A simulation of crustal deformation using a miniature model for the purpose of outreach and education

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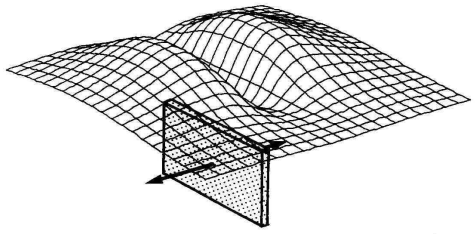
For the purpose of outreach the knowledge respecting the crustal deformation associated with the seismic and the volcanic activities, I tried to simulate these deformations making use of a miniature model. A plastic box of about 17cm length, 13cm width and 8cm height was used. The box was filled with clay or gel material, and a deformation source corresponding to a fault or a magma intrusion was settled in it. I applied this simulation to the following types of theoretical models; a dyke intrusion model, a Mogi's model and an earthquake fault model. In case of the dyke intrusion model, a rectangular shaped rubber bag covered with a half cut DVD case was used as a magmatic pressure source. It was inserted in the filler perpendicular to its surface and was expanded by exerting an air pressure into the bag from the outside. In case of the Mogi's model, a yoyo's balloon was used, and for the fault model a grater was used.

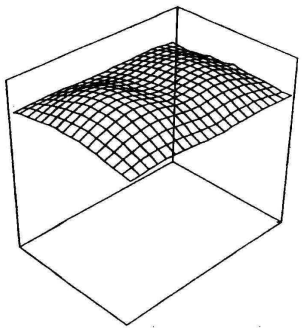
A theoretical deformation associated with the dyke intrusion is shown in the left figure. Here, the region just above the magma intruded body is subsides, and the surrounding region upheaves. The simulated result, which was measured by a laser distance meter is also shown in the right figure. Though the deformation associated with the dyke intrusion is complicated, the both results well resemble each other. This indicates that the miniature model is helpful to understand the real crustal deformation.

The reason why I used the laser distance meter is to get the precise data which enable us to compare the result from the simulation and that from the theory. As for this miniature model, it is possible to realize a large amount of deformation, so to measure it is not so much difficult. Such tools as toothpicks or matchsticks are available to detect the deformation. Each stick, which is inserted onto the surface, moves in proportion to the deformation, and we can recognize the tilt and the upheaval pattern as a whole. A digital camera or a CCD camera is useful to detect the lateral displacement. An IC chip size accelerometer is also useful to detect the tilt. Similarly to the dyke intrusion model, appropriate changes were detected for the Mogi's model and the earthquake fault model.

Instead of the rubber bag, I utilized thin metal plates for the dyke model in order to evaluate the deformation qualitatively. I inserted each plate from the bottom of the box, again perpendicular to the surface, and superposed it one by one. In this case, the amount of the deformation is proportional to the number of the plates. This evidence shows that the qualitative treatment is available in this simulation. So, it is possible to detect the source mechanism from the measured deformation data. Thus, this model is useful not only for demonstration but also for geoscience education from the elementary level to the higher level.



Theoretical deformation



Simulated deformation