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# Mineralogy and Petrology of the Krishna Godavari Basin on Shore Area, East Coast of India

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**Abstract***: Shales are defined as fine-grained terrigenous sediments and rocks that contain 50% or more of terrigenous, and generally argillaceous, clastic components less than 0.062 mm in size. In the shales, clay-size components often dominate their rock properties, such as density, plasticity, parting, compatibility and swelling. Generally the size boundary between clay and silt is 4μm, but most clay minerals are less than 2 μm size siltstone, clay stone and mudstone are broadly called shales.XRD patterns of whole - rock of Raghavapuram shale/clay sample indicate the predominating presence of kaolinite and quartz, with minor chlorite, muscovite, and illite. Iron mineral peaks were not observed, indicating that no hematite / magnetite was incorporated in the clay minerals. Smectite and chlorite are present in trace amounts in some of the samples. Identification of secondary minerals was difficult, because their peaks overlapped by the greater peaks of the major minerals such as kaolinite and quartz. Semi-quantitative analyses, following to method modified after Schultz (1964), showed differences in bulk mineral compositions between the individual samples. Samples richer in kaolinite being poorer in quartz. Some of the samples contain only small amounts of feldspar.*

**Keywords:** Shales, sand stones, feldspar, XRD pattern, kaolinite.

## 1. Introduction

The Krishna-Godavari basin, a pericratonic basin, is located in the central part of the eastern passive continental margin of India. The basin area includes the deltaic plains of the Krishna and Godavari rivers and the interdeltaic regions. Geographically, the basin lies between Kakinada in the northeast and Ongole in the Southwest. Archaean crystalline (Eastern Ghats) rocks acting as the basement on which number of sedimentary rock outcrops ranging from age Triassic to recent are exposed on different parts of the basin. A significant part of the onshore basinal area is covered by Quaternary alluviam. The basin extends southeast into the deep waters of the Bay of Bengal. The Krishna-Godavari basin is located in the southeastern part of the Godavari valley, trending NE-SW and Cretaceous successions comprising Raghavapuram (early Cretaceous) and the Tirupati (middle to late Cretaceous) formations transversely superimpose the Gondwana group of rocks.The study area forms a part of the post Gondwana formations in the Krishna-Godavari basin area. The Raghavapuram formation comprises of clay (shale) dominated with sandstone association, and succeeded by sandstones of Tirupati Formation of Upper Cretaceous age were taken into consideration for the detailed study of Geology, petrology and geochemistry to understand the paleotectonics, provenance and depositional environments of these rocks of the KG basin area.

Clastic sedimentary rocks are indicators of past environments, giving clues even to their geodynamic settings by means of their compositions. The provenance and geodynamic development of shale and sandstone successions can be classified by variety of methods, including petrographic analysis, whole rock chemistry. Above all, clastic sediments can give information on continental and oceanic source regions that have been eroded or metamorphosed through subsequent tectonic processes (Nesbitt and Young, 1982; McLennan, 1989; MeLennan et al., 1993; Cullers, 1994; Condie et al; 1995). Present study uses the petrographic and geochemical methods on Cretaceous shale and sandstone successions from the parts of Krishna-Godavari basin area to decipher the influence of source rock characteristics, chemical weathering during transport and sedimentation, and post depositional diagenetic reactions, all affecting the chemical record of their compositions and consequently, evidence concerning their parental affinities (Nesbitt, 1979; Cullers et al., 1979, 1987; Banfield and Eggelton, 1989; McLennan, 1989, McLennan et al., 1993; Condie et al., 1995). Here the main question concerning the transgressive and regressive sequences of Cretaceous clastic rocks is that the source area was the same or different. There is a paucity of geochemical data available on the formations of Krishna - Godavari basin in general and Cretaceous formations in particular. In the light of the lack of geochemical data, this is the first time that these clastic rocks were analysed for major, trace and REE's, and their interpretations help to elucidate the paleogeographical conditions of this area. In a more general context, this study offers a chance to understand in detail the effects of the various sedimentary processes on the geochemical signature of sedimentary rocks. Although chemical composition of fine clastic rocks, such as shales, are usually emphasized in geochemical provenance studies, this sample sets also allows direct comparison between sandstones and shales. Comparison of the chemical compositions of the two different lithologies allows an evolution of the control of the hydraulic sorting on elemental distributions.The study area is situated in the West Godavari District, in Andhra Pradesh (Fig.1). The area lies between the Lat. $17^{0}10^{1}$N, Long $81^{0}15^{1}$E, and Lat. $16^{0}50^{1}$N, Long $81^{0}40^{1}$E of Topo sheet numbers 65G/12, 65G/8 and 65G/5. The tract of Raghavapuram shale and Tirupati Formations are cropped out abundantly at Komatigunta near

Gopalapuram in West Godavari district, on Highway, on the way to Jangareddigudem

## 2. Laboratory Studies

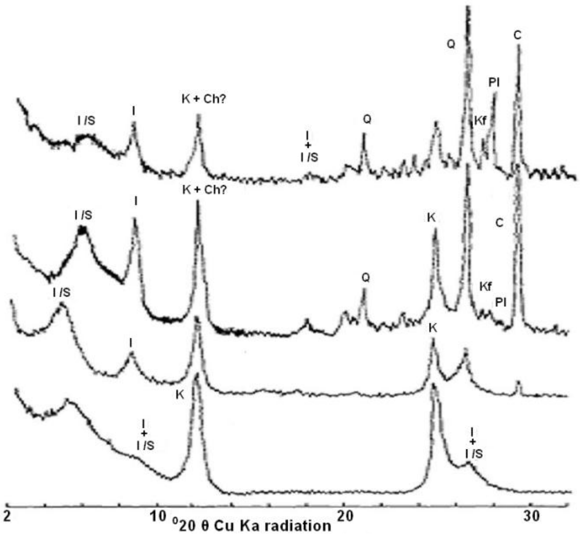


**Figure 1**X-RAY POWDER DIFFRACTION PATTERNS OF RAGHAVAPURAM SHALE /CLAY SAMPLES . Q = QUARTZ, C = CALCITE, KF = K-FELDSPAR, PL = PLAGIOCLASE, I/S = ILLITE/SMECTITE, I = ILLITE, K = KAOLINITE, AND CH = CHLORITE.

**Table 1**

| Sample No. | Kaolinite | Quartz | Chlorite | Smectite/ Illite | Feldspar |
|---|---|---|---|---|---|
| R1 | 67 | 16 | 15 | - | 2 |
| R2 | 72 | 14 | 8 | 4 | 3 |
| R3 | 58 | 22 | 9 | 3 | 2 |
| R4 | 62 | 38 | 7 | 8 | - |
| R5 | 55 | 21 | 12 | 7 | - |
| R8 | 54 | 18 | 9 | 2 | 1 |
| R10 | 44 | 55 | - | - | 1 |

Semi-quantitative (wt%) mineralogical composition of Raghavapuramshales, analyzed by X-ray difractometry, calculations performed by using a method after Schultz (1964)

The upward increase of sandstone beds and quartz correlates with a seaward - stepping of deltaic sequence and sea-level fall. The increase of quartz content and finally sandstones (Tirupati sandstones) is related to source or coastal proximity to the shallowing upward sequence. The variation of quartz content also affects the trends of the other components, mainly kaolinite content. More kaolinite was deposited during periods of falling sea level and less in deposited at high sea level stands. These conclusions agree with Weaver (1961), who noted that a change from low to high kaolinite content represents a change from a relatively more open to a more near shore marine conditions. All the shale samples are rich in kaolinite and quartz, which indicate that they are derived mainly from felsic sources. The less weathered products, such as smectite and chlorite present in some of the samples and low feldspar content suggests a contribution from basic sources. The felsic sediments are derivatives of charnockites, gneissic and granitic rocks of Eastern Ghats granulite belt, whereas the basic component is derived from basic schists and other intrusive bodies. The Raghavapuram shale/clay formation represents the weathering product of Precambrian hinter land rock types under a temperate climate with high rain fall, good drainage and acidic waters. The abundance of kaolinite indicates continental weathering conditions. The clay mineralogy of Raghavapuram shale formation isa response to the tectonic setting of the area and climate.Differential thermal analyses were run for four clay samples of Raghavapuram formation (Fig.2). The whole or unfractionated clay samples were used for DTA studies. The DTA curves produced for clay samples show the dominant traces of Kaolinite. This is due the fact that endothermic and exothermic reactions produced by heating kaolinite represent much greater energy absorption and output than those produced by heating the other clay minerals. The thermal curves produced by the clay samples are quite similar. The broad endothermic peak extending from about $450^0$ to $660^0$C is probably a composite effect of kaolinite, illite and mixed - layer minerals. A high temperature endothermic peak below $900^0$C is slight to be of clay-mineral reactions. to exothermic reaction with a relatively sharp peak at about $410^0$C was produced by organic material. The reactions characteristic of kaolinite are dominant, and probably mask the $500^0$ to $650^0$C. Illite is indicated by a small endothermic peak at $900^0$C. A broad, shallow exothermic reaction extending from about $250^0$ to $425^0$C was probably produced by a small percentage of organic material. A slight endothermic reaction near $200^0$C is indicative of montmorillonite, but this clay mineral was not detected by X-ray analysis. Scanning electron microscope photo of shale (Fig. 3) shows blades of Kaolinite and quartz, which are abundantly present in the shales of this formation.

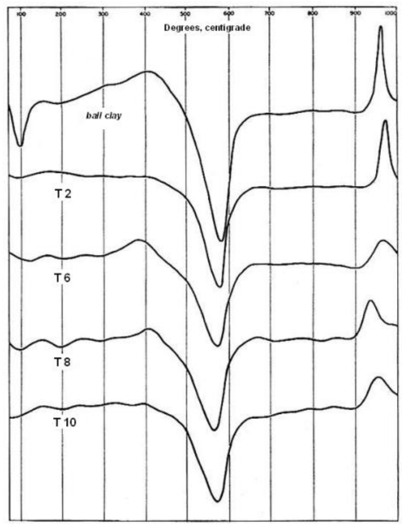


**FIgure 2:**Thermal Curves For Raghavapuram Clay Samples

## 3. Field Observations

The Lower Cretaceous Raghavapuram Shale Formation is composed mostly of white, buff and lilac clay with minor thin lenses and alternating beds of siltstone, mudstone and sandstones. These alternate beds of coarse grained lithologies are dominant in the upper part of the formation and gradually pass into the overlying coarse grained sandstones of the Tirupati Sandstone Formation. Horizontal stratification and parting are the main structures present in this shale formation. Stratification means layering the result of vertical differences in texture and/or grain fabric. Vertical differences are manifested by colour and hardness in layers of variable thickness. Parting, however, is a splitting characteristic of shales, often enhanced by weathering, where in planes of separation occur between layers. Stratification is subdivided into beds and laminae at the traditional 10 cm thickness boundary and these inturn are further subdivided. Parting is divided into slabby, flaggy and platy. The term fissile is mostly used as synonym for parting. The thickness of stratification and parting in the shales is related to many factors including rates of sedimentation and compaction. However, field observations suggest that the most obvious factors the composition, grain size and fabric. Stratification and parting generally decrease in thickness as the relative amounts of clay minerals increase, as the degree of orientation of platy minerals increases, and as the percentages of sand and silt sized mineral fragments decreases.

**Figure 3** SEM Photo of Raghavapuram Shale/Clay Sample

A systematic study of microfossils from the Raghavapuramshales of lower Cretaceous age have revealed the presence of fairly rich assemblage of arenaceous forms. Bhalla (1966) found fifteen species of foraminifera in which the dominant genera are ‘Haplophramgmoides and Ammobaculites’. According to him, the assemblage of microfossils shows affinity with the Cretaceous age for the Raghavapuramshales.

## 4. Conclusions

Raghavapuram shale formations are exposed in a linear NE-SW trending belt. Raghavapuram shale formation is underlain by the Precambrian igneous and metamorphic complex (Eastern Ghats) in most of the area. Locally at Jangareddigudum area this shale formation is underlain by the Kota formation of Jurassic age. Raghavapuram shale formations show conformable contact and have transversely superimposes the Gondwana formations which occur in the main Godavari sub-basins. The Lower Cretaceous Raghavapuram shale formation is mostly composed of white, buff and lilac clay with thin lenses of siltstone, mudstone and sandstones. These lenses of coarse grained lithologies are dominates in the upper part of the shale formation. Horizontal stratification and parting are the main structures present in the Raghavapuram shale formation.

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