Bekko-ame cracking

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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

