CHAPTER 3
REVIEW OF STRATIGRAPHY

3.1 INTRODUCTION

The lithostratigraphy of Cretaceous rocks of the Lower Narmada Valley has been debated for more than 150 years. Since the middle nineteenth century, several authors have proposed and revised the lithostratigraphy of the Bagh Group rocks from the ELNV or/and WLNV (Table 3.1). Most lithostratigraphy is proposed, emphasizing the local lithological variation, and thus end up in variable names of the units. The new units are erected based on the local lithological variation observed and not following the standard norms of nomenclature resulting in synonymy and homonymy in the nomenclature; hence most of the studies have not been able to bracket the age of the units precisely. Several authors have proposed a separate lithostratigraphic classification for the Cretaceous rocks of ELNV and WLNV, while some workers have proposed a single lithostratigraphic classification for the ELNV and WLNV deposits. Initially, the Cretaceous LNV deposits were referred to as Bagh Beds (Blanford, 1869; Bose, 1884; Rode and Chiplonkar, 1935 and are now considered Group (Ruidas et al., 2018). A detailed review of the stratigraphy of the Cretaceous rocks in ELNV and WLNV is discussed below.

3.1.1 LITHOSTRATIGRAPHY OF ELNV

Since the middle nineteenth century, several authors have worked on the stratigraphical, sedimentological, and paleontological aspects of the Cretaceous rocks exposed in ELNV. A brief review of the lithostratigraphic succession of the Cretaceous rocks described by the workers is given below.

Blanford, in 1869 for the first time, systematically studied the rocks exposed in the Tapti and the Lower Narmada valley ranging from Precambrian to Quaternary. The area was mapped,

and the western and eastern limits of the rocks were accurately marked at Baroda (Vadodara) and Barwah, respectively. The rocks were assigned the Cretaceous age, and the term 'Bagh Beds' as described by earlier workers was retained. The Bagh Beds section at Chirakhan (ELNV) was described as sandstone and conglomerate, unfossiliferous Nodular Limestone, Fossiliferous argillaceous limestone abounding in echinoderms, and Coralline limestone in ascending order (Table 3.1a). However, Bose (1884) considered Lametas a part of the Bagh Beds, and the lower sandstone unit was correlated with the Mahadevas of Gondwana Supergroup.

Bose (1884) resurveyed the rocks and separated the Lower Cretaceous sandstone dominated series as Nimar Sandstone. In contrast, the Upper Cretaceous marine series was considered Bagh Beds and divided into three units Nodular Limestone, Deola and Chirakhan Marl, and Coralline Limestone in ascending order (Table 3.1a). He renamed the fossiliferous argillaceous limestone abounding in the echinoderms unit described by Blanford in 1869 as Deola-Chirakhan Marl occurring between the Nodular Limestone and the Coralline Limestone.

Wadia (1919), in his book Geology of India, suggested the extension of the marine Bagh Beds up to Kathiawar in the west and Gwalior in the east. The Bagh Beds were divided into unfossiliferous sandstone and conglomerate (Nimar Sandstone), Nodular Limestone, Deola Marl and Coralline Limestone, and the whole succession was assigned the Cenomanian age (Table 3.1a) based on the occurrence of echinoids, bivalves, polyzoan, corals, and gastropods. The author rightly pointed out that fossiliferous Deola Marl and the Coralline Limestone do not extend westward. The unfossiliferous Songir Sandstone exposed at Baroda (WLNV) was considered to underlie the Bagh Beds, separated from it, and correlated with the Ahmednagar sandstones of Idar state (WLNV).

Rode and Chiplonkar, in 1935, considered Barwah and Wadhwan as the eastern and western limits of the Bagh Beds, respectively. The authors observed the occurrence of the Bryozoan Limestone bed in the Chirakhan area and traced it at many other localities in the ELNV occurring between Nodular Limestone and the Deola-Chirakhan Marl. The new unit was named Lower Coralline Limestone, separated from the upper Coralline Limestone by Deola Marl. The lower Coralline Limestone was observed to pinch out, and the marl occurring between the two

Coralline limestone beds was eroded, often leading to the juxtaposition of the two beds. The Bagh beds were divided into five units, Nimar Sandstone, Nodular Limestone, Lower Coralline Limestone, Deola-Chirakhan Marl, and the Upper Coralline Limestone (Table 3.1a).

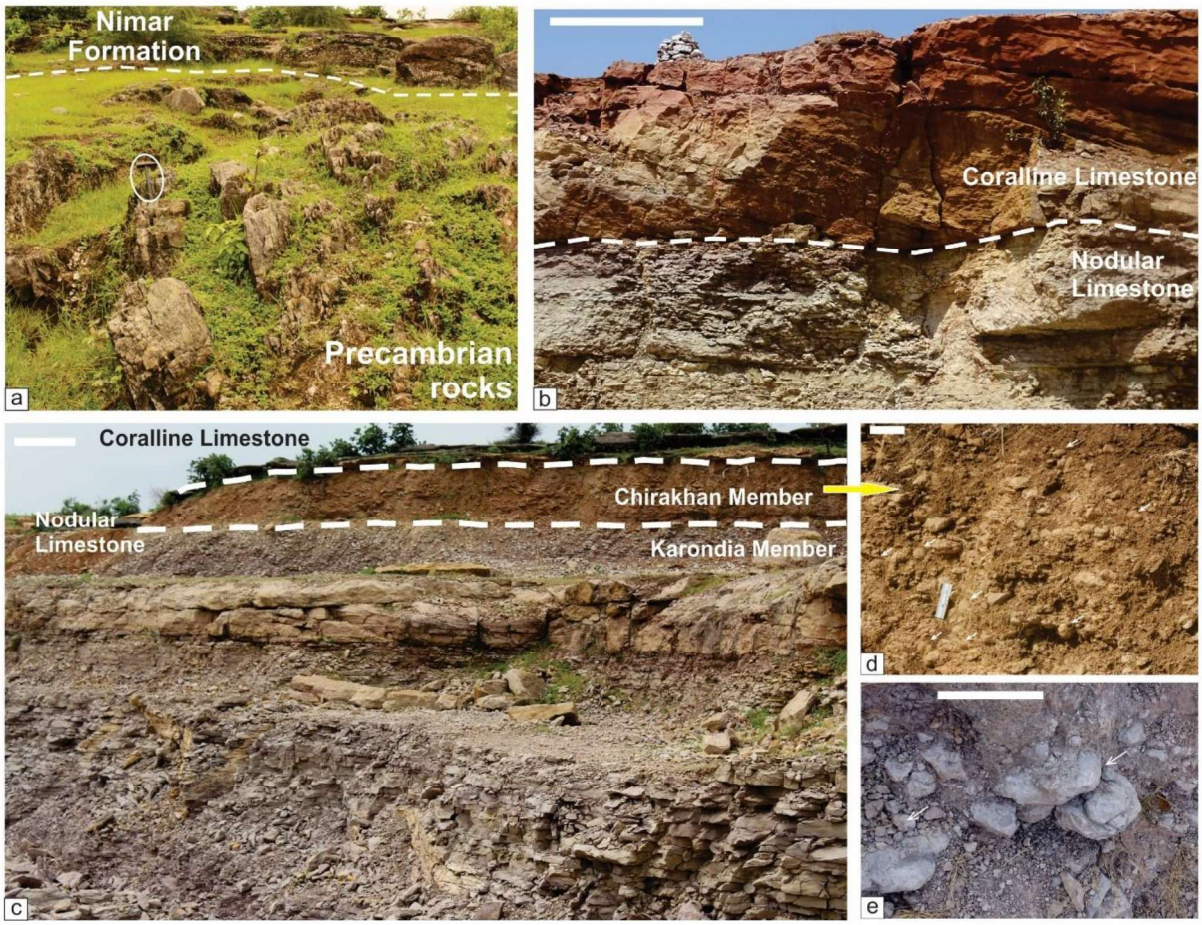


Plate 3.1 Field photographs of the ELNV sections. a. Angular contact between the Nimar Formation and the Precambrian rocks (length of hammer= 32 cm). Sharp contact between the Nodular Limestone and the Coralline Limestone at b. Borghata/Ratitalai village (scale bar= 2 m). and c. Sitapuri village (scale bar– 2 m). d. Echinoderms in Chirakhan Member (white arrows), Sitapuri village (scale bar= 5 cm). e. Ammonites in Nodular Limestone (white arrows), Risawala village/ Gayatri Temple (scale bar= 10 cm).

Pascoe (1959), in his book 'Manual of Geology of India and Burma', defined the western and eastern limits of the Bagh Beds at Rajpipla and Barwah respectively and divided the Bagh Beds of Central India into Oyster Bed, Nodular Limestone, Deola-Chirakhan Marl, and Coralline Limestone in ascending order (Table 3.1a). The Nimar Sandstone exposed in the eastern part of the basin is considered part of the Gondwana Supergroup. In contrast, in the western part, the Bagh Beds sequence is considered to unconformably overlie the Nimar Sandstone, thus separating it from the Bagh Beds. The important observation in the work of Pascoe was the occurrence of the Oyster Bed, which was considered the basal unit of the Bagh Beds based on the field and paleontological evidence; the age of Bagh Beds was bracketed between Middle Cenomanian to Campanian (Senonian).

Roy-Chowdhary and Sastri (1962) considered the Bagh Beds to be the Cretaceous and divided it into Nimar Sandstone with Oyster Bed at the top, Nodular Limestone, and Coralline Limestone (Table 3.1a). The Deola-Chirakhan Marl was considered a part of the Nodular Limestone and ruled out its status as a separate unit in the stratigraphy of Bagh as proposed by Bose (1884).

Murty et al. (1963) proposed new lithostratigraphic units for the Bagh Beds exposed in Jhabua (ELNV). He was the first to elevate the rank of Bagh Beds to Group and divided the sequence into Nimar Group and Bagh Group. The Nimar Group was subdivided into Nimar Sandstone (plant fossils at the base) and Umrali Flagstone. In contrast, the Bagh Group was subdivided into Amlipura Oyster Bed, Kanasgali Grit, and Sejagaon Limestone (Table 3.1a). The Amlipura Oyster Bed was considered doubtfully Neocomian, whereas the age of Kansagali Grit and the Sejagaon Limestone was bracketed between Senonian to Aptian. Murty et al. (1963) recovered plant fossils *Ptilophyllumcutchense*, *Ptilophyllumacutifolium*, *Peltate,* and *Sphenopteris* sp. from the lower carbonaceous clay-bearing unit of the Nimar Sandstone and based on the assemblage suggested fixed the upper age of the unit as Hauterivian, and the Nimar Group was thus tentatively assigned Lower Cretaceous age.

Poddar (1964) proposed separate lithostratigraphic classification for the eastern and western parts of the Lower Narmada Valley. In ELNV, the Cretaceous rocks were divided into

the Nimar Group and the Bagh Group. The Nimar Group was further subdivided into Nimar Sandstone and Umrali Flagstone, separated by a disconformity. The age of the Nimar Group was bracketed between Upper Jurassic to Lower Aptian. The Bagh Group was subdivided into Amlipura Oyster Bed, Kanasgali Grit, Sejagaon Limestone, and Bagh Formation, extending from Middle Aptian-Turonian (Table 3.1a).

Sahni and Jain (1966) revised the lithostratigraphy of the Bagh Beds and divided it into Nimar Sandstone, Oyster Bed, Nodular Limestone, and Coralline Limestone (Table 3.1a). The authors supported the view of Roy-Chowdhary and Sastri (1954) and suggested that Deola-Chirakhan Marl lacks occurrence as a distinct horizon and is absent in most places. They remarked that Deola-Chirakhan Marl is a combined weathered product of the Nodular Limestone and the Coralline Limestone, and the Bagh Beds were deposited in the marine environment during the Cretaceous period.

Verma (1965), based on the collection of shark teeth from the Ambadongar region of WLNV, assigned the Oyster Bed (also known as Bilthana Oyster Bed) Cenomanian-Senonian age, and the age of Bagh Beds was considered to be Cenomanian to Maastrichtian. Verma in 1968 proposed a new lithostratigraphic division of the Bagh Beds (as cited in Verma, 1969), dividing the sequence into Nimar Sandstones (Lower Cretaceous), Oyster Bed (Cenomanian-Turonian), Nodular Limestone (Turonian-Santonian), and Coralline Limestone (Campanian-Lower Maastrichtian) (Table 3.1a). Later Verma, in 1969, based on the fossil shark fauna discovered from the Oyster Bed near Kawant (WLNV), assigned the Bagh Beds Cenomanian-Maastrichtian age and also suggested it to range from Turonian to Lower Maastrichtian but not older than Cenomanian. However, in the correlation chart with the Cretaceous rocks of South India, Verma (1969) assigned the Bagh Beds is Lower Cretaceous-Maastrichtian in age.

Pal (1970) revised the lithostratigraphy of the Cretaceous sequence and divided it into Nimar Sandstone, Lower Coralline Limestone, Nodular Limestone, Upper Coralline Limestone. Pal in 1971, re-revised the units as the Ajantar Bryozoan Limestone (equivalent to the Lower Coralline Limestone), Cave Nodular Limestone (equivalent to the Nodular Limestone),

DeolaMarl, Mohanpura Marl, and Barwah Bryozoan Limestone (Table 3.1a). The Nimar Sandstone was assigned Valanginian to lower Aptian age.

Sastry and Mamgain (1971) proposed a separate division for the Bagh Beds exposed in the ELNV and WLNV. The authors divided the Cretaceous sequence into the Lower Cretaceous Nimar Sandstone with plant fossils overlaid by Cenomanian-Turonian Calcareous Sandstone, Nodular Limestone, and Coralline Limestone (Table 3.1b). Based on fossils, the authors considered the carbonate sequence of WLNV to be much younger than the ELNV.

Jain (1971) marked the eastern and western limits of the Bagh Beds at Indore and Rajpipla, respectively, and divided it into Nimar Sandstone, Nodular Limestone, and Coralline Limestone (Table 3.1b). Based on the occurrence of Turonian ammonites in the Nodular Limestone and the conformable relationship of the underlying Nimar Sandstone, the Nimar sandstone was assigned upper Turonian age, and Coralline Limestone was considered not younger than Coniacian.

Gupta (1975) has revised the status of Bagh Beds to Formation and divided it into Nimar Sandstone, Nodular Limestone, Deola-Chirakhan Marl, and Coralline Limestone without bracketing its age (Table 3.1b).

Dassarma and Sinha (1975) have proposed separate lithostratigraphy for the ELNV and WLNV. The eastern and western limits of the Cretaceous rocks of Lower Narmada Valley were marked at Barwah and Rajpipla, respectively. In the revised lithostratigraphy, Nimar Sandstone was separated from the Bagh Beds and assigned Lower Cretaceous age. The overlying sequence was considered as Bagh Beds. It was divided into Calcareous Sandstones locally with a cluster of Oysters (Upper Nimars), Nodular Limestone, and Coralline Limestone and assigned Cenomanian-Turonian age (Table 3.1b).

Guha (1976) divided the Bagh Group into Nimar Sandstone, Karondia Limestone, and Chirakhan Limestone (Table 3.1b). The name Nodular Limestone was replaced with Karondia Limestone, whereas the Deola-Chirakhan Marl and Coralline Limestone were renamed Chirakhan Limestone, which later became highly debatable.

Singh and Srivastava (1981) studied the Cretaceous sedimentary sequence between Chikli and Barwah and renamed it the Narbada Group to include the Nimar Formation in the Bagh Formation. Narbada Group was divided into Nimar Formation and Bagh Beds (Formation). The Bagh Beds were further subdivided into Nodular Limestone Member, Deola-Chirakhan Marl Member, Lower Coralline Limestone (pinching), and Upper Coralline Limestone Member/Hatini Sandstone Member (Table 3.1b). The authors rightly pointed out that the Nimar Sandstone shows variable lithological properties and interpreted its lower part to be deposited in a fluvial environment, whereas the upper part showed marine influence. However, the authors correlated the Bagh Formation with the Lameta Formation based on the lithology, trace fossils, and stratigraphic position of the Nodular Limestone (Bagh Formation) with the Mottled Nodular Formation (Lametas).

Badve (1987) reassessed the stratigraphy of the Bagh Beds exposed in the Barwah area (Madhya Pradesh) and divided it into Nimar Sandstone with Oyster Bed at the top, Nodular Limestone, Deola and Chirakhan Marl and Coralline Limestone (Table 3.1b). The Nimar Sandstone was considered Lower Cretaceous (Neocomian), whereas the younger series was considered Upper Cretaceous. Based on the occurrence of trace fossils in the upper part of Nimar Sandstone, the author suggested a shallow sublittoral depositional environment with low to moderate energy.

Kumar (1994) studied the Cretaceous rocks of Narmada valley exposed in the Jhabua area (Madhya Pradesh). The author followed the lithostratigraphy proposed by Singh and Srivastava (1981) and divided the Narbada Group into Nimar Formation and Bagh Formation (Table 3.1c). However, the age of Nimar Formation was revised to Late Jurassic based on palynoflora and non-availability of the Early Cretaceous palynofossils and did not comment on the retention of Maastrichtian age for the Coralline Limestone as proposed by Singh and Srivastava (1981). Based on the palynofossils, the author suggested freshwater, warm, humid, swampy depositional environment of the Nimar Formation.

Taylor and Badve (1995) divided the Bagh Group into Nimar Sandstone Formation, Nodular Limestone Formation, and Chirakhan Limestone Formation and bracketed its age

between Neocomian and Turonian (Table 3.1c) considering the previous literature. Based on the occurrence of *Chiplonkarina*in the Upper Tal Shale Limestone (Uttar Pradesh), and the Coralline Limestone (Madhya Pradesh), the authors assigned the Cenomanian-Turonian age to the bryozoan bearing Bagh Group. The authors subdivided the Chirakhan Limestone Formation into Deola-Chirakhan Marl Member and Coralline Limestone Member to separate the marly facies from the coralline limestone. The authors discarded the Barwaha Bryozoan Limestone unit proposed by Pal (1971), stating that it does not occur in the vicinity of Barwaha.

Rajshekhar reported the foraminifera from the Bagh Group in 1991 and 1995 and followed the stratigraphy given by Chiplonkar et al. (1977) and Guha (1976), respectively. Rajshekhar in 1997 observed a different generalized stratigraphic sequence comprising of Nimar Sandstone, Oyster Bed, Nodular Limestone, and Rajpipla Limestone. The Rajpipla Limestone was considered to be younger than the Nodular Limestone (Table 3.1c). Rajshekhar (1997), based on the occurrence of echinoids, foraminifers, bivalves, and gastropods from the Navagam Limestone, suggested a shallow-water depositional environment of the unit.

Akhtar and Khan (1997), based on the studies in Zeerabad and Jobat town of ELNV, divided the Cretaceous rocks into Bagh and Lameta Groups. According to their lithostratigraphic table (Table 3.1c), Bagh Group rocks are overlaid by Lower Deccan Trap (first effusive activity) of Lower Turonian age, Lameta Group, and Upper (main) Deccan Trap in ascending order. Moreover, the Songir Sandstone and Navagam Limestone of WLNV were considered part of the Lameta Group, younger than Bagh Group rocks. The Bagh Group was divided into Nimar Sandstone and Karondia Limestone, and its age was bracketed between Albian-Cenomanian (Table 3.1c). The authors suggested a tidal island model for deposition of the carbonates of Karondia (Nodular) Limestone based on facies variation attributed to shifting islands separated by subtidal areas.

Kumar et al. (1999) have grouped the Bagh Beds into Nimar Sandstone, Bagh Formation, and Lameta Formation; the Bagh Formation is further subdivided into Nodular Limestone, Deola-Chirakhan Marl, and the Coralline Limestone (possible members of the Bagh Formation), whereas the Lameta Formation constitutes of Calcareous Sandstone (Table 3.1c). The Nimar

Formation is considered Early Cretaceous in age and deposited in an estuarine and freshwater environment. The Bagh and Lameta formations are Late Cretaceous in age, deposited in marine and estuarine-freshwater environments, respectively.

Nayak (2000b, 2004) followed the amended classification proposed by Chiplonkar et al. (1977) and Taylor and Badve (1995). Accordingly, the Bagh Group is divided into three formations: Nimar Sandstone, Nodular Limestone, and Coralline Limestone (Table 3.1c). The Nimar Sandstone Formation was subdivided into Oyster Bed, trace fossils horizon, Oyster Bed with shark teeth, ammonoids, and *Jhabotrigonia-Turritella* bed. The overlying Coralline Limestone Formation was further subdivided into Deola-Chirakhan Marl and Coralline Limestone members. The whole Bagh Group sequence was bracketed between Upper Albian and Turonian. Nayak (2000b) studied ostracods of the Nimar Formation (Bagh Group) and suggested its deposition in the warm, shallow water of normal salinity during Cenomanian-Turonian. Based on trace fossils recovered from the Nimar Sandstone, Nayak (2004) suggested shallow sublittoral depositional conditions with moderate to low energy.

Vaidyanathan and Ramakrishnan (2010), in their book 'Geology of India', modified the lithostratigraphic classification proposed by Merh (1995) and followed the classification proposed by Bose (1884) and Chiplonkar et al. (1972-not seen, 1977), whereas the age of the units was revised significantly. The precise age of the upper and lower was not mentioned, and the status of Lameta is also not clear (Chiplonkar et al., 1972-not seen, 1977). The age of Nimar Sandstone with Oyster Bed at top originally considered Valanginian to Albian by Bose (1884) was revised to Valanginian to Aptian, and Nodular Limestone was assigned Aptian age whereas, the age of overlying Deola-Chirakhan Marl and Coralline Limestone was revised to Cenomanian-Turonian and Coniacian-Campanian respectively (Table 3.1d).

Gangopadhyay and Maiti (2012) studied the gastropods and bivalves of the Nodular Limestone exposed in Zeerabad and divided the Cretaceous rocks of ELNV into Nimar and Bagh groups. The Bagh Group was further subdivided into the Nodular Limestone and Bryozoan Limestone formations (Table 3.1d). The authors suggested that the Coralline Limestone name of the topmost unit of the Bagh Group is a misnomer and is devoid of corals but is characterized by

abundant bryozoans in it. The authors proposed to rename the unit as Bryozoan Limestone Formation. Based on the bipolar arrangement of the gastropod shells and convex down position of the bivalve shell, a nearshore beach depositional environment was suggested.

Jaitly and Ajane (2013) divided the Bagh Group into Nimar Sandstone, Nodular Limestone, and Coralline Limestone formations. The Nodular Limestone Formation was further subdivided into Karondia and Chirakhan members (Table 3.1d). Jaitly and Ajane (2013) followed the lithostratigraphic classification scheme of Tripathi (2006); however, no further subdivisions were made to the Nimar Sandstone Formation. The authors too, believed Coralline Limestone's notion to of being a misnomer but suggested retaining it because it is deeply entrenched in the literature. Based on the ammonite *Placenticeras mintoi* collected from different levels in the Nodular Limestone, the authors assigned it Turonian age. The Coralline Limestone was assigned Coniacian age based on the studies of Gangopadhyay and Bardhan (1998) reporting *Barroisiceras onilahyense* from the Coralline Limestone. The Nimar Sandstone was assigned Cenomanian age after the studies of Chiplonkar et al. (1977).

Jha et al. (2016) modified the stratigraphy of Singh and Srivastava (1981) and divided the Bagh Group rocks into Nimar Sandstone, Nodular Limestone, and Coralline Limestone (Table 3.1d) belonging to Cenomanian, Turonian, and Coniacian age respectively, which is similar to the lithostratigraphy proposed by Jaitly and Ajane (2013). However, the authors avoided further subdividing the Nodular Limestone into Karondia Member and Chirakhan Member. Based on the presence of seismites in the Nimar Sandstone Formation, reactivation of the Son-Narmada South Fault during the Cenomanian was suggested, which led to basin subsidence and deposition of marine sediments.

Kumar et al. (2016) followed the stratigraphic unit of the Bagh Group rocks proposed by Jaitly and Ajane (2013) with modification of ages. The Bagh Group was divided into the Cenomanian Nimar Sandstone, Turonian Nodular Limestone, and Coniacian Coralline Limestone (Table 3.1d). The Nodular Limestone was subdivided into Karondia and Chirakhan members, similar to Jaitly and Ajane (2013). However, Karondia and Chirakhan members' age was revised to early-middle Turonian and late Turonian, respectively. Kumar et al. (2016)

recovered suspension-feeding bivalves from the Turonian Nodular Limestone of Bagh Group and suggested availability deposition in a protected lagoonal to the subtidal environment.

Prasad et al. (2017) followed the stratigraphy of Tripathi (2006) and Jaitly and Ajane (2013) and divided the Bagh Group into the Cenomanian Nimar Sandstone, Turonian Nodular Limestone, Coniacian Coralline Limestone and Green Sandstone (Table 3.1d). The authors identified Green Sandstone as a new unit overlying the Coralline Limestone, which yielded abundant shallow littoral shark teeth (*Ptychodus* sp., *Scapanorhynchus* sp. aff. *S. raphiodon*, *Cretodus* sp. aff. *C.crassidens*, *Cretalamna* sp., *Squalicorax* sp. aff. *S. falcatus*), and suggested deposition in the nearshore environment.

3.1.2 LITHOSTRATIGRAPHY OF ELNV-WLNV

Chiplonkar et al. (1977) described the stratigraphy of the Cretaceous rocks of LNV in detail and divided the Bagh Group into Nimar Sandstone consisting of trace fossils horizon and Oyster Bed overlaid by Oyster Bed with shark teeth and ammonoid, *Jhabotrigonia-Turritella* bed, Nodular Limestone with lower *Inoceramus* bed at the top, Lower Coralline Limestone, Deola and Chirakhan Marl with *Hemiaster*, Upper *Inoceramus* bed and Upper Coralline Limestone with Oyster Bed at the top (Table 3.1b). Several authors, including Nayak (2000a), followed the lithostratigraphic scheme of Chiplonkar et al. (1977). Although the authors have strongly criticized the workers who have separated the lithostratigraphy of the eastern and western part of the basin, the units proposed in their study were erected solely based on the lithological and paleontological properties observed in the eastern part of the basin and lacked a description of the western part. Moreover, the absence of Deola-Chirakhan Marl and the Coralline Limestone in the west part of the basin was completely neglected.

Biswas and Deshpande (1983) divided the sequence into the Nimar Group and Bagh Group in ELNV. The Nimar Group of ELNV was correlated with the Songir Group of WLNV, whereas the Bagh Group in ELNV was correlated with the Navagam Group in WLNV. The authors proposed Nimar Sandstone and Umrali Flagstone as the new subdivisions of the Lower Cretaceous Nimar Group, whereas the Upper Cretaceous Bagh Group was divided into Nodular Limestone, Coralline Limestone, and Lameta Formation (Table 3.1b).

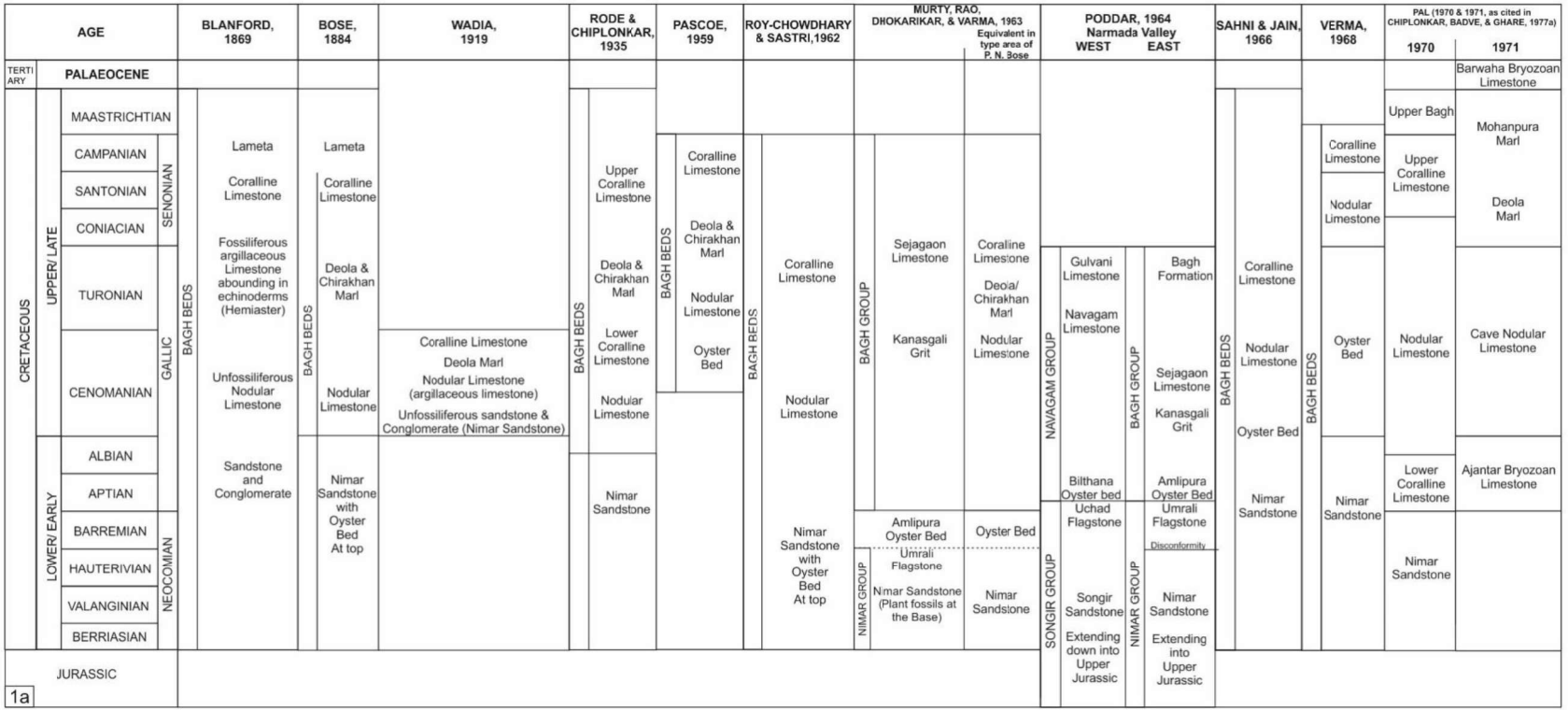
Ramasamy and Madhavaraju (1993) studied the Bagh Group rocks of Madhya Pradesh and revised the lithostratigraphy based on the detailed petrographic analysis. The authors divided the Bagh Group into Nimar Sandstone, Karondia Limestone, and Bryozoan Limestone (Table 3.1c) and discussed the nomenclature, contact, thickness, paleontology, lithology, geographic extension, stratotypes, and age of the lithostratigraphic units in detail.

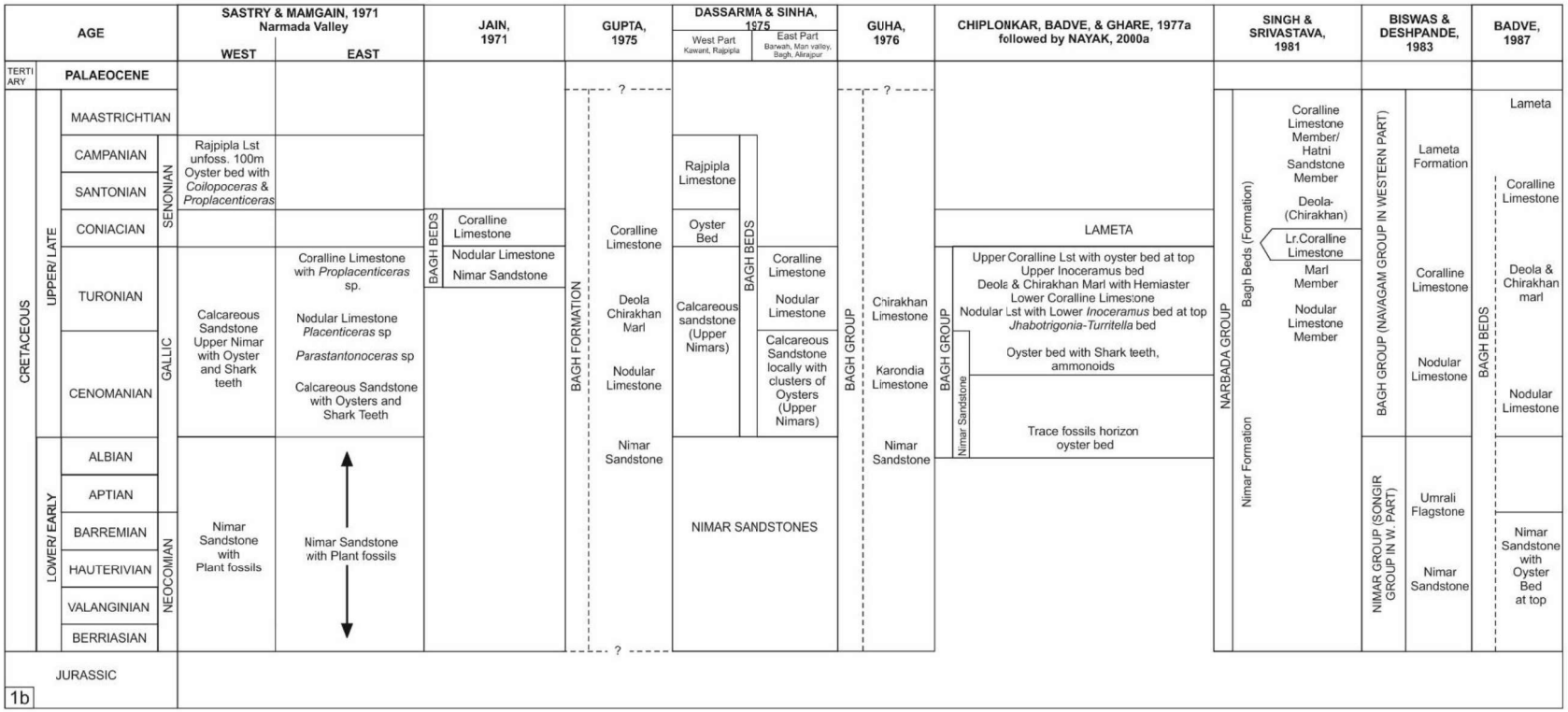
Tripathi (1995) suggested the deposition of the Bagh Group rocks in three sub-basins, namely Zeerabad-Bagh, Jobat-Bhabhra, and Kawant, indicating a south/southwest slope of the basins with occasional basin highs. The author divided the Bagh Group into Nimar Sandstone, Nodular Limestone, and Coralline Limestone formations (Table 3.1c) and proposed Bagh Cave and Bariya members as the new subdivisions of the Nimar Sandstone Formation; the Nodular Limestone Formation was further subdivided into Karaundia Member and Chirakhan Member.

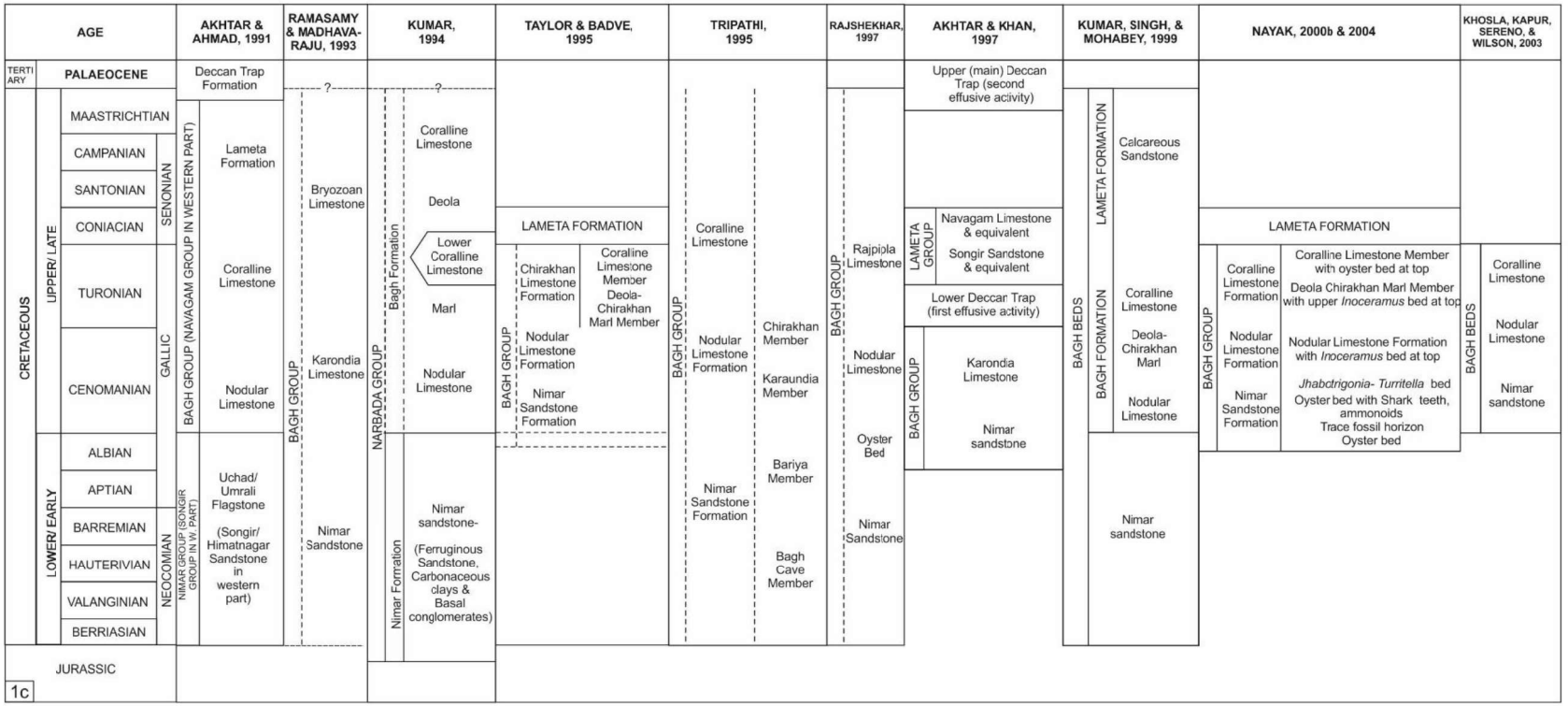
Tripathi, in 2006, revised the stratigraphy of the Bagh Group and divided it into Nodular Limestone and Coralline Limestone. The Bagh Cave Member and Bariya Member subdivisions of the Nimar Sandstone Formation and the Karondia Member and Chirakhan Member subdivisions of the Nodular Limestone from his 1995 classification scheme were retained (Table 3.1d). A hard ground separated the two formations; however, the author proposed to separate the Nimar Sandstone Formation from the Bagh Group. The Nodular Limestone in ELNV was suggested to be deposited in a shallow, open, and slowly sinking basin. In contrast, the Nodular Limestone in Kawant was considered to be deposited in a reducing environment of a deep and stable basin.

Racey et al. (2016) proposed a single classification for the Bagh Group deposited in ELNV and WLNV. The Cretaceous rocks were grouped into the Nimar group and the Bagh Group; the Bagh Group was divided into Nimar Sandstone and Upper Nimar, whereas Nodular Limestone and Coralline Limestone formations as the earlier subdivisions of the Bagh Group were retained (Table 3.1d). The authors suggested separating the lower siliciclastic unit from the rest of the marine deposits and assigned it Nimar Group. The Nimar Sandstonewas assigned Hauterivian to Aptian age, whereas the Upper Nimars was assigned Albian-Cenomanian age,

while the Nodular Limestone Formation and Coralline Limestone Formation were assigned Turonian age.


AGE
BLANFORD, 1869
BOSE, 1884
WADIA, 1919
RODE & CHIPLONKAR, 1935
PASCOE, 1959
ROY-CHOWDHARY & SASTRI,1962
MURTY, RAO, DHOKARIKAR, & VARMA, 1963
Equivalent in type area of P. N. Bose
PODDAR, 1964 Narmada Valley
WEST
EAST
SAHNI & JAIN, 1966
VERMA, 1968
PAL (1970 & 1971, as cited in CHIPLONKAR, BADVE, & GHARE, 1977a)
1970
1971
TERTIARY
PALAEOCENE
CRETACEOUS
UPPER/ LATE
LOWER/ EARLY
MAASTRICHTIAN
CAMPANIAN
SANTONIAN
CONIACIAN
TURONIAN
CENOMANIAN
ALBIAN
APTIAN
BARREMIAN
HAUTERIVIAN
VALANGINIAN
BERRIASIAN
SENONIAN
GALLIC
NEOCOMIAN
BAGH BEDS
Lameta
Coralline Limestone
Fossiliferous argillaceous Limestone abounding in echinoderms (Hemiaster)
Unfossiliferous Nodular Limestone
Sandstone and Conglomerate
Nimar Sandstone with Oyster Bed At top
Upper Coralline Limestone
Deola & Chirakhan Marl
Lower Coralline Limestone
Nodular Limestone
Nimar Sandstone
Oyster Bed
Deola Marl
Nodular Limestone (argillaceous limestone)
Unfossiliferous sandstone & Conglomerate (Nimar Sandstone)
BAGH GROUP
Sejagaon Limestone
Kanasgali Grit
Amlipura Oyster Bed
Umrali Flagstone
NIMAR GROUP
Nimar Sandstone (Plant fossils at the Base)
NAVAGAM GROUP
Gulvani Limestone
Navagam Limestone
Bilthana Oyster bed
SONGIR GROUP
Uchad Flagstone
Songir Sandstone
Extending down into Upper Jurassic
Bagh Formation
Sejagaon Limestone
Kanasgali Grit
Amlipura Oyster Bed
Umrali Flagstone
Disconformity
Nimar Sandstone
Extending into Upper Jurassic
Coralline Limestone
Nodular Limestone
Oyster Bed
Nimar Sandstone
Upper Bagh
Upper Coralline Limestone
Lower Coralline Limestone
Nodular Limestone
Barwaha Bryozoan Limestone
Mohanpura Marl
Deola Marl
Cave Nodular Limestone
Ajantar Bryozoan Limestone
JURASSIC
1a


AGE
SASTRY & MAMGAIN, 1971 Narmada Valley
WEST
EAST
JAIN, 1971
GUPTA, 1975
DASSARMA & SINHA, 1975
West Part Kawant, Rajpipla
East Part Barwah, Man valley, Bagh, Alirajpur
GUHA, 1976
CHIPLONKAR, BADVE, & GHARE, 1977a followed by NAYAK, 2000a
SINGH & SRIVASTAVA, 1981
BISWAS & DESHPANDE, 1983
BADVE, 1987
TERTIARY
PALAEOCENE
CRETACEOUS
UPPER/ LATE
LOWER/ EARLY
MAASTRICHTIAN
CAMPANIAN
SANTONIAN
CONIACIAN
TURONIAN
CENOMANIAN
ALBIAN
APTIAN
BARREMIAN
HAUTERIVIAN
VALANGINIAN
BERRIASIAN
SENONIAN
GALLIC
NEOCOMIAN
Rajpipla Lst unfoss. 100m Oyster bed with Coilopoceras & Proplacenticeras
Calcareous Sandstone Upper Nimar with Oyster and Shark teeth
Nimar Sandstone with Plant fossils
Coralline Limestone with Proplacenticeras sp.
Nodular Limestone Placenticeras sp
Parastantonoceras sp
Calcareous Sandstone with Oysters and Shark Teeth
Nimar Sandstone with Plant fossils
BAGH BEDS
Coralline Limestone
Nodular Limestone
Nimar Sandstone
BAGH FORMATION
Coralline Limestone
Deola Chirakhan Marl
Nodular Limestone
Nimar Sandstone
Rajpipla Limestone
Oyster Bed
Calcareous sandstone (Upper Nimars)
BAGH BEDS
Coralline Limestone
Nodular Limestone
Calcareous Sandstone locally with clusters of Oysters (Upper Nimars)
NIMAR SANDSTONES
BAGH GROUP
Chirakhan Limestone
Karondia Limestone
Nimar Sandstone
LAMETA
BAGH GROUP
Upper Coralline Lst with oyster bed at top
Upper Inoceramus bed
Deola & Chirakhan Marl with Hemiaster
Lower Coralline Limestone
Nodular Lst with Lower Inoceramus bed at top
Jhabotrigonia-Turritella bed
Oyster bed with Shark teeth, ammonoids
Nimar Sandstone
Trace fossils horizon oyster bed
NARBADA GROUP
Bagh Beds (Formation)
Coralline Limestone Member/ Hatni Sandstone Member
Deola- (Chirakhan)
Lr.Coralline Limestone
Marl Member
Nodular Limestone Member
Nimar Formation
BAGH GROUP (NAVAGAM GROUP IN WESTERN PART)
Lameta Formation
Coralline Limestone
Nodular Limestone
NIMAR GROUP (SONGIR GROUP IN W. PART)
Umrali Flagstone
Nimar Sandstone
BAGH BEDS
Lameta
Coralline Limestone
Deola & Chirakhan marl
Nodular Limestone
Nimar Sandstone with Oyster Bed at top
JURASSIC
1b


AGE
AKHTAR & AHMAD, 1991
RAMASAMY & MADHAVA-RAJU, 1993
KUMAR, 1994
TAYLOR & BADVE, 1995
TRIPATHI, 1995
RAJSHEKHAR, 1997
AKHTAR & KHAN, 1997
KUMAR, SINGH, & MOHABEY, 1999
NAYAK, 2000b & 2004
KHOSLA, KAPUR, SERENO, & WILSON, 2003
TERTIARY
PALAEOCENE
CRETACEOUS
UPPER/ LATE
LOWER/ EARLY
MAASTRICHTIAN
CAMPANIAN
SANTONIAN
CONIACIAN
TURONIAN
CENOMANIAN
ALBIAN
APTIAN
BARREMIAN
HAUTERIVIAN
VALANGINIAN
BERRIASIAN
SENONIAN
GALLIC
NEOCOMIAN
JURASSIC
1c
Deccan Trap Formation
BAGH GROUP (NAVAGAM GROUP IN WESTERN PART)
NIMAR GROUP (SONGIR GROUP IN W. PART)
Lameta Formation
Coralline Limestone
Nodular Limestone
Uchad/ Umrali Flagstone
(Songir/ Himatnagar Sandstone in western part)
BAGH GROUP
Bryozoan Limestone
Karondia Limestone
Nimar Sandstone
?
NARBADA GROUP
Bagh Formation
Nimar Formation
Coralline Limestone
Deola
Lower Coralline Limestone
Marl
Nodular Limestone
Nimar sandstone- (Ferruginous Sandstone, Carbonaceous clays & Basal conglomerates)
LAMETA FORMATION
BAGH GROUP
Chirakhan Limestone Formation
Coraline Limestone Member
Deola-Chirakhan Marl Member
Nodular Limestone Formation
Nimar Sandstone Formation
Coralline Limestone
Nodular Limestone Formation
Nimar Sandstone Formation
BAGH GROUP
Chirakhan Member
Karaundia Member
Bariya Member
Bagh Cave Member
BAGH GROUP
Rajpipla Limestone
Nodular Limestone
Oyster Bed
Nimar Sandstone
Upper (main) Deccan Trap (second effusive activity)
LAMETA GROUP
Navagam Limestone & equivalent
Songir Sandstone & equivalent
Lower Deccar Trap (first effusive activity)
BAGH GROUP
Karondia Limestone
Nimar sandstone
BAGH BEDS
LAMETA FORMATION
BAGH FORMATION
Calcareous Sandstone
Coralline Limestone
Deola-Chirakhan Marl
Nodular Limestone
Nimar sandstone
LAMETA FORMATION
BAGH GROUP
Coralline Limestone Formation
Nodular Limestone Formation
Nimar Sandstone Formation
Coralline Limestone Member with oyster bed at top
Deola Chirakhan Marl Member with upper Inoceramus bed at top
Nodular Limestone Formation with Inoceramus bed at top
Jhabdtrigonia- Turritella bed
Oyster bed with Shark teeth, ammonoids
Trace fossil horizon
Oyster bed
BAGH BEDS
Coralline Limestone
Nodular Limestone
Nimar sandstone

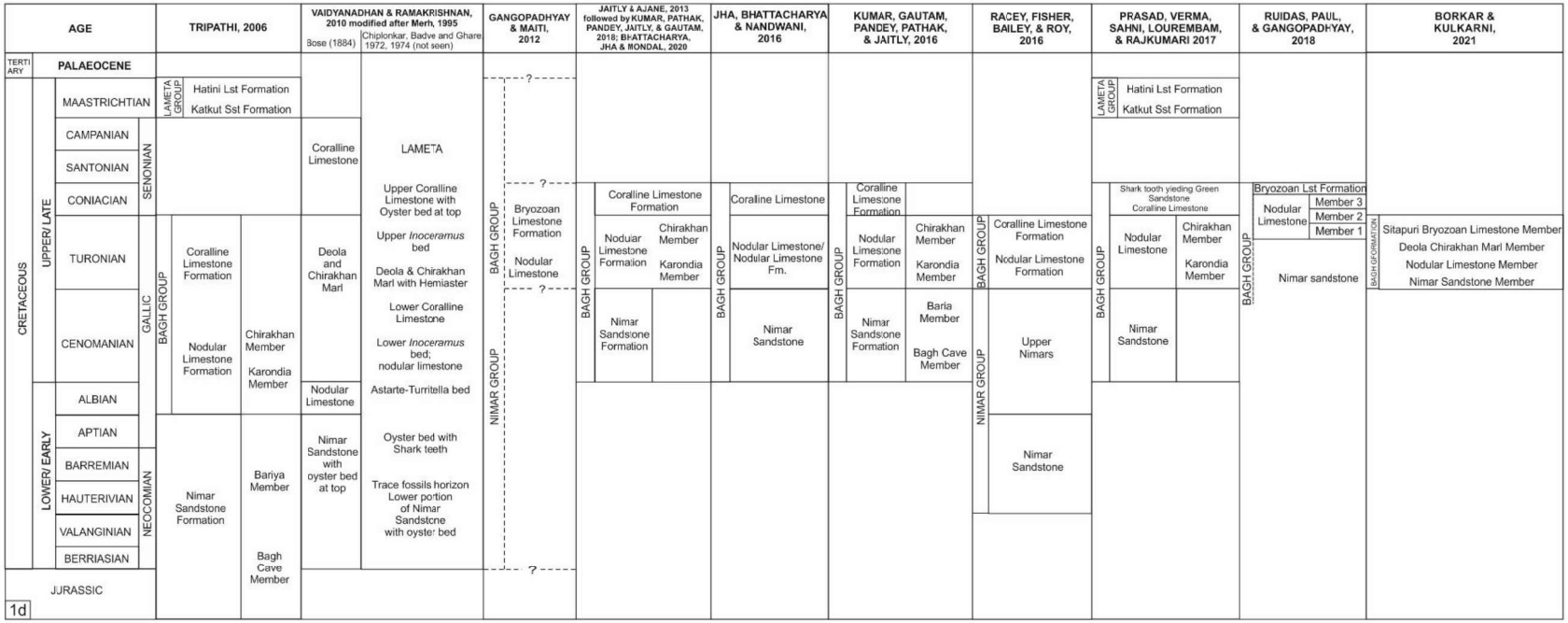


Table 3.1 Correlation of the lithostratigraphic units proposed by different workers for the Cretaceous sequence of the Lower Narmada Valley.

Recently, Borkar and Kulkarni (2021) revised the lithostratigraphy of the upper Bagh Group, and the Corallinc Limcstonc Mcmbcr was rcplaccd by Sitapuri Bryozoan Limcstonc (Member) considering the composition of the rocks (Table 3.1d).

3.1.3 LITHOSTRATIGRAPHY OF WLNV

Poddar (1964) has treated the Bagh Group rocks exposed in the WLNV and ELNV separately and revised the lithostratigraphy of the Bagh Group rocks. The WLNV sequence was divided into Songir Group and Navagam Group. The Songir Group was assigned Jurassic to Lower Aptian age and was further subdivided into Songir Sandstone and Uchad Flagstone. The Navagam Group was subdivided into Bilthana Oyster Bed, Navagam Limestone, and Gulvani Limestone (Table 3.1a). The age of the Navagam Group was bracketed between Middle Aptian to Turonian. The WLNV and ELNV sequence was considered to be contemporaneous. However, the studies lacked a description of the unit, age, depositional environment, assignment of stratotype, boundaries, justification for renaming the old nomenclature, and erecting the new units. The proposed units invalidate the ICSN norms for nomenclature and erection of new units.

Sastry and Mamgain (1971) divided the Cretaceous deposits of the WLNV into Nimar Sandstone with plant fossils, Calcareous Sandstone, Upper Nimar with Oyster, and shark teeth, Oyster Bed with *Coilopoceras* and *Proplacenticeras* and Rajpipla Limestone. The authors divided the lower siliciclastic unit into Nimar Sandstone and Calcareous Sandstone Upper Nimar in the WLNV (Table 3.1b). The Oyster bed and Rajpipla Limestone were considered to be Santonian-Campanian in age. However, Chiplonkar et al. (1977a) have strongly criticized the placement of the two units at a much higher stratigraphic level and the separation of the Oyster Bed from the Calcareous Sandstone.

Dassarma and Sinha (1975) followed the lithostratigraphy of Sastry and Mamgain (1971) and separated the Bagh Group into eastern and western parts. The basal unit, namely Nimar Sandstone, was considered a separate unit, and the Bagh Beds was divided into Calcareous sandstone (Upper Nimars), Oyster Bed, and Rajpipla Limestone (Table 3.1b) however, the ages of the lithounits were revised based on the collection of bivalves, gastropods, ammonites, echinoids, and fish remains.

3.2 SUMMARY

The Cretaceous Bagh Group rocks have been classified by several authors using variable names for the same unit or the same name for different units leading to synonymy and homonymy, which in turn complicates the correlation process. Same units with different names are proposed based on the local lithological variations observed, and thus several units are inadequately established. In addition, the lithostratigraphic classifications are published in field guides, conference volumes, reports lacking availability, and publication in a scientific medium which has led to the proposal of more classification schemes. Considerable debate continues till date over the validity of some lithostratigraphic units (Deola-Chirakhan Marl of Bose (1884); the Lower Coralline Limestone and the Upper Coralline Limestone of Rode and Chiplonkar (1935) and Pal (1970); the Nimar Group and the Bagh Group of Murty et al. (1963), Poddar (1964), Biswas and Deshpande (1983) and Gangopadhyay and Maiti (2012); the Navagam Group and the Navagam Limestone, the Songir Group and the Songir Sandstone of Poddar (1964); the Ajantar Bryozoan Limestone, the Cave Nodular Limestone, the Mohanpura Marl, the Deola Marl and the Barwaha Bryozoan Limestone of Pal (1971); the Karondia Limestone of Guha (1976); the Sejagaon Limestone (Murty et al., 1963; Poddar, 1964); the Bryozoan Limestone Formation of Gangopadhyay and Maiti (2012)).

In ELNV, the basal non-marine sandstone unit, Nimar Group, is separated from the overlying marine unit, Bagh Group (Murty et al., 1963; Poddar, 1964; Biswas and Deshpande, 1983; Gangopadhyay and Maiti, 2012; Racey et al., 2016), similarly it is referred as Songir Group and the Navagam Group in the WLNV (Poddar, 1964; Biswas and Deshpande, 1983) (Table 3.1). However, the usage of the same name for units and their subunits (Nimar Formation in the Nimar Group and the Navagam Formation in the Navagam Group) in the lithostratigraphic schemes by Poddar (1964) and Biswas and Deshpande (1983) invalidates the stratigraphic norms. The earlier studies lack the assignment of formal units to the upper and lower part of the Nimar Group/Formation. Moreover, based on conformable contact of the basal siliciclastic-dominated unit (Nimar Sandstone) with the overlying carbonate-dominated unit, Bose (1884) and Chiplonkar (1983) argued against their separation into different groups. Also, informal stratigraphic names were used for the Bagh Group sequence based on the local lithic characteristics and were described as different groups and formations by various workers (Table 3.1). The locally proposed names complicate the correlation process; for example, the Nodular Limestone is described as Navagam Limestone,

Gulvani Limestone, and Rajpipla Limestone at an even higher stratigraphic level are coeval. Moreover, the lithostratigraphic units overlying the Nodular Limestone in WLNV have a distinct lithological composition compared to the coeval Coralline Limestone in ELNV and have been overlooked until now. Most of the classifications proposed for the Cretaceous sequence of WLNV lacked appraisal of the lateral lithological variation. Some authors who worked in the eastern and western parts of the basin have proposed a separate lithostratigraphic classification. However, a review of the lithostratigraphic classification in the WLNV revealed a lack of assignment of stratotypes to the units and a large number of informal units. To resolve the long-standing controversy of nomenclature of the units, amended lithostratigraphy of the Bagh Group sedimentary succession of Western Lower Narmada Valley was proposed by Shitole et al. in 2021 following the standard stratigraphic norms of the International Subcommission on Stratigraphic Classification (ISSC) and is dealt in the next chapter.