Synthesis and Characterization of Calcium Zeolite-Cowlesite.

Abhijit M[1]*, Suresh Kumar. B. V[2].

[1, 2] Department of Studies in Earth Science, University of Mysore Manasagangothri, Mysore, India.

Email:abhijit.geology@gmail.com

DOI: 10.51201/JUSST/21/05216

http://doi.org/10.51201/JUSST/21/05216

Abstract**—***Cowlesite is a Calcium Aluminum silicate $CaAl_2Si_3O_{10}6H_2O$ which formed under hydrothermal condition of low temperature (180^0C) and pressure (1.013250bar). Cowlesite mineral know for its peculiar occurrence. Synthesis of Cowlesite mineral was carried by suitable stoichiometric composition. Hydrothermal synthesized Cowlesite mineral was characterized by XRD, SEM and EDAX. Cowlesite crystallized in orthorhombic system and a lattice parameter a=23.22Å, b=30.58Å, c=25.01Å, Volume of Unit cell=17758.79Å^3, α=β=γ=90^0. EDAX results show elemental concentration of raw material which was used.*

Keywords**— Cowlesite, Hydrothermal Synthesis, Characterization.**

1. INTRODUCTION

Cowlesite belongs to Calcium-Zeolite group mineral which forms at lower temperature (180^0C) and pressure (1.013250bar). The Mineral chemical formula is $CaAl_2Si_3O_{10}6H_2O$ [1-2]. It was first described by Wise and Tschernich in the year 1975 [1-3]. The name comes from honors of Mr. John cowles. [3]. The mineral crystallize in orthorhombic system with soft and thin, perfect cleavage, Colorless, Gray white to White, pointed bladed Aggregates of thin lath-like crystals habitat [4-5]. It is associated with analcime, chabazite, garronite, levyne, mordenite, phillipsite, heulandites, stilbite, and thomsonite of zeolites minerals and almost known occurrences from basic lava in different parts of the world. Indian possible occurrence is the Deccan traps carry a wide variety of zeolites, mainly calcic, but Cowlesite has not hitherto been reported from this area. The geological environment is favorable for possible occurrence with olivine tholeiitic basalts dykes as a secondary associated mineral in vugs and cavities [5-7]. The main theme of the present work is to synthesis the unusual occurrence and minute availability of the single crystal to simulate the natural condition in laboratory. Using the different molarities of the raw material is used to prepare compound. Low density mineral will form at low pressure condition with zeolite structure with calcium content in composition. At 600^0C completely lose its water content in its structure [8]. Synthesized Cowlesite shows exact lath like crystals was examined under Scanning Electron Microscope.

2. Experimental Technique

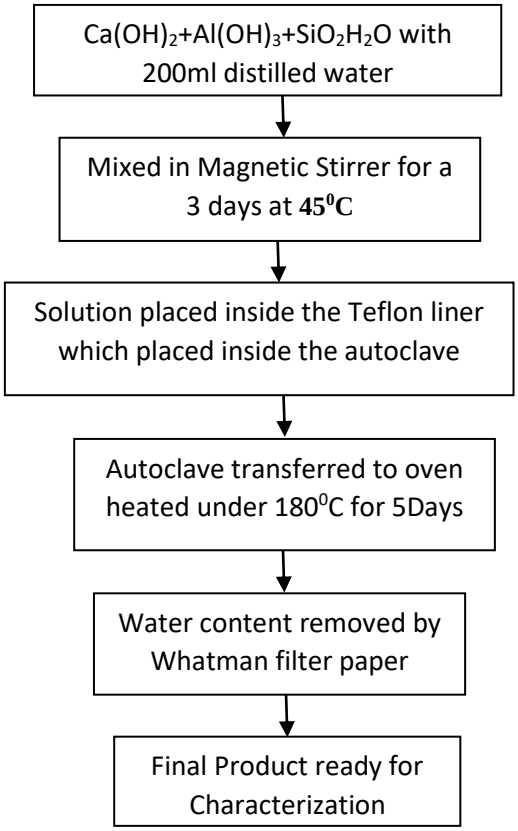
The experiment was carried out to synthesize the Cowlesite in SS-316 general purpose autoclave with low temperature and pressure with suitable stoichiometry. The reactants of the Cowlesite was charged to Teflon liner and placed inside the 200ml capacity autoclave.

The raw material used for the reactant precursor was Calcium hydroxide, Aluminium hydroxide, Silicon Hydroxide Colloidal Hydrate molar ratio in grams (1.48:3.12:3.64) and H_2O added as 200 ml distilled water. The reactants were aged with the magnetic stirrer for well

mixing of compound for the precursor with 45^0C and spin for a 3days with maintaining constant temperature and stirring. The precursor reactant gel was charged into the autoclaves with a temperature of 180^0C for 5 days.

The solution was treated in oven which was placed in autoclave were quenched with cold water to arrest the reaction. The sample taken carefully and water removed using Whatman filter paper placed in funnel and slowly filtered the water gets collected in a conical flask and powder sample on the filter paper in funnel. Wet powder dried in room temperature in a closed system and Sample ready for characterization using XRD, SEM and EDAX.

Flow Chart:-



3. Results and Discussion

The resultant product formed by Stoichiometry in a homogenous phase of Cowlesite. The temperature range of 180^0C mineral formed and shows an orthorhombic crystal system. The Cowlesite crystalline product was formed was confirmed by X-ray diffraction peaks. The cell parameter is a=23.22 Å, b=30.58 Å, c=25.01 Å. Volume of Unit cell=17758.79 $Å^3$, $\alpha=\beta=\gamma=90^0$. Perfect hkl values shows the Globe, Oregon, USA and Kuniga, Oki Island, Shimane, Japan Cowlesite sample pattern plane along which cleavage existence.

The Standard Joint Committee on Powder Diffraction Standard card no 46-1405 compared with Cowlesite synthesized XRD pattern confirms that mineral is Cowlesite. (Fig:-1)

SEM studies shows morphology and particle size of Cowlesite. Lath like structure of mineral formed are clearly seen in SEM. Selected area in sample was targeted by EDAX for atomic weight percentage.

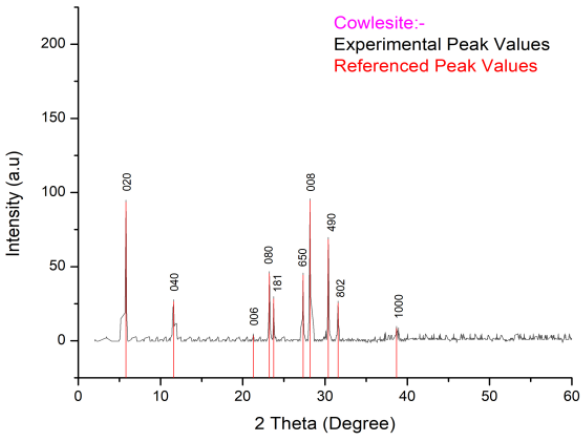


Fig:-1

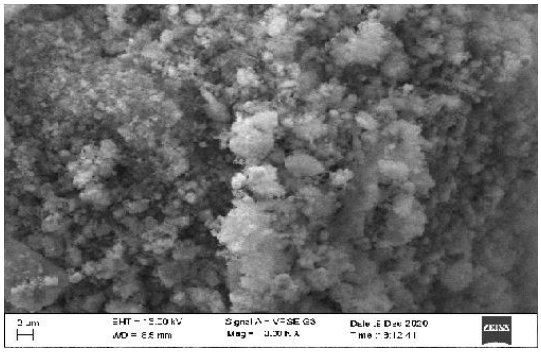


Fig: - 2

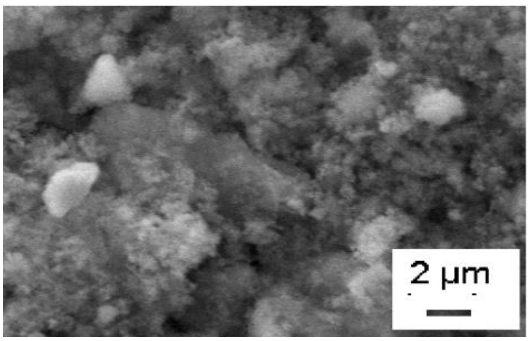


Fig:- 3

Figure 2 and 3 image of SEM of synthesized Cowlesite.
Elemental proportion was carried out the results was plotted in graph Fig:- 4

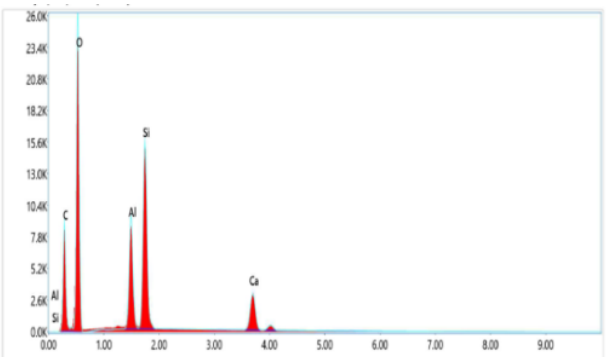


Fig:-4

Element	Weight %	Atomic %
O K	39.69	46.29
Al K	15.13	12.39
Si K	38.37	36.21
Ca K	6.90	5.11

Table:-1

4. CONCLUSION

Purity control and quality enhancement is a main objective of the hydrothermal synthesis. The simulation of hydrothermal process of nature was practiced in laboratory. Cowlesite is a low temperature and pressure calcium Zeolite which was formed in vugs and cavities of trap rocks, single crystal is very rare and restricted to some places so synthesis of this mineral is essential to know its properties. It was synthesized by treating at a temperature 180^0C in a laboratory for a 3days.

5. REFERENCES

[1] *Santoshi Matsubara, Tokiko Tiba and Akira Kato, "The Occurrence of Cowlesite from Kuniga, Oki Islands, Japan", bulletin of the national science museum series c, 1978.*

[2] *Enrico Mugnaioli, Arianna E. Lanza, Giorgio Bortolozzi, Lara Righi, Marco Merlini, Valentina Cappello, Lara Marini, Athanassia Athanassiou, and Mauro Gemmi, "Electron Diffraction on Flash-Frozen Cowlesite Reveals the Structure of the First Two-Dimensional Natural Zeolite", ACS central science, 2020.*

[3] *Szakall S, Feher B and Vezzalini G, "Occurrence of Cowlesite in Andesite at Pilisszentlaszlo, Pilis Mts, Hungary", Acta Minerlogica-Petrographica, Abstract series 5, Szeged, 2006.*

[4] *William S Wise and Tschernich R. W, "Cowlesite a New Ca-Zeolite, American Mineralogist", Volume 60, pages 951-956, 1975.*

[5] *Suresh Kumar. B. V, Prakash Narasimha K. N, "Compositional variation in Zeolites and associated mineral in Deccan Plataea, Maharashtra, India", 103rd Indian Science Congress Conference, Mysuru, india, 2016.*

[6] *Vandana Swarnkar, Radha Tomar, "Sorption of selenate by surfactant modified Cowlesite", Novus International Journal of Chemistry, Volume No 1, 2012.*

[7] *Giovanna Vezzalini, Gilberto Artioli, Simona Quartieri and Harry Foy, "The crystal chemistry of Cowlesite", Mineralogical Magazine, December, 1992.*

[8] *Gottardi G, Galli E, "Natural Zeolites(Rocks and Minerals"), Springer –Verlag Berlin Heilberg, New York 1985.*