

NEW EVIDENCE ON THE AGE RELATIONSHIP OF BAP BOULDER SPREAD AND BADHAURA FORMATION, NORTH-WESTERN RAJASTHAN*

WEST of the Aravalli Range, sedimentary sequence is confined to three Basins; Nagaur, Barmer, and Jaisalmer Basins with the Pre-Delhi and Delhi Super Group of rocks and the Malani Igneous Suite of rocks forming the Basement rocks. The Nagaur Basin preserves 950 m thick sediments, designated as the Marwar Super Group, existing in Rajasthan and Haryana, extending northwards to the Salt Range, in Pakistan and correlatable to the Jhelum Series. These rocks often referred to as Trans-Aravalli Vindhyan are in fact of Cambrian affinity, not correlatable with those of the Main Vindhyan Basin. The Barmer, and Jaisalmer Basins include rock sequences from the Jurassic to the Middle Eocene, the Lower Tertiary also protruding as a narrow exposure through the Kolayat-Palana tectonic embayment, being recorded subsurface as far as Chapri (26° 47' : 73° 54')⁶ and approaching the Aravalli foldings. Close correlations, based on lithology, bio-stratigraphy and palaeogeographic set up indicate that Gujarat and the Lower Indus Basin of Pakistan, formed part of a large and extensive spread of the Tertiary sediments, with Rajasthan and Haryana, being the shelf. Due to tectonic uplifting, Rajasthan escaped Upper Tertiary marine incursions. The palaeogeographic reconstructions indicate that the palaeo-shore lines were receding gradually from the Permian to the Recent¹¹.

The rock assemblages of the different Basins are characteristic. The Bap Boulders (the glacial driftings) do not occur inside in any Basin, but only at the peripheral contact of Nagaur and Jaisalmer Basins. There is a wide range of controversy on their age, considered as Permian^{9,17}, Sakmarian¹⁶, Post-Miocene, Plio-Pleistocene⁸, Pleistocene³, and Post-Eocene possibly Pleistocene¹⁰. The Bap Boulders do not have any matrix, and occur as a "Spread", on the surface, for about 65 km with a NE-SW trend, from Khirwa (27° 17' : 72° 19') to Nokhra (27° 38' : 72° 38'). The boulders do not contain any rocks younger than those of the Bilara Group, and occur as highly assorted boulders, cobbles, pebbles, and erratics, on the

top of those of the Nagaur Group. Northwards, the Kolayat-Palana embayment breaks their continuity and they seem to get buried under the desert cover, reappearing, further in the Salt Range, Pakistan. A boulder bed, comprising rocks of the Malani granites, rhyolites, tuffs and felsite, admixed with local rocks, attaining a thickness, of 60 m, has been recorded from the Salt Range as a part of the Upper Carboniferous Talchir Boulder Bed¹². These are overlain by fossiliferous Speckled Sandstones and Productus Limestone of Upper Carboniferous and Permian age. Towards the south-east, in India, Boulder Bed of Upper Carboniferous age is overlain by 3 m thick highly fossiliferous marine limestone, sandstone and clay bed, near Umaria (23° 32' : 80° 51') in Madhya Pradesh¹².

Tunklian Formation, the topmost unit of the Marwar Super Group, contains pebbles of the Malani granite and rhyolite. The Bap Boulder Spread overlying the Nagaur Group of rocks bears glacial striations and chatter marks indicating driftings by glaciers and icebergs. Westwards, outcrop, the highly fossiliferous sandstones and clays, the Badhaura Formation. Near Badhaura, these sandstones are seen to contain pebbles of the Malani granite and rhyolite in the lower part of the sequence. Boulders of Malani granite occur still attached to the curved underlying sandstone surface. The average modal composition of the rock forming the boulder is microcline and perthite (36%), albite (32%), quartz (16%), carbonates (11%), biotite and muscovite (3%), and minor accessories (2%), confirming the rock as granite. It has a close resemblance to the boulders occurring in the Bap Boulder Spread and is obviously pre-Badhaura in age. The Badhaura Formation^{9,17} contains abundant marine megafauna and is composed of yellowish, ochreous, purple, ill-sorted, ferruginous, fossiliferous sandstones and clays. Basin-shaped outcrops with basin-ward dips are a characteristic feature.

Further westwards, the Badhaura comes in contact with the fluvial arenaceous Lathi Formation. The sequence of the rock formations established in the Nagaur Basin grading into that of the Jaisalmer Basin is given below.

Liassic.	Lathi Formation	Sandstones, ferruginous siltstones, shales and pebble beds with abundant silicified and/or ferruginised fossil wood of gymnospermous origin.
----- Unconformity -----		
Sakmarian Artinskian	Badhaura Formation	Yellowish, ochreous, brownish, purple, ill-sorted, highly fossiliferous sandstones and clays.
----- Unconformity -----		

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Upper Carboniferous	Bap Boulder Spread	Boulders, pebbles, cobbles, of Malani rhyolite, rhyolite porphyry, granite; syenite; slate, quartzite; basic rocks; Bilara limestone and dolomite.
		----- Unconformity -----
Nagaur Group (75-410 m)	Tunklian Formation	Sandstone, occasionally containing pebbles of Malani granite and rhyolite, Bilara chert, dolomite, Delhi quartz, quartzite, specially near Gudarli (27° 11' 30" : 72° 24').
	Nagaur Formation	Brick-red sandstone with greenish clayey pellets; siltstone, shale, very thin to thick evaporite "kick back" sequences, upto 200 m thick, comprising polyhalite potash salts, halite with clay lenses, gypsum, anhydrite, dolomite, and limestone similar to those of Salt Range; locally developed conglomerate at the base.
Marwar		
Super Bilara Group (100-300 m)	Pondlo Formation	Dolomite, dolomitic limestone, cherty dolomite, stromatolitic limestone and dolomite, and siliceous oolites and pisolites near Lordiya (27° 04' : 72° 24').
	Gotan Formation	Limestone with bands of chert and dolomite.
	Dhanapa Formation	Stromatolitic limestone, dolomite, chert, cherty dolomite, and dolomitic limestone.
Group (Cambrian)		
Jodhpur Group (125-240 m)	Girbhakar Formation	Brick-red siltstone, shale, and sandstone, highly current bedded, with pisolites, pellets, near Lohawat and Lohawat-wala-Bhakar.
	Sonia Formation	Maroon-coloured siltstone, and shale; creamish sandstone containing persistent ripple marks, concentric-layered pisolites; salt pseudomorph shales; banded chert-jasper dolomite; fossil brachiopod (<i>Orthis</i>) reported from Rundiya (26° 2' : 75° 43' 30") ⁵ —the sequence divisible into mappable Units A-G.
		----- Unconformity -----
	Pokaran Boulder bed	Locally developed bed comprising pebbles, cobbles, boulders, and erratics of Malani granite and rhyolite in maroon/red-coloured arenaceous silty/clayey matrix ² .
		----- Unconformity -----
Pre-Cambrian	Malani Igneous Suite	Rhyolite, rhyolite porphyry, quartz-trachyte, obsidian, granite, tuff, welded tuff, andesite, felsite, basalt, gabbro, diorite, and intrusives.
	Delhi Super Group	Phyllites, slates, quartzites.

The palaeontological data is suggestive of the Badhaura Formation being of Permian age^{9,11,19,17}. The Post-Miocene age⁷, deciphered on palynology, could be due to contamination of samples, and can hardly be taken as convincing in view of overwhelming megafaunal evidence. The Middle Carboniferous age¹ advanced, on the basis of a pelecypod and cephalopod, is also unaccountable, in view of the studies by Dickins and Shah³; such horizons are not known either in Salt Range or Umaria. The Badhaura fauna is akin to that of Umaria and of Amb Formation of the Salt Range, Pakistan, and also to the uppermost part of Lyons Group and Callythara Formation of Carnarvon Basin of Western Australia⁴. The arm of the Tethys sea could thus have extended from

Salt Range, through Rajasthan, to Umaria, *via* the Narmada drainage¹⁵. The Badhaura is Sakmarian to Artinskian in age.

The computed thickness of the Badhaura outcrop is 30 m. The O. N. G. C. data of drill holes has, however, indicated that 100 m of Permian shales were penetrated in the Pugal well (29° 30' 29" : 72° 48' 30") at a depth of 500 m. and the hole bottomed in anhydrite¹³ (Nagaur Group—authors). Permian sediments of 255 m thickness were pierced in the Shumar Wali Talai (27° 11' 12" : 70° 17') well¹⁸. Permian sediments could thus thicken dipwards, and represent post-glacial sediments.

The occurrence of the solitary outcrops of the Boulder Bed, overlain by the marine Permian at Uma-

na and at Badhaura, and existence of a thick sequence in the Salt Range, amply confirms the existence of glaciers/icebergs during the Upper Carboniferous in Western India and Pakistan. They radiated from the Aravallis, followed by deposition, under marine conditions, as well, of Permian sediments and their extensive removal eventually from elevated lands, by intense Post-Permian erosional agencies. The Bap Boulders do not occur anywhere else in the Jaisalmer and Barmer Basins to deduce Post-Palaeozoic age. The existence of Malani pebbles and boulders in the Badhaura sandstone settles the age relationship of the Bap Boulder Spread, which, based on lithologic, bio-stratigraphic, and palaeogeographic associations cannot be of an age other than the one associated with the Late Paleozoic glaciation.

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ACTION OF PARACETAMOL ON DIVIDING CELLS OF *ALLIUM CEPA*

THE cardinal importance of evaluating the mutagenicity of several environmental contaminants and the potentiality of *in vivo* cytogenetic assay, among the battery of tests available for the purpose, have been stressed by many investigators¹⁻⁹. Drugs which find their places in our modern lives have also to be assessed from these angles. Some attempts have been made in this direction on a few of them using cytogenetical parameters in this laboratory^{6,8-12}. Analgesic and antipyretic agents also deserve special consideration. *In vivo* experiments with mice on the effects of Paracetamol (N-acetyl-P-aminophenol) have shown structural aberrations and numerical abnormalities in the form of polyploidy and univalency of sex chromosomes and autosomes occurring at all periods of treatment. It is surmised that they could collectively be of some genetic risk¹³. There is a lack of information about its action on somatic chromosomes. It is known that such an analysis could be carried out on more than one test system. The utility of root tip cells of *Allium cepa*, from this point of view, has been recognised by Kihlman¹⁴. The present study has been undertaken to determine its effects on dividing cells.

Roots growing from bulbs of *A. cepa* were treated at room temperature with 0.5%, 1.0% and 1.5% of Paracetamol (Crocine, Duphar Interfran Ltd.) for 2, 6, 12, 18, 24, 48 and 72 hours. Adequate controls were grown under identical conditions in distilled water. The roots from both series were processed for haematoxylin squashes as reported earlier¹⁵ after fixation in acetic alcohol.

The action of the drug on dividing cells has been estimated on the basis of changes in mitotic index (MI; Table I) and chromosome aberrations induced by it. A strong dosage effect is obvious from a decline in the MI values with the highest concentration exhibiting a marked decrease. These values for controls and treatments are plotted against periods in Fig. 1. The control curve for MI shows a decline from 2 to 12 hr and then exhibits an upsurge till 24 hr. From then onwards it shows very little change till 72 hr. These variations may be accounted as due to changes in the diurnal rhythm and periodicity of cell division^{16,17}. The curious feature of the experimental curves is that they follow the same trend during the period of treatment as with the control. This interesting observation denotes that the degree of mitotic depressions¹⁸ for various periods were considerably lower than those for controls (see also Table I). However individual differences between concentrations are retained without altering the above trend.