# Introduction to New Kitchen Earth Science

*Kei Kurita[1], Miwa Kuri[2], Satoshi Sakai[3]

1.Earthquake Research Institute,University of Tokyo, 2.International Research Institute of Disaster Sci.,Tohoku University, 3.Graduate School of Human and Environmental Studies,Kyoto University

After intermission of several years we propose the new version of “Kitchen Earth Science” again. As an introduction to this session we explain the current situation and our new aims toward the session proposal. During the intermission period outreach activities have become active and popular and our previous aim to utilize Kitchen Earth Science matters in such occasions has been more or less accomplished. At the same time new problems have arisen in the university education,particularly around the design of experimental course. As the freshmen education in the universities recent trend is to start professional classes as early as possible at the sacrifice of general arts educations. This trend is coupled with the critical reviews on the conventional classes taught unilaterally in large class rooms. Innovations in the freshman education are an urgent task. Recently the tendency of diminishing numbers of students taking earth science classes in the high schools has been apparent so that the earth science lectures at the freshman education in the universities has become important. If these lectures are eliminated or are not taught carefully the last class of the earth science for the most people should be junior-high school class although social demands for higher comprehensions in the earth science matters are increasing such as the understanding of natural hazards and our future environments. Under consideration of these two aspects we propose experimental courses of earth science at the freshman educations could resolve the problems and improve the quality if we can properly incorporate essence of “Kitchen Earth Science”.As an introduction to this session we show several trails in Tohoku University, Kyoto University and Tokyo University.

Keywords: freshman education, experimental course, last chance to study earth science

 

# "Introductory Science Experiments" for first-year students in science and humanity courses at Tohoku University

*Norihiro Nakamura[1], Tsutomu Sekine[3], Shozo Suto[2]

1.Department of Earth Sciences, 2.Department of Physics, 3.Institute for Excellence in Higher Education

Tohoku University provides an opportunity to experience a laboratory work "Introductory Science Experiments" to first-year students in science courses (Medical, Dentistry, Science, Engineering, Pharmacy, Agriculture) since 2004, and also to experience a "Basic Scientific Work" to first-year students in humanities courses (Arts and Letters, Economics, Law, Education) since 2007. Through Introductory Science Experiments, students in science courses learn about scientific logical thinking, basic academic writing skill and willingness to challenge and understand the fundamental concepts of natural phenomena. Students in humanities learn about knowledge of scientific process towards improved scientific literacy by using their own hands in basic laboratory work. More than 19,000 students in scientific courses attended the science laboratory classes during the last twelve years since 2004. About 600 students in humanities courses attended the classes during the last nine years since 2007. We designed five interdisciplinary experiment topics that combined physics, chemistry, biology and earth science for science course students (Earth and Environments, Materials, Energy, Science and Culture, and Life). For humanities students, five topics have been designed (Earth and Environment, Energy, Life, science in our daily life, Science and Culture, and Mathematics as the backbone of natural science). Tohoku University welcomes 2,500 first-year students every year (1,800 students for science courses and 700 for humanity courses). Tohoku University requires all science course (except mathematics and nursing) students to take the laboratory class (compulsory subject), so we open six laboratory classes in a year: three classes in the first and second semesters. Students take time for three hours in pairs to do the laboratory work and then students are required to submit a scientific report based on their own work in a week. About 80 teachers and 180 teaching assistants manage the classes in a year. For humanities students, about 70 students are assigned to the Basic Scientific Work because of its elective subject. Class evaluation by students showed that 62% of the scientific course students found the Introductory Science Experiments were interesting, and 90% of the humanities course students found the Basic Scientific Work were interesting. In the presentation, we introduce an instructional design of the laboratory classes (both science and humanity courses), the detail contents of the classes, their evaluation and future prospect.

 

# Analog experiments on mantle plumes in general education classes

*Kenji Kawai[1], Ichiro Kumagai

1.Department of Earth Science and Astronomy, Graduate School of Arts and Sciences, University of Tokyo

As mantle convection is related to Earth’s evolution such as plate tectonics and hotspot magmatism, it is essential to visualize and understand the flow pattern in the mantle. However, the visualization of the realistic mantle convection is difficult in a class room because of difference of spatial and time scales. Therefore, we have developed an experimental kit of Kitchen Earth Science (KES) aiming at understanding the mantle plume behavior in general education classes. In order to save the cost for the experimental kit, we performed analog laboratory experiments using sugar syrup and common laboratory tools such as rubber plugs and syringes. In the analog experiments, a cylindrical transparent acrylic tank is filled with the sugar syrup. More buoyant less viscous sugar syrup colored with food dye is injected from a nozzle at the bottom of the tank. The flow behaviors of the upwelling plumes depend on the injection flow rate, the rheological properties and volume fraction of the injected and filled sugar syrup, and boundary condition (wall effect), which give insights into the mantle dynamics. In the presentation we will show some interesting flow behaviors observed in the class room experiment.

Keywords: mantle plume, sugar syrup

 

# Magma-like behavior observed in the flow of buoyant plumes in Puyo-puyo gels

*Ichiro Kumagai[1], Kazuki Okawara[1]

1.School of Science and Engineering, Meisei University

We have conducted laboratory experiments on buoyant plumes in deformable porous media to understand the dynamics of magma transport in a partially molten region. As an analogue material of partially molten media, a mixture of Puyo-Puyo gels (transparent hydrogel beads) and viscous fluids was used. A transparent acrylic tank was filled with the mixture, and a buoyant viscous fluid was injected from a nozzle at a constant volume flux into the mixture. The flow behavior depends on the injection flow rate, the rheological properties of the mixture and the buoyant fluid, the volume fraction of the interstitial fluid, and also the boundary condition of the deformable porous media (wall effect). In this presentation we will show some interesting flow behaviors observed in our experiments: plumes with percolation, spontaneous pulsating flow (wave train), sill and dike structures, and so on. Our homemade experiments will provide inspiration and fruitful information of the dynamics of magma transportation.

Keywords: Magma, Plume, Experiment

 

# Bekko-ame cracking

*Kei Kurita[1]

1.Earthquake Research Institute,University of Tokyo

Fracturing is essentially a transient phenomenon and also characterized by more or less probabilistic nature. In demonstrations of fracturing phenomena in class rooms and public outreach activities these are difficult constraints and simple and easy-to-use materials are still necessary. This could be a good challenge in “Kitchen Earth Science”. In this presentation we show an example of Bekko-ame thermal cracking as a class-room subject in understanding the nature of fracturing phenomena. This subject has been used in the university lectures for high school/junior high school students over 5 years. The essential advantages of this material is,1) easy to prepare as a kitchen matter, 2) timing of fracturing is predictable, which can be used in a lecture without a fear of failure, 3) total time scale is up to 10 min., which can be easily implemented in the lecture, and 4) easy observability of the phenomenon by using daily-life instruments.Staffs to prepare and necessary equipments:sugar syrup, vinegar, a cooling pan, a thick-walled container such as Sukiyaki nabe, a thin-walled container,the container size should be around 10-15 cm in diameter. IH heater as a heating device, ice, optional equipments:IR thermometer, sound recorder, digital camera or smart phoneExperimental procedure:1) heating sugar syrup to boiling by IH heater to reduce the water content. A tea-spoon vinegar is added at highest temperature. The amount of syrup is prepared so as to be the final thickness of Bekko-ame in the container of about several mm(2- 6 mm). 2) cool down slowly to about 60C. Make sure to confirm the surface completely solidified. Tapping the surface to check elastic sounds.3) put the container in a cooling pan of ice-water.4) watch carefully by eyes and ears. Just concentration under silence.A sudden cooling induces thermal crackings efficiently. The crack morphology is interestingly dependent on type of the container. In the case of thick-walled container shell-like small circular cracks are formed. The average size depends on the thickness of Bekko-ame. Progressive development of circular cracks is observed with light sounds. In the case of thin-walled container, on the other hand linear vertical large cracks are formed with fairly big fracture sounds. The occurrence is controlled by the thickenss, a longer time delay is necessary for a thicker sample.In both cases origin of stress to induce cracking is a subject to consider. The concept of thermal cracking and stress heterogeneity should be consider to modify the crack morphology. In the thick-walled system space-filling process can be explained in relation to site selection rule of the “next” cracking. The sequential photographs by a digital camera/smart phone can help to grasp the development. In the thin-walled system if crack sounds can be recorded by a sound recorder/smart phone wave form give further interesting information such as an interaction to seismology. Comparing a large event and a small event in the amplitude,duration time and even the spectrum could be further interesting. In the presentation we explain the formation process of cracking based on the variation of temperature fields.We recommend this Bekko-ame cracking as a simple experimental subject not only for outreach demonstrations but also the materials in the introductory experimental class at university because there are plenty of rooms of extensions if students get interested.

Keywords: fracturing phenomena, earthquake generation, demonstration experiment

 

# Interdisipilinary Education by Development of Instruments for Active Volcano

*Miwa Kuri[1], Ryosuke Yajima[2], Genki Yamauchi[2], Keiko Matsumoto[3], Yasuhiro YANAGIDA[3]

1.International Research Institute of Disaster Science, Tohoku University, 2.Graduate School of Engineering, Tohoku University, 3.Graduate School of Science, Tohoku University

[Graduate school program] Inter-Graduate School Doctoral Degree Program on Science for Global Safety (G-Safety) is promoted by Division for Leading Graduate School Programs, Tohoku University Institute for Promoting Graduate Degree Programs, Tohoku University.
Our “Science for Global Safety” is an academic attempt to systematically organize various studies regarding safety, which have developed within different specialized domains, according to their space, time and social aspects from a global perspective, placing disaster prevention/ mitigation for natural disasters and other risks as the central pillars.
This program is constructed based on the three viewpoints of “Understanding safety and security,” “Creating safety and security,” and “Living in safety and security,” supported by collaborations among researchers in science, engineering and humanities & social sciences.
[Student project] It is project-based learning program to provide students with opportunities to obtain in-depth knowledge and experience about natural disasters and disaster prevention. By students of multiple fields, carry out the voluntary planning and management.
[Proposal of development and the plume observation system of long-term operation can be unmanned volcano observation apparatus]
This project consists of 7 members on Engineering and Science. The aim of that is development and the plume observation system of long-term operation can be unmanned volcano observation apparatus under the active volcano. Roles of members is follows,
Device system team
A: Engineering DC1, Unification
B: Engineering DC2, System control design
C: Engineering DC2, Thermal control design
D: Engineering DC1, Web system design
Observation system team
E: Science DC2, Dgital image algorithm development
F: Science DC2, Volcanic observation application design
G: Science DC1, Volcanic observation application design
Device system team performs the development of the observation apparatus of the external power supply system that has been subjected and the improvement of the livelihood of the imaging system of independent power source (battery) system which was developed last year, the measures to snow and freezing, current, cooperation of the Sendai District Meteorological Observatory the obtained, it is carried out operational testing at Zao Jizodake.
The concept of "The development of simple and flexible system" makes the frame of this project. Science team was limted the priority under any condition such as the equipment installation conditions, the available amount of power. Enginering team has the accoutability for selections under each condisions.

Keywords: Interdisipilinary Education, Development of Instrument for Volcano