A POSSIBLE THIRD FESTOON FLOW IN ATALANTA PLANITIA, VENUS.

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Overview: The majority of volcanic features on Venus are thought to be of basaltic composition [1]. One exception to the uniformity of this composition may be the unusual festoon-type flow. Festoons, as defined by *Head et al.* [1], are "radar-bright flows that show organized patterns of internal streamlines (looped or curved components) analogous to the ridge and flow bands typical of viscous terrestrial lava flows known as coulees." Two festoon flows have been studied in detail: one in a lowland plains, the Artemis-Imdr Festoon [2], and one in a highland area, the Ovda Regio Festoon [3,4,5]. However, a third possible festoon, located in the plains region Atalanta Planitia in the northern hemisphere (latitude 69.8° to 70.8°N, longitude 200.9° to 203.1°E), has not yet been studied in detail [1]. Analysis of this flow and using Magellan data leads to the conclusion that its properties are similar to the characteristic properties of the festoon flows previously identified.

Methods and Data Collection: In order to identify the characteristic features of festoon flows, we tabulated specific quantitative attributes of the first two festoons (Table 1). Then, to facilitate comparison, we made the same measurements for the Atalanta flow. The tabulated characteristics of the festoons include data acquired during the Magellan mission, such as emissivity, reflectivity and RMS slope. We used Magellan altimetry data to determine the altitude, topography, and thickness of the flow. We also calculated north-south and east-west dimensions, the area, and the ridge spacing of the ogive-looking flow ridge features. Using the thickness and the area values we calculated the volume of the flow. Finally we determined bulk density, yield strength and viscosity using a combination of previous measurements and calculations utilized by the previous studies done on the identified festoon flows.

Calculations: Measurements of reflectivity are indicators of surface density. Using the Fresnel coefficient formulas the reflectivity is related to the dielectric constant of a material [6]. The equation is:

$$p = \left[(1 - \sqrt{e}) / (1 + \sqrt{e})\right]^2 \qquad (1)$$

where p is the Fresnel reflection coefficient (reflectivity) of the flow and e is the dielectric constant. We can then solve for the bulk density of the flow material using a relationship determined by Olhoeft and Strangway (1975) for lunar rocks and soils. This equation is:

$$e = (\ 1.93 \pm 0.17)^{\ r} \qquad (2)$$

where e is the dielectric constant and r is the density of the flow. This method was used to calculate the bulk density for both previously identified festoons and should apply to a dry planetary surface [2,4,7]. Yield strength was determined using the following relationship:

$$\tau_y = (r\, g\, H^2) / W \qquad (3)$$

where τ_y is the yield strength, r is the density, g is the acceleration of gravity on Venus (8.87 m/s^2), H is the thickness of the lobe and W is the width of the lobe [2]. The viscosity measurements are derived from yield strength. The relationship provides an order of magnitude estimate of viscosity. The equation is:

$$\eta_B = 6 \times 10^{-4}\, \tau_y^{\,2.4} \qquad (4)$$

where η_B is the Bingham viscosity and τ_y is the yield strength. The relationship was derived using topographic data and a cooling model [8].

Discussion: Our analysis indicates that the Atalanta flow has characteristics both similar to and different from the Artemis-Imdr and Ovda festoons.

The primary similarities between the Atalanta flow and the two festoons are:

- all three flows exhibit radar brightness;
- ogive pressure ridges are present on all three flows and ridge spacing measurements are similar;
- thickness measurements for the Atalanta flow and Ovda festoon are most similar, but all three are fairly thick flows;
- density measurements of the Atalanta flow are near the lower bounds of the other two festoons;

- yield strength and viscosity measurements of the Atalanta flow fall within the range of the measurements of the other two festoons.

The primary differences between the Atalanta flow and the two festoons are:

- smaller area and volume of the Atalanta flow by an order of magnitude;
- morphological differences in roughness of the Atalanta flow.

However, these differences do not describe properties intrinsic to a festoon. The quantitative and qualitative characteristics which strongly correlate with the other two festoons are more significant than the differences and indicate a more viscous evolved magma. On the basis of our measurements, we therefore conclude that the Atalanta flow is best defined as a festoon, making it the third such lava flow thus far identified on the surface of Venus.

Results Table of Quantitative Characteristics Comparing the Three Flows

	Artemis-Imdr Festoon (7)	**Ovda Festoon**	**Atalanta Flow**
Latitude	35.9-38.7S	6.0-6.5S	69.8-70.8N
Longitude	163.5-166.7E	95.5E	200.9-203.1E
Geologic Area	Dark lowland plains	Highland tessera	Northern trending ridge system in lowland plains
Region	Aino Planitia	Ovda Regio	Atalanta Planitia
Emissivity Values	.848-.898	.5-.86 (9); .42-.78 (4); .26-.84 (3)	.87-.89; mean=.88
Reflectivity	.065-.150	.16-.46 (4)	.07-.13
RMS slope range (Degrees)	Average range1.03-4.16; total range 0.5-9.0	1.7-9.0	2.2-6.7
Altitude (km)	6051.14	6054.5-6056.6(9)	6050.5-6051.75
Thickness (estimated, m)	500	50-150 (3); 180-280 (5); 52-144 (4)	32-388; mean=65
Ridge Spacing (m)	mean=686m.	640 (4); 625-770 (5); 500-750 (3)	487-575
Dimensions (km)	180 x 250	250 x 300 (3); 280 x 320 (5)	70 x 85
Area (km^2)	47,700	45,000	3500
Volume (km^3)	7,520-11,400	5,500 (3); 4,545 (4)	215-430
Yield Strength (Pa)	$2\text{-}30 \times 10^4$	$2\text{-}6 \times 10^5$ (5)	$2.3 \times 10^3\text{-}3.4 \times 10^5$
Inferred Viscosity (Pa-s)	$1.0 \times 10^7\text{-}8.0 \times 10^9$	$2.0 \times 10^7\text{-}2.6 \times 10^9$ (4); 10^{10} & 10^6 (5)	$7.21 \times 10^4\text{-}1.14 \times 10^{10}$
Bulk Density kg/m^3	2,110-2,360	3,010 and 2,550 (4)	1,649-2,297

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