Sciencia Acta Xaveriana
An International Science Journal
ISSN. 0976-1152

Volume 5
No. 1
pp. 75-82
March 2014

# Mineral Identiication of Coastal Sediment Sample from Karaikal, Pondicherry, India by Ft-ir Spectrosocpic Technique

S.Sivakumar[1], R.Ravisankar[2*], B.Govardhanan[3], D.Prem Anand[4] and J.Prince Prakash Jebakumar[5]

1. Department of Physics, Mailam Engineering College, Mailam - 604304, Tamilnadu, India.
2. Post Graduate and Research Department of Physics, Government Arts College, Tiruvannamalai - 606603, Tamilnadu, India.
3. Department of Physics, Arunai Engineering College, Tiruvannamalai - 606603, Tamilnadu, India.
4. Department of Physics, St.Xavier's College, Palayamkottai - 627002, Tamilnadu, India.
5. Coastal and Environmental Engineering, National Institute of Ocean Technology, Pallikaranai, Chennai - 600100, Tamilnadu, India.

*Email : ravisankarphysics@gmail.com

**ABSTRACT :** The goal of the present work is to analyze the mineral composition of sediment samples collected from the coastal area of Karaikal, Pondicherry by FT-IR spectroscopic technique. The minerals such as quartz, microcline feldspar, orthoclase feldspar, albite feldspar, kaolinite, organic carbon and aragonite were identified with help of the available literatures. From the analysis FT-IR technique seems to identify the mineralogical composition in sediments. The performed technique shows relatively cheaper, quicker and more reliable in mineral analysis.

**Keywords :** Coastal sediment, Mineralogical characterization, FT-IR technique.

(Received : January 2014, Accepted March 2014)

## 1.0 Introduction

Among the various geological formations, sediment plays a predominant role in aquatic radioecology and plays a role in accumulating and transporting contaminants within the geographic area. Sediments are complex mixtures of inorganic and organic components. This composition is determined by their source, abiotic and biotic transformations with respect to time [1].

The mineral analysis in sediment is one of the key research for geologist to identify the heavy minerals in coastal areas. There are number of techniques available for the mineral identification over a decade. Among the number of techniques FT-IR is a potential tool for mineral analysis due to its non-destructive and rapid analysis. FT-IR is used to identify various chemical groups including functional group present in the mineral constituents of the sediments and also alternative method for acquiring quantitative mineralogy.

The basic principle of the FT-IR spectroscopic technique is that the vibrations of covalent chemical bonds which cause a change in dipole moment absorb infrared energy at specific wavelengths. The spectral locations of infrared absorption are indicative of specific chemical bonds or functional groups. Absorption intensity can be measured by either reflectance or transmittance over a wide range of wavelengths, with Fourier Transform instruments and measurements with sufficient signal to noise ratio take on the order of minutes [2].

FT-IR spectroscopy can provide detailed information on organic and minerogenic constituents of sediment records. Moreover, comparing with other techniques, FT-IR spectroscopy has certain advantages such as requirement of small quantity of sample, fast and easy method of sample preparation and short time to analysis.

In the present study, a mineralogical investigation of coastal sediment samples from karaikal of Pondicherry has been carried out using FT-IR technique. The study area chosen for the present work due to the manufacturing unit, mini industries, chemical industries etc are nearby the site.

## 2.0 Materials and Methods

### 2.1 Sample Collection

Sediment samples were collected from Karaikal using Peterson grab. The location of the

sampling point is 10°54'56.72"N, 79°52'45.28"E. The samples were placed in plastic poly Zip-lock bags in an ice chest and transported to the laboratory. The laboratory samples were spread on aluminum foils and air dried. The dried sediments were kept in hot air oven at 110° C to remove the moisture content then the samples werescreened and sieved with a 50 μm grain size for FT-IR investigation.

## 2.2 Sample Preparation

The collected samples were grounded into fine powder using agate mortar. Sample of 2 mg is mixed with 40 mg of spectroscopic KBr in the ratio 1:20 using a mortar and pestle. Before mixing, necessary amount of KBr powder is dried at 120°C for six hours in an oven. Otherwise the broad spectral peak due to free OH will seriously affect the interpretation on the bound hydroxyls associated, with any of the minerals. The mineral sample was weighed in a microbalance and placed in a clean agate mortar along with the proper amount of dry KBr to prepare sample pellet. A pellet of 1mm in thickness and 13 mm in diameter is prepared. A small camel's hair brush is used to transfer the mixture to the die for pressing the pellet. The die is cleaned with water and acetone, and dried before another pellet is prepared. The prepared pellet is preserved in a moisture free glass container before it is placed in a suitable sample holder and introduced in the infrared beam for analysis.

## 2.3 Sample analysis

The Perkin Elmer -1600 series available in Muthurangam Government Arts College, Vellore, Tamilnadu is made use of in the present work for recording i.r. spectra of the samples at room temperature. The KBr pellet technique (1:20) pellets were followed for the mineral analysis. To provide a good characterization of a mineral by infrared spectroscopy, the spectrum should be recorded in the range of 4000–400 $cm^{-1}$. Such coverage of range ensures that most of the useful vibrations active in the infrared will be included.

The instrument scans the spectra 16 times in 1 minute and the resolution is 5$cm^{-1}$. This instrument is calibrated for its accuracy with the spectrum of a standard polystyrene film. Every time, before the spectrum of sample is obtained; the spectrum of the polystyrene film is taken and checked for the accuracy and transmittance. The typical FT-IR spectrum is shown in Fig - 1.

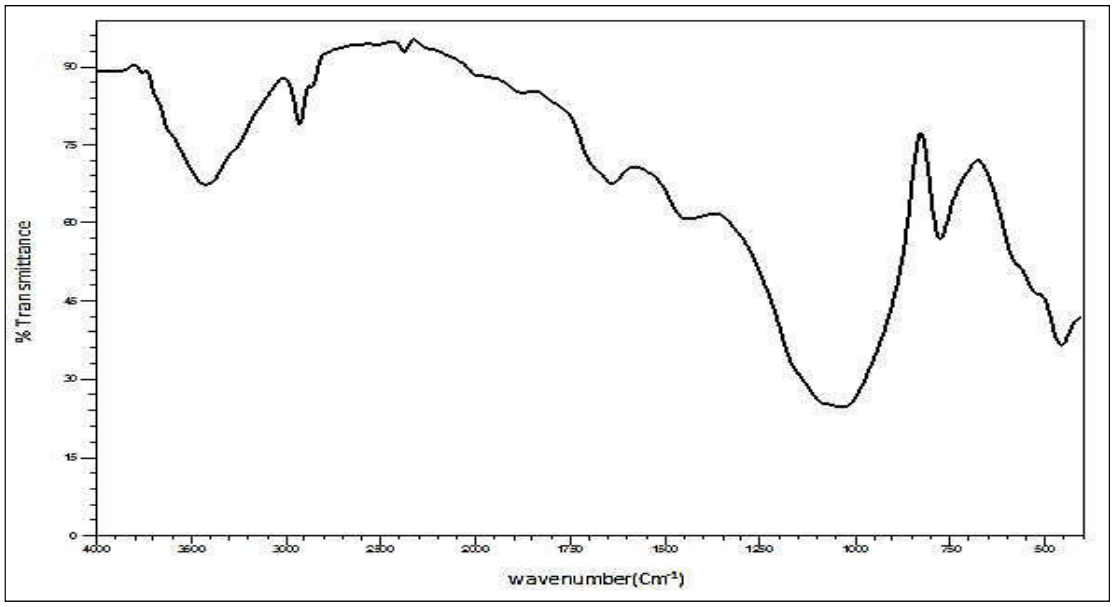


**Figure 1. A typical FT-IR spectrum of Coastal sediment samples of Karaikal, Pondicherry**

## 3.0 Results and Discussions

The absorption frequencies of the peaks in the spectra of site in wave number unit ($cm^{-1}$) are reported in Table - 1. The following minerals were confirmed when the observed frequencies were compared with the literature. They are quartz, feldspar, kaolinite, aragonite and organic carbon. The mineral wise discussion is as follows.

## 3.1. Quartz

Quartz was reported in literature to be the second most dominant of all the minerals in the earth crust [3]. The chemical representation of quartz is $SiO_2$. Quartz is one of the non clay minerals and invariably present in all samples. Quartz forms the major constituent of metamorphic, sedimentary, granite, limestone, etc. In the present study, it is confirmed that the most dominant of all the minerals present is quartz. It could be observed from the Table-1, the i.r. absorption bands appearing at 515-520, 695-700, 775-780, 1090-1095, 1615-1620 & 1870-1875$cm^{-1}$ may suggested the presence of quartz in the samples. This was similar to results recorded in literature [4, 5].

**Table -1**

**Observed wave numbers ($cm^{-1}$) and corresponding minerals from FT- IR spectra**

| S.No. | Minerals | Observed Wave numbers($Cm^{-1}$) |
|---|---|---|
| 1. | Quartz | 519,695,779, 1092,1615,1875 |
| 2. | Microcline Feldspar | 640 |
| 3. | Orthoclase Feldspar | 469 |
| 4. | Albite Feldspar | 420 |
| 5. | Kaolinite | 1020 |
| 6. | Organic Carbon | 2855,2925 |
| 7. | Aragonite | 1785 |

The bending vibration at 700$cm^{-1}$ and symmetrical stretching vibration at 775$cm^{-1}$ are assigned. The pattern of absorption in quartz can be explained by ascribing the 695$cm^{1}$ region (Si-O symmetrical bending vibrations), the bands in the region 775$cm^{-1}$ (Si-O symmetrical stretching vibrations). The peak appearing at 695 $cm^{-1}$ is most useful to determine nature of the mineral with regard to the structural stability. Many workers have calculated the crystallinity index of quartz using the symmetrical bending vibration of Si-O group obtained at 695 $cm^{1}$. As 695 $cm^{-1}$ is present in the spectra of the sample indicate the quartz mineral are well in crystalline form.

## 3.2.Feldspar

Feldspar is also a frequent constituent in sediments. This group of minerals has several types such as orthoclase, microcline, sanidine (K- feldspar), albite (Na - feldspar) and anorthite (Ca-feldspar). Feldspar is an abundant group of rock forming minerals, which constitute 60% of the earth's crust. From the Table - 1, the i.r. absorption peaks appearing at 420-425, 465-470, 640-645$cm^{-1}$ was assigned to feldspar mineral [6,7]. Among the peaks at 640-645cm $^{1}$ indicate the presence of microcline. Orthoclase was observed in the sample by the presence of peaks at 465-470$cm^{-1}$. The peak at 420-425 $cm^{-1}$ is observed for albite.

## 3.3.Clay mineral

Kaolinite is clay mineral crystallizing in the monoclinic system and forming the chief constituent

of china clay and Kaolin. It is a hydrous aluminum silicate commonly formed by weathering and decomposition of rocks containing aluminum silicate compounds; feldspar is a chief source. Kaolinite is the basic raw material for ceramics and large quantities are also used in the manufacture of coated paper. The presence of an absorption band appearing at 1015-1020$cm^{-1}$ in the sample indicate kaolinite. The i.r. absorption peaks of kaolinite are reported by many workers [8].

## 3.4.Organic Carbon

From the spectra as in Table - 1, a very weak absorption band present at 2850-2855 and 2925-2930 $cm^{-1}$ may suggest the presence of organic carbon [8]. These bands are due to C-H absorption contaminants present in the samples.

## 3.5.Carbonate Mineral

Aragonite is the common carbonate mineral in sediments. Carbonates are commonly deposited in marine settings when the shells of dead planktonic life settle and accumulate on the sea floor. It is identified in the sample by the i.r. absorption peaks at 1785-1790 $cm^{1}$ [8-13].

## 4.0. Conclusion

Qualitative mineral identification of coastal sediment of Karaikal, Pondicherry was carried out using the FT-IR technique and the performed analysis indicates quartz, feldspar, kaolinite, organic carbon and aragonite. Among these minerals quartz is considered as major mineral for its i.r absorption peaks whereas feldspar is minor mineral, kaolinite and aragonite are identified as the accessory minerals. Mineralogical composition of the sediments provides a fundamental step in gaining knowledge about the minerals in the study area

The FT-IR approach with respect to the traditional one is tremendous due to preparation (no acidic dissolution is necessary), experimental procedure, cleanliness and simplicity and analysis time.

## Reference

[1] Crompton, T.R. Determination of Metals and Anions in Soils, Sediments and Sludges. Taylor & Francis Books Ltd, 2001. United Kingdom.

[2] Liu, X., Colman, S.M., Brown, E.T., Minor, E.C., Li, H. Estimation of carbonate, total organic carbon, and biogenic silica content by FTIR and XRF techniques in lacustrine sediments, J. Paleolimnol. 50 (2013) 387–398.

[3] Ravisankar, R., Senthikumar, G., Kiruba, S., Chandrasekaran, A., Prince Prakash Jebakumar, J. Mineral Analysis of coastal sediments samples of Tuna, Gujarat, India. Indian Journal of Science and Technology, 2010, 3, 775-781.

[4] Coates , J.P. The IR Analysis of Quartz and Asbestos, Nelioth Offset Ltd., Chesham, England. 1977.

[5] Ravisankar, R., Rajalakshmi, A., Manikandan, E. Mineral Characterization of Soil samples in and around Salt Field Area, Kelambakkam, Tamilnadu, India, ActaCienciaIndica, 2006, Vol. XXXIIP: No.3: 341-346.

[6] Russell, J.D. Infrared methods, A Hand Book of Determinative Methods in Clay Mineralogy, (M.J.Ed.Wilson,) Blackie and Son Ltd. NewYork, 1987;133.

[7] Hlavay, J., Jonas, K., Elek, S., Inczedy, J. Investigation on quartz and feldspar, Clay and Clay Minerals. 1978, 26, 139-143.

[8] Ravisankar, R., Eswaran, P., Rajalakshmi, A., Chandrasekaran, A., Dhinakaran, B. Beach rock from the South East Coast of Tamilnadu, India- A Spectroscopic study, Advances in Applied Science, 2012, 3, 95-102.

[9] Adler, H.H., Kerr, P.F. Infrared spectra symmetry and structure relations of some carbonate minerals, American Minerals, 1963, 48, 839-853.

[10] ClarenceKarr. Jr. Infrared and Raman Spectroscopy of Lunar and Terrestrial Minerals. Academic Press, Newyork, 1974, 1.

[11] Gaffey, S.J. Spectral reflectance of carbonate minerals in the visible and near infrared (0.35- 2.55 microns) calcite, aragonite and dolomite, American Minerals, 1986 ,71, 151-162.

[12] SenthilKumar, P., Parthasarathy, G., Sharma, D.S., Srinivasan, R., Krishnamurthy, P. Mineralogical and Geochemical study on carbonate veins of Salem-Attur fault zone, Southern India : Evidence for Carbonate affinity, Journal of Geological Society of India, 2001, 58, 15-20.

[13] Ravisankar, R., Kiruba, S., Naseerutheen, A., Chandrasekaran, A. Maheswaran, C. Estimation of firing temperature of Ancient potteries of Tamilnadu, India by FT-IR Spectroscopic technique, Der Chemica Acta, 2011, 2, 157-163.