



FTIR Spectroscopic Studies on Coastal Sediment Samples from Cuddalore District, Tamilnadu, India

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ABSTRACT

The coastal sediment collected in and around cuddalore district is subjected to mineral analysis. FTIR spectroscopic technique is applied to sediment samples to identify the constituent minerals. From the infra spectrum, the minerals are identified from the location or band position of peaks with the help of available literature. The minerals such as quartz, orthoclase, microcline, albite, kaolinite, montmorillonite, calcite, aragonite and organic carbon are identified. The performed analyses provided useful information about the mineralogical composition of the sediments. FT-IR spectroscopy seems to be useful method for the mineral analysis of coastal sediments.

Keywords: Coastal sediment, Mineral Analysis, FT-IR technique.

1. INTRODUCTION

Coastal sediments include beach, estuarine, aeolian and deltaic deposits. Sediment sources are from cliff erosion, platforms or submarine outcrops by wave action; biogenic sources such as shell and coral; and rivers, glaciers, waste disposal by man, and aeolian action. Coastal sediments are largely of marine origins at lower elevations, and of alluvial-colluvial-deltaic origin further inland. Coastal plains receive abundant rainfall and are therefore mostly acid, low in content of weather able minerals, and kaolinitic with some hydroxy interlayered vermiculite, except for the marine clays that are montmorillonitic. The sediments are low in content of iron having been subjected to reducing conditions at the time of deposition. Sediment, a naturally occurring material is broken down by processes of weathering and erosion, and is subsequently transported by the action of wind, water, or ice, and/or by the force of gravity acting on the particle itself. Sediments are most often transported by water (fluvial processes), wind (aeolian processes) and glaciers. Beach sands and river channel deposits are examples of fluvial transport and deposition, though sediment also changes in both crystalline and amorphous forms. Infrared spectroscopy utilization significantly in quantitative analysis of the minerals is less attempted. FTIR spectroscopy is a potential

often settles out of slow-moving or standing water in lakes and ocean dunes and loess are examples of aeolian transport and deposition. Glacial moraine deposits and till are ice-transported sediments.

The study area Cuddalore is most populated regions of Tamilnadu, India with intensive huge industrial activities and its effluents may be discharged for a long time into the river. Most of the industries and factories are situated on the banks of the river or very close to the river system. The study area presents a great interest because of the manufacturing unit, mini industries, chemical industries etc. Analysis of sediments provides environmentally significant information. Their chemical characterization is needed to understand the natural and anthropogenic influence on the bodies of water.

Infrared spectroscopy as an analytical tool presents a lot of advantages as it is accurate, inexpensive and reliable, the necessary sample amount is in the sub milligram range and sampling procedure is simple. As a major advantage, infrared spectroscopy permits the identification of the alternative method for acquiring quantitative mineralogy [1]. The main use is the identification of minerals and in structural studies. FTIR spectroscopy has recently been receiving attention

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for its potential use in quantitative mineral analysis. In the present study, coastal sediments collected from cuddalore dist of Tamilnadu are subjected to mineral analysis using FTIR technique.

2. MATERIALS AND METHODS:

2.1. Sample Collection

Sediment samples were collected using Peterson grab at all the designated locations during low tide. The stations were oriented to get the fresh samples in and around cuddalore district. The samples collected from different sites under study were labeled as CTK, CDM, COT, CAP, CSP, CPT and CPI. The distance between each station falls around 7kms. At each sample site, covering a sampling area of 1m², five wet samples were collected, each weighing about one kilogram. Among these five samples from a site, four were from the corners and one from the center. The other one of the sediment samples was also collected from a depth of 5 cm from the surface. The samples were placed in plastic pouches and transported to the laboratory. The location map is given in Figure 1.

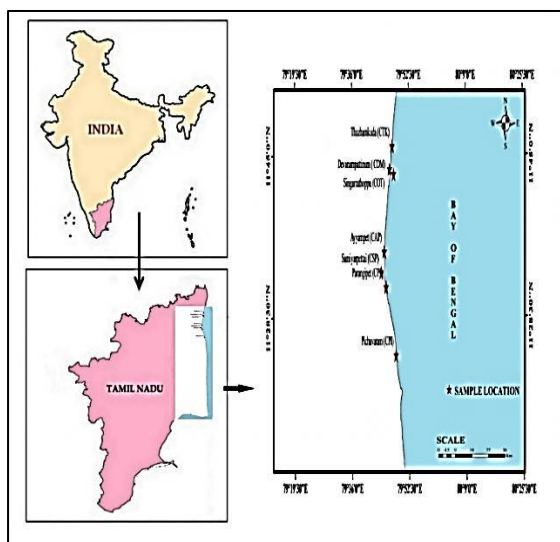


Figure1. Location Map.

2.2. Sample Preparation:

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. This procedure is followed for the preparation of every pellet. 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. For each site, five to six samples were collected and for each sample five to six pellet specimens were prepared.

2.3. Sample analysis:

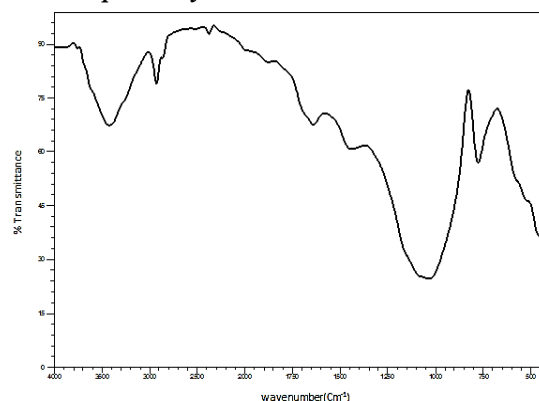


Figure 2. A typical FTIR spectrum of Coastal sediment samples of Cuddalore dist.

The Perkin Elmer FTIR spectrometer available in Department of Chemistry, Muthuramangam Government Arts College, Vellore; Tamilnadu, India is made use of in the present work for recording the FTIR spectra of the samples at room temperature. The KBr pellet technique (1:20) was 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 best spectrum for each site was considered as a representative spectrum of the site. The typical FTIR spectrum is shown in Figure 2.

3. RESULTS AND DISCUSSION

Qualitative analyses are carried out to determine the major and minor constituent minerals present in the samples from the band position or location of the peaks from the prominent FTIR absorption peaks. The minerals are identified with the available literature. The positions of the observed

absorption bands in wave number units are summarized in Table-1 together with minerals.

(i). Quartz

Quartz is one of the commonest of all rock forming minerals and also most important constituent of the earth's crust. It is the second most abundant mineral in the earth's crust. Chemically it is silicon dioxide, SiO_2 . It occurs in crystals of the hexagonal shape commonly having the form of a six-sided prism terminating in a six-sided pyramid; the crystals are often distorted and twins are common. Quartz is a common constituent of granite, sandstone, limestone and many other igneous, sedimentary and metamorphic rocks.

The FTIR absorption peaks of quartz were reported by many workers [1-17]. It could be observed from the Table-1, the FTIR. absorption bands appearing at 455-460, 515-520, 695-700, 775-780, 795-800, 1080-1085, 1615-1620, & 1870-1875 cm^{-1} may suggested the presence of quartz in the samples.

The bending vibration at 700cm^{-1} , symmetrical stretching vibration at 775cm^{-1} and symmetrical stretching vibration 800cm^{-1} are assigned. The pattern of absorption in quartz can be explained by ascribing the 455cm^{-1} region (Si-O asymmetrical bending vibrations), the bands in the region 695cm^{-1} (Si-O symmetrical bending vibrations), the bands in the region 775cm^{-1} (Si-O symmetrical stretching vibrations) and 795cm^{-1} (Si-O symmetrical stretching vibrations).

There is maximum of six to eight peaks are observed in any samples. The characteristic feature of quartz is doublet appearing at or around 800cm^{-1} and 780cm^{-1} . Such a clear observation of doublet was noticed in the samples (CTK, CDM & CPI) and any of these peaks was noticed in the samples (COT, CAP, CSP & CPT). The peak appearing at 695cm^{-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 695cm^{-1} . As 695cm^{-1} is present in the spectra of all the samples indicate the quartz mineral in these samples are well in crystalline form. Band assignments for different minerals of coastal sediment samples of cuddalore district are given in Table 2.

(ii) Feldspar

Feldspar an abundant group of rock forming minerals, which constitute 60% of the earth's crust. Chemically the feldspar is silicates of aluminum contain sodium, potassium, iron, calcium or barium or combinations of these elements. Feldspar is found in association with all rock types including granite, gneiss, basalt and other crystalline rocks

and is essential constituents of the most igneous rocks.

From the table 1, the FTIR absorption peaks appearing at 405-410, 420-425, 425-430, 430-435, 460-465, 465-470, 535-540, 580-585, 585-590, 640-645, 645-650, 720-725, 740-745, 765-770, 785-790, 990-995, 1040-1045, 1050-1055 cm^{-1} was assigned to feldspar mineral. The peak pertaining to the range 535cm^{-1} is due to Si-O. The feldspar group of minerals was analyzed by FTIR. technique and reported by many workers [1- 3, 6, 11, 14, 16-23]. The different types of feldspar minerals are given below.

(a) Microcline

The peaks at 425-430, 460-465, 535-540, 585-590, 640-645, 740-745, & 1050-1055 cm^{-1} indicate the presence of microcline.

(b) Orthoclase

Orthoclase was observed in the samples by the presence of peaks at 430-435, 465-470, 535-540, 580-585, 645-650, 765-770 & 1040-1045 cm^{-1} .

(c) Albite

The peaks at 405-410, 420-425, 720-725, 785-790, & 990-995 cm^{-1} are observed for albite.

(iii) Clay minerals

The presence of kaolinite, illite and montmorillonite indicate clay minerals in samples. 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.

It could be observed from table-1, the FTIR absorption peaks appearing at 470-475, 915-920, 935-940, 1015-1020, 1030-1035, 1115-1120 & 3420-3425 cm^{-1} in the samples indicate kaolinite. Absorbance at 1030cm^{-1} is attributed to Si-O stretching of clay minerals, The i.r. absorption peaks of kaolinite are reported by many workers [1,3,6,11-14,16-18,22,24-30].

Montmorillonite is a very soft phyllosilicate mineral that typically forms in microscopic crystals, forming clay. Montmorillonite, a member of the smectite family is 2:1 clay, meaning that it has 2 tetrahedral sheets sandwiching a central octahedral sheet. It is the main constituent of the volcanic ash weathering product, bentonite.

The FTIR absorption bands at 875-880, 1640-1645 and 3440-3445 cm^{-1} show the presence of montmorillonite in the samples [1,3,14]

Table 1. FTIR observed Frequencies (cm^{-1}) of Coastal sediment samples of Cuddalore District with mineral densifications.

S. No.	Location	Sample ID	Silicate Minerals	Feldspar			Clay Mineral		Organic carbon	Carbonate Minerals	
			Quartz	Microcline	Orthoclase	Albite	Kaolinite	Montmorillinite		Calcite	Aragonite
1	Thazhankuda	CTK	519,695,776, 797,1090, 1619,1875	427, 461, 535, 642	432, 580	405,420, 785,990	915,935, 1016,1030, 1116,3422	880, 1640	2850, 2925	1420	1790
2	Devanam pattinam	CDM	459,515,695,778,795, 1080,1616, 1875	1050	435, 470, 538, 583, 650, 765	720	935,3425	-	2850, 2920, 2930	875, 880, 1795	855
3	Singarathoppu	COT	457,515,695,780,1080, 1622,1875	462, 645, 742	-	787,990	3425	-	2855, 2925, 2930	1795	-
4	Ayyampet	CAP	455,695,779, 1080,1615, 1874	428, 462, 590, 640	-	785	471,3425	-	2855, 2925	-	1790
5	Samiyarpet	CSP	459,695,779, 1080,1620, 1875	460, 640	-	785	3425	-	2850, 2925	1795	1790
6	Parangipet	CPT	455,515, 695,778, 1080,1618, 1875	461, 640	467, 1040	422,785, 991	3425	3440	2855, 2915, 2926	-	1786
7	Pichavaram	CPI	457,515,695,777,795, 1080,1615, 1875	642	435, 467, 540, 581	420,785,993	-	3440	2850, 2925	1795	1785

Table 2. Band assignments for different minerals of coastal sediment samples of Cuddalore district.

Minerals	Frequency (cm^{-1})	Tentative assignments	References
Quartz	459	Si - O asymmetrical bending vibration	[4. 15, 20]
	695	Si - O symmetrical bending vibration	
	780	Si - O symmetrical stretching vibration	
	797	Si - O symmetrical stretching vibration	
Feldspar	535	Si - O asymmetrical bending vibration	[4.15, 18. 20]
	642	Al - O - Co-ordination vibration	
Kaolinite	1030	Si-O Stretching O-H deformation	[6.16, 16]
	935		
Montmorillinite	3440	O-H Stretching of absorbed water molecule	[6. 16]
Calcite	875	Fe^{3+} (Al-OH)	[16]

17,19,25,31,32]. The band typically centred at 3400cm^{-1} is due to O-H stretching of water molecule present in the interlayer region of montmorillinite.

(iv) Carbonate Minerals

The carbonates consist of those minerals containing the anion $(\text{CO}_3)^{2-}$ and include calcite and aragonite (born calcium carbonate), dolomite (magnesium/calcium carbonate) and siderite (iron carbonate). Carbonates are commonly deposited in

marine settings when the shells of dead planktonic life settle and accumulate on the sea floor.

Carbonates are also found in evaporitic settings and also in Karsh regions, where the dissolution and reprecipitation of carbonates lead to the formation of caves, stalactites and stalagmites. The carbonate class also includes the nitrate and borate minerals.

Many workers have suggested that i.r absorption band appearing at 2982, 2519, 1433, 875 & 715 cm^{-1} is assigned to calcite [1,5,7-8,10-11,14-17,22,25,28,33-35].

From table 2.1, the i.r absorption bands at 875-880, 1420-1425 & 1795-1800 cm^{-1} are found to be calcite. Aragonite is identified in the samples by the FTIR. Absorption peaks at 855-860, 1785-1790 cm^{-1} [1,3,6,16-17,23,33,36-39].

(v) Organic Carbon:

From the spectra of all the samples in Table 2.1 a very weak absorption band present at 2850-2855 and 2925-2930 cm^{-1} may suggest the presence of organic carbon [17]. These bands are due to C-H absorption contaminants present in the samples.

3. CONCLUSION

FTIR spectroscopy seems to be a useful method for the mineral analysis of coastal sediments quartz, microcline, orthoclase, albite, kaolinite, montmorillonite, calcite, aragonite and organic carbon. Among these minerals quartz is considered as major mineral for its FTIR absorption peaks whereas feldspar is minor mineral. The accessory minerals are identified as kaolinite, montmorillonite, calcite and aragonite from the IR study. The performed analyses provided useful information about the mineralogical composition of the sediments. This is a fundamental step in gaining knowledge about the constituent of minerals. The FTIR 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.

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4. REFERENCES

- [1]. R. Ravisankar, (2009) Application of Spectroscopic techniques for the identification of minerals from beach rocks of Tamilnadu, *EARFAM*, **19**, 272.
- [2]. V.C. Farmer, (1974) The IR Spectra of

Minerals, *Mineralogical Society*, London, 182.

- [3]. Clarence Karr, (1974) Jr. Infrared and Raman Spectroscopy of Lunar and Terrestrial Minerals, *Academic Press*: Newyork, 1.
- [4]. J.P. Coates, (1977) The IR Analysis of Quartz and Asbestos, Nelioth Offset Ltd., Chesham, England.
- [5]. C.Pichard, F.Frohlich, (1986) Quantitative IR analysis of sediments, Example of Quartz and Calcite determination, *Revue de I Institut Francais du Petrole.*, **41**, 6,
- [6]. J.D. Russell, (1987) Infrared methods, A Hand Book of Determinative Methods in Clay Mineralogy, (M.J.Ed.Wilson,) Blackie and Son Ltd.
- [7]. T.D. Herbert, A. Brian, Tom, C. Burnett, (1992) Precise major component determinations in deep sea sediments using Fourier Transform infrared Spectroscopy, *Geochimica Cosmochim Acta*, **56**, 1759.
- [8]. J.L. Bishop, C. Koeberl, C.Kralik, H.Frosechio, A.Peter, J.Englert, W.Andersen, C.M.Peters, J.R.Wharton, (1996) Reflectance spectroscopy and geochemical analysis of Lake Hoare sediments, Antarctica; implications for remote sensing of the earth and mars, *Geochimica Cosmochimica Acta*, **60**, 765.
- [9]. J.Bertaux, F. Frohlich, P. Ildefonse, (1998) Multi component analysis of FT-IR spectra; Quantification of amorphous and crystallized mineral phases in synthetic and natural sediments, *Journal of Sedimentary Research*, **68**, 440.
- [10]. F.B. Reig, J.V.G. Adelanndo, M.C.M. Moreno, (2002) FT-IR Quantitative analysis of Calcium Carbonate (Calcite) and Silica (Quartz) mixtures using the constant ratio method; Application to geological samples, *Talanta*, **58**, 811.
- [11]. G.E.D. Benedetto, R.Laviano, L.Sabbatini, P.G. Zambonin, (2002) Infrared spectroscopy in the mineralogical characterization of ancient pottery, *Journal of Cultural Heritage*, **3**, 177.
- [12]. N.J. Saikia, D.J. Bharali, P. Sengupta, D. Bordoloi, R.L. Goswamee, P.C. Saikia, P.C. Borthakur, (2003) Characterisation, beneficiation and utilization of a kaolinite clay from Assam, India, *Applied Clay Science*, **24**, 93.
- [13]. T.H. Ko, H.Chu, (2005) Spectroscopic study on sorption of hydrogen sulfide by means of red soil, *Spectrochimica Acta*, Part- A, **61**, 2253.
- [14]. R.Ravisankar, A.Rajalakshmi, E.Manikandan, (2006) Mineral Characterization of Soil samples in and around Salt Field Area,

- Kelambakkam, Tamilnadu, India, *Acta Ciencia Indica*, XXXIIP (3), 341.
- [15]. R.Ravisankar, G.Senthilkumar, S.Kiruba, A. Chandrasekaran, Prince Prakash Jebakumar, (2010) Mineral Analysis of Coastal Sediment samples of Tuna, Gujarat, India *Indian Journal of Science and Technology*, **3**,775
- [16]. R. Ravisankar, S. Kiruba, A. Naseerutheen, A .Chandrasekaran, C. Maheswaran, (2011) Estimation of firing temperature of Ancient potteries of Tamilnadu, India by FT-IR Spectroscopic technique, *Der Chemica Acta*, **2**,157.
- [17]. R. Ravisankar, P. Eswaran, A. Rajalakshmi,A. Chandrasekaran,B. Dhinakaran,(2012) Beach rock from the South East Coast of Tamilnadu, India. A Spectroscopic study, *Advances in Applied Science*, **3**, 95.
- [18]. J.L.White, (1971) Interpretation of infrared spectra of soil minerals, *Soil Science*, **112**, 22.
- [19]. S.N. Ghosh (1978) Infrared spectra of some selected minerals, rocks and products, *Journal of Material Science*. **13**, 1877.
- [20]. J. Hlavay, K. Jonas , S. Elek, J. Inczedy, (1978) Characterization of the particle size and the crystallinity of certain minerals by infrared spectrophotometry and other instrumental methods-II. Investigation on quartz and feldspar, *Clay and Clay Minerals*, **26**, 139.
- [21]. A.K. Neog, R.K. Boruah, O.P. Sahu, P.C. Borah,W. Ahmed, G.D. Boruah,(1999) XRD and IR of Deopani clay, *Asian.Chemical Letters*, **3**,172.
- [22].Z. Xu, B.C. Cornilsen, D.C. Popko, W.D. Penning, J.R. Wood, J.Y. Hwang, (2001) Quantitative mineral analysis by FT-IR spectroscopy, *International Journal of Vibrational Spectroscopy*, **5** , 4.
- [23].R. Ravisankar, S. Kiruba, A.Chandra sekarana, A. Naseerutheen, M. Seran, P.D. Balaji, (2010) Determination of firing temperature of some Ancient Potteries of Tamilnadu, India by FT-IR Spectroscopic Technique, *Indian Journal of Science and Technology* ,**3**,1016.
- [24]. J.K. Crowley, N. Vergo, (1988) Near-infrared reflectance of mixtures of kaolin group minerals; use in clay, *Clay and Clay Minerals.*, **36**,310.
- [25]. R.N. Clark, T.V.V. King, M. Kiejwa, G.A. Swayze, N. Verge, (1990) High spectral resolution reflectance spectra of minerals, *Journal of Geophysics Research*, **95**, 12653.
- [26]. M.E. Summer, (1995) Hand Book of Soil Science, University of Georgia, *Boca Raton Hondor Press*: New York.
- [27]. J.P. Gustafesson, P. Bhattacharya, Karitun, (1999) Mineralogy of poorly crystalline aluminium phases in the B horizon of podzols in southern Sweden, *Applied .Geology*, **14**, 707.
- [28]. Y Sun, P.K. Secombe, K. Yang, (2001) Application of short- wave infrared spectroscopy of define alteration associated with Elurazinc-lead-silver deposit, NSW, Austrila, *Journal of Geochemical Exploration.*, **73**,11.
- [29]. S.Shoval, (2004) Clay sedimentation along the Southern Neo- Tethys margin during the oceanic convergence stage, *Applied Clay Science*, **2**, 287.
- [30]. R. Ravisankar, A.Chandrasekaran,S. Kiruba,G. Senthilkumar, C.Maheswaran, (2010) Analysis of Ancient Potteries of Tamilnadu, India by Spectroscopic Techniques, *Indian Journal of Science and Technology*, **3** ,858.
- [31] K. Oinuma, H. Hayashi, (1965) Infrared study of mixed layer clay minerals, *American Minerals*. **50**, 1213.
- [32].K. Bukka, J.D. Miller, J. Shabtai, (1992) FT-IR study of deuterated montmorillonites: structural features relevant to pillared clay stability, *Clay and Clay Minerals*, **40**, 92.
- [33]. S.J. Gaffey, (1986) Spectral reflectance of carbonate minerals in the visible and near infrared (0.35-2.55 microns) calcite, aragonite and dolomite, *American Minerals*. **71**, 151.
- [34]. A.M. Kalinkin, G.V. Kalinkina, V.N. Makarov, (2003) Mechanical activation of natural titanite and its influence on the mineral decomposition, *International Journal of Mineral Processing*, **69**, 143.
- [35]. T.Shahwan, B. Zunbul, Tunusoglu, Eroglu, (2005) AAS, XRPD, SEM/ EDS and FT-IR characterization of Zn²⁺ retention by calcite, calcite-kaolinte and calcite clinoptilolite minerals, *Journal of colloid and Interface Science*, **286**, 471.
- [36]. H.H. Adler, P.F. Kerr, (1962) Infrared spectra symmetry and structure relations of some carbonate minerals, *American Minerals*, **48**, 839.
- [37]. R.J.P. Lyon, (1967) Infrared Absorption Spectroscopy, Physical Methods in Determinative Mineralogy, (J.Ed. Zussman) Academic press, New York, 371.
- [38]. G.R Hunt, J.W. Salisbury, (1971) Visible and near infra-red spectra of minerals and rocks-II Carbonates, *Modern Geology*, **2**,23.
- [39]. P. Senthil Kumar,G. Partha sarathy, D.S. Sharma, R. Srinivasan, P.Krishna murthy, (2001) Mineralogical and Geochemical study on carbonate veins of Salem-Attur fault zone, Southern India: Evidence for Carbonate affinity, *Journal of Geological Society of India.*, **58**,15.

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