Some Modelling-based Practices in Geoscience Classes

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Overview

We introduced some modelling-based practices at K-12 levels by which natural phenomena are reproduced showing the fundamental principles.

These process and results strongly inspire our students, so they can learn to enjoy making models for themselves. The themes are various geo-linked phenomena such as landscape evolution, earthquake mechanism, plate motions, volcano related phenomena, climate models and sedimentary processes. For example, the students use a bath sparkler for volcanic eruption, water solution of sodium sulphate for stalactites making, styrene foam balls for sand dune and liquidizing of sediments, and melting sugar candy for cooling joints.

Background

Structural geology pros developed “sand box experiment” in 1950's (Hubbert, 1951). However, considering “the scaling law”, these experiments were regarded as meaningless and the rapid development of numerical simulations soon took away these “nerd” experiments at once. Nevertheless, in recent years these “analogue experiments” using home materials are revival cooperated with high-tech apparatus.

The movement studying such analogue models, named “Kitchen Earth Science (Kurita, 2001)”, is now getting more popular particularly among Japanese geoscience researchers. We already developed an example of those concepts showing reverse fault mechanisms using flour and cocoa powder (Okamoto, 2003). This article shows our recent development as following pages.

Themes and concepts

The themes which our students chose in recent years are as follows: Karst landscapes, stalactites in limestone cave, volcanic eruption, pyroclastic flow, meteorite impact, rock magnetism measurement, fault mechanisms, rock joints, mirage above sea and greenhouse effect by carbon dioxide.

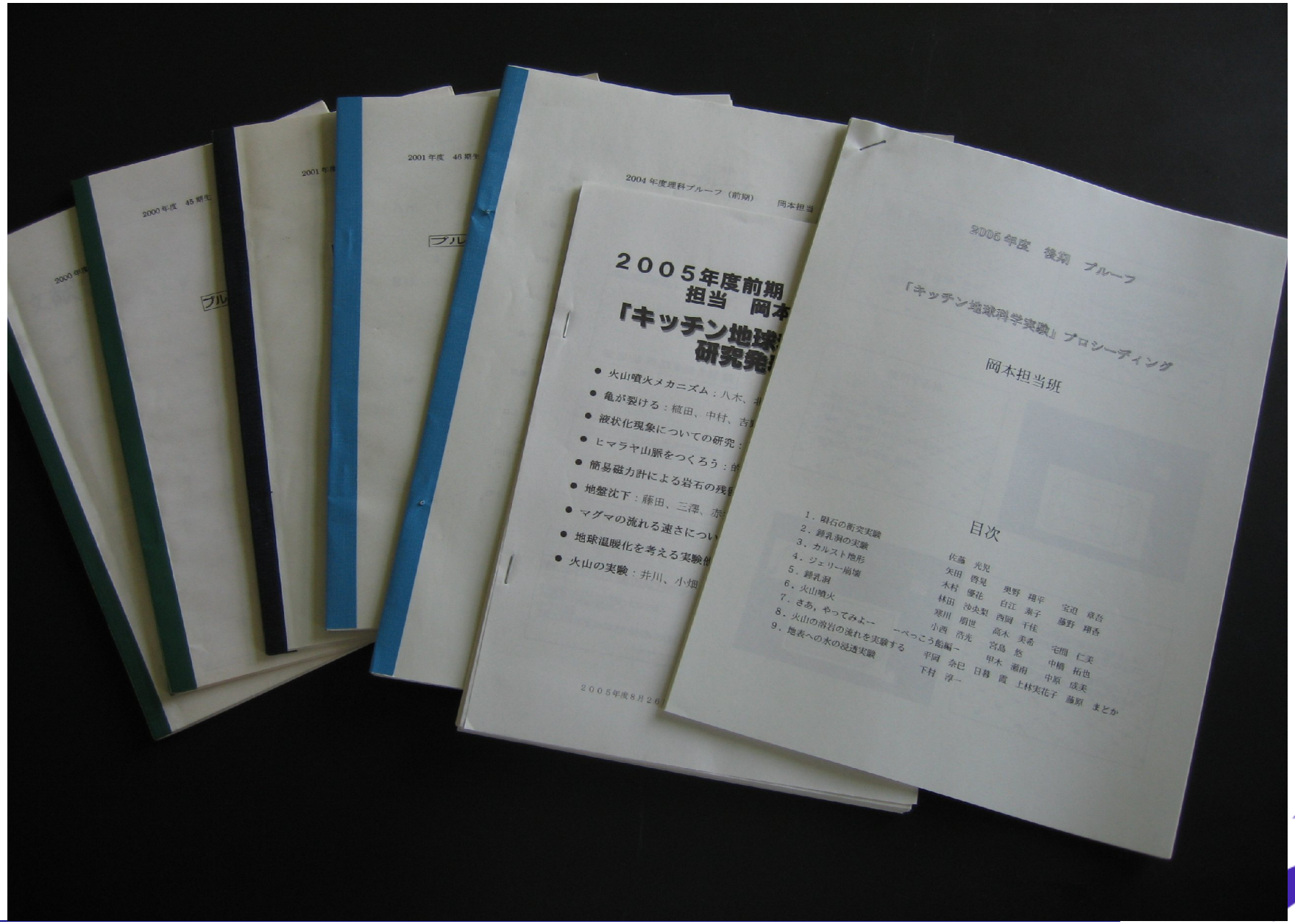
The most important thing in this study is how complicated natural phenomena are reduced into simple models, and also the selection of themes, too.

Models are basically made of cheep kitchen tools, one-dollar-shop items and food materials. Moreover high-technology tools are used for precise measurement and data recording, such as video camera, digital still camera and some measuring apparatus, whose prices have been rapidly down because of their mass production and use.

Technical notes:

1) Students tend to make the models as complex as nature truly is. So,we always emphasize the importance of a process of simplifying and modifying.
2) There is no limit for taking any themes except hardly reconstruction or extremely dangerous
3) Use of high-tech tools, such as digital video camera, infra-red thermometer etc. are highly recommended.
4) Select two parameters among various factors, so measuring them, finding and constructing a relation within them in a quantitative form.
5) Making a graph and a fitting function for their data are much important employing a spreadsheet on PC.
6) A presentation of the research and writing a report are their only duty through this practice.

Student's semi-annual reports:



Examples_1 *Using sugar sweets!*

Fig1. Sugar calmera as a mimic of basalt lava

Fig2. Sugar candy models cool joints of lava flow

Examples_2 *Karst related*

Fig3. Stalactite using Sodium thio-sulphate($Na_2S_2O_3$) aqua.

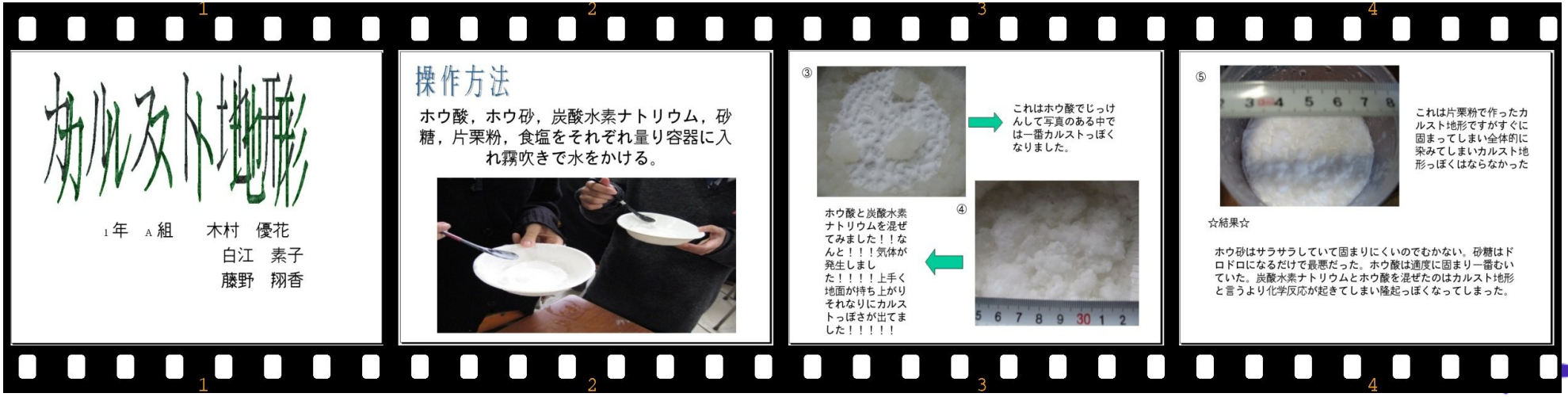


Fig4. Doline like surface using powder and spray.

Examples_3 *Mirage in water and geyser*

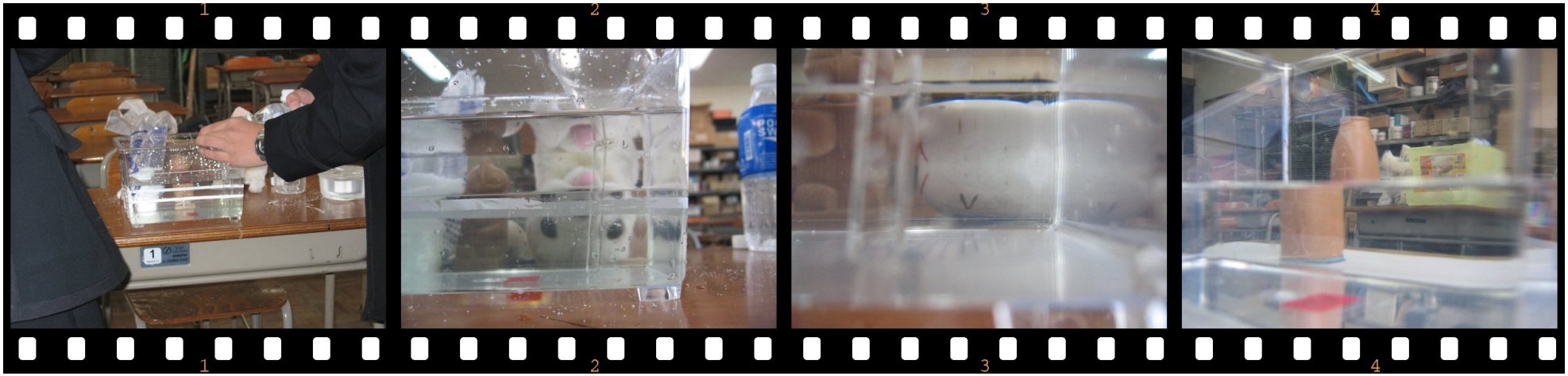


Fig5. Mirage in a fish tank using sugared water.

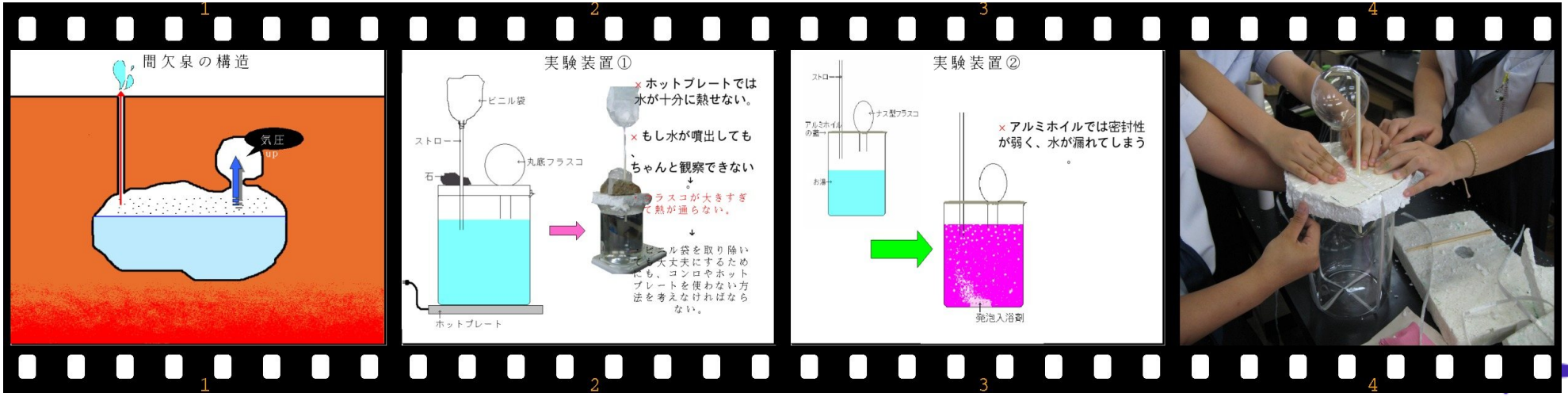


Fig6. A geyser model using a beaker and a flask.

Example_4 *Plate tectonics*

Fig7. Plates collision (Himalayan orogen model with flour).

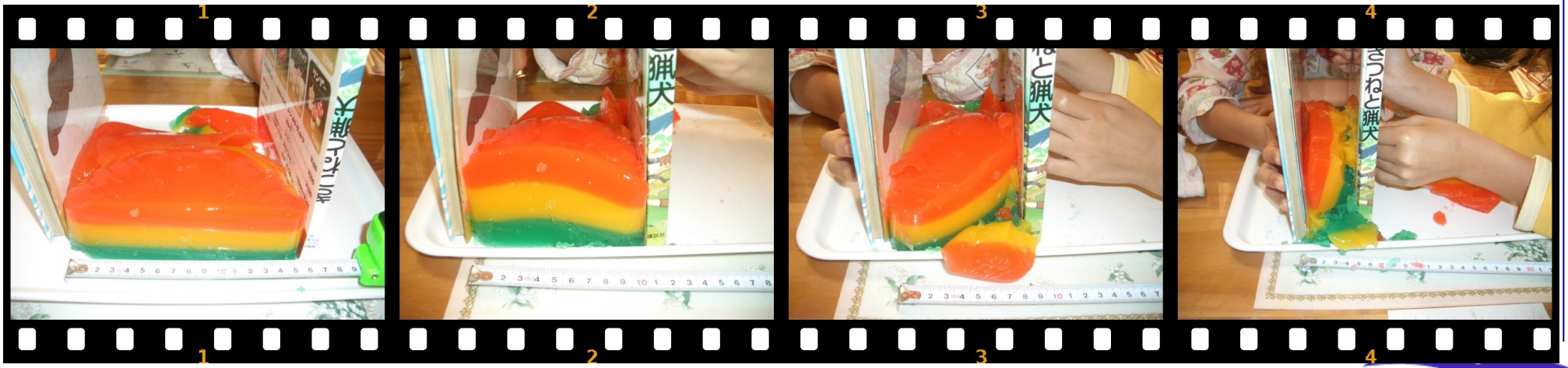


Fig8. A gelatin reverse fault failed.

Example_5 *Volcanic eruption*

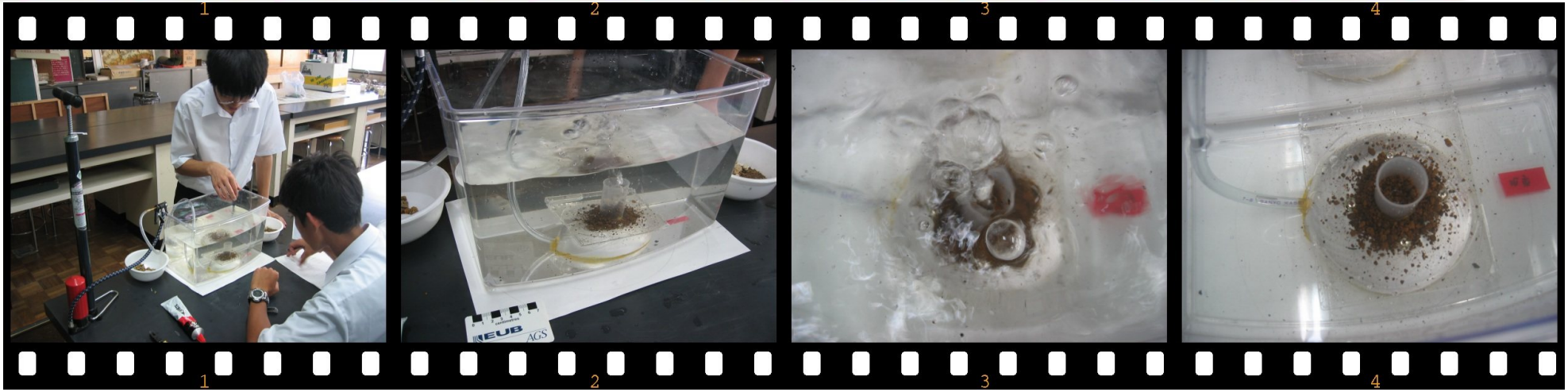


Fig9. Water bottom volcano showing inverse distribution of pumice.

Fig10. A Video capture of a bath sparkler and hot water volcano.

Example_6 *Pyroclastic flow in a water tank*

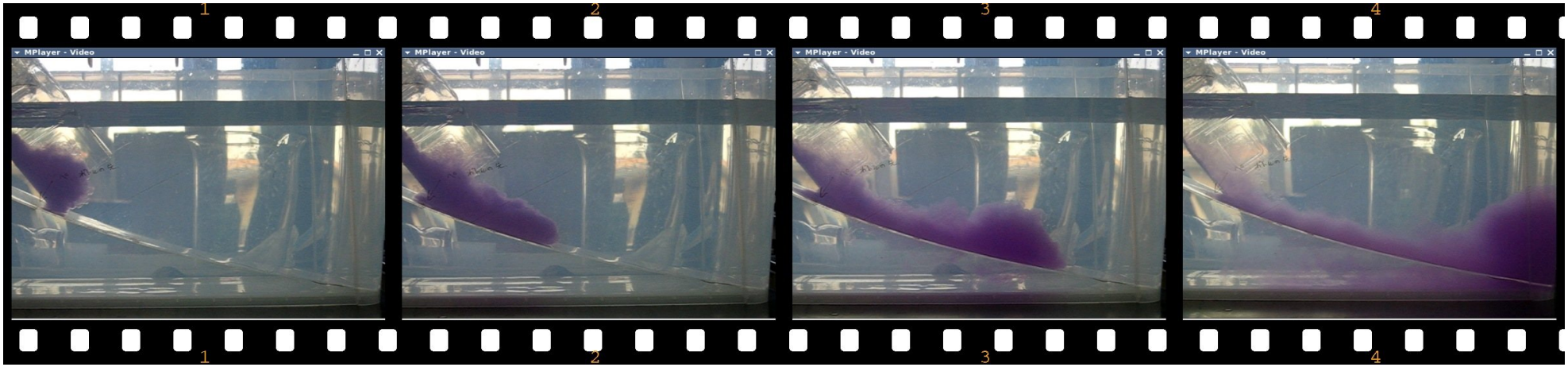


Fig11. A coloured sugar water flow mimics a Pyroclastic flow.

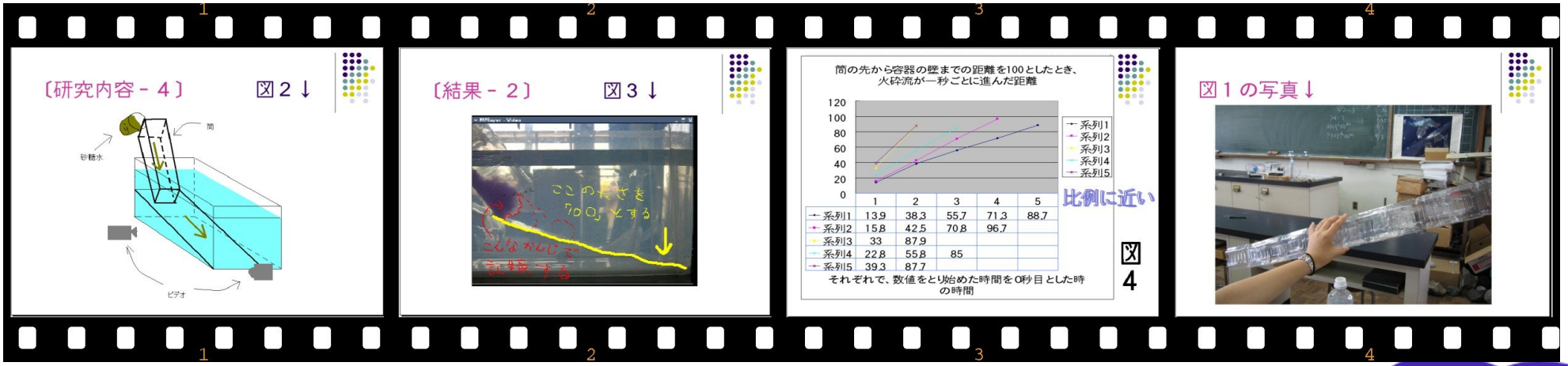


Fig12. An analysis about “Sugar water pyroclastic flow”.

Example_7 *Liquidization and sand_dune*

Fig13. Mixture of plastic balls with vibrate-motor mimic ground liquidizing.

Fig14. A sand dune model using polyethylenes balls.

Example_8 *The 'Japan Island' is sinking---*

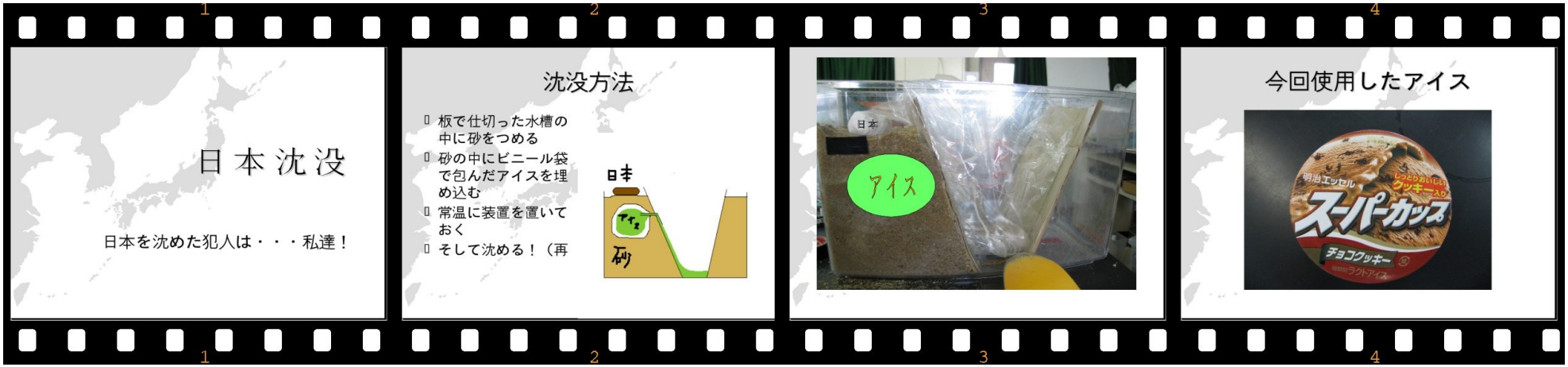


Fig15. 'Japan island' sinks into the pacific plate! After ice cream melting.

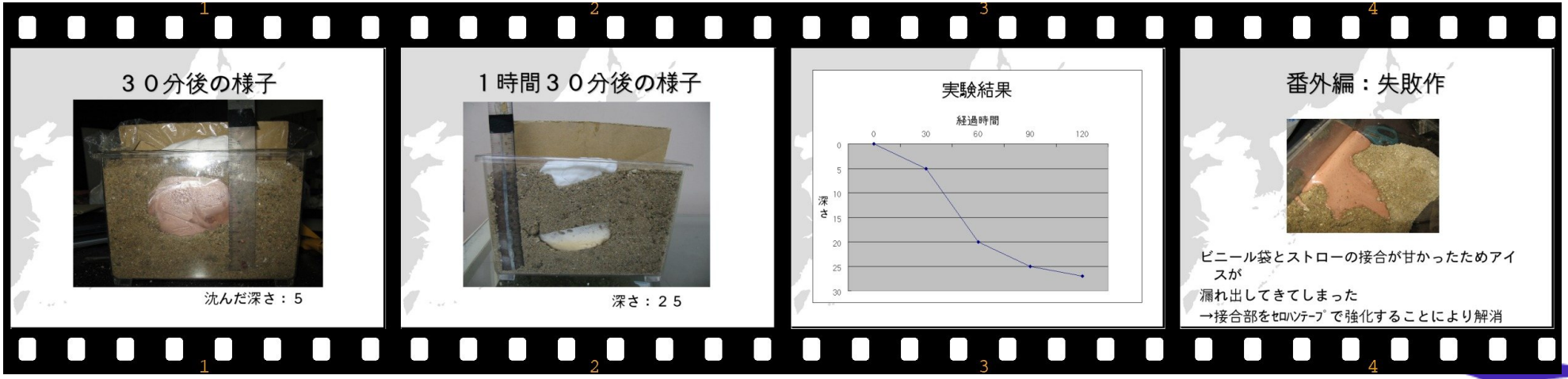


Fig16. Clips, an analysis and a failed example .

Example_9 *'Air mirage' is examined---*

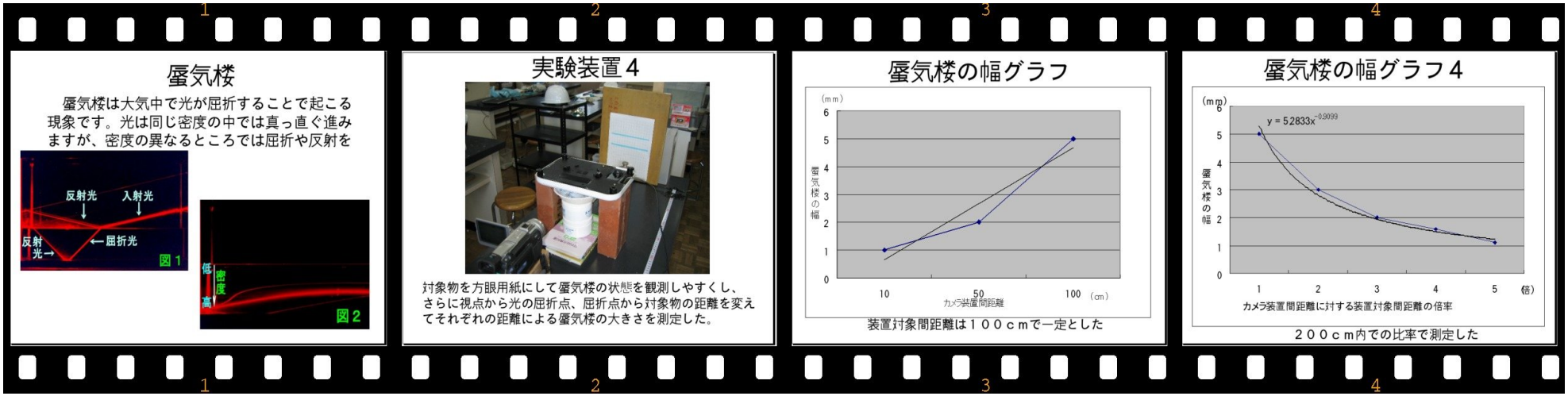


Fig17. 'Air mirage' in a hot and cold chamber .

Fig18. An example showing inverse layer and failed examples.

Example_10 *K/T asteroid impact!!!*

Fig19. Baby powder in a 'Fish tank' and a Japanese food 'Fu' .

Fig20. Volt-meter shows a depletion of sun ray with an impact.

Some clips of experiments:

Fig21. Shake the bottle but not stand. And shake---, succeed!

Fig22. Making chocolate fan??? Too sweet!!!!!

Let's cook!

Fig23. This is not a kitchen but a earth science laboratory.

Fig24. Various food materials and items for experiments.

Merit of these models

1) Thinking process how to construct models is the best way of scientific consideration for students.
2) Making and measuring process of their models are suitable trainings for scientific experimental skills. Also students enjoy it like food cooking or toy making.
3) Those models are quite useful not only for natural science course students but also for humanities science course ones.
4) Some universities start entrance exams like these study.

Limits and future advances

1) Preparation and evaluation of model making are somewhat troublesome and painstaking.
2) Students sometimes can not decide their themes or chose a theme hardly constructive.
3) So, we have to prepare some suitable alternatives as their research themes.
4) The modelling process earns a lots of time!
5) The Class room is temporally occupied with messing items and even smells!
6) The evaluation of student's study is also hard problem.
7) We hope this program to collaborate with our university staffs and to improve experiments more sophisticated and quantified.

Conclusion

1) Nevertheless some demerits, this method fascinates our students very well.
2) Our students enjoyed those modelling process and also made interesting presentations whether they success or not.
3) They learn many things even from failed or insufficient experiments.
4) Those models are quite useful not only for natural science course students but also for humanity science course ones.
5) These program might create a new cutting edge into geoscience education in Japan which is in a pessimistic situation.

Acknowledgements and references:

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