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X-Ray Diffraction Patterns for Quantitative Analysis of Coastal Sediments in Between Mandapam And Vembar, Gulf of Mannar Coast, South India

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***Abstract*- Quantitative analysis was carried out to determine the major and minor constituent minerals present in sediment samples collected at the coastal region between in Mandapam and Vembar, Gulf of Mannar coast, South India by XRD technique. The grain-size distributions of sediments are studied in the study of grain size in relation to mechanism of sediments deposition. The composition of the coastal sediment is dominated by medium to fine sand. The distribution pattern and textural parameters of sediments vary regionally in the Ramanathapuram coastal sediment distribution. Based on the texture of sediments it can be said that the beach consists of medium to fine sand was domains. Sedimentological studies reveal that depositional patterns in the beach are mostly controlled by fluvial and marine processes. The deposition of medium to fine sands in the extreme in our study area attributed to the discharge Vembar and Gundar Rivers. Further, the representative sediment samples were analyzed by XRD technique to yield more information about the minerals. X-ray diffraction methods were non-destructive and can be used in the identification of mineralogical composition. These results confirmed that the applied techniques are relatively quicker and more reliable in mineral analysis. The X-Ray diffraction sediments sample analysis proved that the minerals of calcite, quartz, orthoclase, microcline, biotite, hypersthene, hornblende, albite, anorthite sepiolite, illite, chlorite, halloysite Montmorillonite, halite and heavy mineral garnet, zircon, sillimanite, topaz, cobaltite, kyanite, magnetite, hornblende and ilmenite. The followed by minerals are derived from Recent Alluvium and Southern Granulite Terrain in India.**

Keywords*— *Coastal sediments- XRD- Mandapam and Vember-Tamilnadu.

1. INTRODUCTION

Over the past century, X-ray diffraction (XRD) has gradually become one of the most important analytical approaches used in the qualitative and quantitative study of geological samples (Clark and Reynolds, 1936; Nagelschmidt, 1938; Taylor, 1978; Bish, 1994; Srodon, 2002; Chipera and Bish, 2013). XRD analysis is believed to be the most suitable method for routine quantitative analysis compared to any other single technique, such as Fourier transform infrared spectroscopy (FTIR), chemical analysis and electron microscopy (Bish and Post, 1993; Mumme et al., 1996). The study has been carried out from Mandapam to Vembar (latitudes 9°04' to 9° 16' N and longitudes 78°21' to 79°11' E) in the southern coastal tract of Tamilnadu. It is aimed to unearth the coastal sediments, nature of minerals and their provenance. The grain-size distributions of sediments are studied in the study of grain size in relation to mechanism of sediments deposition. The composition of the coastal sediment is dominated by coarse and medium sand. It is occur in group with the coarse sand and exhibit different shapes and varying roundness. The variation in shape and roundness of pebbles could be attributed to lithological variation but not to the competence and distance of transportation. The distribution pattern and textural parameters of sediments vary regionally in the Ramanathapuram Coastal sediment distribution (Karikalan et al., 2020 a, b, c; Karikalan, 2002, 2013; Kongeswaran and Karikalan, 2015). Based on the texture of sediments it can be said that the beach consists of coarse and medium sand was domains. The deposition of coarse and medium sands in the extreme in our study area attributed to the discharge Vembar and Gundar Rivers. The X-Ray diffraction sediments sample analysis proved that the minerals of calcite, quartz, orthoclase, microcline, biotite, hypersthene, hornblende, albite, anorthite sepiolite, illite, chlorite, halloysite Montmorillonite, halite and heavy mineral garnet, zircon, sillimanite, topaz, cobaltite, kyanite, magnetite, hornblende and ilmenite. The followed by minerals are derived from Recent Alluvium and Southern Granulite Terrain.

2. STUDY AREA

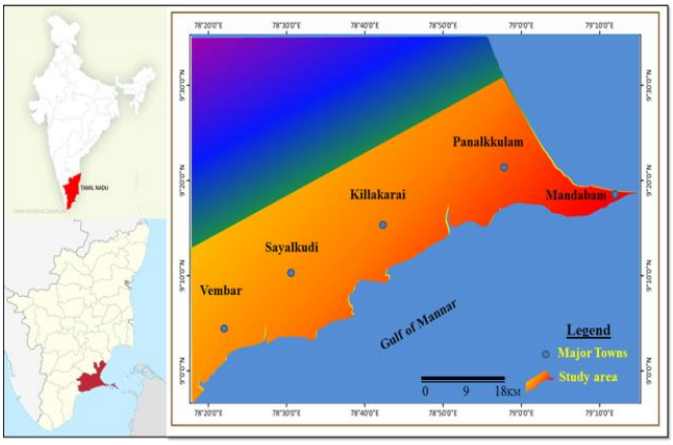

Figure 1. Location map of the study area.

In the southern coastal tract of Tamilnadu covering about 360km the study area has covered from Mandapam to

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 04, April-2020

Vembar (latitudes 9°04' to 9° 16' N and longitudes 78°21' to 79°11' E), has been undertaken for this study. It has covered the districts of Ramanathapuram and Tuticorin coastal area of 101 km. The area falls in the Survey of India, Toposheet number 58K/16 and 58O. It is bounded in the North Eastern side by foot shaped Rameshwaram Island, in the East by the Bay of Bengal, in the west by Western Ghats and in the south by Kanyakumari which is being the southernmost tip of India. The location map of the study area is shown in Fig. 1.

3. MATERIALS AND METHODS

The selected representative of 10 beach sediment samples from the study area was subjected to X-Ray diffraction analysis through XRD instrument "X PertPro" installed in the laboratory of the department of physics, Alagappa University, Karaikudi. The powdered beach sediment samples were directly analysed for general mineralogical studies by setting 2Θ position values from 0-80º in the XRD instrument. The XRD patterns or X-Ray diffraction of the mineral were identified through respective D spacing values and their intensity (Sachinath Mitra 1989) and also from other published literatures. The D spacing values, 2 theta values, relative intensity and name of the minerals are given in the table.

4. RESULT AND DISCUSSION

4.1. X Ray Diffraction Analysis

Over the past century, X-ray diffraction (XRD) has gradually become one of the most important analytical approaches used in the qualitative and quantitative study of geological samples (Srodon, 2002; Chipera and Bish, 2013). Many important theoretical works have been published for the application of qualitative and quantitative work (Chipera and Bish, 2013 and Perumal Velmayil, 2017). XRD analysis is believed to be the most suitable method for routine quantitative analysis compared to any other single technique, such as Fourier transform infrared spectroscopy (FTIR), chemical analysis and electron microscopy (Bish and Post, 1993). This chapter discussed the mineral identification through the X-ray diffraction analysis. The X Ray Diffraction analysis is based on Bragg's law. Tamilnadu coast is the second largest coastal region in India after Gujarat coast. The present study area covers a total length of about 100 km covering coastal districts of Ramanathapuram and Tuticorin. The selected representative of 10 beach sediment samples from the study area was subjected to X-Ray diffraction analysis through XRD instrument "X PertPro" installed in the laboratory of department of physics, Alagappa University, Karaikudi. The powdered beach sediment samples were directly analysed for general mineralogical studies by setting 2Θ position values from 0-80º in the XRD instrument. The mineralogy of the collected ten samples of beach sediments (Table 1- 8) of the coastal area was determined through X ray diffraction analysis. The sample is powdered, mounted on a glass slide and then bombarded with X-rays. Planes of atoms in the crystal structure diffract the X – rays and a pattern is produced on a paper chart. When a powdered sample is analyzed, diffraction occurs for each angle of incidence that satisfies the Bragg equation-ray diffraction produces a unique series of reflections on the strip chart, which is known as diffractogram. In X-ray diffraction minerals are identified through'd' spacing values and their respective intensities (Table 1 to 10). The X-ray diffraction patterns of the beach sediment are shown in Fig. 1 to 10. The x ray diffractogram are identified with the help of the book (sachinath Mitra) and other published literatures. The D spacing values, 2 theta values and name of the minerals are given in the table. The diffraction patterns of the minerals are given in figure.

SB 1			
S.No	**Pos. [°2Th.]**	**d-spacing [Å]**	**Minerals**
1	20.6817	4.290	Quartz
2	23.4062	3.800	Carnalite
3	26.4737	3.366	Quartz
4	27.3928	3.256	Leucite
5	27.8564	3.203	Reinerite
6	30.827	2.901	Epidote
7	32.3913	2.764	Ilmenite
8	34.6236	2.591	Sphene
9	36.3837	2.469	Quartz
10	40.1525	2.246	Stishovite
11	42.2438	2.139	Monazite
12	45.653	1.987	Quartz
13	48.6108	1.873	Calcite
14	53.0672	1.726	Ilmenite
15	54.9387	1.672	Biotite
16	59.7926	1.547	Quartz

Table 1. X-Ray Diffraction values in Vembar Beach sediment

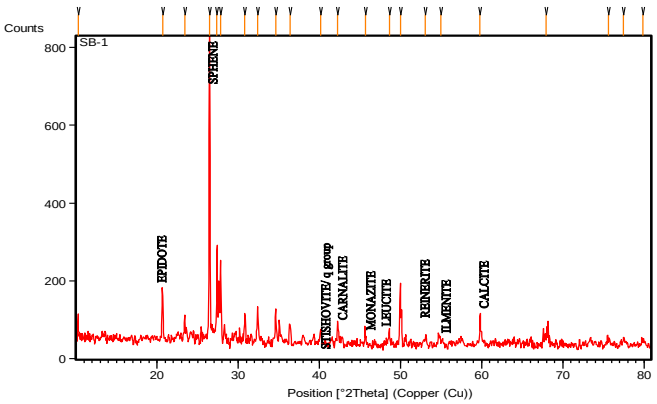

Figure 1. XRD pattern in the Vembar Beach sediment Beach sediment

SB2			
S.No	**Pos. [°2Th.]**	**d-spacing [Å]**	**Minerals**
1	20.6014	4.311	Riebeckite
2	26.3843	3.378	Kaolinite
3	26.8655	3.318	Quartz
4	27.3054	3.266	Terlinguaite
5	27.7805	3.211	Bismuth-sulphur
6	29.6307	3.013	Labradorite
7	30.1696	2.963	Wollastonite
8	36.3341	2.472	Enstatite
9	45.5776	1.990	Halite
10	49.9371	1.826	Azurite
11	59.694	1.549	Quartz
12	68.071	1.378	Hubnerite
13	75.4262	1.259	Halite

Table 2. X-Ray Diffraction values in Vembar River North-Beach sediment

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 04, April-2020

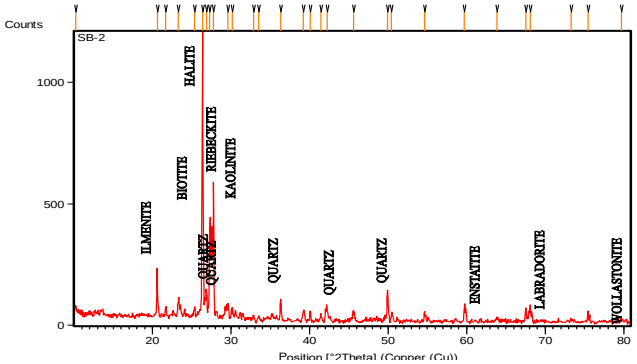

Figure 2.XRD pattern in the Vembar River North - Beach sediment

SB3			
S.No	**Pos. [°2Th.]**	**d-spacing [Å]**	**Minerals**
1	20.6766	4.296	Sepiolite
2	24.1604	3.680	Sodalite
3	26.47	3.367	Muscovite
4	27.3703	3.258	Crocoite
5	29.6392	3.013	Quartz
6	36.384	2.469	Calciotale
7	39.3019	2.292	Cobaltite
8	45.64	1.987	Wavellite
9	50.0014	1.825	Azurite
10	59.765	1.547	Quartz
11	67.9817	1.379	Hubnerite

Table 3. X-Ray Diffraction values in Narippaiyur Beach sediment

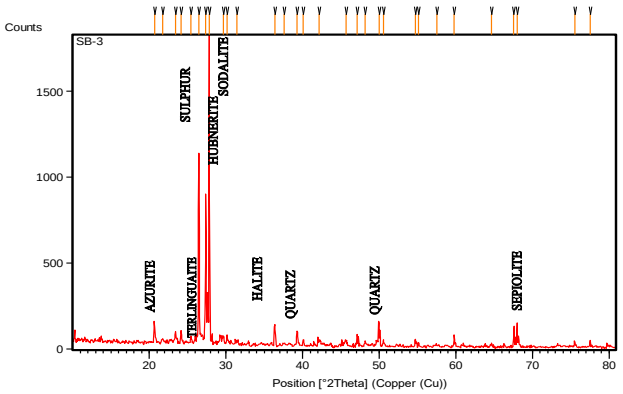

Figure 3. XRD pattern in the Narippaiyur Beach sediment

SB4			
S.No	**Pos. [°2Th.]**	**d-spacing [Å]**	**Minerals**
1	20.6581	4.299	Sepiolite
2	23.3793	3.805	Carnallite
3	26.4469	3.370	Quartz
5	27.8232	3.206	Albite
6	28.2219	3.142	Kyanite
7	42.2798	2.138	Chamosite
8	49.9722	1.825	Azurite
9	50.5177	1.806	Copper
10	59.7494	1.547	Tungstenite
11	75.4737	1.259	Tenorite

Table 4. X-Ray Diffraction values in Mukaiyur Beach sediment

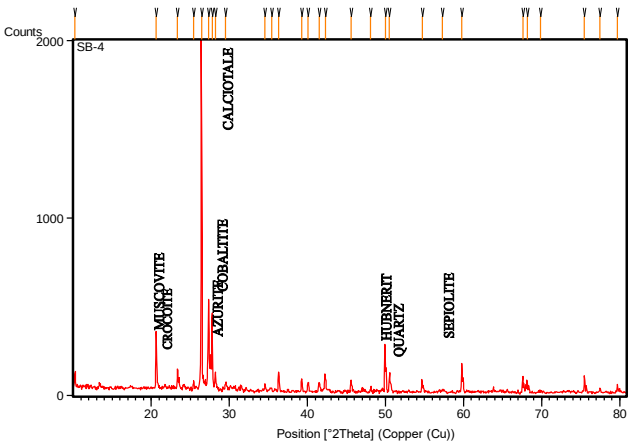

Figure 4. XRD pattern in the Mukaiyur Beach sediment

SB 5			
S.No	Pos. [°2Th.]	d-spacing [Å]	**Minerals**
1	20.6499	4.301	Clinoclase
2	26.4536	3.370	Quartz
3	26.8348	3.322	Sillimanite
4	27.3755	3.258	Crocoite
5	27.8106	3.200	Topaz
6	39.2841	2.290	Cobaltite
7	49.9933	1.825	Azurite
8	59.733	1.548	Lepidomelane
9	67.9573	1.378	Hubnerite

Table 5. X-Ray Diffraction values in Oppilan Beach sediment

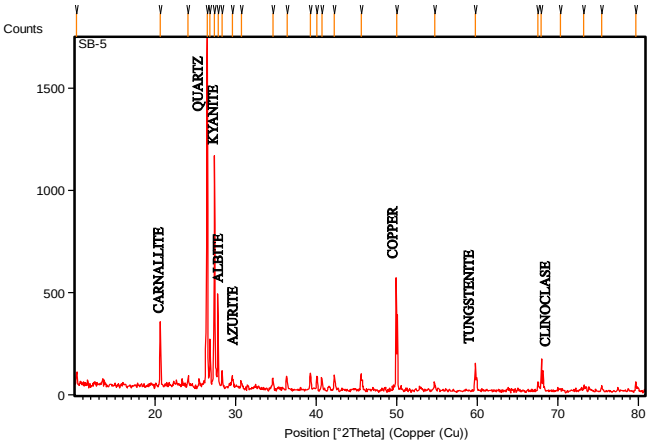

Figure 5. XRD pattern in the Oppilan Beach sediment

SB 6			
S.No	Pos. [°2Th.]	d-spacing [Å]	**Minerals**
1	20.5297	4.320	Metavauxite
2	24.0529	3.700	Fayalite
3	26.3307	3.380	Manganite
4	27.253	3.270	Zircon
5	27.6902	3.222	Labradorite
6	35.093	2.557	Quartz
7	35.8002	2.508	Hematite
8	42.1474	2.145	Cryptomelane
9	59.6608	1.381	Kyanite
10	73.2094	1.291	Garnet

Table 6. X-Ray Diffraction values in Melmunthal Beach

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 04, April-2020

sediment

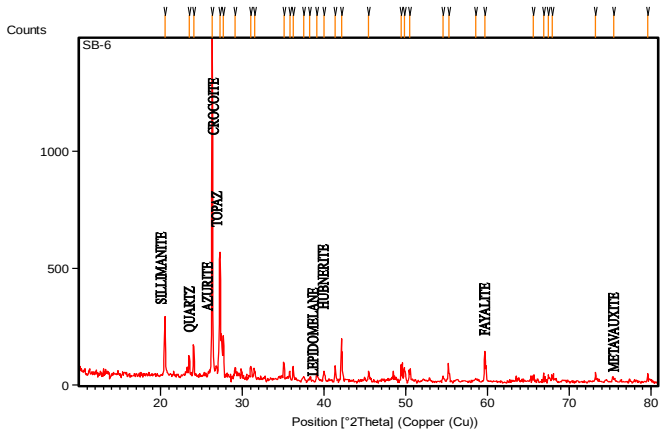

Figure 6. XRD pattern in the Melmunthal Beach sediment

SB 7			
S.No	**Pos. [°2Th.]**	**d-spacing [Å]**	**Minerals**
1	20.6646	4.298	Papagoite
2	26.4519	3.370	Quartz
3	27.3526	3.261	Terlinguaite
4	27.8445	3.204	Reinerite
5	35.1932	2.550	Montmorillonite
6	36.3524	2.471	Talc
7	42.2829	2.138	Chamosite
8	49.9871	1.825	Azurite
9	59.7615	1.547	Tungstenite
10	68.1226	1.436	Hornblende

Table 7. X-Ray Diffraction values in Valinokkam Beach sediment

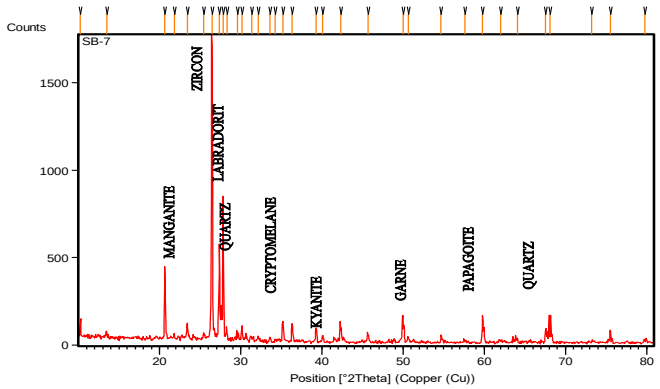

Figure 7. XRD pattern in the Valinokkam Beach sediment

SB 8			
S.No	Pos. [°2Th.]	d-spacing [Å]	**Minerals**
1	20.6609	4.299	Papagoite
2	23.6608	3.760	Albite
3	26.4454	3.370	Quartz
4	27.3531	3.260	Terlinguaite
5	27.8248	3.206	Albite
6	36.358	2.471	Talc
7	39.2715	2.294	Cobaltite
8	42.2989	2.74	Ilmenite
9	49.9812	1.825	Azurite
10	59.7379	1.548	Lepidomelane
11	75.4547	1.259	Quartz

Table 8.X-Ray Diffraction values in Periyapattinam Beach sediment

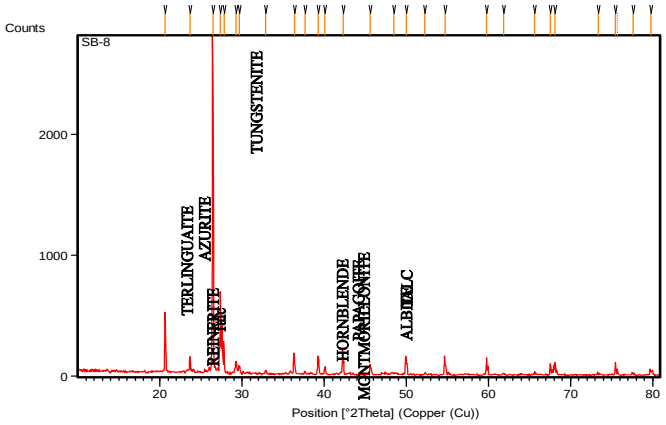

Figure 8. XRD pattern in the Periyapattinam Beach sediment

SB 9			
S.No	Pos. [°2Th.]	d-spacing [Å]	**Minerals**
1	20.6864	4.294	Sepiolite
2	26.4871	3.365	Quartz
3	27.4297	3.252	Leucite
4	27.8491	3.203	Reinerite
5	36.4129	2.467	Lepidocrocite
6	39.3121	2.290	Cobaltite
7	50.0162	1.823	Quartz
8	59.8486	1.545	Azurite
9	67.599	1.385	Aegirine
10	68.1537	1.362	Rutile

Table 9. X-Ray Diffraction values in Mandapam Beach sediment

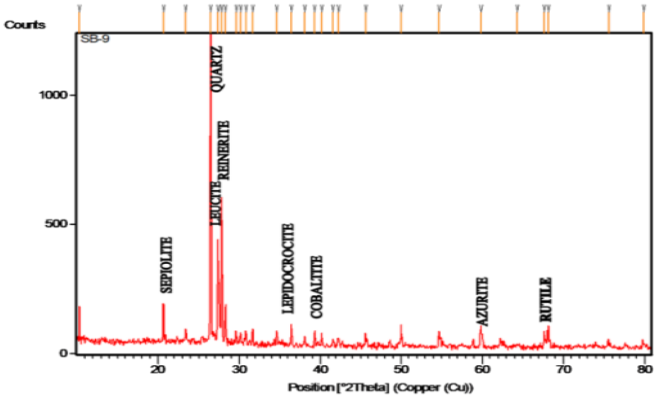

Figure 9. XRD pattern in the Mandapam Beach sediment

SB 10			
S.No	**Pos. [°2Th.]**	**d-spacing [Å]**	**Minerals**
1	20.7364	4.284	Quartz
2	23.5254	3.790	Pumpellyite
3	25.5196	3.490	Anhydrite
4	26.5217	3.361	Muscovite
5	27.4456	3.250	Anorthite
6	27.9092	3.197	Anorthite
7	29.7337	3.005	Staurolite
8	39.3585	2.289	Quartz
9	50.0581	1.822	Heazlewoodite
10	59.8221	1.436	Hornblende
11	68.0172	1.378	Hubnerite

Table 10. X-Ray Diffraction values in Ervadi Beach sediment

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 04, April-2020

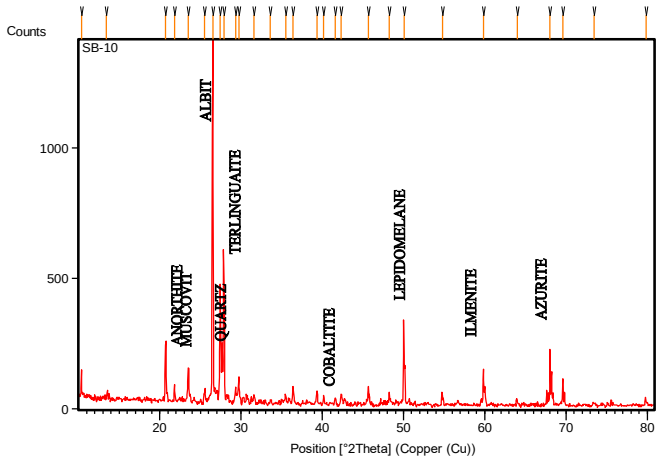

Figure 10. XRD pattern in the Ervadi Beach sediment

The important groups of minerals identified through XRD analysis are quartz group, feldspar, mica, Zn-Cu-Pb association, wollastonite group, leucite group, olivine group and minerals. The Beach sediments are predominantly observed from the samples along with calcite, quartz, orthoclase, microcline, biotite, hypersthene, hornblende, albite, anorthite sepiolite, illite, chlorite, halloysite Montmorillonite, halite and heavy mineral zircon, sillimanite, garnet, topaz, cobaltite, kyanite, magnetite, hornblende and ilmenite from the study area.

5. CONCLUSION

- The grain-size distributions of sediments are studied in the study of grain size in relation to mechanism of sediments deposition.
- The distribution pattern and textural parameters of sediments vary regionally in the Ramanathapuram Coastal sediment distribution. Based on the texture of sediments it can be said that the beach consists of coarse and medium sand was domains.
- Sedimentological studies reveal that depositional patterns in the beach are mostly controlled by fluvial and marine processes. The deposition of coarse and medium sands in the extreme in our study area attributed to the discharge Vembar and Gundar Rivers.
- The X-Ray diffraction sediments sample analysis proved that the minerals of calcite, quartz, orthoclase, microcline, biotite, hypersthene, hornblende, albite, anorthite sepiolite, illite, chlorite, halloysite Montmorillonite, halite and heavy mineral garnet, zircon, sillimanite, topaz, cobaltite, kyanite, magnetite, hornblende and ilmenite. The followed by minerals are derived from Recent Alluvium and Southern Granulite Terrain.

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