Preliminary study potential of heavy metals in geothermal sludge

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Abstract. One of the New Potential Renewable Energy in Indonesia is geothermal potential which its activity in Indonesia is developed into Geothermal Power Plant XY in West Java and as the utilization of geothermal to reduce the dependency of fossil energy progresses, its utilization will create negative impacts on the environment such as landscapes, noises, subsidence, seismic induction, and heavy metal potential. With this background, it is necessary to conduct the identification of those potentials and the possibility of metals’ utilization. The researcher conducted this research by doing identification on dissolved metals types and its potential to harm the environment. The process was conducted by using Atomic Absorption Spectrophotometry (AAS) method. The sampling process performed on solid waste which was the result of geothermal drilling process or Geothermal Sludge and water sample which came off from the PLTP that headed to public waters around citizens residences. The test result of geothermal sludge showed that it contained heavy metals. The water sample collected around citizens residences also showed there were heavy metals.

1. Introduction
Indonesia has the largest geothermal resource in the world (+ 27,000 MW); where around 21.7% are in West Java and are the provinces that have the greatest geothermal potential, spread across 44 locations in 11 districts. Geothermal is the mainstay of energy for West Java. Overall, the geothermal potential in the Bandung Regency area can reach 2,000 megawatts, but now only 700 megawatts have been explored [1].

Along with the use of geothermal energy to reduce dependence on fossil energy, it is undeniable that the use of geothermal energy also has a negative impact. Negative impacts on the physical environment include landscape, noise, subsidence, seismic induction, the influence of heavy metals and rare earth metals in the community [2]. To identify the potential of heavy metals that affect the environment, it is necessary to do a gradual study starting with identifying the potential of these metals, the potential impact on the environment and the possible utilization of the metal [3].

Geothermal sludge originates from deposits in the process of treating wastewater. The resulting liquid waste is injected back into the earth's layer, while solid waste requires special handling so as not to have a negative impact on the surrounding environment and as much as possible a useful material. This solid waste contains metal elements, some of which are heavy metals such as Cu, Pb, Zn, Mn, Fe, Cd, As, Sb, Au, Ag, Hg, and Se.
Geothermal as a process of transferring heat from one place to a particular place in the earth's crust. Geothermal Sludge is a waste produced by geothermal drilling. Heavy metals are chemical elements with a specific gravity greater than 5 gr / cm3. Heavy metals are included in transition metals and are generally trace element [4].

As it is known, the metals Cu, Pb, Zn, Mn, Fe, Cd, As, Sb, Au, Ag, Hg, and Se belong to the heavy metal group. Heavy metals are metal elements which have a density greater than 5 gr / cm3.

![Figure 1. Geothermal Process in Earth.](image)

Heavy metals are high molecular weight metal elements. In low levels of heavy metals, in general, it is toxic to plants and animals, including humans. Including heavy metals that often pollute habitats are Hg, Cr, Cd, As, and Pb [5]. Besides Cd, Hg, Pb, Zn, and Ni. Heavy metals Cd, Hg, and Pb are named as non-essential metals and to a certain extent become metals toxic to living things.

Along with the use of geothermal energy to reduce dependence on fossil energy, it is undeniable that the use of geothermal energy also has a negative impact. Negative impacts on the physical environment include landscape, noise, subsidence, seismic induction, the influence of heavy metals on the community environment. To identify the potential of heavy metals that affect the environment, it is necessary to do a gradual study starting with the identification of the potential of these metals, the potential impact on the environment and the possible utilization of these metals living creatures.

The aims of this study are identifying the potential of heavy metals in locations around the XY Geothermal Project and the location of public waters around the Geothermal Project with chemical analysis, identifying the potential impact of heavy metals on locations around the Geothermal XY Project and the location of the surrounding public waters and classifying potential uses of heavy metal identification.

2. Methods
The object of the research carried out in this study was sampled from geothermal drilling, obtained from the XY Geothermal Project in West Java.

- The research samples taken were from geothermal drilling and water waste around the Geothermal XY Project. The sampling stage is to determine the heavy metal content and water quality in the geothermal environment around community settlements.
- The sampling area is the location of geothermal sludge disposal (geothermal sludge) and the point of extraction of water outside the geothermal area XY.
2.1. Testing phase

The testing phase includes testing of solid and water samples using the AAS method (Atomic Adsorption Spectrophotometry). This research method is carried out with the flowchart in figure 2.

![Flowchart research](image)

**Figure 2.** Flowchart research.

3. Results and discussion

3.1. Identification of potential heavy metals in geothermal sludge and geothermal waters

According to Sagala [6], the geothermal fluid has a high chemical content with the main component as:

- Cations: Na⁺, K⁺, Mg⁺, Ca²⁺
- Anion: Cl⁻, HCO₃⁻, CO₃²⁻, SO₄⁻²
- None Electrolytes: SiO₂
- Minor components: NH₄⁺, Li⁺, Fe²⁺, Mn²⁺, Al³⁺, F⁻, B⁻, I⁻, H₃BO₃. Rb, Cs
- Gas component (NCG): C
- Isotop :²H, ²H, ¹⁷O, ¹⁸O, ³³S, ³⁴S, ¹³C, ¹⁴C, ³He, ⁴He, ³⁸Ar

The results of the 15 samples examined by all samples from geothermal sludge contained SiO₂, Al, Fe, Mg, Na, K, Li, B, Cu, Pb, Zn, As, Sb and Hg. Heavy metals with high content are 13.58 ppm Pb metal, 4.67 ppm Cu and Zn 18.9 ppm. Whereas the results of identification of water testing from 5 different points in the XY geothermal environment were recorded as Pb metal with an average content of> 4.84 mg / l and TDS 359.2 mg / l. Metal Cd has an impact on the environment at sample point 1 with a concentration of 1.14 mg / l.
3.2. Identification of the potential impact of heavy metals in the geothermal environment.

The potential for the formation of heavy metals in geothermal sludge is detected above the heavy metal content permitted by the Ministry of Environment. This potential has yet to be investigated for distribution in a geothermal environment. Analysis results on solid geothermal waste indicate the potential of many heavy metals in the geothermal environment, namely Pb, Cu, and Zn.

The impact of heavy metals on the surrounding geothermal environment needs to be carried out further research by measuring the pollution index. Heavy metals that are concentrated in a place have not had an impact as long as waste management is still monitored. The conditions around the Geothermal XY Project that are related to residential areas need to be considered. Thus, due to the presence of heavy metals that can be carried in public waters, watch out. Based on the heavy metal content that is detected to be aware of is

3.2.1. Pb heavy metal content. The highest metal content detected in geothermal waste samples is Pb metal with an average content of 13.588 mg/l. According to Minister of Finance Minister LH No. 51 of 2004, the Pb heavy metal content permitted in the waters was 0.05 gr/l. This high content needs to be investigated in the form of binding to other metals so that the potential that endangers the environment can be reduced [7].

3.2.2. Cu heavy metal content. Cu metal content was detected high in geothermal waste samples with an average content of 4.672 mg/l. According to Minister of Finance Minister LH No. 51 of 2004, the Cu heavy metal content permitted in the waters is 0.05 gr/l [7].

3.2.3. Zn heavy metal content. Zn metal content is detected high in geothermal waste samples with an average content of 18.9 mg/l. According to Minister of Finance Minister LH No. 51 of 2004, the heavy metal content of Cu permitted in the waters is 0.1 gr/l [7].

Based on the availability of heavy metals in the earth's crust it already contains metal elements, but at small concentrations. If there is a geological enrichment process, the metal content will increase several folds so that at some level it can have economic value and can be mined. Average concentrations in the earth's crust, minimal economic value and enrichment factors (enrichment factors) of precious metals [8].

![Figure 3. Method of utilizing geothermal sludge.](image)

The extraction of heavy metals derived from geothermal sludge described in figure 3, the geothermal sludge containing silica is deposited, then the Lithium absorption process is carried out to obtain Lithium Hydroxide (LiOH) and Lithium Carbonate (Li2CO3). The electrochemical process was then carried out by Lithium Carbonate with Zinc Sulphate and Manganese Sulphate which originated from manganese.
and zinc precipitation. The electrochemical results were obtained from Mn, Zn and Li metals. Whereas manganese and zinc precipitation are returned to injection wells to avoid contamination of heavy metals in the soil or waters.

4. Conclusion
In conclusion, first finding is some of the heavy tasks carried out at locations around the Geothermal XY Project include Pb (lead), Fe (iron) and Zn (zinc). The second finding, from the results of several studies on the general locations of known Geothermal Body Weight Projects, Pb and Cd, the identification of potential hazards at the Geothermal XY Project site and the commonly used locations are Pb, Cu, and Zn, but they can have an effect. This can be done to carry out tasks both water and human biota is slow and a blood check is necessary.

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