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Qualitative and Quantitative Analysis of Heavy Metal and Mineral of Volcanic Ashmount Sinabung by Using Inductively Coupled Plasma (Icp-Oes)

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ABSTRACT

The research to analyze the concentration of heavy metal and mineral of volcanic ash Mount Sinabung after eruption in July-August 2016 by using Inductively Coupled Plasma (ICP-OES) was conducted. Sampling was taken in two village s at surrounding Mount Sinabung, which is in Sigarang-garang and Sukandebi Provinsi Karo Sumatera Utara. Sampling was done by collecting volcanic ash which is located in the area affected farm population eruption of Mount Sinabung. Weighted 5 g of volcanic ash and added 5 ml of concentrated HNO_3, after that added aquadest up to 50 ml and then heated for 2 h, cooled and then filtered with Whatmann filter paper. The extract obtained is then analyzed by ICP-OES Variant Liberty. Qualitative analysis of Sinabung volcanic ash was done by using X-ray diffraction (XRD) instrument and has obtained the results which consist of heavy metals and minerals are (Ca, Na) $(Al, Si)_2 Si_2O_8$; (K, Ca, Na) $(Al, Mg, Fe)_2 (Si, Al)_4$ (OH);Ca Mn^{+2} Si_2O_6; PbO; CuO; ZnO. And, measured of concentration of heavy metals by using Inductively Coupled Plasma (ICP-OES) method, the results were Fe ± 136.5710 ppm, Mn ± 1.0799 ppm, Zn ± 0.2187 ppm, Pb ± 0.0120 ppm, Ca ± 36.3112 ppm, Al ± 4.7699 ppm, Na ± 4.4322 ppm. The presence of heavy metals, there are Al, Pb, Zn although with little concentration still need special attention, because of the eruption of Mount Sinabung continues over time.

Keywords: Volcanic ash, Sinabung metal, Inductively Coupled Plasma (ICP-OES), X-ray diffraction (XRD)

INTRODUCTION

Mount Sinabung is a Pleistocene-to-Holocene stratovolcano. It is located in a relatively cool area on a fertile plateau with mountains bounding the north. The summit crater of the volcano has a complex, longer form due to vents migrating on the N-S line. The 2,460 m high andesitic-todacitic volcano comes from the Sunda Arc. This is created by the seduction of the Indo-Australian Plate under the Eurasian Plate [1] Sinabung has a total of four volcanic craters, one of them being active currently [2].

Activity of Mount Sinabung had issued a volcanic ash and smoke in 2010. Then in 2013 ash emission occurred again. Results of the volcano eruptions emit thick black smog. The volcanic ash covering thousands of hectares of crops farmers in the surrounding mountains. In July until August 2016 eruption of Mount Sinabung happen again and ash emission occurred with ash column height reaching 3000 m above the summit crateras [3]. Based on research Canion et al., on the research of trace analysis of Indonesian volcanic ash using thermal and epithermal neutron activation analysis founded that elements on Mount Merapi volcanic ash are Cr, Ni, Ti, V and several rare earth elements (Ce, Dy, Eu, La, Sm, Tb). Clift et al., did the research to analyzed trace and rare earth element chemistry of volcanic ashes from sites 918 and 919: implication for Icelandic volcanism and found that Rb, Sr, Y, Zr, Nb, Ba, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Lu, U in sample. From this research, we can see that volcanic ash contained by heavy metals, mineral and rare earth element [4].

Volcanic ash is composed of fine particles of fragmented volcanic rock (<2 mm diameter). Volcanic ash is often hot very close to the volcano but is cool when it falls at greater distances. It is formed during volcanic explosions, from avalanches of hot rock that flow down the side of volcanoes, or from red-hot liquid lava spray. Ash varies in appearance depending upon the type of volcano and the form of the eruption (IVHHN). Volcanic ash generally contains metals, both beneficial and harmful to humans. Volcanic ash soil chemical compounds generally contain SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, Na_2O, K_2O, MnO, TiO_2, P_2O_5, H_2O and other heavy metals. Effects of ash on health may be divided into several categories: respiratory effects, eye symptoms, skin irritation and indirect effects (IVHHN). The volcanic ash led to crop farmers who were on the mountain slopes a lot of dead and damaged. It is estimated that an area of 15.341 ha of agricultural crops in the Karo threatened crop failure [5].

Heavy metals are individual metals and metal compounds that can impact human health. Eight common heavy metals are discussed in this brief: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. These are all naturally occurring substances which are often present in the environment at low levels. In larger amounts, they can be dangerous. Generally, humans are exposed to these metals by ingestion (drinking or eating) or inhalation (breathing).

Working in or living near an industrial site which utilizes these metals and their compounds increases ones risk of exposure, as does living near a site where these metals have been improperly disposed. Subsistence lifestyles can also impose higher risks of exposure and health impacts because of hunting and gathering activities [6].

Malemta T has conducted research on the comparative study of heavy metal content (Fe, Mn, Zn, Pb, Cu, Al) and Na on Dust eruption of Mount Sinabung and Land before Eruption. The eruption of Mount Sinabung has occurred during the past few years that many resulting negative impact on the lives of the surrounding mountains.

It is necessary to re-analysis of the content of heavy metals and minerals contained in dust eruption of Mount Sinabung in July until August 2016 to know how big the levels are still below the threshold SNI and its impact on the environment and living things such as plants, vegetables and fruits.

In this case the method of Inductively Coupled Plasma (ICP-OES) is the method used and has advantages in terms of analyzing heavy metals in the number of small ones and mentode X-ray diffraction (XRD) for the qualitative test that can be known metals whatever dust contained in the eruption of Mount Sinabung. This process is applied to facilitate the detection of sample qualitatively and quantitatively [7].

MATERIALS AND METHODS

Material and reagents

Chemistry matters that used in this research are chemistry matters with pro analysis purity degree Matters used in this research are dust eruption of mount Sinabung (2014 until 2016), Standard Multielemen 100 ppm (Fe, Mn, Zn, Pb, Cu, Ca, Al dan Na), HNO_3 (E. Merck), Aquadest.

Apparatus

Instrument that used in this research are: To do preparation are glasses Instrument, like pumpkin measure 100 ml, 1000 ml; pipettes volume 5, 10, 25, 50 ml; measuring cup 100 ml and pipette drops, X-ray diffraction (XRD) Shimadzu 6100, Instrumentasi Inductively Coupled Plasma (ICP-OES) Varian Liberty.

Preparation of sample

Weighed 5 g of ash volcanic, added 5 ml of concentrated HNO_3 and 50 ml of aquadest, heated for 2 h. Then, cooled them and filtered by Whatmann filter paper. After that, added 50 ml of aquadest. And the last, analysed the extract by using ICP-OES Variant Liberty

Preparation of HNO_3 solution

Measured 76, 9 ml of concentrated HNO_3 (65%) and then, be diluted by aquadest to 1000 ml.

Preparation of standard solution

Pipetted 10 ml of Multi Element standard solution, and then diluted by HNO_3 (5%) up to 100 ml. After that, 10 ppm standard solution is obtained. Pipetted 5 ml of 10 ppm standard solution, and then diluted by HNO_3 (5%) up to 100 ml. After that, 0.5 ppm standard solution is obtained. Pipetted 10 ml of 10 ppm standard solution, and then diluted by HNO_3 (5%) up to 100 ml. After that, 1.0 ppm standard solution is obtained.

RESULTS AND DISCUSSION

Analysis result of the content of heavy metals and minerals while the content of heavy metals contained in the dust which are contained in the dust of the eruption of mount Sinabung using lasma ICP-OES method can see in the Table 1.

The Table 1 above shows that the content of heavy metals and minerals in the dust of the eruption of mount Sinabung in the village of Sigarang-garang of the most high contained in the metallic iron (Fe) that is 136.571 ppm and the lowest is copper metal (Cu) with a concentration of 0.00025 ppm. As for metallic minerals, namely sodium (Na) and calcium (Ca) each have levels high enough, is 36.4934 and 94.0375 ppm.

Table 1: Concentration of heavy metal and mineral of mount sinabung volcanic ash in desa sigarang-garang

S. No.	Parameter	Concentration (ppm)
1	Iron (Fe)	136.571
2	Manganese (Mn)	1.13619
3	Zinkum (Zn)	0.22078
4	Timbel (Pb)	0.01207
5	Copper (Cu)	0.00025
6	Calsium (Ca)	94.0375
7	Aluminum(Al)	4.75977
8	Sodium (Na)	36.4934
9	Magnesium (Mg)	4.22658
10	Cobalt (Co)	0.10009

Table 2: Concentration of heavy metal and mineral of mount sinabung volcanic ash in desa sukandebi

S. No.	Parameter	Concentration (ppm)
1	Besi (Fe)	141.006
2	Mangan (Mn)	1.17023
3	Zinkum (Zn)	0.20547
4	Timbal (Pb)	0.08667
5	Tembaga (Cu)	0.00025
6	Kalsium (Ca)	93.9283
7	Aluminium (Al)	44.812
8	Natrium (Na)	38.4456
9	Magnesium (Mg)	3.89751
10	Kobalt (Co)	0.11551

The above shows that the content of heavy metals and minerals in the dust of the eruption of mount Sinabung in the village of Sukandebi Village of the most high contained in the metallic iron (Fe) that is 141.006 ppm and the lowest is copper metal (Cu) with a concentration of 0.00025 ppm. As for metallic minerals, namely sodium (Na) and calcium (Ca) each have levels high enough, is 38.4456 and 93.9283 ppm.

Rumus based on the above Tables 2 and 3 are obtained more or less 49 the content of the compounds contained in the dust of the eruption of mount Sinabung that almost all of the content of such compounds has a negative impact on the environment, especially on agriculture this test is a qualitative test that is carried out before determining the concentration of heavy metal and minerals by using ICP-OES method.

Table 3: Qualitative analysis by using X-ray diffraction

Number	Card number	Mineral name
1	4-0835	Nickel Oxide
2	8-0117	Titanium Oxide
3	5-0682	Titanium
4	6-0297	Boron Oxide
5	27-1402	Silicon
6	6-0686	Iron Carbide
7	9-0402	Cobalt Oxide
8	39-0145	Calcium Titanium Oxide
9	4-0673	Tin
10	20-0312	Chromium Oxide Hydroxide
11	1-1236	Iron Nitride
12	25-1047	Calcium Silicate Hydrate
13	17-0333	Tungsten Carbide
14	34-1084	Iron Carbide
15	27-0997	Zirconium Oxide
16	25-0322	Copper Zinc
16	34-0394	Cerium Oxide
17	21-0920	Iron Oxide
18	33-0900	Manganese Oxide
19	5-0561	Lead Oxide
20	6-0615	Iron Oxide
21	34-0140	Iron Chromium Oxide
22	5-0592	Lead Sulfide
23	10-0393	Sodium Aluminum Silicate
24	19-0629	Iron Oxide
25	6-0399	Barium Zirconium Oxide
26	24-0511	Iron Chromium Oxide

27	8-0454	Barium Sulfide
28	6-0644	Molybdenum Boride
29	29-1487	Aluminum Silicate Hydroxide
30	10-0490	Potassium Barium Aluminum Silicate Hydroxid
31	19-0771	Magnesium Oxide
32	19-1461	Zinc Manganese Oxide
33	10-0425	Aluminum Oxide
34	34-0977	Tantalum Oxide
35	18-1304	Barium Oxide
36	7-0233	Aluminum Antimony
37	6-0233	Sodium Aluminum Silicate
38	33-1204	Copper Oxide
39	5-0667	Aluminum Silicate Hydroxide
40	14-0164	Sodium Aluminum Silicate
41	44-0103	Iron Carbide
42	20-0508	Antimony Oxide
43	5-0534	Aluminum Silicate
44	16-0602	Aluminum Oxide
45	10-0173	Calcium Silicate Hydroxide
46	29-0330	Chromium Boride
47	26-0420	Nickel Sulfide
48	12-0041	Nickel Iron Oxide
49	10-0325	Sodium Aluminum Silicate

From the research data obtained by the concentration of heavy metals in volcanic ash of Mount Sinabung are higher than the concentration of heavy metals in the soil were not affected by the eruption (Figure 1). ICP-OES Variant Liberty had used in this study because it is so sensitive and can accurately detect a wide variety of items at once; the measurement results can be programmed into heavy metal concentrations (ppm). Although the concentration of heavy metals in volcanic ash of Mount Sinabung is not too high, if the eruption is prolonged then the danger posed difficult to predict because of the ongoing research is needed to find back the content of heavy metals in the volcanic ash of Mount Sinabung from year to year.

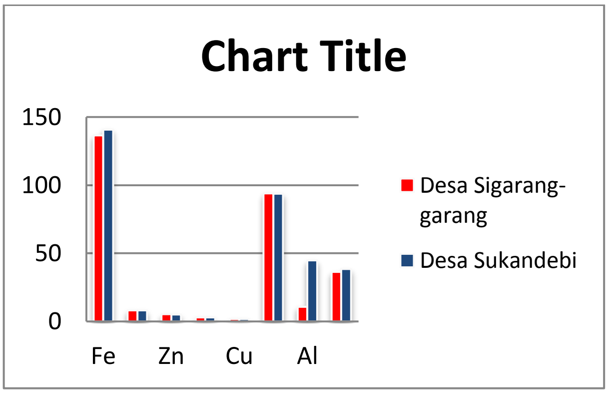

Figure 1: Comparison of levels of heavy metals in soil were not affected by the eruption and Volcanic ash of Mount Sinabung

Based on Figure 1, showed that concentration of heavy metals in the soil that were not affected by the eruption by previous research Malemta T, metal content of Fe of 4.0250 ppm, Mn of 0.0570 ppm, Zn of 0.3800 ppm, Pb of 0.0055 ppm, Cu of 0.0280 ppm, Al of 7.1220 ppm, Na of 1.2250 ppm. While the concentration of heavy metals in volcanic ash of Fe of 136.5710 ppm, Mn of 1.0799 ppm, Zn of 0.2187 ppm, Pb of 0.0120 ppm, Ca of 36.3112 ppm, Al of 4.7699 ppm, Na of 4.4322 ppm.

The concentration of heavy metals in the soil before eruption is smaller than the concentration of heavy metals in volcanic ash of Mount Sinabung. In this study, it can be seen that the concentration of heavy metals and minerals in the volcanic ash of Mount Sinabung located at three Village surrounding of Mount Sinabung, there are Sigarang-garang, Sukandebi, Surbakti showed no difference that is too far away, but each will have elevated concentration of heavy metals and minerals if the eruption of Mount Sinabung occur continuously [8].

CONCLUSION

The conclusions of this research are:

- The dominant concentration of heavy metals in volcanis ach are Fe of ± 136.5710 ppm, Mn of ± 1.0799 ppm, Zn of ± 0.2187 ppm, Pb of ± 0.0120 ppm, Ca of ± 36.3112 ppm, Al of ± 4.7699 ppm and Na of ± 4.4322 ppm.
- Concentrations of heavy metal in volcanic ash Mount Sinabung always increase continue from first eruption to next eruption.

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