ABSTRACTS

CONFERENCE

ON

BIOSEDIMENTOLOGY OF PRECAMBRIAN BASINS

February 19-21, 1997

The Department of Geology, University of Lucknow
Lucknow

The Palaeontological Society of India
Lucknow

ABSTRACTS

CONFERENCE

ON

BIOSEDIMENTOLOGY OF PRECAMBRIAN BASINS

February 19-21, 1997

Organised by

The Department of Geology, University of Lucknow, Lucknow

The Palaeontological Society of India, Lucknow

Sponsored by

University Grants Commission, New Delhi

Geological Survey of India, Calcutta

Department of Science & Technology, New Delhi

International Geological Correlation Programme No. 380

Birbal Sahni Institute of Palaeobotany, Lucknow

Ministry of Mines, New Delhi

Directorate of Geology & Mining, U.P.

Oil & Natural Gas Corporation, Dehra Dun

BIOSEDIMENTOLOGY OF PRECAMBRIAN BASINS

February 19-21, 1997

ORGANISING COMMITTEE

Chief Patron	Prof. S.P. Singh Vice-Chancellor University of Lucknow Lucknow
Patrons	Prof. R.C.Misra, FNA & Prof. B.S.Tewari President, Palaeontological Society of India
Chairman	Prof. I.B.Singh, FNA Head, Department of Geology University of Lucknow Lucknow
Organising Secretary	Prof. S. Kumar Department of Geology University of Lucknow
Prof. H.N.Verma	Pro-Vice Chancellor University of Lucknow Lucknow
Prof.V.K.Srivastava	Dean Faculty of Science University of Lucknow
Prof. S.K.Singh	Emeritus Professor Department of Geology University of Lucknow Lucknow
Prof. K.P.Vimal	Former Head, Department of Geology Babuganj, Lucknow

Mr. Ravi Shanker	Deputy Director General Geological Survey of India Northern Region Lucknow
Dr. G. Rajagopalan	Director Birbal Sahni Institute of Palaeobotany Lucknow
Shri I.K. Dalela	Director Directorate of Geology & Mining, U.P. Lucknow
Dr. P.K. Maithy	Deputy Director Birbal Sahni Institute of Palaeobotany Lucknow
Prof. M.P. Singh	Secretary Palaeontological Society of India

RECEPTION COMMITTEE

Prof. M.P.Singh
Dr. A.R. Bhattacharya
Dr. A.C. Nautiyal
Dr. A.K. Srivastava
Dr. A.K. Jauhri
Dr. N.L. Chhabra
Dr. D.D. Awasthi
Dr. K.K. Agarwal
Dr. Vibhuti Rai
Dr. Rameshwar Bali
Dr. Munendra Singh
Dr. Ajai Mishra

INVITATION COMMITTEE

1. Dr. M.P. Singh
2. Dr. A.K. Srivastava

TRANSPORTATION & ACCOMODATION COMMITTEE

1. Dr. K.K.Agarwal
2. Dr. Rameshwar Bali
3. Dr. Ajai Mishra

REGISTRATION COMMITTEE

1. Dr. N.L. Chhabra
2. Dr. P. Bali
3. Dr. A. Rastogi
4. Dr. Rahul Srivastava
5. Ms. Rajita Gautam
6. Ms. Shikha Sharma

AUDITORIUM COMMITTEE

1. Dr. D.D. Awasthi
2. Mr. Rajeev Srivastava

TECHNICAL SESSION COMMITTEE

1. Dr. V.Rai
2. Dr. R.Bali

CATERING COMMITTEE

1. Dr. M.P. Singh
2. Dr. Munendra Singh
3. Dr. Shobhit Chandra

PUBLICATION, PRINTING & POSTERS

1. Dr. A.K. Jauhri
2. Dr. V. Rai
3. Dr. A.K. Kulshrestha

EXHIBITION COMMITTEE

1. Dr. V.Rai
2. Dr. Munendra Singh

FINANCE COMMITTEE

1. Dr. A.K. Srivastava
2. Mr. Ram Shankar Misra
3. Nominated person from Finance Office

PUBLICITY COMMITTEE

1. Prof. M.P. Singh
2. Mr. Dhruv Sen Singh

TECHNICAL PROGRAMME

February 18, 1997

15:00 - 17:00	Registration

February 19, 1997

08:30 - 9:45	Registration
10:00 - 11:30	Inauguration, Inaugural Address by Dr. S.K. Acharyya, Director General, Geological Survey of India, Calcutta. Prof. S.P. Singh, Vice Chancellor, University of Lucknow would preside over the function.
11:30 - 12:00	Tea Break
12:00 - 13:30	Technical Session I
13:30 - 14:30	Lunch Break
14:30 - 16:30	Technical Session II
16:30 - 17:00	Tea Break
17:00 - 18:30	Meeting of IGCP Project 380

February 20, 1997

09:00 - 10:00	Special Lecture By Mr. Ravi Shanker, Dy. Director General, Geological Survey of India, Northern Region, Lucknow.
10:00 - 11:30	Technical Session III
11:30 - 12:00	Tea Break
12:00 - 13:30	Technical Session IV
13:30 - 14:30	Lunch Break
14:30 - 16:30	Technical Session V
16:30 - 17:00	Tea Break
17:00 - 18:30	Technical Session VI

February 21, 1997

9:00 - 11.30	Technical Session VII
11:30 - 12:00	Tea Break
12:00 - 13:00	Valedictory Function
13:00 - 14:00	Lunch

Table of Contents

CARBONATE BUILD-UPS

1. PROTEROZOIC STROMATOLITIC REEFS : POSSIBLE EXAMPLES FROM THE HIMACHAL HIMALAYA

O.N. BHARGAVA

539, Sector 18 B, Chandigarh

The stromatolite carbonate bodies form relief, show evidences of wave-resistant structure and early cementation. The microfacies present are (i) boundstone, (ii) rudstone, (iii) packstone, (iv) grainstone (rare), (v) grapestone (rare), and mudstone.

These attributes are comparable with those of the Phanerozoic Reefs. As the present study is of preliminary type, a line of detailed study is suggested.

2. BIOSTRATIGRAPHIC ZONATION OF CARBONATE BUILD-UPS OF THE SEMRI GROUP IN SON VALLEY AREA, SONBHADRA DISTRICT, U.P.

S.GUPTA, V.C. SRIVASTAVA, K.C. JAIN AND MAHENDRA SINGH

Geological Survey of India, Northern Region, Lucknow

The carbonate build-ups of the Semri Group belonging to the Vindhyan Supergroup are well known for prolific development of stromatolite in Son Valley area, Son Bhadra district U.P. The Semri Group of rocks show three distinct cyclic sedimentary succession of arenite, argillite and carbonate facies. Each cycle consists of the lower clastic part and the upper carbonate part containing stromatolites of various types.

The geological studies undertaken in parts of Kajrahat, Dala, Deotara, Patwadh, Salkhan, Chawrihwan and Newari areas have yielded profusely developed biohermal, reefal and biostromal colonies in Kajrahat, Bargawan and Rohtas limestone horizons. The individual stromatolite beds are comparatively thin but several of these beds are superimposed to form composite stromatolite units of tens of metre thickness. The stromatolites vary from stratified, mound shaped, domical, hemispheroidal, columnar types with branched and unbranched forms exhibiting progressive morphological changes and diversification.

On the basis of evolutionary trend exhibited by characteristic stromatolite assemblages, four distinct Biozones viz. (a) *Omechtenia - Irregularia* (biozone I), (b) *Platella- Conophyton-Jacuphyton-Colonella* (biozone II) (c) *Conophyton - Jacutophyton- Colleniella* (biozone III) and (d) *Weedia -Stratifera* (biozone IV) have been established in Son Valley area. These assemblage zones are helpful in inter- and intra-continental correlation and age determination.

The stromatolite assemblsage like *Omechtenia* sp., *Irregularia* sp., *Pseudo-collenia* sp. *Colleniella* sp. constituting Biozone I and *Kussiella kussiensis*, *Colonnella discreta, Conophyton garganicus,* elongated ripple like forms *Platella* sp. representing Biozone II are characteristic of Kajrahat limestone horizon. Each of these biostromal and biohermal colonies are separated by cyclic beds of stratified carbonate mats and argillites.

The Bargawan limestone representing the second sedimentary carbonate sequence is characterized by reefal, mound shaped and columnar stromatolite forms like *Colleniella* sp. *Conophyton gargiganicus, Conophyton cylindricus, Colonnella columnaris, C. compacta,* and *Jacutophyton* sp. representing Biozone III. The *Conophyton* forms are circular, oblong, lanceolate or augen shaped in cross section, while *Jacutophyton* forms are giant size, inverted conical structures showing markedly divergent branching. The domed biostromes with closely spaced columnar, conical and branched stromatolites are believed to have developed in intertidal to subtidal environment.

The Rohtas limestone representing the uppermost carbonate sedimentary sequence of the Semri Group is characterised by hemispheroidal, bunshaped, stratified algal laminites and imprints of early Metazoan life. The stromatolite forms like *Weedia* sp., *Stratifera* sp., *Colleniella* sp. are characteristic of the horizon and constitute Biozone IV.

Stratified stromatolites with domal and columnar forms occur as a part of the repeated sedimentary rock cycles, in which each cycle was deposited during progradation and upward shallowing of the basin caused by the sediment aggradation. The detailed study of stromatolites and associated primary inorganic sedimentary structures are suggestive of deposition of carbonate build-ups under subtidal to intertidal to supratidal environment.

On the basis of stromatolite assemblasges and their gross morphological features, the age of the Kajrahat limestone, Bargawan limestone and Rohtas limestone is inferred to range between late lower Riphean to Upper Riphean and are correlatable with the Bijawar Group of the Bijawar type area in M.P. and the Pakhal Group of rocks of Gadchiroli district, Maharashtra. Presence of characteristic stromatolite forms like *Platella* sp. and *Conophyton garganicus* in Kajrahat limestone approximately fixes its age to Middle Riphean i.e. 1200 (50 Ma (Walter, 1972), which is in conformity with the radiometric dating of glauconite 1110 ± 60 Ma (Vinogradov *et al.*, 1964) from the Basuhari Sandstone Formation.

Biosedimentology of Precambrian Basins, Lucknow, February 19-21, 1997.

3. IMPLIICATIONS OF CYCLES IN STROMATOLITIC AND NON-STROMATOLITIC CARBONATES FROM THE MESOPROTEROZOIC CHITRABHANUKOT DOLOMITE, LOKAPUR SUBGROUP,BAGALKOT GROUP,KALADGI BASIN, INDIA

VIVEK S. KALE, SUSHMA NAIR and SHILPA PATIL

Department of Geology, University of Pune, Pune

The Kaladgi Basin on the northern fringes of the Dharwar craton contains pericratonic, shallow marine platform sediments of Mesoproterozoic and Neoproterozoic age, assigned to the Bagalkot and Badami Groups respectively. The first transgression in this basin is preserved in the form of Lokapur Subgroup, constituted of the Saundatti Quartzite, Manoli Argillite, Mahakut Chert-breccia and Chitrabhanukot Dolomite Formations. They represent coeval deposits in coexisting facies during the early transgression into the Kaladgi Basin.

The study of stromatolitic growth from the Chitrabhanu Dolomite was undertaken covering more than 20 bioherms exposed at Yargatti and Chitrabhanukot. The geometry of the laminations comprising the bioherms (lamination thickness, radius of curvature, base to height ratios) was measured in details both in hand specimens (on polished surface) and in thin sections. The aim of this study was to examine the variations in these parameters from the base to the crest of the bioherms. Petrological characters of these carbonates evidence their deposition in a shallow shelf with low gradient under varying degrees of influence of the tidal currents.

Exhaustive measurements of megascopic laminations (thickness and petrological characterisation) of a sequence of non-stromatolitic limestone exposure of the same Formation near Gaddankeri were carried out for having data on a "control reference section" which was deposited outside the influence of the algal activity. This measured section is of a total vertical thickness of more than 55 m, comprising 3218 laminations in all.

Both, in the stromatolitic bioherms as well as the non-stromatolitic section, the lamination thicknesses display a recurring cyclicity of atleast two separate orders.

The smaller cycles have a magnitude of 2-5 cm and contain up to 7 laminations in each cycle. These cycles are superimposed upon by larger magnitude cycles having decametre (x10 cm) scale. The second order cycles contain upto 8 first order cycles. The details of the cycles and their implications are presented in this paper. Significantly, although minor differences can be recognised in the statistical parameters of the stromatolitic carbonates, on gross dimensions there are no difference.

There is therefore reason to believe that the cycles recorded in the stromatolitic bioherms represent signature of the tidal cycles prevailing at the time of their formation, i.e. during the Mesoproterozoic. Drawing an analogy from modern tidal and intertidal carbonate accumulation rates recorded to range between 20 - 70 cm/Ka, the second order cycles may be attributerd to a tidal rhythm which operates on a Ka scale duration, while the first order cycles may be the manifestations of smaller duration tidal agency.

Two primary implications can be drawn from this study (a) irrespective of whether the carbonate accumulation in the Kaladgi Basin was biotic or non-biotic, it preserves the record of a tidal cyclicity. This tidal cyclicity belongs to dual systems, one of which is superimposed upon the smaller period cycles and (b) neither the lamination thickness nor the cycle magnitudes in the stromatolitic bioherm are statistically different from those recorded from non-stromatolitic, parallel laminated limestone beds from the same Formation. This resurrects the debate on the degree of influence of algal mats on the actual stromatolitic growth. This study suggests that the algal systems may have contributed to the lamination geometry and sphericity, but did not significantly enhance or suppress the accumulation potential of the carbonate sediments in the depositional system.

4. ON SIGNIFICANCE OF *CONOPHYTON* FORMS IN KUTESHWAR (KAJRAHAT) LIMESTONE OF VINDHYAN SUPERGROUP FROM BARHI, JABALPUR (M.P.)

P.S. MISHRA

Engineering Geology Division, Geological Survey of India, Nagpur

The Kuteshwar (Kajrahat) Limestone, Semri Group, of Middle Proterozoic time exposed at the tail end of Bansagar Lake is characterized by *Stratifera-Conophyton* stromatolite assemblage. A pronounced cyclicity in algal forms with AB-C-AB type cyclothems, is noted. The algal cones in C Phase of cycles, contain a medial cylindrical pipe. The crowns of cones are invariably ornamented with radially arranged slender crystals of calcite.

Attributes of Conophyton forms, cyclothemic characteristics and their petrographic associations are described. The significance of these in unravelling rhythmic sedimentation in protected domain of a lagoon is discussed.

The limestone deposit being explored with drill holes has generated significant data specially on evolution of *Conophyton* forms. The trend of evolution of algal forms is also discussed.

5. PRECURSORS OF STROMATOLITES OF THE CHHATTISGARH BASIN AND THEIR POSSIBLE BIO-SEDIMENTOLOGICAL IMPLICATIONS

A.K. MOITRA

Geological Survey of India, Calcutta

Diverse and abundant filamentous and cooccoid cyanobacteria along with acritarchs and some fragmentary algal remains are observed in the Raipur Limestone and Charmuria Limestone of the Proterozoic Chhattisgarh basin in M.P.

Altogether seventeen genera and twentyseven species including five new species among cyanobacteria and other microfossils have been recorded. Majority of the cyanobacteria fossils belong to Chlorophyceae, and Chrooccocaceae family. These are seen in the rocks adjacent or close to stromatolitic beds.

Overwhelming dominance of Oscillatoriaceae family indicates the forms belonging to this family played most vital role in the formation of stromatolites. A filament observed in the lamina of a stromatolite strongly corroborates this interpretation.

Significantly maximum diversity of biota is observed in black to grey pyritiferous shales and relatively much less in grey and black cherts.

Degree of preservation of biota in shales, colour indices, nature of walls of the acritarchs, dominance of certain genera of Oscillatoriaceae family namely *Oscillatoriopsis, Siphonophycus* and *Eomycetopsis* are certain features which give valuable clues about many sedimentological aspects of the sediments. In brief, these are :

1. The degree of preservation of the biota including acritarchs in the shales indicate that the sediments have undergone less of diagenetic hazards.

2. The honey yellow or yellowish brown colour of the biota and absence of eucaryotic forms indicate that temperature during sedimentation was higher than 40°C but less than 100°C.

3. Dominance of *Oscillatoriopsis* sp., *Siphonophycus* sp. and *Eomycetopsis* sp. indicates that sediments were deposited near shore in a shallow water environment.

6. STROMATOLITES FROM THE BLACK CHERT OF BANDED IRON FORMATION OF BAILADILA GROUP, MADHYA PRADESH, INDIA

S.N. PARULKAR AND P.K. RAHA

Geological Survey of India , Central Region, Nagpur

The Banded Iron Formation (BIF) of the Bailadila Group on the eastern margin of Katri rift basin near Sonadehi, Bastar district, Madhya Pradesh, showed profuse development of algal laminites, domal and irregularly developed stromatolites which include forms like *Nucleella, Irregularia* and *Stratifera* which are long ranging forms. This is the first record of stromatolites from this BIF of Bailadila Group.

The Bengpal Group, over which the Bailadila Group occurs as a folded belt, comprises amphibolite to granulite facies, gneisses and supracrustal rocks. The oldest age in the Bastar craton is indicated to be 3610 ± 336 Ma by Rb/Sr whole rock isochron age for Tonalite-Trondhjemite Granodiorite gneisses (Sarkar A., *Geol. Surv. Ind., Misc. Pub.*28, p. 466, 1990). The Bailadila Group represents superior type Iron ore cycle of the world (Ramakrishnan, M., *Geol. Surv. Ind. Misc. Pub.* 28, p. 44, 1990). The Bailadila Group is intruded by Dongargarh Granite which is dated as 2300 Ma (Sarkar *et al.* 1990).

7. SILICIOUS STROMATOLITES OF THE AGORI FORMATION, MAHAKOSHAL GROUP, JOGAIL (~JUNGEL) AREA, UTTAR PRADESH - A PRELIMINARY REPORT

JAYANTA KUMAR PATI

Geological Survey of India, Northern Region, Lucknow

The silicious stromatolites the from Agori Formation belong to the Mahakoshal Group (earlier known as Bijawar Group) of Early Proterozoic age. The Mahakoshal Group is broadly composed of metamorphics, metabasics, metatuffs, basic-ultrabasic intrusives, vein quartz, etc. and is further subdivided into the Chitrangi, Agori, and Parsoi Formations with Granitic gneisses (Bundelkhand Granitoid Complex) being the tentative basement unit.

These stromatolites occur 1.5 km SE of Jungel Water Tank, Sonbhadra District, U.P. The outcrop (24^{o} 30'28"; 82^{o}51'54") is lenticular in outline, approximately 220m long along N40^{o}E and maximum width is nearly 50m. The thickness of the unit is around 30m.

Stromatolites are found to be of silicious in nature with a trace of chlorite± pyrite, and a few are observed to contain tuffaceous sediments in their matrix. The stromatolite horizons occur in close association with ash flows and bands, pyroclastics, and amygdular basalt. Siliciclastic beds have also been observed in the vicinity.

Most of the stromatolite forms acquire columnar shape. In transverse section, they are circular to elliptical. A few forms are elongated in one direction. At a few places, the stromatolites are poorly developed and can be referred to as algal-mat horizons.

The importance of this occurrence lies in its unique setting, well preserved morphology, and siliceous nature.

8. A NEW RECORD OF STROMATOLITE IN THE BASAL FORMATION OF THE RAIALO GROUP AROUND KHO-DARIBA COPPER PROSPECT, RAJASTHAN

M.L. Patil[1], D.M.Banerjee[2], A.B. Roy[3]

[1]Hutti Gold Mines Co. Ltd, Hutti
[2]Department of Geology, University of Delhi, Delhi
[3]Department of Geology, M.L. Sukhadia University, Udaipur

The region around Kho-Dariba in south-central Rajasthan exposes one of the best developed sections of the Delhi Supergroup of rocks. Although stromatolitic structures have been recorded from the Kushalgarh Formation in the Alwar District, the present communication is aimed at reporting the first record of stromatolite in the dolomitic marble of the Basal Formation of the Raialo Group. The stromatolite bearing horizon is sandwiched between beds of meta-quartz arenite and non-stromatolitic argillaceous dolomite. Tectonic deformation and metamorphism in green-schist facies have produced mosaics of polygonal and equidimensional calcite and dolomite rhombs interspersed with recrystallised quartz. Occasional large flakes of biotite and antigorite in the dolomitic marble reflect the variations in the metamorphic grade. The stromatolitic structures are found in the basal part of the Raialo Group close to the unconformity surface with the underlying rocks. Best development of stromatolites are seen in the outcrops north of Paota village (Toposheet No.54 A/8) and extend for over 100m and are distributed in a thickness of about 30m. Stromatolitic columns are almost undisturbed by the regional tectonics. Three morphological types, namely, Bulbous, Columnar and Spheroidal stromatolites have been recorded. Systematic morphological study of these stromatolites by some of us (MLP) will be carried out in the next few months. The presence of shallow water features like stromatolitic carbonates, ripple marked and cross bedded underlying quartz arenites and deeper water flute-casted immature quartzites and argillites in the overlying formation have been used for the palaeo-environmental reconstruction.

9. MICROBIAL BUILD-UPS AND GLOBAL SEA LEVEL FLUCTUATION: AN EXAMPLE FROM NEOPROTEROZOIC KROL FORMATION, LESSER HIMALAYA, INDIA

VIBHUTI RAI

Department of Geology, University of Lucknow, Lucknow

Phanerozoic sea-level curves have been well established on the basis of sequence stratigraphy, geological events and palaeontological evidences. The Proterozoic encompasses a long time span, almost four times that of Phanerozoic and therefore, the processes involved during it need special characterization and study for assessment of global sea-level conditions for its different time divisions.

The upper part of the Krol Formation (of the Krol Belt of Lesser Himalaya) has shown the development of microbial build-ups of clotted and branching microbial fossils (Calcareous algae) with several intermediate morphologies. Taxonomically, many of these can be assigned names such as *Renalcis, Bija, Epiphyton, Angulocellularia* and *Girvanella.* In one of the better exposed sections of the Garhwal Synform, exceptional occurrences of these microbial build-ups generated huge colonies several meters in dimension. These horizons show massive occurrence of irregular shaped bodies with the growth of microfossils along their peripheral part. A closer scrutiny revealed that the entire horizon represents a "Karst" like situation where the large cavities and vesicles were filled by these carbonate precipitating micro-organisms which grew all along the surface of the cavities.

Possibly, a regression of the sea in the depositional area generated a "Palaeo-Karst" at about the terminal Vendian times. This data is in conformity with other regions as well and attests the regression model at the end-Precambrian. The present finding, therefore, provides us an opportunity to examine the extent of utility that the microbial build-ups can have in tackling such crucial problems like the global sea-level conditions at the Precambrian-Cambrian Boundary.

10. A UNIQUE STROMATOLITE BUILD-UP FROM THE DEOBAN GROUP, INNER CARBONATE BELT, LESSER HIMALAYA, INDIA

VIBHUTI RAI AND ARUN KUMAR SINGH

Department of Geology, University of Lucknow, Lucknow

The occurrence of stromatolites from the Deoban Group has been known for several decades. In fact two distinct stromatolitic assemblages were identified in classifying the Deoban Group. A recent study of the Deoban succession (Carbonates) in its type area provided some detailed information regarding the nature of the carbonate build-up. It was noticed that a large part of the succession shows flatly bedded carbonates (specially in the upper part of the Deoban Group) where about 3000 meters of thickness shows the development of uniform pattern of stromatolite growth throughout. A closer scrutiny of these horizons indicated that they are microbial build-ups which were deposited in a more or less uniform set of settings with little change in lithological compositions. Minor amounts of shales do occur within these laminated microbial build-ups.

These parallel laminated centimeter thick grey to cream coloured layers of carbonates show the development of horizontal columns of 20 to 50 centimeters length, 2 to 5 centimeters width, lying flat along the bedding and show stacking of columns in a vertical profile. In a perpendicular direction, the stacking is well represented by circular to oblong and irregular to ovate cross-section of the columns. A three dimensional reconstruction of the stromatolite form indicated that these columns show all sorts of morphological characterstics such as bridging, branching etc. that are diagnostic of stromatolites. The decimeter thick pile of carbonate beds show the occurrence of only such flat lying columnar stromatolites without change in the direction of column axis.

The above occurrence is a unique configuration of stromatolitic build-up where unlike the usual development of an upright column with slight changes in the column angle varying between 10^{o} to 20^{o}, the columns show their growth in a horizontal direction. As per the concept of stromatolite growth, the photosynthesis process involving sun-light and microbial community together induces the release of O_2 resulting in the precipitation of CaCO3 laminations. The direction of incoming sun-light, therefore, influences the growth direction of the column which is also controlled by physical factors such as currents, waves, etc. In the light of this unusual occurrence of present stromatolite, a new name is proposed herewith *Kumariella deobanica.* The systematics of this new form is being dealt in this paper. It is firmly believed that *Kumariella deobanica* would prove to be a crucial stromatolite form in correlating widely separated belts of Shali, Larji, Deoban and Garhwal which together constitute the Inner Carbonate Belt of the Lesser Himalaya.

11. MICROSTRUCTURE AND MICROFABRIC STUDIES OF PALAEOPROTEROZOIC SMALL DIGITATE STROMATOLITES FROM THE VEMPALLI FORMATION, CUDDAPAH, SOUTH INDIA

MUKUND SHARMA AND MANOJ SHUKLA

Birbal Sahni Institute of Palaeobotany, Lucknow, Uttar Pradesh, India

Small digitate stromatolites (15-20 mm long) are present in carbonate units of the lower parts of the Vempalli Formation (Papaghani Group) of the Cuddapah Supergroup. These stromatolites occur in the Kadiri region of the Anantapur district of Andhra Pradesh. Stromatolites are columnar, stratiform, mostly branched slightly dendritic or umbellate generally without wall structure and are mostly silicified. Columns are cylindrical to turbinate with rounded to lobate cross section with 2 - 12 mm in diameter.

Microstructure of these stromatolites correspond to the regular banded type composed of dark lamellae or microbial mat; and coarser light lamellae representing less pigmented portions of the microbial mats. Densely pigmented lamellae are microcrenate. Radial fibrous fabric intersect the light and dark lamellae and are almost parallel. The origin of this microstructure has been discussed. Dense/dark pigment production may be attributed to increased environmental stress probably due to long exposures to air, shallow water or radiation or insolation. Round or lobate cross section of columns may be due to the filamentous cyanobacteria as indicated by the studies of similar Chinese stromatolites of the Wumishan Formation containing erect and vertical tubes of filaments. The growth of radial fabric, alternatively, may be attributed entirely to the chemogenic process resulting from the radial growth formed at an early stage of stromatolites formation. Further such stromatolites have invariably been found associated with shallowing upward sequence as represented by intraformational brecciated carbonate laminae and underlying oolites. This association may be one of the reasons for their smaller size.

It is characteristic that small stromatolites, in India and other regions of the world (Canada, China, Australia), are noted in upper part of the Palaeoproterozoic sequences. The age of the sediments containing these stromatolites has been inferred 1817± 24 Ma on the basis of Rb/Sr dating of a sill intruding the Papaghani and Chitravati groups which is considered the younger limit to the sedimentation of these groups. Pb isotope suggests an age of 1759± 48 Ma representing a younger limit for sedimentation/diagenesis of dolomites of the Vempalli Formation. It is concluded that digitate stromatolites are characteristic of Palaeoproterozoic sequences and were formed by cyanobacterial filaments.

FACIES ARCHITECTURE
AND
SEDIMENTOLOGY

12. LOWER BHANDER SANDSTONE OF CENTRAL INDIA: A LATE PROTEROZOIC LAGOONAL-TIDAL FLAT SEQUENCE

A. Chakrabarti[1] and James D. Howard[2]

[1]Indian Institute of Technology, Kharagpur,
[2]Formerly of Skidaway Institute of Oceanography, P.O.Box 13687. Savannah, Georgia, U.S.A.

The Late Proterozoic Lower Bhander Sandstone (80m thick) of Central India, is a regressive siliciclastic, depositional sequence containing an abundance of well-exposed, primary sedimentary structures which make up six depositional facies; lagoonal-tidal flat transition, lower tidal, lower tidal flat, upper tidal flat-channel, transgressive bar-shoal and supra-tidal flat. A lagoonal facies of mainly laminated shales and centimeter-thick wave ripple laminated sand layers marks the the beginning of the sequence. Upward there is gradual coarsening with an increasing array of sedimentary structures reflecting a wide range of energy conditions. Sand intercalations become thicker and channel sands of wide lateral extent predominate over shale intrercalations in the upper tidal-flat/channel facies. Ripple marks in these sand bodies record a change from wave-generated ripples, common in the lagoon and lower tidal flat, to current ripples in the upper tidal flat channels. Shale clasts, scour pools, and large sand waves characterize the transgressive bar-shoal facies. Continued shallowing and finally exposure is recorded in the supra-tidal flat facies by large desiccation cracks. The Lower Bhander is visualized as a regressive, shallowing upward lagoon-tidal flat sequence protected by a bar shoal that transgressed across the tidal flat surface. Following the transgression a supra-tidal desiccation flat developed. Comparing with their geologically younger counterparts, it is worthwhile to search for the traces of biogenic activity in these sediments, particularly in the lagoonal-tidal flat transition sequence, in order to appreciate the significant role played by biogenic activity in coastal sedimentation.

13. MIDDLE PROTEROZOIC PORCELLANITES OF SON VALLEY : THEIR FACIES ARCHITECTURE AND DEPOSITIONAL ENVIRONMENT

NAGESHWAR DUBEY

Department of Geology, Banaras Hindu University, Varanasi

Middle Proterozoic Porcellanite bearing Lower Vindhyan of Son Valley is the only example of well developed volcaniclastic sedimentation in Indian stratigraphy. Porcellanite in its type locality, i.e., Chopan (24 32' & 83 04') represents huge thickness (100-115 m), distinct bedding/lamination parallelism, three sets of joints, conchoidal fracture and alternation with argillites. Chemically they are very similar to rhyolites except their less alumina and more silica content. On the basis of lithology, grain size, texture, sedimentary structures and unit geometry, six lithofacies were established. They are (1) black porcellanite - dark/black, argillaceous, laminated and pyritic (2) banded porcellanite - grey (more micaceous) and white (more siliceous) bands 2 - 20 cm thick (3) massive porcellanite - thick greyish white bands generally devoid of physical sedimentary structures (4) green porcellanite - thinly to thickly bedded chloritoid/epidote bearing (5) conglomeratic porcellanite - subangular to sub-rounded chert pebble bearing (6) tuffaceous porcellanite - showing rhyolitic texture and syndepositional deformational structures. Porcellanites were deposited in a shallow marine lagoonal environment with volcanic materials along with siliciclastics. Vertical and lateral lithofacies differentiation of porcellanite have gained more emphasis in the present study.

14. ARCHEAN BANDED IRON FORMATION OF GANDHAMARDAN HILL, KEONJHAR DISTRICT, ORISSA - ITS PRIMARY SEDIMENTARY STRUCTURES, FACIES ARCHITECTURE AND MICROBIOTA

N. PANDEY

Department of Geology, Nagaland University, Kohima, Nagaland

The Banded Iron Formation (BIF) of Gandharmardan Hill occurs as an outlier of the Noamundi-Jamda-Koira Iron Ore Group, 15 km west of Keojhargarh, Orissa. It is mainly confined to the Lake Superior type oxide facies with subordinate sulphide and carbonate facies. Practically, it is unmetamorphosed and is found intrinsically associated with volcanic and volcaniclastic rocks. The complete sequence of BIF has been divided into three facies from bottom to the top - (i) The pyritic black chert (sulphide facies), (ii) The tuffaceous shale with taconite (carbonate facies) and (iii) The banded hematite jasper with iron ores (oxide facies).

The pyritic black chert, which directly overlies the altered older volcanics, consists of intraformational chert breccia, black chert with 30 to 35 % syngenetic pyrite of microscopic to 5mm size cubic crystals and banded hematite/magnetite black chert. Except monotonous parallel laminations, no other sedimentary structure is visible in these rocks. It indicates chemical pecipitation under anaerobic, relatively quiet, below wave-base off-shore basinal condition.

The overlying porous chocolate brown to greenish calcareous silicified tuff, variegated ferruginous shale and bedded silica/jasper (taconite) comprised the carbonate facies. Besides parallel and slightly lenticular laminations, small scale slump structure are also present in this facies. The succeeding Banded Hematite Jasper (Jaspellite) with iron ores exhibits a rich assemblage of primary sedimentary structures and attains the maximum thickness all along the hill range. The presence of mud cracks, cross laminations, ripple and rill marks indicate the deposition of chemically precipitated iron and silica gel above wave base near-shore environment. The occurrence of intraformational brecciations, convolute laminations, pods, and other penecontemporaneous deformation structure at periodic intervals suggest occasional water turbulence and current action produced due to sudden slumping or syndepositional palao-seismic activity.

Based on colour, minerological composition, thickness, mode of occurrence of individual bands and sedimentary structural features, four distinct sub-facies type viz. Iron oxide (I), silica or jasper band (J), composite band (C) and penecontemporaneously deformed composite band (Pc) have been identified for the BIF. The application of first Markov chain analysis reveals the following probable upward facies transition.

(I)↔(J)↔(C)↔(Pc)

Mutual substitutability analysis further reveals the strong substitutability pairs between (I)↔(C) and (J)↔(Pc). A low entropy set values and slightly asymmetric A-4 type cycle characterize the basal part of BHJ, whereas the value for entropy sets increases and gradually passes from B to C or mixed type cycle as topographically higher areas are reached. The causative explanation may be modification of individual band, especially composite band (C) by supergene enrichment processes or intermittent instability accompanied by changes in water mass composition due to seasonal variation.

The Scanning Electron Microscopic studies have revealed spectacular occurrence of filaments, coccoid and rod shaped alga-like microbial forms within the BIF of Gandhamardan Hill. The pyritic bacterial spherulites were encountered in the sulphide facies, while coccoid, spheroid and filamentous type forms resembling *Tasmanites* cf. *punctatus* Newton, *Turuchanica alara* Rudauskaja, 1964 and *Archaeorestis schreiberensis* Barghoorn, 1971 respectively characterize the oxide facies. Besides these a doubtful organic form similar to asymmetrical cell of Barghoorn, 1971 and some unidentified doubtful biogenic structures have also been recorded. The presence of such a microbiota in the BIF further supports biogenic influence during the deposition of iron and silica.

15. LITHOFACIES ANALYSIS OF THE LARIAKANTHA QUARTZITE AND ITS IMPLICATION ON THE GENESIS OF THE BLAINI FORMATION, KUMAUN LESSER HIMALAYA

CHARU C. PANT AND PRADEEP K. GOSWAMI

Department of Geology, Kumaun University, Nainital, U.P.

The Lariakantha Quartzite (Member) of the Blaini Formation around the Nainital region comprises mainly fine to coarse grained quartzarenite with subordinate siltstone, shale and pebbly sandstone. Four major lithofacies have been identified and assigned to specific depositional environments. These are fine to medium grained cross-bedded quartzwacke interbedded with silty shale (Lithofacies A), cross bedded pebbly quartzarenite (Lithofacies B), massive to parallel laminated quartzarenite (Lithofacies C), ripple cross-laminated quartzarenite interbedded with silty shale (lithofacies D).

The vertical and lateral association of the lithofacies and dispersal pattern of these quartzites demonstrate that the Lariakantha Quartzites represent a progradational sequence. The sedimentation took place in high energy environments, storm dominated lower to middle shoreface (Lithofacies A), subtidal longshore bars (Lithofacies B), tide-wave dominated beachface (Lithofacies C), and intertidal mixed flat and tidal channel environment (Lithofacies D).

The various lines of evidence suggest that the Lariakantha Quartzite was deposited by traction currents in a shallow coastal realm rather than in deep sea environments by the turbidity currents.

16. STRATIGRAPHY OF CAMBRIAN SEQUENCES OF ZANSKAR AREA OF LADAKH HIMALAYA, INDIA

S.K. PARCHA

Wadia Institute of Himalayan Geology, Dehra Dun

The Zanskar area together with the Spiti basin constitutes the largest marine basins of the Higher Himalayan ranges. The Zanskar Basin constitutes the southern part of Ladakh Himalaya. It lies between the Great Himalayan Ranges in the south and Indus Valley in the Northeast. Geologically, it represents the north- west extension of the main Spiti Basin. The Zanskar Basin represents a thick pile of sediments of varying characteristics. A complete succession of rocks ranging in age from Precambrian to Tertiary is well exposed in the Zanskar area (SE of Ladakh). In the present course of study concentration was given to the Cambrian sequences only. The Cambrian rocks are well exposed along the left bank as well as on the right bank of Kurgiakh stream in Kurgiakh Valley. In Kurgiakh village, the fossiliferous section is cropping out along the path from Kurgiakh to Sarchun-La. The sequence is well exposed in Kuru and Tanzee in the Kurgiakh Valley. Besides this, the Cambrian rocks are also exposed in Karsha village. In the present course of study, a variety of trace fossils as well as trilobites and brachiopods were collected from the Cambrian sequences of this area. The present report is the first report of trace fossils and trilobites from the Lower and Middle Cambrian sequences of the area. On the basis of present fossil findings, the Cambrian stratigraphy of the area is worked out. The nature of the lower contact of sedimentary sequence is marked by various workers in different ways. Various workers think that the contact between the Tethyan Zone and the Higher Himalaya is a tectonic one. But unless typical fauna of early Cambrian age is not reported, the precise boundary cannot be fixed. However, on the basis of present find of trace fossils in the Kurgiakh Zoomar-La section of Zanskar area the Precambrian/Cambrian boundary can be identified. The appearance of *Phycodes pedum* has been considered as a chararacteristic trace fossil of Lower Cambrian age. It is considered as a horizon-marker for the beginning of the Cambrian though it extends further upwards but does not occur below the Cambrian. The present find of fossils has been very much useful in demarcating the age of various formations given by earlier workers. The present work is a considerable improvement on the existing knowledge of the Cambrian stratigraphy of Zanskar.

17. STUDIES IN SEQUENCE STRATIGRAPHY OF PAURI FORMATION, GARHWAL HIMALAYA

C. PRASAD, S.P.SINGH, AND M.P.S. BISHT

Department of Geology, HNB Garhwal University, Srinagar, Garhwal

Studies carried out in the synclinal basin of Pauri, in the western part of the Dudatoli synclinorium, between the North Almora and South Almora Thrusts, has revealed a thick sequence of phyllites overlain by quartzites.

Detailed petrological investigations have revealed that the Pauri Formation contains metagraywacke at the base, followed by slates and phyllites, all relating to a flyschoidal sequence. However, the presence of carbonaceous and calcareous slates, towards the top of this sequence, indicates shallowing of the basin and deposition of shelf mud. These slates are followed unconformably by the Devithonk and Khirsu quartzites, which suggest deposition under coastal plain conditions. The central part of this basin is occupied by the schists and gneisses, which appear to constitute the core of this orogenic belt. The granites of this locality have revealed an age of 1800 Ma.

Therefore, it appears that the flyschoidal sequence of Pauri might have been older than 1800 Ma and in this way, they are equivalent to Aravallies, i.e., Middle Proterozoic. The shallow water deposits of Devithonk and Khirsu quartzites may represent the molasse of the above geosynclinal belt, and these may be upper Proterozoic.

Studies further indicate that these phyllite and quartzite might be different from the Chandpur-Nagthat sequence (Upper Proterozoic).

18. DEVELOPMENT OF LATE PRECAMBRIAN IN THE HIGHER HIMALAYAN TETHYAN ZONES - THEIR PALAEOGEOGRAPHIC IMPLICATIONS AND DISTRIBUTION IN SPACE AND TIME

A.K. SINHA

Wadia Institute of Himalayan Geology, Dehra Dun

In the Himalayan region of southern and northern terrace, there has been a wide palaeogeographic distribution of Precambrian basins in space and time. In the central and N-W sector of Indian Higher Himalayan Zones the Late-Precambrian and Early Palaeozoic sequences are represented by very low grade metamorphosed sedimentary sequences. Such a sedimentary pile, named the Martoli Group, tectonically overlies the highly metamorphosed crystalline sequence of the "Vaikrita" Group which has been intruded by younger granites. Over the Martoli Formation we encounter a thick horizon of Ralam conglomerates followed by carbonate and pelitic sequence of Garbyang and Variegated Series. In them we find lower Ordovician and Silurian fossils. In the NW sector similar horizons of the late Precambrian, called the Haimanta sequence, tectonically overlies the sillimanite and kyanite grade crystalline metamorphic rocks of the Vaikrita Formation. The overlying sequences are continuous Palaeozoic horizons from Cambrian onwards. A wide range of reefal growth has been found, encompassing the upper Ordovician and Silurian. Interestingly, the lower Haimanta Formation has also been intruded by 500 Ma granitic bodies which in turn have again been invaded by younger granites. The Palaeogeographic configuration in this region of Higher Himalaya during Late Precambrian shows deeper depression in the northwestern region of Spiti and Lahaul basins, whereas in the eastern part there has been marked shallowing. There are also some highs intervening between the depressions.

Recent investigations in the Karakoram region in northwestern sector has revealed a Precambrian crystalline basement on unconformably overlain fossiliferous strata. The conceptual model of terrane in Himalaya and Karakoram region reveals a new interpretation of the palaeogeographic configuration of terranes during Precambrian.

19. BIOSEDIMENTOLOGY OF THE PRECAMBRIAN BASINS OF THE LESSER HIMALAYA AND THEIR CORRELATION

VINOD C. TEWARI

Wadia Institute of Himalayan Geology, Dehra Dun

The Palaeo- to Neoproterozoic sedimentary basins of the Lesser Himalaya are well developed in a linear fashion. The southern and northern boundaries of these basins are defined by Main Boundary Thrust (MBT) and Main Central Thrust (MCT) respectively. Two major peritidal carbonate cycles are recognized in sequence stratigraphic order in the central sector of the Lesser Himalaya. Microbial buildups are extensively found in the Shali-Deoban-Tejam belt (Palaeo- to Mesoproterozoic) and Krol belt (Neoproterozoic to Precambrian-Cambrian boundary) passive marginal basins of a Proto-Tethys Ocean (PTO).

Stromatolites and other microbial build-ups (microbial reefs, thrombolites) occur as biostromes and bioherms developed in a shallow marine platform. Biosedimentological and stable isotopic analyses suggest that biomicritic laminae of stromatolites are formed by cyanobacterial colonies and show high $\delta^{13}C$ and $\delta^{18}O$ values. The biosedimentology of the Proterozoic stromatolites of the Lesser Himalaya and their correlation is discussed.

PRECAMBRIAN BIOTA

20. NOTEWORTHY ORGANIC-WALLED MICROFOSSIL ASSEMBLAGE FROM THE SHALE MEMBER OF THE UPPER TAL FORMATION, MUSSOORIE SYNCLINE, LESSER HIMALAYA, UTTAR PRADESH

RUPENDRA BABU AND P.K. MAITHY

Birbal Sahni Institute of Palaeobotany, Lucknow

A thick pile of argillo-arenaceous sequence is exposed in the Upper Tal Formation of Mussoorie Syncline. The Upper Tal succession is divided into the following.

Upper Quartzite Memeber
Limestone Member
Arkosic Sandstone Member
Shale Member
Lower Quartzite Member

The Shale Member of the Upper Tal Formation is well known for its palaeontological remains and tribolite, viz., *Redlichia noetilingi* and brachipods - *Magnicanalis, Walcottina, Lingulella, Obolus and Obolella.* On the basis of the reported assemblage of animal remains the age of the beds has been derived to be Botomian stage of the Early Cambrian. The beds containing those animal fossils are exposed:

(a) About 1.5 Km from Dhaulagiri, towards Maldeota along Maldeota-Surkhet-Gopi Chand Ka Mahal section, Mussoorie Syncline

(b) At 8 Km stone before Mussoorie near Jabarkhet Toll Barrier along Mussoorie - Dhanaulti section.

The rock sample comprise greyish - black shale interbedded with quartzite. The black shales in petrographic thin section show preservation of rich and diversified organic-walled microfossils previously unreported from this bed. The recorded organic-walled microfossils belong to acritarchs, viz. Sphaeromorphitae (Monosphaeritae - Favosospheridium, Stictosphaeridium and Nucellosphaeridium; Polysphaeritae (Symplassophaeridium), Prismatomorphitae (Octaedryxium), Polygonomorphitae (Anguloplanina) and Versimorphitae (Pulvinomorpha). The macerated residue comprises *Obruchevella, Sphaerocongregus* and *Micrhytridium.* The assemblage shows continuation of PC/C marker forms.

Biosedimentology of Precambrian Basins, Lucknow, February 19-21, 1997.

21. THE HUMBLE SHALL INHERIT THE EARTH

R. K. Kar

Birbal Sahni Institute of Palaeobotany, Lucknow

The change in structure of an organism is primarily due to the fact that it has to successfully cope with the physical environment for survival. Prolonged changes in physical environment induce subtle changes in forms involving innovations. The organism changes owing to its inherent weakness. The larger the organism the more vulnerable it is to extinction, in response to adverse changes in the physical environment. Also the larger organism display larger nucleus and more number of chromosomes than their smaller cousins. The Cyanophyceae also known as blue-green algae are typified by smaller magnitude, which cannot even afford a small organised nucleus, are the earliest known algal fossils surviving for more than 2 billion years and reported from the several parts of the world. *Animikiea septata* described from the Gunflint Chert could very well match with the extant Nostocales, while *Entosphaeroides* amplus closely resembles Chamaesiphonales. Cyanophyta are reported to occur as single cells of microscopic size or as small cell colonies of various shapes and as multicellular filaments. They have flourished in all possible habitats i.e. fresh or salt water, in anaerobic or aerobic condition from arctic cold water to hot spring. Though the blue-green algae undergo cell division by an ingrowth of the septum, but lack a well defined nucleus and do not exhibit sexual reproduction, but still have the most ancient fossil history and even today thrive as a formidable group. The acid test for the fitness of a population is its inherent survival stength. If a particular group could exist for more than two billion years braving all possilble hazards of climateic vicissitudes then one should seriously assess the cause for its enormous strength. The obvious answer to such a query, firstly lies in tiny or humble magnitude of populations superbly maintained through million of years of earth's history. Secondly, the lack of nuclear membrane is dictated by the small cell size permitting the dispersion of nuclear material in Prokaryotic architecture, demanding least energy for reproduction of the population. It would indeed be an utter understatement to call the blue-green algae as the most primitive, rather they should be hailed as the most practical, successful and at the same time flexible group, which is ruling the earth since its inception.

22. TRACE FOSSIL LIKE STRUCTURES IN RIPPLED QUARTZITE OF DELHI SUPERGROUP, JAIPUR DISTRICT, RAJASTHAN

RAVINDRA KUMAR AND U.B. MATHUR

Geological Survey of India, Western Region, Jaipur, Rajasthan

Early form of life in the Middle Proterozoic Delhi Supergroup of north eastern Rajasthan is well documented by algal stromatolites exposed in the Alwar district. Microfloral remains comprising bluegreen algae have also been recorded from the Kushalgarh Formation of the Ajabgarh Group around Baraud village in the Alwar district. More recently, sinuous to spindle shaped structures, somewhat resembling worm trails and traces have been regarded as the evidences of the presence of early metazoans of Middle Proterozoic in India. However, a variety of raised, fusiform and sinuous to "figure-8" shaped structures from the Proterozoic of Australia viz., Umbertana Group (Late Precambrian), Flinders Range, south Australia and Heavitree Quartzite and Bitter Springs Formations (Late Precambrian) central Australia, identical to those described from the Delhi and Vindhyan Supergroups have been assigned an inorganic origin by a number of workers. Therefore, the authors have had a fresh look at the trace fossil-like structures present profusely in the Quartzites of the Alwar Group exposed in the Kanakghati and Jaigarh Fort area of Jaipur district. In this paper these structures are described and their possible origin discussed.

23. MICRO-ORGANISMS FROM THE BEDDED CHERT, THE SIRBU SHALE (FORMATION), BHANDER GROUP, BUNDI AREA, RAJASTHAN

S. KUMAR AND PURNIMA SRIVASTAVA

Department of Geology, University of Lucknow, Lucknow

Thin lenses and bands of black bedded chert within the dolomitic horizons of the Sirbu Shale, (Upper Vindhyan), the Bundi area Rajathan has yielded well preserved microfossils of variable affinities. The dolomitic horizon is exposed at about 6 km from Bundi, on Bundi-Chittorgarh motar road. Since data regarding Upper Vindhyan microfossils is meagre (specially from petrographic thin sections of chert), the present report is significant and adds information about life during Upper Vindhyan sedimentation.

Palaeo-ecologically, the assemblage represents planktic mode of life. Microfossils occur within and in between the oolitic grains and at a very few places evidences of algal mats are seen. Microfossils show a noticeable variation in size as dimensions vary from 1m to 260m. The identified morphotaxa are:

COCCOID FORMS

Cynobacteria - *Gloeodiniopsis* sp. *Glenobotrydion* sp., *Myxococcoides* sp., *Eoentophysalis* sp., *Sphaerophycus* sp., *Eomicrocystis* sp.

Acritarchs - *Trachysphaeridium* sp., *Leisophaeridium* sp., *Cymatiosphaera* sp.

FILAMENTOUS FORMS

Siphonophycus sp. *Archaeotrichion* sp. *Obruchevella* sp., *Oscillatoriopsis* sp., *Palaeolyngbya* sp., cf. *Gunflintia* sp.. Forms comparable with fungal hyphae, bacterial forms and division stages representing chlorophycean affinity are reported. Domination of cyanobacterial mat building community is a common feature of Lower Vindhyan microfossil, whereas planktic forms dominate the present assemblage.

24. CELLULARLY PRESERVED MICROFOSSILS FROM THREE BILLION YEARS OLD IRON ORE SUPERGROUP, KASHIA AREA, ORISSA, INDIA

P.K.MAITHY[1], S.KUMAR[2], R. BABU[1] and SHEENU SHARMA[1]

[1]Birbal Sahni Institute of Palaeobotany, 53, University Road, Lucknow
[2]Department of Geology, University of Lucknow, Lucknow

Cellularly preserved spheroidal and tubular microfossils have been identified in bedded carbonaceous cherts from the Archaean of Iron Ore Supergroup considered to be ≅ 3.0 Ga old. The bedded carbonaceous chert is exposed at Kashia mines, Barbil, Orissa. The spheroidal fossils are either solitary with distinct vacuole or they are arranged in loose colonies. Some of them preserve distinct organic sheaths around individual cells. In some cases distinct binary fission is seen. The tubular forms are narrow and septate. These fossils are among the oldest now known from the geological record of India and their findings substantiate previous reports of Archaean microfossils in Iron Ore Supergroup.

25. THE ROLE OF PRIMITIVE BIOTA IN THE Fe-Mn PRECIPITATION IN ARCHAEAN BASINS

C. MANIKYAMBA AND S.M.NAQVI

National Geophysical Research Institute, Hyderabad

The precipitation of iron as oxide, carbonate and sulfide facies in the Banded Iron Formation (BIF) is confined in space and time with a major peak at 2700 m.y. ago. On the other hand the precipitaion of Mn has been extremely rare during Archaean with a major peak of deposition during Proterozoic. Mn bearing strata in Archaean is invariably associated with stromatolites, carbon phyllites and microfossils with both authentic and doubtful syngenesity and biogenesity. Geochemical characteristics such as carbon isotopes, Ce and Eu anomalies along with total REE in association with other incompatible elements have indicated that primitive microbiota has played a very significant role in precipitation and fractionation of iron and Mn formations at different places in the basins where Sandur, Chitradurga and Shimoga belts were deposited. Differences in the O_2 fugacity within the basins were apparently caused by the organic productivity near the shore lines within the photic zone where stromatolites were found. Photosynthetically produced oxygen at the shore line and the iron, Mn bearing hydrothermal fluids from the deeper part of the basin were brought together by the ocean circulations due to thermal and chemical potential differences between the deep site vents and shore line. This created a continuous ocean water with different redox potential and resulted in precipitation of Mn and iron formations at different sites. In higher redox potential region, Mn-oxide and at the lower redox potential, oxide facies iron formation were laid down. Sulfidic BIF which are found to be auriferous at many places were deposited in a reducing environment, the region where O_2 produced by microbiota could not reach. Both iron and Mn being toxic to organic matter, autocanablastic reaction between the microbiota and precipitating Fe-Mn oxides produced carbonates of different types and composition such as siderite-Mn siderite and Kutnahorite. The carbon isotopic data of such carbonates indicates that carbonate, facies BIFs contain both primary and secondary minerals. Rhodocrosite is found in suspected microbial filaments only.

During post Archaean period, a phenomenal growth of stromatolites and consequent organic productivity has taken place. This organic productivity increased the oxygen fugacity of Proterozoic basins where by deposition of Mn became predominant and since most of the Proterozoic basins had a very high content of O_2, deposition of BIFs has not taken place. The chemical precipitation from BIF predominant situation in the Archaean to phosphorite predominant situation in the Proterozoic, through an intermediate stage of Mn deposition appears to have been mainly governed by the continuously increasing microbial productivity, which has converted the environment, friendly for the growth of higher species of the evolutionary trend.

26. PROSPECTS OF PRECAMBRIAN BIOTA IN MEGHALAYA AND ARUNACHAL PRADESH

U. K. MISHRA

Geological Survey of India, Shillong

In North Eastern Region, the biosedimentological studies in Pre-Cambrian basins is negligible but the tectonic set-up of the sediments are likely to yield Precambrian biota in near future. The Precambrian sediments are well developed in Meghalaya plateau and Arunachal Pradesh.

In Meghalaya plateau, the sediments of Shillong Group which covers a large part of the plateau has been subdivided into Shillong Quartzite Formation and Mawngap Phyllite Formation. These formation have also been named as Upper Mawphlang Formation and the Lower Manai Formation. The group is an entirely clastic sequence and is made up of sandstone and siltstones. The Shillong Group of rocks display mainly relict primary sedimentary structure and have undergone low grade regional metamorphism prior to the igneous activities in the area. The weakly metamorphosed members are basal conglomerates, sandstones, quartzite, siltstones and shales. In Mawphlang Tyrsad section, the black shales and siltstones are exposed which are likely to yield microbiota.

In Arunachal Pradesh, the Precambrian belt is bounded to the north by the Tibetan plateau, to the south by the Gondwana sediments and to the north-east by the Mishmi massif. The sediments are well developed in Kameng, Subansiri and Siang districts of Arunachal Pradesh. The Kameng district, the shale units in Saleri Formation of Bichom Group are likely to yield microbiota. In Subansiri district, Yazali member of Khetabari Formation characterized by carbonate rocks, phyllites and arenaceous bands may yield Precambrian biota. The search for such biota can be attempted in Buxa Group of sediments in Siang district as *Stratifera* sp. has already been reported.

27. PRECAMBRIAN BIOTA FROM THE VANIVILAS FORMATION, CHITRADURGA GROUP, SOUTH INDIA

P.C. NAGESH AND H.M. NAGARAJA

Department of Geology, University of Bangalore, Bangalore

Diverse assemblage of well preserved Precambrian microbiota from thin sections of chert and banded ferruginous quartzite. The litho-types have been reported from Voblapur area of the Vanivilas Formation, Chitradurga Group, Karnataka. The rocks are also well known for good development of significant and varied stromatolites. The study revealed the presence of microfossils of septate, algal filament, spheroidal algal unicells, associated with stromatolites. These microfossils show affinities with

Oscillatoriaceae: *Entosphaeroides amplus, Filiconstrictosis* sp., *Palaeolynbya bargooriana, Siphanophycus* sp.;

Nostacaceae: *Eomycetopsis filiformis*;

Chroococeaceae: *Gloeodiniopsis lamellosa, Archaeococcus diversus, Myxococcoides minor* and *M. reticulata*.

Chlorellaceae: *Caryosphaeroides tetras, C. pristina* and

Eubacteriales: *Biocatesnoides spherula*.

Majority of the species are identical and morphologically comparable to those reported from Australia, China, Canada and Russian microbiota of Late Precambrian age, and also points to a shallow marine conditions of deposition for rocks of the Vanivilas Formation.

28. FUNGI AND CYANOBACTERIA FROM THE STROMATOLITIC BLACK CHERT OF BANDED IRON FORMATION OF BAILADILA GROUP, MADHYA PRADESH, INDIA

P.K. RAHA[1], S.N. PARULKAR[1], S. SHOME[2] AND U.S. KUNDU[2]

[1]Geological Survey of India (CR), Nagpur
[2]Geological Survey of India, Calcutta

Unicellular cyanobacteria of 0.5 to 1.0 µm diameter have been recorded in profusion in the Black Chert of Banded Iron Formation of the Bailadila Group. These black cherts show microlamination and stromatolite structures. Besides these miniature unicellular organisms, certain unicellular globular structures, 3 to 4 µm in diameter and having root like structures simulating fungii have been recorded. The *in situ* growth of these organic bodies is indicated by their occurrence within the chert grains, some of the structures being partially covered in chert grains due to difference in level of etching. Some rod like filaments 0.3 µm in diameter show growth of unicellular coccoides having diameters of around 0.5 µm attached and scattered around them. Binary cell division in a cluster of coccoides with terminal flower-like structures have also been observed in some samples. The small size of the biota, 0.3 to 0.5 µm and 1.0 µm diameter of the major unicellular cyanobacteria also indicate their very primitive nature. The age of Bailadila Group is between 3600 Ma and 2600 Ma.

The methodology for this study in brief is as follows : Fresh chips from inner part of the samples of stromatolitic black chert, cut parallel to bedding, were taken for studies in Scanning Electron Microscope (SEM). The chip samples were etched in HF (diluted to 10% by volume) for ten minutes, washed thoroughly with distilled water and dried overnight in the furnace at 110°C. These were coated with gold and scanned in SEM for microbiota. The study was repeated after lapse of two months with fresh chips from the same samples and thus got confirmed the presence of these microbiota in them.

29. MICROBIAL EUKARYOTES AND ACRITARCHS FROM THE BEDDED CHERT OF KROL 'A' MEMBER, SOLAN AREA, HIMACHAL PRADESH, INDIA

VIBHUTI RAI AND RAJITA GAUTAM

Department of Geology, University of Lucknow, Lucknow

The Krol microfossils from bedded chert nodules have proved crucial in demarcating the various evolutionary stages of the biosphere during the Terminal Proterozoic time span. Two global events - The Varanger Ice age and the Lower Cambrian radiation of animal phyla delimit the Terminal Proterozoic (= ? Vendian). The diverse microfossil assemblage of Krol 'A' Member of the Krol Formation preserves a host of morphological entities. Apart from the cyanobacterial filamentous and coccoidal forms such as *Siphonophycus, Eomycetopsis, Salome, Obruchevella, Tetraphycus, Gleodiniopsis, Eoentophysalis* and others, the assemblage also includes definite eukaryotic microfossils such as branched filaments, remnants of septate rhodophycean forms and a huge population of acritarchs. The study is mainly focussed on the acritarch assemblage in order to understand their morphological complexity and diversity in the context of global correlation of various evolutionary events.

The acritarch assemblage ranges from small, simple vesicles to large, ornamented forms. Highly ornamented, very large vesicles of the order of 500 μm or more constitute a unique pattern of gigantism. These forms occur as compressed or collapsed vesicles. A morpho-taphonomic study of the assemblage indicates that these vesicles suffered collapse (possibly due to their own weight), degradation and rupturing either before or during preservation. Many forms like *Ericiasphaera*, *Asterocapsoides*, Cymatiosphaeroides and *Appendisphaera* represent architecturally complex and ornamented vesicles. The extreme delicate processes and spines seen preserved insitu in some forms help greatly in identifying the taphonomically distorted specimens. The wall structure of the vesicles is also preserved exceptionally where the pristine layered as well as degraded structure can be seen in different parts of a single specimen.

Simple, spheroidal vesicles (mostly *Leiosphaerids*), without any processes or prominent surface ornamentation also occur in the assemblage. They generally occur as solitary bodies and form a rare component of the assemblage in comparison to the ornamented forms. The acritarch assemblage is significant in ascertaining the evolutionary events during the Terminal Proterozoic. A comparison of the present acritarch assemblage with the Neoproterozoic assemblage of Doushantuo Formation of China and Draken Conglomerate Formation of Svalbard, Spitsbergen shows close similarity of forms and can be considered as another most authentic, highly diversified and exceptionally well preserved occurrence throughout the globe.

30. MICROFOSSIL ASSEMBLAGE FROM THE MESOPROTEROZOIC BHAGWANPURA LIMESTONE (LOWER VINDHYAN), CHITTORGARH DISTRICT, RAJASTHAN, WESTERN INDIA

ANJU RASTOGI

Department of Geology, University of Lucknow, Lucknow

Well preserved microfossils are described from the petrographic thin sections of the black bedded cherts of Mesoproterozoic Bhagwanpura Limestone (Lower Vindhyan). The fossiliferous chert occurs as lenses and bands, associated with domal stromatolites. The assemblage consists of coccoid and filamentous forms which are largely of cyanophycean affinity. The coccoid forms show more morphological variations than the filamentous forms. The assemblage includes thirteen species belonging to nine genera and one form of uncertain affinity.

The present assemblage shows a variable degree of degradation. At places degradation is very high obliterating the original morphological characters of the microfossils. The possible degradational stages of *Eoentophysalis cumulus* and *Palaeoscytonema* sp. are discussed.

The following assemblage is reported:

Coccoid Forms: *Glenobotrydion aenigmatis, Gloeodiniopsis mikros, Tetraphycus major, Sphaerophycus parvum, Sphaerophycus medium, Myxococcoides minor, Myxococcoides inornata, Myxococcoides grandis* and *Eoentophysalis cumulus*. Filamentous Forms: *Siphonophycus robustum, Siphonophycus septatum, Oscillatoriopsis majesticum, Palaeoscytonema* sp. and an unidentified form.

31. PALAEOBIOLOGICAL SIGNIFICANCE OF MICRO-ORGANISMS FROM MESOPROTEROZOIC, KHEINJUA FORMATION (SEMRI GROUP), SON VALLEY AREA, UTTAR PRADESH

PURNIMA SRIVASTAVA AND S. KUMAR

Department of Geology, University of Lucknow, Lucknow

Microfossils are cellularly preserved in black bedded cherts of the Fawn Limestone member (~ 1200 Ma) of the Kheinjua Formation, in Son Valley area. The fossiliferous cherts are well exposed in Newari locality of Sonbhadra district, Uttar Pradesh. In all 51 morphotaxa inclining towards variable affinities represented by cyanobacteria, (most dominating community), bacteria, algae, fungi, acritarchs and forms showing some resemblance with the extant chrysophycean (diatoms) affinities are identified.

The significant features of the Newari assemblage are

- Presence of bacterial forms.
- Forms assignable to fungal hyphae and budding like features
- A specimen comparable to the extant *Volvox* colony (evidence supporting presence of eukaryotes).
- Specimen comparable to diatoms (Chrysophycean affinity).
- Forms assignable to cholorophycean affinity.
- Thin sheet like structures comparable to extant eukaryotes of cyanobacterial affinity.
- Newari micro-organisms represent mat builders, mat dwellers (benthic) and allochthonous (planktonic) micro-organims.

Considering the morphological and taxonomical diversity variable palaeoecological distribution and presence of very small (less than 1 μm) to large sized (upto 160 μm) microfossils, the Newari assemblage can be categorized as one of the most evolved and well preserved microfossil assemblage of Mesoproterozoic.

BOUNDARY PROBLEMS

32. ORGANIC-WALLED MICROFOSSILS OF THE CHERT-PHOSPHORITE MEMBER OF TAL FORMATION, KORGAI SYNCLINE, LESSER HIMALAYA AND PRECAMBRIAN-CAMBRIAN BOUNDARY

MEERA TIWARI

Wadia Institute of Himalayan Geology, Dehra Dun

Organic walled microfossils of Late Proterozoic and Cambrian age has received much attention during the last few decades the world over. Most Proterozoic and Cambrian acritarchs are cosmopolitan because they occur in all kinds of marine shelf deposits. Their versatality in occurring in several ecological realms makes the group important. Lower Cambrian acritarch have been found useful in identifying various Lower Cambrian stages and in delineating the Precambrian - Cambrian boundary sequences.

There are only a few records of the presence of acritarchs in the Lesser Himalayan succession. The Chert - Phosphorite Member of the Lower Tal Formation in Korgai Syncline offers a unique opportunity for studying Lower Cambrian microbiota. The present work demonstrate the presences of these microfossils in abundance and their usefulness in correlating the early Cambrian sediments.

The microbiota studied include small acanthomorphic acritarchs, spheromorphs, cell clusters, isolated cells, rare filaments and sponge spicules. These are identified as *Micrhystridium lanceolatum, M. lanatum, M. tornatum, M. dissimilare, M. minutum, Cymatiosphaera* sp., *Polydryxion* sp., *Leiosphaeridia* sp., *Archaeodiscina* sp., *Estiastra minima, Siphonophycus* sp., and sponge spicules of hexactincllid affinity. The assemblage is suggestive of a stratigraphic position of the Chert - Phosphorite Member as close to the boundary or within the transition from Phanerozoic to Proterozoic. The strata, therefore, may represent a very critical interval in earth history for the understanding of plant and animal evolution through early Cambrian as well as the identification of the Lower boundary of the Cambrian.

Together with SSF, trilobite, trace fossils the organic walled microfossils of possibly eukaryotic phytoplankton may constitute one of the best available tools for establishing and correlating the Precambrian - Cambrian transition.

33. SOME UNUSUAL BIO-SEDIMENTARY STRUCTURES AND THEIR POSSIBLE SIMILARITY TO VENDIAN TRACE FOSSILS, JODHPUR FORMATION (LATE PROTEROZOIC - EARLY CAMBRIAN), JODHPUR, RAJASTHAN

M. MASROOR ALAM

Department of Geology, Aligarh Muslim University, Aligarh

With the cessation of Aravalli-Delhi orogeny and culmination of Malani volcanism, Western Rajasthan has experienced widespread fluviatile and marine sedimentation in Bikaner-Nagaur basin. The 1700 m thick sedimentary sequence of this basin comprises of lower arenaceous (Jodhpur Formation), middle calcareous (Bilara Formation) and upper arenaceous, calcareous and evaporite (Nagaur Formation) facies. On the basis of superposition on Malani volcanics (745±10 Ma) with a pronounced unconformity and presence of some doubtful orthis, brachiopod and algal remains in Bilara and Nagaur Formations, these rocks have been assigned an age of Late Proterozoic - Early Cambrian.

Late Proterozoic - Phanerozoic transition marked a major turning point in the geological and biological record. This transition is marked by increased abundance and complexity of, otherwise meager and simple trace fossil biota before the appearance of skeletelized fossils near the base of the Cambrian known as "Cambrian Explosion". A great deal has been given to select standard global stratotype section and point (GSSP) by IGCP (IUGS) with special attention to the "Ediacara" type of trace fossils of Vendian to mark Proterozoic - Phanerozoic boundary. In the Indian sub-continent, too, considerable work has been carried out specially in Salt Range, Hazara district, Pakistan and in the lesser Himalayan sequences of India in this context but the rocks of Bikaner-Nagaur basin have not been subjected to extensive studies despite their stratigraphic potential.

The sandstones of the Jodhpur Formation offer a good opportunity by virtue of their age to investigate the trace fossils of Vendian age. The sandstones, very well exposed in sandstone quarries, are highly rippled and crossed laminated suggesting prolonged period of shallow water conditions, an ideal habitat for the early organisms. A preliminary investigation in these sandstones has resulted in finding of some unusual biosedimentary structure (trace fossils ?). Notable of these are individual snake like and branching epichnial meandering forms akin to *Helminthopsis* of Vendian age but exceptionally large in size. Few resting traces of *Astropolichnus* type were also found. These rocks need extensive investigations for more trace fossil biota of Vendian age.

34. ON THE MODE OF PRESERVATION AND CHRONOSTRATIGRAPHIC SIGNIFICANCE OF *COLEOLOIDES TYPICALIS* WALCOTT IN THE PRECAMBRIAN-CAMBRIAN TRANSITION STRATA OF THE NORTHWEST HIMALAYA

D.K. BHATT

Geological Survey of India, Jaipur

The fossil fragments of *Coleoloides typicalis* Walcott are recovered from the strata of both the Lesser Himalaya and the Higher Himalaya in the northwest. They are reported from various localities in the Krol Belt succession of the Lesser Himalaya. From the Higher Himalayan terrain, their report comes from the strata of Zilant Formation, on the southern slopes of the Pir Panjal Range. *Coleoloides typicalis* Walcott was originally described from the Lower Cambrian of New Foundland. The taxonomic status of the animal is uncertain.

Identification and mode of preservation

The fossils of *C. typicalis* consist of cylindrical elements of various lengths and diameters. The preservation of complete shell is known to be rare universally. The length of the individual broken elements in the Himalayan material usually reaches a mm or more. The surface of the fossil fragments is invariably marked by parallel striations along the length of the cylinder. The cylindrical shape of the fossil is due to the infilling of the tubular structure of *C. typicalis* shell. The infilled character of the fossil elements of *C. typicalis*, giving them a solid appearance, and their fragmented nature has apparently led to their description in the literature as *steinkerns*.

A characteristic feature of the *steinkerns* of *C. typicalis* is their ochre colour, which is invariably present in all the specimens, imparting a tinge of limonitic coating.

Lithofacies association and age

The *steinkerns* of *C. typicalis* are recovered from a wide variety of rock-facies in the Himalaya. In the Krol belt of Lesser Himalaya, *C. typicalis* is present in abundance in the phosphate strata of Chert-Phosphorite Member of Tal Formation in the

Mussoorie Syncline. It also occurs widespread in the phosphatic dolomites of the Sherwood Member (Krol E) and the Giwalikhet Member of Tal Formation in the Naini Tal Syncline. In the Paristan locality of the Higher Himalaya, the presence of *C. typicalis* is recorded from an association of black shales and chert layers. The mode of preservation of *C. typicalis* remains remarkably identical in all the widely differing rock-facies. The uniform mode of preservation of *C. typicalis*, characterised by the infilled character and the replacement of the shell (calcium carbonate) with ocherous material, however preserving the finely developed outer shell-wall striations, in the different rock-facies, indicates high facies-resistant character of the *C. typicalis* fossil.

Coleoloides typicalis forms an abundant constituent of the small shelly fauna recovered from the phosphatic strata of the Chert-Phosphorite Member of Tal Formation in the Mussoorie Syncline. The microfaunal yield of the Chert-Phosphorite Member is precisely correlatable to the Precambrian-Cambrian transition interval of the early Meishicunian age, i.e., Meishicunian Zone I. The Meishucun section is South China also displays a shelly microfauna-yielding phosphate horizon, similar in the lithofacies set-up to that of the Mussoorie Syncline of the Lesser Himalaya. In the Naini Tal Syncline, the upper part of the Krol Belt succession, consisting of phosphatic dolomites, only yields rare, ill-preserved elements of small shelly fossils, except for *C. typicalis*, which occurs frequently throughout the 150 m thick fossiliferous section. The black shale/chert association of the Zilant Formation in the Pir Panjal Range (Higher Himalaya), on preliminary examination, yielded only a fragmentary ? small shelly fossil element, but a few well-preserved specimens of *C. typicalis*.

Conclusion and proposal

The occurrence of early Meishicunian microfauna is observed to be facies-controlled, being profusely present only in the phosphate rocks, as in the global type area of Meishucun (South China) or the phosphorite facies of Tal Formation of the Lesser Himalaya. In the other sections of early Meishicunian age where phosphate facies is not developed, as in the Naini Tal or Pir Panjal sections, the preservation of shelly microfauna may either be inadequate or its mode of preservation may not be suitable for extraction by the acid treatment, except for its facies-resistant constituents, viz., *C. typicalis*.

It is, therefore, postulated that in the Naini Tal or the Pir Panjal sections, where there is a dearth of the phosphatic lithofacies, *C. typicalis* is recovered as a hardy, facies-resistent remnant of the early Meishicunian small shelly fauna. Consequently, it is proposed that the fossil of *Coleoloides typicalis* Walcott is an universally available marker of the existence of Precambrian-Cambrian transition level of early Meishicunian age in the Himalayan sequence.

35. MICROBIAL BUILD-UPS vs PROTEROZOIC STRATIGRAPHICAL PROBLEMS IN INDIA

VIKRAM RAI[1] and VIBHUTI RAI[2]

[1]Geological Survey of India, Northern Region, Lucknow
[2]Department of Geology, University of Lucknow, Lucknow

The Proterozoic saw the dawn of life in the early part and its development and diversification during the later part of the era. In fact, the first definite evidence of life is recorded as microbial fossils which are best represented by stromatolite in its different morphotypes. Since stromatolites represent a product of biotic and abiotic constituents, their study generates important data regarding the nature of microbial communities, the processes involved in their development and the environment of deposition. The microbial community throws light on the evolutionary process of the biosphere. Important step in the evolution of microbial build-ups is the precipitation of carbonate minerals by the organic community as a safety measure against environmental rigours and also as a means of strengthening their living systems. The measure consequence of this step was the production of microbial fossils such as calcareous algae, small shelly fossils, etc.

The Proterozoic sequences across the world have drawn the attention of sedimentologists as well as palaeontologists on account of their close association with stromatolites (in Limestones and Dolostones) on a global scale. Several morphogenera of stromatolites have been utilized for correlating widely spaced geological sequences for a long time.

In the light of sparse geochronological data available from basins like Vindhyan, Cuddapah, Kaladgi, Kurnool and Bhima in the Peninsular India and Shali, Larji, Deoban, Garhwal and Krol in the extra-peninsular region, the role of stromatolitic build-ups and calcareous micro-communities is over-emphasized in fixing the age of associated sediments and evolutionary events associated with different global phenomena of biospheric evolution. This involves prokaryotic and eukaryotic microbial communities, acritarchs and calcareous microbial fossils. The following crucial stratigraphical problems were handled effectively using the microbial build-ups and the evolutionary events associated with them:

1. The occurrence of *Conophyton-Baicalia* assemblage in the Krol 'C' Member of Krol Formation in Nainital area helped in assigning a late Proterozoic age to the Krol succession which was earlier considered to be Mesozoic in age.
2. The discovery of stromatolites and cryptalgalaminites from the Blaini Formation provided significant information on the depositional environment of the succession. Since the Blaini Limestone is a "cap-carbonate" (usually found to be very finely laminated) that overlies a glacial diamictite sequence, the occurrence indicates a global phenomena of a cold carbonate precipitation.
3. The discovery of calcareous algae such as *Epiphyton, Girvanella, Bija, Renalcis* and *Angulocellularia* along with thrombolitic fabrics and possible archaeocyathids in the Krol 'E' Member of the Mussoorie and Garhwal areas was helpful in deciphering the upper age limit of the Krol succession as Vendian.
4. The Deoban Group has been classified into different lithostratigraphic subdivisions where carbonate lithologies dominate the entire sequence. The various carbonate fabrics could be best utilized to subdivide the entire succession into different lithounits. Associated stromatolites and microbial build-ups would substantially help in such a classification. Since the microbial build-ups also have an expression of depositional environment preserved in its various facies, a study of such a sequence provided an additional tool towards the evolution of the basin and its development through time. The lower part of the sequence showed a high energy inter-tidal to supra-tidal facies, the middle part showed a shoaling cycle with stromatolitic reef development and the upper part of the sequence showed the development of low to very low energy sub-tidal to upper shelf depositional environment.
5. In the Cuddapah basin, an assemblage of stromatolites such as *Conophyton, Collenia* and *Cryptozoon* broadly provided an age of Palaeoproterozoic to the succession.

6. On the basis of variation in stromatolitic build-ups and identifiable form generic assemblages the Cuddapah and the Kurnool basins have been distinctly identified.
7. In the Vindhyan basin *Conophyton, Baicalia, Kussiella, Tungussia, Jacutophyton* and associated microbial build-ups provided the main correlation tool in this widely distributed basin. The stromatolitic assemblage distribution of the Lower Vindhyan (Semri Group) when compared with that of the Upper Vindhyan (Bhander Group) indicates the significance and utility of microbial build-ups in correlation and age assignments.

   All the above-mentioned points have been analysed in the present paper in the light of developing concepts of microbial build-ups.

36. TRACE FOSSIL LINEAGES AND PRECAMBRIAN-CAMBRIAN TRANSITION IN INDIA

S.K. SHAH

Department of Geology, University of Jammu, Jammu

The terminal Precambrian and Early Cambrian is globally marked by a remarkable expansion of trace fossils both in quantity and diversity. While this is a reflection of the rapid and sometimes explosive evolution of metazoans, the population explosion being almost coeval with spontaneous diversification does not correspond to the diversification model in the Phanerozoic record. In most of the forms it is not possible to determine the affinities of the traces and relate them to specific animal groups. Such forms, while being useful otherwise, have little significance in evolving a diversification pattern and relating it to events during the Precambrian-Cambrian transition. However, there is a wide variety of forms with well established affinities, especially those related to arthropods, where the lineages can be evaluated and linked to the body fossils appearing in Early Cambrian. The analysis of such forms across the transition in various basins of Himalaya have indicated a well marked transition event. This appears to be the only bioevent at this level which has a global distribution and, therefore, could constitute a boundary event transgressing the facies control. Attempts have been made to correlate this event with the known transition parameters of the Precambrian-Cambrian boundary.

GEOCHEMISTRY

37. STABLE ISOTOPIC COMPOSITIONS OF CARBONATES FROM A CYCLIC CARBONATE-EVAPORITE ROCK SEQUENCE IN BOREHOLE P/47 IN HANSERAN FORMATION OF WESTERN RAJASTHAN-A PRELIMINARY REPORT

D.M. Banerjee[1], H. Strauss[2], V. Kumar[3], A.Mazumdar[1], S. Grover[1] and B. Nath[1]

[1]Department of Geology, University of Delhi, Delhi
[2]Institut für Geologie, Ruhr Universität, Bochum, Germany
[3]Geological Survey of India, Jaipur .

In the preliminary leg of study, eleven carbonate-anhydrite-gypsum interlayers in the borehole no. P/47 by the Geological Survey of India near Lakhasar in Bikaner district were analysed for oxygen, carbon and sulfur isotopes. The evaporite-carbonate sequence was analysed from the bore-hole cores; 50.10 m to 641.00 m depth. The rock samples from core section composed of thick rhythmic carbonate-evaporite sequence belong to Hanseran Formation of possible Terminal Proterozoic-Lower Cambrian age. Initial results show the carbonate rocks to have $\delta^{13}C$ values in the range of -0.40 to +1.85 ‰ $\delta^{18}O$ between -4.20 and -2.50 ‰ vs PDB. These values are consistent with reported global values of carbonate rocks of this age. Although $\delta^{18}O$ values show ~2 ‰. overall variation, the variability of $\delta^{18}O$ is more pronounced than that of $\delta^{13}C$ throughout this part of the bore-hole section. It is interesting to note that both $\delta^{13}C$ and $\delta^{18}O$ show covariance and progressively gets depleted towards the overlying evoporites within each carbonate-evaporite cycle. There is considerable variance of the $\delta^{34}S$ value from +27.50 to +35.60 ‰. The carbon and oxygen isotope data and their covariance are not directly reflective of deposition in marginal evaporite basins due to continuous evaporation of sea water and instead imply effects of interaction with isotopically light meteoric water. The variability of sulfur isotopic data for the sulfates associated with these carbonates in all probability reflect similar effects of diagenesis. The limited set of data generated so far is inadequate to suggest any true secular variation in the isotopic values. More detailed petrographic and geochemical work in this and other bore holes of the region is in progress.

38. STABLE ISOTOPIC STUDIES OF PROTEROZOIC BHIMA BASIN, KARNATAKA, INDIA

S.K. BHATTACHARYA[1], R.A. JANI[1] AND P.K. MAITHY[2].

[1]Physical Research Laboratory, Ahmedabad
[2]Birbal Sahni Institute of Palaeobotany, Lucknow

The Proterozoic Bhima Basin from the South Indian Peninsula has a thick sequence (~ 270 m) of limestones and shales with minor conglomerates and sandstones. It has received considerable attention recently due to the reported discovery of Precambrian-Cambrian transitional fossil Sabellidites along with Chuaria-Tawuia assemblage in the shale member of the Halkal Formation in the upper part of the Bhima Group (Das Sarma et al., 1992). To investigate this interesting finding in more detail a field trip was organized by the members of the IGCP 303 during October, 1993 and a large number of samples were collected from measured sections in Kolkur, Chennur and Gangurti areas. Carbon and oxygen isotopic studies were carried out in the carbonate phase of these samples to decipher the environment of deposition of the sediments and identify, if possible, the Precambrian-Cambrian transition signature. The carbon isotopic ratios in samples from the three Formations (Shahbad, Halkal and Katamdevarhalli) spanning the reported Pc-C transition zone show only a small range of variation between 1.5 and 3.5 ‰. (w.r.t. PDB) while the oxygen isotopic ratios show a gradual decrease from -5.5 to -9.0 ‰.(w.r.t. PDB) as shown in figure 1. The usual signature of the Pc-C transition zone in the form of large depletion of $^{13}C/^{12}C$ ratio at the boundary (Bhattacharya et al., 1995) is not found here. The oxygen isotopic ratios are well within the range of Proterozoic carbonates from India studied earlier (Sathyanarayan et al.,1987). The gradual ^{18}O deficiency in the upper part of the basin is probably due to incursion of isotopically light fresh water related to shallowing of the basin with time

References:

1. Das Sarma, D.C., Raha,P.K., Moitra, A.K., Ashok Kumar P., Anantharaman S., Rama Rao, M. and Sundaram V. Discovery of Precambrian-Cambrian transition fossil Sabelliditids from India. *Curr. Scie.* 63, 140, 1992.

Bhattacharya, S.K., Jani, R.A., Mathur, V.K., Absar, A., Bodas, M.S., Kumar, G. and Shanker, R. Stable carbon and oxygen isotopic changes and rare earth elements across Precambrian-Cambrian boundary, Lesser Himalaya. Proc. Symp. N.W. Himalaya and Foredeep, *Geol. Surv. India Spl. Publ.* 21, 225, 1996.

3. Sathyanarayan, S., Arneth, J.D. and Schidlowski, M. Stable isotope geochemistry of sedimentary carbonates from the Proterozoic Kaladgi, Badami and Bhima Groups, Karnataka, India. *Precamb. Res.* 37, 147, 1987.

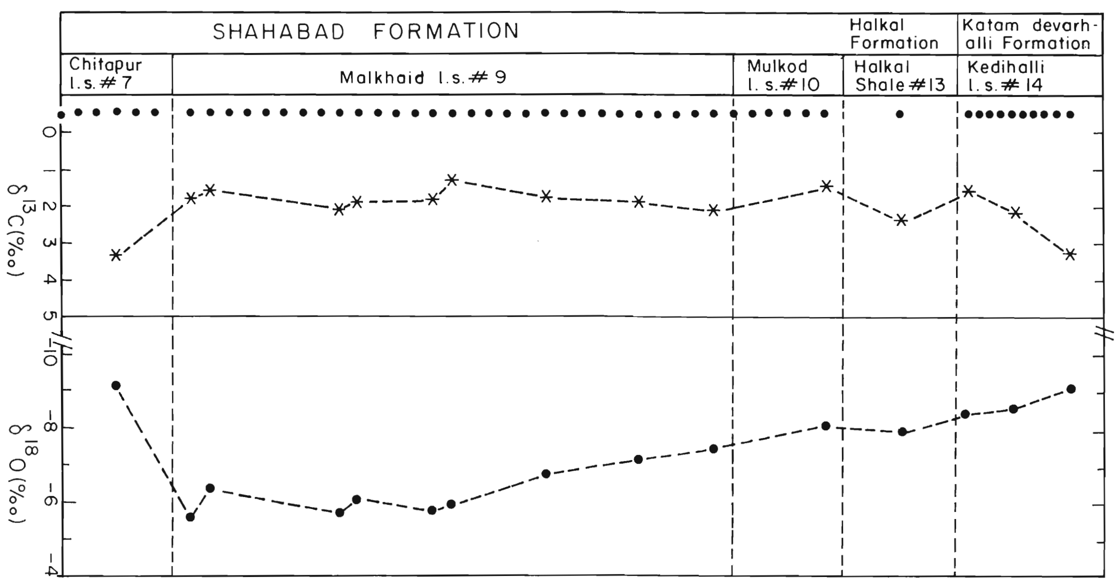

Fig.1. $\delta^{13}C$ and $\delta^{18}O$ variations.

39. CARBON AND OXYGEN ISOTOPE GEOCHEMISTRY OF PRECAMBRIAN CARBONATES OF INDIA

B.KUMAR[1] , B. SREENIVAS[1], M.N. RAO [1], M.SHARMA[2] AND V.C.TEWARI[3]

[1]National Geophysical Research Institute, Hyderabad
[2]Birbal Sahni Institute of Palaeobotany, Lucknow
[3]Wadia Institute of Himalayan Geology, Dehra Dun

Carbonate buildups in the Precambrian of India have been extensive $\delta^{13}C$ and $\delta^{18}O$ signatures in these carbonates can provide significant information on the conditions of early atmosphere and biosphere, carbon burial rates and oxygen budget changes through geological times. The carbon and oxygen isotope data of about 100 Precambrian carbonates from Dharwar and Aravalli cratons; Cuddapah and Bhima basins and Mussoorie syncline, Lesser Himalaya are discussed. The important findings are :

I) An extremely early origin of life and $\delta^{18}O$ deficient depositional environment in the Dharwar Craton.

ii) Extremely heavy carbon ($\delta^{13}C$ between +8.5 to +11.1 ‰ vs PDB) in the carbonates from Jhamarkota formation of Aravalli craton suggesting increased organic productivity.

iii) No significant change in the isotope chemistry of ocean surface during deposition of Vempalle dolomites, Cuddapah basin and Bhima basin carbonates.

iv) An increase in carbon burial rate, increased availability of CO_2 in the then prevailing environment, enhanced rate of photosynthesis and high oxygenated environment at the end of Precambrian in Mussoorie syncline.

40. PETROLOGY AND GEOCHEMISTRY OF STROMATOLITE BEARING PROTEROZOIC KALADGI CARBONATES, BAGALKOT, KARNATAKA

S. SATHYANARAYAN

Department of Geology, Manasa Gangotri, University of Mysore, Mysore

The Precambrian succession in the state of Karnataka starts with Archean Sargur Group (3.0 Ga) and the Archean-Proterozoic Dharwar Supergroup (2.4-2.6 Ga) which are separated by a major unconformity that covers a tectono-thermal event of considerable temporal extension. These ancient rocks are succeeded by an unmetamorphosed sedimentary sequence of middle to late Proterozoic age comprising the Kaladgi Group and the overlying, roughly coeval Badami and Bhima Groups, all believed to fall broadly into the time interval 1.0 - 2.0 Ga.

The Proterozoic Kaladgi Group attains a thickness of 2500 m and consists mainly of clastic sediments, argillites interrupted by carbonate rocks of intertidal to subtidal origin. Lithostratigraphically divisible into Ghataprabha Dolomite, Gaddankeri Limestone and Vidyanagar Dolomite, the carbonates exhibit prominent association of algal stromatolites and oncolites confined mainly to the dolomites. The algal mats are dolomitised. Syndepositional structures suggest that the precursor rocks of both dolomite members had formed in a moderately to strongly agitated realms, whereas the intercalated Gaddankeri limestone was deposited under quiet water conditions with minor agitated interludes.

Petrography as inferred from stained hand-specimens and thin-sections, acetate peels and cathodoluminescence indicates the preservation of primary depositional fabrics as relict structures with overprints of recrystallization and replacement. Ghost allochems, intraclasts, pellets and bioclasts (algal mat debris) set in a matrix of micrite, sparite and microspar, clotted micrites (textures grumeleuse), microstylolites and microfracture are characteristic of textural and mineralogical complexities in response to diagenesis and tectonism.

Major and trace element distribution in Kaladgi carbonates do not reveal any conspicuous pattern which is not surprising in view of post-depositional signatures. The large scale incorporation of bivalent (ferrous) iron into dolomite lattice gives eloquent testimony as to the prevalence of reducing conditions during the proccess of dolomite formation. The strontium values in the Gaddankeri limestones were found to scatter between 200 and 300 ppm. They decrease to (50 ppm in dolomitic lithologies in response to progressive dolomitisation and preferential removal. Stable isotope geochemistry indicates a pronounced $\delta^{18}O$ deficiency pointing to diagenetic reconstitution of precursor carbonate with a large scale involvement of meteoric waters of low ionic strength. With δ^{13} C values tethered closely to the permil line, the dolomites and limestones of the Kaladgi Group represents a marine carbonate facies. Unusual $\delta^{13}C$ values (3.6 ‰) for dolomites are probably result of incorporation of biogenic carbon dioxide into parts of bicarbonate precursor of the present carbonate.

41. STEROID(S) : POSSIBLE BIOMARKERS FROM THE PROTEROZOIC SHAHBAD LIMESTONE, BHIMA BASIN

MANOJ SHUKLA[1], GOPAL MISRA[2], AND S.K. NIGAM[3]

[1]Birbal Sahni Institute of Palaeobotany, Lucknow
[2]National Botanical Research Institute, Lucknow
[3]B 2/3 Balda Road Colony, Lucknow

The known records of TOC in Precambrian and Phanerozoic sediments are more or less similar. The sediments as old as 1700 Ma have yielded organic compounds ofcourse artifacts. The presence of steroid(s) in the extractable organic matter from Shahbad limestone, Bhima Basin is reported here. The continuous extraction, commonly known as soxhleting, of Late Proterozoic Shahbad limestone resulted in extracting presumably a steroid(s) as it responded positively to Libberman's Bourchardt test.

INDEX OF AUTHORS

Army Printing Press, Lucknow