

# Cross-sectional profile of Baltis Vallis channel on Venus: Reconstruction from Magellan SAR brightness data

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Baltis Vallis is a 6800-km long canali-type lava channel on Venus. Formation process of canali has proposed to be either constructional or erosional. Levee structure is characteristic of constructional channel. The majority of channels on Venus have well-defined levee, however, SAR images of Baltis Vallis and other canali do not reveal obvious levees. From radar foreshortening, or image distortion, depth of Baltis Vallis has been estimated to be several 10s meters. However, this estimate is subject to 75-m resolution of Magellan SAR images. Spatial resolution of Magellan altimetry data is ranging from several km to ten km. Because the width of canali is only a few km, it is impossible to reconstruct cross-sectional profile from altimetry data. Instead, a new method of precise reconstruction of small scale topography from brightness data of SAR image is developed in this study.

We apply Muhleman's backscattering function to brightness of the Magellan FMAP images. It is well known that an intensity of the backscattering of the SAR image depends on slope, roughness, and dielectric constant of surface. Apparently, Muhleman's function relates an intensity of the backscattering only with radar incidence angle. Roughness and dielectric constant of planetary surface are included in two local parameters in this function. Radar incidence angle in Muhleman's function consists of an incidence angle with respect to the mean surface, tilt angle from the mean surface both parallel and perpendicular to the direction of the flow, and average slope. Average slope is estimated from altimetry data. The Magellan have orbited from the north pole to the south pole and transmitted radar pulses to east or west in the direction perpendicular to the line of flight. We can therefore consider that each FMAP image is illuminated from nearly due west or due east. The Magellan SAR incidence angle for the mean surface is given as a function of latitude.

We take 120 sites of about 10-km by 1.5-km rectangular region across Baltis Vallis. We reconstruct average cross-sectional profile in each region over 6000-km reaches of Baltis Vallis. The reaches lower than 6000-km are not examined because flow track is hardly identified on the radar images. Roughness and dielectric constant are supposed to be different every site. We therefore determine two parameters in Muhleman's function on each site. Brightness are stacked over 20-pixels, namely 1.5-km, along the channel. Stacking cancels random noises of radar images and minor variation of slope in the flow direction. Finally, we correct image distortion resulting from radar foreshortening. In summary, the 120 profiles of the channel reveal average depth and width of 47-m and 2.1-km, respectively. The depth profile along the channel is highly undulatory. In contrast, the variation of the width is small. It is demonstrated that a clear levee structure can be recognized at only 31 % among the all 120 sites. And the bottom surfaces of the channel are lower than the surrounding plains by several 10s meters at 88 % of these sites. The groove-like morphology as well as the lack of levee structure indicate that Baltis Vallis is likely erosional in origin. The channel formed by thermal erosion is expected to decrease depth with the increasing flow distance. However, such decreasing trend of depth is not observed. Therefore we conclude that Baltis Vallis is most likely to have been formed by not thermal but mechanical erosion in general. It is noteworthy, however, that ratio of the sites with levee structure is about 70 % at upper reaches between 0 and 1500-km from the source and is distinguished from the average. In contrast, erosion of the bottom surface is limited to 67 % in this reach. These observations suggest that not only erosion but also construction plays an important role in the formation process of Baltis Vallis at upper reach.