Executive Summary of the Thesis entitled

Sequence Stratigraphic Analysis of the Bagh Group of Gujarat, Western India

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Apurva Dilip Shitole

Under the guidance of

Prof. Satish J. Patel

DEPARTMENT OF GEOLOGY
FACULTY OF SCIENCE
THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA
VADODARA

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Sequence Stratigraphic Analysis of the Bagh Group of Gujarat, Western India

Introduction:

The NNW-SSE movement between Africa and the eastern Gondwana comprising Seychelles, India, Madagascar, Antarctica, and Australia initiated the separation of Gondwana due to the Karoo plume (Eagles and König, 2008; Gaina et al., 2013; Gaina et al., 2015; Nguyen et al., 2016; Reeves et al., 2016). With this, many Precambrian lineaments were reactivated, and rift basins in the continents evolved. The Cretaceous period in the earth's history has witnessed a series of global events like the rifting of continents, eustatic sea-level changes, large-scale Deccan volcanism, evolution, and extinction of flora and fauna. The sea level was around 250m higher than the present day and flooded the continents, depositing chalk worldwide. During the Early Cretaceous, reactivation of the Son-Narmada lineament in the Indian peninsula resulted in the regional uplift with an intervening graben (Kaila, 1986; Racey et al., 2016). Reactivation along the ENE-WSW trending rift formed the Narmada Basin, and encroachment of the sea during the Cretaceous laid down a thick marine sequence (Biswas, 1987). The Lower Narmada Valley (LNV) preserves marine and non-marine sediments, which are well-exposed in the Madhya Pradesh and Gujarat states, and for convenience, it is divided into Eastern Lower Narmada Valley (ELNV) and Western Lower Narmada Valley (WLNV), respectively. The Cretaceous sedimentary rocks of ELNV are described as Bagh Group, and the same nomenclature is followed for the WLNV, which is distinct from the younger Cretaceous Lameta Group. The Bagh Group rocks are studied at 36 localities in the LNV (Fig. 1), namely (1) Songir, (2) Ghantoli, (3) Chosulpura, (4) Chametha, (5) Vajeriya, (6) Agar, (7) Naswadi, (8) Devaliya, (9) Uchad, (10) Sultanpura, (11) Bilthana, (12) Bhekhadiya, (13) Bhadarwa, (14) Navagam, (15) Gulvani, (16) Mathsar, (17) Karvi, (18) Ambadongar, (19) Vajepur, (20) Mogra, (21) Chikhli, (22) Galesar, (23) Mohanfort, (WLNV); (24) Sejagaon, (25) Rampura, (26) Naingaon, (27) Jaminyapura, (28) Risawala, (29) Sitapuri, (30) Avral, (31) Badiya, (32) Chakdud, (33) Atarsuma, (34) Dhursal, (35) Borghata, and (36) Jeerabad (ELNV).

The study area, Western Lower Narmada Valley, lies between 21° 42'00" to 22°27' 00"N latitudes and 73°30' 00" to 74°06'00" E longitudes (Fig. 1). The Bagh Group rocks in WLNV are exposed from ChhotaUdepur-Kawant in the east to Songir-

Chosalpur in the west. The Bagh Group rocks rest unconformably over the Precambrian basement and are covered by Deccan Traps and Quaternary alluvium. The Bagh Group rocks exposed, as detached outcrops, are studied in detail at localities 1-23 (Fig. 1) of the WLNV.

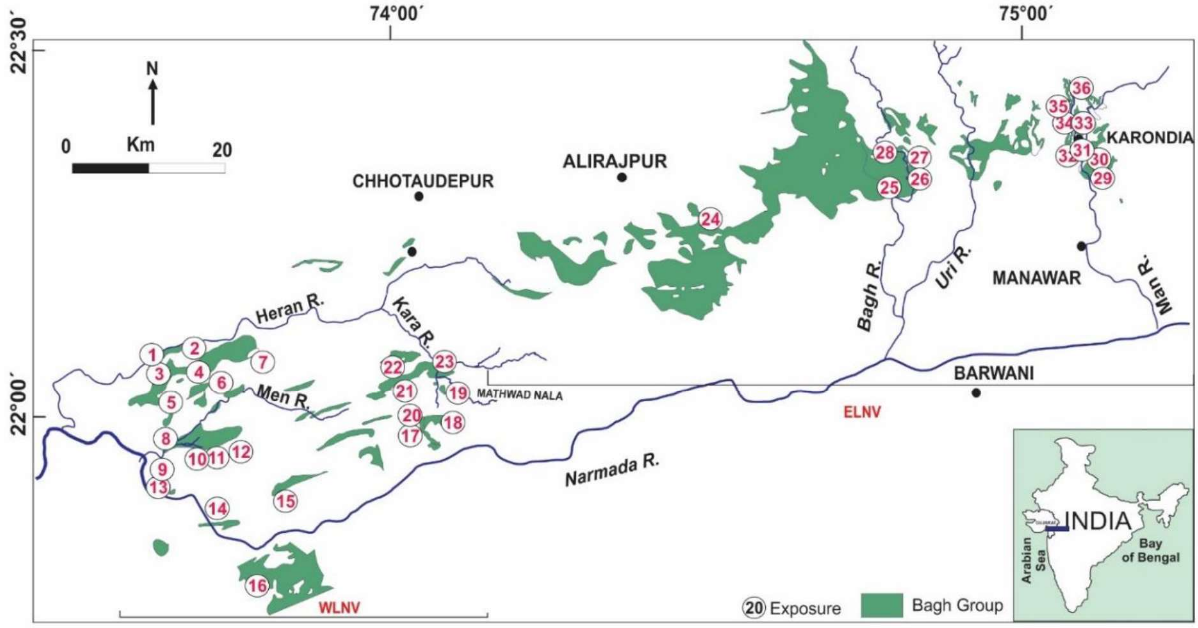

Figure 1. Map showing the studied sections of the Bagh Group of WLNV (location no. 1-23) and ELNV (location no. 24-36).

2.Aim and objectives

The study aimed to investigate the Bagh Group sequence of the WLNV on sedimentological and ichnological aspects and reconstruct the sequence stratigraphy.

The objectives of the thesis are:

1. To formalize the lithostratigraphy and analyze the sedimentological characteristics.
2. To document the trace fossils and analyze for paleoecological parameters.
3. To integrate sedimentological and ichnological data to delineate the sequence stratigraphic (boundaries, surfaces, and system tracts) and reconstruct the sequence architecture of Bagh Group rocks of Lower Narmada Valley of Gujarat.

3. Methodology

To achieve the above objectives following methodologies have been adopted:

1.Stratigraphic sections have been measured at different localities, and lithologs were prepared.
2. Systematic sample collection and documentation of sedimentary structures (physical and biological) was done.
3. Petrographic study of the samples was done for textural parameters and mineralogical composition.
4. Based on field observations and laboratory studies and the observed vertical and lateral lithological variations, lithostratigraphy is revised as per the International Subcommission on Stratigraphic Classification.
5. Lithofacies analysis has been done based on field and laboratory data.
6. Trace fossils were identified at the ichnospecies level, and their stratigraphic position was marked.
7. Density and diversity of the trace fosssils were observed; ethological, ichnoassemblage, and ichnofacies analysis was done to interpret the palaeoecological parameters.
8. Based on ichnological and sedimentological data, various sequence stratigraphic surfaces, boundaries, and system tracts are evaluated; a sequence stratigraphic model was constructed.
9. The sequence of the WLNV was compared with the pervasive Tethyan basins to understand the various geological events.

3. Research Outcome

Chapter 1: This chapter provides background information on the phases of the Gondwana breakup and paleogeographic position of India, global sea-level changes, Deccan volcanism, and extinction events of the Cretaceous Period. The concepts of stratigraphy and lithostratigraphy, stratotypes, methodology to establish new units, lithostratigraphic units, their characteristics, and correlation, followed by concepts of sequence stratigraphy, sedimentary facies, microfacies, ichnofacies, ichnoassemblages, and application of trace fossils to sequence stratigraphy are briefly described. Descriptions were supported by various figures, maps (location and paleogeography), and flow charts.

Chapter 2: This chapter deals with the general geology of the Narmada Basin, its tectonic history, and evolution with a brief description of the Precambrian rocks, Bagh

Group, Lameta Group, Deccan Trap, Quaternary deposits, along with supporting geological, structural, and paleogeographic maps and table.

Chapter 3: This chapter describes the Cretaceous lithostratigraphy of the Bagh Group rocks. Several authors have geographically divided the Lower Narmada Valley into the ELNV and WLNV, which comprises of coeval deposits; however, show lateral lithological variations. A discussion on the lithostratigraphy of the Bagh Group rocks proposed by several authors either separately or combined for the ELNV and WLNV is provided in comprehensive tables, which forms the base of the next chapter.

Chapter 4: Over the last century, stratigraphy for the Bagh Group rocks has been proposed by many workers (discussed in chapter-3) based on observations supplemented by local variations depending on the area. The western and eastern part of the LNV basin consists of informal lithostratigraphic units; the multiplicity in nomenclature was caused due to lack of mapping and emphasis on local geographical names by workers.

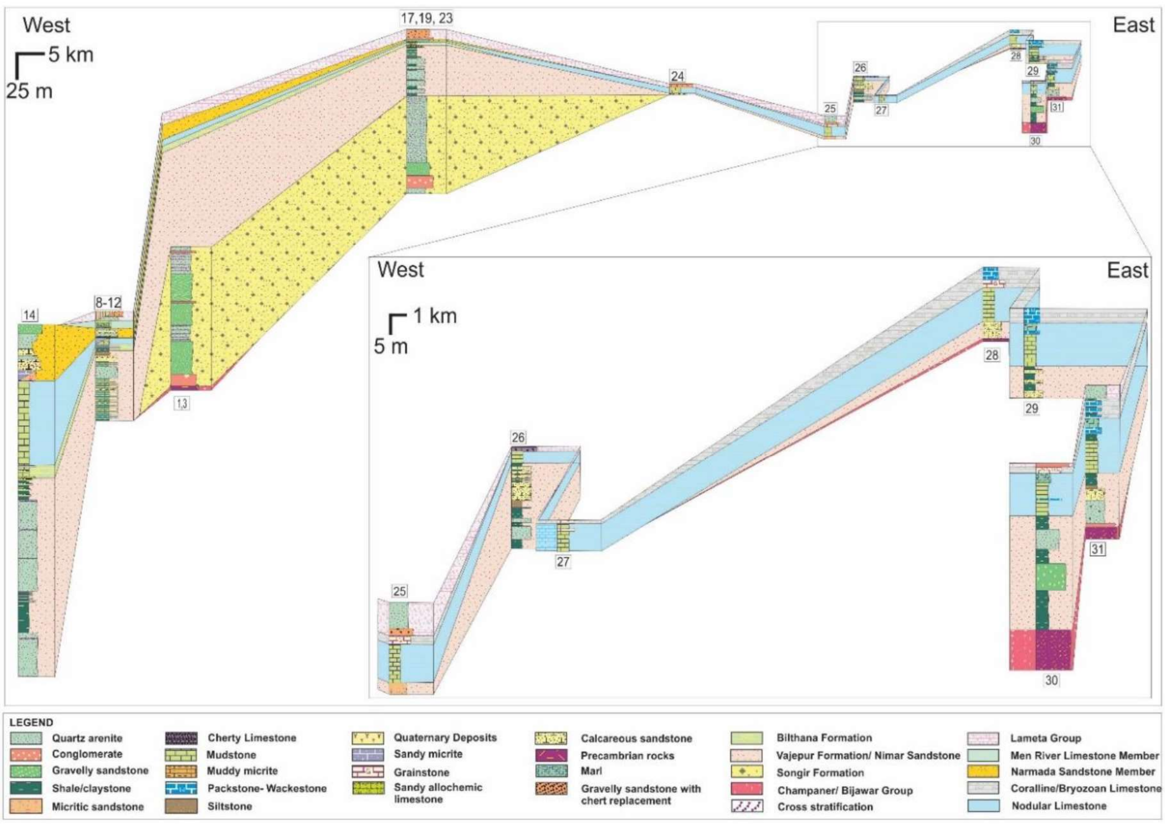

Figure 2: Stratigraphic correlation of the Cretaceous Bagh Group rocks sections in the Lower Narmada Valley; Men River Valley (8-12) and Mohanfort-Vajepur (17, 19, 23) are the composite profiles (Shitole et al., 2021).

To overcome the prevailing disparity in the usage of the lithostratigraphic units, the author has revised the Cretaceous succession of the WLNV according to the standard stratigraphic norms of ISSC. Each unit is described systematically, considering the historical background, intent and utility, designation, description, stratotypes, boundaries, age, and depositional environment. The exposed sequence is correlated amongst the different sections of WLNV which facilitates further correlation in the basin; comparisons have been made with the ELNV sections to observe the continuity and variation of facies of the given time slice (Fig.2). Based on sedimentological, stratigraphical and paleontological data, formal lithostratigraphy of the Cretaceous sequence was proposed (Table.1). The Bagh Group was assigned to the Cretaceous succession of the WLNV and was further subdivided into the Songir, Vajepur, Bilthana, Nodular Limestone, and Uchad formations (Table.1). It ranges from Berriasian? (Neocomian) to Coniacian in age and was deposited in a fluvio-marine environment.

Age	Group	Formation	Member
Coniacian	Bagh	Uchad (57m)	Men Nadi Limestone (7m)
			Narmada Sandstone (50m)
Turonian		Nodular Limestone (80m)	
Cenomanian-Turonian		Bilthana (9m)	
Albian- Cenomanian		Vajepur (46m)	
Berriasian? (Neocomian)-Aptian		Songir (127m)	

Table 1: Lithostratigraphy of the Bagh Group sedimentary succession, Western Lower Narmada Valley (Shitole et al., 2021).

Chapter 5: The Bagh Group rocks have been studied by several authors for their rich faunal assemblage (cephalopods, gastropods, bivalves, echinoids, oysters, bryozoans, brachiopods, foraminifers, dinosaur remains, shark teeth, etc.) and trace fossils. To analyse the sedimentological characteristics, 23 localities of the WLNV (Fig. 1) are studied for detailed lateral and vertical variation, which reveals siliciclastic, carbonates, and mixed siliciclastic-carbonate composition. Fourteen sedimentary facies have been identified (conglomerate, planar and trough cross-stratified sandstone, horizontal-thinly bedded sandstone, massive sandstone, bedded quartz arenite, shale, calcareous sandstone, micritic sandstone, sandstone-siltstone-shale, sandy/silty allochemic limestone, fossiliferous limestone, sandy/silty micrite, mudstone, and muddy micrite) and interpreted. The fluvial facies association suggests deposition in alluvial fan and braided channel environments due to debris flow, sheet flood, migration of subaqueous dunes, and sediment gravity flow. The overlying facies of marginal-marine to marine environment suggests deposition in foreshore to the offshore environment.

Chapter 6: This chapter dealt with ichnological study; trace fossils were identified, marked their stratigraphic position, and analyzed for paleoecological parameters. The trace fossils are mainly recovered from the fine-grained sandstone-siltstone, calcareous sandstone, planar cross-stratified sandstone, sandy allochemic limestone, bedded quartz arenite, mudstone, fossiliferous limestone, and micritic sandstone facies. Identifiable trace fossils specimens reveal the presence of twenty-six ichnospecies belonging to seventeen ichnogenera (*Apectoichnus, Archaeonassa, ?Arenicolites, Bergaueria, Conichnus, Conostichus, Didymaulichnus, Gordia, Helminthoidichnites, Lockeia, Oniscoidichnus, Palaeophycus, Ptychoplasma, Planolites, Skolithos, Taenidium* and *Thalassinoides*).

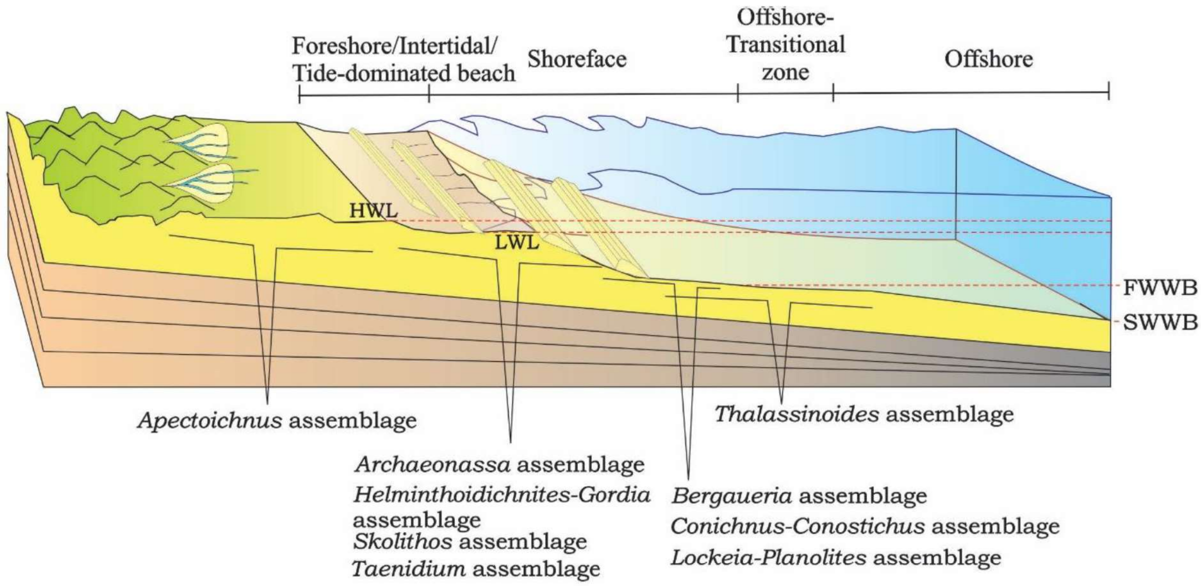

Figure 3: Schematic 3-dimensional diagram representing ichnoassemblages in the shallow marine depositional environment of the Western Lower Narmada Valley.

These trace fossils genera are categorized into five ethological groups, represented by cubichnia, pascichnia, domichnia, repichnia, and fodinichnia observed at different stratigraphic levels (Table 2). Trace fossils are grouped into nine ichnoassemblages named

Table 2: Trace fossils abundance, preservation, behaviour, trophic type, trace makers are shown in the various facies of Bagh Group, and their stratigraphic range.

after the dominant ichnogenus- *Apectoichnus, Archaeonassa, Bergaueria, Conichnus-Conostichus, Helminthoidichnites-Gordia, Lockeia-Planolites, Skolithos, Taenidium,* and *Thalassinoides* (Fig. 3) representing *Skolithos, Cruziana,* and *Glossifungites* ichnofacies. These ichnofacies revealed the palaeoecological parameters such as oxygenation, hydrodynamic conditions, substrate conditions, salinity, food supply, and bathymetry during the deposition of the sediments of the WLNV.

Ichnotaxa	Frequency				Stratino-my			Ethology					Lithofacies								Trophic			Probable Trace maker	Stratigraphic range
	Very rare (1 specimen)	Rare (2-5 specimens)	Common (6-20 specimens)	Abundant (>20 specimens)	Epirelief	Fullrelief	Hyporelief	Cubichnion	Repichnion	Domichnion	Fodichnion	Pascichnion	Fine-grained sandstone-Siltstone	Calcareous sandstone	Planar cross-stratified sandstone	Sandy allochemic limestone	Bedded Quartz arenite	Mudstone	Micritic Sandstone	Fossiliferous limestone	Suspension feeding	Deposit feeding	Predation		
Apectoichnus				x		x				x							x					x		Bivalves	Early Cretaceous-Miocene
Archaeonassa			x		x				x			x	x	x								x		Mainly Gastropods and possibly arthropods and echinoderms in marine env. Annelids or mollusks in non-marine env.	Cambrian-Recent
?Arenicolites				x		x				x								x			x	x		Polychaetes or crustaceans	Cambrian-Recent
Bergaueria				x			x	x		x						x					x			Actinarian or ceriantharian coelenterates	Precambrian-Miocene
Conichnus		x					x	x		x			x			x					x			Actinarian (sea anemones)	Cambrian-Tertiary
Conostichus		x					x	x		x			x			x					x			Actinarian (sea anemones)	Ordovician-Cretcaeous
Didymaulichnus	x				x				x				x								x	x		Gastropods, bivalves or arthropods	Precambrian-Cretaceous
Gordia	x				x				x		x	x			x							x		Worms, insect larvae or gastropods	Precambrian-Recent
Helminthoidichnites	x				x							x			x							x		Arthropods, nematomorphs or insect larvae	Precambrian to Pleistocene
Lockeia			x		x			x						x								x		Bivalves	Ediacaran-Eocene and Late Cambrian-Pleistocene
Oniscoidichnus		x			x				x					x									x	Isopod	Paleozoic-Recent
Paleophycus			x		x					x			x	x		x					x	x	x	Polychaetes	Ediacaran-Recent
Planolites		x			x							x	x	x		x						x		Worms or arthropods in terrestrial env.	Precambrian-Recent
Ptychoplasma	x						x		x				x											Wedge-foot bivalves	Ordovician-Recent
Skolithos				x		x				x									x	x	x		x	Annelids or phoronids in marine env. or by insects and spiders in terrestrial env.	Precambrian-Recent
Taenidium		x				x					x	x		x								x		Arthropods (terrestrial myriapods), insects, annelids (earthworms) or variety of organisms	Cambrian-Recent
Thalassinoides				x		x					x			x		x		x		x	x	x		Infaunal crustaceans or other kind of arthropods	Cambrian-Recent

Chapter 7: This chapter is divided into two parts; in the first part, the concepts of sequence stratigraphy (parasequence, systems tract, base-level, accommodation, transgression, regression, stratal stacking patterns, sequence stratigraphic model, surfaces, boundaries, methodology, and hierarchy) are briefly discussed. The second part deals with the sequence stratigraphic analysis of the Bagh Group rocks. The author has made a first attempt to analyze the Cretaceous sequence of the WLNV for sequence stratigraphy based on sedimentological and ichnological aspects. For analyzing the succession, the Genetic Sequence model is used to define the sequential filling of the WLNV. The fluvio-marine

Bagh Group of the WLNV represents intracratonic rift and comprises the genetic sequence of the 1st order. The 1st order sequence is further divided into five 2nd orders depositional events based on stacking pattern which includes HAST, LST, TST-I, HST-I, and TST-II(Fig. 4) separated by a Sequence Stratigraphy Surface, Systems Tract Boundary, Sequence Boundary (Maximum Flooding Surface) and two Within-Trend Flooding Surfaces. These depositional events are further subdivided into seventeen 3rd order events identifying the processes-related facies. The sequence stratigraphic analysis of the Bagh Group rocks displayed an overall progradational, aggradational, and retrogradational stacking pattern. The illustrated sea-level curve of the WLNV compared with the eustatic sea-level curve marked the impact of the global events in the basin-fill sediments.

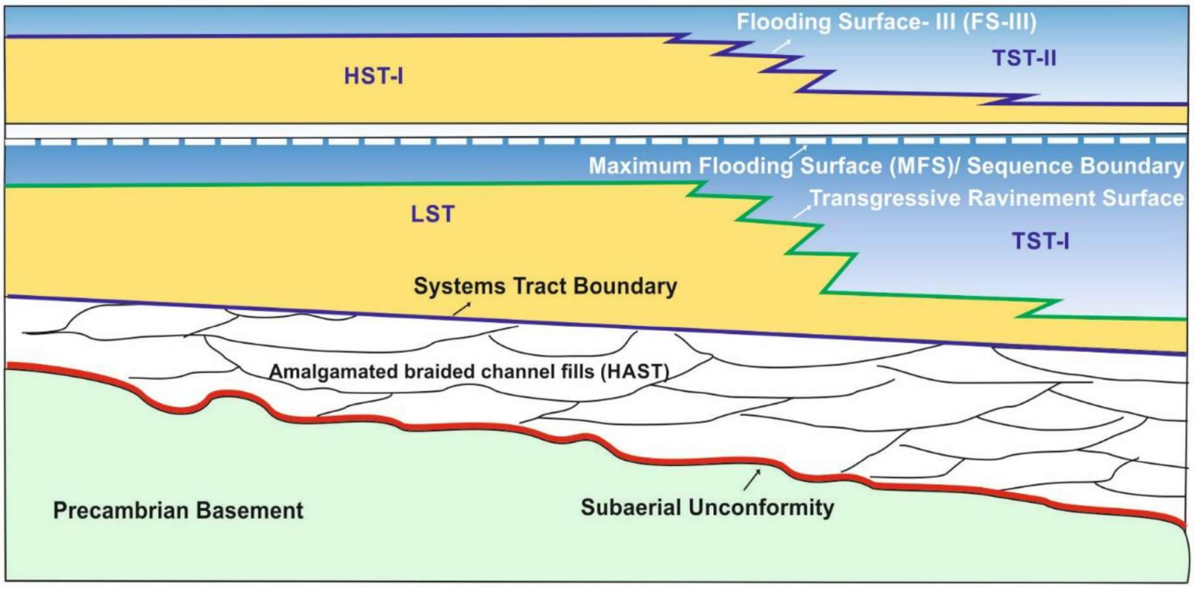

Figure 4: Conceptual sequence stratigraphic model of the Cretaceous Bagh Group rocks, WLNV showing stratal stacking pattern.

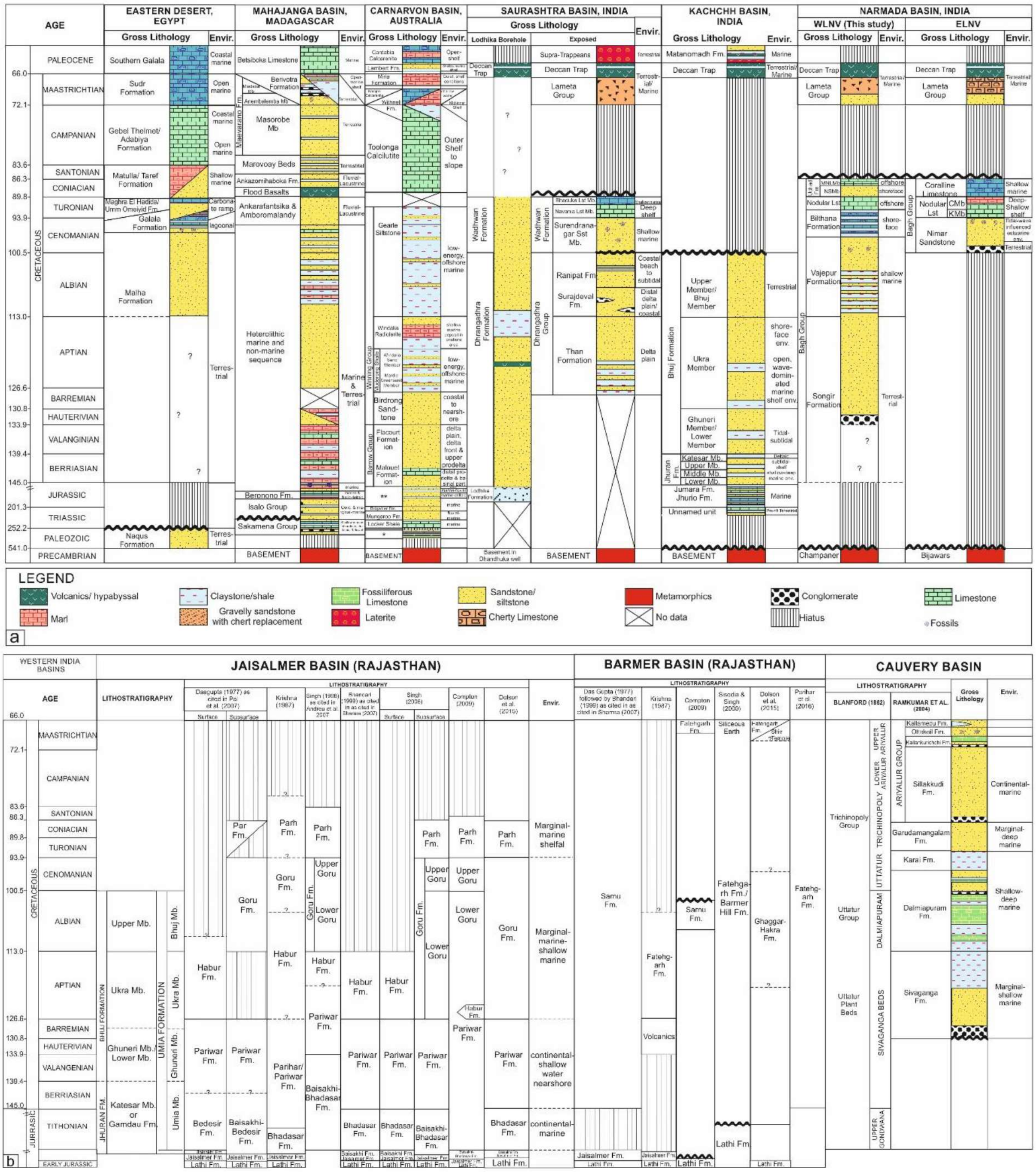

Figure5: Generalized stratigraphic succession and the depositional environments of the Cretaceous Tethyan basins. a. Eastern Desert, Mahajanga, Carnarvon, Saurashtra, Kachchh and Narmada and b. Jaisalmer, Barmer, and Cauvery (modified after Shitole et al., 2021).

Chapter 8: The position of the Indian subcontinent was discussed in context to the Gondwanaland during the Cretaceous. The Tethyan basins comprise the pre-, syn-, and post-rift basins filled with fluvio-marine sediments. The WLNV deposits of Narmada Basin are compared with the pervasive Tethyan basins like the Eastern Desert (Egypt), Mahajanga

(Madagascar), Carnarvon (Australia), Saurashtra, Kachchh, Eastern Narmada, Jaisalmer, Barmer, and Cauvery (India) (Fig. 5) to understand the sedimentology, stratigraphy, and tectonics.

Rifting started in the Early Cretaceous in the Narmada, Mahajanga, Cauvery, and Saurashtra basins and deposited the early-rift Songir Formation, Malha Formation, Sivaganga Formation, and the Than Formation, respectively (Shitole et al., 2021). Deposition of Early Cretaceous terrestrial and Late Cretaceous marine sediments are common to the Eastern Desert, Saurashtra, and Narmada Basin is suggests a similar role played by tectonics, and Cenomanian-Turonian transgression. During Early Cretaceous highstand of sea-level deposited the marine sediments in the Carnarvon, Cauvery, Kachchh, and Mahajanga basins while Eastern Desert, Saurashtra, and Narmada basins were experiencing the continental environment. The Early Cretaceous terrestrial succession was overlain by the shallow marine non-clastic rocks deposited during the Late Cretaceous encroachment of the Tethys Sea in the Narmada and Saurashtra basins. The age of the youngest unit observed in the Bagh Group (Coralline Limestone in the ELNV and Men Nadi Limestone Member in the WLNV) coincides with the rift event of India from Madagascar and outpour of flood basalts in the Mahajanga Basin (Storey et al., 1995; Rogers et al., 2000).

Finally, the conclusions are listed, drawn from various studied aspects of lithostratigraphy, sedimentology, ichnology, sequence stratigraphy of the Bagh Groups of the Western Lower Narmada Valley and pervasive Tethyan basins.

4. Conclusions

1. The lithostratigraphy of Cretaceous succession of WLNV is amended and assigned the Bagh Group according to ISSC ranging in age from Berriasian? (Neocomian) to Coniacian.

2. Bagh Group is divided into five formations, namely Songir, Vajepur, Bilthana, Nodular Limestone, and Uchad formations in ascending order. The old names such as Songir Bilthana and Nodular Limestone are retained; Vajepur and Uchad formations are the new units introduced. The Uchad Formation is further subdivided into the Narmada Sandstone and Men Nadi Limestone members.

3. The stratigraphic succession of the Bagh Group comprises siliciclastics, mixed siliciclastic-carbonates, shales, and carbonates rocks which are further classified into fourteen facies, conglomerate, planar and trough cross-stratified sandstone, horizontal-thinly bedded sandstone, massive sandstone, bedded quartz arenite, shale, calcareous sandstone, micritic sandstone, sandstone- siltstone-shale, sandy/silty allochemic limestone, fossiliferous limestone, sandy/silty micrite, mudstone, and muddy micrite.

4. The Songir Formation at the base of the Bagh Group succession is composed of non-marine sediments and deposited in a fluvial-braided and alluvial-fan environment. It lies unconformably above the Precambrian basement and corresponds to the initial rift phase.

5. Overlying Vajepur Formation marks the onset of base-level rise during the Albian. It is represented by the cross-stratified sandstone-shale in the lower part and the laminated and rippled calcareous sandstones (marine fossils) in the upper part.

6. The Bilthana Formation constitutes oyster beds intercalated with the shale and shows the presence of well-preserved body and trace fossils. The succeeding Nodular Limestone is widely traceable in the LNV containing abundant ammonites of the Turonian age. The sedimentological and ichnological evidence suggests deposition of Bilthana Formation in lower shoreface/offshore transition and Nodular Limestone in the offshore environment.

7. Uchad Formation differs from the underlying Nodular Limestone in having a distinct lithological assemblage and bed geometry. The Narmada Sandstone Member represents the high-energy shoreface environment, whereas the overlying Men Nadi Limestone Member consists of distal shoreface deposits.

8. Sandy allochemic limestone, micritic sandstone, sandstone-siltstone-shale, fossiliferous limestone, mudstone, bedded quartz arenite, planar cross stratified sandstone, and calcareous sandstone facies are low-to moderately bioturbated and show the presence of twenty-six ichnospecies belonging to seventeen ichnogenera,

including *Apectoichnus, Archaeonassa, ?Arenicolites, Bergaueria, Conichnus, Conostichus, Didymaulichnus, Gordia, Helminthoidichnites, Lockeia, Oniscoidichnus, Paleophycus, Planolites, Ptychoplasma, Skolithos, Taenidium*, and *Thalassinoides*.

9. Overall density of the trace fossils is low and represents five ethological categories, including cubichnia, pascichnia, domichnia, repichnia and fodinichnia.

10. Nine trace fossil assemblages, namely *Apectoichnus, Archaeonassa, Bergaueria, Conichnus-Conostichus, Helminthoidichnites-Gordia, Lockeia-Planolites, Skolithos, Taenidium*, and *Thalassinoides* represent three ichnofacies namely, *Skolithos, Cruziana*, and *Glossifungites* which reflect the environmental conditions (bathymetry, salinity, oxygenation, energy conditions, sedimentation rate, substrate characteristics).

11. Occurrence of abundant plug-shaped burrows- *Bergaueria hemispherica, Conichnus conicus, Conostichus stouti*, and *Conostichus broadheadi* recorded from the Cenomanian-Turonian Bilthana Formation is limited to the fine-grained, soft, unconsolidated, non-fluidized clastic sediments, which appears to be favorable for sea anemone colonization.

12. Uniform fill, prominent relief, and lack of slump structures suggest that all the sea anemones simultaneously vacated the burrow, which was subsequently filled by the overlying sandy allochemic limestone indicating an increase in energy conditions in the shoreface environment.

13. The presence of densely packed, unaltered, least abraded, disarticulated, unoriented oyster shells with faint growth lines and the presence of *Thalassinoides* and plug-shaped burrows at the sole of the oyster limestone bed suggests surface exhumation followed by storm events in the offshore-transition environment.

14. The increase in ichnodiversity observed in the upper part of the Vajepur Formation suggests a low-energy, nutrient-rich, shoreface environment. In contrast, the ichnofauna of the Bilthana Formation is dominated by comparatively deeper feeding burrows of *Thalassinoides* followed by plug-shaped burrows.

15. The high ichnodiversity and ichnodensity of deposit-feeding burrows in the sandy allochemic limestone and fossiliferous limestone facies of the Bilthana Formation suggest concentration of nutrients in a well-oxygenated substrate, while the occurrence of plug-shaped burrows of suspension feeders suggests ample supply of nutrients from the water column.
16. An abrupt decline of body fossils and trace fossils in the Nodular Limestone and the presence of pyrite suggest reduced oxygen or dysoxic conditions.

17. Overall, the Cretaceous Bagh Group is characterized by low-moderate ichnodiversity, dominated by large *Thalassinoides* burrows suggesting flourishment of decapod crustaceans followed by sea anemones, gastropods, polyphyletic vermiform, and arthropods.

18. The *Cruziana* ichnofacies is characterized by moderate diversity of horizontal structures made by mobile organisms, suggesting low to moderate-energy conditions, and abundant nutrients and oxygenation in the sediments in the shoreface environment.

19. The *Glossifungites* ichnofacies are characteristics of the Bilthana Formation suggesting unlithified, stable, cohesive substrate such as dewatered muds produced due to burial and later made available to the organisms due to erosion.

20. The *Skolithos* ichnofacies observed in the Narmada Sandstone Member suggest changes in the substrate consistency, well-oxygenated bottom water conditions, and abundant suspension food supply in the shoreface environment.

21. Sedimentological and ichnological data of the Bagh Group revealed first-order genetic sequence characterized by various System Tracts, Sequence Stratigraphic Surface, Systems Tract Boundary, and Sequence Boundary.

22. HAST is characterized by the alluvial fan and braided channel deposits in Songir Formation represented by conglomerates facies, planar and trough cross-stratified

sandstone facies, horizontal-thinly bedded sandstone facies, and massive sandstone facies.

23. LST is characterized by prograding and aggrading deposits, which filled the accommodation space created by the rising base-level. LST is poorly bioturbated and consists of *Helminthoidichnites-Gordia* and Taenidium assemblage. The low ichnotaxonomic diversity and density of trace fossils suggest deposition in a stressed foreshore environment.

24. The TST-I comprises rippled quartz arenite/calcareous sandstone and micritic sandstone facies of the Cenomanian Vajepur Formation; fossiliferous limestone-shale, shale, sandy allochemic limestone facies belonging to Bilthana Formation of Cenomanian-Turonian age, and the mudstone and sandy micrite facies of the Turonian Nodular Limestone. The lower part of the TST-I comprises abundant plug-shaped burrows of sea anemones with *Archaeonassa, Oniscoidichnus, Lockeia, Ptychoplasma*, and *Thalassinoides*, while the upper part comprises abundant marine body fossils and trace fossils of shoreface to the offshore environment.

25. TST-I is characterized by the Maximum Flooding Surface (Sequence Boundary), two minor Flooding Surfaces (FS-I and FS-II), and Transgressive Ravinement Surface (TRS); it shows a retrogradational stacking pattern and a fining-upward succession characterized by an increase in the carbonate content towards the top suggesting the rate of base-level rise outpaced the sedimentation during the Turonian.

26. The transgressive phase shows an abrupt change in lithofacies and ichnofacies (*Skolithos*) in Narmada Sandstone Member represented by the Highstand Systems Tract-I (HST-I) where progradation and aggradation took place during the highstand of base-level and high rate of sedimentation has outpaced the accommodation space resulting in normal regressive deposits.

27. TST-II marks the second transgressive event during the Coniacian characterized by muddy micrite, shale, and mudstone facies of the Men Nadi Limestone Member. The facies variation across the minor within trend surface (Flooding Surface-III) shows a retrogradational stacking pattern due to base-level rise.

28. The sedimentological and ichnological data of the WLNV reveal the stratigraphic succession is correlatable with pervasive Cretaceous Tethyan basins like ELNV, Eastern Desert, and Saurashtra while differs from the Carnarvon, Mahajanga, Cauvery, and Kachchh.

29. The (Berriasian?-Aptian) Songir Formation is correlatable with the Early Cretaceous fluvial Himmatnagar Sandstones of Cambay basin, fluvial Nimar Formation of the ELNV, the fluvio-deltaic Bhuj Formation of the Kachchh Basin, and the fluvial Dhrangadhra Group of the Saurashtra Basin.

30. Albian-Cenomanian calcareous sandstone of Vajepur Formation (WLNV) is correlatableSurendranagar Sandstone Member (of the Saurashtra Basin); the Turonian Nodular Limestone of WLNV and ELNV are correlatable with the Navanaia Limestone of the Saurashtra Basin, and Coniacian Uchad Formation is correlatable with Bryozoan/Coralline Limestone of the ELNV and the Bhaduka Limestone Member of the Saurashtra Basin.

31. The age of the youngest unit of the Bagh Group, Coralline Limestone of the ELNV and Men Nadi Limestone Member of the WLNV, coincide with the rift event of India from Madagascar and outpour of flood basalts in the Mahajanga Basin.

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