

[JJ] Evening Poster | S (Solid Earth Sciences) | S-VC Volcanology

[S-VC43] Volcanic and igneous activities, and these long-term forecasting

convener: Teruki Oikawa (GSJ, National Institute of Advanced Industrial Science and Technology), Takeshi Hasegawa (Department of Earth Sciences, College of Science, Ibaraki University), Daisuke MIURA (一般財団法人 電力中央研究所 地球工学研究所 地圏科学領域, 共同), Nobuo Geshi (Geological Survey of Japan, The National Institute of Advanced Industrial Science and Technology)

Sun. May 20, 2018 5:15 PM - 6:30 PM Poster Hall (International Exhibition Hall7, Makuhari Messe)

This session focuses on generation and accumulation processes of magmas, magma-crust interaction and degassing, and modes of eruption, long-term forecast of eruption, dispersal and emplacement of the volcanic products. The discussion spans petrological, geochemical, geophysical, and geological processes related with volcanic activity and products in the past, the present and the future.

[SVC43-P02] Possible existence of lava tube caves under the pits and lava yield strength of Elysium Mons, Mars

*Tsutomu Honda¹ (1. Vulcano-speleological Society)

Keywords: Mars, Elysium Mons, Lava yield strength, pit, Lava tube, cave

[Introduction]

Image data of vertical pits size in the neighborhood of Elysium Mons obtained by HiRISE with Mars Reconnaissance Orbiter are listed by Y. Goto et al of JAXA¹⁾. Possible existence of a lava tube cave under these vertical pits are considered by using these data and Bingham flow model. The key parameter of this model, yield strength, was estimated by the lava flow thickness of Elysium Mons obtained by J.H. Paschert et al²⁾. The smallest value among each yield strength obtained by the lava flow stop condition is used for lava tube cave height estimation³⁾.

[Considered model]

The lava flow is modeled by Bingham fluid flowing on the inclined plane or in the inclined cylindrical pipe with gravity potential. For the lava flow of density ρ , and yield strength f_B , with slope angle α , under the gravity g , the lava flow stop condition is $H = n f_B / (\rho g \sin \alpha)$ where H is the lava thickness. The case which flows on the inclined plane with a free surface is $n=1$, and the case which flows through an inclined circular tube is $n=4$. The yield strength is obtained from $f_B = H (\rho g \sin \alpha)$ for $n=1$, then, the lava tube cave height will be obtained from $H = 4 f_B / (\rho g \sin \alpha)$, for $n=4$.

[Estimation of the yield strength of lava]

As shown in Fig.1, the lava flow thickness of the neighborhood of the Elysium Mons is obtained by J.H. Paschert et al²⁾. By using this lava flow thickness H , the yield strength can be obtained from $f_B = H (\rho g \sin \alpha)$ as shown in Fig.2. The used value for density is $\rho = 2.5 \text{ g/cm}^3$, for gravity is $g = 373 \text{ cm/s}^2$. The calculated yield strength decreases from up to down from $2.63 \times 10^5 \text{ dyne/cm}^2$ to $1.84 \times 10^3 \text{ dyne/cm}^2$. These values are considered to be an apparent yield strength because of a deviation from simple flow structure due to lava flow inflation or lava flow multiplication³⁾. For estimation of lava tube cave height, the minimum value of $1.84 \times 10^3 \text{ dyne/cm}^2$ for 0.1 degree and for 11.3 m of lava thickness is used so that the influence of inflation or multiplication is considered as minimum.

[Estimation of the lava tube cave height for the vertical pits]

The depth and diameter of the pits are listed by Y. Goto et al¹⁾ as shown in the left column of Table1. The slope angle at the position of the pits are estimated from a contour line of Elysium volcano in the

geologic map⁵⁾. The limiting conditions used for estimation of the lava tube cave height is the $H_c = 4f_B / (\rho; g \sin \alpha;)$ and H_c is indicated in the right column of Table1. There is a possibility that a lava tube cave exists under the vertical pit because it's $H > H_c$ at all vertical pits.

[Summary]

There is a possibility that a lava tube cave exists under the vertical pits of Elysium Mons, but its cave height is small compared with the vertical pit depth. Many lava tube caves may intersect in the lava layer through the vertical pit. The vertical pits would be regarded as the pit crater⁶⁾ similar to devil's throat⁷⁾ of Hawaii Kilauea instead of skylight of a lava tube cave.

Reference:

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- 2) J.H.Paschert, H.Hieginger, D.Reiss (2012): Icarus 219(2012) p443-457
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- 6) G.E. Cushing (2012): Journal of Cave and Karst Studies, v. 74, no. 1, p. 33--47. DOI: 10.4311/2010EX0167R
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