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STRATIGRAPHIC REFINEMENT IN INDIA : INTRA-BASINAL TO GLOBAL PERSPECTIVES EXAMPLED THROUGH THE KACHCHH MESOZOIC

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SUMMARY

The presentation is exclusive to the exposed shallow marine sedimentary successions. The exposition is initiated with state of the art along with outlining of the fundamentals, followed up with approaches and results in the Kachchh Mesozoic, and concluded with focus on salient intra-basinal to global perspectives of the refinement realized.

State of the Art : The science of stratigraphy originated with the enunciation of the principle of order of superposition in the 17th century, yet the quantum leap forward could be made much later between 1820 to 1860 as a consequence of the demonstration of the principle of faunal and floral succession in 1813. Erathems and most of the Phanerozoic systems were established between 1820 to 1840, soon followed by the organization of the West European Jurassic - Cretaceous successions into stages (1840-50) and zones (1850-60). These major fundamental advancements in stratigraphy were notably already made several decades prior to the discovery of radioactivity by Becqurel in 1894, nothing to speak of the start of absolute dating of rocks. The Mesozoic underwent greater refinement than either Paleozoic or Cenozoic. Even as early as 1858, the Jurassic was already differentiated into 28 zones with zonal resolution of little over 2 my. At present the average Phanerozoic zonal resolution is of the order of one to two million years. Currently, the ca 62 my long Jurassic is the best resolved of all the Phanerozoic systems into 70 zones, 140 subzones and 330 horizons with average horizonal resolution of ca 200,000 yrs. High resolution geological refinement at present makes the subdiscipline of Microstratigraphy which includes divisions of one 1 my and finer. In conjunction with sequence stratigraphic data, fine orbitally influenced Milankowich climatic cycles of 100, 000 yrs, 37-41000 yrs and 19-23000 yrs have also been unearthed in favourable conditions. In much contrast the Indian scenario unfortunately continues to be abysmally dismal in spite of good foundation studies of the 19th century in splendidly developed rock successions. Nothing to speak of zonal and finer refinement, even systems and stages remain poorly differentiated in the Indian geological record.

Outline of the Stratigraphic Fundamentals : The stratigraphic refinement continues to follow the classical approach of detailed lithostratigraphic differentiation (NL) of the guide fossil rich stratigraphic sections, and guide fossil sampling from precisely measured lithostratigraphic positions (NP) in the sections lithostratigraphically differentiated, followed by guide fossil systematics and bio/chronostratigraphic formulations (NB and/or NC) in the laboratory. These long known fundamental stratigraphic steps are integrated here into a simple equation $NL = xNP = xyNB$ or $xyNC$, where x and y are constants, x being smaller than y and invariably greater than 2. It is clear from the equation that the lithostratigraphic differentiation number NL is at least twice that of the differentiated guide fossil positions NP, and still greater than the bio/chrono stratigraphic formulation number NB/NC. So much so the key to the desired order of bio/chronostratigraphic formulations is crucially held in the painstakingly and patiencefully realized several fold greater lithostratigraphic differentiation perfected in the field.

Salient Results Using Ammonoids as Chronometers : Ammonoid cephalopods long known as the rapid-most evolving organisms of all time are used as chronometers in the ca 300 my long Devonian – Cretaceous interval, lately but quite reliably also increasingly made to serve as bathymetric, paleolatitudinal and paleogeographical sensors. The study of heterochronic evolutionary framework of ammonoids has been applied for high resolution differentiation of time. Two main processes involved are peramorphism and paedomorphism respectively referring to centripetal extension inside the ammonoid spiral from its terminal most part and centrifugal extension outward from the centre of the spiral of innovative morphological features found advantageous in combating the environmental changes – particularly bathymetric. Applying ammonoids in the above manner, exemplary and extremely high stratigraphic refinement has been realized in the Kachchh basin. The ca 23 my Callovian – Tithonian (164.3 my to 141.2 my) ammonoid rich interval of the Jurassic has been organized into a succession of 25 zones, 55 subzones and 90 horizons, 15 3rd order depositional sequences, in-turn further differentiated into fine climatic sequences of the order of 100, 000 yrs, 40,000 yrs and 20,000 yrs.

Intrabasinal Geological Dynamics : The refinement as above allows us much better and more precise comprehension of intrabasinal geological dynamics For example the classical post Dhosa Oolite stratigraphic gap of unknown duration in the Jurassic of Mainland Kachchh has been precisely measured , also, its long held subaerial understanding revised as submarine. This stratigraphic gap is also found completely filled in the proximal-most exposed part of the basin in Wagad. The 2nd order maximum flooding of the Kachchh Mesozoic is interpreted in the mid – Middle oxfordian Subschilli Horizon of the Schilli Subzone of the Transversarium Zone at Kantkot in Wagad. This does not agree with the same order maximum floodings in Europe either of distinctly older Callovian/Oxfordian boundary age or younger near the Late Kimmerdgian Eudoxus Zone / Beckeri Zone boundary.The discordance is attributed to strong influence in Kachchh of basinal/regional tectonics. In the stratotype sections of the studied interval the Dhosa Oolite is determined as the slowest sedimented (ca 1 mm per 1000 yrs) near the closing phase of the 2nd order transgressive interval, while the mid – Late Oxfordian Berrense Zone in the Kantkot – Bharodia section or the latest Late Kimmeridgian Beckeri Zone in the Ler section are considered as the fastest sedimented (1 m per 1000 yrs) in the 3rd order regressive interval within the 2nd order regression with crude ratio of 1:100. Lithologically and physically identical sands earlier considered coeval from basin to margin are surprisingly found highly diachronous differing in age by over 20 my.

Global Perspectives : In global perspective, the drastic ammonoid compositional change from dominantly Pantethyan to overwhelmingly Indo - East-African at the Bathonian/Callovian boundary around 164 my is interpreted as change from warm to less warm climate on account of southward latitudinal shift of East Gondwana vis-à-vis West Gondwana along the Davies transform plate boundary from subtropical to subtemperate latitudes. The origin of the transient shallow marine Gondic corridor along the same transform boundary across the Gondwana is précised in late Late Tithonian around ca 140 my. Using ammonoids the Gondwana dismemberment is here discussed in a new Axial and Outer Gondwana framework . The origin of the Dravidian corridor between the axial and outer Gondwana in the India - Australo-Antarctica sector takes place near the Barremiam/Aptian boundary around ca 112 my. The origin of the Indian ocean and shaping of the Indian East coast results from initiation of spreading between Axial and Outer Gondwana in this sector around 121 my at the Aptian/Albian boundary. The growth of the Indian and South Atlantic oceans proceeds from east to west and south to north. The origin of the Lemurian corridor between India and Madagascar is interpreted near the Coniacian/Santonian boundary around 85 my, and until then is interpreted continued togetherness of the Axial Gondwana constituents. The oceanic separation of Madagascar from India , shaping of the Indian West coast, anticlockwise rotation of India and the growth of the Indian ocean in the west is surmised mostly during Maestrictian on the evidence of unique Late Maestrictian exclusive to India, when India is completely isolated oceanically from all other Gondwana constituents to allow its rapid drift northward for collision and union with Asia later in Paleogene.