J. Myanmar Acad. Arts Sci. 2019 **Vol. XVII. No.2A**

CHARACTERIZATION OF MUD OF MUD VOLCANO IN MINBU (NAGA BWET TAUNG) AS GEOPOLYMER RAW MATERIAL

Khin Moe War[1],Yu Mar lar Lwin[2], Me Me Soe[3]

Abstract

The mud of mud volcano sample was collected from an eruption site named "Naga Bwet Taung", Minbu, Magway Region for characterization.X-ray fluorescence (XRF) was used to measure the chemical composition of mud of mud volcano and fly ash. Structure properties of mud and fly ash were examined by X-ray diffraction(XRD).XRD Analysis showed that the major constituents of mud are SiO_2 which are higher than those in fly ash. Scanning Electron Microscopy (SEM) was used to observe the microstructure and shape of the mud to compare fly ash. Fourier Transform Infrared Spectroscopy (FTIR) was performed to determine the bonding between the particles in mud and fly ash. The crystalline sizes were also calculated. In brief, the contents in mud of mud volcano is similar to that of fly ash which is commercial product and it was shown that the mud of mud volcano has potential as a raw material in geopolymer system due to characteristic of mud which is comparable to the fly ash.

Keywords: geopolymer, XRF, XRD,FTIR,SEM

Introduction

Myanmar has a few active volcanoes related to the mud volcanoes in Indonesia. There are three active and extinct volcanoes in Myanmar. List of active and extinct volcanoes in Myanmar are shown in Table (1) and Fig (1).

Mud volcanoes are formed from methane gases trapped deep below the ground being forced to the surface. In some instances, the pressure will push though the water table and mix the clay or mud in the surrounding areas to create a "volcano" such as the ones found in Minbu. It is situated on the western shore of the Irrawaddy near the oil-fields of Yenangyaung. Locally, the mud volcanoes of Minbu are known as Naga Bwet Taung which is loosely translates to something about Dragons breath.

1. Dr, Assistant Lecturer, Department of Physics, University of Yangon
2. Assistant Lecturer, Department of Physics, University of Yangon
3. Assistant Lecturer, Department of Physics, University of Yangon

Unlike regular volcanoes, there is no heating involved and in fact, the mud is cool to the touch. The landscape is in Minbu looks like the surface of the moon with multiple vents bubbling out of ever-growing creators in the ground. Fig (2)

Fly ash is the fine solid particulated residue driven out of the boiler with the flue gases in coal-fired power plants. During the combustion of coal, the products formed are fly ash, bottom ash and gases or vapours.Most of the fly ash particles are glassy oramorphous. Fly ash is the fine part of the ash which is entrained in the flue gases, whereas the bottom ash is the residue consisting of coarser discrete or fused particles heavy enough to drop out of the combustion zone onto the bottom of the furnace. Fig (3). The vapour and gases from the volatilized fraction of the carbonaceous material which are partly discharged into the atmosphere and partly condense onto the surface of the fly ash particles.Some of the carbon particles do not burn and thus the fly ashes also contain unburned carbon or carry over carbon particles. The efficiency level of the coal burning power plant is also reflected in the quality of fly ash it produces. Thus, better plant efficiency means getting a better fly ash for use in concrete mixes.

The properties of fly ash are extremely variable and depend upon several factors, such as the type and origin of coal(bituminous, sub-bituminous and lignite coals), degree of coal pulverization, flame temperature, oxidation conditions and pretreatment during or to burning for SO, removal, method of collection and storage of fly ash. Fly ash is categorized into Class N, F, C and S. Class F and C pozzolans refer to fly ash derived from the burning of different coals. Class F refers to fly ash derived from burning anthracite or bituminous coal. Class C refers to ashes derived from burning lignite or sub-bituminous coal and contains less than 50 percent as oxides of silica (SiO_2), alumina(Al_2O_3) and iron (Fe_2O_2). In this study, Class C fly ash is used as a comparison process of mud of mud volcano (Naga Bwet Taung) .

About 500 million tonnes of coal combustion residue(ash) is produced annually by thermal power plants all over the world. The efficient use of coal ash as structural fill in embankments and dykes as an admixture in cement and concrete as sub-base and base course of roads as back fill for retaining structures, as till for land reclamation, etc. has transformed the costly liability of its disposal into an economic and environmentally safe proposition. Fly ash also find use as raw material in the manufacture of cement and for the production of sintered lightweight fly ash aggregates and bricks.

Table 1: The active and extinct volcanoes in Myanmar

Name	Elevation		Location	Last eruption
	meters	Feet		
Lower Chindwin	385	1263	Along the lower Chindwin River in central Myanmar	Holocene
Mount Popa	1518	4980	At the northern end of the BagoYoma Hills range	442 BC
Singu Plateau	507	1663	In north-central Myanmar, north of the city of Myanmar	Holocene

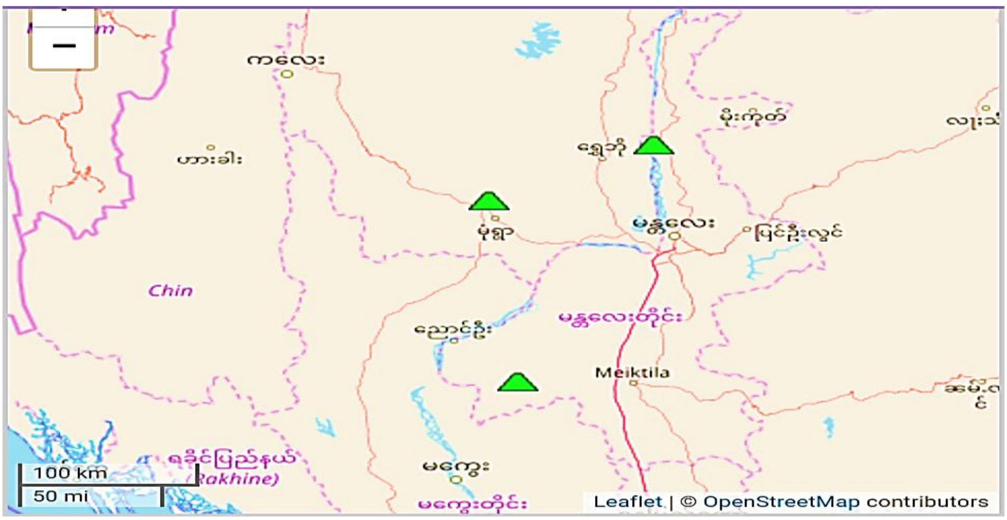


Figure 1: Map of volcanoes in Myanmar

Figure 2: Mud volcanoes in Minbu(Naga Bwet Taung)

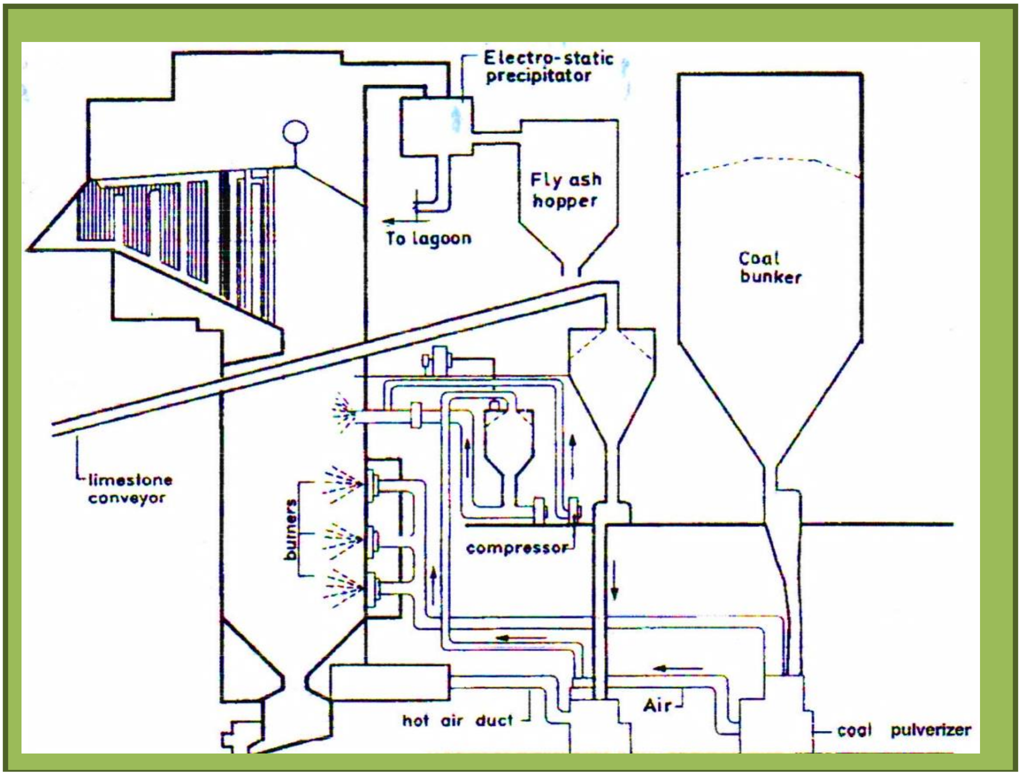


Figure 3 :Schematic diagram showing fossil fuel furnace, anti- pollution additive equipment and fly ash collection system

Experimental Procedure

Sample collecttion

The mud volcano sample was collected from the eruption sites called the Naga Bwet Taung mud volcano which is situated in Minbu, Magway Region. And, the fly ash sample was collected from the Tee Gyit coal industry, Shan State. Fig(4)

Figure 4: The raw mud (liquid)

Sample Preparation

The mud was transferred into sealed container. It was medium gray in colour. Firstly, the mud in the container was dried through direct sunlight under atmospheric pressure for three or four day and ground by agate mortar to obtain the powder form for testing purpose. Fig (5,6,and7)

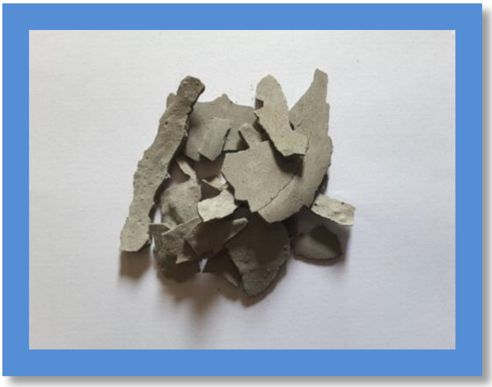


Figure 5: The dried mud of mud volcano after burning in direct sun light

Figure 6: Agate mortar

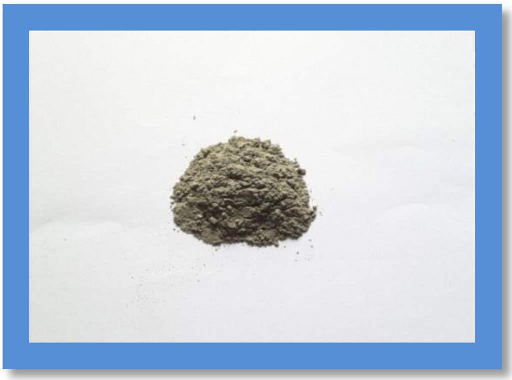


Figure 7 : The obtained mud powder after grinding

Sieve Analysis

For obtaining the unnecessary materials and uniform size of mud, sieve analysis by using mesh size of (100X100) microns pan was done. A small quantity of mud was placed in the pan and did the analysis twice to get the pure and uniform size of mud. Fig (8) and Fig (9). Moreover, the block diagram of experimental methods of raw mud is shown in Fig (10).

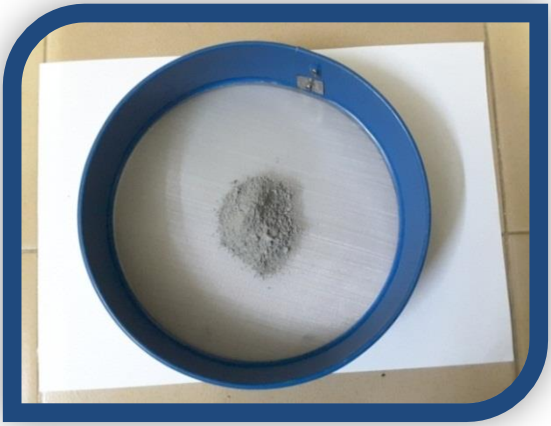


Figure 8 : Sieve analysis of mud of mud volcano using with mesh

Figure 9 : The pure and uniform size of mud

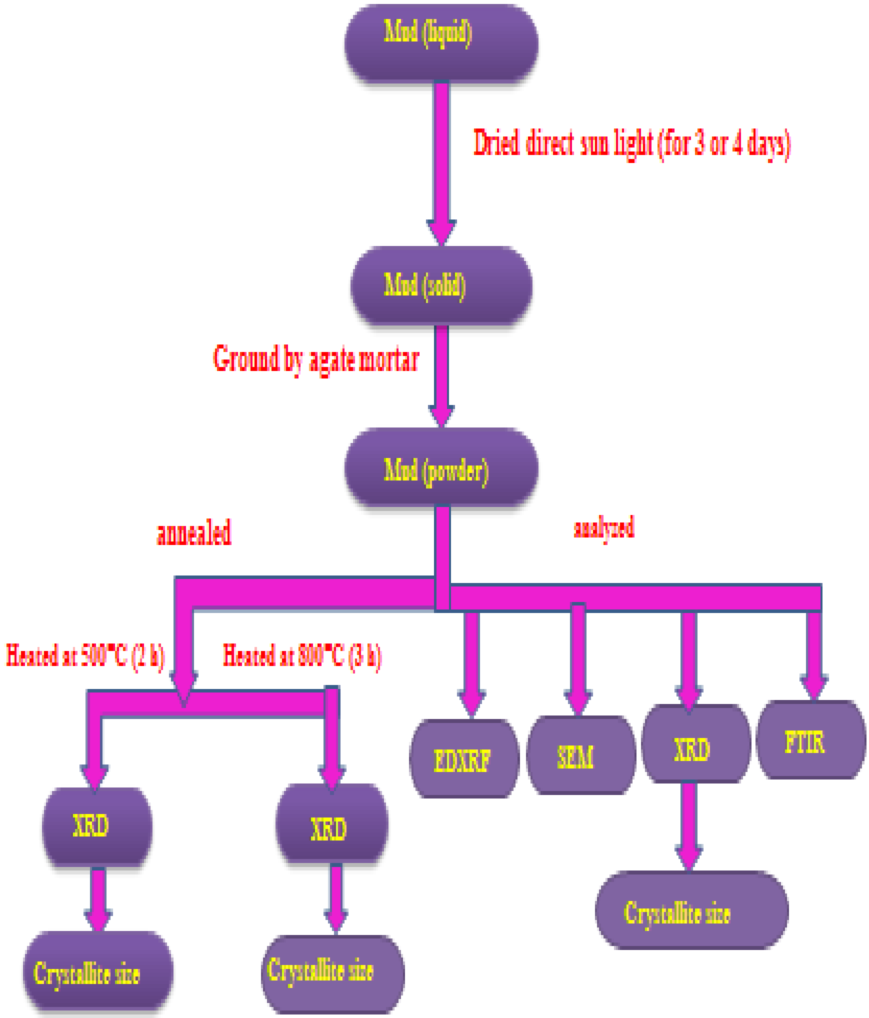


Figure 10: The block diagram of experimental methods of mud

Laboratory Methods

The block diagram of experimental methods of mud was shown in Fig (10).The mud and fly ash were collected and analyzed for different parameters by EDXRF, XRD, SEM and FTIR methods at Universities of Research Centre (URC), Yangon. Fig (11) (a),(11) (b) and (11)(c).

Figure11: (a) Shinmadzu EDX-700 X-ray spectrometer

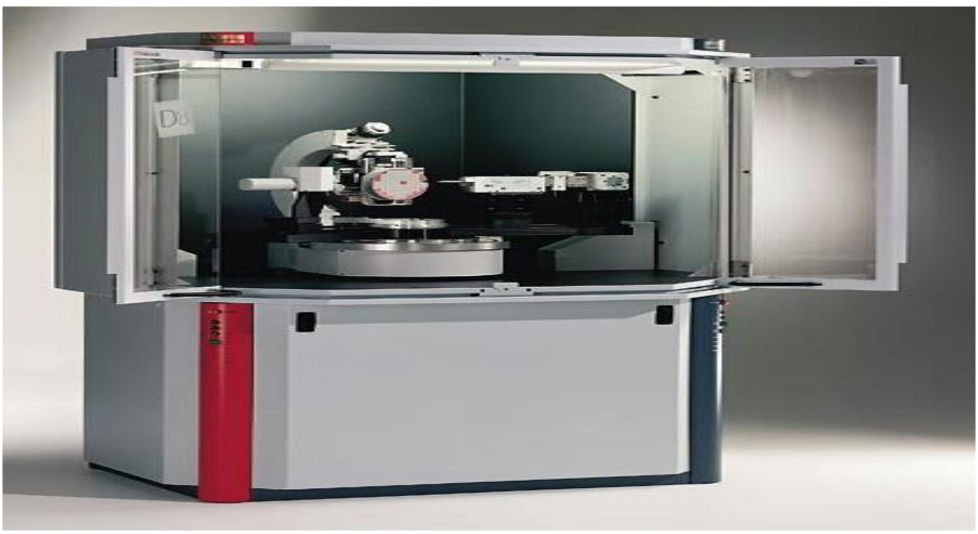


Figure 11: (b): XRD spectrometer

Figure11: (c) SEM (JSM-5610) spectrometer

Results and Discussion

In this present work, the chemical composition of mud and fly ash is shown in table (2) and fig (12) by EDXRF method. The EDXRF results showed that the chemical compositions of mud and fly ash and they had the major constituents of Si (75.98%) and (68.98%) . It was found that the concentration of Si in mud was higher than that of fly ash. It was showed that the mud was suitable to replace as a raw material for production of cement.

Table 2: The major chemical concentration of the mud compared to fly ash.

Elememts	Mud of mud volcano (Naga BwetTaung) %	Fly ash Tee Gyit coal industry, Shan State. %
Si	75.98	68.98
Ca	1.54	2.243
Ti	1.42	1.706
Fe	16.29	18.791
K	4.88	5.687
Mn	0.298	0.313
Zr	0.122	0.152

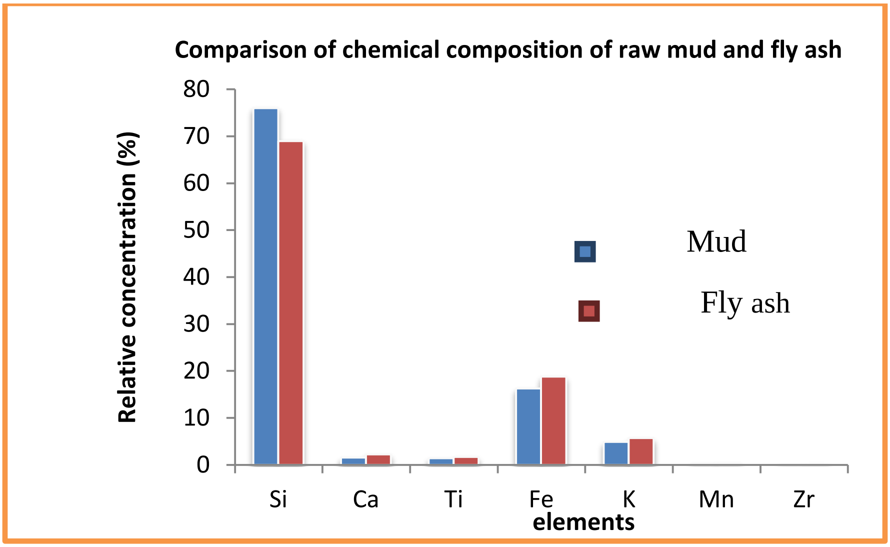
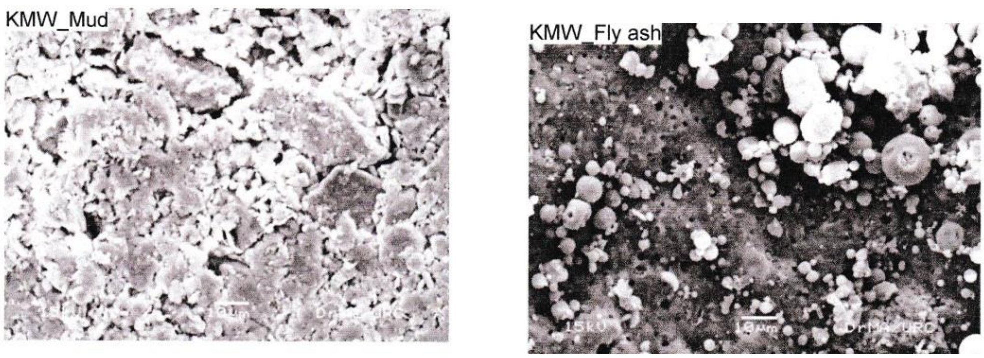


Figure 12: Comparison of concentrations of raw mud and fly ash

SEM investigation of raw mud and fly ash

The morphology of the mud and fly ash were examined by using SEM (JSM-5610) with accelerating voltage 15 kV and photo magnification 1000. SEM analyzed of the mud compared to fly ash is shown in Fig 13 (a) and (b). As seen in Fig 13(a), the particles of mud were plate-like structure and as seen in Fig 13(b), the particles of fly ash were spherically-shaped.

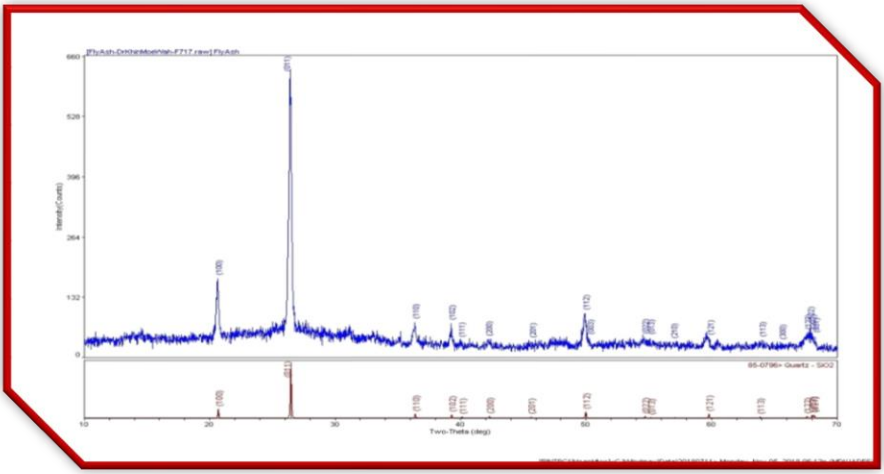


(a) (b)

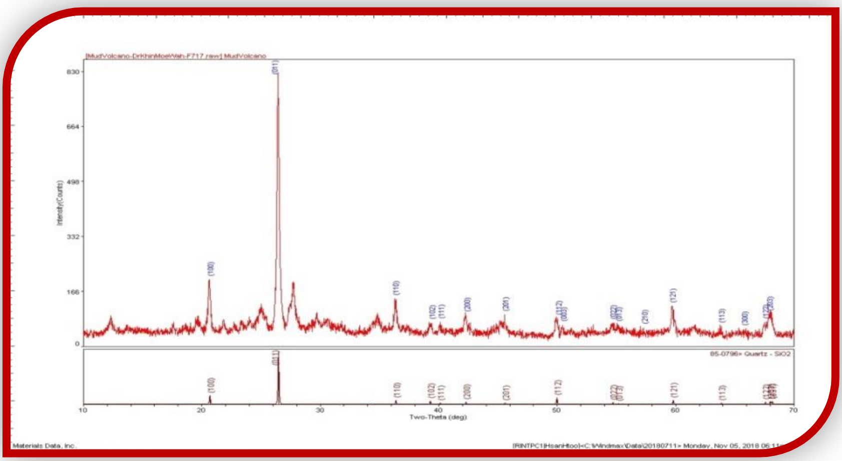
Figure 13 : (a) SEM of raw mud of mud volcano (b) SEM of mud of mud volcano

X-ray Diffraction analysis

X-Ray diffraction (XRD) patterns for the mud compared with fly ash are shown in Figure 10. Both starting materials exhibit a peak at 2 thetha where 2 thetha = 20º - 32º, which is characteristic of structurally disordered compounds, and the peak at 2 thetha = 27° of mud shows slightly towards higher than fly ash due to higher composition of SiO_2 in mud compared to fly ash.(fig 14(a) and (b))



(a)



(b)

Figure14: (a): X-ray Diffraction pattern of fly ash (b) X-ray Diffraction pattern of mud

Fourier Transform Infrared Spectroscopy (FTIR)

Infracted spectra of mud fly ash were recorded at room temperature in the range from 400cm^{-1} to 4000 cm^{-1} using FTIR (8400, SHIMSDZU, Japan). The FTIR spectra of mud and fly ash were reported in Fig 15(a) and (b). The transmission band of the range from 423 cm^{-1} to 450 cm^{-1} is due to overlapping bending modes of Si-O-Si and 440cm^{-1} to 550 cm^{-1} is due to deformation vibrational modes of Si-O-Si, indicating the presence of Si in mud. Between the band 3570 cm^{-1} and 3200 cm^{-1} was assigned to the stretching vibration of O-H and H-OH groups from the weakly-bound water molecules which were absorbed on the surface of the mud.

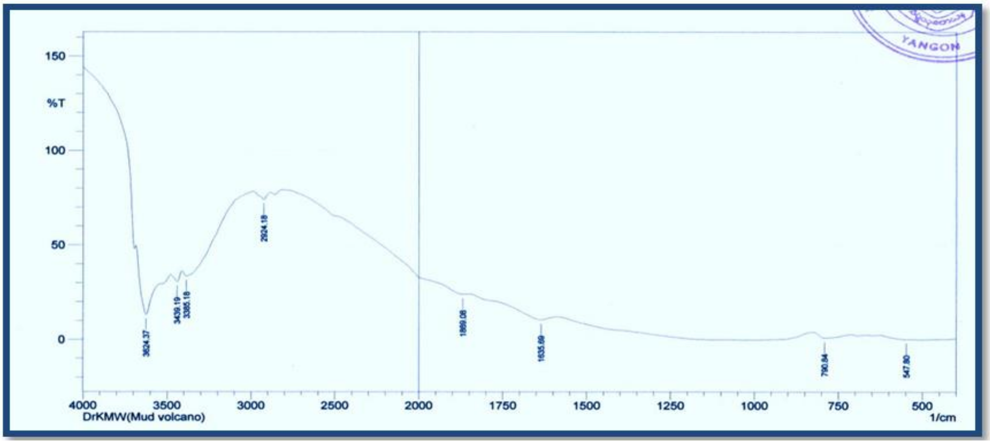


Figure 15: (a) FTIR spectrum of mud of mud volcano

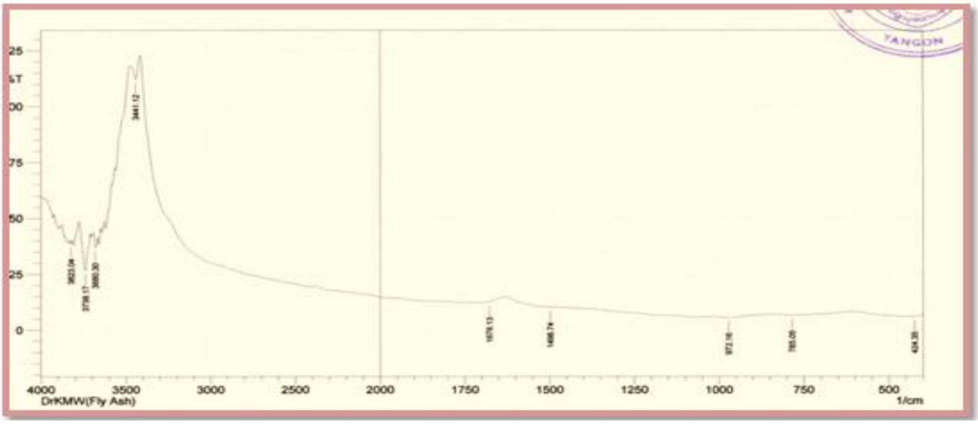


Figure 15: (b) FTIR spectrum of fly Ash

Investigation of crystalline size of raw mud and fly ash

The crystalline size of mud and fly ash can be calculated by Scherre's equation.

The equation of crystalline size is

$$D = \frac{0.9\,\lambda}{\beta\ \cos\theta}$$

Where, D is the crystallite size, β is the full width half maximum (FWHM) of the peak in radian, and θ is the diffraction peak position. The calculated value of crystallite sizes are shown in table (3).

Table 3: The calculated value of crystallite sizes of raw mud and fly ash

Samples	β	θ	cos θ	**D(nm)**
Raw Mud	0.227	13.210	0.9735	359.48
Fly Ash	0.229	13.201	0.9735	356.33

XRD analysis of the annealed mud at 500° and 800°C

The mud samples were annealed at 500°C and 800°C for 3 h and analyzed by XRD method to know the compound and to calculate the crystalline size. The XRD spectrums of the annealed mud were shown in fig 16 (a) and (b).It was found that the the peak at 2 thetha = 27° of mud is higher than fly ash due to higher composition of SiO_2 in mud compared to fly ash.The crystal sizes of the annealed mud were calculated by Scherre's equation.

The comparison of crystallite sizes of ordinary mud, the annealed mud and fly ash shown in Table (4).It was evaluated that the crystalline size of ordinary mud and fly ash were nearly equal but that of the annealed mud (800°C) was larger than any other samples and the annealed mud (500°C) was smaller the crystalline size of all samples. The lesser crystalline size was more suitable for replacing the fly ash. Therefore, The annealed temperature less than and equal 500 °C was the best to use. The data was shown in Table (5).

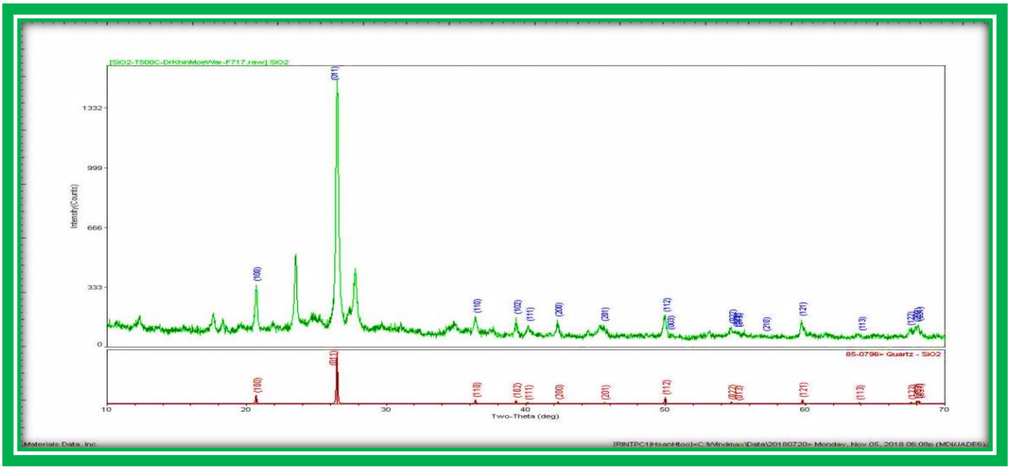


Figure16 : (a) XRD spectrum of mud at 500°C for 3 h

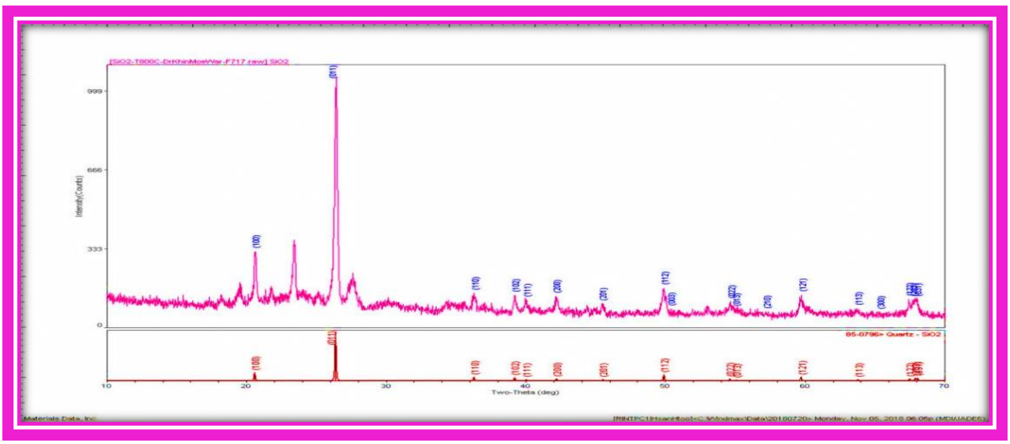


Figure16 : (b) XRD spectrum of mud at 800°C for 3 h

Table 4: The calculated values of crystallite sizes in annealed mud (500°C and 800°C)

Samples	Temperature(°C)	β	θ	cos θ	D(nm)
Mud	500	0.234	13.248	0.9733	348.77
	800	0.222	13.209	0.9735	367.566

Table 5: The comparison of crystallite sizes of raw mud, the annealed mud and fly ash

Samples	β	θ	cos θ	D(nm)
Raw mud	0.227	13.210	0.9735	359.48
Annealed mud (500°C)	0.234	13.248	0.9733	348.77
Annealed mud (800°C)	0.222	13.209	0.9735	367.566
Fly ash	0.229	13.201	0.9735	356.33

Conclusion

Analysis was carried out to explore the characteristic of mud of mud volcano as the potential benefits of the unstoppable mud flow. The EDXRF results showed that the chemical compositions of mud and fly ash and they had the major constituents of Si (75.98%) and (68.98%). It was found that mud contained higher amount silicon which is suitable to use as a raw material for production of cement. SEM analyzed the microstructure of the particles of mud and fly ash. The particles of mud were plate-like structure and the particles of fly ash were spherically-shaped and they all were different sizes. XRD analysis showed the mud was slightly towards higher than fly ash due to higher composition of SiO_2 in mud compared to fly ash. The crystalline size of ordinary mud and fly ash were nearly equal but that of the annealed mud (800°C) was larger than any other samples and the annealed mud

(500°C) was smaller the crystalline size of all samples. The lesser crystalline size was more suitable for replacing the fly ash. Therefore, The annealed temperature less than and equal 500 °C was the best to use. The FTIR peaks indicated the existence of Si-O-Si and H/OH bonding in original mud. Finding from this study shows that the mud of mud volcano has potential as a raw material in geopolymer system due to characteristic of mud which is comparable to the fly ash. Research will continue replacing the cement by mud for various methods and will continue to study how to relate the properties of compressive strength, will investigate the radon measurement.

Acknowledgements

I would like to thank Professor Dr Khin Khin Win, Head of Department of Physics, University of Yangon for her kind permission to carry out this research.

I also would like to thank Dr Aye Aye Thant, Professor, Department of Physics, University of Yangon, for her allowing me to do this work.

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