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## Utilization as particulate adsorbents of special volcanic soils widely deposited in the South Kyushu, Japan

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### Abstract

Special volcanic soils such as Bora, Sirasu and Akahoya, which are widely deposited in the southern Kyushu, Japan, are not suitable for use in agriculture and industry. Therefore, effective use of them is strongly desired. This study aimed to utilize effectively the special volcanic soils. First, the components of the chemical composition, the apparent porosity, pore size distribution and specific surface areas of the several kinds of special volcanic soils were measured, and the difference in physical and chemical properties of each soil were clarified. Particularly, the measurements exhibited that Akahoya possessed a significantly high porosity and specific surface area. Hence, the possibility of utilization as dyes and NO<sub>x</sub> adsorbents of the ceramic from Akahoya soil was examined with the Methylene blue and NO<sub>x</sub> adsorption tests.

**Keywords:** Volcanic soil, Porous ceramics, NO<sub>2</sub>, Methylene blue, Adsorbent

### 1. Introduction

The special volcanic soils such as Bora, Shirasu and Akahoya are widely deposited in the southern Kyushu, Japan. Most of the special volcanic soils are not suitable for use in agriculture due to the lack of nutrients necessary for plant growth. The use as civil engineering materials is also limited to some soils. Therefore, effective use of them is strongly desired.

From the situation, this study aimed to utilize effectively the special volcanic soils. First, the components of the chemical composition, the apparent porosities, pore size distributions and specific surface areas of the several kinds of special volcanic soils were measured, and the difference in physical and chemical properties of each soil was investigated. The

measurement results exhibited that Akahoya soil possessed a high porosity and an extremely high specific surface area. Focusing on the material properties, the possibility of utilization as dyes and NO<sub>x</sub> adsorbents of the ceramic from Akahoya soil was examined with the Methylene blue (termed MB) and NO<sub>x</sub> adsorption tests.

### 2. Materials and methods

#### 2.1 Samples used for MB and NO<sub>x</sub> adsorption tests

Figure 1 shows the photographs of three kinds of special volcanic soils and clay, which are raw materials of samples used for MB and NO<sub>x</sub> adsorption tests. The samples for MB and NO<sub>x</sub> adsorption tests were produced in the following process. (1) The raw materials except for Bora and Shirasu were crushed using the rotary mill and then sifted with a 0.3 mm-mesh screen. (2) The crashed soils were solidified by pressing into a mold at 10 MPa. The molded samples had a diameter of 74 mm and a thickness of 50–60 mm. (3) The molded samples were heated at a firing temperature of 1073 K in an electric furnace. (4) The ceramic samples after firing were crushed and selected to yield a particle size of 0.5-1.0 mm or 1.4-2.0 mm.

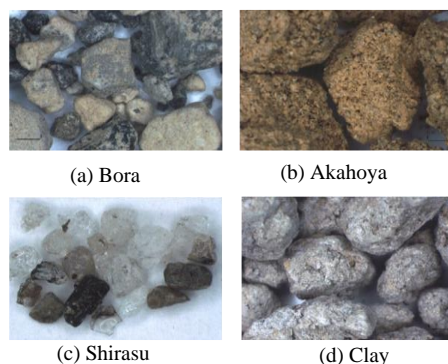


Fig. 1 Photographs of special volcanic soils and clay

Table 1 shows the apparent porosities and specific surface areas of samples. Akahoya possessed a very large specific surface area in comparison with other samples, in contrast that of Shirasu was small.

**Table 1 Apparent porosities and specific surface areas of samples**

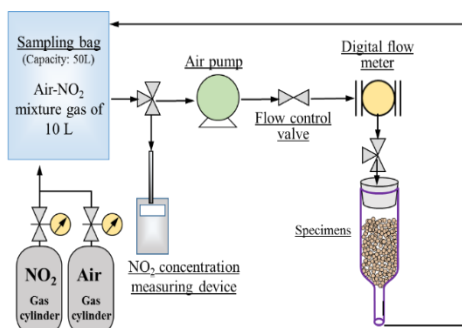
Samples	Apparent porosity (%)	Specific surface area (m <sup>2</sup> /g)
Bora (non-firing)	-	9.52
Akahoya (Fired at 1073 K)	44.9	58.9
Shirasu (non-firing)	-	2.25
Clay (Fired at 1073 K)	31.9	10.0

## 2.2 Experimental MB adsorption test

MB adsorption test was performed using MB solution with concentration of  $1 \times 10^{-4}$  mol/L [1]. A 1-g portion of the granular sample with a particle size of 0.5-1.0 mm was placed into a beaker containing 50 mL of MB solution and the MB solution was stirred with a stirring device at a speed of 150 rpm. MB dye concentration were measured after 1, 10, 30, 60 and 120 min.

## NO<sub>2</sub> adsorption test

Figure 2 shows a schematic diagram of the NO<sub>2</sub> adsorption testing [2]. The adsorption test was performed using NO<sub>2</sub> gas with concentration of approximately 5 ppm. A 5-g portion of the sample was placed into a test tube. We allowed the NO<sub>2</sub> gas to pass through the test tube containing the sample at a flow rate of 1.0 L/min, and the NO<sub>2</sub> and concentration in sampling bag was measured at intervals of 5 or 15 minutes.

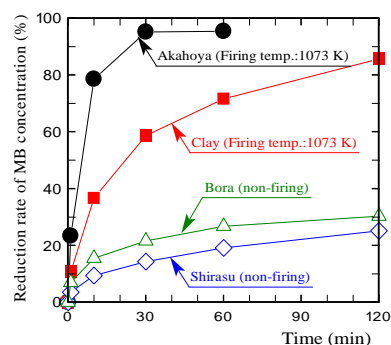


**Fig. 2 A schematic diagram of NO<sub>2</sub> adsorption test**

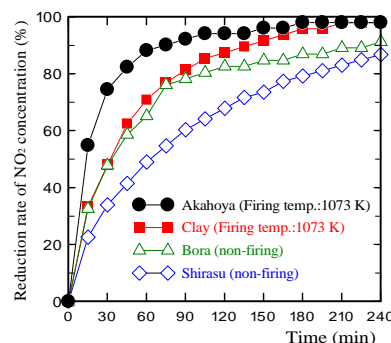
## 3. Results and discussion

### 3.1 MB dye adsorptivity of the samples

Figure 3 shows the reduction rate of the MB dye concentration on each sample. The reduction rate of Akahoya was extremely high in comparison with those of other samples, and those of Bora and Shirasu were



**Fig. 3 The reduction rates of the MB dye concentration for various samples**



**Fig. 4 The reduction rate of the NO<sub>2</sub> concentration for various samples**

low. It is presumed to be because Akahoya possessed both a very high porosity and an extremely large specific surface area.

### 3.2 NO<sub>2</sub> adsorptivity of the samples

Figure 4 shows the reduction rates of the NO<sub>2</sub> concentration of the samples. The results also confirm that Akahoya possessed an excellent NO<sub>2</sub> adsorptivity.

## 4. Conclusions

- 1) The measurements regarding the material properties of the special volcanic soils exhibited that Akahoya soil possessed a high porosity and an extremely high specific surface area.
- 2) The results of MB dye and NO<sub>2</sub> adsorption tests with the special volcanic soils verified that Akahoya ceramic possessed their high adsorptivity. From the above, the use as adsorbents of Akahoya ceramic can be expected.

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## References

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