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Research Article

SEDIMENTOLOGICAL STUDIES OF KALLAMEDU FORMATION IN ARIYALUR AREA, TAMIL NADU, INDIA

S. Ramasamy, *A. Ramachandran, K. Velmurugan,
David Lalhmingliana Chawngthu, S.Bhuvaneswari and M.Suresh Gandhi
School of Earth and Atmospheric Sciences, Department of Geology, University of Madras,
Guindy Campus, Chennai-600 025Tamil Nadu, India
**Author for Correspondence*

ABSTRACT
The Kallamedu sedimentary sequence, one of the least investigated sedimentary formations in South India (Ariyalur District, Tamil Nadu State), is well known for the occurrence of dinosaur remains. For the present study, detailed field and laboratory investigations have been conducted for understanding the depositional environment of Kallamedu Formation. The field studies comprise of collection of representative samples, measuring litho-sections and recording sedimentary physical structures such as parallel beddings and laminations besides planar and trough cross beddings. It has been observed in the field that dominant lithologies comprise of fine grained siltstones and fine laminated clays with rare occurrence of coarser sandstones and polished pebbles in the fine sandstone units. The dinosaur remains are mostly fragments of bones, and we rarely observed well preserved animal remains in the exposed litho-units. At places calcrete formation and vertically grown calcite crystals over the substratum of siltstones are observed.

Thin section petrography revealed the presence of argillaceous siltstones, wackes, calcretes and minor arenites. Most of the petrographic types contain considerable amount of argillaceous material. The framework grains are angular quartz grains of silt and fine sand sizes. The grain size data of selected sand-dominated samples of the Kallamedu Formation reveal that the presence of coarse- to fine-grained, moderate to poorly sorted, fine skewed and platykurtic with bimodality. Clay mineralogy reveals the dominance of kaolinite followed by illite, smectite and chlorite. Perhaps the granitic gneissic terrain released feldspars which altered to kaolinitic clays. Illitic clays have been formed in a diagenetic environment which altered the kaolinite. The sediments have experienced a moderate to deep burial diagenesis.

The high amount of organic carbon attests the existence of many swamp basins, which are ideal for organic matter accumulation due to restricted oxygen circulation with luxuriant growth of plants around them. Most of the trace elements (Co, Pb, Cu, Zn and Ni) are related to detrital phase and as such are correlatable. SEM studies of fine silty clayey sediments reveal low undisturbed energy level existed during the deposition of clays excepting flocculation which resulted in a juxtaposed arrangement of clay plates. However bioturbation is not evident during/after deposition in the fine sediments. The sand grains surface texture indicate angular to subangular shape with thick secondary precipitation of argillaceous/calcium carbonate over the irregular undulated grains topography. Thus most of the clastics did not suffer much textural alteration and were derived from nearby source. The present study points out that the Kallamedu clastic rich sediments have developed in a moderate energy level, most likely in a terminal fluvial setting where coarse materials with cross bedding features formed in channels and fine silts and clays deposited vertically over the flood plains. The dinosaur remains preserved in the fine clastics perhaps point out the existence of a depositional system ranging from fluvial marshy to estuarine environments.

***Key Words**: Kallamedu, Late Maastrichtian, Dinosaur bones, fluvial signatures, Ariyalur area*

INTRODUCTION

The Cretaceous Formation of the Ariyalur area (Ariyalur District, Tamil Nadu) is one of the best-developed sedimentary sequences in South India. Blanford (1862) was the first to work on the stratigraphy of this formation and he divided the litho-units into three groups: Uttatur, Trichinopoly and Ariyalur. These three groups are largely disconformable and occasionally unconformable at places. The geology and the stratigraphy of this area are accounted by many workers (Rama Rao, 1956; Ramanathan, 1968; Banerji, 1972, Sastri et al, 1972; ONGC, 1977; Sundaram and Rao, 1979 & 1986; Ramasamy and Banerji, 1991; Banerji et al, 1996; Gonvindan et al, 1996). Ramasamy and Banerji (1991) have revised the stratigraphic framework of the exposed Pre-Ariyalur sequence based on detailed lithological and petrographical variations. Banerji *et al.*, (1996) have redefined the Uttatur Group and identified within it four distinct formations comprising reefoidal bodies, sandy clay, coarse sand bar and gypsiferous silty-clay units. Madavaraju (1996) has presented a detailed geochemical and petrographical account of Ariyalur Group of sediments and Kallamedu Formation is the youngest unit of this group. Further REE distribution and its importance in establishing anoxic/oxic conditions in lime rich Kallankurichi Formation was attempted by Madavaraju and Ramasamy (1999). The sedimentary rocks of Cretaceous – Palaeocene age are well developed in the Ariyalur area, which consist both clastic and carbonate facies. The diversity of fauna is very large in the vast sedimentary basin that has attracted the attention of geologists not only from India but also from foreign countries. Sastry *et al.*, (1972) have further divided the Ariyalur Group into four formations mainly based on lithological changes and characteristic faunal content: i) Sillakudi ii) Kallankurichi iii) Ottakoil and iv) Kallamedu Formations. This classification has been followed by various workers of varied interests. Kallamedu Formation (Late Maastrichtian) is the youngest formation of the Ariyalur Group and it exhibits large variation in lithology. The exposed area looks like a badland topography with sparse vegetation. Excavation at favourable spots in Kallamedu Formation has yielded a number of well-preserved skeletal parts of Carnosaurs (Yadagiri and Ayyasami, 1987). The lithological association of this formation includes sandstone, siltstone, calcareous sandstone, silty shale and thin band of limestone. The sandstone and siltstone are well exposed in the nala sections near north of Kallamedu village (Fig. 1). Govindan et al. (1996) have assigned Maastrichtian age for the continental deposits of the Kallamedu Formation. Kallamedu Formation is overlain by the Niniyur Formation of Early Paleocene age.

MATERIALS AND METHODS

The geological field investigation was undertaken mainly along the network of nala sections of the badland topography which only expose the Kallamedu Formation. The attitude of beds, sedimentary structures, lithological variations and other fine sedimentary features are recorded in the field. Many sections were measured and lithological contrasts were noted.

Though the samples are soft, most of the sandstone and siltstone samples were cooked in Canada balsam to strengthen them before making thin sections. Around 25 thin sections were prepared and studied for petrological variations. Scanning Electron Microscopy of representative sand size grains and clay samples from the formation are included for discussion For SEM analysis of surface texture of moderate to fine sand size grains, samples (sand grains cleaned with stannous chloride to remove the Fe-Mn oxide coatings) were mounted on brass stubs (1 cm in diameter) using a double-sided adhesive carbon tape and coated with platinum for about 90 to 120 seconds (JEOL: JFC) ion sputtering device to render the surface of the sand grains conductive for scanning. To obtain lucid illustration, microphotographs of different views of sieved sand grains of 45 ASTM mesh sizes were taken using a Scanning Electron Microscope (JEOL-6360). Further 32 samples were subjected to $CaCO_3$ distribution and organic carbon and 15 representative samples were used for trace element geochemistry using an Atomic Absorption Spectrophotometer The calcium carbonate is determined following the rapid titration method of Piper (1974). For trace element geochemistry the method discussed in Tessier (1997) has been followed. The trace elements such as copper, cobalt, nickel, zinc and lead are determined. Six representative clay-rich fine sediments were scanned through powder X-Ray diffraction method. Around 10 sand-rich samples were subjected to mechanical analysis for size distribution. Thirty-two samples were analyzed for organic carbon following the method described in Gaudette *et al.,* (1974).

RESULTS AND DISCUSSION

Geology and Stratigraphy

The Cauvery Basin lies in the east coast of India. It consists of a thick (5-6 Km) pile of syn-rift (more than 1000m) and post-rift (about 5000m) sedimentary rocks resting over the Archaean basement (Rengaraju *et al.,* 1993). The Cretaceous rocks in the Cauvery Basin occur as five isolated patches in the western margin fringing the Archaean basement. The marine transgressive and regressive sedimentary sequences of the study area have acted as repositories for the accumulation of varying litho units with rich faunal and floral assemblages. They are more useful in the inter-regional correlation of the Indo-Pacific regions.

Kallamedu Formation (Late Maastrichtian), the youngest formation of the Ariyalur Group, exhibits large variation in lithology. The exposed area (Fig.1) is generally badland topography. The lithological association of this formation includes sandstone, siltstone, calcareous sandstone, silty shale and thin band of limestone.

The sandstone and siltstone are well exposed in the nala sections near north of Kallamedu village. Kallamedu Formation is unconformably overlain by the Niniyur Formation of Early Paleocene age (Table-1) which is composed of fossiliferous calcareous sandstone, sandy clay and fossiliferous limestones. Niniyur Formation is rich in fossils that include foraminifera, corals, ostracods and algae.

For the present study observations and sampling are accomplished in four nala sections (Fig. 2) which expose generally cross bedded sandstones and fine micaceous clay rich sequences.

In the KM-I section, very fine- grained earthy colour siltstones and clays are observed (Fig. 3a). At the bottom of the sequence, the lithology become more arenaceous and it exhibits a fining upward sequence. At the top sequence of siltstones and clays, casts of gastropods and pelecypods are recorded. However no well preserved faunal materials are collected. In the same nala section towards east “sub-Recent” kankary pebble bed overlying Late Maastrichtian clay bed is noticed. The KM-II section reveals a similar fining upward sequence, but the bottom arenaceous sequence portrays various planar, and trough cross bedding structures which become very fine laminated sandstone and white colour siltstones towards top (Figs.3b,c,d). At places the fine clastics enclose remnants of dinosaur bones. In another rather a deep nala section west of KM-II, the sequence display monotonous white colour creamy fine sandy and silty units displaying horizontal laminations. Along this nala section towards north (KM-III) the lithology become more gritty sandstone towards top and the underlying fine sandstone enclose highly polished pebbles (Figs.3e,f) In another nala section east of KM-I thick sequence of laminated siltstone overlies red and green clays (KM-IV, Fig.3.g) and the siltstone is soft and become friable against little pressure. The area around this section shows more scattered remains of dinosaur bones and also mud crack features (Fig.3h) on surface. In some places in this location, a layer of calcite growth is observed on surface probably formed in a hot semi-arid climate.

Petrography

We prepared 25 thin sections from these friable sand- to silt-rich samples after cooking in Canada balsam. These sections were investigated microscopically to have insights on textural and mineralogical attributes. All these uncovered thin sections were subjected to staining treatment with Alizarine Red-S and Potassium Ferricyanide solutions to assess the presence or absence of calcite/dolomite as well as iron rich/iron poor status of the lithology. Petrographic types such as Calcareous wacke, Micaceous wacke, Calcareous conglomeratic subarkose, Argillaceous siltstone and calcretes are identified in the varied lithologies of the Kallamedu Formation.

The Calcareous wacke petrographic type exhibits assorted angular linear shape quartz grains with considerable clay matrix where grain flow is visible faintly (Fig.4a). This lithology is unfossiliferous and fine grained. It represents the argillaceous sandstone unit of the formation. The Micaceous wacke is slightly coarser but assorted (Fig.4b). The quartz grains are angular and deposited with horizontal laminations as clearly demarcated by dark brown biotite mica. Hence vertical sedimentation is visible as found in a flood plain like environment. Few coarser grains are also found which may attest a variable energy condition in the depositional system. It is recorded at the middle level of the Kallamedu Sections, KM-III and KM-IV.

The Calcareous conglomeratic subarkose has a framework of very coarse quartz rich conglomerate (Fig.4c). Feldspar content is considerable and most of them are alkali-clan. Though majority of the quartz grains are subangular, considerable number still exhibit subrounded features. Few feldspar grains are still fresh and unaltered, though many show alteration features. Most of the quartz grains are monocrystalline and many of them are fractured. Cement is calcite as exhibited by deep red stain against Alizarine red-S. It is identified in the top sequence of KM-III. The fine grain argillaceous siltstone contains considerable amount of argillaceous matrix (Fig.4d). The whole section is generally obscured due to clay entrapment into the spaces among silt size angular quartz grains. The clay seems to be detrital in nature and the rock is devoid of any organic remains, perhaps suggesting that these materials have deposited over flood plains. Argillaceous siltstone is free from any carbonate material and is recorded in the KM-IV section.

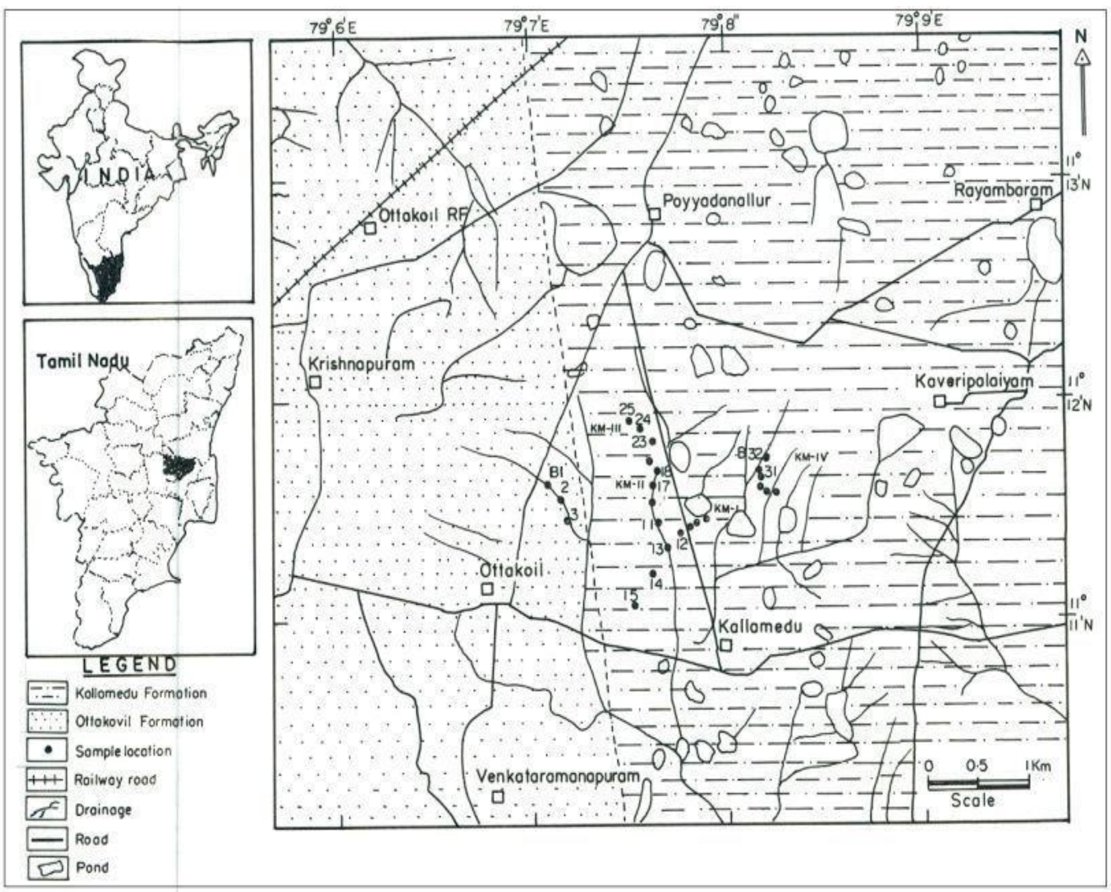

Figure1: Geological map of the study area

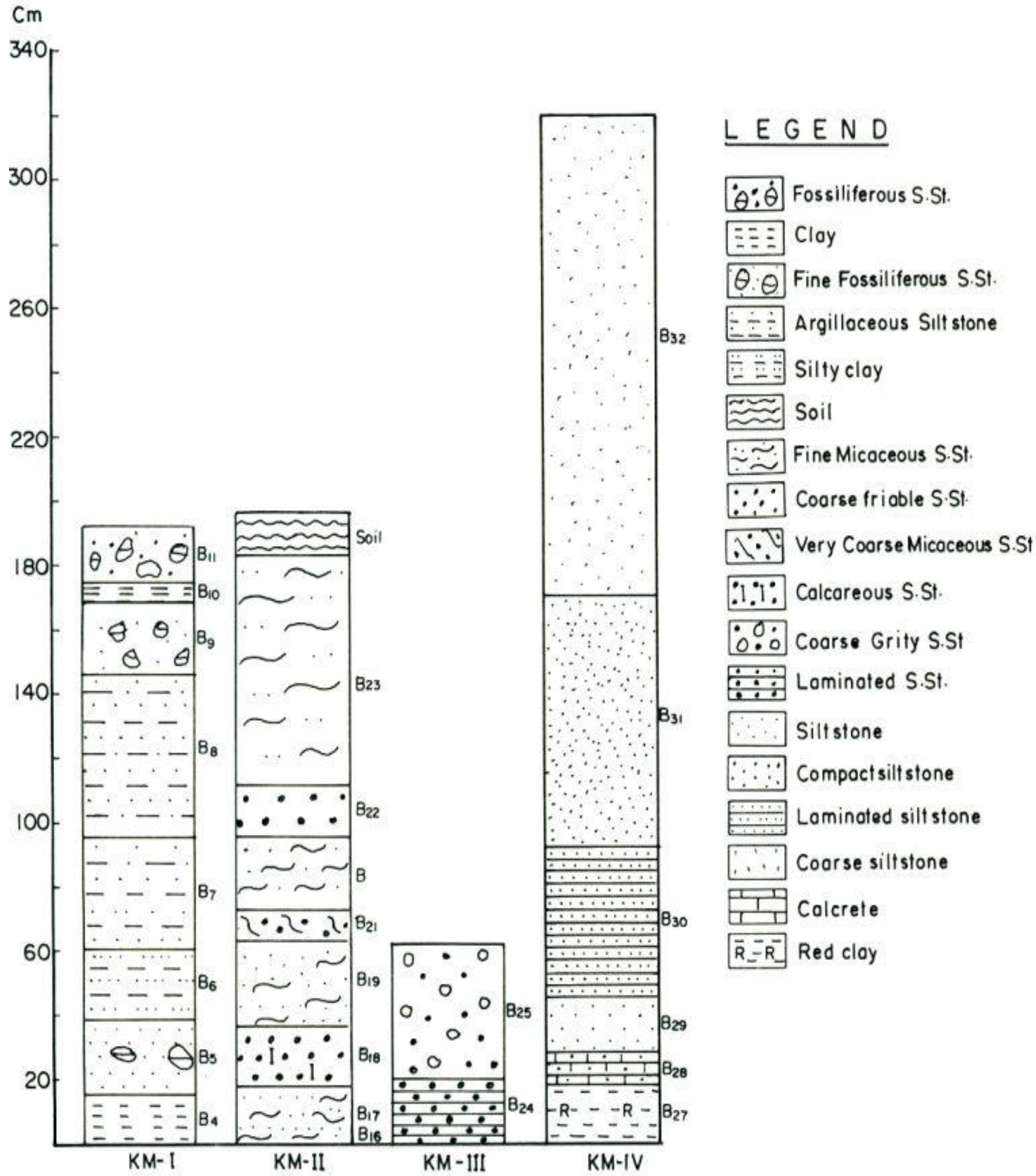

Figure 2: Litho-sequence of Kallamedu Formation as observed in nalla sections

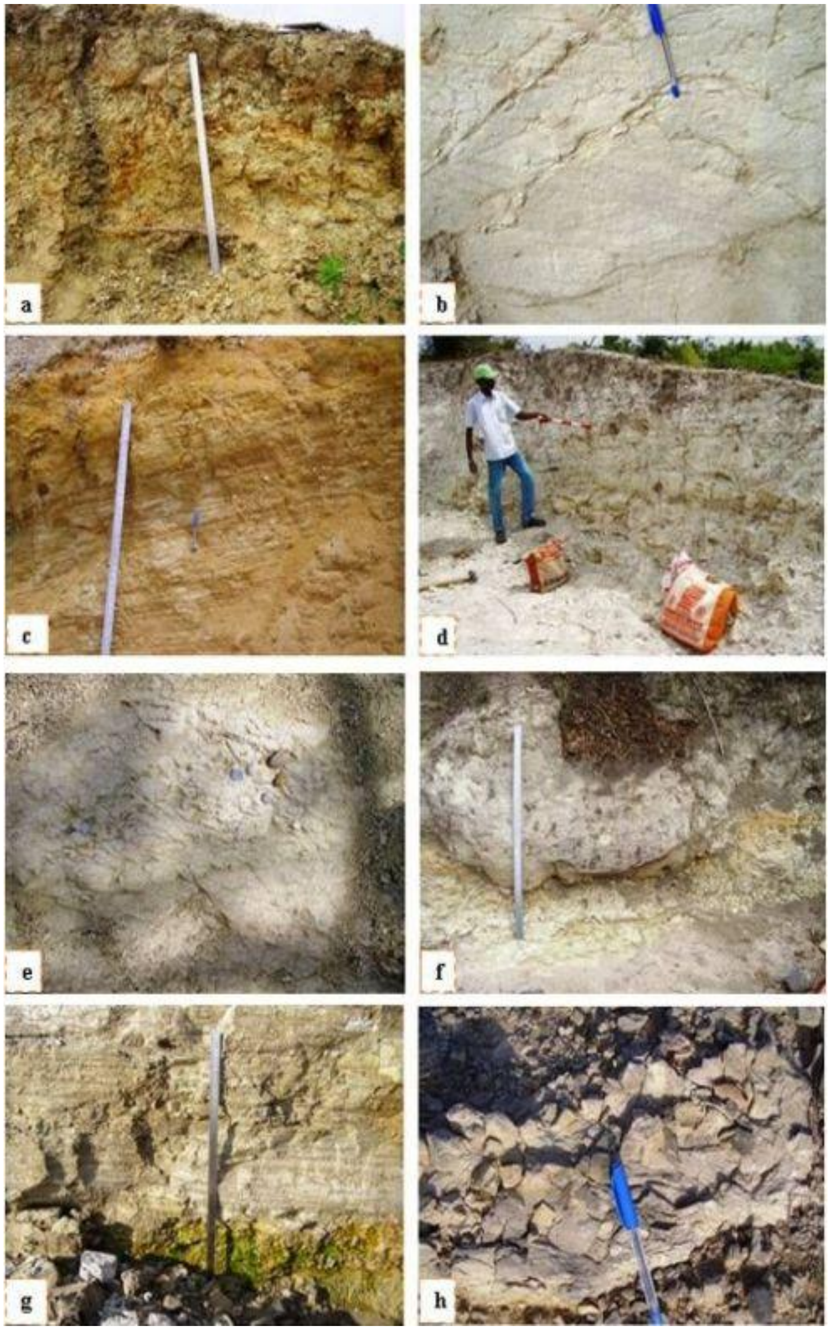

Figure 3: a. Photograph of KM-1 section showing upward fining sequence – sandstone, siltstone and clays towards top; b. Trough cross bedded sandstone of KM-II section; c. Plane bedded sandstone sequence at the bottom and fine siltstone and clays towards top in KM-II section; d. Photograph showing fine laminated whitish siltstone sequence towards top in the KM-II section e. Field photo exhibiting few polished quartz/quartzite pebbles in the sandstone unit north of KM-III section. f. Photograph showing coarse gritty sandstone overlying the fine sandstone/siltstone unit towards north of KM-III section – suggesting cyclic sedimentation; g. KM-IV section illustrates greenish and red clays at the bottom and fine laminated sandstone/siltstone towards top; and h. Mud crack features on the surface near KM-IV section.

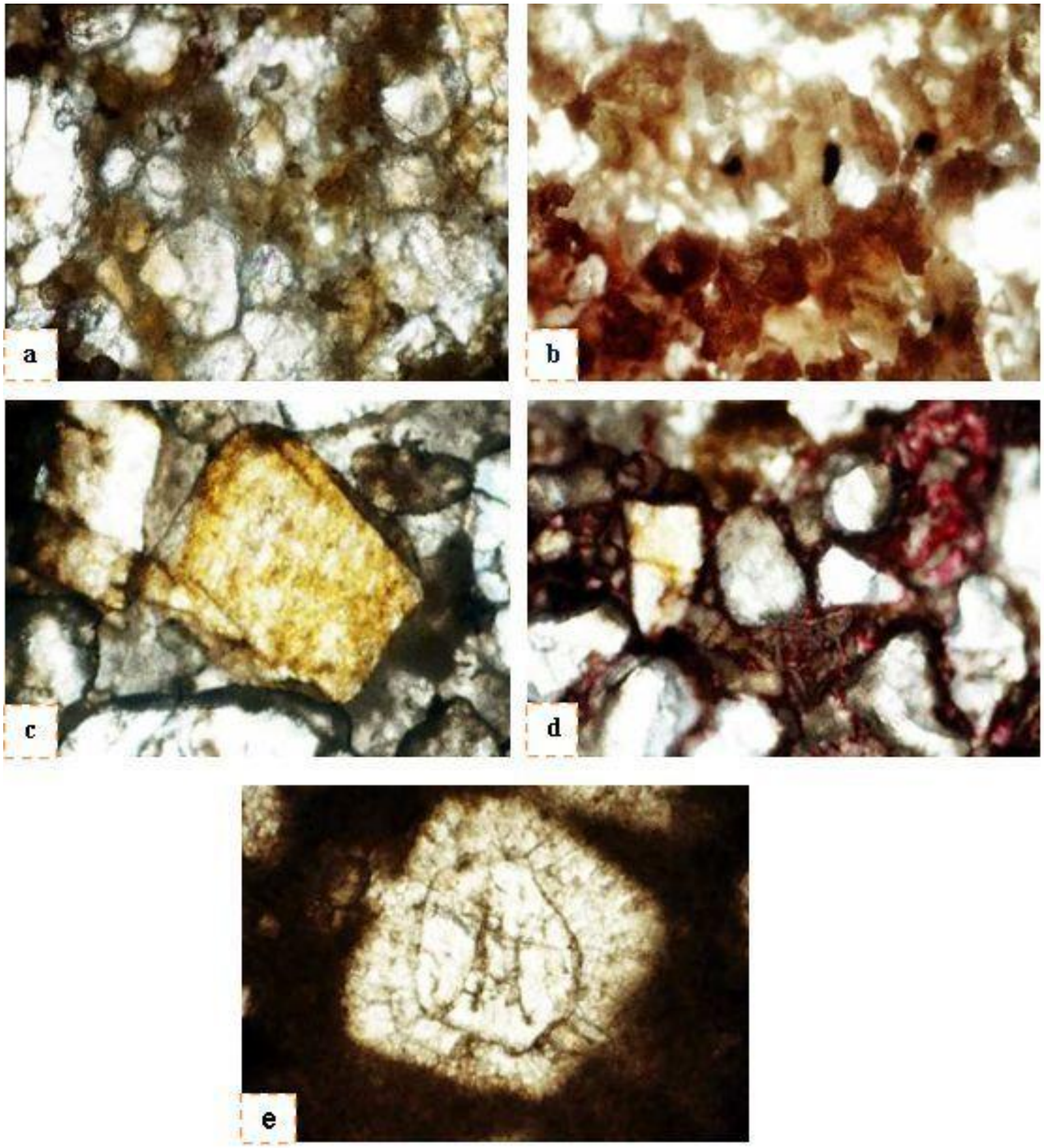

Fig. 4

Figure 4: a. Photomicrograph showing Calcareous wacke with assorted linear quartz grains with considerable amount of argillaceous matrix. (40x parallel); b. Microphoto of Micaceous wacke revealing biotite mica flakes along with linear assorted quartz and feldspar grains. (40x parallel); c. Photomicrograph exhibiting Calcareous conglomeratic subarkose with large unaltered feldspar and many angular quartz grains with considerable argillaceous matrix. (40x parallel); d. Argillaceous siltstone revealing considerable amount of clay matrix and assorted angular quartz grains. (100x parallel); and e. Photomicrograph shows two-tiers of carbonate cement around a quartz grain in a calcrete petrographic type (40x parallel).

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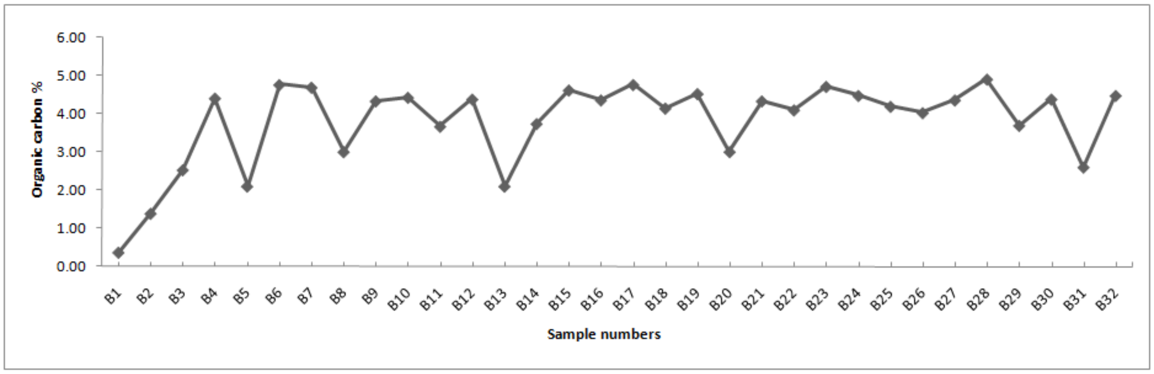

Figure 5: Distributive trend of organic carbon in Kallamedu Formation

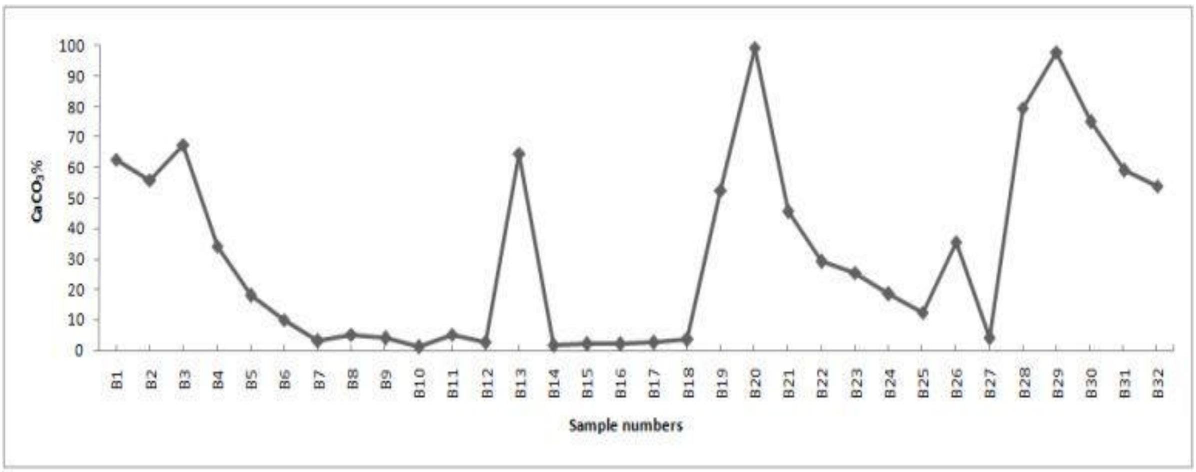

Figure 6: Distributive trend of calcium carbonate in Kallamedu Formation

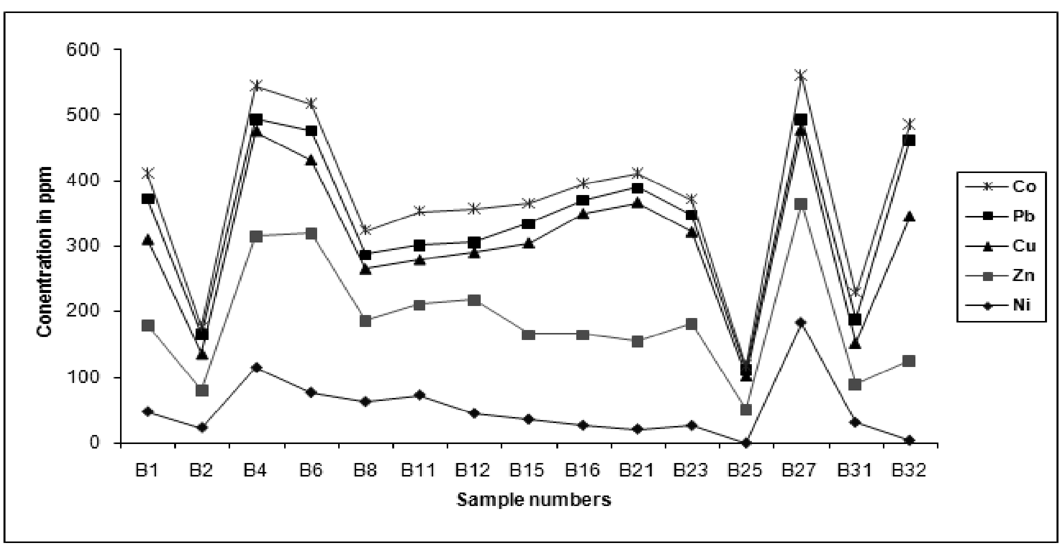

Figure 7: Distribution of trace elements in Kallamedu

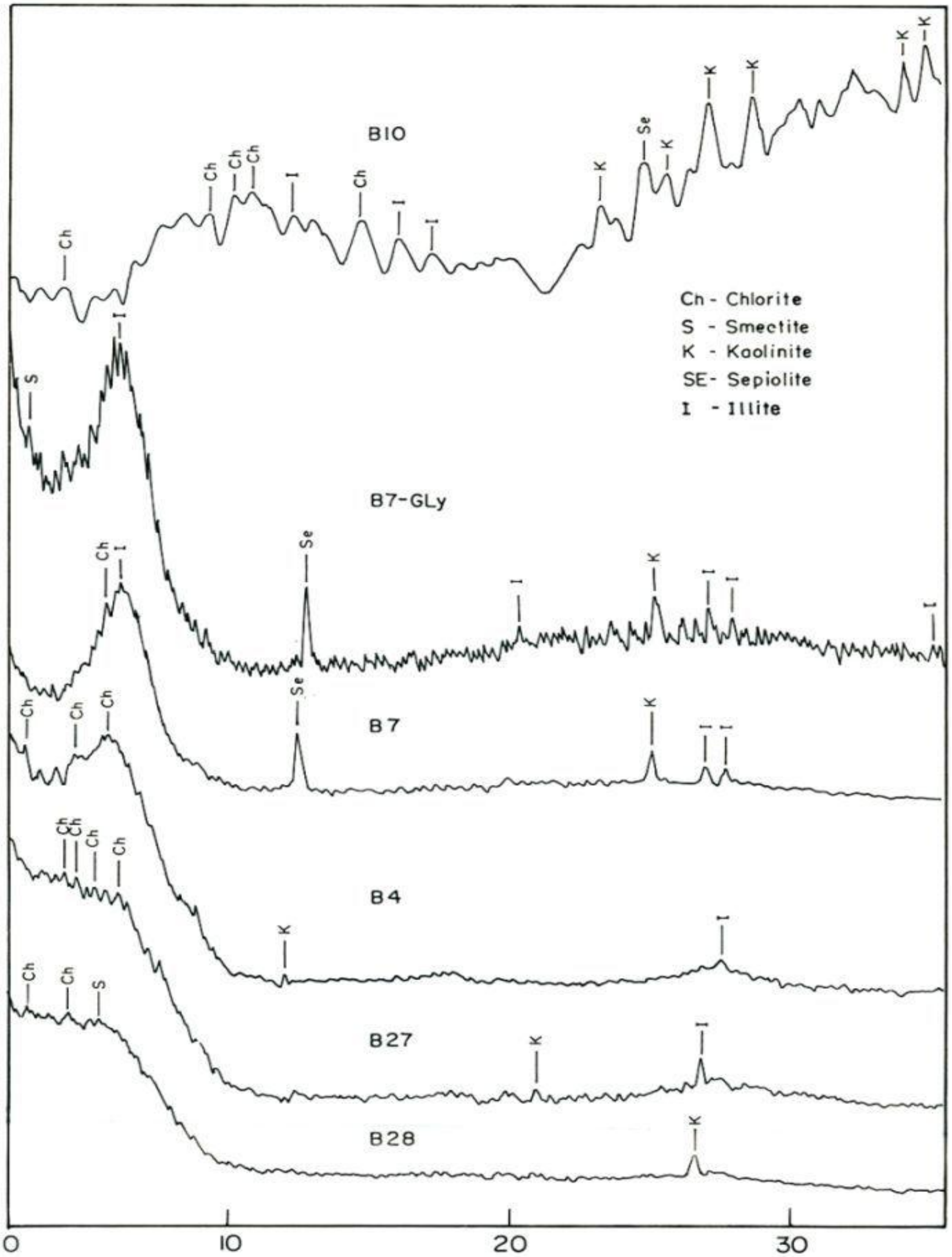

Figure 8: X-ray diffraction patterns of Kallamedu Formation

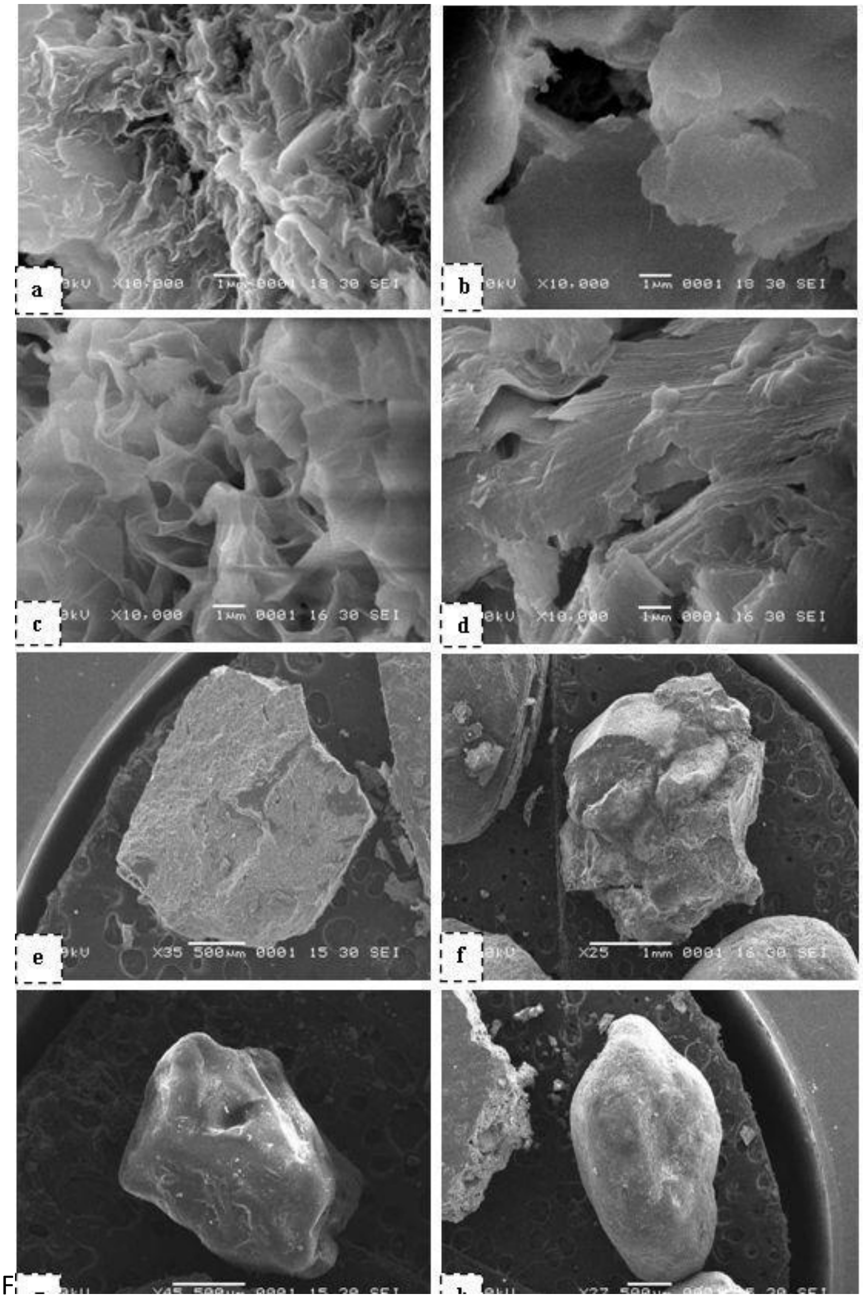

Figure 9: a&b. show the clay flakes within the pore spaces of clastic rocks; c&d. Crumbled clay flakes after expulsion of water from inter-spaces; e. SEM photographs of a angular quartz grain showing curved scratches on the surface; f. SEM photographs exhibit an angular clustered quartz grains and deep cracks and linear depressions on its surface; also seen are precipitations of calcite.
g. SEM photos of an angular quart grain showing deep depressions and curved scratches on its surface; h. SEM photographs showing a grain with a rounded outline and curved depressions along with argillaceous/calcite precipitation over its surface.

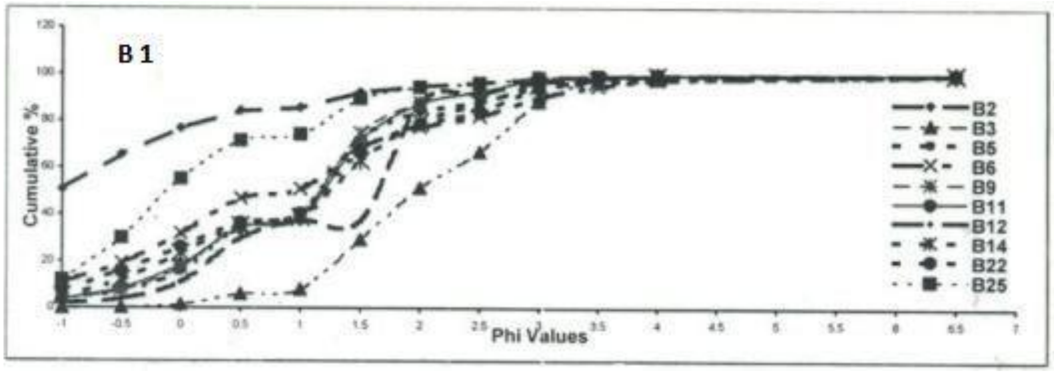

Figure10: Cumulative frequency curves of Kallamedu samples

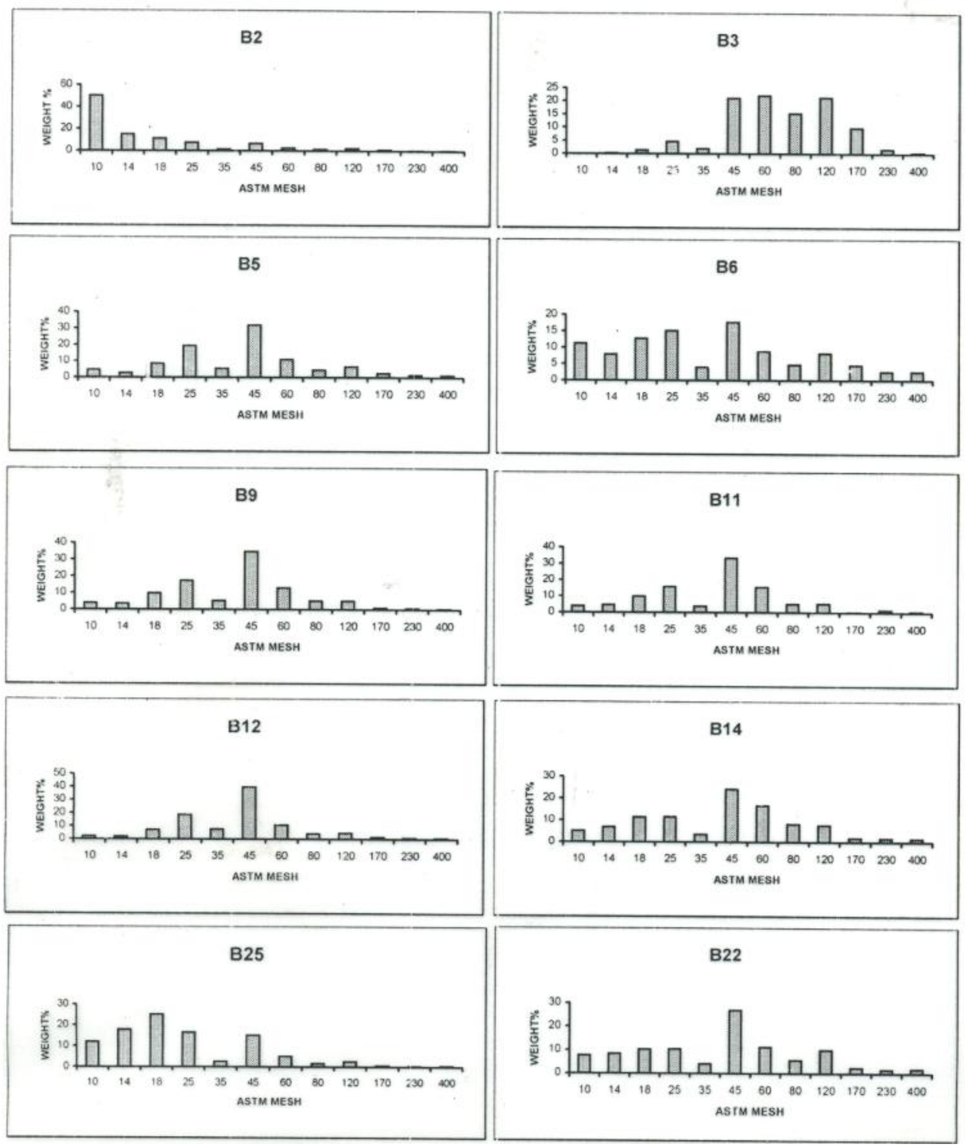

Figure 11: Histograms of Kallamedu samples

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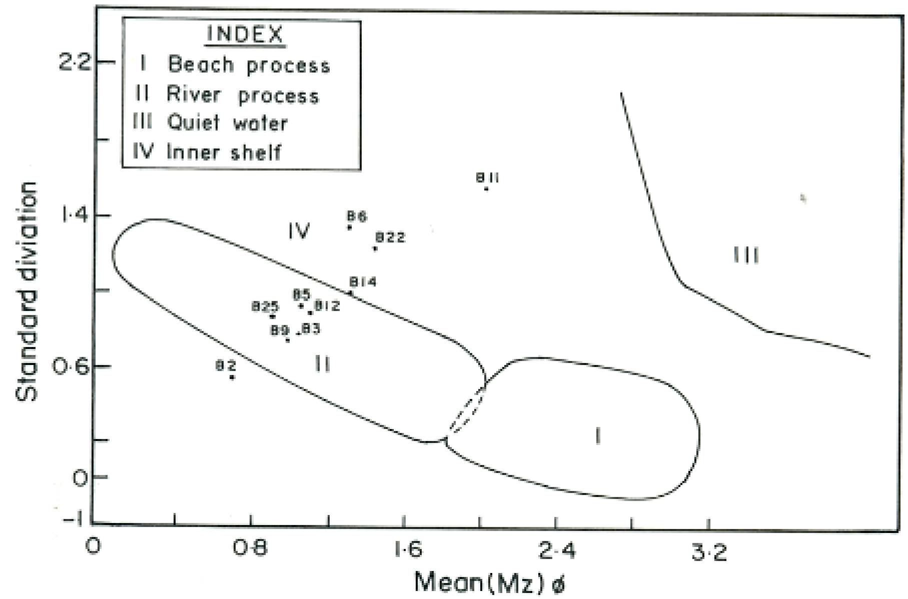

Figure 12: Energy process diagram *(after stewart, 1958)*

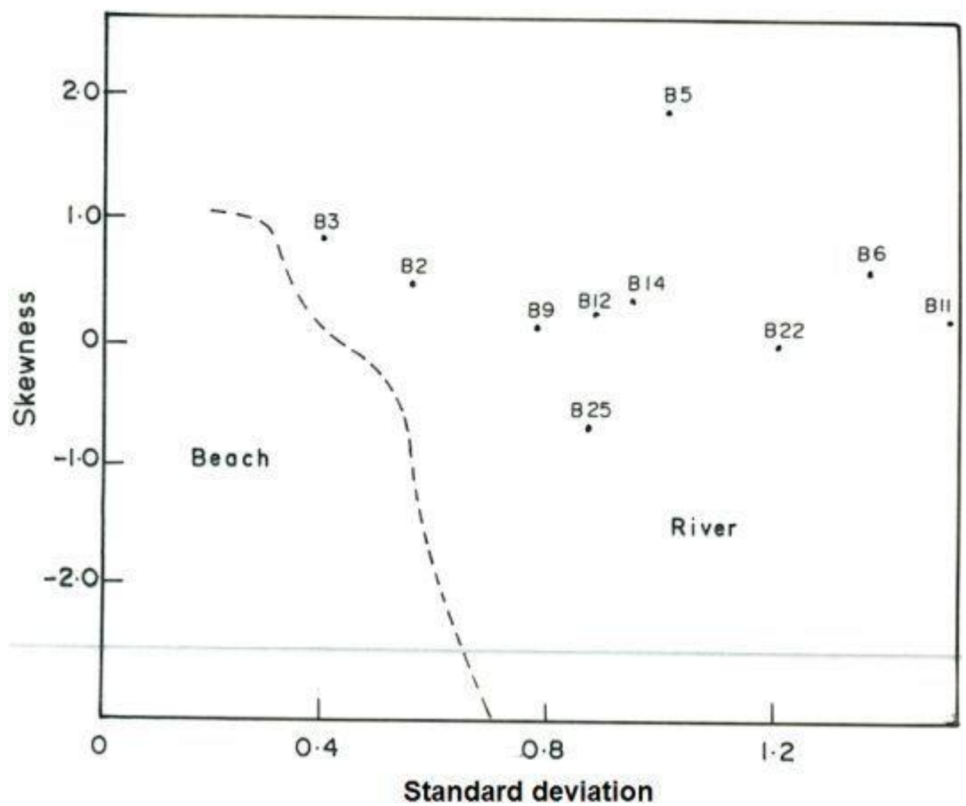

Figure 13: Standard deviation vs Skewness (After Friedman, 1959)

Table 1: Lithostratigraphy of Ariyalur group (modified after sastry *et al.*, 1972)

Group	Formation	Lithology	Age
	Niniyur		Danian
	Kallamedu	Unfossiliferous fine to Coarse grained inter-bedded with siltstone, sandy clay, ferruginous clay and marl	
	Ottakoil	Fossiliferous calcareous sandstone Interbedded with sandy clay	
	Kallankurichchi	Fossiliferous calcareous congolomeratic sandstone Interbedded with sandy clay, sandy fossiliferous limestone, fossiliferous limestone and marl	Maastrichtian
Ariyalur	Sillakkudi	Unfossiliferous calcareous sandstone, fossiliferous calcareous gritty sandstone, Fossiliferous calcareous sandstone Interbedded with sandy clay and thin band of sandy limestone	Campanian
Trichinopoly			Late Turonian tosantonian

Table 2: Grain size statistical parameter by graphical method

Sl.No	Sample No	Median	Mean M_Z	Standard Deviation σ	Skewness SK_1	Kurtosis K_G	Standard Deviation class	Skewness class	Kurtosis class
1	B2	1.1	0.666	0.568	0.524	0.861	Moderately Well sorted	Very fine skewed	Platykurtic
2	B3	1.3	1.100	0.803	0.417	0.585	Moderately sorted	Very fine skewed	Very platykurtic
3	B5	1.05	1.100	0.964	0.192	0.194	Moderately sorted	Fine skewed	Very platykurtic
4	B6	101	1.300	1.345	0.755	0.868	poorly sorted	Very fine skewed	platykurtic
5	B9	1.11	1.033	0.793	0.203	0.861	Moderately sorted	Fine skewed	platykurtic
6	B11	1.20	2.067	1.504	0.316	0.946	poorly sorted	Fine skewed	Very platykurtic
7	B12	1.14	1.100	0.887	0.255	0.894	Moderately sorted	Very fine skewed	platykurtic
8	B14	1.2	1.300	0.953	0.350	0.455	Moderately Well sorted	Very fine skewed	Very platykurtic
9	B22	1.19	1.400	1.225	0.177	0.676	poorly sorted	Very fine skewed	Very platykurtic
10	B25	0.00	0.733	0.858	-0.545	0.563	Moderately Well sorted	Near symmetrical	Very platykurtic

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The calcrete samples are typically showing interspersed assorted angular silty quartz grains with carbonate micritic matrix. The carbonate shows reticulate network of precipitation. Around the quartz grains, there are 2-3 tiers of bladed calcite crystals (Fig.4e) grown perpendicular on the surface of the grains in a semi-arid environment. Clouded micrite is identified at places in the microscopic view. The calcite present in the matrix took deep red stain with Alizarine red-S solution. Many cracks have also developed around quartz grains. These samples are collected on the surface of the siltstone in KM-IV section as well as in the middle part of KM-II.

Geochemistry

In the present study the organic carbon in the Kallamedu Formation ranges from 0.36 to 4.91 % (Fig.5) and the average estimated organic carbon content is 3.828 %. The lowest value is recorded in the sample B1 (0.36%) and the highest value in sample B28 (4.91%). The distributive trend of calcium carbonate shows enrichment in calcrete and calcite cemented sandstones/siltstones and depletion in other samples (Fig.6).

Trace elements content such as nickel, zinc, copper, lead and cobalt (Fig.7) are determined in the clastic rich samples. In general all the trace elements are pertained to clastic phase. The nickel concentration is found to be highest (182.9 ppm) in red clay (KM-IV) and the lowest level (3.9 ppm) is found in the fine siltstone sequence. The remaining samples exhibit the concentration ranging from 20.9 to 114.4 ppm. The highest concentration of zinc (243.4 ppm) is recorded in silty clay (KM-IV) and the lowest (50.4 ppm) content is found in the friable coarse sandstone. Other samples show varied content ranging from 56.7 to 201.1 ppm. The copper distribution is high (219.6 ppm) in the fine siltstone and low in friable coarse sandstone (51.6) and in the remaining samples it varies from 55.9 to 211.8 ppm. The Pb content is found highest (116.3 ppm) in the coarse fossiliferous calcareous sandstone (KM-I) and lowest in the friable coarse sandstone (9.2ppm) and its distribution in other samples ranges from 16.9 to 62.6 ppm. The Co is recorded highest in coarse bedded sandstone (66.2 ppm) and lowest in the very coarse calcareous sandstone (6.5 ppm). Rest of the samples shows a range from11.9 to 51.9 ppm.

Clay Mineralogy

Few representative samples which show high clay matrix content during petrographic observations and other clay rich samples were analysed in a Brucker Powder diffraction system. Illite is the major clay mineral present in almost all the samples and found to be a dominant species in the study area samples. Illite has been identified by the basal reflections at 6.05to 8.29Å, 26.62Å, and 27.65Å. And it is also identified by the presence of other reflections at 6.05Å and 8.69Å (Fig.8). It shows considerable variation across the litho-sequence. Illite may be formed by the alteration of mica minerals or kaolinite in a diagenetic environment. Smectite is another clay mineral present in all the samples. The presence of smectite is identified by the existence of expandable clay (B7-glycolated sample) which shows the expansion from 3 to 6Å peak. In the study the distinct 6 to 6.09Å glycolated peaks have been identified implying the presence of smectite species. Kaolinite is also present in almost all the samples and identified by the basal reflections at 24.84Å and 11.60Å. The presence of these reflections will interface and coincide with the reflections of chlorite. Kaolinite may be formed by the weathering of K-feldspars or by hydrothermal attack of acidic solution on feldspars and mica. Kaolinite shows major variation in its intensity and distribution (Figs.8). Chlorite is identified by the basal reflections at 7.74Å and 2.83Å. However because of interference and coincidence with kaolinite, it is also identified by the reflections at the 2.39Å and 11.9Å (Fig.8). The sepiolite species is identified in some samples by the reflections at 12.31Å and 12.33Å. Similarly montmorillonite is also recorded in few samples. It is identified by peak values of 7.32Å, 14.95Å, and 14.9Å. Its presence also reflected at 19.65Å.

In the Kallamedu Formations clays have deposited both as individuals beds as well as ingredients within pore spaces of siltstone and sandstone and an attempt has been made to resolve the structure of clay mineral species through SEM studies at higher magnifications (up to 10000 times the green clays of the KM-IV section shows clays flakes with interspace porosity as well as fractures due to expulsion of water and shrinkage (Figs.9a,b,c,d&e). These clays do not show horizontal stacking patterns. Perhaps slight churning actions by feeble energy conditions might have resulted in the chaotic deposition of clay flakes. However they seem to be detrital clays.

Grain Size and Surface Texture

Grain size analysis was carried out for 10 arenaceous rich samples of the Kallamedu Formation and the graphical statistical parameters (Table .2) were calculated using the formulae of Folk and Ward (1957). Besides the grain size data were used to establish histograms, frequency curves (Fig.10) and various bivariate plots to establish the transportation and depositional conditions. The mean size of the samples ranges from 0.666 to 2.067ϕ. The standard deviation values range from 0.568 to 1.504 and fall in the categories from moderately to poorly sorted. The sorting variations so observed are attributed to difference and variability in the velocity of depositional currents. The skewness values on the other hand range from 0.545 to 0.755 and indicate dominantly of fine skewed nature of the sediments. The sediments samples show kurtosis values ranging from 0.194 to 0.946 and the samples are distinctly very platykurtic. Histograms (Fig.11) established for all the samples support mixing of populations as already indicated by kurtosis values. The various bivariate plots (Figs.12&13) amply reveal the fluvial signatures in the sediments and therefore the depositional environment is dominantly a fluvial system.

In general most of the clastic quartz grains retrieved from the Kallamedu Formation exhibit angular outlines, conchoidal fractures, moderate relief and precipitation of clay flakes on them. But few other grains on the other hand reveal angular shape with sharp edges, surficial medium size pits, moderate relief and straight steps (Figs.9f). However few grains are very angular showing high relief, deep pits, conchoidal fractures, curved scratches and grain attritional cavities (Figs.9g). Rarely few grains show rounded outlines (Fig.9h) but originally they were subangular with moderate pits showing moderate relief. On many of the grains enormous deposition of argillaceous matrix along with infiltration $CaCO_3$ is clearly seen.

Depositional Environment

The Kallamedu Formation is the youngest unit of Ariyalur Group of sediments. It is dominantly made up of fine clastics of siltstone and clays. Sandstone is fine grain and is rare. However little numbers of coarser polished pebbles are found. Unlike other older formations, Kallamedu Formation is carbonate free (except calcrete) and encloses only casts of invertebrate fossils, perhaps they are derived from the older units. The in situ fossils are only dinosaurian remains. These dominant whitish to grayish colour fine sediments appear as floodplain fluvial system with over bank deposits and swamps to estuarine sediments. The occasional occurrence of trough cross bedded sandstone sequence is channel deposits whose current strength was variable and inconsistent. The bivariate textural plots also supplemented the data on fluvial signatures. Perhaps dinosaurs roamed around these lushy overbank swamps which are many sq.km in areal extent. The overbank deposition was continuous without many interruptions as evident from the absences of bioturbated features. The intense weathering of the Pre-cambrian gneissic and granitic rocks in the source area lying towards west released copious supply of fine kaolinitic clays to be deposited in the swamp basins. The vegetation growth has contributed organic matter enrichment in the fine sediments of the swamps. The occurrence of illitic clays could be attributed to diagentic alteration of kaolinitic clays in alkaline milieu. Latter at the end of the Maastrichtian the basin experienced a semi-arid climate with the development of calcrete layers at the top of the sequence. The SEM petrography of sand size grains reveals the angular nature which implies nearby source area which contributed these clastics. Thick coating of fine argillaceous material over the clastic grains points out the enormous movement of suspended sediments in the drainage systems which deposited sediments in the overbank swamps. Perhaps a good amount of reworked sediments from older Cretaceous units was possible with the occurrence of enormous number of casts of invertebrates.

Kallamedu Formation in the Ariyalur area is a distinct lithological unit which is underlain and overlain by true marine formations with enriched marine faunal materials such as Ottakoil and Niniyur (Paleocene) units. The Kallamedu sediments have suffered moderate burial diagenesis as evident from grains packing in thin sections. Few grain fracturing features are also observed.

Conclusion

i) Based on the present investigations of the Kallamedu Formation the following inferences as conclusion are presented.
ii) The lithology comprised of fine grained siltstones, argillaceous siltstones, fine laminated clays and minor occurrence of coarser sandstones and fine sandstones enclosing polished pebbles.
iii) The petrograhic analysis also reflects the field observations of lithological variations with the identifications of argillaceous wackes, calcretes and minor arenites.
iv) The grain size data reveals that the Kallamedu samples dominantly made with fine sediments with moderate to poorly sorted nature, fine skewed and platykurtic. Majority of the histograms fall within the category of bimodality and the sediments likely deposited in a moderate fluvial energy in terminal fluvial setting. Coarse sediments and cross bedded other sandy materials deposited in the channels and fine materials of silt and clay over flood plains. The organic remains found in the KM-I section are casts and brought from older marine sequence.
v) The clays are dominant with illite, kaolinite followed by smectite and chlorite. The illite and chlorite have formed more in a diagenetic environment.
vi) Organic carbon content is quite high in many of the samples due to restricted oxygen circulation in a swamp environment with deposition of more plant debris. The distribution of $CaCO_3$ is largely controlled by calcite cement and calcrete presence. The distribution of trace elements is accommodated more in the detrital phase.

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