Magnetic Susceptibility and Morphology of Natural Magnetic Mineral Deposit in Vicinity of Human's Living

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Abstract. Magnetic susceptibility and morphology of magnetic minerals have been explored to some samples from the different environment near the vicinity of human's living, such as hot spring, apple plantation, paddy plantation, and reservoir. Magnetic susceptibility ranged from -0.0009 × 10^{-6} m^3/kg (Peat in central Borneo) to 98.27 × 10^{-6} m^3/kg (Polluted Soil in Jalan Sukarno Hatta Malang). The grain size of magnetic mineral not more than that of 300 μm. Data analysis informs us that each environment where the magnetic minerals were deposited, influenced the two physical properties both of magnetic susceptibility and morphology of magnetic minerals. Regarding the environment process, magnetic susceptibility depends upon the grain size beside the kinds of magnetic minerals. So, it can be concluded that in every environment, the magnetic minerals have specific properties including magnetic susceptibility and the morphology of magnetic minerals.

Keywords: Magnetic susceptibility, morphology, magnetic minerals, specific environment.

1. Introduction

As the main carrier of magnetic properties in sediment, soil, or other natural samples, the magnetic mineral may contribute as a clue of special environment along it was growing. The change in kind, structure, shape, and size of magnetic minerals may change its magnetic properties [1]. The change on magnetic mineral represents a specific information related to environments and even a climatic system that has been influenced [2, 3]. It is also known that many natural magnetic minerals are valuable for industries. That is way we need to study further regarded to magnetic minerals.

In many cases, measuring of magnetic properties as a clue of environment and industrial studies, is very common in using magnetic susceptibility, natural remanent magnetization. In this study we use the two special techniques i.e., magnetic susceptibility and morphology using scanning electron microscope (SEM) to recognize the magnetic mineral in a specific environment clearly. The measurement of magnetic susceptibility has been used for many soil samples as an evaluation of polluted and non-polluted soils [4, 5, 6, 7]. Moreover, these measurements can be used to trace the existing of heavy metals dissolved in the samples [8]. Chemical composition of soils also influence on magnetic susceptibility [9, 10, 11]. The existing of magnetic mineral and analyzing of the size based on the SEM data and the connection to the magnetic susceptibility have been conducted on reservoir sediment in Selorejo [12]. However, the perfect relationship of these parameters has not formulated yet.

2. Experimental Method

Sediment or soil samples in this research were taken from some area, such as rivers, reservoir, plantation area, mangrove, peat area, and hot spring in the form of cores or a representative pick out a small portion. In some wet area, usually we picked out the sample using cores by covering the boat and in the area of plantation. Usually, we picked out a small portion. A sub-sample was then picked in the standard plastic holder for magnetic measurement, and some sample was extracted to get the magnetic mineral that carries of magnetic properties as the sample. A bulk sample was then measured the magnetic susceptibility by using magnetic susceptibility meter MS2B, and the extract of the magnetic mineral image was conducted by SEM (Scanning electron microscope). The composition of elements of extracted samples were characterized using EDAX. The measurements were performed in Central Laboratory of Universitas Negeri Malang, Indonesia.

3. Results and Discussion

Table 1. List of magnetic susceptibility of some samples in specific environment

Sample	Sample Location	Magnetic susceptibility ($\times 10^{-6}$ m^3/kg)	Susceptibility dependence (%)
Soil Plantation	Apel orchard soil Pujon, East Java	6.54 – 16.24	Not calculating yet
	Apel orchard soil Poncokusumo, East Java	9.39 - 18.49	Not calculating yet
	Paddy plantation Araya, Malang East Java	5.12 – 5.6	Not measuring yet
	Paddy plantation Madiun, East Java	0.58 – 2.96	0.2 – 7.2
	Paddy plantation Malang, East Java	0.85 – 3.82	0.3 – 9.4
Polluted Soil	Polluted soil in Jalan Sukarno Hatta Malang, East Java	5.93 – 98.27	Not calculating yet
Reservoir	Selorejo, Ngantang, East Java	4 – 47	1-4
	Wlingi, Blitar, East Java	2.59 – 38.82	0.6 – 4
	Small pond Araya Malang, East Java	12.36 – 13.48	Not calculating yet
Rivers sediments	Metro river, Malang	25.89 – 29.68	1.91 – 1.99
	Small river in Araya	11.83 – 16.16	
	Kamp Wolker river, Papua	11 - 25	0.031 – 0.37
	Hubai river, Papua	4 - 16	0.10 – 1.03
Hot Spring sediment	Pacet, East Java	1.50 – 4.63	2.11
	Cangar, East Java	1.40– 4.82	2.48
Mangrove sediment	Prigi, Trenggalek, East Java	2.13 – 34.61	0.29 – 1.36
	Wonorejo, Surabaya, East Java	0.44 – 22.47	0.14 – 2.88
	Clungup beach, Malang, East Java	0.05 – 10.58	0.70 – 3.47
Peat	Central Borneo	- 0.0009 – 0.08	- 37.85 – 42.9

Magnetic susceptibility of some magnetic mineral that deposited in any specific environment such as rivers, plantation area, hot springs and some other places are listed in Table 1. The magnetic susceptibility is also depended in what kind of magnetic minerals. Besides of magnetic susceptibility, we discuss the morphology of magnetic minerals. The image of magnetic minerals from scanning electron microscope (SEM) data was analyzing on four environment background, such as hot springs, paddy plantation area, apple plantation area and reservoir sediments.

3.1 Hot Springs

Some samples were taken from the two hot springs area, located in East Java Indonesia, called Pacet and Cangar. The magnetic susceptibility is ranged from 1.40 – 4.82 × 10^{-6} m^3/kg. The morphology of the extracted magnetic minerals shows in Figure.1. The size of magnetic mineral is of around 200 μm and tend to have a rounded angle. In hot spring environment background, natural magnetic mineral grows with the smooth surface relatively, and some of them have a crystalline structure. Finer surface grain in hot spring environment occurs due to the flowing of warmer water that influenced of the minerals growing with a temperature of about 50 °C. Figureure 1 and Figureure 2 shows the distribution of magnetic minerals extracted from the sediment of hot spring area. In Figureure 1, we can find some crystalline magnetic minerals dissolved in C1.3 sample ID that taken from Cangar hot spring area. The magnetic susceptibility of the low frequency of this sample is 4.82 x 10 6 m^3/kg^{-1} and susceptibility dependence frequency 0.392. The Fe content of this sample is about 42.26 %.

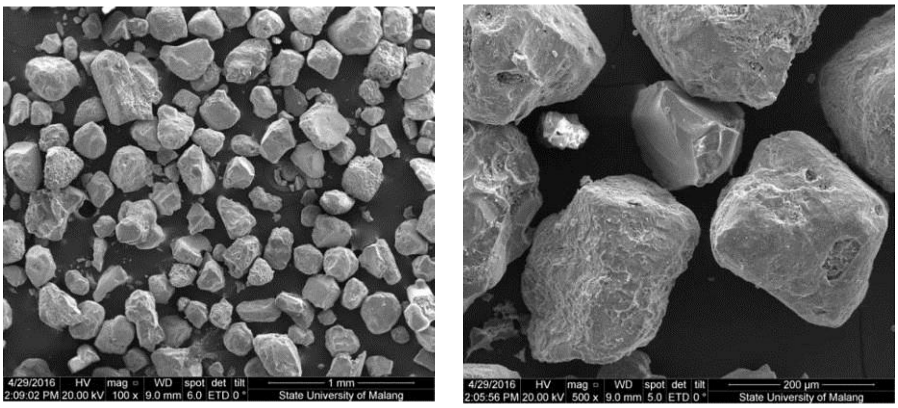

Figure 1. Image of magnetic mineral extracted from C1.3 sample, taken from Cangar hot spring with the size of around 200 μm.

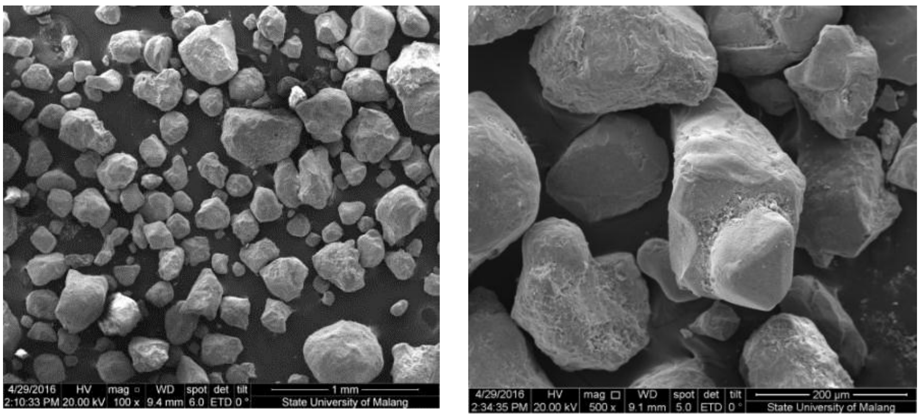

Figure 2. One of another sample is P1.3 ID that taken from Pacet hot spring area. The magnetic susceptibility is about 1.496 and susceptibility dependence frequency 0.663. Fe element contained in the mineral assembly by EDAX is about 36.33 Wt%.

3.2 Apple plantations

The soil of apple plantation has magnetic susceptibility ranged from 6.54 to 18.49. Because of the existing of magnetic mineral have been deducted influenced the apple growing and fruit quality, we extracted the magnetic minerals in the apple orchard soil and imaging by SEM is presented in Figure. 3.

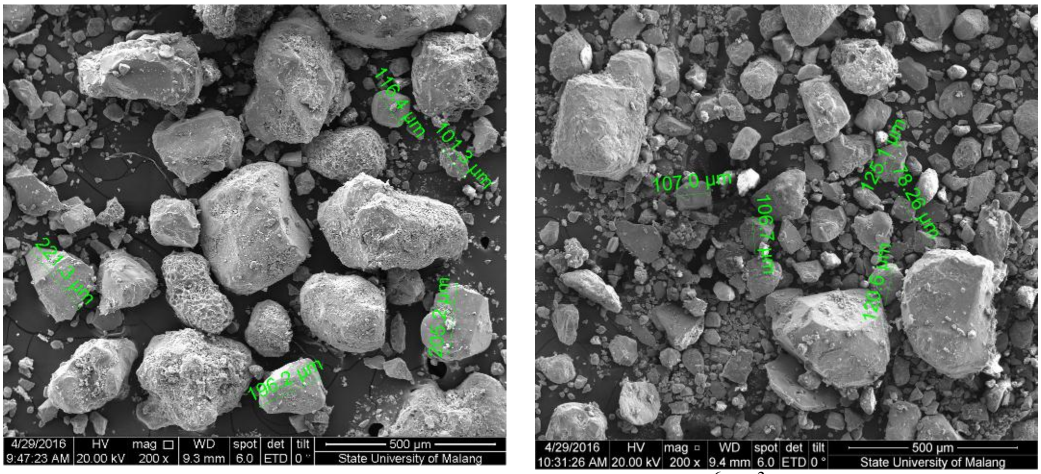

Figure 3. Sample AT6L1 with susceptibility 16.24 × 10^{-6} m^3/kg (left) BT1L8 with susceptibility 9.79 × 10^{-6} m^3/kg (right)

The size of the magnetic mineral is ranged from fine grain around 10 μm to a coarse grain that has a size up to 300 μm. The shape of magnetic minerals also very random, some are tended to spherical grains, and some are tens to elongated grains.

3.3 Paddy Plantation

Clay from paddy plantation has a lower susceptibility an order than that of soils apple orchard soils. The imaging of the magnetic mineral as shown as in Figureure 4. The magnetic susceptibility of the two area are ranged from 0.584 – 2.961 × 10^{-6} m^3/kg and the averaged is about 1.67 × 10^{-6} m^3/kg for Madiun and ranged from 0.847 – 3.817 × 10^{-6} m^3/kg with the average is about 2.1× 10^{-6} m^3/kg for Malang.

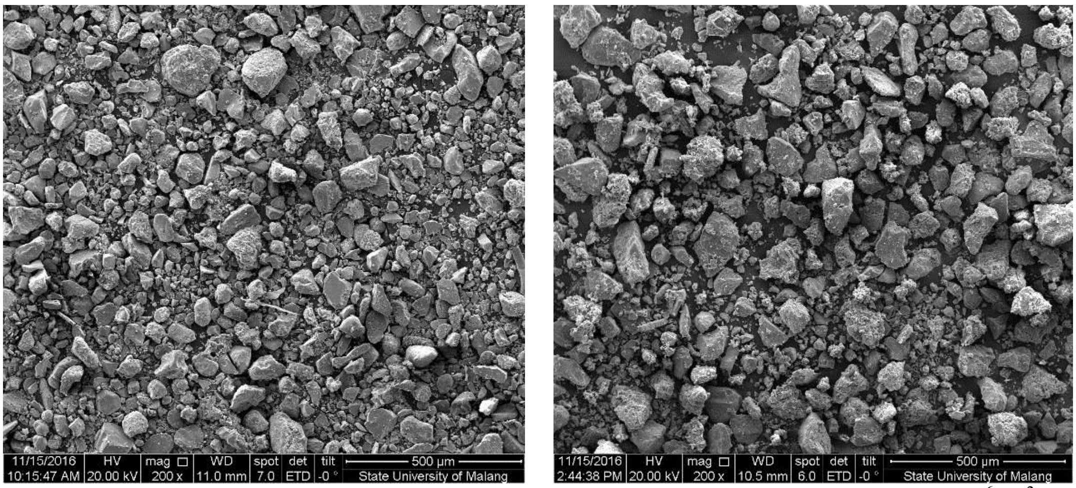

Figure 4. Sampel ID MDN.L2.S3(2) with the magnetic susceptibility 0.582 × 10^{-6} m^3/kg (left) and MLG.L1.S3(4) with susceptibility 3.802 × 10^{-6} m^3/kg (right)

The magnetic susceptibility of the two sample in deference order shows the different morphology of magnetic mineral. The sample which the magnetic susceptibility relatively low, has the smaller grain size and vice versa.

3.4 Reservoirs
Magnetic susceptibility of sediment from Selorejo reservoir has a same order of Apple plantation in Pujon and Poncokusumo Malang, as seen in Table 1. Magnetic minerals from the sediment of that reservoir shown in Figure. 5.

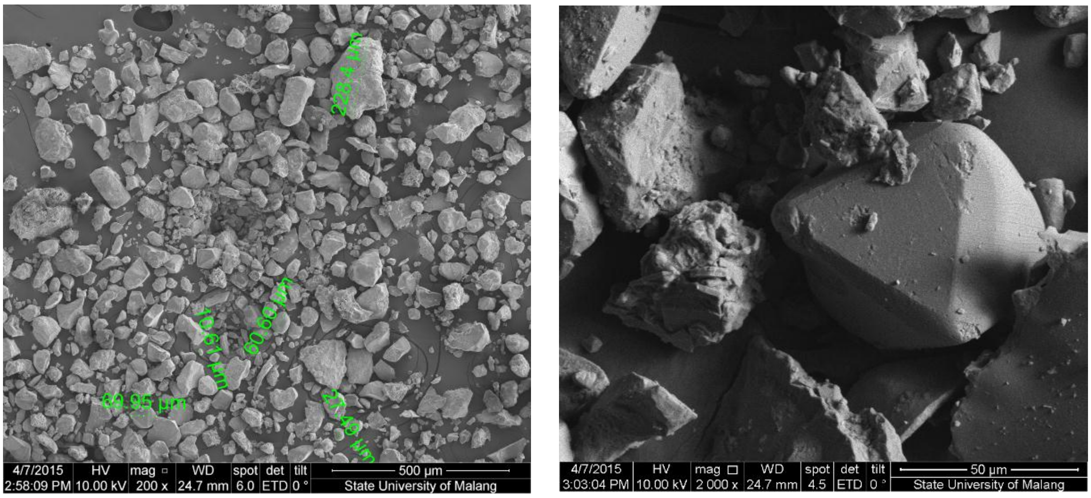

Figure 5. Sample ID TT7 with the magnetic susceptibility 2.28 □ 10-6 m3/kg (left) and crystalline magnetic mineral suggested titanomagnetite dissolved in TT7 (right).

The sediment reservoir still has a magnetic mineral that also has a random shape and size. For example, the sample that taken from the center of the reservoir has a magnetic mineral size of around 10 μm to 225 μm.

4. Conclusion
The magnetic susceptibility of some soil and sediment samples in general is ranged from 0.5 to 30 × 10^{-6} m^3/kg. In some natural samples, the size is not more than 300 μm and we still find a crystalline of magnetic mineral with has a more smooth or finer surface than that of other minerals. Some of the magnetic mineral has changed in size, and shape or its morphology was originated from the change of the environment. It was shown clearly in hot spring that influenced by the flowing warmer water were causing the rounded angle of crystal. The transformation in morphology of magnetic minerals informs us a good clue of environmental change.

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