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Double cone structure in Central Elysium Planitia, Mars

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Abstract

In Central Elysium Planitia (CEP) on Mars, very young aged (10Ma or less) flows have been identified while the origin is still under debate. In this area a distinct morphological unit, called as Double Cone Structures (DCS) is a key in interpretation of the geological context. This structure has 3 characteristics; 1) inside caldera-like depression surrounded by low rise rim (moat) main cone stands, 2) vent-like depression at top of the cone, and 3) another small cone in side depression. The terrestrial counterpart of DCS can be found in lake Myvatn, Iceland. Based on the morphological analysis, we conclude that DCS and the young aged flows is volcanic origin, not aqueous origin.

1. Introduction

The formation of Central Elysium Planitia is still an enigma. CEP plains consist of young material which emanated from Cerberus Fossae [1]. The origin of flow is still under debate: lava flow [2] or aqueous flow [3]. If most of landscape in this area are lava flow origin, then this young volcanism is distinct from those at Tharsis Montes and we consider it should be a key to understand present-day thermal state of Mars. If they are mostly aqueous flood origin high temperature lava is not necessary, which suggests different thermal state in the present mantle.

Pervasive existence of cone-like morphological features (CLF) in CEP have been revealed by high resolution images. Until now three different interpretations are proposed for the origin of CLF: rootless cone [4], pingo [5] and mud volcano [6].

Rootless cones are products of phreatomagmatic eruption, which are located on lava flows that have moved over a substrate containing ice/water at the surface or subsurface (e.c. lake Myvatn, Iceland). Pingo is a periglacial morphology, which is formed by upthrust of underground ice. Mud volcano is formed by effusion of mud by over-pressurization. The first interpretation is consistent with lava flow origin while the latter two support aqueous flood origin. Thus, CLF is a key morphology to reveal the identity of CEP's youngest flow. Particularly some CLFs have Double Cone Structure (DCS, Fig. 1). This feature is unique because it could be found only in CEP, on Mars.

In this study, we will focus on the specific type of CLF, DCS by using high resolution image. We will compare DCS with terrestrial similar morphologies.

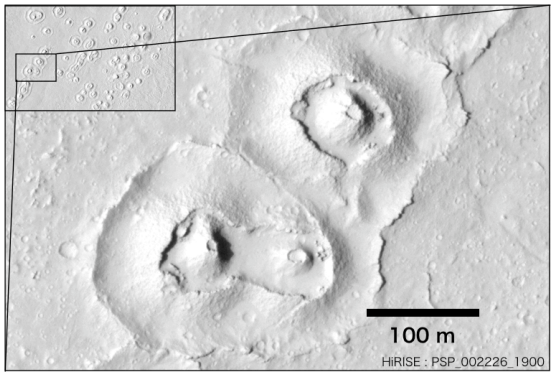

Fig.1 : Double Cone Structure in Central Elysium Planitia.

2. Description of CLF

To identify the origin of CLF and the young aged flow, we investigated morphological characteristics as well as the distribution of cones in CEP by using HiRISE image (MRO/NASA).

2.1 Morphological characteristics

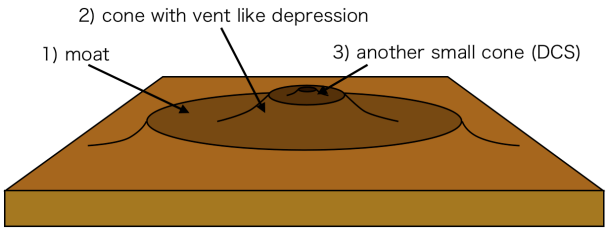

Fig.2 : Morphological units of DCS, a specific type of cone-like morphological feature in CEP.

Target structure has 3 characteristics (Fig. 2); 1) inside caldera-like depression surrounded by low rise rim (moat) main cone stands, 2) vent-like depression at top of the cone, and some has 3) another small cone in side depression.

2.2 Size

We measured CLF's diameter and its topography by using photoclinometry.

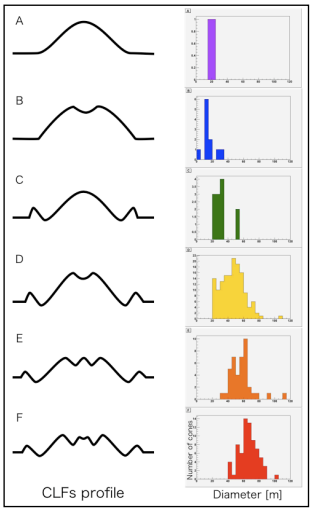

Fig.3 : Histograms of CLF's diameter of each shape.

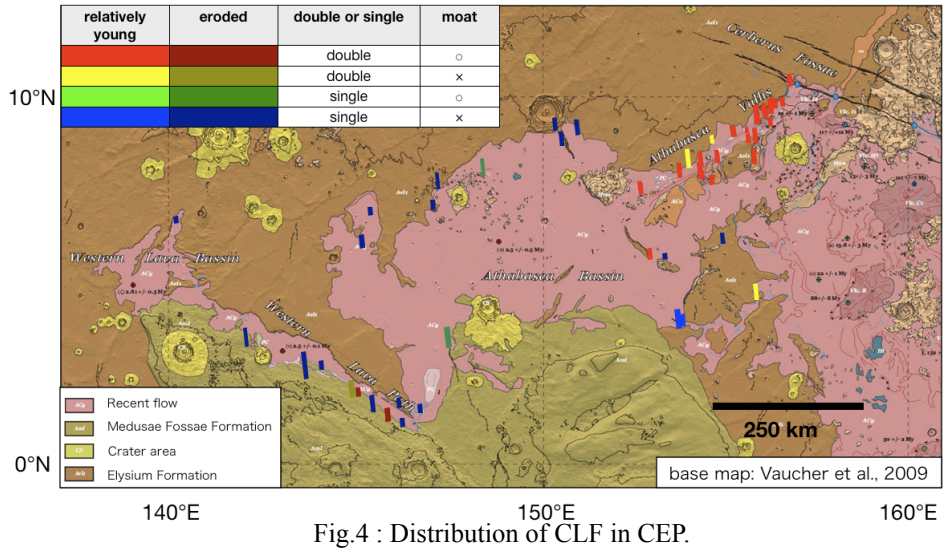

Fig.4 : Distribution of CLF in CEP.

Fig. 3 shows CLF's diameter of each shape, which shows the larger the diameter, the more complex cone's structure. DCSs are larger than single cones.

Result from photoclinometry, CLFs has about 30 m height. The slope angle of CLF's edifice is ~40°.

2.3 Distribution

Fig. 4 shows the distribution of cones in CEP. Cones concentrate in the boundary of the flow and original plain. DCS distributes preferentially in the region close to Cerberus Fossae.

3. Comparison with terrestrial counterparts

Fig.5 : Rootless cone in lake Myvatn, Iceland (Photo : RTH Sigurdsson).

In lake Myvatn, Iceland, some rootless cones have double cone structure,which is similar to DCS. These structure were formed on the lava flow [7]. On Earth, pingo is not known to have double cone structure. The terrestrial pingo has radial cracks from the summit, which can not be recognized on DCS. For mud volcano, concentric ring structure is common, while double cone structure is rarely identified. From these comparisons we conclude CLF as well as DCS is volcanic origin. We will present a model of formation process of DCS. We consider DCS could be formed by multiple passage of higher temperature lavas.

4. Summary and Conclusions

Cone-like morphological feature in Central Elysium Planitia is thought as rootless cone due to follow reason;

1) Rootless cone has double cone structure.

2) Pingo and mud volcano does not have DCS.

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