

DEPTH PROFILES OF VENUSIAN CHANNELS AND VALLEYS: A COMPARISON AMONG CANALI, SINUOUS RILLES, AND VALLEY NETWORKS. S. Oshigami¹, N. Namiki², and G. Komatsu³, ¹Department of Earth and Environmental Sciences, Nagoya University (Oshigami@nagoya-u.jp), ²Department of Earth and Planetary Sciences, Kyushu University (nori@geo.kyushu-u.ac.jp), ³International Research School of Planetary Sciences, Università d'Annunzio (goro@irsps.unich.it).

Introduction: More than 200 Venusian channels and valleys have been mapped based on analyses of Magellan SAR images. Channels are widely distributed on Venus and have a great diversity of both scale and morphology [1]. The origin of Venusian channels and valleys has been an unresolved issue since their discovery. Cross-sectional morphologies of these channels and valley networks are of special importance in discussing their formation processes both qualitatively and quantitatively. Characteristics of cross-sectional morphology of some Venusian channels have already been studied; Baltis Vallis, the longest canali-type channel [2], and 9 sinuous rilles [3]. Here, we compare representative types of Venusian channels and valleys, which are canali, sinuous rilles, and labyrinthic valley networks in order to clarify their differences and obtain some implications for Venusian geological history.

Classification and geological settings: Canali have a unique combination of morphological characteristics: extraordinary length, a single main conduit, and a degree of similarity with terrestrial rivers. Canali are concentrated in several plain regions [1]. Vesper Vallis is located at 59.3°S, 180.0°E, eastern Aino Planitia. This is the area where canali-type channels are concentrated [1]. As well as Baltis Vallis [4], the elevation varies considerably along Vesper Vallis. The length of Vesper Vallis has been reported to be 610 km [5].

Sinuuous rilles are the most abundant type of channels, and they are widely distributed on Venus. Morphological characteristics of sinuous rilles include sinuous narrowing reaches, source depressions, and lengths of several 10s to a few 100s of km. More than one half of sinuous rilles (39 of 59) and also some valley networks occur on or near coronae, coronae-like features, or arachnoids [1]. Longitudinal profiles along the sinuous rilles in general slope gently downhill toward their termini [6]. One of the sinuous rilles studied in [3] is located at 33.2°S, 16.6°E. This channel shows nearly perpendicular branchings similar to valley networks, which may have resulted from structural control. The direction of the branchings is parallel or perpendicular to the deeply incised lineaments in the surrounding plains.

Valleys usually exist in interconnected groupings and have outlets for fluids that likely flowed on their

floors [7]. However, they are distinct from the channels in that they do not necessarily have their boundaries shaped by fluid flow [7] and that they completely lack bedform indicative of surface flows [8]. Venusian valley networks form a complex system of branching valleys with their morphology similar to those produced by groundwater sapping processes on Earth and Mars [7]. Venusian valley networks have been classified into three subclasses; rectangular, labyrinthic, and pitted or irregular. They are commonly observed in highlands and are sometimes closely associated with sinuous rilles [1]. Labyrinthic valley networks are the most common type on Venus. The depths and widths of this type of valley networks appear to have been enlarged [8]. A labyrinthic valley network located at 8.6°S, 86.9°E occurs in the vicinity of a cluster region of sinuous rilles that are located on a domal rise.

Characteristics of longitudinal depth profiles:

We reconstruct the channel cross-sections using a radar clinometric method [2]. Depth and width profiles as a function of distance are obtained from cross-sectional profiles reconstructed at various sites along the channels and valleys.

Vesper Vallis. Groove morphology is observed at the most studied sites. The horizontal axis of Fig. 1 represents the distance from the one end of the channel. It is not clear from the image or the longitudinal topographic profile which terminus is the source region. Both the depth and width widely fluctuate along the channel while the both show rather negative correlation with the distance from one end. The correlation coefficient between depth and distance is -0.4. Vesper Vallis does not show clear correlation between depth and width (+0.3). This value corresponds approximately to that of Baltis Vallis (+0.2) [2].

A sinuous rille. Channel floors of the sinuous rille are lower than the surrounding plains. Fig. 2 shows depth and width distributions along the channel. The horizontal axis of Fig. 2 represents the distance from the source region. The depth profile exhibits a clear decreasing trend toward the terminus. The correlation coefficient between the depth and distance is -0.8. The width and distance also have a strong negative correlation (correlation coefficient: -0.9). The sinuous rille shows extremely strong correlation between depth and width. The correlation coefficient is more than 0.9.

These correlation coefficients between depth, width, and distance are typical values of some sinuous rilles.

A labyrinthic valley network. Groove morphology is observed at every studied sites. Neither the depth nor width shows decreasing trend along the valleys (Fig. 3). Since source and flow direction are difficult to determine from the image, we tentatively measure the distance starting from the site numbered 5 (Fig. 3). Then the correlation coefficient between depth and distance is -0.1. On the other hand, the correlation between depth and width of this valley network is rather strong (correlation coefficient: 0.7).

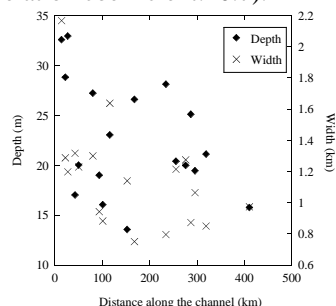


Fig. 1. Depths and widths along Vesper Vallis.

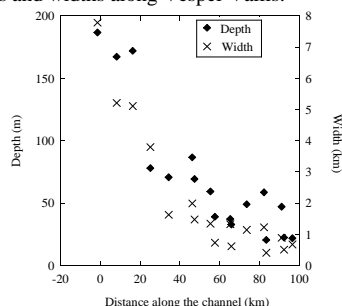


Fig. 2. Depths and widths along a sinuous rille located at 33.2°S, 16.6°E.

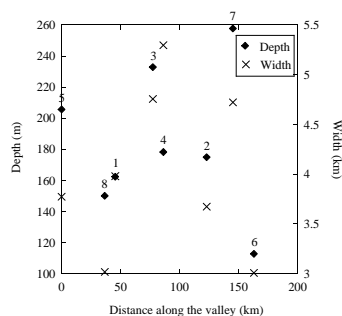


Fig. 3. Depths and widths along a labyrinthic valley network located at 8.6°S, 86.9°E

Formation processes: The groove morphology observed for these channels and valley network at the most studied sites implies their erosional origins. The depth profile along Vesper Vallis is highly undulated. Such depth distribution is comparable to terrestrial fluvial channels, therefore implying formation by mechanical erosion. Depth distribution along a sinuous rille (33.2°S, 16.6°E) exhibits a clear decreasing trend

despite its surface structural control, indicating a thermal erosional origin. A labyrinthic valley network located at 8.6°S, 86.9°E seems to have formed under strong structural control. This inference is supported by the orientations of tectonically-deformed structures associated with this valley network. The orientations of the tectonic deformations in the surrounding area can be detected from the image brightness using 2-dimensional Fourier analysis. The directions of the periodic tectonic structures are consistent with those of the principal valleys. This valley network shows neither a correlation between surface slopes and directions of valleys nor a decreasing trend in the depth profile toward a specific direction. These observations imply that low viscosity lavas flowing through the existing fractures mechanically eroded and enlarged them.

Implications for Venusian geological history:

The majority of canali appear to have modified by subsequent tectonic, volcanic, and impact events [4], whereas many sinuous rilles seem to be more pristine in comparison [6]. The temporal relationship between canali and the surrounding topography indicates that canali are old landforms in the plains and that their formation is related to the last extensive plain-forming event [9]. If the sinuous rilles are in general younger than canali, the differences between both channel types carry implications for spatio-temporal variations of Venusian channel-forming processes. The unusual conditions of the hypothesized extensive plain-forming event possibly caused the formation of canali. After the plain-forming event, mantle temperature may have increased with time by radiometric heat generation within the planetary body. This temperature rise may have been hastened by a development of thick stagnant lid at the top of Venusian mantle [10]. Consequently partial melting of high-temperature mantle produced hot basaltic or ultramafic lavas. The formation of sinuous rilles possibly resulted from the eruption of these lavas. Mafic and ultramafic lavas are also consistent with our inference that sinuous rilles formed by thermal erosion [1].

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