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AMMONITE ZONATION OF THE JURASSIC ROCKS OF THE GANGTA BET AREA, WAGAD REGION, EASTERN KACHCHH, INDIA

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ABSTRACT

Gangta Bet, a structurally controlled elliptical dome, occurs as small detached landmass situated on the western fringe of Wagad highland and comprises thick marine clastic and non-clastic sequence of the Upper-Middle Jurassic period. It comprises 103 meter thick exposed sequence, which consists of various types of sandstones, shale, conglomerate, and limestone. Top part of the sequence is composed of abundant ammonitic fauna; the intercalated calcareous sandstone-shale consists of *Peltoceras athleta, Peltoceratoides semirugosum;* the Gangta ammonite band, a limestone unit, occurs near the top of the sequence as an important marker horizon and consists of *Mayaites (mayaites) maya, Mayaites* sp. *Perisphinctes (Arisphinctes) helenae, Perisphinctes (kranosphinctes) kranaus Perisphinctes (Dichotomosphinctes)* and *Perisphinctes* sp., belonging to super family Stephanocerataceae and Perisphinctaceae. The ammonite species of Gangta Bet display three Biozones and five subzones which indicate that the age of the Gangta Bet rocks ranges from Late Callovian to Early Middle Oxfordian.

Keywords: Ammonite, biostratigraphy, Late Callovian to Early Oxfordian, Gangta Bet, Wagad region, Eastern Kachchh, India

INTRODUCTION

Wagad region is a most conspicuous highland area in the eastern part of Kachchh Mainland and comprises a thick sequence of Mesozoic and Cenozoic sediments. Attempts have been made by various workers to develop biostratigraphic zonation of the Jurassic of Kachchh. Many of them confined their studies only to the section exposed at Jumara dome, the so called type section of the Chari Formation. Waagen (1876), the proponent of the original four-fold rock-stratigraphic divisions, divided the Jurassic of Kachchh into eight biostratigraphic units. His 'Patcham Group' includes only one unit, 'Chari Group' four units, 'Katrol Group' two units and 'Umia Group' one unit. He mentioned that these units had their own ammonite taxa. As such, they are virtually assemblage zones according to modern concept. Later, Spath (1933) introduced sixteen biostratigraphic divisions within the Mesozoic of Kachchh. Biswas (1977) proposed a lithostratigraphic classification of Kachchh and recognized a number of stratotypes. The present study is mainly concerned with biostratigraphy and the authors prefer to use the classification of Biswas (1977). Recently, Agrawal and Pandey (1985) made a detailed biostratigraphic study of the rocks of Gora Dongar in Patcham Island; it was followed by work on Keera dome by Bardhan and Datta (1987), on Jara dome by Kanjilal and Prasad (1992) and on Keera and Jara Domes of the western mainland Kachchh by Prasad (1998).

Gangta Bet occurs between the island belt and Wagad highland, between N 23°46' and N 23°43' longitude, E 70°30' and 70°33' latitude (Fig.1).The purpose of the present work is to study the ammonite fauna for biozonation of the Gangta Bet sequence and to correlate with the zones of the neighbouring area (Mainland Kachchh).

GEOLOGICAL SETTING

The Khadir Formation (Biswas 1977), which is divided into five ascending members: (1) Cheriya Bet Conglomerate Member, (2) Hadibhadang Shale Member, (3) Hadibhadang Sandstone Member, (4) Gadhada Sandstone Member and (5) Bambhanka/ Gangta Member. The Gangta Member is the youngest member of the Khadir Formation and is considered as equivalent to the Bambhanka Member. The rocks of the Bambhanka Member are more argillaceous and exposed at the Bambhanka, Kakindia bet, Karabir and Gorabir, south of the Khadir Island. The rocks of the Gangta Member is well exposed in Gangta bet, the western part of the Wagad Highland and considered to be the type section of the topmost unit of the Khadir Formation (Biswas, 1977).

The stratigraphic sequence of the study area consists of the topmost member of the Khadir Formation, i.e. Gangta Member, which is mainly exposed in the Gangta Bet area of eastern Kachchh. It comprises 103 m thick fining upward sequence of ferruginous sandstone-shale intercalations at the base and intercalated calcareous sandstone shale in the middle and capped by the fossiliferous ammonite rich limestone shale sequence (Fig.2). At places, the sandstone grades into intraformational conglomerate which contains flat pebbles of mud and balls of sandstones. The Gangta ammonite band is an important marker near the top of this sequence. A thin ferruginous conglomerate containing ammonite and fossil wood occurs at the top of the formation.

BIOCHRONOLOGY

The rapid evolution, pelagic habit and the near worldwide distribution of many species of the ammonites make it one of the most important index fossils for the biochronological dating. Biochronozones, the standard zones, create a standard reference for temporal correlation within a given region (Collomon, 1984; Smith *et al.,* 1988). The collection of the zonal index species is not required to indicate the presence of a zone; instead, it can be recognized by a specific assemblage of temporally restricted species (Smith *et al.,* 1988; Clapham *et al.,* 2002). The comparison of local biostratigraphic successions with the biochronological standard (e.g. a zonation) allows not only to assign relative ages to rocks, but also to estimate

the extent of stratigraphic gaps (Remane, 2003). The regional zonation for the Kachchh area erected by Krishna (1984, 1991) and Prasad (1998) is adopted in the present study.

DISTRIBUTION OF AMMONITES

The present study reported seven species of ammonites which belong to superfamily Stephanocerataceae and Perisphinctaceae. The bulk of the material comes from the 12m thick limestone shale sequence of the Gangta Member which includes *Mayaites (mayaites) maya, Mayaites* sp. *Perisphinctes Arisphinctes helenae, Perisphinctes kranosphinctes kranaus Perisphinctes Dichotomosphinctes, Perisphinctes* sp. and intercalated calcareous sandstone–shale sequence consists of *Peltoceras athleta, Peltoceratoides semirugosum* (Pl. I). Range chart of ammonite species (Table 1) of the Gangta Bet sequence shows three biozones and five subzones. Well-differentiated boundary may be observed while considering ranges of the genera.

AMMONITE BIOZONATION

Comprehensive work on the systematics of the Jurassic ammonites of Kachchh was done by Waagen (1873-75) and Spath (1928-33). They subdivided the Jurassic sediments on the basis of lithology and contained fauna. They also attempted the correlation of the Jurassic of Kachchh with the European Jurassic. However, later work showed that neither the subdivision of Jurassic nor the correlation suggested by them between the Mesozoic sediments of the Mainland Kachchh, Island belt and the Wagad region is tenable. Table 1 provides a lithostratigraphic division of Middle and Late Jurassic sediments of Kachchh (Biswas, 1977). Biostratigraphically, the Middle-Late Jurassic rocks are classified into three major assemblage zones (Krishna, 1984, 1991 and Prasad 1998). The Gangta Bet sequence represents three ammonite assemblage zones that include: 1. Helena Assemblage Zone 2. Maya Assemblage Zone and 3. Athleta Assemblage Zone.

In a few cases, the zonal name is repeated for the subzonal level as well. This is because of the richness of diagnostic fossil species at a particular stratigraphic level and the difficulty of any other marker form for the subzonal nomenclature.

Athleta Assemblage Zone (Late Callovian)

Athleta Assemblage Zone was named by Krishna (1984). It is characterized by sudden appearance and frequent occurrence of *Peltoceras (Peltoceras) athleta* (Phillips) (Pl. I, fig.1), which was first authentically recorded from Jara by Prasad and Kanjilal (1985). Athleta Assemblage Zone is well exposed in Jara dome. Majority of peltoceratins are restricted to this zone with rare occurrence of *Peltoceras* in Early Oxfordian bed of Gangta.

Maya Assemblage Zone (Early to Middle Oxfordian)

It is characterized by the first appearance of the subfamily Mayatinae and extinction of families Pachyceratidae and Strigoceratidae, and subfamilies Macrocephalitinae and Reineckeinae. However, the subfamily Peltoceratinae with its reduced strength continues up to Maya Assemblage zone. The characteristic genera/subgenera of this zone are *Mayaites* (*mayaites*) *maya* (Pl. I, fig.5), *Mayaites* sp. (Pl. I, fig.6) and *Peltoceratoides semirugosum.* The *Maya* Assemblage Zone can be divided into two distinct subzones viz., Semirugosus and Maya Subzones in ascending order.

Semirugosus Subzone (Early Oxfordian)

Peltoceratoides (*Peltoceratoides*) *semirugosus* (Pl. I, fig.3) is the characteristic and frequently occurring species of this

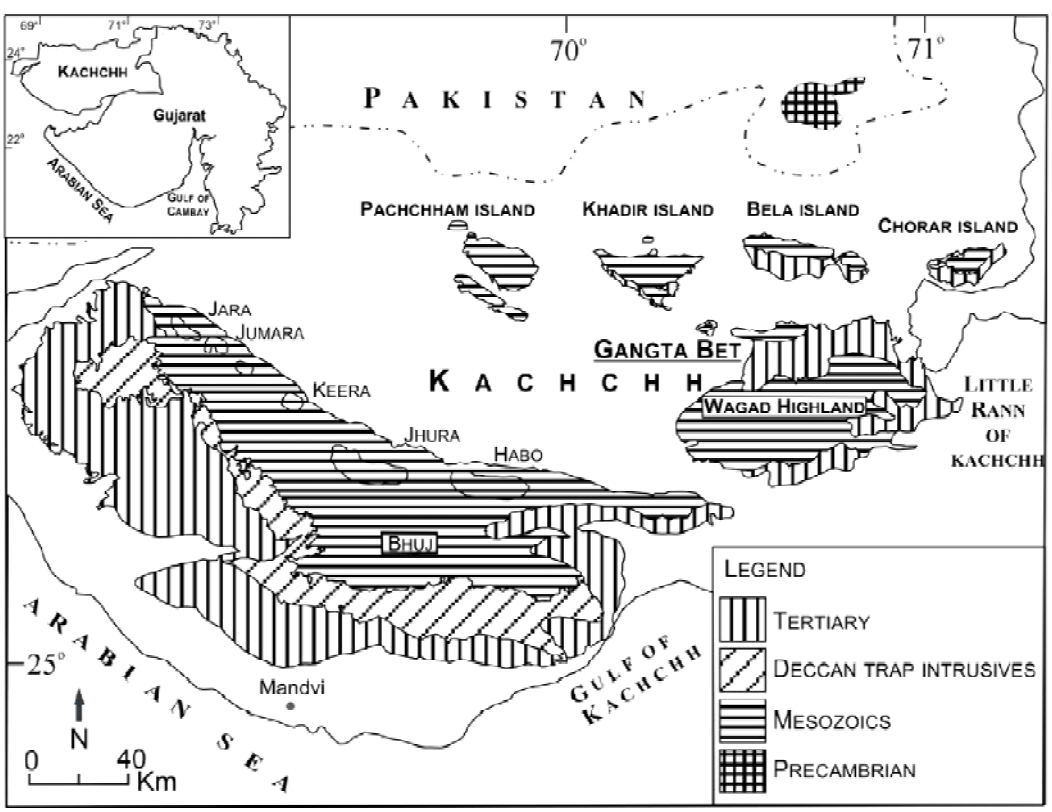
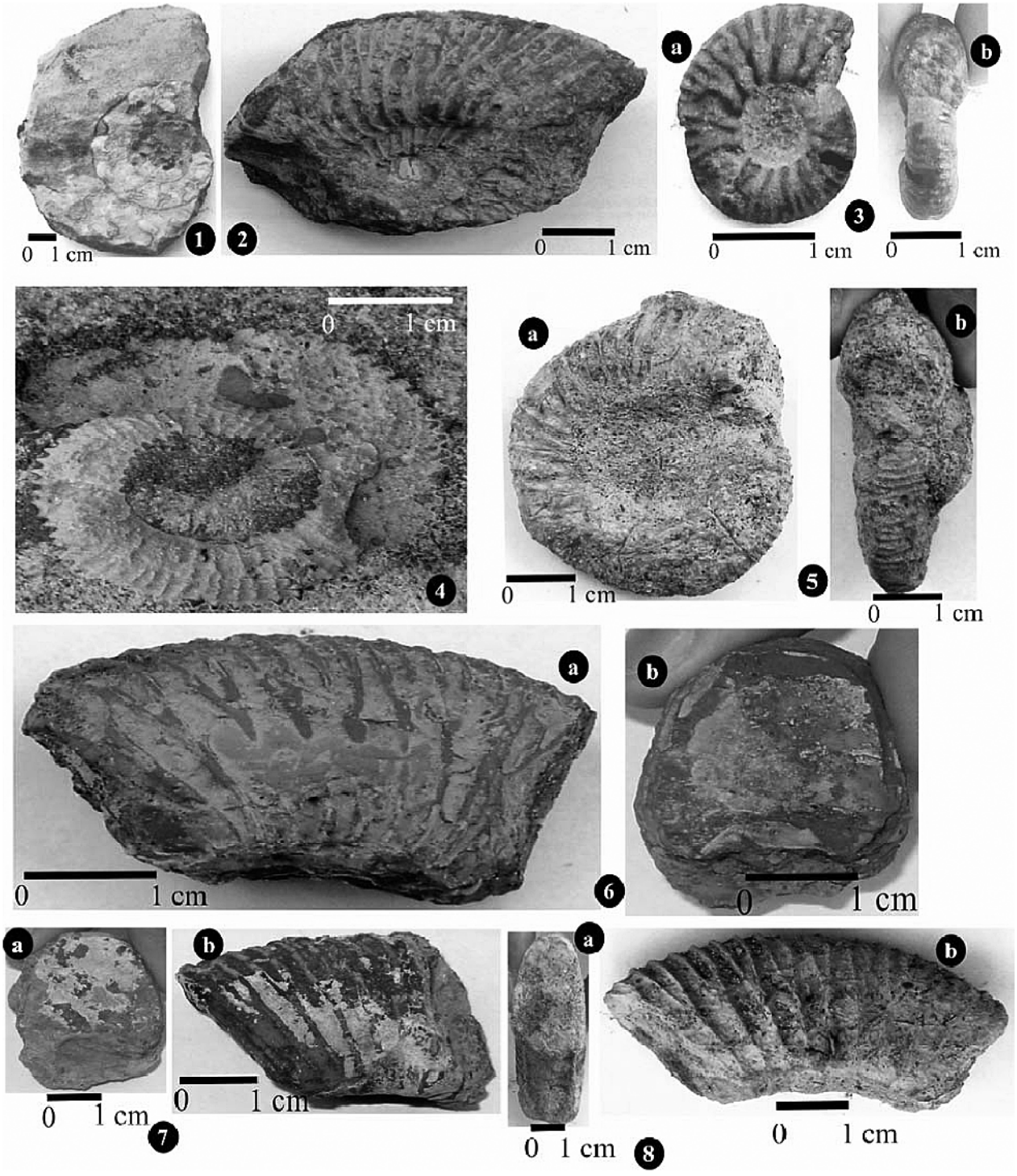


Fig. 1. Location map of the study area.

Plate I



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EXPLANATION OF PLATE I

1. ***Peltoceras athleta,*** Evolute, equatorial section shows large body chamber, tubercles are present in the inner whorl, represent wavy outline. Incomplete material.

2. ***Perisphinctes (Dichotomosphinctes*)**, Evolute, strongly compressed, bifurcation of ribs near the mid outer part of the chamber. Incomplete material.

3. ***Perisphinctes*** sp., (a) umbilicus view and (b) apertural view, strongly compressed and evolute nature.

4. ***Peltoceratoides semirugosum,*** Evolute, compressed nature, ribs originated from the umbilical edge, giant outer whorls gradually become bituberculate.

5. ***Mayaites (mayaites) maya***, Shell compressed and evolute; a) lateral view b) apertural view Whorl section rounded.

6. ***Mayaites*** sp., Strongly involute and compressed nature; triangular to somewhat elliptical whorl section. Incomplete material.

7. ***Perisphinctes (kranosphinctes) kranaus,*** Evolute, whorl section triangular to elliptical (a). Ribs present and bifurcate above the two third of the chamber height (b). Incomplete material,

8. ***Perisphinctes (Arisphinctes) helenae*,** compressed in nature. Whorl section elliptical to triangular (a), moderately spaced ribs originated from the umbilical wall (b). Incomplete material.

subzone and *Mayaites* very rare in this subzone. It represents Early Oxfordian age for the rocks.

Maya Subzone (Middle Oxfordian)

The Semirugosus Subzone is overlain by Maya Subzone. It is enriched in *Mayaites* (*mayaites*) *maya* which makes its appearance at the top of Semirugosus Subzone and goes up to the Kranaus Subzone with much reduced frequency. *Mayaites (mayaites) maya* has maximum frequency of distribution in Maya Subzone, which is considered to be of Middle Oxfordian age.

Helenae Assemblage Zone (late Middle Oxfordian)

Helenae Assemblage Zone constitutes the youngest biostratigraphic unit and occurs over Maya Subzone. The evolute genera and subgenera like *Perisphinctes* (*Arisphinctes*) *helenae* (Pl.I, fig.8), *Perisphinctes* (*kranosphinctes*) *kranaus* (Pl.I, fig.7), *Perisphinctes* (*Dichotomosphinctes*) (Pl. I, fig. 2) and *Perisphinctes* sp. (Pl.I,fig.4) frequently occur in this assemblage zone. It covers 3-5 m thick part of brown oolitic algal limestone. It has been subdivided into two subzones viz., Helenae and Kranaus.

Helenae Subzone

The subzone is characterized by *Perisphinctes* (*Arisphinctes*) *helenae* Spath, 1933. The other forms noticed within this subzone is *P.* (*Dichotomosphinctes*) aff. *Virgulatum*.

Kranaus Subzone

This is the youngest biostratigraphic unit of the Gangta Bet succession. It characteristically consists of species *Perisphinctes (Karanaosphinctes) kranaus,* but it is associated with other species of *Perisphinctes*.

Sometimes, it is very difficult to separate the two subzones of Helenae Assemblage zone from each other due to highly weathered nature of the limestone–shale sequence of the Gangta Member.

DISCUSSION

Athleta Assemblage Zone, from which *P. athleta* was first recorded by Prasad and Kanjilal (1985), is assigned to Late Callovian. This zone is equivalent to Athleta bed of Waagen

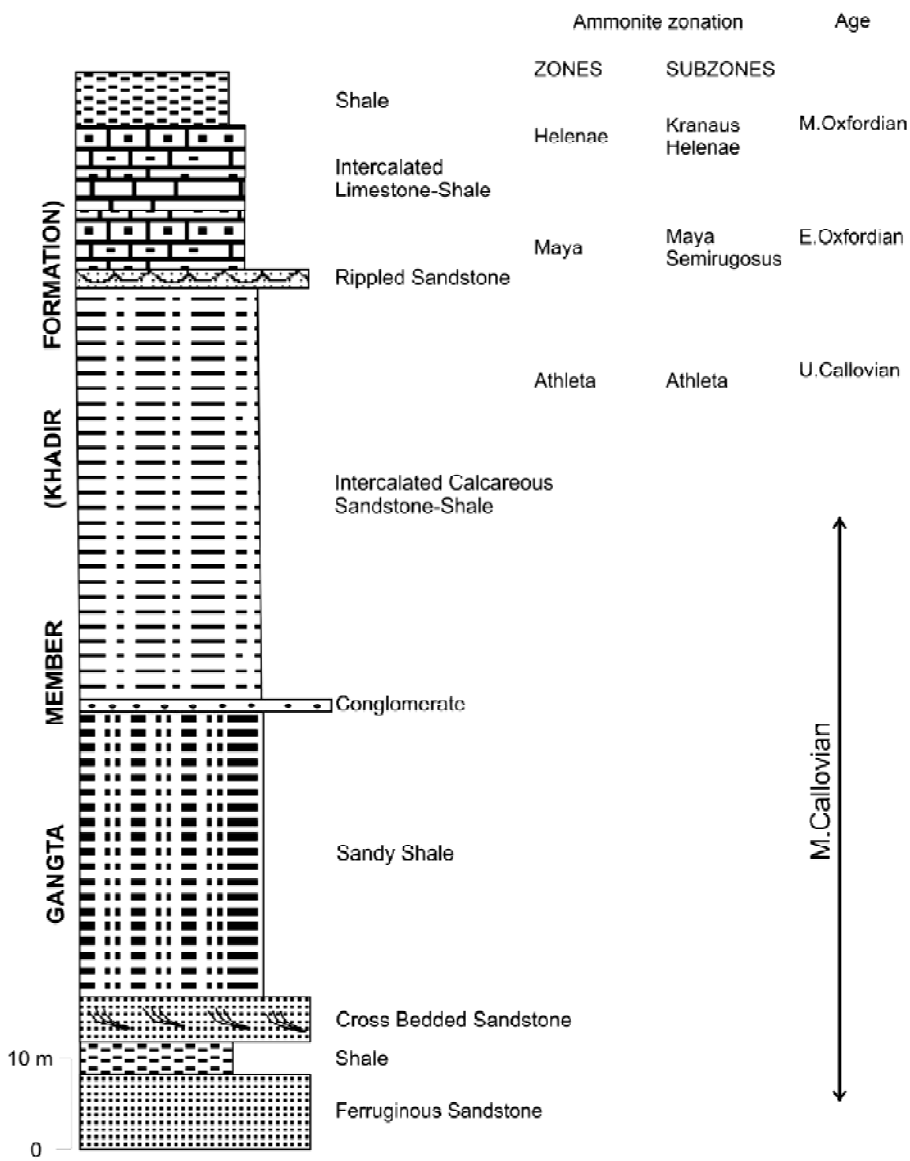

Fig. 2. Lithocolumn showing ammonite zonation of the Gangta Bet sequence.

Table 1. Biochronostratigraphic chart shows the ammonite zones and their correlation with those of the Mainland Kachchh.

Ages		Mainland Kachchh				Gangta Bet (Present study)	
		Lithostratigraphy (Biswas, 1977)	(Prasad, 1998) Ammonite zones	Ammonite subzones		Ammonite zones	Ammonite subzones
Middle Oxfordian	L	JUMARA FORMATION: Dhosa Oolite Member	HELENAE	Kranaus		HELENAE	Kranaus
	M			Helenae			Helenae
	E		MAYA	Maya		MAYA	Maya
Early Oxfordian				Semirugosus			Semirugosus
Late Callovian	L	JUMARA FORMATION: Ridge Sandstone Member	ATHLETA	Lalandeanum		ATHLETA	Athleta
	E			Athleta			
				Kleidos			
Middle Callovian	L		ANCEPS	Singulare			
	M			Lucyclum			
	L			Anceps			

(1873), Lower and Upper Athleta beds of Spath (1933) and Athleta and unnamed zone of Krishna (1984). Maya and Helenae Assemblage Zones are proposed for the first time to represent the sequences of Early and Middle Oxfordian (Gygi, 1977, 1990) in Kachchh. The Maya assemblage zone has been divided into two subzones viz., Semirugosus and Maya in ascending order. The Semirugosus Subzone represents Early Oxfordian and the Maya Subzone the early Middle Oxfordian. The Semirugosus Subzone can be correlated with Semirugosus Zone of Krishna (1984). The Helenae and Kranaus subzones of Helenae Assemblage zone indicate the late Middle Oxfordian age.

The ammonite species of Gangta Bet represent three biozones and five subzones which indicate that the age of the rocks of Gangta Bet is Late Callovian to Early Middle Oxfordian. A 60 m thick sequence (Fig.2) below the first ammonite species (*P. athleta*) may be extendable to the Middle Callovian age and is equivalent to the Ridge Sandstone Member (Biswas, 1977) of the Mainland Kachchh.

CONCLUSIONS

The Gangta Bet succession of eastern Kachchh has been investigated for their ammonite fauna and following important observations are made.

1. The lithocolumn of Gangta Bet comprises +103 m thick succession of marine, clastic and non-clastic sediments and the top of the sequence consists of abundant ammonites.
2. The well-differentiated boundary is observed while considering the ranges of individual genera; three assemblage zones and five subzones have been established viz., Athleta zone (Early Late Callovian), Maya zone - Semirugosus subzone (Early Oxfordian) and Maya subzone (Middle Oxfordian) and *Helenae* zone - Helenae and Kranaus subzones. (Early Middle Oxfordian).
3. The lower part of the sequence of the Gangta Bet Member is equivalent to the Ridge Sandstone Member and the upper part of the sequence is equivalent to the Dhosa Oolite Member of the Jumara Formation of the Mainland Kachchh.
4. Ammonite fossils of Gangta Bet indicate Middle Callovian to Middle Oxfordian (Upper Jurassic) age for the Gangta Shale Member.

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