The possibility of hypothesis that sinuous rille on the moon generated by thermal erosion of lava flow

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Sinuous rille on the moon and terrestrial planets is one of conspicuous morphological feature. The origins of the topographic features which are winding, meandering, channels or valleys on the lunar surface has been discussed by many researchers. On the other hand, normal rilles are straight or gently curved and are considered to be graven type faults. Crater chains in some times form irregular fractures like a rille, but they are exclude from the definition of the sinuous rilles. The typical dimensions are the lengths of 30 - 40 km, the widths of less than 1 km, and the meandering wavelength of 1 - 7 km. The hypothesis of the origin of this features which is the river where the water flows has been denied, because the analyses of the sample returned by Apollo and Luna mission has proved that there is not a water on the moon at all. Since the sinuous rilles occasionally found on the maria and at mare-highland boundaries, the origin of sinuous rilles has been related to the generation of the basaltic lava flow on the maria of the moon. However, the argument for the mechanism of generation remains. Although we can see the constructional lava levees in the basaltic lava flow on the Earth, there is not the observation of these features around the sinuous rille. Then, we studied the sinuous rille that would have been formed by thermal erosion of a single basaltic lava flow. The basaltic samples returned by Apollo and Lunar mission restrict the chemical properties of this lava flow. The physical parameters such as density, viscosity, thermal conductivity, specific heat of the lava depend on the chemical properties and lava temperature. As the observed thickness of lava flow on the lunar maria (e.g., Mare Imbrium) is less than 20 m, we adopt the value of thickness which is less than 20 m as the thickness at the eruption point. And, we adopt the initial temperature at the eruption point which is ranging in 1473 - 1873 K, because some studies suggests that the magma which is the temperature of more than 1873 K could erupt on the moon, especially, Oceanus Procellarum which has the thicker crust than that of other maria. For comparison the result of simulation with the sinuous rille on the moon, we apply a slope of ground at the existence of sinuous rille to the simulation.

On the other hand, for the comparison, we estimate the depth variation of some sinuous rilles as a function of distance from vent with the orthophotomap of contour and high-resolution pictures taken by Apollo 15. Using the contour map, we read the values of elevation inside and outside of sinuous rilles, and the depth of sinuous rille as a function of distance could be defined as the difference of both values. On the other side, using the high-resolution pictures, we evaluate the depth variation of sinuous rilles from the length of shadow in the rilles. Finally, although there are some differences between contour and photo data, we employ the two data as depth variations of sinuous rlles. As a result of estimation, the depth of sinuous rille from the vent decreases with distance along the down slope excepting the Hadley rille.

It has been recognised that the thermal erosion feature formed with the basaltic lava flow hardly depends on the slope of ground in the range of existences of sinuous rilles actually according to the model simulation. Furthermore, the calculated depth profiles don't depend on the chemical properties in the range of all of the returned basaltic samples. Then, the characterized parameters of thermal erosion feature are the thickness (eruption rate) and temperature at the vent. In the case of agreement between the calculated depth and observed one, because the eruption rate and volume of basaltic lava flow are consistent with that of estimation of other basaltic lava flows (e.g., in the Mare Imbium), the sinuous rille could be made by not 'constructional' but 'erosional'.