

The Callovian Ammonoid Chronology in Kachchh (India)

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Abstract : The Callovian ammonoid succession is investigated in its best Kachchh development, the Keera section. The ca 210 m thick column, constituting the major part of the Chari Formation and characterised by frequent transgressive condensed/starved pebbly/nodular levels of the para/mini 4th to 6th order depositional sequences, is differentiated into 390 beds of which over 150 yield ammonoids. The succession is dominated by the Macrocephalitinae and the endemic Indo - East-African Eucycloceratinae and Kinkeliniceratinae (nov. subfamily for the Indo - East-African proplanulitins) together with the accessory Pseudoperisphinctinae, Reineckeinae, Peltoceratinae, Hecticoceratinae etc. The proposed scheme includes 7 zones, 13 subzones and 25 horizons with possible applicability to the entire Indo - East-African province from East Africa in the west to the Indian subcontinent in the east.

The accessory elements common to both the Tethyan margins permit precise correlation at subzonal level within the Tethys. Significant faunal changes are observed across the Chrysoolithicus/Semilaevis zonal, Ramosa/Kleidos, Pseudorion/Depressum and Athleta/Ponderosum subzonal/zonal boundaries which are interpreted as 3rd order sequence boundaries. The Lower/Middle Callovian boundary is marked by overlap of Reineckeia anceps and Subkossmatia ramosa, and the Middle/Upper Callovian boundary by the first Peltoceras athleta in association with Orionoides pseudorion.

INTRODUCTION

The Jurassic ammonoids of Kachchh (India) have been long known through the early works of Sowerby [1], Waagen [2] and Spath [3], which, however, invariably lacked precise stratigraphic information on the taxa described and discussed. In recent years there has been considerable revival of interest in the Kachchh Jurassic ammonoids, specially, of Lower Callovian interval [4-13]. The Keera area is the stratotype of Chari Formation. It is one of several isolated block-faulted and domally uplifted Jurassic domes in the Kachchh Mainland (Fig. 1), about 70 km north-east of Bhuj, bounded by longitudes 69 14 15" to 69 14 33" E and latitudes 23 35 13" to 23 35 5" N. The Chari Formation is well exposed in an elliptical outcrop with Dhosa Oolite as its youngest Member.

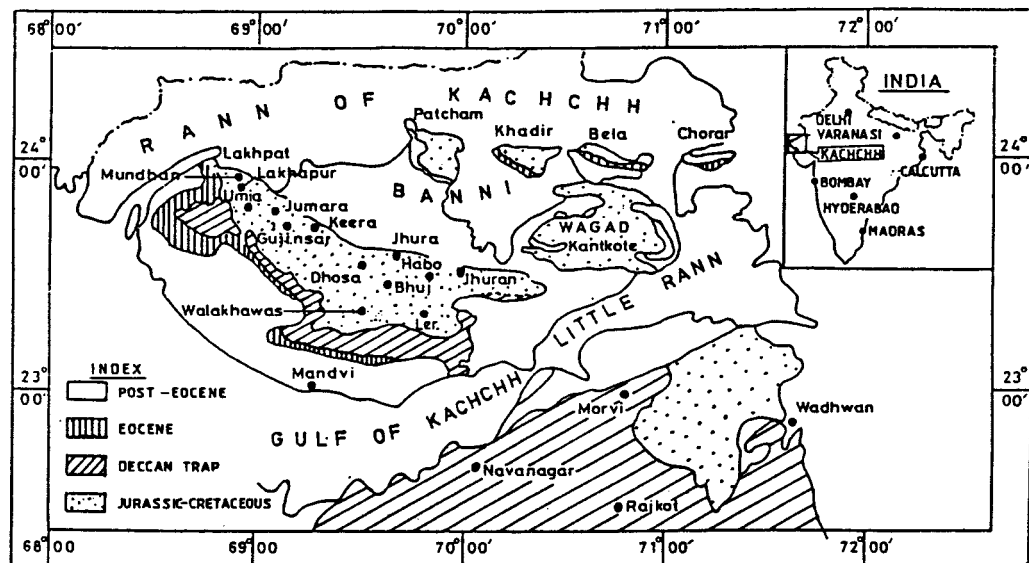


Fig. 1. The simplified geological map of Kachchh with Keera and other Jurassic localities.

LITHOSTRATIGRAPHIC FRAMEWORK

A summary of the Callovian sedimentary succession (from base to top) belonging to the Chari Formation is given below, and the vertical ranges of the ammonoid taxa are indicated in Figs. 2 to 5 :-

Sediment Interval 0 (beds 1 to 32, 15 m) : Alternation of limestones, ferruginous calcareous sandstones and shales, scarcely fossiliferous.

Sediment Interval I (beds 33 to 92, 55 m) : Golden oolitic limestones intercalated with shales, highly fossiliferous.

Sediment Interval II (beds 93 to 118, 25.59 m) : Alternation of variegated limestones and gypseous shales.

Sediment Interval III (beds 119 to 130, 6.60 m) : Alternation of variegated soft muddy oolitic limestones and shales/siltstones, highly fossiliferous.

Sediment Interval IV (beds 131 to 160, 5 m) : Alternation of white marly/pebbly bands and shales or maroon fractured marly bands and shales, highly fossiliferous.

Sediment Interval V (beds 161 to 192, 25 m) : Variegated hard jointed pebbly calcareous sandstones intercalated with shales/siltstones, highly fossiliferous.

Sediment Interval VI (beds 193 to 278, 45.5 m) : Variegated fractured marly to pebbly hard bands capped by shelly limestones, intercalated with gypsaceous shales, highly fossiliferous.

Sediment Interval VII (beds 279 to 334, 15.4 m) : Maroon to white pebbly fractured bands intercalated with shales, highly fossiliferous.

Sediment Interval VIII (beds 335 to 336, 0.37 m) : Whitish maroon limestone intercalated with yellowish brown shale, highly fossiliferous.

Sediment Interval IX (beds 337 to 390, 15.5 m) : White to maroon marly to pebbly somewhat fractured shelly bands alternating with shales, highly fossiliferous.

AMMONOID CHRONOLOGY (Figs. 2 to 5)

Whereas the Kachchh Callovian ammonoid assemblages are by and large dominated by endemic Indo - East-African elements, the minor/accessory elements common with Europe permit precise correlations at least at the subzonal level within the Tethys. The zonal boundaries are marked mostly by first appearances yet sometimes also by the acme or abundance of the species. The individual zones are otherwise characterised by their assemblages as a whole. The zones have been named after a characteristic and commonly present species appearing at the base or otherwise significant in the zone. The ammonoid zones, subzones and horizons are initially developed as biostratigraphic units. It is emphasized that once the ammonoid zonal boundaries are confirmed as time boundaries through intrabasinal and long distance correlation, these ammonoid based biostratigraphic units have been also formalised as chronostratigraphic units. Horizons are considered as the smallest bio/chronostratigraphic units. Many taxa of the Kachchh subzones and even horizons are present elsewhere in the Indo - East-African province cf. Madagascar. The proposed scheme is considerably refined, yet remains tentative. It is based on the first bed by bed collection of ammonoids, and includes 7 zones, 13 subzones and 25 horizons, of which 2 zones, 7 subzones and all the 25 horizons are new. A significant feature of the study is the high number of beds which yield ammonoids. The ammonoid clades are found geographically restricted lineages as under :-

Macrocephalitinae lineage : Macrocephalites madagascariensis - M. transitorius - M. chrysoolithicus - M. diadematus in the major part of the Lower Callovian up to Diadematus Subzone.

Eucycloceratinae lineage : Macrocephalites formosus - M. semilaevis - Eucycloceras eucyclum/Subkossmatia opis - S. ramosa from Formosus Subzone to Ramosa Subzone and

Kinkeliniceratinae lineage : Kinkeliniceras kleidos - K. paramorphum - Kinkeliniceras (Obtusicoelites) obtusicoelita - K. catillus - K. depressum in the major part of Middle and Upper Callovian from Kleidos Subzone to Depressum Subzone.

ZONES, SUBZONES AND HORIZONS

Lower Callovian :

This interval includes 3 zones, 6 subzones and 12 horizons as under :-

Madagascariensis Zone Krishna and Cariou 1990 : Used first as assemblage by Krishna and Westermann 1987 and formalised later as a zone in Krishna and Cariou 1990. It is characterised by the dominance of the zonal index M. madagascariensis Lem. M with the exclusion of M. transitorius (Spath) M.

M-I Horizon (beds 1 to 17) : It is indicated by scarce yet near exclusive Macrocephalites in Keera e.g. M. cf. madagascariensis Lem. M, M. cf. triangularis Spath M, and M. gr. gibbosus/indicus (Spath) M, the last species with thick, blunt and sparser primaries.

M-II Horizon (beds 18 to 35) : It is indicated by the first M. madagascariensis Lem. morph I exclusive of the morph II of the species. Rare compressed nucleii of M. cf. triangularis Spath M continue from below.

M-III Horizon (beds 36 to 41) : It is indicated by the first Choffatia gr. madani Spath M and Oxycerites sp. indet. M in association with M. madagascariensis Lem. M continuing from below. M. madagascariensis Lem. M, the nominal and the most significant species of the Madagascariensis Zone is considered morphologically very close to the European M. verus Buck. of the Kepleri Subzone, basal Herveyi Zone [14] and could be a coeval provincial subspecies, which in turn allows precise subzonal correlation.

Chrysoolithicus Zone Krishna and Cariou 1990: Used first as assemblage by Krishna and Westermann, 1987 and later formalised as a zone in Krishna and Cariou 1990, emended here. The base is defined by the first M. transitorius (Spath) M. and its possible dimorph M. habyensis (Spath) m. M. chrysoolithicus (Waagen) M is the dominant species in this zone along with its dimorph M. elephantinus (Sow.) m.

Transitorius Subzone : Its base is defined as for the zone. It includes two horizons.

C-I Horizon (beds 42 to 49) : It is indicated by the first transient morph I of M. transitorius (Spath) M while M. madagascariensis Lem. M continues.

C-II Horizon (beds 50, to 55) : It is characterised by Kheraicerias bullatus (d'Orb.) M and its successor smaller variant with the first Subgrossouvria gr. blakei Spath M. Choffatia aff. subbackeriae (d'Orb.) M is also present. The Kheraicerias provides good basis of correlation with Bullatus (uppermost part) and Prahequense Horizons of France [15-16].

(HAC ET AL. 1987)	STAGE	SUBMEDITERRANEAN PROVINCE (CARIOU ET AL. 1990)		KACHCHH (KRISHNA & OJHA 1994)			
		SUBSTAGE	GENES	HORIZONS	HORIZONS	SUBZONES	ZONES
152 Ma	UPPER	LAMBERTI		PAUCICOSTATUM	P-II	PONDEROSUM	ATHLETA
			LAMBERTI	LAMBERTI	P-I		
			PARLAMBERTI		A-III		
		FOCULUM	ATHLETOIDES	A-II	DEPRESSUM		
			SUBTENSE	A-I	PSEUDORION		
			MODULOSUM	O-III	CATILLUS		
		COLLOTIFORMIS	COLLOTIFORMIS	O-II	OBTUSICOSTA	OBTUSICOSTA	
			PIVETRAUI (ODYSSEUS)	O-I			
		TREBENSE	TREBENSE/ATHLETA	A-V	PARAMORPHUM	ANCEPS	
			LECKENBYI	A-IV			
		ROTA	PSEUDOPBTCERAS	A-III	KLEIDOS	ANCEPS	
			ROTA/REGULARE	A-I			
	LEUTHARDTI	WAAGENI	A-II	RAMOSA			
		LEUTHARDTI	A-I	EUCYCLUM/OPIS			
	BAYLEI	BAYLEI	S-III	SEMILAEVIS	SEMILAEVIS		
		VILLANTENSIS	S-II	FORMOSUS			
	TYRANNIFORMIS	RICHRI	S-I	DIADEMATUS	CHRYSOOLITHICUS		
		BLYENSIS	C-VI	CHRYSOOLITHICUS			
	STUEBELI	TURGIDUM	C-V	TRANSITORIUS	CHRYSOOLITHICUS		
		BANWENSE	C-IV				
	PATINA	KILIANI	C-III	MADAGASCARIENSIS	MADAGASCARIENSIS		
		BOGINWENSE	C-II				
	MICHALSKII	MICHALSKII	C-I				
LAUGIERI		M-III					
PICTAVA	TYRANNA (PICTAVA)	M-II					
	GROSSOUVREI (REHMANNI)	M-I					
FRANCOUENSE	FRANCOUENSE						
157 Ma	LOWER	BULLATUS	MOOREI				
			LEPTUS				
		FORCULUS					
		DEMARIAI					

Fig. 2 The correlation of the Kachchh Callovian Horizons with the Submediterranean

C-III Horizon (beds 56 to 57) : It is characterised by the first Indosphinctes. It is significant to note that the first Indosphinctes in France occurs in Laugier Horizon, permitting correlation of the respective horizons of Kachchh and France.

Chrysoolithicus Subzone Krishna and Cariou 1990 emend. : Its base is defined by the first M. chrysoolithicus (Waagen) M along with its dimorph M. elephantinus (Sow.) m. It includes two horizons.

C-IV Horizon (beds 58 to 75) : It is marked by the presence of Indosphinctes errans Spath M.

C-V Horizon (beds 76 to 87) : It is marked by the presence of Hecticoceras chanaziense Par. and Bon. M common in the Michalskii Horizon of France for correlation. Choffatia cf. baluchistanensis (Noet.) M is also present.

Diadematus Subzone Krishna and Cariou 1990 : It is defined by significant M. diadematus (Waagen), and includes only one horizon.

C-VI Horizon (beds 88 to 91) : It is indicated by the last extremely inflated M. diadematus (Waagen) M. This horizon corresponds to the Subboreal Galillaeii Horizon near the top of the Koenigi Zone, which also includes similarly inflated Macrocephalites.

Semilaevis Zone Krishna and Cariou 1990 : Its base is defined by the first M. semilaevis (Waagen) M and acme of M. formosus (Sow.) M.

Formosus Subzone Krishna and Cariou 1990 emend. : Its base is defined as for the Semilaevis Zone. It includes just one horizon.

S-I Horizon (beds 92 to 95) : It is marked by the acme of M. formosus (Sow.) M and its dimorph M. subtrapezinus (Waagen) m together with M. chariensis (Waag.) M, the latter being exclusive to this Horizon. H. michalskii Lew. M provides correlation with Michalskii Horizon of France.

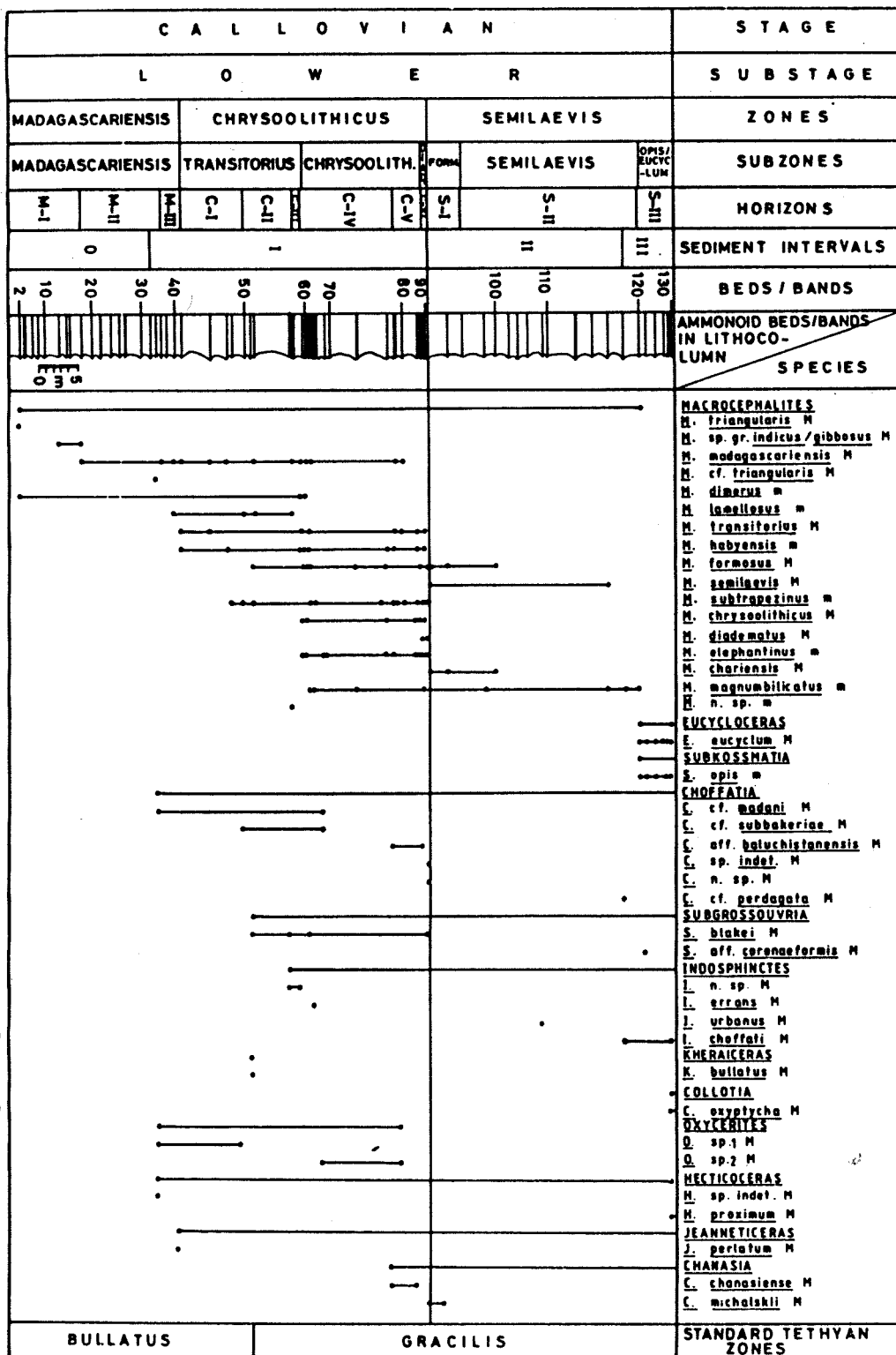
S-II Horizon (beds 96 to 119) : It is marked by near exclusive M. semilaevis (Waag.) M, I. urbanus Spath M and I. choffati Spath M, suggesting correlation with Michalskii and Proximum Horizons of France.

Opis/Eucyclum Subzone Krishna and Cariou 1990 emend. : It is characterised by Eucycloceras eucyclum (Waagen) M and Subkossmatia opis (Sow.) m, and includes only one horizon.

S-III Horizon (levels 120 to 131) : It is indicated by the abundance of Eucycloceras eucyclum (Waag.) M and Subkossmatia opis (Sow.) m. H. proximum Elmi M and Collotia oxyptycha (Neum.)

 Note : The origin of M. formosus (Sow.) M is here derived from M. madagascariensis Lem. M instead of M. gracilis (Spath) M as proposed earlier [8-9].

Fig. 3 The stratigraphic occurrence and ranges of the ammonoid species in the Lower Calloviaian of Keera.



M in common between Kachchh and France provide precise correlation of this horizon of Kachchh with Proximum Horizon of France.

Middle Callovian :

This interval includes 2 zones, 5 subzones and 8 horizons :-

Anceps Zone Opperl 1856-58 : It is indicated by significant R. anceps (Reinecke) M, while the endemic S. ramosa Spath M, Kinkeliniceras kleidos (Spath) M and K. paramorphum (Waagen) M are also significant.

Ramosa Subzone : It is characterised by S. ramosa Spath M with R. anceps (Reinecke) M, and includes one horizon.

A-I Horizon (beds 132 to 163) : It is defined by significant R. anceps (Reinecke) M, S. ramosa Spath M and single Chanasia hartmanni Zeiss M, the latter providing correlation with Bannense Horizon of France.

Kleidos Subzone : It is defined by the first Kinkeliniceras kleidos (Spath) M at the base, and includes one horizon.

A-II Horizon (beds 164 to 167) : It is characterised by the first Kinkeliniceras kleidos (Spath) M and Choffatia lateralis Spath M. I. aff. peregrinus Spath M is exclusive to this horizon.

The common I. cf. peregrinus Spath M suggests correlation of Kleidos Subzone with the Bannense and Medea Horizons of France.

Paramorphum Subzone : It is defined by the first K. paramorphum (Waagen) M at the base, and includes three horizons.

A-III Horizon (beds 168 to 175) : It is characterised by the first K. paramorphum (Waagen) M at the base. I. aff. indicus (Siemeradzki) M and I. calvus (Sow.) M are exclusive to this horizon.

A-IV Horizon (beds 176 to 193) : It is characterised by the last K. kleidos (Spath) M with the significant exclusion of Indosphinctes.

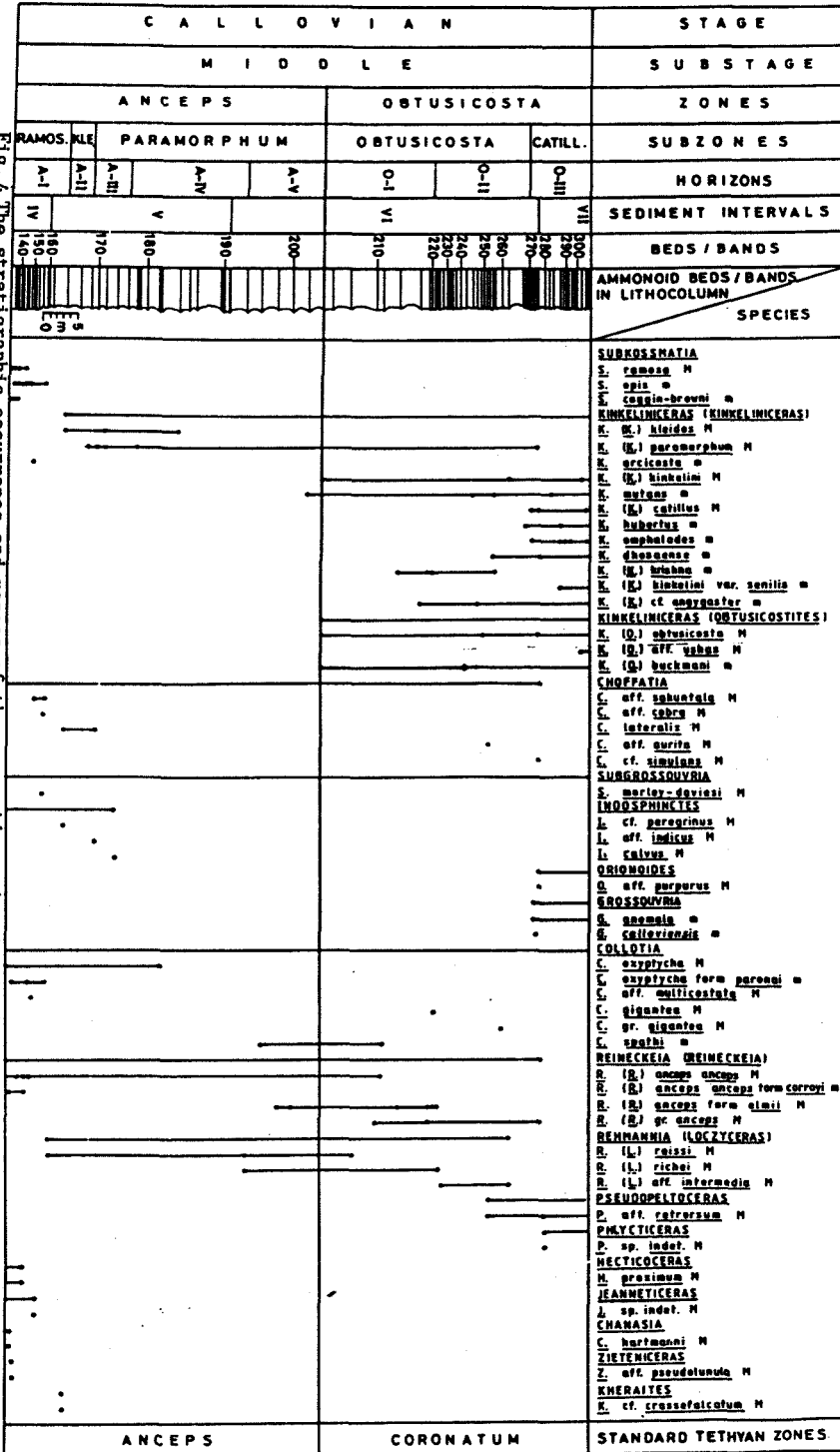
A-V Horizon (beds 194 to 203) : It is characterised by the first Reineckeia (Loczyceras) richei (Rom.) M and Collotia multicosta - spathi group, providing correlation with Jason Horizon of France.

The Paramorphum Subzone on the strength of common R. (L.) richei (Rom.) M and C. gr. multicosta - spathi correlates well with the Jason Subzone of France.

Obtusica Zone : It is defined by the first Kinkeliniceras (Obtusica) obtusica (Waagen) M, and includes two subzones.

Obtusica Subzone : The base is defined as for the Obtusica Zone. R. (L.) richei (Rom.) M is still present while Collotia

Fig. 4 The stratigraphic occurrence and ranges of the ammonoid species in the Middle Callovian of Keera.



gigantea Bourquin M marks its earliest occurrence. It includes two horizons.

0-I Horizon (beds 204 to 221) : It is indicated by the first K. obtusicosta (Waag.) M. R. (L.) richei (Rom.) M continues.

0-II Horizon (beds 222 to 269) : It is indicated by C. gigantea Bourquin M and R. (L.) intermedia (Bourq.) M, the latter being exclusive to this horizon.

Catillus Subzone : It is marked by first K. catillus (Waagen) M and Orionoides. It includes one horizon.

0-III Horizon (beds 270 to 307) : It is marked by the first K. catillus (Waagen) M and first Orionoides, providing correlation with Rota Horizon of France.

Upper Callovian :

This interval includes 2 zones, 2 subzones and 5 horizons :-

Athleta Zone Opperl 1856-58 : It is indicated by the first scarce Peltoceras through Peltoceras athleta (Phillips) M and first Orionoides pseudorion (Waagen) M at the base. Binatisphinctes is exclusive to this zone, while Poculisphinctes registers its first occurrence in this zone. The last Subgrossouvria occurs in this zone. It includes two subzones.

Pseudorion Subzone : Its base is defined as for the Athleta zone. It includes one horizon.

A-I Horizon (beds 308 to 331) : It is marked by the first P. athleta (Phillips) M and Q. pseudorion (Waagen) M. S. gr. gudjinsirensis Spath M is also significant.

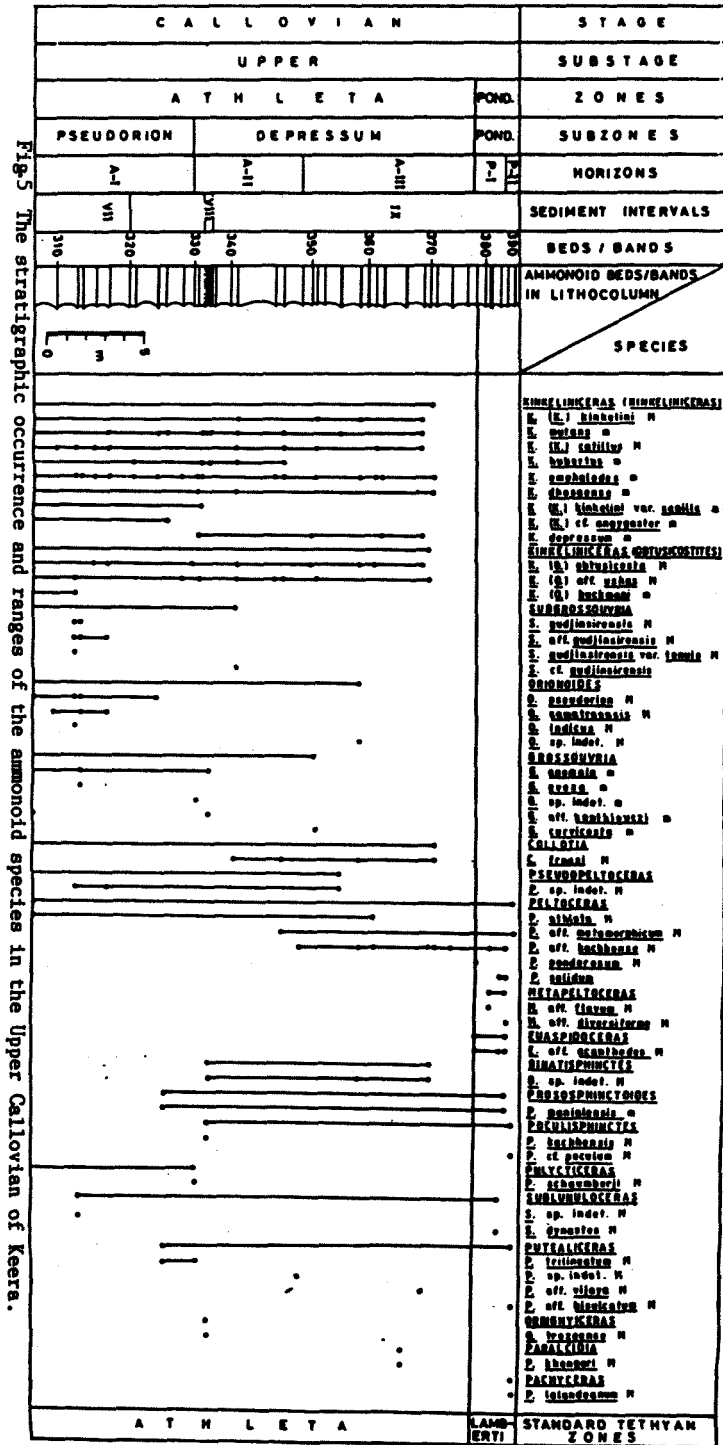
Depressum Subzone : Its base is defined by the first K. depressum (Spath) m. It includes two horizons.

A-II Horizon (beds 332 to 347) : It is indicated by the first K. depressum (Spath) m, Binatisphinctes and Poculisphinctes and the last Subgrossouvria.

A-III Horizon (beds 348 to 377) : It is marked by the first Peltoceras aff. kachhensis Spath M, the last kinkelinceratins, the last Binatisphinctes, the last Orionoides as also the last P. athleta (Phillips) M along with solitary Paralcidia cf. khengari Spath M.

The Depressum Subzone is correlated with the French Collotiformis Subzone in view of common C. fraasi (Opperl) M, P. metamorphicum Spath M, P. vijaya Spath M, and morphologically close Binatisphinctes and Paralcidia.

Ponderosum Zone : It is defined by the first Peltoceras ponderosum (Waagen) M. It includes two horizons.



P-I Horizon (beds 378 to 385) : It is indicated by the first P. ponderosum (Waagen) M, the first Euaspidoceras, the first Metapeltoceras and the first P. solidum Spath M, suggesting good correlation with Subtense Horizon of France.

P-II Horizon (beds 386 to 390) : It is indicated by the first Pachyceras lalandeanum (d'Orb.) M, Prososphinctoides manialensis Spath m, and single Poculisphinctes cf. poculum (Lackenby) M which suggest correlation with Athletoides Horizon of France.

FAUNAL ANALYSIS

The presence of ammonoid elements in Kachchh in common with South Europe almost all through the Callovian has allowed fairly precise correlation of all the 7 zones, 13 subzones and nearly half the number of horizons across the two margins of the Tethys. In spite of the invariable limited geographical (local to intraprovincial) extent of the horizons, there is no conceptual or practical impediment to the inter-provincial correlation of the ammonoid horizons. The myth that the ammonoid horizons can not be correlated inter-provincially is found unacceptable.

The Stage and Substage Boundaries : The first 35 m (beds 1 to 41) of the studied column representing the Madagascariensis Zone includes only scarce, fragmentary, endemic and near exclusive Macrocephalites except for a single fragment of Choffatia cf. madani Spath M in the youngest M-III Horizon. This scarce fauna (M. madagascariensis Lemoine M, M. triangularis Spath M and M. gr. indicus/gibbosus (Spath M)) has hardly any bearing to the demarcation of the Bathonian/Callovian boundary. The first two species are known to transgress from Upper Bathonian into Lower Callovian, while the third is considered mostly exclusive to the Upper Bathonian [7,9-11,17], and so any firm indication can not be made at present of this boundary. The Madagascariensis Zone is provisionally considered exclusively Lower Callovian, yet the assignment of its early part to Upper Bathonian can not be altogether ruled out. The Lower/Middle and the Middle/Upper Callovian boundaries in the studied section are precisely marked. These are based on the same evidences as on the North Tethyan margin respectively by the first Reineckeia anceps (Reinecke) M and the first Peltoceras athleta (Phillips) M. However, the assignment of the Callovian/Oxfordian boundary has remained unresolved either due to lack of knowledge of the corresponding late Upper Callovian (Lamberti Zone) and early Lower Oxfordian (Mariae Zone) Tethyan representatives on both the margins of the Tethys or their absence in Kachchh or even the presence of a significant hiatus across this boundary in Kachchh. The Ponderosum Zone of Kachchh in view of common Poculisphinctes poculum (Lackenby) M, Pachyceras lalandeanum (d'Orb.) M, Euaspidoceras and Metapeltoceras is found precisely correlatable to the Poculum Subzone of France. The Poculum Subzone was earlier included in the early part of Lamberti Zone [15] but in a recent work [16] it is included in the Athleta Zone as its youngest subzone.

Salient Features : Most of the Callovian succession at Keera except for the beds 1 to 41 is quite rich in ammonoids,

distinctly richer than either the underlying Bathonian or the overlying Oxfordian in the entire Mainland Kachchh. In fact in terms of the presence of diverse North Tethyan ammonoid subfamilies (10 subfamilies), genera and species, the Callovian at Keera is by far the richest known to date of the Kachchh Jurassic. Even the quantitatively rich and dense Middle Oxfordian Transversarium Zone ammonoid fauna discovered recently [18] at Wagad in the most proximal exposed part of the Kachchh basin outside the Mainland Kachchh is not so diverse in the North Tethyan elements. The Lower (100 m) and Middle (90 m) Callovian at Keera are somewhat equal in thickness compared to the distinctly lesser thickness (20 m) of the Upper Callovian. Considering the respective duration of the Callovian substages (3 My, 1 My and 1.25 My) the Middle Callovian provides faster sedimentation than either the Lower or Upper Callovian. The Middle and Upper Callovian have 16 cosmopolitan Tethyan genera while the Lower Callovian only 10 such genera. The Upper Callovian is interpreted to have the slowest sedimentation and maximum bathymetry of the entire Callovian stage interval. The Ponderosum Zone is the only interval of the entire Kachchh Callovian which does not include even a single geographically restricted subfamily or genus. This again supports maximum bathymetry and maximum communication across the two margins of the Tethys for ammonoid expansion in the Ponderosum Zone.

It is significant to note that the Callovian ammonoid succession of Keera includes intervals which are quantitatively and qualitatively rich in the North Tethyan genera, which are found to alternate with distinctively thicker intervals relatively depleted in the North Tethyan ammonoids. Among the intervals of the first kind particular mention can be made of beds 30 to 32 (M-II Horizon), beds 50 to 66 (C-II Horizon), beds 132 to 160 (A-I Horizon), beds 260 to 280 (O-III Horizon), beds 334 to 336 (A-II Horizon), beds 378 to 390 (Ponderosum Zone). These relatively thinner/starved/condensed intervals evidence expansion of ammonoids from the low latitude Mediterranean region on either side to the high latitude Indo - East-African (inclusive of Kachchh) and the Submediterranean regions during intervals of eustatically influenced sea-level rise. On the other hand the intervals of the second category are interpreted to correspond to the remaining duration of still stand and sea-level fall of the successive depositional sequences. Among the above six transgressive condensed intervals rich in the North Tethyan genera, those corresponding to the early Middle Callovian Ramosa Subzone, the early Upper Callovian Pseudorion Subzone and the mid. Upper Callovian Ponderosum Zone are found more significant. In conjunction with data on facies migration in the basin, particularly of marker sandstones, the recognition of the above transgressive intervals relatively rich in the North Tethyan ammonoid genera permits interpretation of the 3rd/4th order depositional sequence boundaries at the base of the Ramosa Subzone at the base of Depressum Subzone and at the base of the Ponderosum Zone which is in fairly good agreement with the sequence stratigraphic framework developed in the Submediterranean Europe. The cycles are found asymmetric with the ammonoid devoid greater thickness corresponding to the

relatively shorter intervals of still stand to fall while the intervening much thinner condensed ammonoid rich parts to longer transgressive intervals of sea-level rise. For example the condensed part (beds 132 to 160, *Ramosa* Subzone) is interpreted as the transgressive interval/component while the overlying distinctly thicker part (beds 161 to 259, *Kleidos* to *Obtusicosta* Subzones) as corresponding to the still stand / fall duration of the concerned depositional sequence.

CONCLUSION

The proposed zonation in the Callovian of Kachchh scores three-fold refinement over the earlier broad eight faunas of Spath [3]. It has possible future applicability in the entire Indo - East-African faunal province. The species common to Europe and Kachchh are considered coeval leading to precise correlation across the Tethys. Eustatically influenced sea-level rises are interpreted in the *Ramosa* Subzone, *Pseudorion* Subzone and *Ponderosum* Zone, while the P-II Horizon interval is considered the slowest deposited in maximum bathymetry with the best communication between the two margins of Tethys.

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