Pressure oscillation generating in flow of complex fluid

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1. Introduction

Low frequency earthquakes and tremors are occurring at depths of volcanic edifice, where fluid is expected to exist. It is widely considered that the fluid phase plays a significant role in the generation of the oscillation. Though physical picture of the process is considered to be important for further developments of this research, it is poorly understood. Object of this study is to investigate oscillation generating in flow of the fluid with various characters and to propose a possible mechanism of the low frequency earthquakes and tremors.

Complex fluid such as emulsion, slurry and suspension is found to show various behaviors depending on interaction between its structure materials. The suspension where clay particle called Laponite (diameter of about 30nm and thickness of about 1nm) is dispersed in water has rheology that changes with time and depends on how to deform the suspension. In this study the flow behavior of the Laponite suspension was investigated.

2. Experimental method

A pipe with diameter of 6 cm is connected to a tank with the Laponite suspension and a tube with diameter of 1.2 mm. The suspension flows through the pipe and the tube from the tank, and pressure and flow rate in the pipe are measured. The experiment is carried out under a condition where difference in height between the tube exit and the suspension level in the tank is constant. Besides, viscosity of the suspension is measured with a rheometer.

3. Result and Discussion

The pressure increases with time, and in a matter of time oscillational behavior is observed to be superimposed on the trend of the pressure increase. It is found that the oscillation has a characteristic frequency. The flow rate decreases with time. The viscosity firstly increases with time, and when time passes it shows drastic increase and subsequently gradual reduction.

The rheology data suggests that the behavior of the Laponite suspension changes from viscous fluid to viscoelastic fluid. The drastic increase and the subsequent gradual reduction of the viscosity can be considered to correspond to elastic deformation and viscous flow under stress above yield strength of the suspension, respectively. From the rheological character the pressure increase and the decrease of the flow rate with time is considered to be because of the viscosity increase. The pressure oscillation might correspond to a cycle of the elastic deformation and the viscous flow due to appearance of the yield strength.

We will investigate effect of parameters such as the suspension concentration and the pressure difference on the characteristic frequency of the pressure oscillation and discuss the physical mechanism generating the oscillation.