INFILTRATION CHARACTERISTICS OF THE VOLCANIC ASH DEPOSIT AT MOUNT UNZEN

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1. INTRODUCTION

It has been frequently observed that after volcanic eruptions and ash deposition on the hill slopes, the debris flow had been triggered by small rainfall that had not caused it before the eruption and ash deposition. The debris flow, which occurred in 1978 with the Usu Volcano eruption in 1977, was a typical example of this kind of phenomenon. This case was explained by Ikeya (1978) as : The rainfall onto the ash deposition on the hill slope formed mortar-like layer at its surface, and it prevented the infiltration of rainwater and easily caused surface runoff. The same explanation was proposed also for the debris flow at Mizunashi River, Unzen (Ikeya, 1993). Yamamoto et al. (1980) and Yamamoto (1984) has done some infiltration capacity tests at the Usu volcano, these, however, described the long term variation of infiltration characteristics, not to examine how the rainfall has influenced on the infiltration characteristics. The objective of the experiment reported here is to examine the change of infiltration properties of volcanic ash that were caused by rainfall using the volcanic ash deposit from the Fugendake volcano, Unzen.

2. MATERIALS AND METHODS

2.1. Ash Samples Preparation

Fugendake's Mount Unzen's volcanic ash samples that were used for this experiment had been collected in Shimabara city. These ash samples were oven-dried in laboratory under 105 °C during 24 hours. Dried ashes were sieved with a 2.0 mm mesh from the height of 86 cm into sample rings. The ash properties were : ash particles consist of clay (22.3%), Silt (34.8%) and sands (42.9%). Particle density and total porosity were 2.585 g/cm^3 and 0.49 respectively. The sample ring's dimensions were 20 cm^2 in surface area and 2.5, 5, 10 and 15 cm in height (Fig.1). Sample rings were made of steel and specially for water content distribution experiments were made of plastic that can be separated into every 1 cm.

2.2. Experiment Procedures

The experiments were carried out as follow (see also Fig. 2)

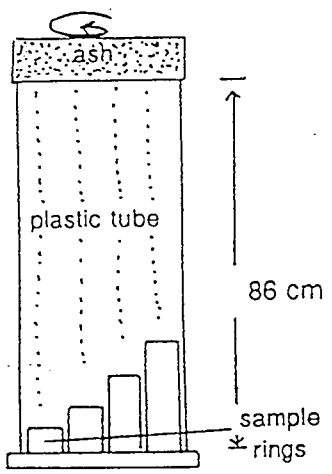


Fig. 1. Samples Preparation

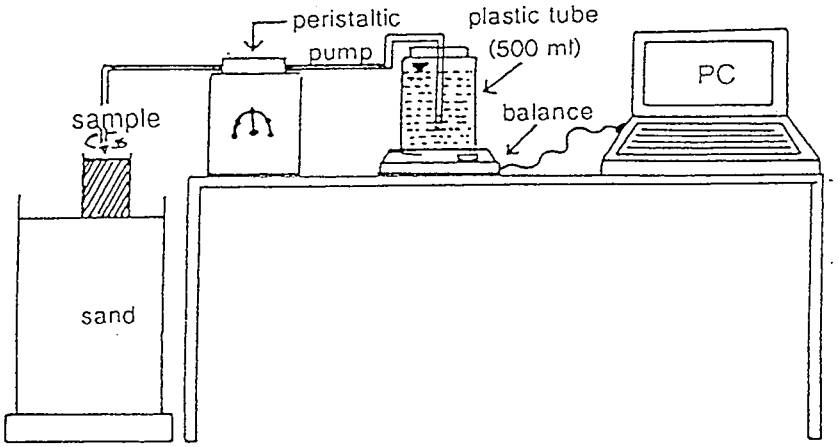


Fig. 2. Experiments Setting Apparatus

Fugendake's ash deposit samples were put on the surface of sand column and simulated rainfall was given onto sample surface. Rainfall simulator consisted of a peristaltic pump that was connected by small pipe to a plastic bottle (volume of 500 ml). Plastic bottle was put on an electrical balance that was connected to a personal computer to record the rainfall intensity. Recording was done every 5 seconds. The rainfall intensity was adjusted manually as same as infiltration rate by controlling the speed of the pump. If rainfall intensities almost exceed the infiltration rate and then the pump (rainfall simulator) was adjusted slowly to be able to generate smaller rainfall intensity. The initial rainfall intensities (R_o) were given 458, 362, 300, 123, 70 and 35 mm/hour.

3. Results and Discussion

The infiltration rate (I_f) of Fugendake's Mt. Unzen's ash deposits at various initial rainfall intensities (R_o) is shown in Fig. 3. The infiltration rate was high initially and then decreased with time to a constant value. At R_o of 458 mm/h, I_f decreased in 75 seconds and at 362, 123, 70, 35 mm/hr decreased in 110, 550, 1055 and 2020 seconds respectively. The constant value of infiltration rate was approximately 14 mm/hr, which means that at rainfall intensity of less than 14 mm/hr, surface flow will not be generated.

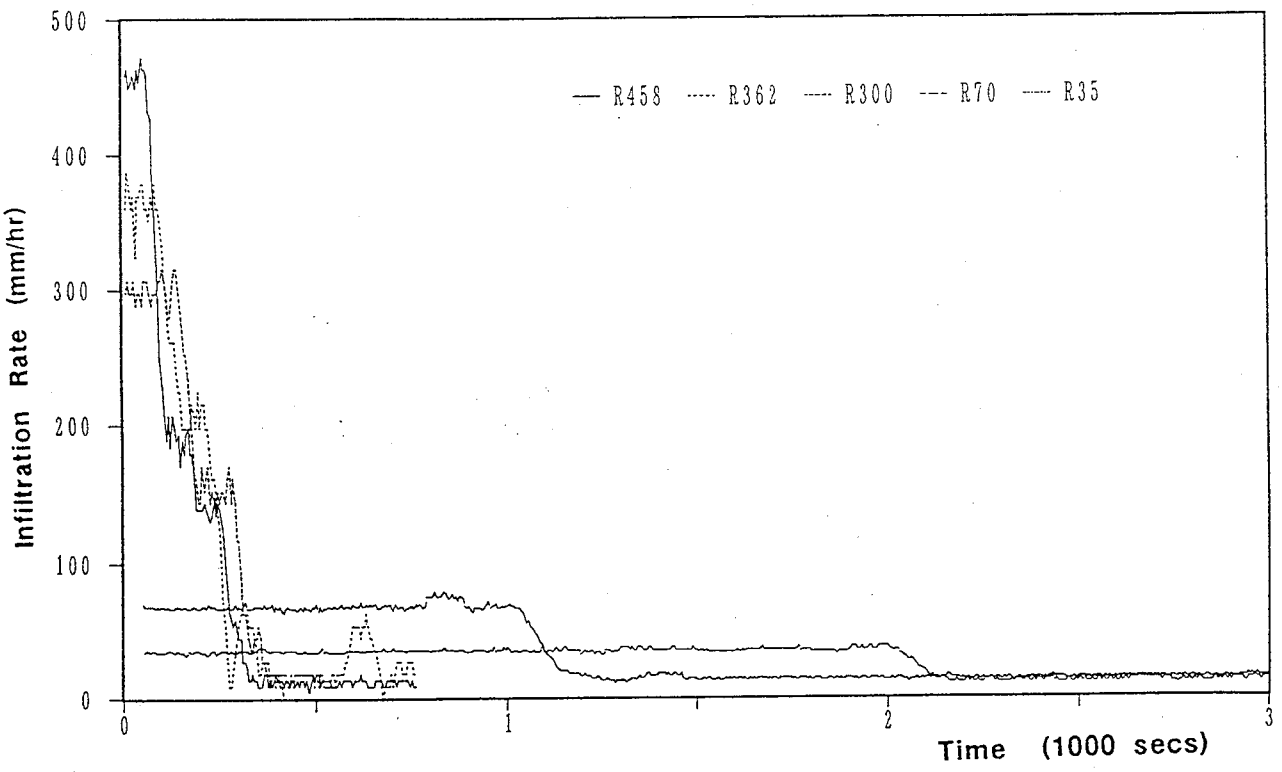


Fig. 3. Infiltration Rate of samples of 5 cm Depth with Different Initial Rainfall Intensities

At high initial rainfall intensities (here, more than 120 mm/hr), infiltration rate decreased before water content reached saturated condition, and for low initial rainfall intensities, here lower than 70 mm/hr, infiltration rate decreased at near saturation condition (Fig. 4).

By observing water content distribution in a 5 cm sample depth at the time when infiltration rate decrease under various rainfall intensities, it is suggested that 2 cm upper part of the layer has important role to control infiltration rate. In the time when infiltration rate changed, water content in 2 cm upper part of the samples under various initial rainfall intensities were almost the same, that were almost at saturated condition (Fig.5).

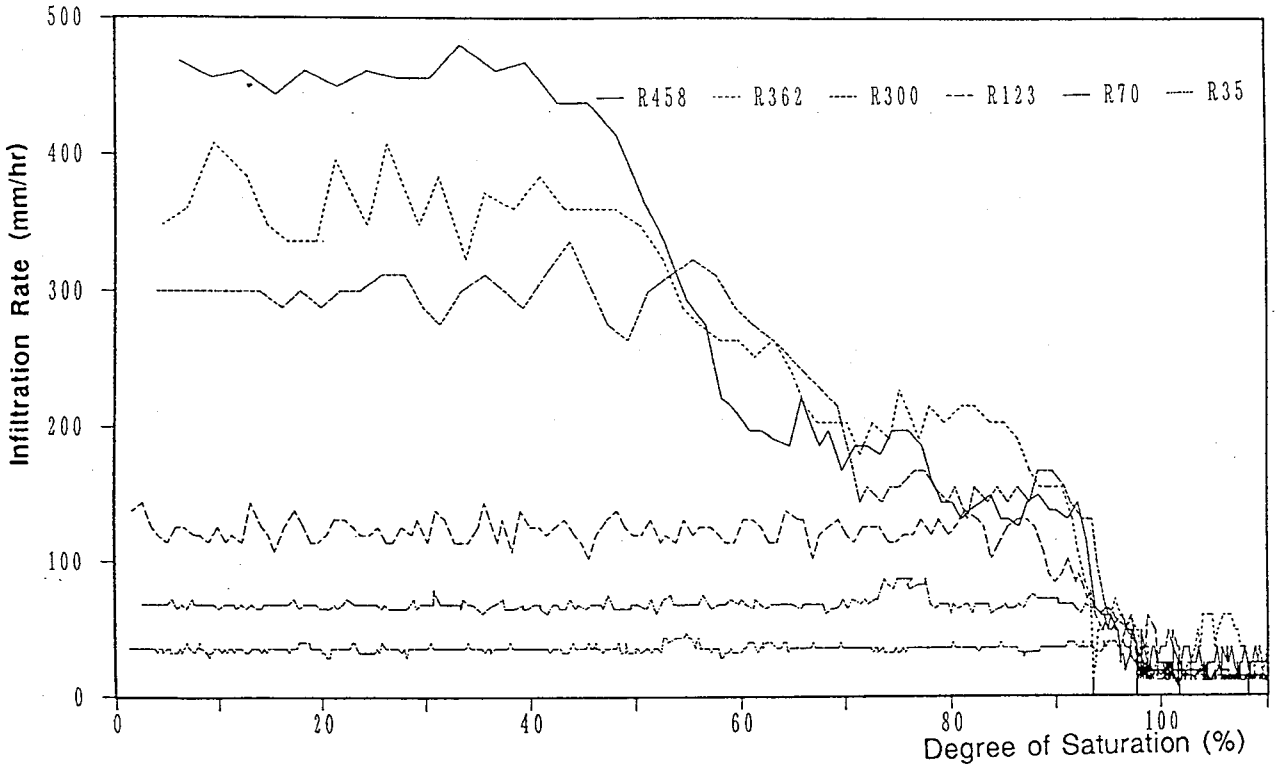


Fig 4. Relationship Between Initial Rainfall Intensities and Degree of Saturation of Samples of 5 cm Depth

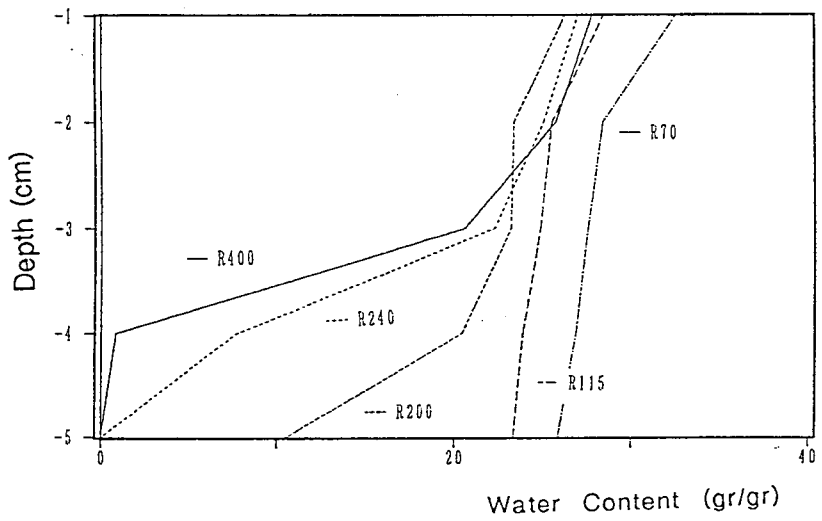
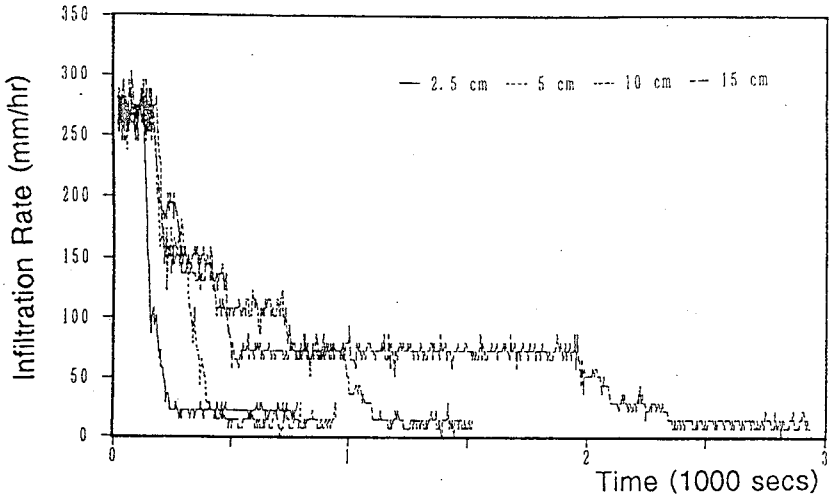
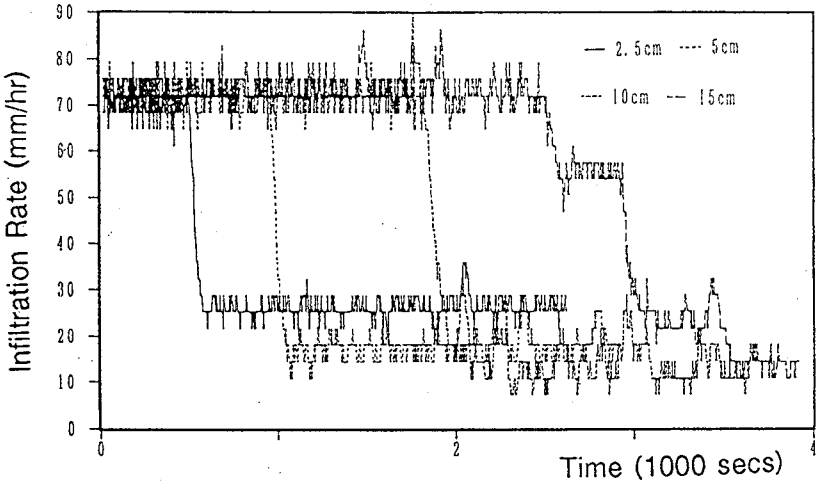


Fig. 5. Water Content Distribution in 5 cm Depth at Various Initial Rainfall Intensities

The time when infiltration rate changed on the cases of high initial rainfall intensities were not influenced by ash deposit depth, but on the cases of low initial rainfall intensities, the depth of sample influenced the time required to decrease infiltration rate. The deeper ash sample depth, the longer time required to decrease infiltration rate (Fig 6 a & b). In the cases of low initial rainfall intensities, it due to that infiltration rate decreased after water content reaches near saturation condition.



(a)



(b)

Fig. 6. Infiltration Rate Changes of 4 Different Sample Depths
(a). Under High Rainfall Intensities
(b). Under Low Rainfall Intensities

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4. REFERENCES

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