Developments and Practices of Earth-STEM Learning utilizing High-Quartz sand, Rhyolite and Basalt from Niijima, Japan

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This research is one of the STEM learning material development specialized in the geology of Japan. We utilized white sand, black sand, rhyolite and basalt from the Niijima, Tokyo. The purpose of this study was visualization of the etymology of sand, development of Earth Science STEM learning, and fostering curiosity for children in Earth Sciences.

Clastic materials from the regions upstream and downstream are mixed together in the sand of Honshu, making it extremely difficult to identify their hinterlands and unable to identify their host rocks, and thus it has been difficult to visualize from specimens the fact that the sand is derived from weathering and erosion of rocks. In contrast, the white sand in Niijima-Island, which is entirely composed of rhyolite, is much clearer than the coastal sand in Honshu with respect to their hinterlands and host rocks; therefore, we can clearly show that the weathering and erosion of the rock are responsible for its formation. Contamination in Niijima sand include the basalt from northern area and clastic materials from the seas around island. Therefore, Niijima sand seems to be useful as teaching materials for beginners. Black sandy beaches, of which the color is derived from the basalt, are distributed in the northern part of the island, indicating that the difference in the geological features of the hinterlands is reflected in the constituent minerals of the sandy beach.

Niijima sand and its host rocks are also used in industrial products such as glass and firebrick. They are among international export items from Japan. Therefore, they may be valuable as teaching materials to explain industrial use of minerals, and thus may be utilized as teaching materials for STEM learning using minerals. One of the attractive points of Niijima sand is that it contains a large amount of high-quartz with relatively large grain size (about 1 mm/grain) and a high degree of transparency, making it appearing beautiful both in naked-eye.

Concerning the development of this teaching material, we demonstrated Earth Science STEM learning at the Sience Festival at Gotenba. During the festival, we spent about 15 minutes on observation of minerals, comparative observation between sands and rocks, and an introductory explanation of Niijima glass arts. After the session, the participants (n=117; 4-17 years-old) answered their impressions; "What did you realize for the first time here?" Some children commented on the origin of sand (e.g. a 7-year-old child noted that a rock is a collection of grains, a 8-year-old child pointed out that a rock turns into sand, and a 10-year-old child described how a rock is made up of minerals.) Comments on the secondary use of rock and mineral were also confirmed (e.g. a 7-year–old child noted that a rock is doing something good for our life, a 9-year-old child stated that glass is produced from a rock, and a 10-year-old child remarked that mineral is processed into something useful for our life.) As to the awareness of the usefulness of rock and mineral, a questionnaire was conducted previously among junior high school students. Of the 154 students (3rd grade), 56 % (n=87) students answered that rock and mineral is not useful, or that they are not sure about it (Takebayashi and Kumano, 2017). Therefore, this educational material can be one of the empirical data that will not only explanation of sand formation mechanism but also show the usability of mineral for our life.

STEM learning is spreading in science education in the world, and Japan is beginning to adopt STEM learning. Therefore, developments and practices for STEM learning in the field of Earth Science is becoming one of the important tasks in Sciences Pedagogy. This study considers the possibility of STEM learning development specialized in geology of Japan, from the development of teaching materials that emphasizes geology of Niijima and the practical reports at the educational site utilizing samples from Niijima.

Keywords: STEM learning, Niijima, High quartz, sand, teaching materials, ryolite

