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STROMATOLITE BIOSTRATIGRAPHY IN THE CHHATTISGARH BASIN AND POSSIBLE CORRELATION WITH THE VINDHYAN BASIN

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ABSTRACT

Correlation of stromatolite-bearing beds is difficult due to restricted vertical span and scanty exposures, separated by vast tracts of soil cover/alluvium in the Chattsigarh Basin. The geological set up is used for biostratigraphic correlation in this tectonically undisturbed area. The lower biozone of the Chhatisgarh Basin is comparable to the assemblage of stromatolites in the Semri Group of the Vindhyan Basin where an assemblage of *Kussiella, Conophyton* and *Colonnella* have been observed and given an early Riphean to Mid-Riphean status. In the Chhattisgarh Basin, in addition, three groups, namely, *Anabaria, Baicalia* and *Tungussia* are seen where *Anabaria* is characteristic of the Mid-Riphean age. The *Inzeria-Gymnosolen* combination of the Chhattisgarh basin in its upper biozone is also seen in the upper part of the Bhander Group of the Vindhyan Supergroup along with the *Baicalia-Tungussia* combination, suggesting Upper Riphean to Vendian age.

Key words: Stromatolite Biostratigraphy, Chattisgarh Basin, Riphean, Vendian.

INTRODCTION

Due to restricted vertical span and scanty exposures, separated by vast tracts of soil cover/ alluvium in the Chattsigarh Basin correlation of stromatolite-bearing beds is difficult. In order to overcome these constraints, the author utilizes the geological set up of the basin which is tectonically undistrubed. The stromatolite succession in the 670 m thick Raipur Limestone were computed based on topographical control of the exposures. However, the local disturbances causing minor shifts in sediments seen rarely in this basin, have been carefully avoided for this study.

Both surface studies and scrutiny of subsurface data from deep quarries over an extensive area reveal two vertically defined assemblages of stromatolites, with little or no correlatable aspect of facies variation. Two assemblages which indicate two distinct temporal set ups are mainly found at two topographic levels, namely R.L. 213 – 266 m and 270-340 m (table 1).

GENERAL GEOLOGY

The intracratonic Chhattisgarh Basin is set betwen two major Proterozoic basins of India namely, the Cuddapah to its south and the Vindhyan to its north. The basin occupies roughly an area of 35,000 sq km and contains about 2000 m, thick sediments mainly composed of subhorizontal beds of limestone, dolomite, shale and sandstone (fig. 1).

Due to laterite capping and soil cover, the outcrops are patchy and discontinuous. The sandstone units resistant to weathering are best exposed compared to the vast expanse of the Raipur Limestone having isolated exposures in mounds, nalas and deep quarries. River banks and road cutting provide good sections for study of various lithounits. The general geological sequence of the area is given given below in table 2.

According to this author, the Chhattisgarh sequence has six major units, namely, the basal Chandarpur Sandstone followed by Charmuria Limestone, Gunderdehi Shale, Raipur Limestone, Khairagarh Sandstone and Tarenga Shale (table 2). One of the opinions is that the Khairagarh Sandstone is an intercalating unit within Raipur Limestone (Das, Ganguly and Arora, 1990). The Raipur Limestone is the only formation showing presence of stromatolites. These stromatolites show prolific growth and wide diversity.

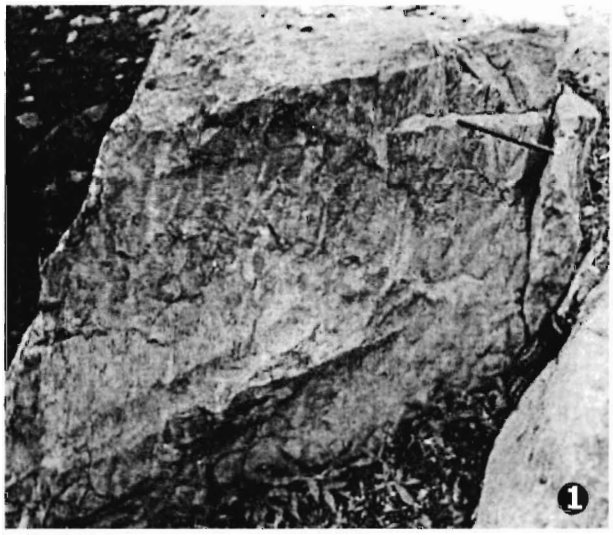
Table 1: Distribution of stromatolites at different topographic levels.

Group	Name of the Stromatolites	Locality	Topographic Level	Horizon
Colonnella	*C. discreta*	Khyarkhane	252 m	Raipur Limestone
		Chilhati	250 m	.do.
		Jamunia nala	250 m	.do.
	C. elongatus	Jamunia nala section	250 m	.do.
		Tulsi	266 m	.do.
	C. Laminata	Akaltara II	249 m	.do.
		Jamul Quarry (Bench 5)	256 m	.do.
	C. conica	Near Hirri	RL 266 m	.do.
Inzeria	*I. tijomusii*	PathriMines	RL 284 m	.do.
		Purena	RL 300 m	.do.
		Akaltara I	RL 307 m	.do.
Baicalia	*B.* cf. *burra*	Murhipar R.S.	RL 327	.do.
		Kotni	RL 288 m	.do.
		Rawan	RL 296 m	.do.
		Karhi	RL 284 m	.do.
		Champa	RL 272 m	.do.
	B. capricornia	Murhipar RS	RL 337 m	.do.
		South of Pindaraon	RL 296 m	.do.
		Nandini	*RL 270 m	.do.
Baicalia	*B. constricta*	L km SW of Murhipur RS	RL 327 m	.do.
		Chandi	RL 300 m	.do.
		Nariaree	RL 280 m	.do.
		NW of Mulmula	*RL 260 m	.do.
		Joratarai	RL 296 m	.do.
	B. cf. *lacera*	Karhi	RL 280 m	.do.
		Jamul Quarry	RL 289 m	.do.
	B. bifurcata	Deodongar	RL 327 m	.do.
	B. prima	Nandini Mines	RL 260 m	.do.
		Purena (Quarry)	*RL 276 m	.do.
	B. baicalica	Deorjhal	RL 260 m	.do.
		Behesar	RL 250 m	.do.
Gymnososlen	*G. rotandus*	Karhi	RL 280 m	.do.
		Mopar	RL 289 m	.do.
		Joratarai	RL 296 m	.do.
	G. furcatus	Chunkatta	RL 296 m	.do.
		Bhatapara	RL 286 m	.do.
Anabaria	*A.* cf. *radialis*	Jamul Quarry(Bench I)	RL 266 m	.do.
		S.of Kharkhena	R1 256 M	.do
Conophyton	*C.* cf. *cylindricus*	Sonadin	RL 256 m	.do.
		Akaltara I	RL 3-7 m	.do.
Kussiella	*K.* cf. *kussiensis*	Akaltara II	RL 249 m	.do.
	K. irregularis	Nagpura	RL 266 m	do.
Linella	*L.* cf. *avis*	Akaltara I	RL 306 m	.do.
		Pathri Mines	RL 296 m	.do.
Omachtenia	*O.* fm. *indet*	Champa	RL 260 m	.do.
Acaciella	*A.* cf. augusta	Dhabadih	RL 290 m	.do.
Jacutophyton	*J.* fm. *indet*	Chandi	RL 286 m	.do.
		Akaltara II	RL 254 m	.do.
		Nandini	RL 261 m	.do.
Tungussia	*T. inna*	Kotni	RL 290 m	.do.
		Akaltara I	RL 302 m	.do.
	T. fm. *indet*	Hathbandh	RL 260 m	.do.
		Bhatapra	RL 262 m	.do.

*These fall out of the norm.

EXPLANATION OF PLATE I

1. Longitudinal section of ***Baicalia* cf. *lacera*** length of the pen equals 16 cm.
2. Longitudinal section of ***Baicalia bifurcata*** Length of the pen equals 16 cm.
3. Longitudinal section of ***Colonnella* cf. *elongatus*** Length of the pencil equals 16 cm.
4. Longitudinal section of ***Linella* cf. *avis***.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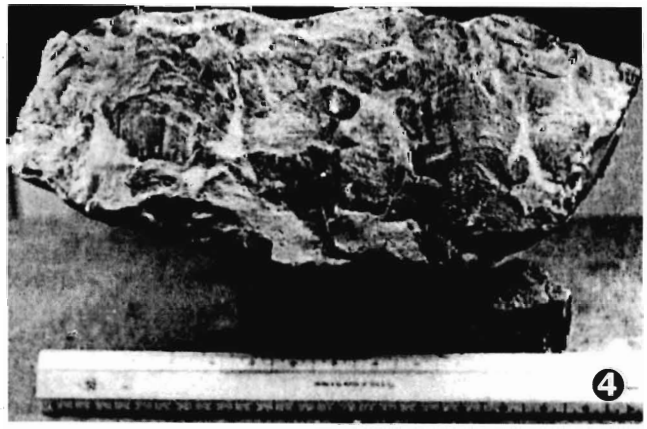
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Table 2: Lithostratigraphic classifications of the Chattisgarh Basin.

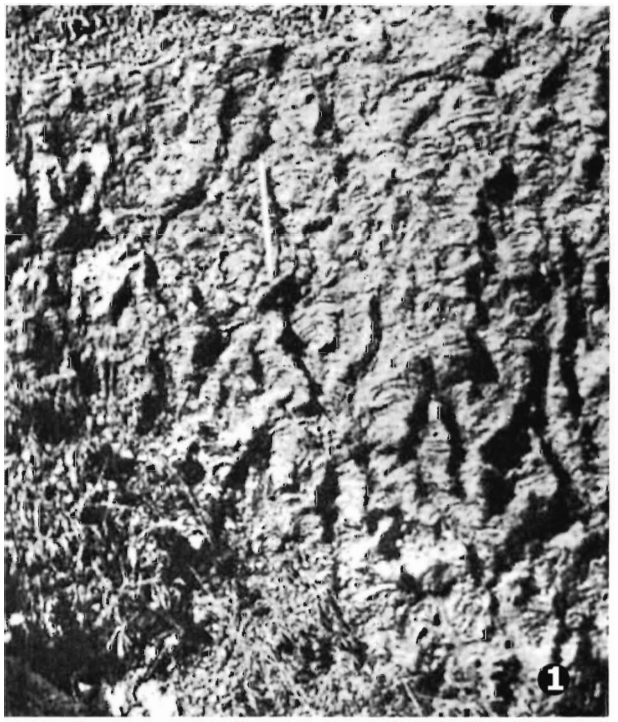
Dutta (1964)				Murti (1987)		Moitra (1990)	
PRECAMBRIAN	KURNOOL SERIES	Raipur Shale		Tarenga Shale		Tarenga Shale	(180 m)
		Limestone					
		Khairagarh Sandstone		Chandi Limestone		Khairagarh (Deodongar) Sandstone	Variable
		Gunderdehi Shale	CHHATTISGARH SUPERGROUP	Raipur Group	Khairagarh Sandstone	Raipur Limestone	(670 m)
		Charmuria Limestone					
		Chandarpur Sandstone			Gunderdehi Shale	Gunderdehi Shale	(430 m)
					Charmuria Limestone	Charmuria Limestone	(490m)
				-------Unconformity-------		--? Local unconformity--	
				Chandarpur Group	Kanspathar Formation	Chandarpur Sandstone	(390 m)
					Chaporadih Formation		
					Lohardih Formation		
				-------- Unconformity----------		-------- Unconformity----------	
				Granite, quartzite (Precambrian)		Granite, quartzite (Precambrian)	

BIOSTRATIGRAPHY

A survey of the stromatolites in the Chhattisgarh basin, which includes distribution pattern and relation with facies variation, shows that stromatolites show a temporal distribution and that the environment of deposition has a minor role in controlling the size and frequency of stromatolites in different parts of the basin. The distribution pattern of stromatolites

EXPLANATION OF PLATE II →

1. Longitudinal section of ***Bacicalia constricta*** Length of the pen equals 16 cm.
2. Longitudinal section of ***Conophyton*** cf. ***cylindricus***.
3. Longitudinal section of ***Inzeria tijomusii***.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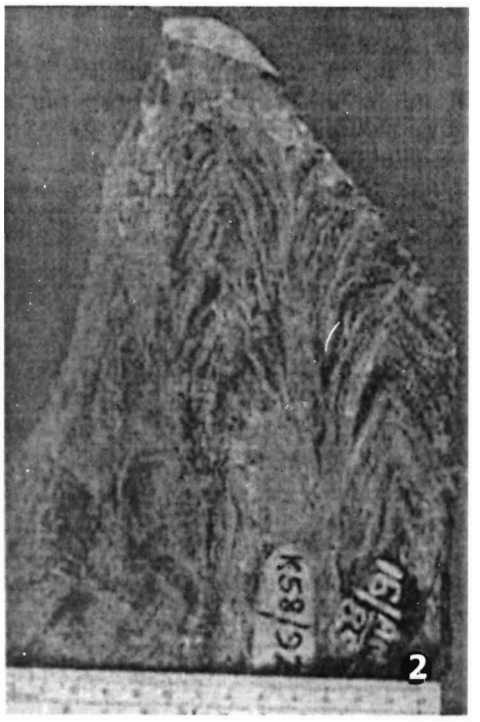
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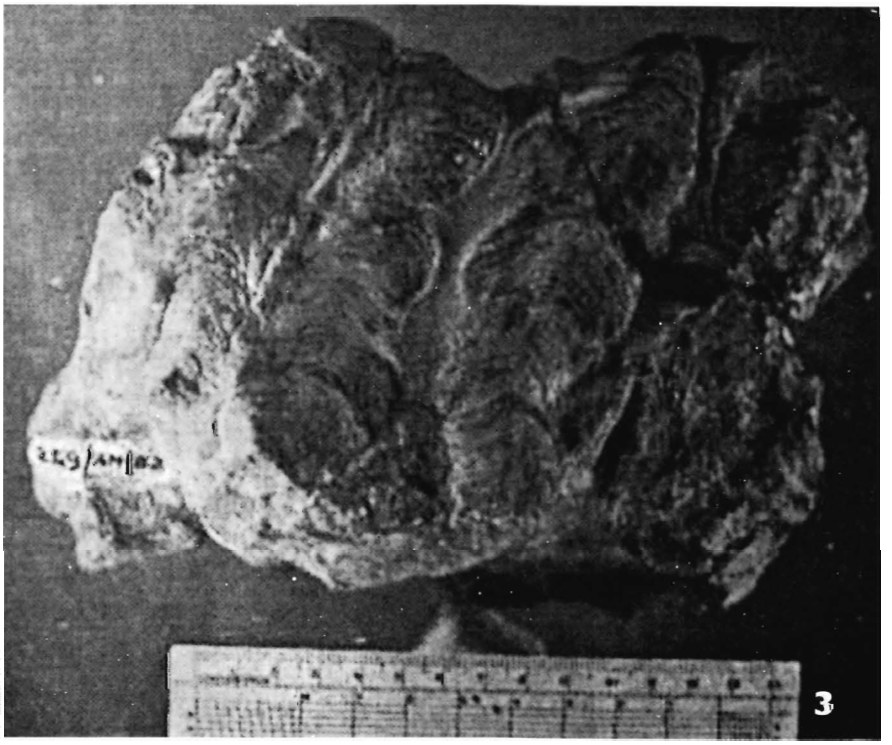
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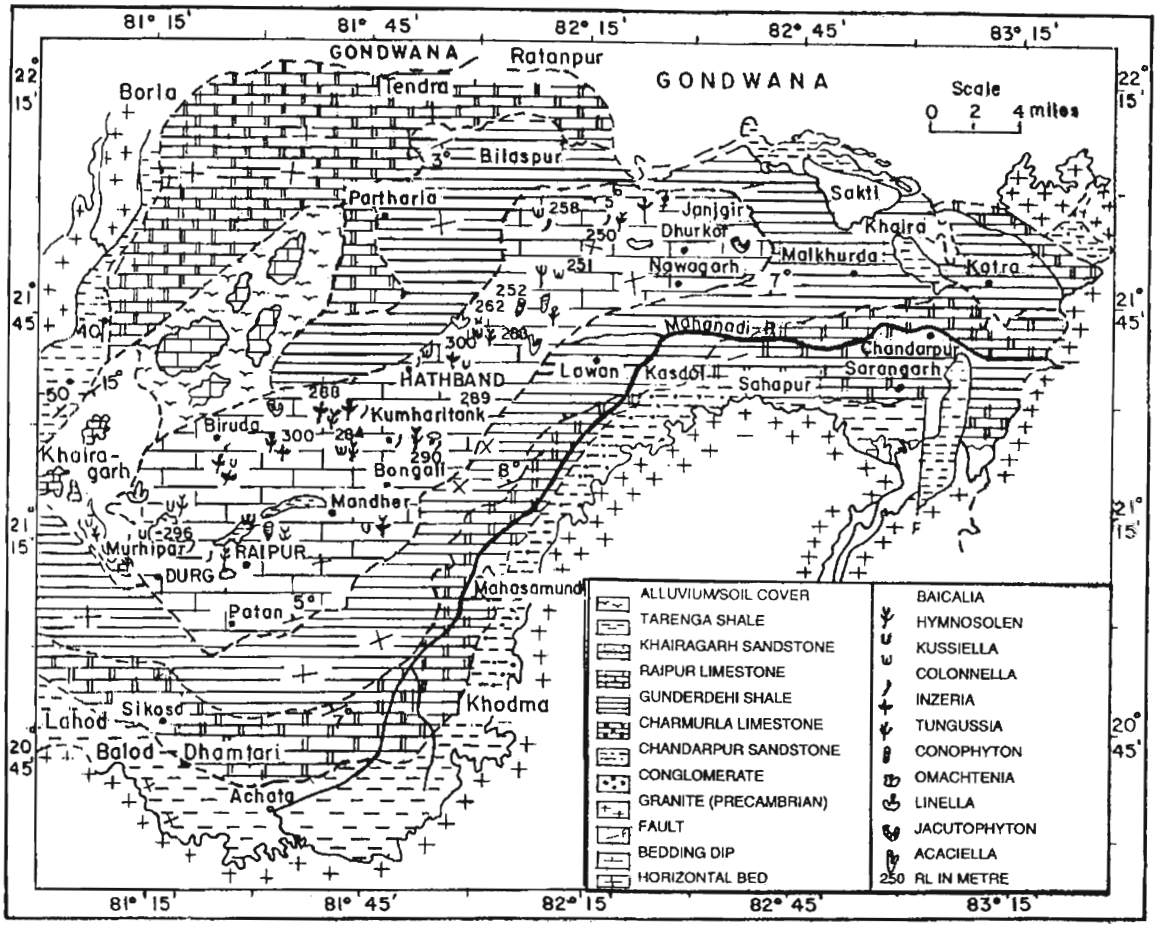

Fig. 1. Geological map of the Chhattisgarh Basin.

indicates two distinct assemblages confined to two different topographic levels (table 3). The lower assemblage (referred here to as the Biozone I) consists of certain forms comparable to the Mid-Riphean forms of Siberia and Ural sections described by Krylov (1967). The upper assemblage (referred here to as the Biozone II) consists of upper Riphean-Vendian stromatolites such as *Gymnosolen* and *Inzeria.* Some of the groups are common to both the assemblages, though a close scrutiny indicates that their forms show more specific temporal set up. For example, *Baicalia burra, B. capricornia* and *B. lacera* are associated with Upper Riphean assemblage, namely, *Gymnosolen, Inzeria* and *Linella,* whereas *Baicalia baicalica* and *B. prima* occur in association with Mid-Riphean *Anabaria.* Selected stromatolites that are biostratigraphically significant are illustrated in Plates I and II.

Two distinct assemblages which indicate two bistratigraphic zones, have been worked out (Moitra, 1999) for the Chhattisgarh Basin. While *Anabaria* is restricted to Biozone I, *Gymnosolen, Linella* and *Inzeria* are confined to Biozone II.

Precambrian and Early Palaeozoic columnar stromatolites are generaslly narrow, tall, erect and ramifying, while those of younger horizons are broad and unbranched (Walter, 1972). The diversity of stromatolites increases from Pre-Riphean to Mid-Riphean, then sharply falls in the Late Riphean, Vendian and Cambrian (Awramik, 1971, Semikhatov, 1974). These obserevations are corrobrated in the Chhattisgarh Basin where the stromatolitic diversity is more in the Mid-Riphean (table 4).

In the Chhattisgarh Basin, the role of environment on morphology of stromatolites is not clearly understood. The biogenic control is also not decipherable due to diagenetic effect.

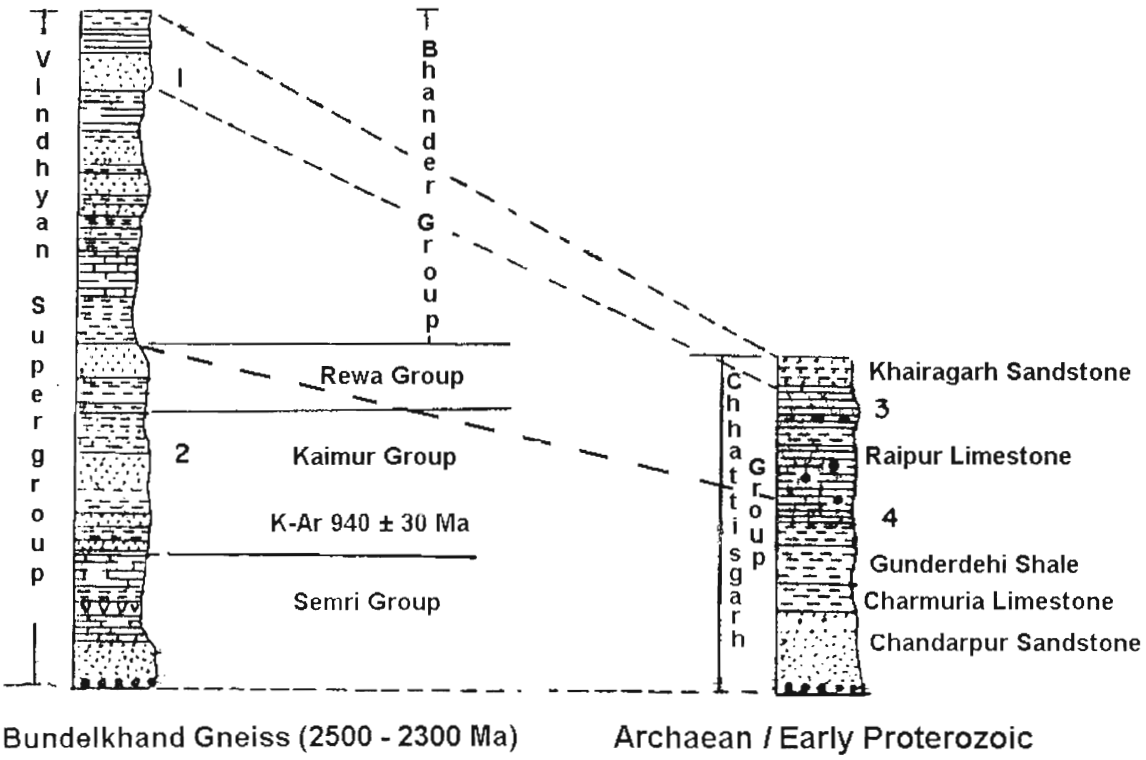

Fig. 2. Biostratigraphic relationship between Vindhyan and Chhattisgarh basins. 1. *Baicalia, Tungussia, Boxonia,* 2. *Kussiella, Baicalia, Colonnella* 3. *Gymnosolen, Inzeria, Linella, Tungussia, Baicalia,* 4. *Baicalia, Anabaria, Tungussia, Kussiella, Conophyton, Colonnella, Jacutophyton, Omachienio.*

Table 3: Biostratigraphic zones.

Topographic Level	Assemblage	Age
L 270-340 m	*Gymnosolen rotandus, G. furcatus, Tungussia inna, Baicalia capricornia, B.* cf.. *lacera. B. cf. burra, B. constricta, B. bifurcata, Linella avis, Acaceilla augusta, Inzeria tjoumusi*	Vendian to Upper Riphean Biozone II
R.L.23-266 m	*Baicalia prima, B. baicalica, Tungussia* frm. indet., *Kussiella* cf. *kussiensis, K. irregularis, Conophyton* cf. *cylindricus, Jacutophyton* fm. Indet., *Anabaria radialis, Omachtenia* fm. Indet., *Colonnella discreta, C.* cf. *elongatus, C. conica, C. laminata.*	Mid-Riphean Biozone I

The biozones are comparable to those established in other Proterozoic Basins of India (fig. 2) and elsewhere in the world. The *Inzeria-Gymnosolen* combination is also seen in the upper part of the Tadpatri Formation and the Vempallin Formation of the Cuddapah Supergroup (Gururaja and Chandra, 1984).

In the Umbertana Group of the Adelaide Geosyncline, *Tungussia etina* is seen associated with *Inzeria* fm., and the assocation was assigned to the Upper Riphean (Preiss, 1992). In the Chhattisgarh Basin, *Tungussia inna,* closely resembling *T. etina,* occurs with *Inzeria,* thereby making the upper part of the Raipur Limestone comparable to the Umbertana Group. *Inzeria* and *Gymnosolen* are also reported from the Ural and Siberian sections, U.S.S.R., designating them as Upper Riphean assemblages (Serebrykov, 1975). The Bhander Formation of the Vindhyan Supergroup shows combination of *Baicalia* and *Tungussia* (Verma and Burman, 1980) which is also present in the upper biozone of the Raipur Limestone. *Inzeria tjoumusi* is reported from the Hinde Dolomite (Cloud and Semikhatov, 1969) near the McArther Basin, indicating a Late Riphean age.

Table 4: Characteristic features of various stromatolites identified in the basin.

Group	Name of the Stromatolite	Geological Horizon	Characteristic features
	C. discreta	Raipur Limestone	Non branching columns are subcylindrical varying in size within a bioherm and are perpendicular to the bed. The interspace is usually more than the diameter of the column and occasionally half of the margins are uneven. Macrolamina shows coarsely banded structure. Thickness of two laminae are usually equal.
	C. elongatus	.do.	Non branching merging to *Colonnella discreta,* columns show appreciable change in diameter along their lengths. Margin uneven with cornices. Bridging noticed occasionally. It is finely banded.
	C. laminata	.do.	Non branching laminae are never enveloping. Banded strcuture. The ratio of thickness of laminae in general is 1.
	C. conica	.do.	Non branching discrete in nature, tapering upwards and giving conical shape to the columns, start from the same level of the bioherm.
Inzeria Krylov, 1963	*I. tjournuri*	.do.	Seen sometimes in assocation with *Tungussia,* Niche projection frequent. They are short, narrow, sometimes slightly elongated, set into niches at the side of the main column.
Baicalia	*B.*cf.*burra*	.do.	Actively ramifying. Laminae are flat to highly convex. Patchy walls are seen. Small peaks, Cornices are quite frequent.
	B. capricornia	.do.	Columns are subcylindrical. The branches are at places bridged towards top, diameters of branch of column vary appreciably, transverse section is circular, in other parts irregular.
	B. prima	.do.	Actively ramifying branches. The branches rapidly increase in diameter from their points of emergence. Macrostructure is coarsely banded.
	B. baicalica	.do.,	Actively ramifying branches. Branches are constricted at the base. Laminae show film microstrcture,
Gymnosolen	*G. rotandus*	.do.	A new form. Branching mostly bifid, rarely trifid, and branches are parallel to subparallel. Curving of the extreme branch roughly from the mid point. The curved branch ultimately becoming parallel to other branches. Laminae highly convex, forming wall.
	G. furcats	.do.	Bifid and rarely trifid branching. Branches are parallel to subparallel. Widening of one of branches at the central point is quite frequent. Margin smooth with wall all along.
Anabaria	*A.*cf.*radialis*	.do.	Actively ramifying branches. The columns show abrupt widening before branching. Branches fan out from locus of the branching.
Conophyton	*C.*cf. *cylindricus*	.do.	Columns are subcylindrical, diameter varying from 1 to 6 cm. The laminae are conical with angular crests. Near the column margin the laminae dip at high angle ($60^{\circ} - 70^{\circ}$).
Kussiella	*K.*cf. *kussiensis*	.do.	Parallel branching. Laminae are flat to moderately convex. Fine banded structure. Dark laminae is made up of micritic calcite whereas the lighter ones are of sparitic calcite and dolomite.
Baicalia	*B. constricta*	.do.	Constrictions both in columns and branches at fairly regular interval. Margin is uneven or ragged. Film microstructure.
	*B.*cf. *lacera*	.do.	Columns irregularly subcylindrical and actively ramifying, finely banded.
	B. bifurcata	.do.	Columns are tuberous or irregularly subcylindrical. Diameter of the branch does not vary appreciably. Tendency to widen away from the point of branching and at the point of maximum widening the branch show bifurcations. Margin is ragged with bumps.

The lower biozone of the Chhattisgarh Basin is comparable to stromatolites assemblage of the Semri Group of Vindhyan Basin, wherefrom an assemblage of *Kussiella, Conophyton* and *Colonnella* has been described (Kumar, 1988) and assigned an Early to Mid-Riphean age. In the Chattisgarh Basin, in addition to those of the Semri Group, three more stromatolite groups, namely, *Anabaria, Baicalia* and *Tungussia* are recorded. *Anabaria* is characteristic of Mid-Riphean age.

Baicalia-Conophyton assemblages of the Bangemall Group and the Burma Group-Callana Bed sequence is characteristic of the Middle Riphean of the U.S.S.R., corroborated by radiometric data of 1080 Ma. Similar assemblage is also found in the Chhattisgarh Basin, with the addition of *Tungussia* in the lower biozone suggesting an age not older than the Mid-Riphean.

All these observations indicate that the stromatolitic Raipur Limestone ranges from the Middle Riphean to the Vendian Period.

CONCLUSION

Two stromatolite biozones have been recognised. The lower biozone, Mid-riphean in age, is comparable to the Semri Group (Vindhyan Supergroup), whereas the upper bio-zone belongs to Upper Riphean-Vendian age and is correlatable to the Bhandar Group of the Vindhyan Basin.

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