Fluid property measurement for Kitchen Earth Scientists: rheological measurements using DIY falling-ball viscometer combined with image analysis

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We propose a simple rheological measurement using a DIY (Do It Yourself) falling-ball viscometer coupled with image analysis. The simple viscometer consists of a transparent plexiglass cylinder, a rubber plug, and a commercial video camera that we can easy to buy on the internet. The rheological properties of not only Newtonian fluid but also Non-Newtonian fluid are obtained in this rheometer. An image sequence of the falling ball in a fluid was captured by the video camera, and the spatio-temporal image was created by a free software, ImageJ. The obtained image could provide the information of rheological properties such as shear rate dependent viscosity, elastic property, and yields stress. In this presentation, we will show some examples: sugar syrup as Newtonian fluid; a mixture of gel beads and water as Non-Newtonian fluid.

We will also demonstrate the flow behavior of a buoyant fluid, whose viscosity is unknown, in a viscous fluid. The apparent viscosity of the buoyant fluid is estimated through the image analysis of its flow motion. Our homemade viscosity measurement using a falling-ball viscometer will provide fruitful information of the rheological properties of the fluid and be useful for the Kitchen Earth Scientists.

Keywords: Rheology, falling-ball viscometer, experiment

Laboratory Seismic Exploration Experiment for Education and Demonstration

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We developed a laboratory experiment to simulate a seismic refraction survey for educational purposes. The experiment is a tabletop scaled experiment using the soft hydrogel as an analog material of a layered crust. Therefore, we can conduct the seismic exploration experiment in a laboratory or a classroom. The softness and the transparency of the gel material enable us to observe the wave propagation with our naked eyes, using the photoelastic technique. By analyzing the waveforms obtained by the image analysis of the movie of the experiment, one can estimate the velocities and the structure of the gel specimen in the same way as an actual seismic survey. We report details of the practical course and the public outreach activities using the experiment.

Keywords: Analog experiment, Hydrogel, Seismic exploration, Image analysis

Introduction of a laboratory syrup eruption experiment for outreach activity

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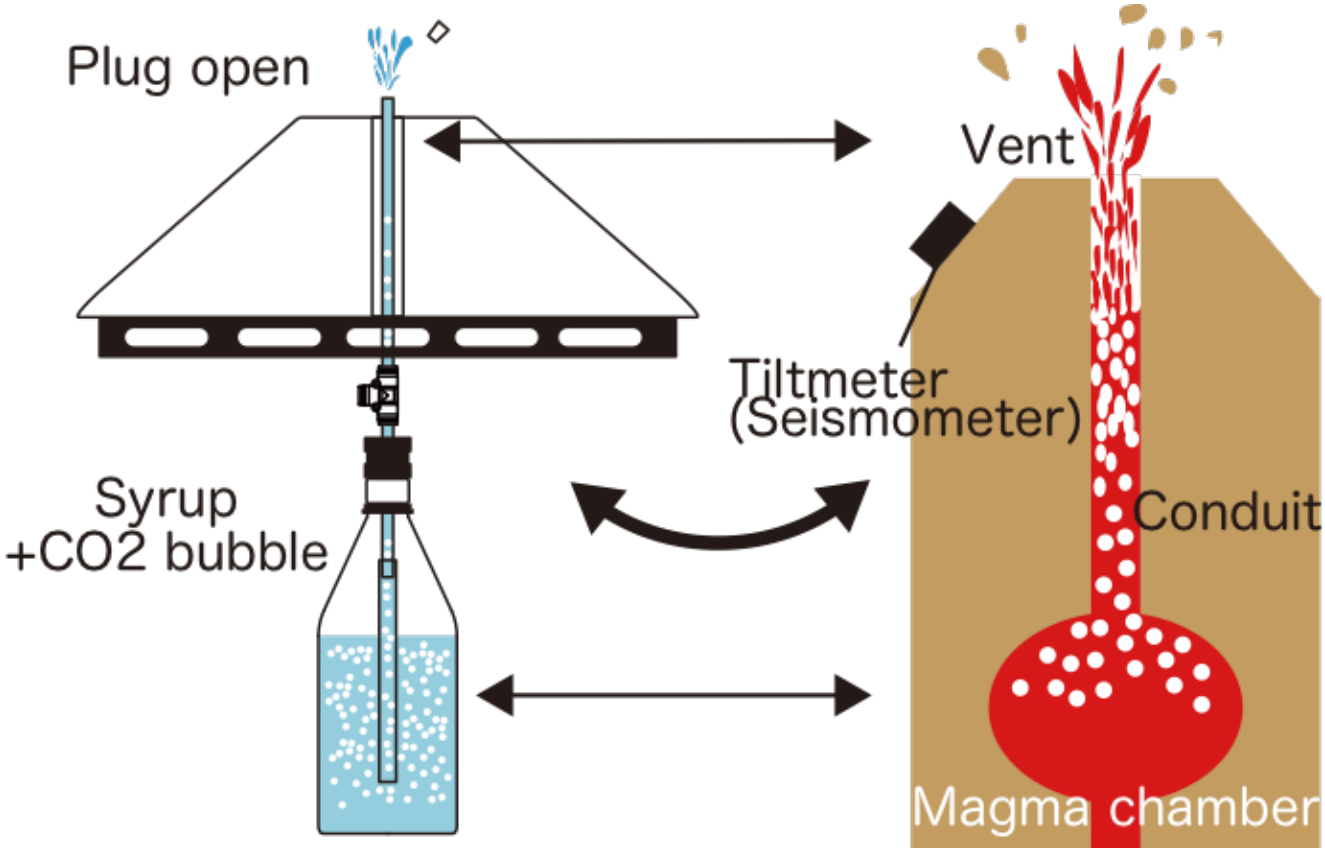
We have conducted syrup eruption experiments based on the existing outreach eruption experiment (Takeuchi, 2006), and conducted improvements mainly for the open campus of the Earthquake Research Institute since 2014. In this experiment, it is an experimental system integrating individual mechanisms assumed in the dynamics of the volcanic eruption. The experiment, which can be done with the demonstration and measurements at the same time, makes it possible for public people to image the dynamics of the eruption and also to suggest the importance of the observation and disaster prevention.
For the analog fluid, we prepare two kinds of syrup of different pH, with citric acid and sodium bicarbonate. Mixing these two fluids in a plastic bottle, foaming is started by chemical reaction. To prevent air leakage, foaming starts by chemical reaction. The tube is connected by using an original designed adapter. The upper end of the tube is softly closed with a rubber plug. When the internal pressure inside the container rises due to foaming, the plug at the upper end of the tube is blown off and vigorous syrup eruption starts. The experiments are recorded by using a pressure gauge, a microphone, and a USB-camera. We can see all data on the display in real time as the demonstration, and constructed a system that can review the data immediately after the experiment.
In the experiment, after opening the plug, vigorous syrup is blown out of the tube and then the syrup is intermittently blown up from the tube. When the pressure goes down, the force to blow up the syrup decreases, and the syrup is drained from the tube effusively. In the pressure gauge, the pressure gradually rises towards the plug opening. Just after the opening, the waveform which suddenly drops is measured. It reminds us a waveform of tilt change before and after the eruption. The acoustic wave is also recorded on the microphone at the same time as the spurting syrup.
I would like to continue to demonstrate this outreach experiment to widely convey the importance of observation, consciousness of disaster prevention, and above all, the fun of investigation volcanic eruption dynamics.

Keywords: Dynamics of volcanic eruptios, Outreach activity, Disaster prevention, laboratory analogue experiment, starch syrup



A Study on the Effect of Education for Disaster Prevention using Science and Technology

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The East Japan great earthquake disaster that occurred in 2011 has had a big influence on us. The insufficiency of attention to disaster prevention measures is among the most pressing ones to achieve the safety and security society. Therefore, this research focused on an instructional activity to improve the awareness of the disaster prevention as a part of Inter-Graduate School Doctoral Degree Program on Science for global safety. Through this instructional activity, we intended to acquire interdisciplinary viewpoints, which are an essential ability to consider disaster prevention.
In this research, several styles of disaster prevention education were carried out by members whose specialized fields are different each other. In 2016 year, we performed four events: (1) a support to research projects of Furukawa Reimei high school students, (2) the Science Day "G-Safety mini-lecture, Tohoku University students teach global safety!”, (3) Suzaki technical high school class and practical lecture, and (4) combination activity with the Program for Leading Graduate Schools of Kochi Prefectural College, “DNGL”. First, in the research plan meeting for Furukawa Reimei high school, G-Safety students gave the high school students some advices about their research projects for advancing their studies as a part of the disaster prevention education. Second, on the Science Day, we gave several lectures on science and technology to participants of the event, who were from children to adults. Third, in Kochi Prefectural Suzaki technical high school, we lectured on the present conditions and problems of providing disaster and emergency information to residents at the time of East Japan great earthquake disaster. Finally, in Kochi Prefectural College, we understood the disaster correspondence judging from medical viewpoints and had an interdisciplinary discussion about disaster prevention with Inter-Graduate School Doctoral Degree Program students by exchanging opinions from viewpoints of engineering and disaster nursing science.
In each activity, participants deeply understood that technologies are useful for disaster prevention and that using the technologies appropriately is important. After the lecture at the Kochi Prefectural Suzaki technical high school, some high school students commented that their consciousness for the Nankai trough earthquake, which is expected to occur in near future, was improved. Our activities were good opportunities for public people to learn past disasters and consider effective measures when disasters happen. Therefore, this study contributed to improving consciousness for disaster prevention.

Keywords: Education for Disaster Prevention, Science and Technology

The analog experiments on the 3D RRIM model

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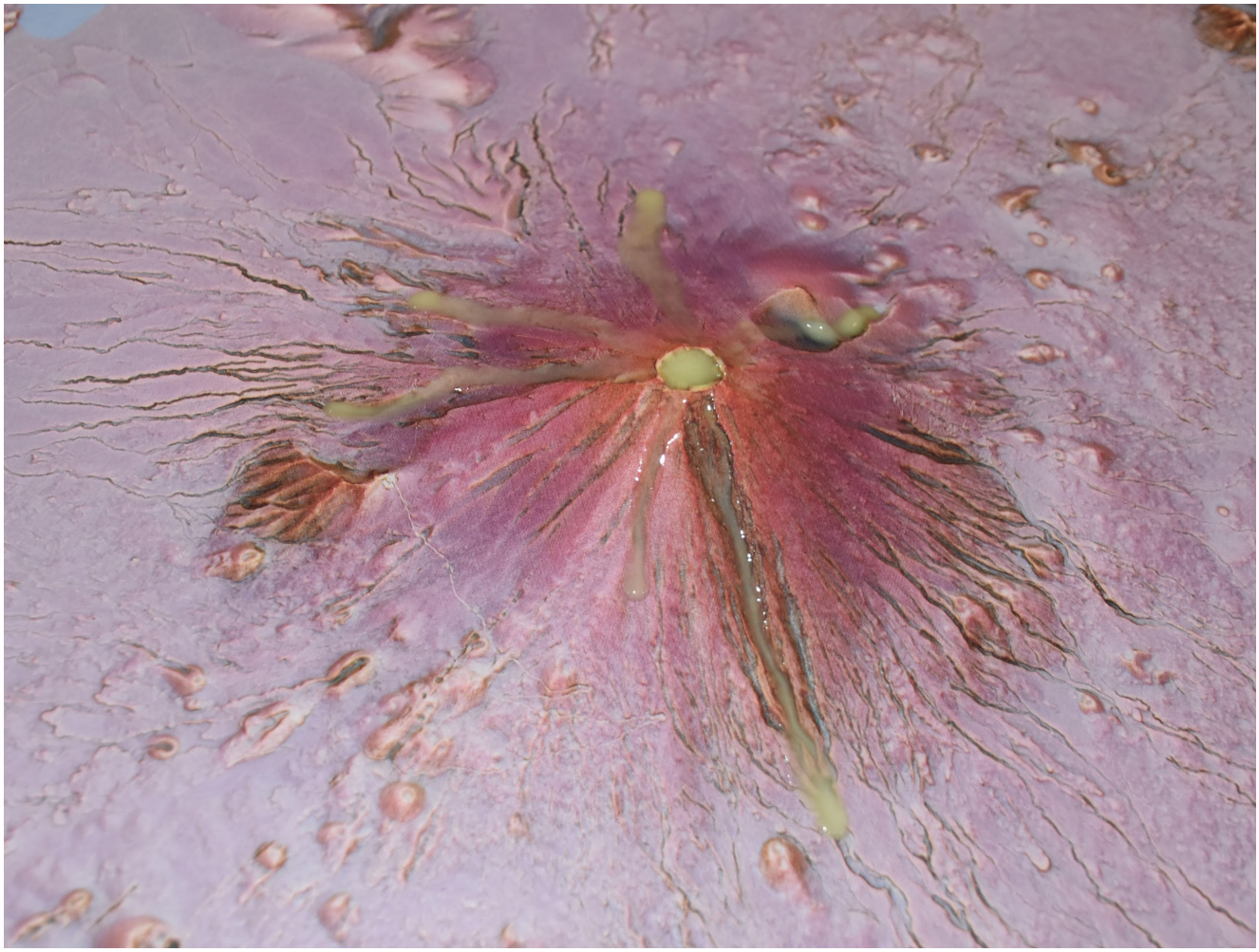
1. Introduction
The Red Relief Image Map (RRIM; Chiba et al. 2006 etc.) is a method that developed for visualize the micro topographical feature of the Aokigahara lava flow of Mt. Fuji using the data acquired by Airborne LiDAR. The RRIM has been used in various cases, since it is possible to express micro to large topography simultaneously and stereoscopically with one sheet (Chiba, 2011).
2. 3D RRIM model
In the conventional method of coloring in the surface of the model, vegetation coverings always expressed by colors that based on aerial photographs. However, it is inappropriate in the case of using elevation data (DEM) excluding the influence of trees. Therefore, attempts have been made to stereoscopically print a RRIM on the surface of the topography model. It becomes very easy to understand topography due to the synergistic effect of the microtopographic representation of RRIM and the stereoscopic expression by modeling. Approximately 10 years have been passed since the development of this method, but so far we have been making in Izu-Oshima, Mt.Usu, Mt.Ontake, Mt.Bandai, Mt.Iwate, Mt.Azuma, Mt.Adatara, Miyakejima, Sakurajima, and Mt.Fuji.
3. Analog model experiment
Because this topographical model is excellent in water resistance and heat resistance, it is possible to conduct an analog model experiment by running a liquid on it. So far, the debris flow and lava flow are split water of the rinse in shampoo, the adjustment of the viscosity depends on the proportion of water. Restoration and collapse of the mountain is possible with wet sand, it has been used for various disaster prevention plans, disaster prevention education, and outreach activities. However, the results differed subtly from each experiment, and there was a problem in quantitative evaluation.
4. Time lapse record
Therefore, during the model experiment, we attempted to take time lapse photography with a single-lens reflex using a tripod and to take a record. The model used is the 1:50000 Mt.Fuji model set at the entrance of Mount Fuji Research Institute. Time lapse shooting was done at 1 pace per second and at playback it was played at 30 pictures per second. It can be said to be 30 times faster shooting. Here, we introduce video and discuss the method of quantitative evaluation.

Keywords: Analog , terrain model , red relief image map, disaster prevention



Review on rheology of complex fluids usable in kitchen earth science

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Some kinds of fluid,which are known as complex fluids in the field of soft matter physics exhibit peculiar behavior in many occasions. Because of this unexpected behavior these fluids have been widely used as an effective demonstration evangelist to represent fascinating nature of science. In spite of high popularity nature of this peculiar behavior has not been well understood and it is still hot subject under investigation. Overall rheology is tightly coupled with the internal structure, which evolves with time and deformation. This make the fluid complex.
In this presentation we review the rheology of various types of complex fluids, which can be used in demonstration experiments of kitchen earth science. We selected target fluids under the criteria below,
1. Safety. Safe to through into a waste box after the experiment without any special treatment. This is an important must in kitchen earth science. Hopefully not into a waste box but into our stomach is desirable.
2. Easy to prepare without any sophisticated device. This makes the experiments open to everybody.
3. Low cost. Although this is not chicken science but kitchen earth science, low cost is essential to start up experiments immediately.
The fluids we focus here are KELZAN,sodium arginate,thermogel,methyl cellulose,LUDOX and various kinds of yogurt. Some of these are used as a thickner in food additives. We will summarize rheological characteristics which significantly control the peculiar behaviors. Among rheological parameters yield stress plays most importsnt role in bifurcation of solid and liquid behavior. In complex fluids yield stress is not uniquely defined but exhibits maltivalued nature. This means the value depends on various environmental parameters. Coupled with the existence of yield stress negative dependence of flow stress with strain rate enhances local instability. Furthermore agening is an another important parameter. In the presentation we present various examples of curious bahaviors coupled with the rheology.

Keywords: complex fluid, rheology

