in putative Ediacaran-Tommotian rocks?

Determination of reliable depositional age of the Kurnool Group would be possible when appropriate igneous rocks (tuff, flows, intrusions, if any) in the sedimentary succession are dated and if the preservation of some carbonate rock (e.g. in the Narji Formation) allows $^{207}Pb/^{204}Pb$-$^{206}Pb/^{204}Pb$ dating as has been done on some Lower Vindhyan carbonates (e.g., Sarangi et al. 2004; Chakrabarti et al. 2007). If the Kurnool Group were to be 570-524 Ma in age as the discussant concludes, the carbonates would mimic other ä13C and SIS profiles, even if they are unrelated to glaciation as in the Neoproterozoic in SE Siberia (Melezhik et al. 2009; Fairchild and Kennedy, 2007). Such is not the case. As of now, the absolute age of the deposition of the Kurnool Group remains unknown.

The exposition on the age of the Bhima Group by the discussant generally agrees with my understanding (Basu, 2009b) and does not require any response.

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Note: Asterisk-marked references in the text can be found in the original paper (Basu, 2009, Jour. Geol. Soc. India, v.73, pp.528-536).