Identifying High-Quality Quartz for Sensor Fabrication through Infrared Spectroscopic Analysis of Metamorphic (Granite) Rocks

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ABSTRACT

This research underscores the economic growth driven by the quality of quartz and its importance in national development, with a particular focus on India and the mineral-rich terrain of Tamil Nadu. The study explores various analytical methods employed for mineral identification, emphasizing meticulous procedures for spectrum recording and precautionary measures. Findings are interpreted against existing literature, highlighting crucial parameters such as crystallinity index, absorbance, and extinction coefficient. The infrared analysis of rocks from different regions of Tamil Nadu reveals a mineral profile featuring feldspar, garnet, chlorite, and ubiquitous quartz. Quartz, consistently present in all samples, is scrutinized through extinction coefficient comparisons. Keelaiyur stands out with the highest extinction coefficient, indicating superior quartz abundance and heightened crystallinity among the samples. Highly quality Quartz are abundant in Kellaiyur, Madurai District. These quartz are used to fabricate high quality quartz based sensors. Quartz-based sensors are high-quality due to their piezoelectric properties, stability, sensitivity, and precise fabrication techniques, ensuring reliable performance. This research sheds light on the geological wealth of Tamil Nadu, emphasizing the vital role of quartz and other minerals in economic development.

KEYWORDS

Rocks and Minerals, Quartz, infrared-based identification, crystallinity index, absorbance, extinction coefficient.

INTRODUCTION

The investigator is interested to study the importance of Rocks and minerals and their study by infrared method. The rocks are grouped into three large classes namely igneous rocks, sedimentary rocks, metamorphic rocks. The mineral characters of Metamorphic rocks are tremolite, kyanite, stautolite, talc, serpentine, mica and chlorite. Infrared spectroscopy is one of the foremost capable explanatory strategies which offer the plausibility of chemical distinguishing proof and is a powerful tool in identifying quantitative and qualitative analysis of the minerals present in geological samples. The collected samples from Tamilnadu, India are analyzed by infrared spectroscopic method and indicates the presence of quartz, feldspar, diapside, garnet and chlorite minerals. The obtained results are interpreted in light of available literature with special reference to crystallinity index, absorbance and extinction coefficient.

SCOPE OF THE PRESENT WORK

The present Investigation is to analyze and to obtain the constituent minerals of granite rocks with special reference to Erode, Salem, Krishnagiri, Trichy, Madurai and Virudhunagar district of Tamilnadu, India.

REVIEW OF LITERATURE

Many workers have carried out investigation on quantitative estimation of minerals.

- Infrared (IR) technique has been applied to study of soil mineralogy by Russell et al., (1970)
- IR spectra of two minerals viz., Urkut quartz and Swedish feldspar were carried by Hlavay(1977)
- The usefulness of IR spectroscopy in mineral Identification is illuminated by Kadma and Oinuma (1963)
- Hunt and Turner (1953) have detailed that Minerals constituents of rocks were distinguished by comparing their spectra with the spectra of immaculate minerals.
- General guidance on lR methods are given by (1996) work on IR spectra for selected minerals are tabulated by White (1971)
- The Far-IR spectroscopic analysis of inorganic minerals were investigated by Kerr and Kovach (1969)

SELECTION AND COLLECTION OF SAMPLES

For present Investigation different types of granitic sample were collected from different parts of Tamilnadu. They are photographed and listed in table-1.

Photographs of the Sample

Table.1

S.No.	Variety Name	Location	District
1	Green Onyx	Sivamalai	Erode
2	Kashmir White	Keelaiyur	Madurai
3	Kashmir Gold	Keelaiyur	Madurai
4	Madura Gold	Keelaiyur	Madurai
5	Sivakasi Yellow	Tiruthangal	Virudhunagar
6	Red Wars	Jakkery	Krishnagiri
7	Jabarana Gold	Thogamalai	Trichy
8	Black	Mettur	Salam
9	Paradise	Sulamalai	Krishnagiri
10	Columbu Jabarana	Thogamalai	Trichy

EXPERIMENTAL DESIGN:

- Put 5 to 10 mg of sample into agate solution, then add 10 to 15 drops of ethanol to the mortar for wet grinding. Collision of samples is done only manually.
- 2 mg of sample is mixed with 40 mg of spectrally dry KBr powder.
- Products with 1 mm thickness and 13 mm diameter were prepared.
- Use a small hairbrush to transfer the mixture into the mold to press out any lumps.
- Place the object in a suitable sample and introduce infrared light for analysis.
- A Perkin – Elmer 1600 series FTIR Spectrometer provided by the Municipal Research Institute, Gandhigram,Tamil Nadu, India was used to record the spectra of the samples in this study. This measure ment range is between 4000 cm-1 and 400cm- 1

A Perkin – Elmer 1600 series FTIR Spectrometer

DATA ANALYSIS

Observed absorption frequencies of granite samples collected from various places of Tamilnadu. India

Table-2

Site No.	Quartz	Feldspar		Garnet	Diopside	Chlorite
		Orthoclase	Albite			
1	695.2 777.7 1081.6	540.0 640.1	586.3 1033.0 1444.0	--	--	--
2	693.4 777.6 1083.2	539.6 642.3	585.6 1010.2 1443.1	--	--	450.0 3566.0
3	691.2 778.0 1080.6	535.8 643.7	582.0 1005.0 1442.2	1449.0	668.0	3566.1
4	694.4 777.5 1081.4	539.9 638.5	589.8 1041.0 1440.0	--	668.1	--
5	695.3 777.7 1081.4	540.6 640.3	586.0 1014.0 1443.0	--	--	--
6	692.4 776.5 1083.6	535.8 645.6 762.2	588.2 1034.0 1440.0	--	--	450.2 3567.4
7	691.5 776.3 1081.2	540.7 640.5	586.3 1010.0 1442.9	1450.2	668.5	--
8	695.3 777.3 1083.2	539.5 641.0	589.5 1037.1 1443.6	--	668.0	--
9	692.6 778.1 1081.7	538.8 642.3	586.2 1005.7 1443.6	1451.3	668.4	450.3 3567.4
10	692.4 777.0 1090.1	5394 640.5	587.3 1009.9 1443.1	1450.5	668.2	--

The extinction coefficient and crystallinity index of granite samples are tabulated

Table-3

Sample No.	Extinction coefficient of quartz	Crystallinity Index
1	51.6417	0.8666
2	87.1298	0.8947
3	70.0580	0.6111
4	330.0743	0.5000
5	87.5261	0.7058
6	302.6020	0.5833
7	165.8436	0.8132
8	74.7153	0.7058
9	5.3600	0.8750
10	47.2410	0.8182

It is observed that site 4 is having a maximum extinction coefficient of 330.0743. This site is taken as reference to have maximum quartz.

The crystallinity index is significant to site number 4

DISCUSSIONS AND CONCLUSIONS OF FINDINGS

Infrared analysis of various rock samples collected from different parts of Tamil Nadu revealed the presence of quartz, feldspar, diopside, garnet and chlorite minerals.

The researcher determined the presence of Quartz in each region by comparing the extinction co-efficient and crystallinity index of the samples.

Therefore, the quality of Quartz (Site number 4 - Keelaiyur) in Madurai District is higher than in other places of Tamilnadu.

Quality of Quartz in Keelaiyur, Madurai District is higher. The quartz are used to fabricate sensors. Quartz-based sensors are high-quality due to quartz's piezoelectric properties, stability, and precision. They exhibit high sensitivity, low drift, and high Q-factors. Examples include Quartz Crystal Microbalance (QCM), quartz oscillators, and Surface Acoustic Wave (SAW) sensors, fabricated with advanced lithography and deposition techniques for reliable performance.

REFERENCE

1. Aiyengar N.K.N., “Minerals of Madras”, Department of Industrial and Commerce, Madras (1964).
2. Bahat, D., “J. Geol.Soc.Aust.”, 17 (1970) 93.
3. Clearance Karr, Jr., “Infrared and Raman Spectroscopy of Lumar and Terrestrial Minerals”, Academic Press, Newyork., (1975)
4. Edward A.Hay, A. Lee M C Alester, “Physical Geology”, Prentice Hall Inc, Englewood cliffs: New Jerky, (1984) 93.
5. White J.L and Roth, B., : Infrared Spectoscopy methods of soil Analysis part I “Physical Mineralogical methods, Soil Science society of America (1996)
6. Sharna B.k., : Instrumental methods of clinical Analysis”, Goel Publishing House, 19th Edition, (2000)
7. Farmer V.C , “Clay Minerals”, 7(1968) 373.
8. Saravanan,S, “Geology of Tamilnadu”, Tamil Pub., (1984)
9. Kerr. J.C and Kovach.J “Appl. Spectrocopy”, 23 (1969) 219.