

An experiment of tsunami-like flow through coastal vegetation designed for classrooms

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This paper present an experiment for simulating tsunami-like bores passing over coastal vegetations designed for being performed in classrooms. Easy experimental facilities are used to display and study which layout of coastal vegetations can greatly reduce the bore speed. An acrylic tank which is divided into two regions by a movable gate is used to generate a tsunami-like bore. At the downstream region, different layouts of acrylic cylinders are placed to simulate the planting of coastal vegetations. When the gate is suddenly removed, the water in the upstream regions will flow through cylinders and go outside of the open end of the tank. The longest distance of the flow out of the tank is measured by a video camera. Finally the longest distances of all layouts are compared to find out the best design of layout for reducing the flow speed. The experiment not only can be performed in classrooms, but also provides an insight to the role of coastal vegetations in disaster reduction.

Keywords: experiment for classrooms, tsunami-like flow, coastal vegetation, disaster mitigation

Western classical music about ocean

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The influence of ocean phenomenon on western classical music is preliminarily studied. Main purposes of this interdisciplinary study are to explore the correlation between natural ocean phenomenon and music elements and how they affect each other. Ocean phenomenon considered include the climate, wave conditions, coastal landform, and other natural events around or on the sea. For some specific music pieces, it is clear that all these phenomenon greatly influence the composers' moods and the music pieces they composed. Some music compositions specially in the 19th and the early 20th centuries will be introduced herein to elucidate the whisper between ocean and music. Finally, present idea may give a way for music teachers to include the ocean elements in their classes.

Keywords: western classical music, ocean phenomenon, interaction with ocean

Mathematical tools for studying internal wave equations

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For undergraduate students who are interested in physical oceanography, fluid mechanics, or wave dynamics, mathematical tools are basic and important to analyze and derive model equations and wave theories. In this paper, the derivation of internal wave equations is introduced as an example of using some mathematical tools. Two important techniques used are the perturbation analysis and the Pade approximation. Based on these techniques the long-wave equations for a two-fluid system are derived and analyzed. Some wave properties predicted by the model equations are also investigated. As mathematical tools play an important role in ocean studies, the teaching of these techniques is of great importance in classrooms.

Keywords: mathematical techniques, internal wave equations, perturbation analysis, Pade approximation

Field Lectures at the Classroom sessions of The Open University of Japan

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Classroom Sessions (Schooling) of The Open University of Japan, is a good opportunity to outreach Earth Science in the context of Lifelong Learning Program. 4 field program planned and held at 3 Study Center, each program limited about 20 students to join, but there were 80 applicant in average. The student had a wide range in age and background, half of them were over 60, which belong hiking and climbing mountain lover generation, and often had knowledge about biology and other field of science. These multi discipline field works set by biologist and geologist, is a suitable way to recognize how Earth Science is important for our life.

Keywords: Fieldworks, Open University of Japan, Lifelong Learning, Natural History

Geological structure of the Kanto sedimentary basin ?An analog model-

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The geologic history of the Kanto Plain, central Japan, is briefly introduced for the purpose of educational promotion of the geology and earthquake disaster prevention. Thick sediments were accumulated between Northeast and Southwest Japan during the Japan Sea opening (20-15 m.y. ago). The grabens and half-grabens were developed under extensional stress field during this stage. The topographic up-and-down structure in basement rocks was then covered by marine sediments widely from 15 m.y. until ca. 10 m.y. ago in the Kanto district. The tectonic deformation had been slight between 15 and 3 m.y. ago. However E-W contractive deformation has suddenly begun at 3 m.y. ago, and reverse-faulting and folding were started in the Japanese islands. The thick sediments below the Kanto Plain were then deformed and active faults, such as the Tachikawa Fault, were finally cut the surface. The scenario of this history is useful for interpretation of subsurface structure deduced from geophysical exploration.

Keywords: outreach, earth science, geology, educational promotion

Gelatin experiments on magma ascent and eruption for outreach program

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Analog experiments are useful for outreach program. We cannot see the inside of a volcano directly, though an eruption is caused by underground magma. I develop the see-through experiments to understand a process from magma system to eruption. Liquid-filled cracks are injected in gelatin under the stress field. We can examine the factors controlling magma ascent to eruption, such as density, viscosity, the physical properties of the earth, the stress field etc. I introduce several examples of the experiments: magma ascent to eruption, crack behaviors under the stress field, magma movement with bubbles, the crack interactions, two phase flows, crustal behavior in the liquid filled crack. These experiments were carried out at elementary schools, junior high schools, science museums, the open house in AIST, training course for school teachers in YIES, and lectures of university, the international training course of JICA, APEC, COV.

Keywords: outreach, volcanology, magma, eruption, analog experiment, dike

GANSEKI as an educational material: Application of JAMSTEC deep seafloor rock sample database

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On the basis of Data-Sample Handling Policies of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC)[1], data and samples obtained during research cruises of JAMSTEC vessels are treated as common properties of the human community; data and samples are stored and publicized to the public for second-hand uses with research/educational purposes. After two-years of moratorium period during which on-board researchers and colleagues have a priority to use data and samples, information on data and samples are disclosed through JAMSTEC data sites, and are utilized for foreign/domestic activities of research, education, press report and public relation.

JAMSTEC vessels collect several hundreds of rocks from the deep seafloor each year. These rock samples and associated data are also subject to be publicized. Sampling information and associated data of rock samples are accessible from the website "Deep Seafloor Rock Sample Database (GANSEKI)[2]". Currently, GANSEKI exhibits information of more than 19,800 entries of JAMSTEC rock samples including inventory information of ~9,000 actually available samples, and geochemical data and literature information of JAMSTEC/non-JAMSTEC rock samples.

After the major update in 2013, minor system tuning and data maintenances have been applied to GANSEKI. Now GANSEKI is attracting general educators and students, as well as limited number of research specialists. New GANSEKI search system allows complex filters for screening samples to support various users with different purposes. Improvements on sample/thin-section photo view allow users to effective data handling using visual information.

JAMSTEC maintains several data sites other than GANSEKI. Some of these data sites are linked together so that users can utilize data more effectively. Users can come-and-go between GANSEKI and "Data Research System for Whole Cruise Information of JAMSTEC (DARWIN)[3]" to pick up rock sample information in GANSEKI and associated information in DARWIN, such as cruise/dive information, geophysical observation data, cruise reports and literature information. Rock sample information in GANSEKI is also linked to dive movies/photos in "JAMSTEC E-library of Deep-sea Images (J-EDI)[4]", and users can comfortably look into sampling scenes of interested rock samples and surrounding geology.

GANSEKI users can now access to massive online data, which are almost comparable to those provided to onboard researchers. Disadvantages for second-hand users are getting smaller and these users can perform more practical research/educational activities. GANSEKI can be utilized not only for mineralogical/petrological purposes, but also for other various purposes, such as surveys of contemporary activities in ocean geology, case studies for observation data handling or online database system, and so on.

References: [1] "JAMSTEC Basic Policies on the Handling of Data and Samples" http://www.jamstec.go.jp/e/database/data_policy.html. [2] "Geochemistry and Archives of Ocean Floor Rocks on Networks for Solid Earth Knowledge Information (GANSEKI)" <http://www.godac.jamstec.go.jp/ganseki/e>. [3] "Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)" <http://www.godac.jamstec.go.jp/darwin/e>. [4] "JAMSTEC E-library of Deep-sea Images (J-EDI)" <http://www.godac.jamstec.go.jp/jedi/e>.

Keywords: rock sample, curation, on-line database, outreach, marine geology

Quaternary Scientific Programs for School and Lifelong Education of Kikai Island located in the Amami Islands, Japan

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The Amami and Okinawa Islands show active tectonics indicated by uplifted marine terraces consisting mainly of raised coral reefs. Especially, Kikai Island shows a rapid rate in uplift (reaches 1.8 m/ka) due to subduction along the Ryukyu Trench. This study arranges geoscientific contents and produces a geostory for school and lifelong educational programs of Kikai Island. The geostory focuses groundwater springs, limestone caves, uplifted terraces (uppermost surface is 214 m) and coral stones, and highlights geomorphic processes characterized by the most rapid uplift in Japan and a hydrologic cycle in the Quaternary limestone region. This geostory was repeated and practiced in half-day geotour targeting undergraduate students and residents of Kikai including high school students. Their comments suggest the significance and the interest on field observation of local landscape related with a global geoenvironmental system.

Keywords: Quaternary, limestone, geostory, geotour, Kikai Island, Amami Islands

Educational Approach for Risk Reduction in Himalayan Seismic Zone I -Bridging the Gap Between Knowledge and Practice-

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How can we encourage people to take preventive measures against damage risks and empower them to take the right actions in emergencies to save their lives?

The conventional approach taken by scientists had been disseminating intelligible information on up-to-date seismological knowledge. However, it has been proven that knowledge alone does not have enough impact to modify people's behaviors in emergencies (Oki and Nakayachi, 2012). On the other hand, the conventional approach taken by practitioners had been to conduct emergency drills at schools or workplaces. The loss of many lives from the Great East Japan Earthquake and Tsunami has proven that these emergency drills were not enough to save people's lives, unless they were empowered to assess the given situation on their own and react flexibly.

Our challenge is to bridge the gap between knowledge and practice. With reference to best practices observed in Tohoku, one of which is known as "*The Miracles of Kamaishi*," our endeavor is to design an effective Disaster Preparedness Education Program that is applicable to other regions in the world, even with different geological, socio-economical and cultural backgrounds.

The two key concepts for this new approach are "community-based understanding of disaster risks" and "personal empowerment to take preventive actions." This approach requires collaboration and participation from people from diverse fields of expertise, cultures, and generations, touching on interdisciplinary areas of study including seismology, geology, community development, education and psychology.

In this presentation, we will introduce how we designed the programs and activities for disaster preparedness workshop held at a high school in the Lesser Himalayan Region in North India, under an Indo-Japan collaborative projectⁱ, and share good practices and lessons learned from this experience.

ⁱProject on Information Network for Natural Disaster Mitigation and Recovery (DISANET) <http://disanet.interliteracy.info/about/?lang=e>

Keywords: Disaster Preparedness Education, International Cooperation, Hazard Map Making, Workshop

Educational approach for risk reduction in Himalayan seismic zone II -Hazard map making workshop at a high school

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The 2011 Great East Japan Earthquake confronted us with the fact that the knowledge of science alone would not motivate someone take preventive action. This indicates that risk reduction cannot be completed only by hazard assessments but also by motivating people to take preventive action.

With the concept of "community-based understanding of disaster risks" and "personal empowerment to take preventive action", we held a workshop at a high school in the Lesser Himalayan Region. The workshop consists of 2 sessions; 1) understanding the scientific backgrounds of earthquakes and disasters, and 2) hazard map making. Prior to the workshop, we carried out a questionnaire survey to high-school students about how they perceive the risk of the local hazard. After the first session, we provided about an hour of question time, and carefully analyzed what they said. Together with the answers of the questionnaire, it is strongly implied that they understood scientific backgrounds but do not have awareness of disaster and are not motivated to take preventive action.

Session-2 consists of several parts such as giving clear images of earthquake consequences, leading them to imagine each victim's life that was broken up all of the sudden on March 11th 2011 as well as showing how to find out and manage risks by making hazard map. The workshop was closed with their presentation that clearly shows the internal change of the participants. Many of them referred to the importance of lives such as "Life is a precious gift to us from God. Don't take it as a fun. And if you take it as a fun, then remember your family."

In the presentation, we share the good practice that can be applied to other disaster-prone countries if we pay regard to the community-based understanding of disaster risks.

Keywords: disaster prevention, earthquake, hazard map

Educational Materials for the Community-based Understanding of Disaster Risks -Taking Advantage of four-frame Cartoon

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One of the lessons from the 2011 Great East Japan Earthquake is that educational approach to prevent natural disasters can compensate the limitations of earthquake science and technologies. Hereinafter we call it as "BOSAI education". BOSAI can be translated as disaster prevention based on individual awareness of disaster risks and leading to personal empowerment to take preventive action. After the earthquake, more schools started to conduct BOSAI education, while the government had not provided schools with certain time, textbooks, and curriculum guidelines.

As well as learning how to react to protect lives at the moment, one of the goals of BOSAI education for mid-school students is to deal with a dilemma situation that may take place afterwards. We provided a BOSAI educational material to take up the situation of evacuation site to ask students how to distribute aid supply if the total number is less than that of evacuees. The educational material is made as a four-frame cartoon as follows: 1) 12 hours after the earthquake at an evacuation site... 2) Person1: "There arrived 100 of aid supply!", 3) Person2: "What? We have 500 people here." 4) Person1: "Mmm... ". Students have to give an appropriate line that follows "Mmm..." Some of the answers were "We should put a priority to elderly persons and small kids" or "Why don't we ask for cooperation to those who brought their own emergency supplies in their backpacks?"

Another point of great importance of this material is to let the local school teachers join and share. We asked for advice to improve the material, and collected comments and suggestions. Some said they will have another class with the improved material. They can arrange the contents to bring community-based understanding of disaster risks. In the presentation, we share the material and report good practices.

Keywords: disaster prevention, education, earthquake, tsunami, evacuation site, mid-school

Analog model of basement structure below the Kanto Plain

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It is commonly discussed the difficulties on promoting the geologic results for the students as well as citizens. To solve this problem, I made three-dimensional analog model of basement structure below the Kanto Plain. The horizontal scale of model is 1/200,000 but vertical scale is emphasized as 400%. Because the model was painted by gradations in color from yellow (Shallow) to dark blue (deep), it can be easily recognized the contrast between subsurface steep precipice and gentle slope of basement structure. Among them, the Tachikawa Active Fault is characterized by sharp drop of basement depth below the Kanto Plain. Thus the analog model of basement structure below sedimentary basin would be helpful to understand why long-period ground motion is amplified in the sedimentary plain.

Keywords: outreach, earth science, geology, educational promotion

How does the understanding of volcano advance? ; An example from the experiment on forming stratovolcano

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Experiment on Polygenetic stratovolcano using waste food oils and colored sands (Kasama et al. , 2010) was demonstrated at grade schools to high schools in Kanagawa prefecture and Shizuoka prefecture. Two cross section pictures of stratovolcano were drawn by many students. One is a imagination sections before experiment and another is a sketches after experiment. These pictures were divided into several types by inner stratigraphy (Kasama, 2012a) and had a tendency corresponding to age (Kasama, 2012b). Furthermore, many educational practices have done from 2012 to 2014. Many data from 1409 people have obtained. According to the result, it becomes clear that the tendency corresponding to age, residential area and scientific interest of volcano, especially Mt. Fuji. The experiment type (ET) was drawn by lines changed from lower horizontal lines to upper tilted lines. ET was found in the experimental stratovolcanoes and was considered to be exact depiction. Textbook type (TT) was drawn by piling similar triangles. Horizontal type (HT) was drawn by horizontal lines like stratum (Kasama, 2012a).

Fig.1 shows a relation between horizontal type drawn before experiment (HTB) and experimental type drawn after experiment (ETA). They had negative correlation. ETA indicates observation capability. ETA increases with age. HTB indicates misunderstood prior knowledge. Misunderstanding was thought to be caused by the education of the stratum of the 6th grader. Because HTB was not so high at the 3th to 4th grader, but the 6th grader was highest of all. There was found no HTB in a science club which consisted high school and junior high school students, Kanagawa. But, teachers of elementary school of Kanagawa drew same HTB, and ETA did not beyond the high school students. It is an important problem that we must think about.

TTB and ETA had correlation. TTB indicate right back ground but it is not so exact. ETB and ETA also had correlation. ETB is thought to be the best expectation, but its proportion was low.

How to write outside slope lines of stratovolcano is divided into three types. Simple straight lines (SL) which like the side slopes of a scoria cone, convex curves (CV) which like the side slopes of a lava dome and concave curves (CC) which are suitable for the slopes of a stratovolcano. Ratios of three types were not so much depended on age, but heavily depended on arias in which students live. Many students living in Shizuoka prefecture wrote concave curves before experiment (CCB). A high school at Shimizu, Shizuoka indicated the highest CCB ratio. It was thought that students can see Mt. Fuji and its frank easily.

References

Tomohiro Kasama, Daiji HIRATA, Shuichi NIIDA, Hiroyuki YAMASITA and Saeko ISHIHAMA (2010) Development of Experiment on Polygenetic Volcanoes Using Waste Food Oils. *Earth Science Education*, 63, 5.6, 163-179.

Tomohiro KASAMA (2012a) Cross sections of stratovolcanoes drawn by sixth grader. Japan Geoscience Union Meeting 2012, G02-P-9, Chiba.

Tomohiro KASAMA (2012b) Cross sections of experimental stratovolcanoes drawn by students of various age. The Geological Society of Japan Meeting 2012 Osaka, R19-O-8.

Keywords: experiment, stratovolcano, cross section, Mt. Fuji, children and students, teachers

G02-P02

Room:Poster

Time:April 29 18:15-19:30

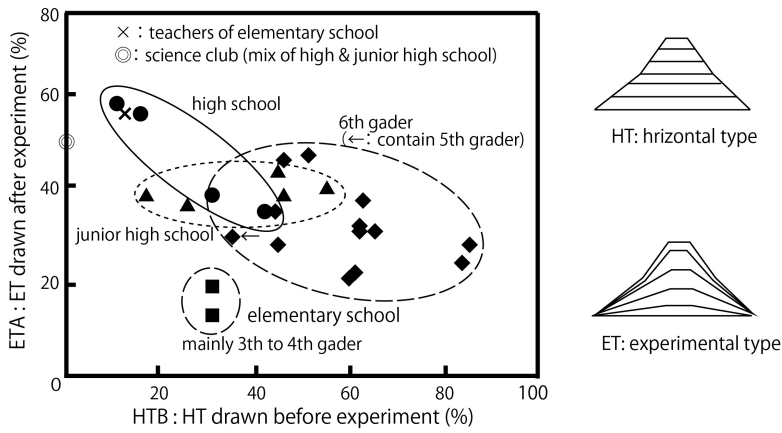


Fig.1 An analysis of pictures, showing a correlation between HTB and ETA.

3D visualization and outreach of subsurface geological information using multi-layered miniature produced by 3D plotter

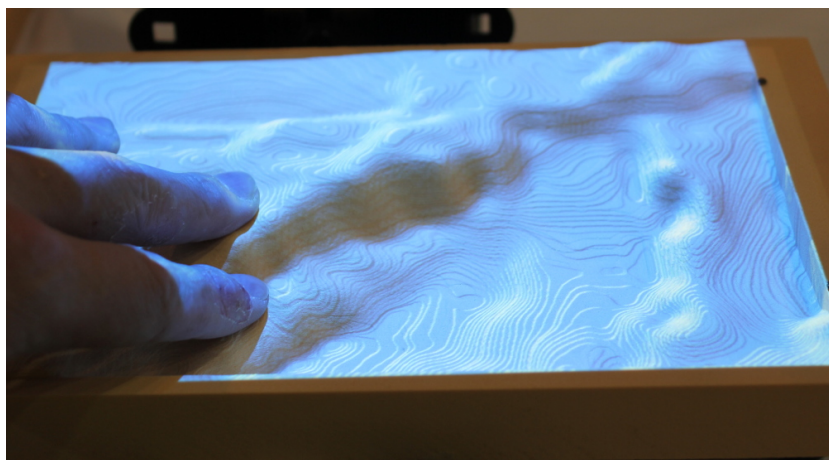
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In recent years, people can access to geological information quickly and easily with the help of information technologies. However, it is difficult to recognize three dimensional distribution of geological structure without professional training of map reading. To solve this problem, several techniques were established to build up finely-detailed miniature with rapid prototyping and projection mapping. There are extremely small contours on the surface of the miniature. These contours are used for marker to calibrate projection. This miniature, called Highly realistic Projection system (HiRP system) is used for outreach and research activities in museums, schools, geoparks etc.

I, the present writer, will report about 3D visualization about subsurface geological information using multi-layered miniature. A number of geological datasets, such as borehole datasets, 3D subsurface structure model published by Geological Survey of Japan (GSJ) are also used to modeling interior structure of the model. I will also report about interactive miniature coupled with GIS, and global trends in rapid prototyping.

Keywords: Geological information, 3D model, Rapid prototyping, Projection mapping, 3D plotter, Geopark



Benefit of intergenerational course training as a "Science Seminar" in earth science

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A science outreach program "Science Seminar" has been given to junior and senior high school students by graduate students in Niigata University since 2009. We will present an effective age to educate earth science exhibited by statistics of questionnaire and how the intergenerational course training is arranged in the science seminar.

Keywords: Delivery lesson, Graduate student, Earth science for junior high school students, Career education for young scientist

How should the outreach activity for the earth and planetary sciences be promoted?

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The earth and planetary sciences cover various scientific and technological fields so that it is clear that the earth and planetary sciences are one of the most important fields of academic study for the society, and meanwhile the public is responsible for them. Many outreach activities have been held, and interactive ways have been especially remarkable in this decade. The communication which is mediated with scientific knowledge and perspectives is called as "Science Communication". Science Communication is not only the enlightenment of science by academic groups for the public but also the role for picking up the voice of the public. The context for Science Communication has been changed over time, therefore, it is more important how the Science Communication should be promoted as needed than why it should be. However, the schematic concepts for Science Communication less have been established.

We "Universal Earth" have hypothetically proposed the concept of Science Communication and verified it through the science events. Science Cafe is one of useful ways to promote Science Communication with the available facilities and also it is one of the largest number of events are held in Japan. However, Science Cafe is just one way of Science Communication so that we had another symposium to discuss how Science Communication should be promoted and what we can do with other Science Communication tools.

In this presentation, we report the conclusions of the Science Cafe and the symposium about Science Communication held in 2013. We hope our presentation generate the discussions.

Keywords: Outreach, Science Communication, Science Cafe

Delivery lecture for elementary school students with hand auger boring

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In order to awareness building of earth and environment science for elementary school students, we conducted outdoor practices as a delivery lecture at a Buddhist temple on the Toshima upland (the Musashino I surface), Tokyo. The first lecture in the summer of 2012 was unsuccessful due to miss allocation of time and excessive schedule of study topic with indoor lecture. Even an auger boring using handy soil corer(hand auger LS-3 series, Sanyo testing machines Co. ltd.) took 3 hours, despite that the work was carried out by four adults. In the aftermath, the students could not advance sample treatment and description works, and finding ground water.

In the summer of 2013, the schedule focused on the boring, sample treatment and measurement. As a result, students experienced the following subject; boring work in 4 meters in depth, sample description, measurement of soil color and temperature, verification of ground water. The answers of the questionnaire after the lecture shows the students amazed a variety of characteristics of geology and environmental study and long history of the earth which were recorded at under their foot. We are planning further lecture and boring at the temple in next year.

Keywords: earth science education, summer homework, core description, the Kanto loam, soil temperature, ground water

Approach to the improvement of the field work

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We started up a new project “ Geo Education ” in 2012. This project purpose is increase awareness for geo-scientific education in elementary and secondary level through field excursions. In other words, it is the knowing the earth by touching and seeing the real. The members consist of scientist, engineer, teacher and university students specialize in earth science. It is probably new activity which prepares the operation methods and the instructor cooperation with the school.

In 2012, we held the field excursions with two junior high schools in Tokyo. Through the two field excursion, we will clarify figuring out of field materials and future problems involved. In 2013, we did activities about the development of field materials to the improvement of the field excursions.

In this presentation, we will introduce our project “ Geo Education ” and report the results and problems on this year’s activities.

Keywords: Geoscience education, field materials, field excursion, awareness activity, elementary and secondary level

G02-P08

Room:Poster

Time:April 29 18:15-19:30

Outreach activities of AIST for geothermal energy, 2013: simple paper materials

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¹AIST

We developed a pen-and-paper game to study various uses of geothermal energy in 2012, and reported it in last JpGU meeting (Mizugaki et al., 2013). In 2013, we developed an additional material, a simple paper model illustrating cascade use of geothermal energy.

These materials are used in following outreach events:

AIST Tsukuba open house 2013

Geoscience Exhibition in Miyagi 2013

Keywords: outreach, geothermal energy, paper model, pen-and-paper game

An Evaluation of Sieving Effect of Volcanic Ash Fine Particles by A Statistical Particles Image Analysis

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¹Malvern instruments A division of Spectris Co., Ltd.

1. Introduction

The analysis of particle size and shape characterization is an important evaluation of volcanic ash. It is well known that particles size and shape is one of dominant parameter of volcanic ash for flowability, flying property and abrasively. A sieving is used for particle size analysis of volcanic ash as common method. However, particle has possibility to have shape effect when it goes on through mesh of a sieve. In conventionally, a manual microscope approach has been used for few number of particles shape observation. It is not able to described particle shape as significant number. On the other hand, a fine particle characterization of volcanic ash (less than 50 μ m) has also importance to hazard protection issue which is a fine particle has possibility to long duration time in air. Our group has reported particle characterization and classification of a volcanic ash fine particle using by images for the purpose of determining particle size distribution which is based on described in ISO13322. The particles are appropriately dispersed and fixed on an optical microscope implemented a fully automated sample stage and an automated real time particle image analysis function on software. This report will be discussed for effect of sieving and precise classification against volcanic ash fine particle by a statistical particle image analysis.

2. Material and method

In this study, the volcanic ash was sampling from Ito flow in Kagoshima. This sample was already filtered coarse particles before, and sieved by a analytical sieve (TOKYO SCREEN CO.,LTD), these mesh size were 75 μ m, 50 μ m, 32 μ m. It was passed to 75 μ m, 50 μ m and only trapped on 32 μ m. As a statistical particle image analysis, Morphologi G3-SE (Malvern Instruments) was used for evaluation of particle size and shape. The observation mode was diascopic mode (Transmittance mode) and magnification was 100x in total magnification. The sample was dispersed with SDU (Sample Dispersion Unit) which attached Morphologi G3-SE. Number of measured particles was 120,000 and a parameter filter function on software was used based on shape and pixel number of particle image.

3. Result

A classification based on sieving were under 32 μ m sample (sample 1), over 32 μ m sample (sample 2) and no pretreated sample (sample 3). Those samples were analyzed on over 60,000 particles by statistical particle image analysis. As a result, Number Based Circle Equivalent Mean (NCED Mean) was 8.7 μ m (sample1), 13.9 μ m (sample 2) and 9.6 μ m (sample 3) on each. However, 510 particles of over 32 μ m particles were detected in sample 1. It was assuming from this result that shape effect happened. Therefore the result of focus on over 32 μ m particle to consideration of more precise classifications was shown in Table 1. This result showed sample 1 was the most elongate in the same size particles. Intensity Mean (IM) is reflected to sample thickness and transparency. High IM particles are tin particles or glass like particles in normally. Therefore, it can possible to classification glass liked particle or non glass like particle in volcanic ash based on IM parameter. According to results, sample 1 was most of including a glass like particle in amount of particles (Table 2, Fig 1).

4. Conclusions

In summarize of this study, it was clarified particle shape effect against sieving. This report will be more discuss about application and capability of numerical definition of volcanic ash by the statistical particle image analysis as new approach for this research area.

Keywords: Volcanic ash, Particle size, Particle shape, Particle image analysis, Sievng

Japan Geoscience Union Meeting 2014

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G02-P09

Room:Poster

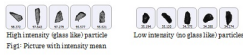
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Table 1: Each Class Data

Class	sample	Number of particles	OE Diameter Mean (μm)	Aspect Ratio Mean
Class 1 (12-25 μm)	sample 1	83	14.8	0.65
	sample 2	3,543	14.9	0.65
	sample 3	891	16.4	0.64
Class 2 (12-42 μm)	sample 1	116	29.9	0.65
	sample 2	4,044	39.5	0.65
	sample 3	453	39.9	0.64
Class 3 (over 42 μm)	sample 1	38	45.2	0.62
	sample 2	4,918	47.8	0.62
	sample 3	378	46.6	0.64

Table 2: Intensity Mean by Class

class	sample	Mean Intensity	number	Intensity mean > 80 %
class 1 (12-25 μm)	sample 1	63	133	39%
	sample 2	61	102	26%
	sample 3	54	107	31%
class 2 (12-42 μm)	sample 1	63	84	47%
	sample 2	57	1,051	39%
	sample 3	58	102	37%
class 3 (over 42 μm)	sample 1	79	24	62%
	sample 2	88	2,187	66%
	sample 3	81	192	61%



Primary environmental radioactivity education

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The physics of radioactivity or the radiation has very close relation to developments of physics from the beginning of the 20th century. The human being does not have an organ taking in radioactivity directly, which is different from visible light, hearing, temperature, and the taste. The radioactivity is an extremely mysterious phenomenon historically in this way, and this is why the elucidation was pushed forward. In addition, the radiation is statistical phenomenon because radiation is a phenomenon caused by an atomic nucleus change and an electronic state change of the atom. However, this historically important and mysterious phenomenon is not almost taught in a beginning class or the secondary education. It is only handled for a last unit in physics II of the high school. A public, who did not learn physics about the radioactivity and who experienced the nuclear power plant accident that it follows East Japan great earthquake disaster of 2011, face the radioactivity. As a result, confusion occurred about intuitive and sensible understanding about the radioactivity. On the basis of the above-mentioned background, we make a teaching plan about the beginning class in the radioactivity education and report the result that we practiced in high school and university cooperation educations.

Keywords: Radioactivity education

Investigation of disaster memorials of the 2005 Fukuoka Earthquake and the 1982 Nagasaki Flood

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After the huge tsunami disaster of 2011, the existence such as the monuments which ticked away the teaching of the ancestor who conveyed a disaster was performed a close-up of in each place. The history of the past valuable teaching and disasters such as monuments might be forgotten with time. Therefore, it is an opportunity to raise disaster prevention awareness to convey history of disaster and a disaster sign.

We investigated the disaster memorials of the 2005 Fukuoka Earthquake and the 1982 Nagasaki Flood. We surveyed in 24 sites around Fukuoka and 23 sites around Nagasaki, we was able to confirm some disaster memorials. And we made the map which could take a walk through these damage traces.

Keywords: 2005 Fukuoka Earthquake, 1982 Nagasaki Flood, Disaster memorials

The Earthquake-making Event of Meteorological Research Institute

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¹Meteorological Research Institute

The Otenki-Fair at Tsukuba has been conducted in every August by Meteorological Research Institute, Aerological Observatory, and Meteorological Instrument Center. The Earthquake-making Event is one of the exhibitions in the Otenki-Fair. Participants jump on the floor 1 m away from a seismometer, then calculated magnitude will be displayed on the screen of a PC. The magnitudes usually range from -4 to -6. This event is popular with children.

The software for the Earthquake-making Event worked on a PC9801 computer by a program written in N88BASIC. Because a long time has passed since the cessation of production of PC9801, this event faced possible discontinuance due to hardware trouble. Therefore we transplanted the program into VisualBasic to continue the event with current Windows machines. At the poster meeting place, we will demonstrate the event.

Keywords: event, earthquake, magnitude

”Listen to the sound of earthquake!” - Experiment of sonificated seismic wave in public relations events

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¹Meteorological Research Institute

Meteorological Research Institute (MRI) located in Tsukuba city carries out an annual public relations event titled ”Otenki Fare Tsukuba” on a weekday during the summer school holiday. Every event has two to three thousands visitors mostly from Tsukuba city or neighbor cities. Typical visitors are a group of school child(ren) and their mother. This event is a good opportunity for MRI not only to appeal its research activities but also to diffuse basic knowledges widely on weather, earthquakes and so on.

Edutainment titled ”Listen to the sound of earthquake!” has developed (Hayashi and Takayama, 2009; *QJS*), by which we can hear a sound of any earthquake selected from a menu. The substance of the edutainment is just a presentation file created by Microsoft PowerPoint(R); and interactive operating environment with a menu is realized by using PowerPoint’s functions of slide-show and animation. Therefore, the file can easily be modified by other technicians than the author.

The contents, or various sounds of earthquakes, are WAVE-formatted sound data produced by 10 - 1000 times fast-forwarding using actually observed seismograms. The process, which assume that seismograms are time-series of compression wave transmitted in the air, sacrifices the physical accuracy, but the process without accompanying frequency modulation conserves the scaling law of the sound source; and then, we can feel a material of the source of ”sounds of earthquakes” by listening differences of pitches, intensities and tones. The edutainment intends to make listeners understood on the existence of the diversity of earthquake based on various type of earthquake. By the way, ”sounds of deep low frequency earthquake”, which were processed by the same method as above, were used in the TV program of NHK titled ”Megaquake III” in 2013 so that the difference of source mechanism between slow earthquakes and ordinary ones were explained.

”Listen to the sound of earthquake!” has been displayed for one of the attractions in ”Otenki Fare Tsukuba” every year since 2007. Its display and contents have been improved; the line out from each personal computer (PC) is now divided into three headphones, in order to match the requirements of number of visitors increasing year by year, and the typical guests consisting of a mother and two children; in addition, contents has replaced after the occurrence of major earthquakes.

However, there are still several problems remained. The first one is that 45-seconds experience is too short for most primary school children to feel the diversity of earthquake, which the edutainment want to teach them, from listening their sounds. They just simply enjoy and end. The second one is that the interface using mouse and selecting contents from the displayed menu is becoming user-unfriendly for children in the age of smart phones and tablet PC. The last one is essentialness of multi-language interface.

In the JpGU2014 meeting, PCs installed ”Listen to the sound of earthquake!” will be displayed, after experiment, discussions on possible improvements and application to other public relations event will be welcomed.

Keywords: diversity of earthquake, edutainment, elementary school children, PowerPoint, sonification of seismic wave

Survey of educational study on disaster prevention

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The consciousness of importance and need of the disaster prevention education for the natural disaster is increasing more. In this study, we tried that we grasped the actual situation of the study on previous disaster prevention education through compiling of research paper title by the some keywords. We set that the keywords are the causing phenomenon of the disasters, e.g. earthquake, tsunami, volcano, typhoon, and directly expression word of disaster prevention education, safety education. Our result shows these selected words are not so many used in the title of previous research papers. Although this procedure has an inadequacy, we can understand a tendency and the actual situation about the methods and contents of the disaster mitigation education.

Keywords: Disaster mitigation education, Title of reserch paper

Student science continuation study on rocks and minerals weathering experiment 2

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I have been instructing the continuation study to check rocks and minerals change experimentally as a student study of junior high school science club for 23 years. In this continuation study, I have valued the study of the change basalt and fayalite with ultraviolet rays and the water most. This study is for a purpose to clarify one of the causes with much iron oxide on Mars. Therefore, students irradiate ultraviolet rays to the basalts and fayalites soaked into purified water and check their change. There is much basalt and fayalites on Mars probably. In addition, it is estimated that water existed on past Mars. Therefore, in past Mars, it is thought that ultraviolet rays and water were one of the factors to change rocks .

At first I am interested in the study and I decide directionality and the plan of the study of science club and prepares for tools. And the student who was interested in the study joins the scientific club and studies it. In other words it is a teacher-led science continuation study, but values the idea and opinion of the students. In a junior high school and the elementary school science, I think that such a teacher-led science study should be carried out more lively in Japan. And I think that it is easy to practice such a teacher-led science continuation study in the field of earth planet science and the field of biological science in particular.

Keywords: student study, ultraviolet rays, water, fayalite, basalt, change

Planning and practice of our delivery lecture at Betsukai elementary school

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¹Geological Survey of Japan, AIST, ²Meiji Consultants Ltd., ³Kushiro Branch, Hokkaido University of Education

Triggered by the Tohoku Earthquake on March 11, 2011, science education for disaster prevention and mitigation, are reviewed the importance of earth science education, especially in the field of education. However, we hear often from teachers in elementary school, junior high, and high school. "There are no instructional materials about local geology and geomorphology on the science textbook around here.

Kazuto Ishiwata in Betsukai museum was consulted me about "In the study period, which is expected to occur in November, I want you to plan visiting lectures about local geology for target 13 people in grade 5 and 6 of Betsukai elementary school ". At that time, it was to be three students from Hokkaido University of Education, Kushiro branch aimed at teachers in future come in field training associated with Prof. Yasuo Ikeda. Therefore, we plan to conduct a special science class with them in Betsukai elementary school in last November. We will report our planning delivery lecture at Betsukai elementary school about "Let's examine the origin of land using by geological and geomorphological information!" and responses from students.

Keywords: Betsukai elementary school, delivery lecture, geomorphology and geology, origin of land, eastern Hokkaido, marsh

Computer Based Educational Seismology System for Regional Elementary School Students

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¹Yokohama City University

Japan is one of the most seismically active countries in the world. Catastrophic earthquake can happen anywhere in the country and large offshore earthquake sometimes cause destructive Tsunami. Since no one can predict the exact date and location of the earthquakes, it is important to get prepared in advance to protect their homes and families. For this purpose, education of disaster preparedness is crucial for everyone. After the 2011 great Tohoku Oki earthquake occurs, importance of the education of disaster preparedness was rediscovered and various educational activities were held in schools and other public facilities. However the mechanism of earthquake itself (Why and how it happens, why the strong ground motion can be generated, what controls the ground motion intensity, etc.) is rarely taught in the classroom. Both comprehensive knowledge of the earth science and disaster drill should go together for the effective disaster prevention. In addition, the education of the earth science including seismology for younger generation is very important to encourage them to be a future scientist or/and leader of disaster prevention. In this study, we develop a computer based educational seismology system targeted for elementary school students. The system will be aimed at being used in the classroom to support their better understanding of earthquake and earth system. Prior to this project, we performed a series of survey in the local elementary school to figure out what teachers want for this type of learning system and how to adopt it in their class. Based on the survey, we developed a prototype of the system. Since it is targeted for little children, we made efforts so that it to be not only practical but also enjoyable. For example, as the prototype, we developed the computer game to determine the hypocenter of earthquakes, which is practical and visually enjoyable. In the game, students will pick P- and S-wave by themselves and compete the score. Furthermore, since we are trying to distribute the system to the local elementary school, we included the learning contents of the local geology, tectonics and historical earthquakes in the system so that they can learn them effectively and prepare for the future earthquake that affects their home town.

Keywords: Disaster prevention education, Educational seismology, Outreach, Computer game, Elementary school

A direction of geographic education for disaster prevention after Great East Japan Earthquake

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One perspective from environmental education after the Great East Japan Earthquake (GEJE) gives us an opportunity to rethink the following attitude: learning about nature and physical environment makes you a person solving problems among them. This can be described as the gap between recognize and action. This concept is lack also in geographic education, where recently problem solving learning often carried out on the context of Education for Sustainable Development.

The aim of disaster prevention education in school is to foster children's competence for recognition and action about disaster and its prevention. However in geographic education so far, the learning approaches were categorized in 2 patterns as point out the correlation between disaster and topographic condition through evaluating map and aerial photographs (1), and find out place of danger with comparing old-new topographical map (2). They were just recognize approach for disaster and would lead to scientific rational recognition like hazard map. The action was not to be in considered. Moreover GEJE shows us the needs of mental- and ethical behavior should be foster in education. Against these challenging ethics education offer a new approach from the theoretical background of Kohlberg's stages of moral development. Life is getting to be an issue also in geographic education.

This presentation shows the cross-linking approach of scientific rational- and ethical aspects of disaster prevention education with concrete example.

Keywords: Great East Japan Earthquake, Geographic Education, Education for Disaster Prevention, Education for Sustainable Development, cross-linking approach

Learning Tsunami Physics by Numerical Simulation: A Curriculum of Physical Oceanography Education in High School

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In this study, we have developed the curriculum for high school students to learn the physics of tsunami waves. A special feature of this curriculum is that students try to perform numerical simulations to understand the basic behavior and dynamics of tsunami waves. This curriculum is composed of two successive classes of physics for second grade high school students (each class is 45 minutes in length). In the first class, we explain the physical characteristics of tsunami waves, the physical laws governing tsunami waves, and the basics of numerical simulation approach. In the second class, every student plays the numerical simulations of tsunami waves by using PC.

Keywords: Tsunami Wave, Numerical Simulation, Physical Oceanography Education, Marine Education

Geoscience curriculum on High School research program

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Background: A new system for research program on high school had started at 2013. And some school has started the research program as SSH, SPP and so on. Many universities and research instituts supports research by high school students. In many case scientist suport sturents on specific skill not basic skill. As increeasing the number of SSH, theme for research had diversified lile as the interrraction of science and society.

Basic skill Lesson: Authors had suported for the resson of basic skill to cross the filds, referenc skill, cretical thinking and so on.

Activities: Lessons from the Great East Japan Earthquake are summarized in White Paper on Science and Technology 2012. The public trust in scientist declined from the gap between expectation and real. Promotion of integrated research of different fields such as seismology, geology, archaeology and history to enough understand earthquake and tsunami is a pressing need. Risks and uncertainty involved in science and technology have not been seriously considered with regard to the provision of information by the government and experts for the public. Therefore most of the people did not have an adequate understanding of the situation. Social Engineering, Social Sciences, and Humanities have to be considered in implementing countermeasures. Anticipating massive earthquakes and tsunamis by taking every possibility into account.

Propose: The uncertainty of geocience has been the reason to avoid geosience in school curriculum.

Keywords: geoscience, statistics, refference

Multi-site observation program of sprites in collaboration with high schools and universities: from 10-year activities

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As one of the educational projects in geoscience, TLE (Transient Luminous Events: sprites, elves, etc.) triangulation has been carried out since 2004 with collaborating many high schools in Japan and Kochi University of Technology (KUT). Since 2006, some high schools has been funded by Japan Science and Technology Agency (JST). In this decade, collaboration has been improved educationally and scientifically, resulting almost full-coverage of Northern sky over Japan by high-sensitivity CCD video cameras (Wat-100N) and motion-detective software (UFOCapture V2) operated by high school students. The activity generated the largest TLE observation network in the world by participating 30 or more high schools. After ended the funding from the JST as the SSH consortium or Core SSH, high school teachers and students continued their relationship to study the science of TLEs with having internal meetings twice per year until now.

The first sprite detection was made in Dec. 2004. More than 3000 TLE events were detected by high school students, creating many scientifically interesting results, i.e., the world first triangulation of elves in 2008, a few examples of gigantic jets with VLF signals. Existence of an elf with apparent stripe wave pattern was clearly confirmed by simultaneous observation of the elf, suggesting modulation by gravity waves. Such results were and will be presented by high school students with their impression at the domestic scientific meetings like JpGU high school student session as well as some international conferences (see Shirahata et al., 2014; a scientific paper submitted by Iwata Minami high school team).

Thus, the campaign was very successful to obtain new results of TLE as well as the special educational project for high school students. Their research activities were widely introduced to people in Japan by NHK special TV program "The cosmic shore" in 2012. In this talk, 10 years collaboration between high schools and university activities will be presented.

Reference: Shirahata et al., Striped structure observed in the elves: Relation to turbulences in the upper atmosphere, AS28 session, AOGS 2014, Sapporo, 2014.

Keywords: high school student, collaboration with high school and university, Astro-HS, Super Science High school (SSH), multi-site observation, sprite

Deployment of a teaching material for observing electric field by sprite parent storm at high school

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Sprites are observed by many high school students by means of high sensitivity CCD cameras. They have revealed the optical characteristics of sprites (e.g. morphology and 3-dimensional location). However, they do not have materials to observe electrical phenomena originating from sprites. So, we developed a low cost field mill data acquisition system observing surface electric field change produced by sprite parent storms. Then, we deployed some field mills at high school in Tokyo. We will present some sample of the data observed and problems on the observations revealed.

Keywords: sprite, electric field observation, teaching material

Let's Observe the Sun with Hinode! - Coordinated Observation Campaign with High School Students -

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Hinode is the solar observation satellite that launched in 2006. Since its launch, Hinode has given us great new observation results. In addition, it is encouraged to use of the observation data for education. So, as one of education and public outreach(EPO) activities of Hinode, we have proposed to perform coordinated observations with high school students, public observatories and science museums, every year since 2010. The proposal is adopted as "EPO campaign observation mainly for high school students(HOP173)". The goals are that they have interests in Hinode data and compare their own data with Hinode data. They compare Hinode data with their data and obtain new solar knowledge, which make their motivation higher on their activities. The students have a presentation on the observation results at a science contests. Foreign researchers have high interests in the coordinated observations, which contribute to extension of Hinode mission.

In this presentation, we report the results of the coordinated observations, and the effects.

Keywords: Hinode, sun, astronomical education, outreach, coordinated observation, high school

G04-06

Room:423

Time:April 29 11:00-11:15

Making "high schools list of the whole country which can study Earth Science"

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In Japan Society of Earth Science Education, it is tackling making "high schools of the whole country which can study Earth Science" list beginning in the 2013 fiscal year, and has posted on the society homepage.

From the result of this list, the present condition of today's high school earth science education is considered.

Keywords: high schools, Earth Science

Finding Instructional Difficulties on Basic Earth Science for High School Students

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In February 2011, the author carried out a questionnaire research to science teachers about the awareness of any difficulties on new subject Basic Earth Science lesson for senior high school students under the new Course of Study in Japan. One of aim of the research was to get some responses from science teachers in Akita and Kagawa prefectures. In this year, the author conducts the second research to teachers so that to discuss any perception gap of difficulties between the 2011 and 2014 researches.

Keywords: science teacher, senior high school, Basic Earth Science, questionnaire research

Is the Earth Science Education of High School at the Stable Standing ?

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As a result of the revision of the government guidelines for teaching, the number of students who learn the *Basic Earth Science* increased sharply from *Earth Science I* of the previous guidelines. However, it cannot necessarily mean that the educational world had a new appreciation of the importance of earth science education in high school. This problem is considered from a viewpoint of the number of textbooks demand and the number of teachers' adoption. Also, it to be discussed how the contents of this subject have changed in comparison to the previous ones.

Keywords: high school earth science education, textbook demand, teacher adoption, Basic Earth Science

Development of laboratory seismic exploration experiment for education and demonstration

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¹IFREE, JAMSTEC

We developed laboratory seismic exploration experiment apparatus for education and demonstration. As an elastic medium, we use agarose-gel. Because agarose-gel is transparent and its s-wave velocity is 3 orders of magnitude smaller than the seismic waves that propagate earth's crust, we can easily observe wave-propagation by the photo-elastic technique. We report the detail of the experimental apparatus and practice of seismic exploration using the apparatus for high school students.

A simplified focal model constructed with plastic spheres and slinky springs

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¹Osaka Kyoiku University

In the high-school earth-science text books, it is written that the P-wave first motions of an earthquake show a four quadrant distribution, which is related to the focal mechanism. However the detail of mechanism about this phenomenon is never shown. Among the seismology text book, although there are many introduction about this quadrant polarity using mathematical formula, which is too difficult to understand for non-professionals. Therefore, we developed a simplified focal model with cheap cost and easy construction.

By this model we can demonstrate the relation between the focal mechanism and the P-wave first arrivals for educational and outreach purposes. The model consists of 1) Two transparent plastic half spheres purchased at home centers eg. Tokyuu Hands. 2) Two acrylic plates 3) Four Slinky Springs(plastic springs can be used as alternatives) attached to spheres with tapes. Two alternate plates mimic a buried fault and a sudden dislocation of this fault causes an earthquake. If the fault moves, the four slinky springs attached to two plastic spheres might show compressional or dilatational first P-wave motions consistent with the fault geometry. We can observe the detail of this phenomenon with high speed video movies. In our tests of this model, we can barely recognize the polarity of the first motions. We also try to improve our model to carry out more comprehensive demonstration.

Keywords: focal sphere, P-wave first motion, earthquake mechanism, fault, slinky spring

Problems and Possibility of "Science and Human Life"

NAKAJIMA, Takeshi^{1*}

¹Shiga Pref. Ohtsu-seiryō High School

Science and Human Life was established in the revision of the government guidelines for teaching, the number of students who learn *Science and Human Life* is about 400000, and is much larger than the number of students who learn *Basic Earth Science*. Contents of earth science field that are covered by the *Science and Human Life* is about one fifth of the whole, but they should not be ignored for earth science education, because one in three high school students takes this subject. In addition, this subject deals with the relationship between humans and nature, the benefits received from nature, and natural disasters in particular. However, the contents of this subject can not be said to be enough. In order for the students to master the skill necessary to make our society sustainable, it is necessary to further review the contents of this subject.

Keywords: high school earth science education, textbook demand, Science and Human Life, general subject of science

A reconstruction of "Film Case Seismometer" employing "Arduino" and "Processing"

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We reconstruct so called "Film Case Seismometer (Okamoto,1999)" for class room use. The legacy system had developed about two decades ago and was a full seismograph involving a moving magnet sensor and a PC recording system as a simplified mimic of a modern digitalized seismograph and a logger system. While the sensor was simplified and easy constructed enough, however the recording system was somewhat complicated and employ a specific program language on the limited PC. Therefore, the system was not so far contributed and/or demonstrated at mid-school's class rooms. In this regard, now we try to fully model-change the old system to an innovative style using "Arduino" (one chip micro-computer including both I/O and A/D converter devices) and "Processing" (Java based language for easy programing). The main aspects are as follows,

1) The sensor consists a rounded coil on a acrylic pipe and a strong Neodymium bar magnet hanging with a series rubber band from a main pillar hook. The Neodymium magnet can supply a sufficient signal and an appropriate damping by induced current with a surrounded metal pipe.

2) The recording system and software are improved more simplified and can applicable on any PC or even tablet.

3) The micro-tip used for I/O and A/D converting is "Arduino Uno" (Italian made and a cheap cost, 30 USD), which is easily controlled by a simple software written in Processing language and exchanges signals via USB port.

4) Processing language is used for A/D driving and logging, which is running on any operation system such as Windows, Mac, Linux and even Android.

5) The additional hardware for natural earthquake observation is a circuit employing OP amps for signal boost, which is divert from our legacy system.

6) All system is constructed in a transparent acrylic box for recognizing mechanism at a glance.

7) The wave signal is displayed on PC or tablet at real time with second time-marks and also save to PC as a graphic mode or digital mode at each moment.

8) The logging and displaying capacity can be extended to three channels easily.

Keywords: seismograph, Arduino, Processing, education, USB

Development of an educational tool for seismic exploration study using piezoelectric buzzer and general-purpose laptop

GOTO, Akio^{1*}

¹CNEAS, Tohoku University

I have developed an inexpensive ground motion detecting system as an educational tool for seismic exploration study, consisting of geophone which uses a piezoelectric buzzer as a sensor and general-purpose laptop.

Piezoelectric buzzer, which is used to transmit electric signal to sound in general, excites electric pressure when an external force is applied. To catch the ground motion it is fixed on the bottom of a cylindrical plastic bin, and a nail is put into the open mouth of the buzzer through a hole opened on the bin lid. When the vertical motion hits the bin from beneath, the nail behaves as a fixed point by its inertia, push the buzzer, and then the electric pressure is excited. We install these sensors near the shot point and the observation site, and record the signal from them synchronously. From the distance and the signal arrival time delay we can determine the elastic wave velocity of the ground.

We need high rate sampling multi-channel data logger for recording, which is not necessarily inexpensive. Instead of it we use a laptop whose audio stereo inlet is available for synchronous recording. A sound recording software may be preinstalled in PC, but it depends on the OS. Because the laptop differs from student to student, and to unify the instruction, we adopt a freeware *Audacity* for recording. A wav format signal file recorded by *Audacity* will be transformed into text format using a freeware *WaveGraph*. Another compatible software may be available for recording and transforming. You should notice there is another *WaveGraph*, which does not have a function for wav to text transform and is not available for our purpose. The transformed text file can be opened by some graphic software to read the time delay between the two sites.

In the classes students firstly constructed the sensor, and then confirmed the utility of their laptop for signal recording. At the field we hit the ground by large wooden hammer to excite the ground motion for one minute with five seconds interval. In case the sensor was far from the shot we heightened the gain by putting some amount of clay on the nail to enhance the inertia. Twelve signals by one-minute recording were stacked to confirm the noise reduction. We confirmed the arrival time to the sensors delayed linearly with distance between 3 and 24 m from the shot point with 3 m interval, and obtained direct wave velocity as 560 m/s. We did not detect refractive wave, it may be because the test field in the university campus was not appropriate for this purpose.

The present system, consisting of inexpensive hand-built sensors and general-purpose laptop, is an educational tool not only for seismic exploration study but to show students the possibility of overcoming the difficulty from the lack of expensive sophisticated equipment for experiments by their ingenuity. On another front this system obviously has some weak points. For examples, it is unclear our sensor is really suitable for ground motion detection, because we have no data on its frequency response, which may depend not only on the property of piezoelectric buzzer and the inertia of the nail but on the manufacturing precision such as the position of the hole on the lid to insert the nail. Due to the insufficient electrical insulation between right and left channels of most laptop stereo inlet we have to attenuate the intense signal from the shot using a resistance to prevent it from interfering. We have found the signal through the laptop stereo inlet is low-cut filtered and is not suitable for precise recording, although it does not seem to affect our present use seriously. If we count the performance evaluations of the present system in a part of the experiment, it may improve the education effect more.