Concentration of Some Metals in Water and Soil Samples at Some Locations near the Hotmud Flow at Porong Disaster Area, Sidoarjo, East Java, Indonesia.

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Abstract. More than hundred thousands people in the Porong subdistrict have been displaced by the hot mud flowing from a natural gas well being drilled by Lapindo Brantas, an oil well company since late May 2006. The mud was estimated to be flowing at a rate of 125,000 m³ per day and rapidly flooded surrounding areas displacing hundred thousands of people. For about thousand people had to seek medical treatment after exposure to and inhalation of a poisonous gas. This disaster is happen continue until now. The monitoring of mud flow and water quality are performed by taking separate samples in the field and transporting the samples to the laboratory for analysis. The sediment and water samples of hot mud flow at Porong Area, East Java, Indonesia, were taken from several points and analyzed are as follow ; concentration of Cr, Cd, Zn, Cu, Pb, Fe in sediment samples in the range of : 0.26 – 0.42; 0.16 – 0.34; 54.80 – 61.10; 21.22 – 24.16; 3.45 – 9.83; 1314 – 1526 ppm respectively. And concentration of Cr, Cd, Zn, Cu, Pb, Fe in water sampels in the range of : 0.14 – 0.27; 0.001 – 0.002; 0.19 – 0.42; 0.012 – 0.036; 0.26 – 0.36; 0.20 – 0.58 ppm respectively. The soil and water samples were taken from several locations near the hot mud flow at Porong Area, East Java, Indonesia and the concentration of Cr, Cd, Zn, Cu, Pb, Fe in soil and water samples are not detected.

1. Introduction

THE 29th of May 2006 a sudden eruption of 100°C mud and gas started in NE Java. This event marked the birth of the mud volcano named Lusi (i.e. Lumpur-Sidoarjo), located along the major Watukosek strike-slip fault zone. The eruptions of mud volcanoes normally last a few days, whereas the Lusi eruption surprisingly continued and escalated. After three days, the flow rate from Lusi reached 50,000 m³/day rising to a record high of 180,000 m³/day at the end of September 2006. The mud flow currently covers an area of 7 km² although large September 2006.

The mud flow currently covers an area of 7 km² although large amount of mud is constantly diverted to the neighbouring Porong river. About 40,000 people have been displaced and the mud volcano is still active after nearly 3 years. Lusi seems to be unstoppable, and all the attempts to halt the mud eruptions have so far failed [1; 2].

The strong flow has begun to cause subsidence, and a caldera has begun to form. On the basis of clay mineralogy, vitrinite reflectivity, and biostratigraphy, the erupted mud is derived from between 1615 and 1828 m depth in the Upper Kalibeng Formation [3]. Evidence indicate that the mud polluted the Porong River with hazardous material such as H₂S Hydrocarbon Sulphide, Hg (Mercury), Cd (Cadmium), Cr (Chromium), As (Arsenic) and phenol [4].

Some heavy metals have a wide range of toxicities, leading to toxic effects on the renal, respiratory and nervous systems [5]. The measurement of metals for variety of reasons, characterization system in environmental, medicine, biological process, nutrition monitoring and industry [6].

Metals enter from terrestrial to environments as inputs from natural and anthropogenic sources. The geochemical cycling involves the transport, adsorption, desorption, precipitation, dissolution and complexation of metals in water system. Many contaminants have a high affinity for particles [7].

Lead (Pb) occurs in the environment in a wide range of physical and chemical forms, which greatly influence its behavior and its effects on the ecosystem. Most of lead in the environment is for the
majority of lead contamination [8].

Cadmium (Cd) is a priority pollutant which enter environments via atmospheric deposition and effluent discharges form point source. Anthropogenic inputs into the environment are the main source of cadmium [9].

Chromium (Cr) in the environments is complex and occurring reactions and process can affect is chemical behavior. These include oxidation-reduction, precipitation, adsorption and desorption, chemical speciation and biological interaction. Chromium occurs in both asCr(III) andCr(VI) in the environments. It has unique toxicological characteristics and bioaccumulation is dependent on its chemical form [10]. Copper (Cu) is widely distributed in nature, especially as sulphide, arsenide, chloride, and carbonate deposits. Cu is one of the most common environmental contaminants. Zinc (Zn) is one of the most ubiquitous and mobile of the heavy metals. Zn is found in the form of as a number of important ores such as sphalerite, smithsonite, zincspar [11].

Java island is located on an active continental margin and belongs to the tectonically most active regions worldwide. The Indonesian island arc has been very active in the past years as documented by, for example, the 2004 Tsunami following a major submarine earthquake, the Yogyakarta earthquake in 2006 and the Merapi Mount eruption in 2010 [12].

This experiment is to comparing the metals concentration in mud flow samples and in the water and soil samples at some locations near the hot mud flow at Porong disaster area, Sidoarjo, East Java, Indonesia.

2. Experimental Method

2.1. Reagent and Standard Solution [13].

1. Hydrochloric acid (HCl), concentrated (sp.gr.1.19) and Nitric acid (HNO₃), concentrated (sp.gr. 1.41).
2. 1000 ppm Cadmium stock solution, 1 mL = 1000 ug Cd : dissolve 1.000 g Cd metal, in 50 mL (1+1) HNO₃ with heating to effect dissolution. Let solution cool and dilute with aquadest in a 1 L volumetric flask.
3. 1000 ppm Chromium stock solution, 1 mL = 1000 ug Cr : dissolve 1.923 g CrO₃, in 120 mL (1+5) HNO₃. When solution is complete, dilute to volume in a 1 L volumetric flask with aquadest.
4. 1000 ppm Copper stock solution, 1 mL = 1000 ug Cu : dissolve 1.000 g Cu metal, with 50.0 mL (1+1) HNO₃, with heating to effect dissolution. Let solution cool and dilute in a 1 L volumetric flask with aquadest.
5. 1000 ppm Lead stock solution, 1 mL = 1000 ug Pb : dissolve 1.599 g Pb(NO₃)₂, in a minimum amount of (1+1) HNO₃. Add 20.0 mL (1+1) HNO₃ and dilute to volume in a 1 L volumetric flask with aquadest.
6. 1000 ppm Zinc stock solution, 1 mL = 1000 ug Zn : dissolve 1.000 g Zn metal, in 50 mL (1+1) HNO₃, with heating to effect dissolution. Let solution cool and dilute with aquadest to volume in a 1 L volumetric flask.
7. 1000 ppm Iron stock solution, 1 mL = 1000 ug Fe: dissolve 1.000 g Fe metal, in (1+1) HCl, with heating to effect dissolution. Let solution cool and dilute with aquadest in a 1 L volumetric flask.

All stock solution was prepared to the concentration of 0.0; 1.0; 2.0; 3.0; 4.0; 5.0 ppm as standard solution.

2.2. Apparatus

Atomic Absorption Spectrometre (Flame AAS) (Shimadzu, Japan, AA 6200) was used for the measurement of metals at specific wavelength and other condition (Table 1).

| Condition | Cu | Pb | Cr | Zn | Fe | Cd |
|-----------|----|----|----|----|----|----|
| Current (mA) | 4 | 5 | 7 | 5 | 5 | 4 |
| λ (nm)    | 324.8 | 217 | 357.9 | 213.9 | 248.3 | 228.8 |
| Slit (nm) | 0.5 | 1.0 | 0.2 | 1.0 | 0.2 | 0.5 |
| Acetylene (L/minute) | 8 | 8 | 8 | 8 | 8 |
| Air (L/minute) | 0.8 | 2 | 2 | 0.8 | 2.2 | 0.8 |
Figure 1. The location of the hot mud flow at Porong, Sidoarjo, East Java, Indonesia

2.3. Sampling Location
Sampling location at some villages/location near hot mud flow and at hotmud flow as in Figure 2. Sample no. 2, 3, 4, 5 compare to sample no.1 (figure 1).

2.4. Sample preparation procedure for analysis of total metals [14].
Solid and aqueous samples are prepared in a similar manner for analysis. Nitric and hydrochloric acids are dispensed into a beaker containing an accurately weighed or measured, well mixed, homogeneous aqueous or solid sample. Aqueous samples are first reduced in volume by gentle heating. Then, metals are digested (temperature 80°C) from either solid samples or the undissolved portion of aqueous samples by covering the beaker with a watch glass for 30 min. After digestion, the solubilized analytes are diluted to specified volumes with distilled water. Diluted samples are to be analyzed by the atomic absorption spectrometry (AAS) methods as soon as possible after preparation.

2.5. Measuring absorbance of metals in the samples and standards solution.
Each metals (Cd, Cu, Cr, Pb, Zn, Fe) in standard solution and samples solution were measured by using the Flame AAS. Comparing the concentration of metals in mud samples and in soil and water samples taken at villages near the hot mud flow.
3. Results and Discussion

Tabel 2. Concentration of metals in sediment and water samples from hot mud flow.

| Sample  | Cr (ppm) | Cd (ppm) | Zn (ppm) | Cu (ppm) | Pb (ppm) | Fe (ppm) |
|---------|----------|----------|----------|----------|----------|----------|
| Sediment| 0.26 – 0.42 | 0.16 – 0.34 | 54.80 – 61.10 | 21.22 – 24.16 | 3.45 – 9.83 | 1314 – 1526 |
| Water   | 0.14 – 0.27 | 0.001 – 0.002 | 0.19 – 0.42 | 0.012 – 0.036 | 0.26 – 0.36 | 0.20 – 0.58 |

Concentration of metals in sediment and water samples from hot mud flow are presented in Table 2. The soil and water samples were taken from several locations near the hot mud flow at Porong Area, East Java, Indonesia and the concentration of Cr, Cd, Zn, Cu, Pb, Fe in soil and water samples are not detected. So the hot mud flow was not affected to the concentration of metals (Cr, Cd, Zn, Cu, Pb, Fe) in the soil and water in some location near the hot mud flow.

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