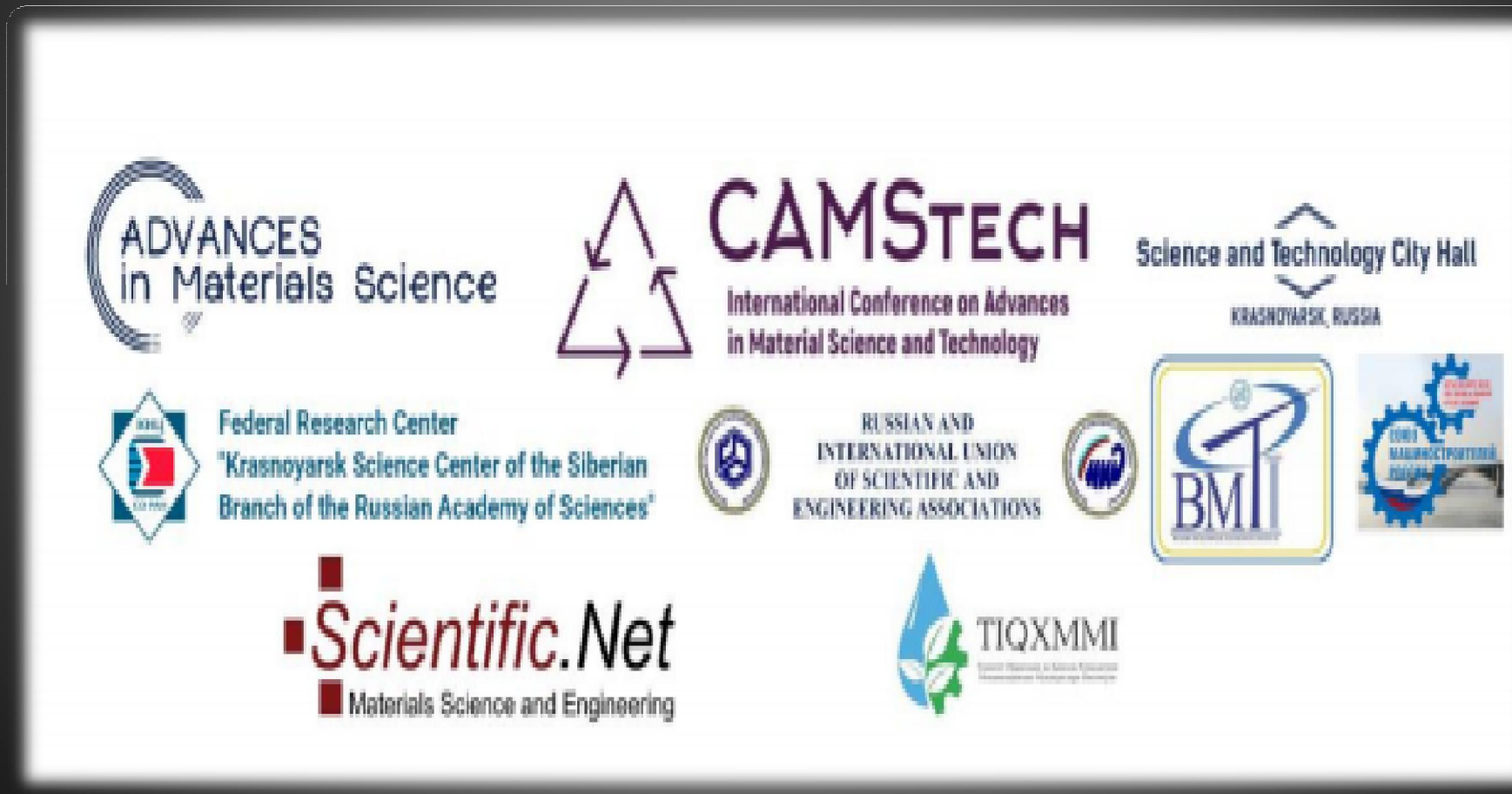
II International Scientific Workshop «Advances in Materials Sciences» “AMS-II -2021”



II International Scientific Workshop
«Advances in Materials Sciences»
“AMS-II -2021”
II Международный научный семинар
«AMS-II Workshop: Достижения в области материаловедения»

Chemical Characterization of Sri Lankan Dolomite for Waste Water Treatments

Author/Speaker: Suresh Aluvihara

University of Peradeniya, Sri Lanka

Introduction

- Dolomite is an economically valuable mineral which is known as an industrial mineral.
- Usually the mineral dolomite is found that associate with dolomite rocks (lime stones) most probably with the mineral calcite which is having much similar characteristics of dolomite [1-4].
- The general physic-chemical profile of dolomite is described in the Table 1 [1-6].

Introduction Cont'd

Table 1. General characteristics of dolomite

Characteristic	Description
Chemical formula	$CaMg(CO_3)_2$
Color	Colorless, white, pale brown, grayish white, reddish white, pink, greenish white, pale black
Streak	White
Luster	Vitreous, pearly
Hardness	3.5
Magnetism	None
Density (gcm^{-3})	2.9
Diaphaneity	Transparent, translucent
Tenacity	Brittle
Cleavage	Non-evident
Crystal system	Trigonal

Introduction Cont'd

- According to the existing industrial applications of such dolomites, mainly the lime productions for building materials and some of advanced chemical applications such as the production of CaC_2 can be emphasized
- Apart from that a large number of research and investigations are being progressed with the advanced chemical and water treatment applications of different dolomite types [1,2,4,5,6].

Introduction Cont'd

- In the existing research there were expected to characterize a selected dolomite variety in Sri Lanka in chemically and microscopically based upon the investigations of some outstanding characteristics of such dolomites and finding of the applicability of some of advanced chemical and water treatment applications in the modern research world.

Materials and Methodology

- The dolomite samples were collected nearby the relevant quarry which is located in Matale region in Sri Lanka.
- The collected dolomite chips were stored in cleaned polythene bags while preventing the contamination with foreign materials.
- The stored dolomite chips were further processed as necessary for the experiments using standard apparatus, chemical agents and methodologies.

Materials and Methodology Cont'd

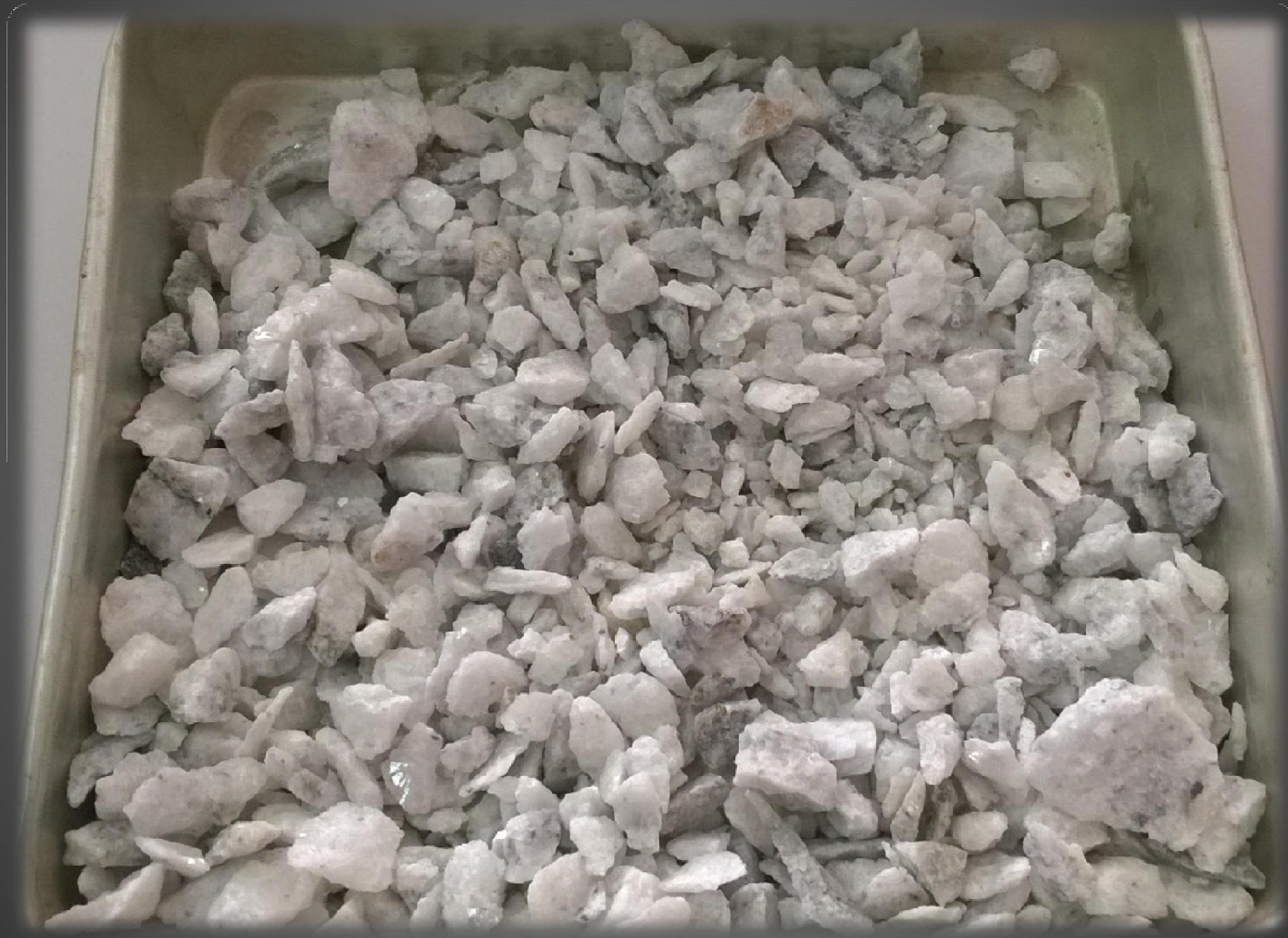


Figure 1. Dolomite chips (comminuted dolomite masses)

Materials and Methodology Cont'd

- A few of batches of randomly selected dolomite chips were collected and washed them with distilled water and oven dried for 24 hours at 110C until the removal of moisture.
- The dry dolomite chips were crushed using mechanical crushers, ceramic crucibles and ball mills and it was experienced the brittle property.
- In the selections of particles sizes the 0.075mm sieve mesh was taken as the indicator and the <0.075mm portion was selected for the experiments.

Materials and Methodology Cont'd

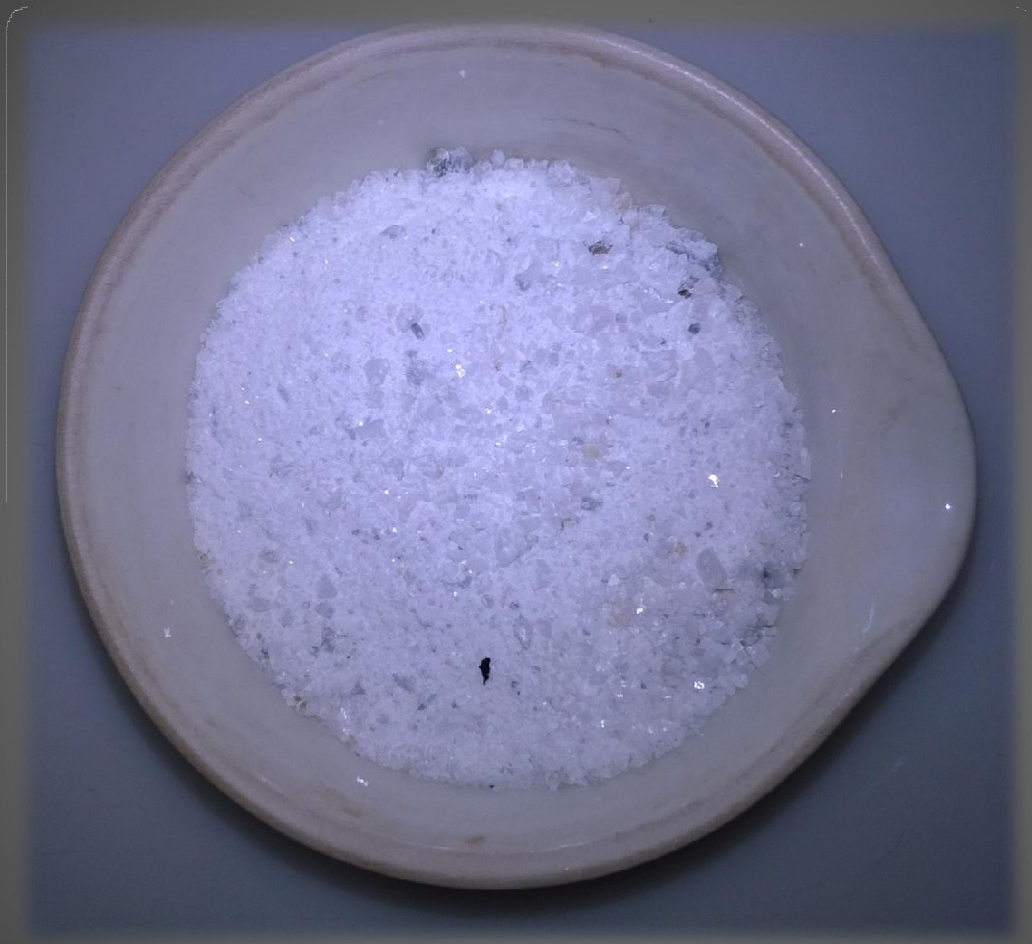


Figure 2. Powdered dolomite masses

Materials and Methodology Cont'd

- In the selections of final representative samples of the coning and quartering method was followed as shown in the Figure 3.
- The coning and quartering method is a technique that can be applied in the selections of a reasonable representative sample from a large amount of powdered solid materials such as clay, sand and powdered minerals.

Materials and Methodology Cont'd

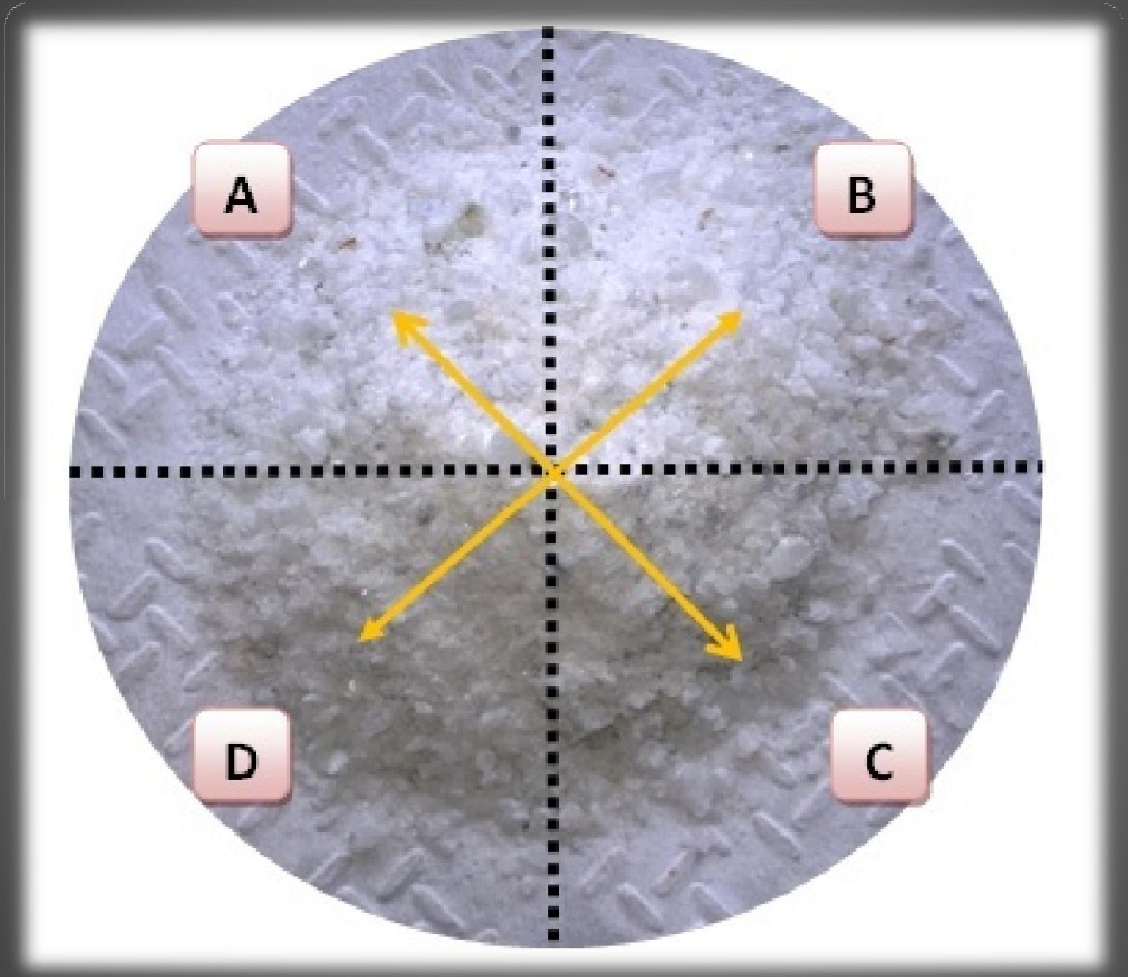


Figure 3. Coning and quartering method

Materials and Methodology Cont'd

- The prepared representative samples were transferred for following instruments based upon following relevant analysis.

I. X-ray fluorescence (XRF) spectrometer - Elemental analysis

II. Fourier transforms infrared (FT-IR) spectrometer - Chemical structural and functional group analysis

III. Optical microscope - Analysis of the particle shapes, diaphaneity and colors

IV. Scanning electron microscope (SEM) - Analysis of crystal systems, crystal shapes and microstructures

Materials and Methodology Cont'd

Figure 4. X-ray fluorescence (XRF) spectrometer

Materials and Methodology Cont'd

Figure 5. Fourier transforms infrared (FT-IR) spectrometer

Materials and Methodology Cont'd

Figure 6. Optical microscope

Materials and Methodology Cont'd

Figure 7. Scanning Electron Microscope (SEM)

Results and Discussion

- The X-ray fluorescence (XRF) analysis results of dolomite are shown in the following figure and table.

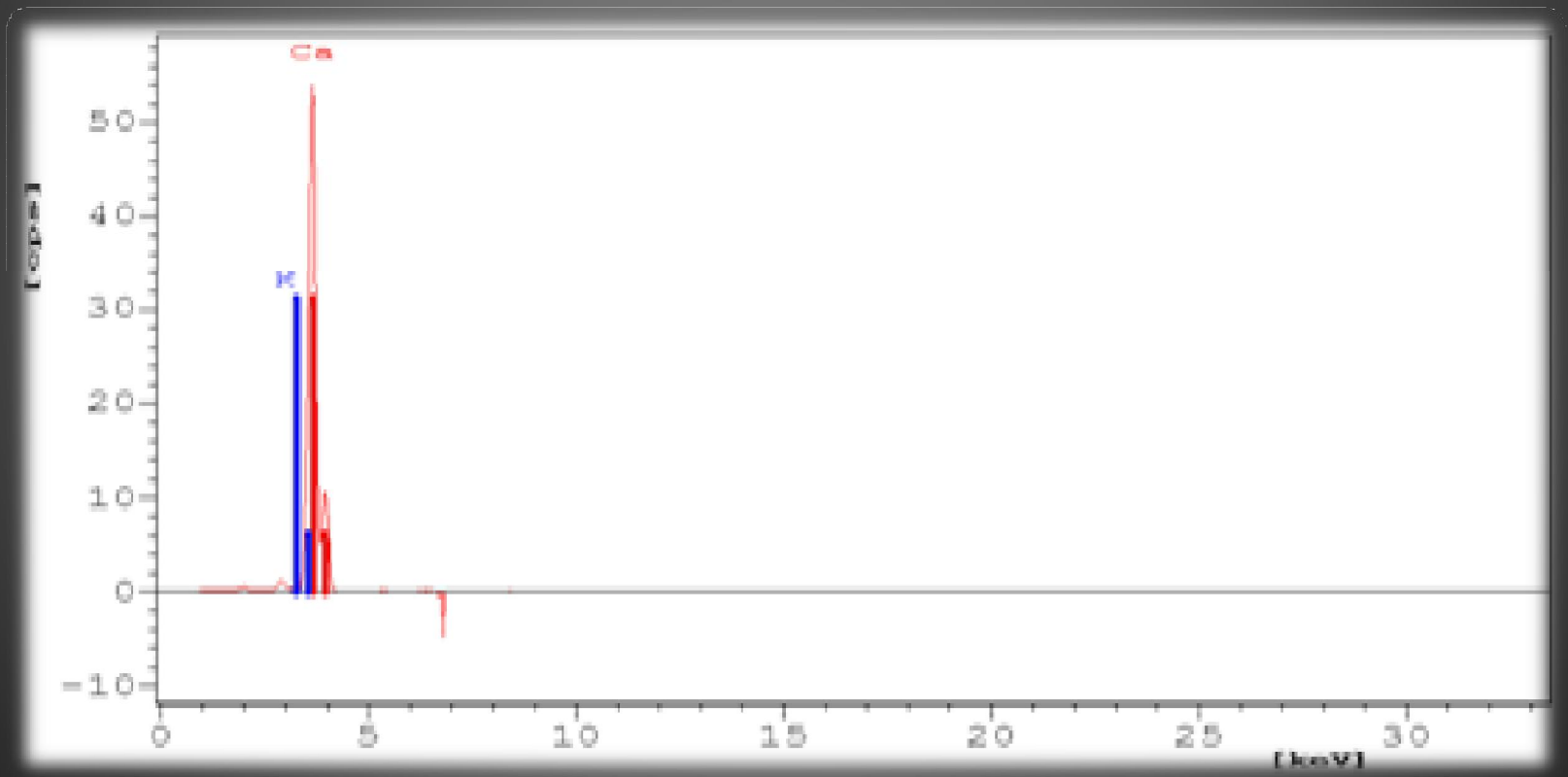


Figure 8. X-ray fluorescence (XRF) spectroscopy of dolomite

Results and Discussion Cont'd

Table 2. Elemental chemical composition of dolomite

Element	Content (%)
Ca	99.46
K	0.54

- According to the above results, it seems that this dolomite type was composed with relatively higher amount of calcite because of the higher Ca content while it was not observing evidence about Mg which is a major element that presence in dolomite [1,3,4,5,6].
- This would be an alkaline dolomite variety because of the presence of K.

Results and Discussion Cont'd

- The Fourier transforms infrared (FT- IR) spectroscopy and assignment of dolomite are shown in the following figure and table.

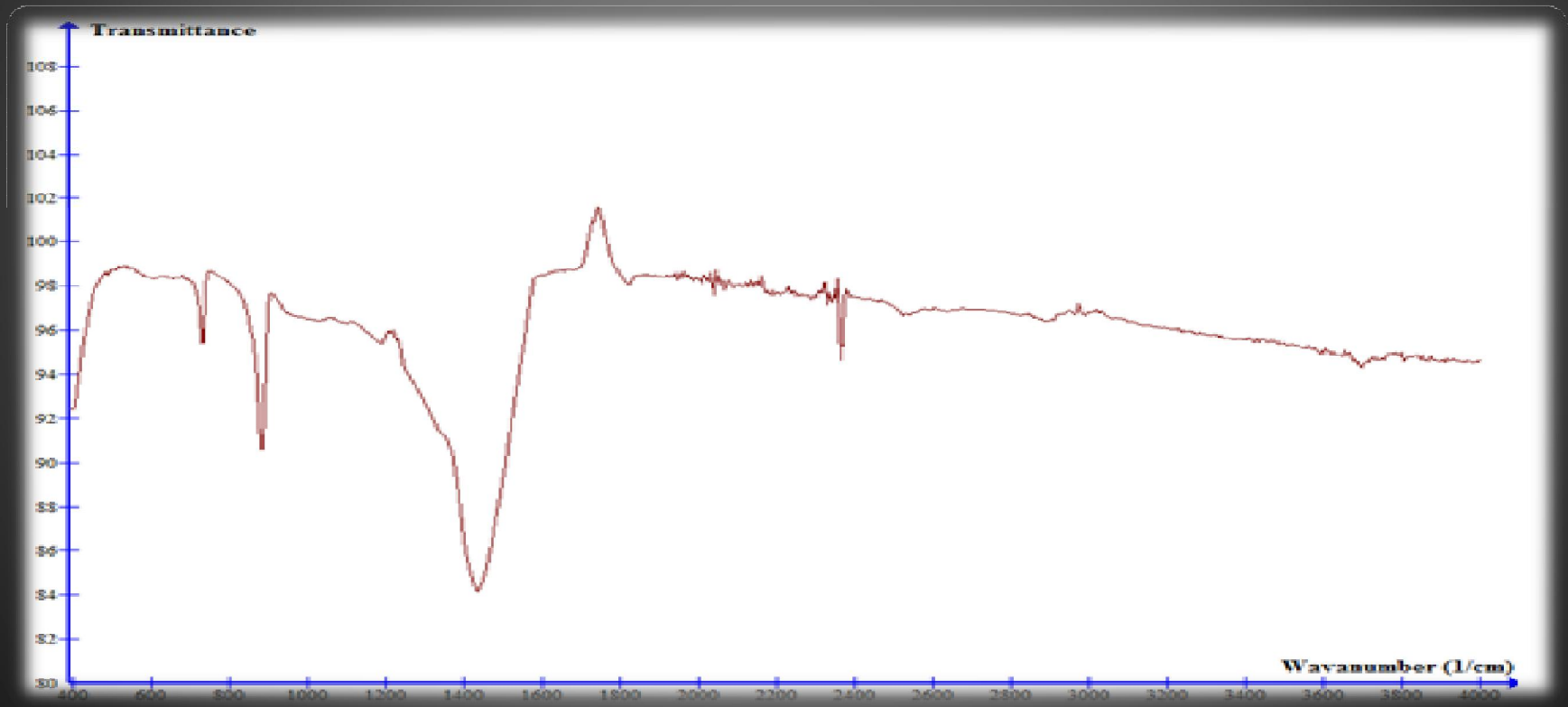


Figure 9. Fourier transforms infrared (FT-IR) spectroscopy of dolomite

Results and Discussion Cont'd

Table 3. Chemical structural analysis of dolomite

Wave Number (Cm^{-1})	Assignment
729	Si-O stretching of feldspar
881	Out plane bending of calcite
1433	CO_3 stretching
2365	-
3699	OH stretching

- According to the above results, it can be concluded that the presence of outer planer bending and CO_3 stretching which are presence in both calcite and dolomite [2,3,5,6].
- Since the FT-IR spectrums of calcite and dolomites are much similar, it is much knotty to distinguish the calcite or dolomite alone with FT-IR results [1-6].

Results and Discussion Cont'd

- A few of optical micrographs of dolomites are shown in the following figures.

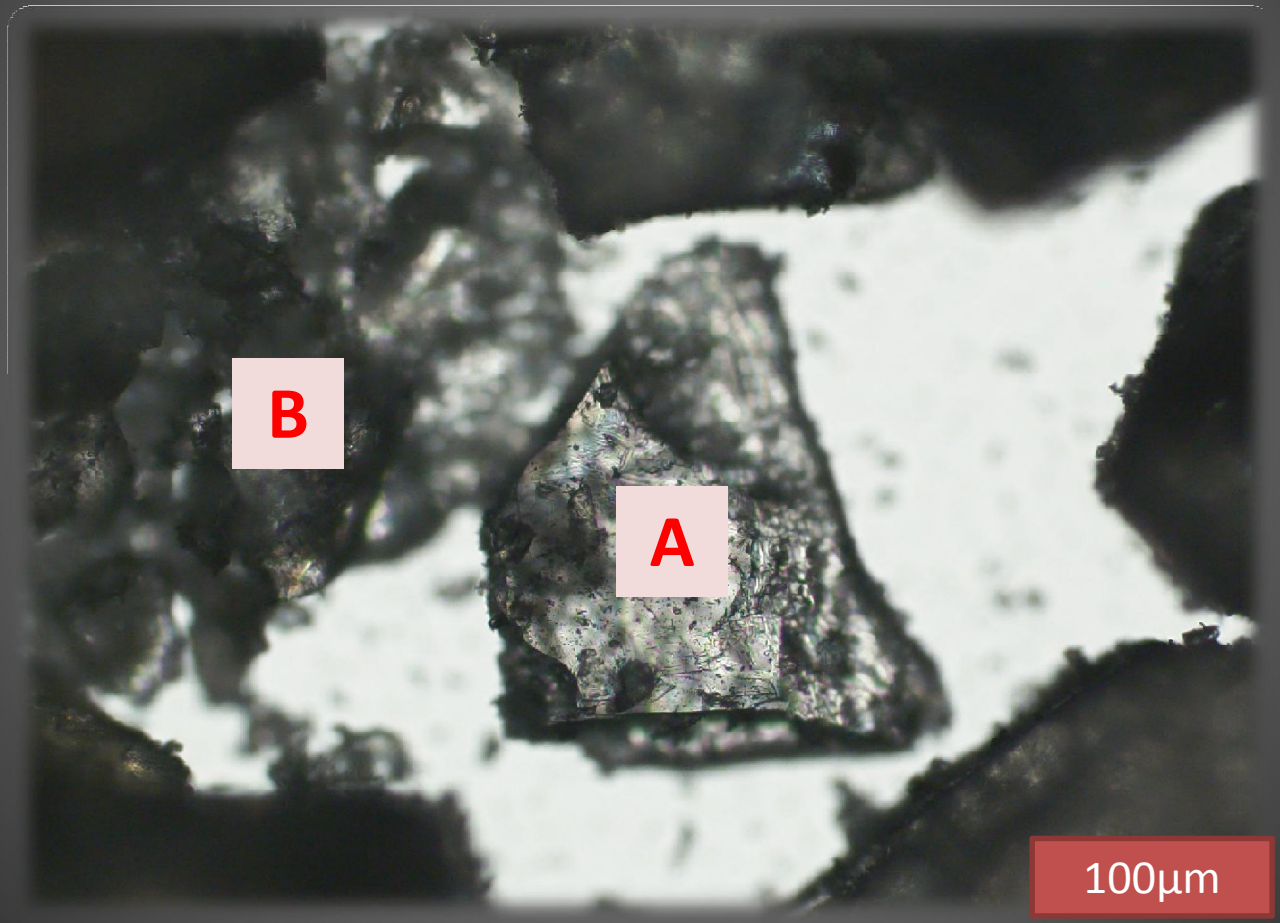


Figure 10. An optical micrograph of dolomite

Results and Discussion Cont'd

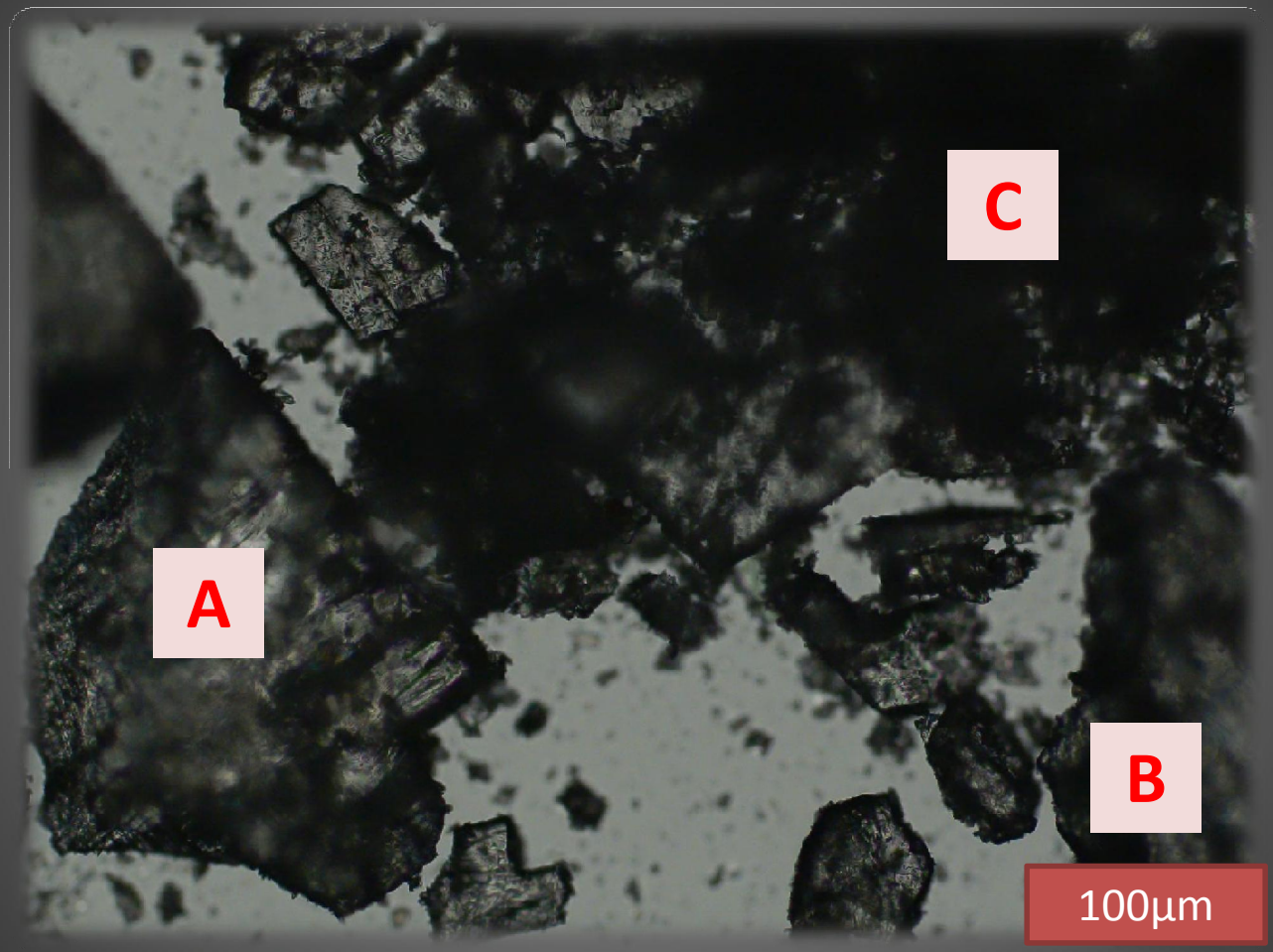


Figure 11. An optical micrograph of dolomite

Results and Discussion Cont'd

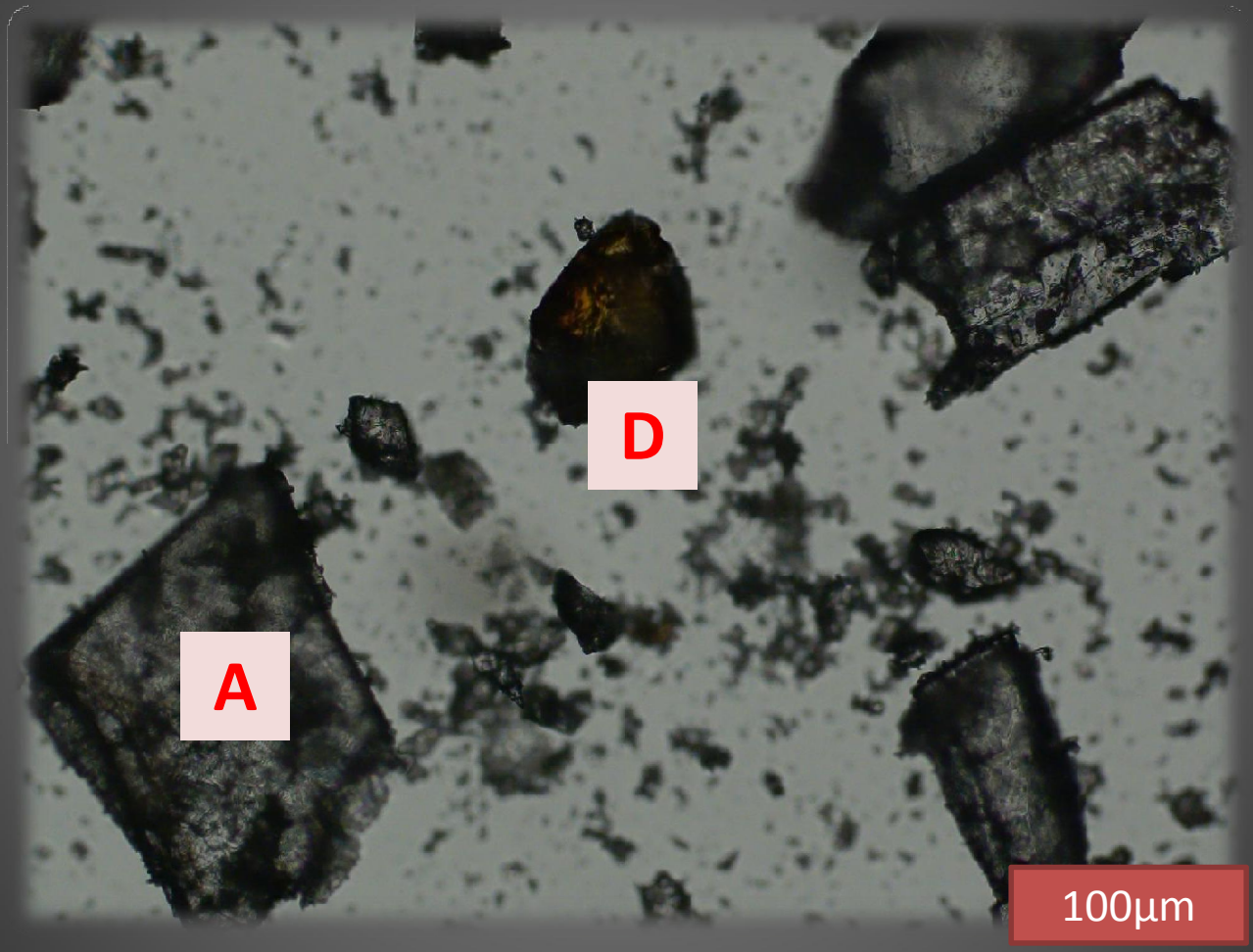


Figure 12. An optical micrograph of dolomite

Results and Discussion Cont'd

- According to the above optical micrographs, following important observations were captured.

I. A- Tabular and massive crystals with some flat surfaces, curvatures, cavities and ripple marks on the crystal surfaces with cleavages.

II. B- Colorless crystals and white crystals.

III. C- Transparent or translucent crystals.

IV. D- Reddish color crystals in trace percent

Results and Discussion Cont'd

- A few of SEM micrographs of dolomites are shown in the following figures.

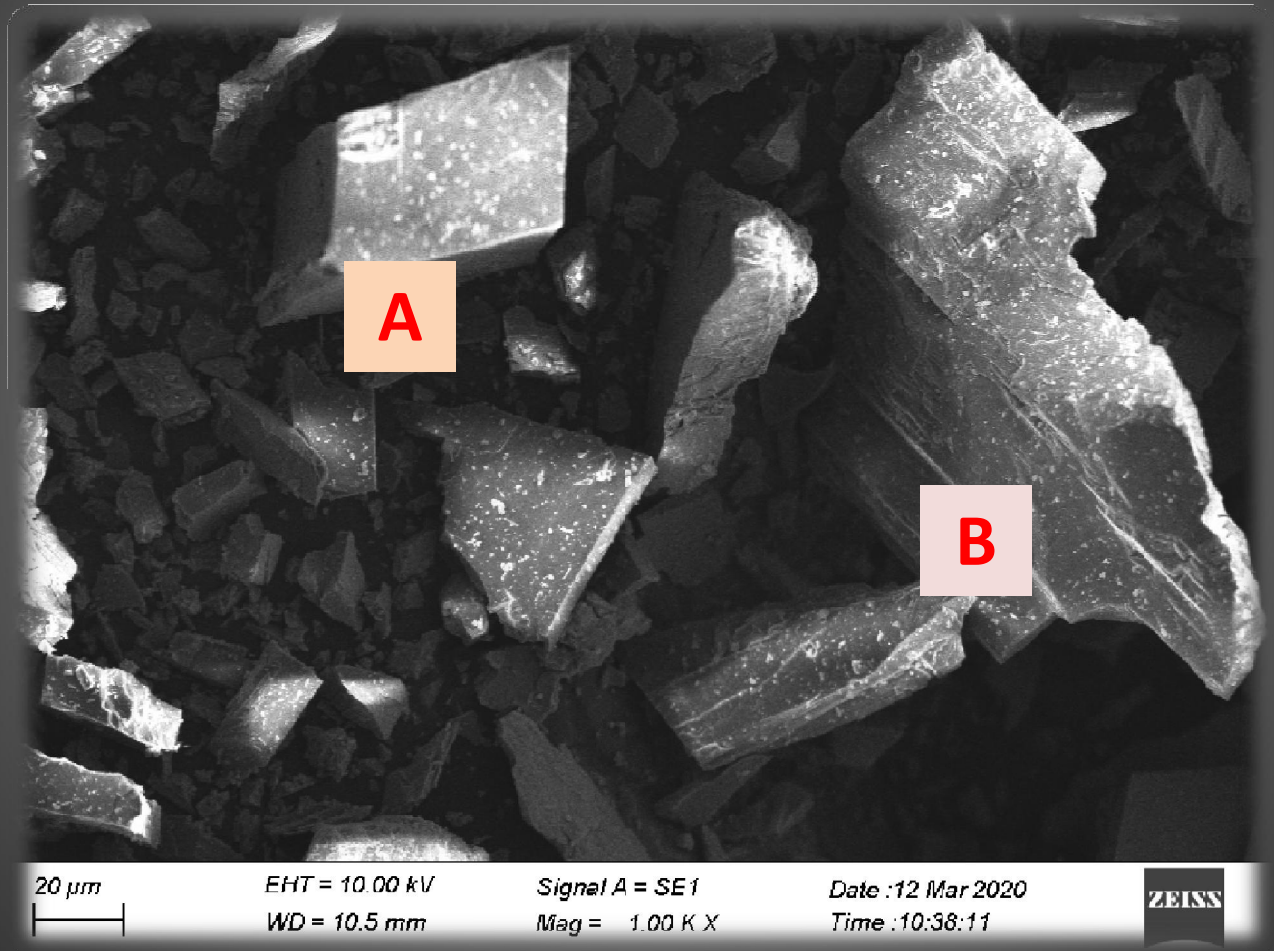


Figure 13. SEM micrograph of dolomite

Results and Discussion Cont'd

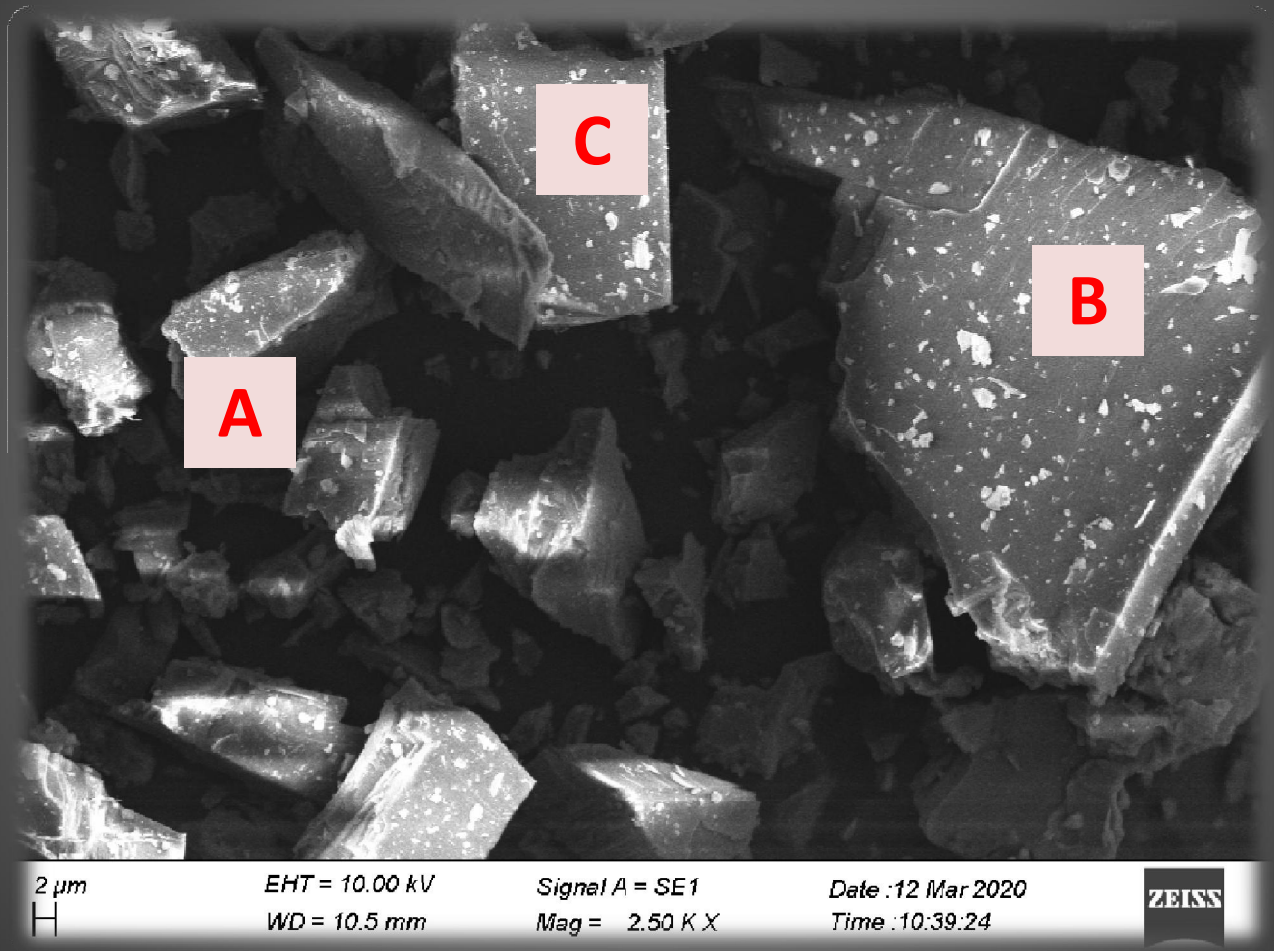


Figure 14. SEM micrograph of dolomite

Results and Discussion Cont'd

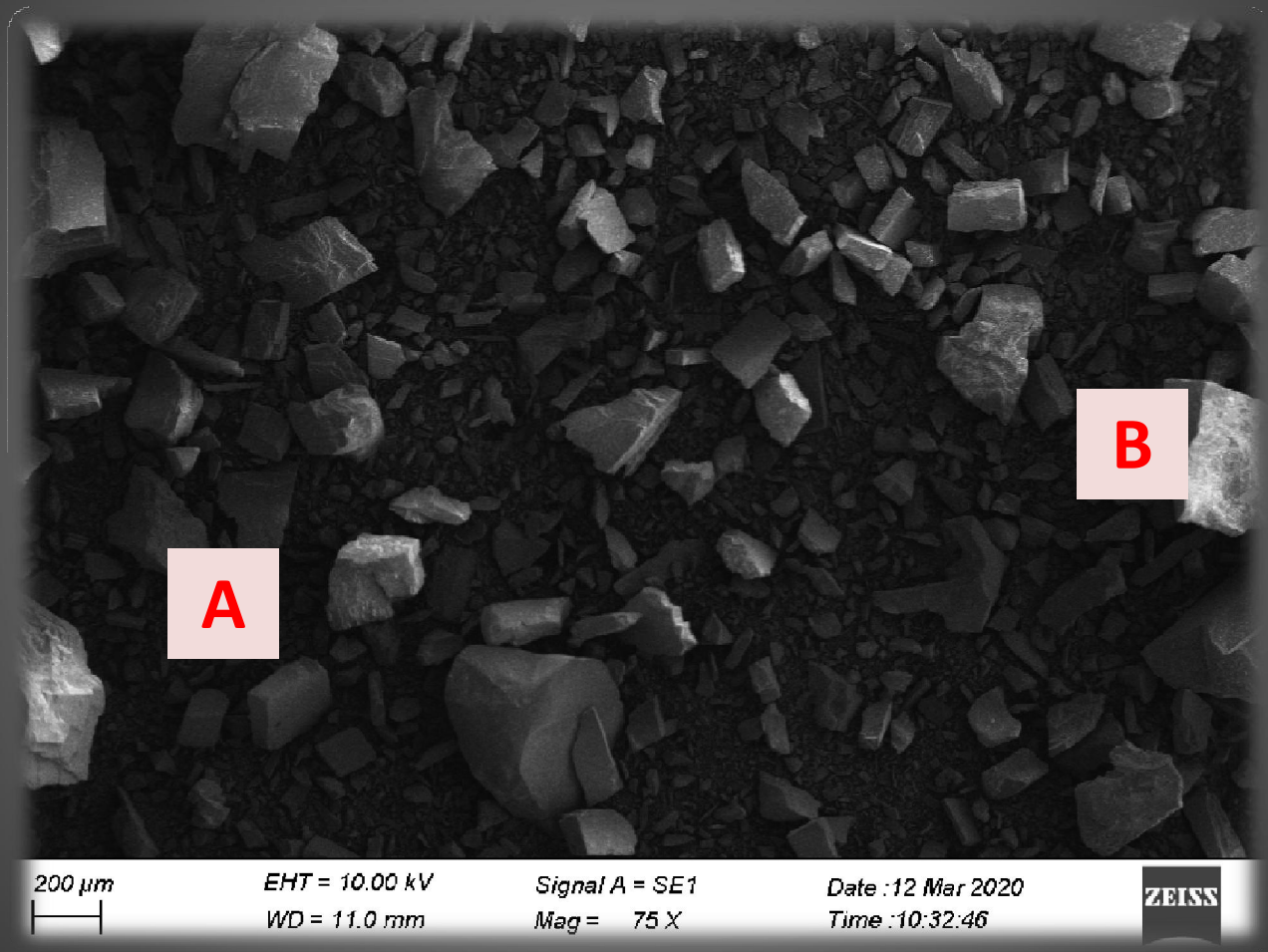


Figure 15. SEM micrograph of dolomite

Results and Discussion Cont'd

- According to the above SEM images, following important observations were capture.

I. A- Cleavage planes and tabular crystals

II. B- Massive crystals and flat surfaces

III. C- Curve shaped surfaces and ripple marks

- Based upon the above observations, it is confirmed the presence of large amount of calcite since having less impurities this dolomite type [1-5].

Results and Discussion Cont'd

- In the consideration of the observed characteristics of this dolomites, it is possible to recommend following advanced applications with the necessary synthesis methods [1-6].

I. Removals of heavy metals, pathogens and hardness from the waste water because of the adsorption capacities of $CaCO_3$ and $CaMgCO_3$ as massive bodies, chips and nano particles.

Results and Discussion Cont'd

II. Removal of pathogens, organic matter, suspended solid particles and heavy metals from waste water in the forms of CaO (burnt calcite/dolomite) as nano particles and $Ca(OH)_2$ (production of the reaction of both CaO and water) as nano particles. (in the synthesis of nano-particles it is required some standard chemical and physical synthesis methods)

Results and Discussion Cont'd

III. Removal of the hardness from extra-hard water and adjusting the acidity of water as dolomite and calcite bodies due to the adsorption.

IV. It can be used as a recovery material for some unnecessary compounds that dissolved in water such as phosphates.

V. Also it can be developed as a refractory material because of CaO and $CaCO_3$.

Conclusion

- This type of dolomite rock was composed relatively higher amount of calcite with trace amount of dolomite with crystal surfaces and brittle structure.
- Therefore, it is possible to recommend this dolomite type for the uses in the removals of hardness, pathogens, heavy metals, suspended solids and controlling of the acidity as the massive forms and also the nano-forms of CaO and $Ca(OH)_2$.

Recommendations for Future Research Works

- Entire compositional analysis of this dolomite rocks using an advanced analysis method such as Neutron Activation Analysis (NAA).
- Advanced microscopic analysis of this dolomite rocks such as Transmittance Electron Microscope (TEM).
- Development of dolomite nano-materials and experimentations of their absorption capacities and catalytic strength.

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IV. Department of Chemistry, University of Peradeniya.
V. Department of Zoology, University of Peradeniya.
VI. Department of Material Science and Engineering, University of Moratuwa.

References

[1]. Kocaoba S (2007) Comparison of Amberlite IR 120 and dolomites' performances for removal of heavy metals. J Hazard Mater., 147:488–496.

[2]. Mohammadi M, Ghaemi A, Torab-Mostaedi M, Asadollahzadeh M, Hemmati A (2015) Adsorption of cadmium and nickel from aqueous solutions using dolomite powder. Desalin Water Treat., 53(1):149–157.

[3]. Brady PV, Papenguth W, Kelly JW (1999) Metal sorption to dolomite surfaces. Appl. Geochem., 14:569–579.

[4]. Zachara JM, Cowan CE, Resch CT (1991) Sorption of divalent metals on calcite. Geochim. Cosmochim. Acta., 55(6):1549–1562.

[5]. Ambrosi M., Dei L., Giorgi R., Neto C. and Baglioni P. (2001). Colloidal particles of Ca(OH)2: properties and applications to restoration of frescoes.Langmuir, 17(14), 4251–4255.

[6]. Gao C., Zhang W., Li H., Lang L. and Xu Z. (2008). Controllable fabrication of mesoporous MgO with various morphologies and their absorption performance for toxic pollutants in water,Crystal Growth and Design, 8(10), 3785–3790.

Thank you

Author/Speaker: Suresh Aluvihara

Affiliation: Department of Chemical and Process Engineering, University of Peradeniya, Peradeniya, 20400, Sri Lanka

***Email: sureshaluvihare@gmail.com

***Telephone/ Telegram: +94758578194