Petrography of the Sedimentary Rocks in and Around Vanur, Pondicherry Area

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Abstract-Textural studies, Petrography and magnetic susceptibility studies were carried out the sedimentary rock materials in and around Vanur, Pondicherry area. The descriptive petrography of sandstone and claystone in Katrambakkam, Vanur and Thoruvai were studied in the field as well as in the laboratory to understand the depositional and post-depositional sedimentary processes

Keywords: Vanur, Sandstone, Petrography, Magnetic susceptibility

INTRODUCTION

Sedimentary units are types of rock units that are formed by the deposition and subsequent cementation of that material at the Earth's surface and within bodies of water. Before being deposited, the sediment was formed by weathering and erosion from the source area, and then transported to the place of deposition by water, wind, ice, mass movement or glaciers, which are called agents of denudation. Sedimentation may also occur as minerals precipitate from water solution or shells of aquatic creatures settle out of suspension. The Cretaceous period was one of the most eventful time –spans in the Indian geological history. The Pondicherry area occupied one of the important palaeogeographical locations in Indo-pacific region during the Cretaceous period. The marine transgressional and regressional sedimentary sequences of the study area have acted as repositories for the accumulation of varying litho-units with rich faunal and floral assemblages. But the sedimentary units in Pondicherry area is one of the least studied sedimentary unit in south India. The rocks exposed in and around Puducherry are represented by Valudavur, Mettuveli, Karasur, Manaveli, Cuddalore formations in chronological order.

The geochemical studies of sedimentary rocks are significant to interpret the provenance, source rock composition, weathering intensity and the tectonic settings. (Dickinson and Suczek, 1979; Nesbitt and Young, 1982; Bhatia, 1983; Bhatia and Crook, 1986; Roser and Korsch, 1986, 1988; McLennan and Taylor, 1991; McLennan, 1989, 1993, 2001; McLennan et al., 1993; Madhavaraju and Ramasamy, 2002; Nagarajan et al., 2007a, b; Madhavaraju and Lee, 2010; Madhavaraju and Gonzalez-Leon, 2012; Madhavaraju et al., 2016; Armstrong-Altrin et al., 2013)

STUDY AREA

Puducherry region is situated on the Coromandel Coast between 11°45′ to 12°03′N and 79°37′ to 79°53′E with an area of 293 sq. km. The Cauvery rift basin trending NE-SW, ranges from Late Jurassic to Early cretaceous (Powell et al., 1988).

The study area is mainly concentrated in Vanur, Pondicherry area. It is located near to the border of Pondicherry union territory in the Villupuram district of Tamil Nadu state. The study area is 30km away from Tindivanam on the way to Pondicherry and it is 10km away from Pondicherry city. The study area is located about 7km away from the eastern coast of India.

Fig.1. Study area with sample locations

Geologically, the area under investigation consist of Vanur sandstone, Turuvai limestone, Ottai clay, Cuddalore sandstone of tertiary and followed by gneisses and charnockite of Archean age.

The Vanur sandstone is overlained by Ottai claystone, which is light grey or dull green, splintery when dry and has incipient fissility. This formation contains rich foraminiferal assemblage which indicates a Maastrichtian age (Sastry et al., 1973, 1981). The Turuvai limestone conformably overlies the Ottai claystone and it composed of oyster limestone, calcareous sandstone and claystone. Clay and sand are invariably present in the limestone.

Therefore, in the present paper, it is attempted to understand the minerals and its association in the rock units, the geochemistry of the rocks and the Magnetic susceptibility nature of the rock units.

MATERIALS AND METHODS

Sedimentary samples were collected from five different locations of Vanur, Pondicherry area.

Table .1. Details of sample collection.

Sl No.	Location	Latitude	Longitude	Type of Sample	Lithology
1	Katrambakkam (station 1)	790 45’ 11” E	120 3’ 27.1” N	Hand specimen Core sample	Sandstone/ Grit
2	Katrambakkam (station 2)	790 45’ 6.5” E	120 3’ 26.7” N	Hand specimen	Sandstone
3	Vanur	790 44’ 04” E	120 01’34.8” N	Hand specimen	Sandstone/ Grit
4	Panjavadi	790 46’ 09” E	120 0’ 48.9” N	Hand specimen	Limestone
5	Thoruvai	79045’ 54.4”E	120 1’ 32.4” N	Hand specimen	Claystone

TEXTURAL ANALYSIS: The samples collected from various locations are crushed and the pebbles and other quartz grains are collected from the crushed samples. These grains are observed under binocular microscope or Petrographic microscope and photos of the textures are taken.

PETROGRAPHY: THIN SECTION STUDIES

The petrographic studies were made from the thin sections of sandstone, limestone and claystone samples. The primary constituents like quartz, feldspars, mica, and rock fragment were studied with the help of petrological microscope.

Modal analysis involves identification of rock constituents at a number of, points in a thin section. The number of points counted per thin section, and therefore the labor intensiveness of the analysis, depends upon the precision required. For most applications, at least 300 points must be counted per thin section to ensure an acceptable level of precision. Data derived from point counting is used to evaluate quantitative rock properties.

HEAVY MINERAL ANALYSIS

Heavy minerals are concentrated naturally by hydrodynamic sorting, usually in shallow marine or fluvial depositional setting. The cleaned fraction of 120 mesh was separated for heavy minerals using bromoform (2.89 specific gravity) as separating medium and centrifuged for 10 minutes. After separating the lighter fraction carefully the heavy minerals were transferred to small glass bottles.

MAGNETIC STUDIES

The magnetic susceptibility (MS) in soils is a fast and non-destructive technique that can be used to infer the concentration of magnetic minerals. The 7 samples were taken which include sandstone, limestone and claystone with approximately 10 gram, packed tightly into a standard $10cm^3$ cylindrical Perspex holders for magnetic analysis (magnetic susceptibility, χfd %. Neither magnetic nor χfd is useful grain indicator by itself, however, for each is dependent on the concentration of the magnetic minerals in the samples as well.

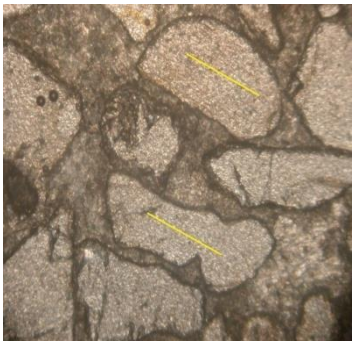
RESULTS AND DISCUSSION

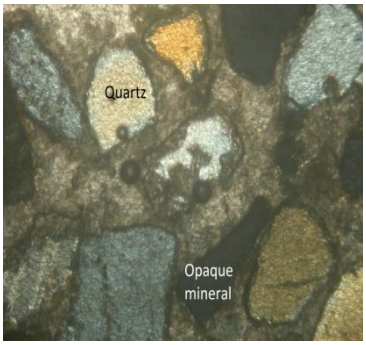
The textural features of sedimentary rocks are studied in order to understand the transport condition and depositional environment. The pictures of quartz grains that are taken using Petrographic microscopes are used to study the surface textures. The surface textures identified from the samples are given below.

The important surface textures identified are Conchoidal fractures, Solution cavity, Ridges, Pits, V shaped pits, Straight scratches and Pits filled with secondary materials. The Conchoidal fractures in the quartz grains indicate the littoral environment (beach and near shore). This shows that these sedimentary formations are formed in near shore environment. The V shaped pits are surface textures that are formed by chemical etching and it can form mechanically also. The solution cavities are surface textures that are formed by chemical weathering of grains. In this solution cavity secondary minerals are filled during precipitation. The textures such as scratches, pits and ridges are developed during the transportation process of the sediments. The straight scratches are good indication for traction mode of transportation.

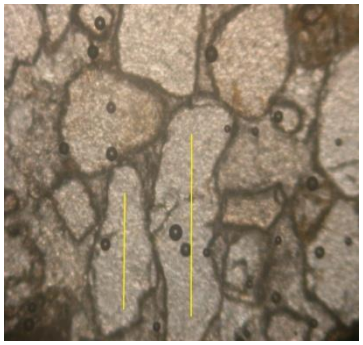
From these surface textures it is inferred that the sediments were transported from different areas and deposited in near shore environment. Then the marine transgression and regression would have resulted in chemical weathering and precipitation in the sediments.

Thin sections of 6 samples were made and analyzed under Petrological microscope. The primary constituents like quartz, feldspars, mica, and rock fragment were studied under plane polarized light and cross polarized light. The photos of the thin sections taken using Petrological microscope are given below.

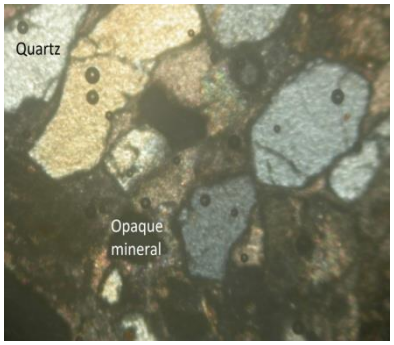




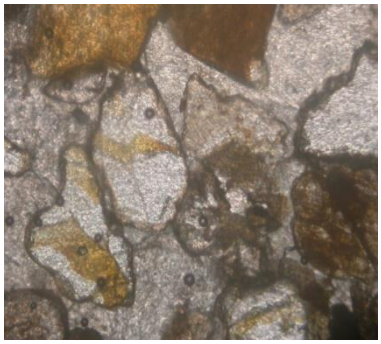
Katrambakkam sandstone-1(pp)



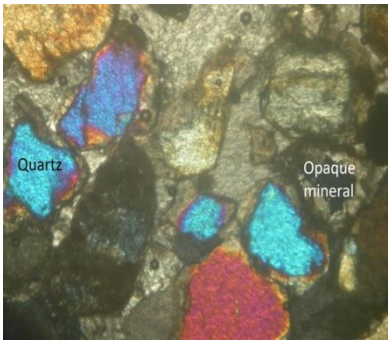
Katrambakkam sandstone-1(xpl)



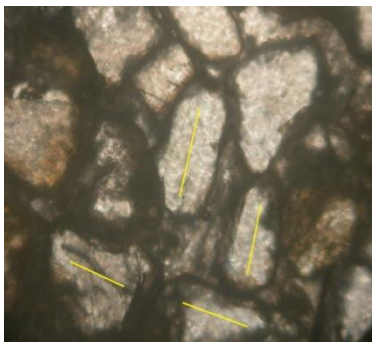
Katrambakkam sandstone-2(pp)



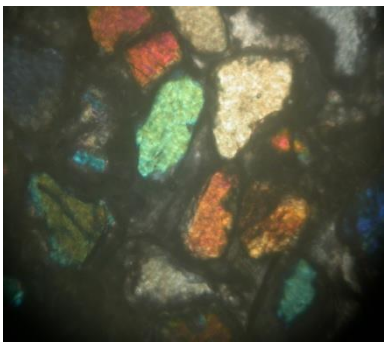
Katrambakkam sandstone-2(xpl)



Katrambakkam sandstone-3(pp)



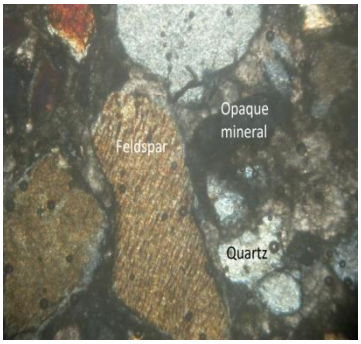
Katrambakkam sandstone-3(xpl)



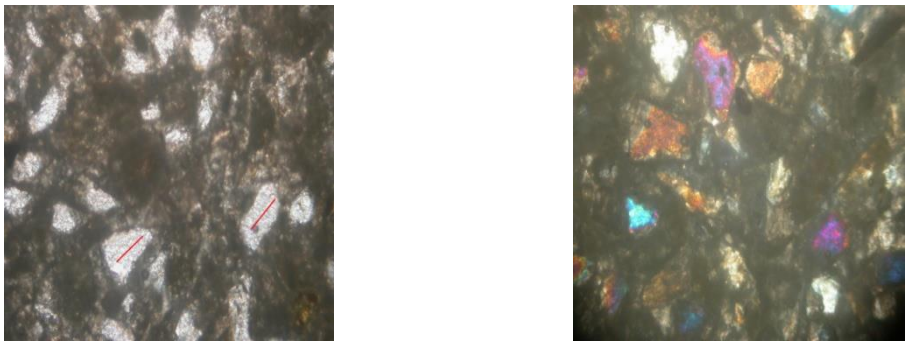
Vanur sandstone -1(pp)

Vanur sandstone -1(xpl)

Vanur sandstone -2(pp)



Vanur sandstone -2(xpl)



Panjavadi limestone | Panjavadi limestone (xpl)

Fig.2. Microphotographs of rock thin sections

The clast in sandstone shows sub angular texture. The long axes of the grains are facing single direction. The rock sample is mostly matrix supported and the clast is floating in the matrix. The clast materials mainly contains quartz, feldspar and opaque minerals.

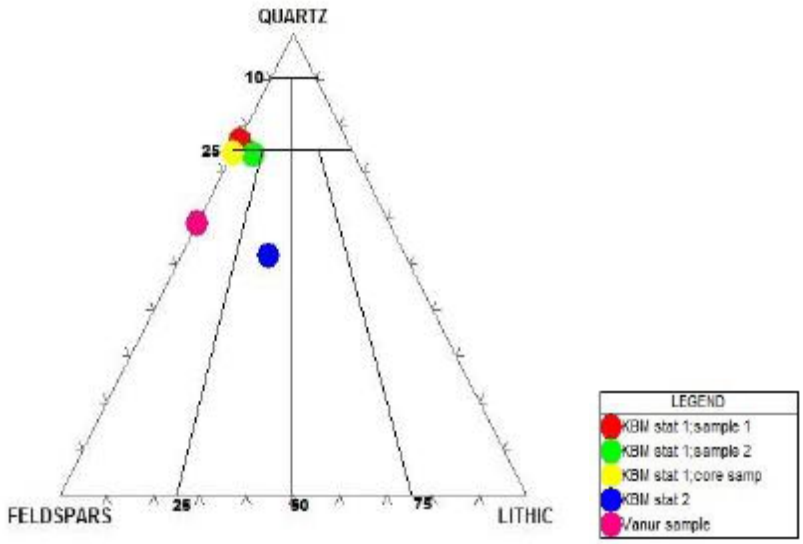


Fig.3. QFL plot for the samples

The classification of sandstone shows that the sample 1 sandstone of Katrambakkam station 1 is subarkose. Then the sample 2 and core sample of the Katrambakkam station 1 is arkose. The Vanur sandstone is also arkose in nature. Whereas, the sandstone of the Katrambakkam station 2 is a lithic arkose.

The modal analysis results gives the data that the sedimentary formations in the Vanur, Pondicherry area is quartz rich. The Thoruvai claystone has a high amount of feldspars than that of other formations. Opaque minerals are very less in Thoruvai claystone. Mica is present in all the formations almost in same amount. The core sample of Katrambakkam sandstone and Vanur sandstone is having the presence of Olivine. Opaque mineral concentration is high in Katrambakkam sandstone.

The magnetic data shows that frequency is less for both Vanur sandstones in low frequency and high frequency graph. In both high frequency and low frequency graph frequency is high for Thoruvai claystone. Magnetic susceptibility of Vanur sandstone is very less, where it is very high for Thoruvai claystone. Magnetic susceptibility is moderate for Katrambakkam sandstones & Panjavadi limestone. From this magnetic susceptibility studies, it can be infered that the concentration of ferromagnetic minerals are high in the Thoruvai claystone, whereas it is less in Vanur sandstone.

From the results of heavy mineral analysis, it is found that in all the samples percentage of garnet is high. In every sample 25% of magnetite is present. In the case of hypersthene the Vanur sample is having high percentage than that of other two samples. The percentage of Olivine is almost the same for all the samples, about 10%. According to the data produced, high percentage of zircon is identified in all samples compared to hypersthene and olivine. From the data, it is confirmed that higher amount of garnet, magnetite and zircon is present in all the samples.

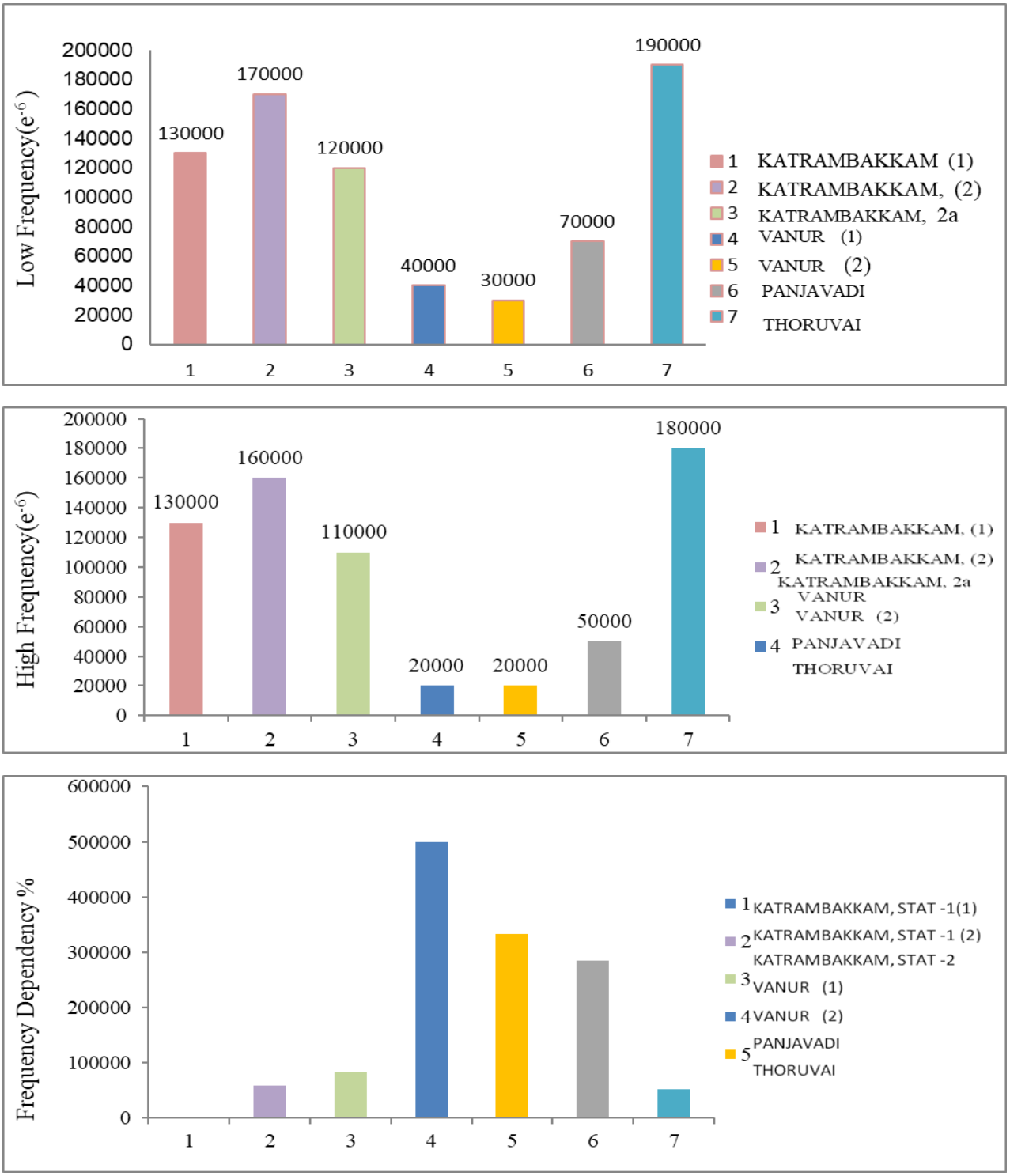


Fig.4. Bar diagram of magnetic susceptibility & frequency dependency of susceptibility

CONCLUSIONS

Litho units in Pondicherry area shows the clast materials in sandstones are moderately sorted and sub-angular to sub-rounded indicating the sediments are transported for short distance. The claystone consist platy minerals as clast, orienting in different direction indicating slow settling of fine sediments within the basin. Limestone consists of carbonate matrix and cement which indicating, the sedimentation occurred by the precipitation of dissolved carbonates within the basin. Also indicating the sediments are autochthonous. The modal analysis results gives the data that the sedimentary formations in the Vanur, Pondicherry area is quartz rich. The important heavy minerals are garnet, magnetite and zircon indicate the provenance of sediments are igneous, metamorphic and sedimentary. The surface textures suggests the traction mode of transportation of sediments. The solution cavity indicate chemical action and these cavities are filled with carbonate materials during late diagenesis. Thoruvai claystone shows high magnetic susceptibility, which indicates that the ferromagnetic mineral concentration in claystone is high. The iron rust colors in the Thoruvai claystone sample also represent the presence of ferromagnetic minerals.

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