## The relationship between the shape of columnar jointing and the viscosity of lava flow

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Columnar joints are columnar volcanic landforms that consist of cracks in the direction perpendicular to the cooling surface, which can be formed by the lava flow cooling in the cold atmosphere and solidifying while causing volume contraction. Generally, the cross section of columnar joints is said to be regular hexagons, and theoretically all should be regular hexagons. However, when observing the actual columnar joints, I realized that not all the cross sections were regular hexagons, but many were distorted shapes such as pentagons. Therefore, I wondered why there are shapes other than the regular hexagon that should not theoretically exist, and whether there are features such as figures that frequently appear for each columnar joint, and I began this research. It was First, as a hypothesis that answers the above questions,

I thought that the viscosity of the lava flow that created columnar joints might affect the shape of the cross section. Then, in order to prove this hypothesis, the following verifications were conducted and research was advanced.

First, an experiment was conducted in which the starch starch was dissolved in water, and then the water was evaporated to cause volume contraction to reproduce the "columnar joint" 1). Also, the difference in viscosity was reproduced by changing the amount of water dissolved in the same amount of potato starch. Then, we considered how many polygons are included in the created one by comparing the appearance frequency for each "pillar" while counting and comparing with other conditions. Although detailed data is not mentioned in the preliminary paper, lava flow with low viscosity was found to increase the proportion of figures with a larger number of angles in the case of mixing more water with the same amount of starch starch powder than in other cases. It was found that the number consisting of consists of more figures with more angles.

Next, we paid attention to the figure called Voronoi figure, and made it possible to create a Voronoi figure on a PC and perform more diverse and repeated experiments. Voronoi figure is a figure made from a perpendicular bisector that connects an arbitrary point and its adjacent point, and is said to be able to reproduce the shape of columnar joints 2). Moreover, Python and its module OpenCV were used for the creation on the PC. Further, the number of points plotted per same area was changed, and this was set as a condition corresponding to "viscosity". Although detailed results are not described here, the polygon shape increases when the viscosity is low because the proportion of pentagons increased when the plot points were increased (= increasing cooling nuclei = reproducing viscous lava flow). Then, the result was consistent with the result of the potato starch experiment.

Then, in order to confirm whether the same can be said for the actual columnar joints as well as the results obtained in the experiment of Katakuri powder and Voronoi figure, the columnar joints were aerial photographed with a drone to create an ortho image and analyzed with GIS.

Currently, we are conducting GIS analysis, and I would like to introduce the results on the day of JpGU. Also, I will introduce the consideration based on everything I did on the day.

1) Noritaka Endo et al., Modeling of topographical phenomena (2017)

2) Akihito Ota et al. Statistical analysis of columnar joint morphology using high-precision 3D model by drone and its origin (2019)

Keywords: Columnar joint, Volcano, Lava flow, Earth science, Geology