QUATERNARY GEOLOGY OF THE DELTAS OF ANDHRA PRADESH

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Quaternary Geology of the deltas of Andhra Pradesh has been systematically mapped and studied with the twin objectives – academic and applied, aided by sequential topographic maps, aerial photographs and high resolution satellite imagery along with subsurface geological and geophysical study by stratigraphic drilling and well logging, buttressed by a few radiocarbon dates. The three major deltas of A.P. – the Krishna, Godavari (KG) and Penner constitute a chunk of the coastal plain and support dense population, intense farming and industrial activity. In contrast to the prograding KG deltas, which protrude prominently into the Bay of Bengal, the Penner delta exhibits a generally straight, meridian coast, revealing varying morpho-tectonic set-up and basin geometry and sedimentation pattern. The Kolleru Lake, sandwiched between the prograding KG delta systems, is a silted and shrunken remnant of a natural lagoon now subjected to environmental degradation.

The basic parameters identified, analysed and recorded were discussed. They include (i) geomorphic features and morphostratigraphic units, (ii) litho-stratigraphic units, (iii) palaeo-strandlines, iv) palaeolobes, (v) delta growth pattern, (vi) sea level indicators, (vii) neotectonic features viii) subsurface geophysical and stratigraphic drilling/litholog data (ix) economic mineral and groundwater resources and (x) geological hazards and remedial measures. The geological mapping of the deltas is based on the concept of chronological development of the land-scape. The pattern of land forms in deltas indicates that the geomorphic evolution is controlled by eustatic sea level changes, climate, structure and lithology, which have influenced in various degrees giving rise to a complex geomorphic pattern that we see today.

The sub aerial deltas covering more than 10,000 sq km of the coast are floored by unconsolidated Quaternary deposits, mostly belonging to the Holocene age. The deltaic deposits can be broadly classified into two groups: older and active (younger) - which in turn can be subdivided and mapped into 13 morphostratigraphic units based on geomorphic, lithologic and pedogenic criteria. Calcretes and ferricretes were found useful as markers across the regional area for differentiating and correlating the Quaternary formations. Truncation of one set of beach ridges against the successively younger set and similarly, palaeo-lobes abutting against the successively younger strandlines enabled in assigning of relative chronology to the deltaic formations. Rock formations of Precambrian to Neogene ages, flanking the deltas, are pervasively weathered into laterites.

Sea level fluctuations have affected the evolution of the deltas. Presence of a number of strandlines across the above deltas reveals both transgression and regression of the sea during the Holocene. Older deltaic sediments (noticed up to about 35 km inland and rising up to a height of 1-8 m) are overlapped by younger marine sediments of age < 6, 500 Y.B.P over the older deltaic sediments. Episodic recession of the sea is evident from ca.6, 500 Y.B.P to 1,500 Y.B.P, as corroborated by ^{14}C dates.

In general, the delta sediments primarily consist of brown, salt-pepper grey, ill-sorted, quartzose and gravelly sands with peat lenses, silty clay with some calcrete horizons. The thickness of the sediments gradually increases towards the sea and is of the order of 400 m in Godavari delta, 280 m in Krishna delta and 240-260 m in the Penner delta. The younger delta deposits have yielded a host of marine micro fauna including benthic forms. The archaeological evidences include occurrence of Palaeolithic tools and index pottery belonging to the Satavahana Period, recovered from the upper delta formation along the Nellore coast. The lateritised sediments of the outer coastal zone and the calcrete bearing deltaic sequences reveal fluctuating climate from tropical to arid conditions during the last glacial maxima.

For planning coastal engineering projects and ushering in scientific urban development, subsurface Quaternary geological information is essential. Attempts made to gather and collate subsurface geological information as obtained from geophysical surveys, well log data and shallow stratigraphic drilling provided significant information on the Quaternary stratigraphy. The thickness of Quaternary sediments in Penner delta is of the order of 28 m to 120 m with intercalated gravel and pebble layers. An important and persistent pebble horizon recognized at the depth of 33 to 38 m, possibly represents a time interval in the Quaternary period. Borehole litholog in the lower part of the Penner delta indicated a thick pile of sediments belonging to the Tertiary (Mio-Pliocene) and Quaternary ages- the former capped by laterites and conglomerates and the latter by 50 to 75 m thick deltaic sands and clay beds, underlain by the laterites. In the Central Godavari delta around Razole town, a significant lithological break is encountered at depths ranging from 29 m to 49 m the below ground level (bgl), marking the contact between the older and active deltaic units comprising unconsolidated sand, silt and clay and compact sand and sandy clay formations, respectively. Profile type mapping by means of drilling shallow bore holes, led to delineation of a possible contact between the Upper Pleistocene and Holocene sequences at about 9 m to15 m bgl in the Kakinada town area, East Godavari district. The top sedimentary sequence comprises stiff and sticky brown clay with profuse nodular calcrete, followed by mottled clay beds.

The Quaternary deltas are affected by neotectonic activity. The important neotectonic features are some morpho-structures including fault lineament (e.g. Narsapur-Amalapuram fault), off-setting of beach ridges, and topographic and drainage anomalies. These features noticed and interpreted from high resolution aero-space data, were corroborated by ground evidences and geophysical surveys

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(Bouguer gravity and seismic) and drilling records The unidirectional northerly migration of Penner to the extreme left flank of its own delta, possibly due to neotectonic blocks upliftment Presence of a linear strip of Gondwana inliers within Krishna delta alluvium is possibly the result of neotectonic fault controlled upliftment

The deltas are endowed with some important economic mineral deposits, besides forming the favoured and strategic locations for transportation, agriculture, industries, defense, recreation and setting of industrial and geotechnical projects Diamond constitutes the most important economic mineral of the Quaternary gravels of A P The palaeochannels of Krishna and Penner in their delta reaches and offshore area may also form important loci for placer diamonds Other mineral resources include shell beds, *kankar*, lime stone, common salt, gypsum, sulphur, glass and foundry sands and atomic minerals and also building/construction materials The KG deltas have also emerged as potential blocks of hydrocarbon prospects The older delta replete with buried channels and fluvial delta plains and levee complexes form good repositories of potable ground water Fine resolution stratigraphic studies coupled with shallow drilling and geophysical studies at selected places along with absolute dating of suitable samples are highly necessary for building up delta models and reconstructing Quaternary events of the deltas

INTEGRATED METHODS OF GEOLOGICAL, GEOPHYSICAL AND GEOCHEMICAL EXPLORATION IN CONCEALED TERRAIN – A MODERN APPROACH (by C.P. Sisodia, AMSE Wing, Bangalore).

Metals like copper, lead, zinc, gold, silver, tin, tungsten etc find extensive use in agriculture and in almost all industrial sectors like defence, automobiles, electrical and utility industries These are the basic requirement for the industrial growth of any country and are also of strategic importance With the changing scenario and for the economic growth of the country, infra-structure development has become essential For this the basic requirement is steel, cement and coal apart from other commodities Hence demand of iron ore, manganese, nickel, chromium, coal, limestone etc , has increased manifold It is now well known that most of the deposits which were outcropping or having surface indications in the form of gossan, old working, oxidized zone etc , have been explored The time has now come for adopting a systematic approach to locate new mineral deposits in the concealed terrain and in inaccessible areas The concealed terrain may be soil covered or areas under thick sand or alluvium, whereas inaccessible areas may be thickly forested and snow covered Mineral exploration in such terrain is not any easy task and the cost of carrying out exploration including drilling has gone up several times Therefore an integrated approach, which includes airborne geophysical surveys followed by geological, ground geophysical and geochemical characteristics is essential to delineate potential target areas more accurately with high confidence level Thus a flow sheet of mineral exploration by integrated surveys has been worked out and adopted

Airborne Mineral Surveys and Exploration Wing of Geological Survey of India has discovered several small and medium size base metal deposits in Rajasthan, Karnataka and Andhra Pradesh and gold deposits in Rajasthan by integrated surveys The best example of discovery of base metal deposit is Kayar Zinc and Lead deposit in Ajmer district, Rajasthan This deposit which is totally concealed has been discovered only on the basis of Airborne geophysical Survey anomaly evaluation followed by geochemical sampling and geological mapping and ultimately drilling using above mentioned flow sheet The host rock of mineralization is quartz mica schist-belonging to Ajabgarh Group of Delhi Supergroup The area forms the northern most part of South Delhi Fold Belt

9 18 million tonne of zinc and lead ore has been estimated in Kayar area for a continuous strike length of 1160 m, upto a vertical depth of 240 m The width of the ore body varies between 3 m and 12 and the average grade is 13 82% Zn and 1 55% Pb (Total Metal content is 15 37%)

EVOLUTION OF CONTINENTAL LITHOSPHERE - A BOTTOM-UP VIEW (by Fareeduddin)

The nature and origin of mantle beneath cratonic nucleus, stablized during earliest part of the earth's history, has remained one of the most fascinating research topics for modern petrologists and geophysicists A variety of models exist and most are dependent on the piecemeal indirect information from the seismic waves and the direct observation on tiny mantle xenolithic fragments sampled and couriered to the surface by the mantle derived postassic ultramafic rocks like kimberlites and lamproites.

Attention of our readers of this journal is drawn to an interesting article by Dante Canil entitled "Canada's craton - A bottom-up view" published by GSA Today, v 18, no 6, pp 4-10 The paper traces the events that led to the formation of the lithosphere beneath Canadian craton by way of 'stacking processes' in a convergent plate