Depth wise analysis of recently excavated Vellar river sediments through FTIR and XRD studies

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Abstract: The Fourier transform infrared (FTIR) spectral analysis has been carried out for sediments of Vellar river, Tamilnadu collected at various depths from twenty seven different locations. The minerals such as quartz, feldspar (microcline and orthoclase), kaolinite, palygorskite, calcite, aragonite, montmorillonite, cerussite, hematite, sepiolite, magnesium oxalate and organic carbon are identified. Among these, quartz, feldspar and kaolinite are the major minerals and palygorskite, calcite, aragonite, montmorillonite, cerussite, hematite, sepiolite, magnesium oxalate and organic carbon are minor and traces. The relative distribution of these three major minerals was determined by computing the extinction co-efficient. The crystalline nature of quartz is judged by calculating crystallinity index which shows that the crystalline nature decreases with increase of depth. The observation made through relative distribution, shows that the amount of quartz and feldspar are relatively reduced and that of kaolinite is increased from upper to inner depth. As the depth increases the bands of kaolinite progressively broaden and shift to higher wave number side which suggests that the content of kaolinite increases with disorderedness. From XRD analysis, the minerals such as monazite, zircon and kyanite are additionally identified. The crystalline nature of quartz is also confirmed.

Keywords: Mineral analysis, FTIR, XRD

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1. Introduction

Although infrared techniques are most commonly developed for qualitative studies, careful examination of intensities leads to a most useful tool for quantitative analysis as well [1]. One of the most important and value added applications of the infrared spectroscopic study is the identification of the minerals in the sediment samples.

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Using the infrared spectra, unique information about the group of minerals to which the specimen belongs, the degree of crystalline and non-crystalline impurities and reactions of minerals with chemicals in their environment can also be inferred. For mineral analysis, IR in the range of 4000-400 cm\(^{-1}\) is of importance [1-3].

Minerals have few but more intense IR absorption bands than most organic compounds. Sediments are a composite of many minerals. Hence, with the few available intense bands, the constituent minerals in the sediments were identified with the help of the available literature [4].

Madejova [5], demonstrated the transmission and reflection FTIR techniques which were used to distinguish the different type of clay minerals and to derive information concerning their structure, composition and structural changes upon chemical modification.

Normally, buildings are constructed using bricks, steel, pieces of granites or granitic powder, cement and sediments. Among these, sediments are used in major quantity when compared with others. In the present study, the sediments from Vellar river, Tamilnadu, India were selected. The main aim of this study is to characterize the various minerals and its distribution over the sampling area using FTIR and XRD techniques.

2. Materials and methods

2.1. Sample collection:

The Vellar river covers a total length of 200 km and from which, 27 locations were selected along the course and are shown in Figure 1. Each location is separated by a distance of 7-8 km approximately. All the samples were collected during the summer season. In each and every site, four samples (at the upper layer, at 1 feet depth, at 2 feet depth and at 3 feet depth) were collected. Each sample has a weight of 3-4 kg. The collected samples were dried at room temperature in open air for two days and stored in black polythene bags.

2.2. Sample preparation and Instruments used:

**FTIR spectroscopic technique**

Wet grinding was carried out by placing 30 to 50 mg of the sample in an agate mortar along with 20 to 25 drops of ethanol. The ground samples were dried in a hot air oven at 110°C to remove the moisture content. Using pellet technique, the samples were mixed with KBr at various ratios viz., 1:10, 1:20, 1:30, 1:40 and 1:50 (sample:KBr). The mixture was then pressed into a transparent disc in an evacuable die at sufficiently high pressure. The samples in the ratio 1:40 was taken for further analysis, since it gives rise to maximum transmittance and observable peaks. This ratio was checked for 2 to 3 times for its accuracy.

The Nicolet-Avatar 330 series FTIR spectrophotometer was made use of in the present work for recording the FTIR spectra of the samples at room temperature. It scans the