

Types and occurrence of volcanic features and their relations to tectonics of Freyja and Danu Montes. J.D. Burt and J.W. Head; Brown U. Providence, RI, 02912

Introduction: Ishtar Terra is a continent-sized highland of the northern hemisphere of Venus. It is surrounded by linear mountain belts, including Danu Montes in the south and Freyja Montes to the north. The broad structures of the montes consist of a mountain belt, an outboard rise, a foredeep, a 2-3 km scarp, and a plateau, structures consistent with compression, flexure, underthrusting, and possible crustal loss^{1,2,3,4}.

The distribution and tectonic associations of the volcanic features observed in these mountain belts (volcanic plains, sinuous rilles, troughs, and pits) provide important evidence for the volcanic processes contributing to the belts' origin and evolution. This paper summarizes observations of the characteristics and distribution of these features using Magellan radar images, and presents preliminary conclusions regarding their implications.

Volcanic Plains: Volcanic plains are observed north of Freyja in Itzpapalotl Tessera, but not within Freyja or Danu montes. The plains embay large ridge units and fill lows between terrains. The plains texture varies from uniform and featureless with broad mottlings, to gridded or speckled.

A large unit of plains at 76.5 N, about 50 km wide north to south, lies between and embays two ridged units. These plains are characterized by broad dark and light mottlings and scattered irregular lineations which could be flow fronts or ridges. One prominent feature of this plains region is a sinuous rille or channel, 1-2 km wide (fig. 1, A), floored in places by dark material, that runs east-west for about 50 km through the midst of the plains but has no apparent source. These and similar plains occur in low areas between higher-standing ridged units and clearly postdate the formation of the ridges. No clear sources for the plains appear, though the rille, if produced by volcanic flow, indicates one possible mode of emplacement. Where ridged terrains change character across intervening plains a tectonic boundary may be indicated.

A contrasting type of plains is situated in northern Itzpapalotl, just south of Uorsar Rupes. Paralleling Uorsar, and having about a 25 km width, the plains appear to embay ridges to their south while being cut by ridge-like features, possibly tectonically related to Uorsar, on their north side. While most of the surface of this plains unit has a gridded texture produced by a system of irregular intersecting lineations, other areas are speckled or dark and featureless.

Another large region of plains lies within the foredeep trough north of Uorsar Rupes. Lacking interior ridges or other textural characteristics these plains are generally featureless except for broad shadings of dark material.

Troughs: A prominent feature of Danu Montes, but not most of Freyja, is a set of troughs. Broad, rectangular, flat floored depressions, bounded by linear scarps, they resemble graben in form, and are 20-30 km long and 5-10 km wide (fig. 1, B). The floors are marked in some cases by small pits or troughs, by cross-cutting scarps, or by broad ridges. All appear to lie primarily in Danu Montes, though some may extend into Vesta Rupes. Several large troughs form a parallel NNE-trending set cross-cutting and interrupting the principle WNW trend of the major ridges of Danu. Ridges continue across troughs as low, broad rises bounded by scarps. Other troughs lie between and parallel to the Danu ridges and may represent ridge-normal extension. Where these cross-cut the NNE trending troughs, scarps are visible within the cut trough. Ridge-normal troughs may be embayed by material in lows between ridges, leaving outlying trough extensions. These embaying units have faint, flow-like mottlings in an otherwise smooth, low-contrast texture and may cut or overlay other structures such as low scarps or ridges. No source is observed and these possible flows do not appear to extend into the plains below Vesta Rupes.

Pits and Pit Chains: Pits are circular structures ranging from <1 to >10 km in diameter and having uniform or faintly mottled floors. Although common in and just north of Danu, few pits are observed in Freyja Montes. Pit chains are straight lines of small pits (fig.1, C). The pit chains and small pits usually lie within the mountains, the chains paralleling the major Danu ridges possibly as a result of ridge-normal extension. Pits and pit chains may lie along extensions of ridge-parallel trough trends, or within a trough. Large pits usually occur singly on the northern flank of Danu. Pits may be created by withdrawal of magma from chambers or dikes below the montes and collapse of surface material into the resultant void.

Sinuous Rilles: Sinuous rilles are long (50 km), winding, channel-like features extending from Danu Montes into Lakshmi Planum (fig. 1, D). Troughs in the northern slopes of Danu form at or near the heads of the rilles. The width of the rilles is 1 km at the trough and diminishes going away from Danu. Apparent rille depths also decrease in that direction, with the combined effect that the rilles blend into the plains without an abrupt termination. Rilles may branch or lead into pit chains and form small networks of minor channels or chains. A distinct type of rille is illustrated in figure 1 (A). It displays less tapering over its observed length, remaining at about 1-2 km in width, lacks a heading trough, and ends by fading into the plains.

Discussion and Conclusions: The volcanic or volcanic-related features of Danu and Freyja are as distinct as the mountain belts themselves and emphasize the differences in history and tectonics of the two belts. Freyja Montes proper contains no observed volcanic features except a sparse scattering of pits. North of Freyja, Itzpapalotl Tessera is characterized by volcanic plains filling low zones between ridged crustal units and filling the foredeep north of Uorsar Rupes.

The three plains types described may be of differing ages or tectonic environments. The gridded plains could be relatively older and tectonically deformed. The more sparsely lineated type, with the sinuous rille, may be formed by alternating stages of volcanism and tectonism. The featureless plains may be the product of a widespread, uniform eruptive style, or of some other process capable of producing broad, featureless regions. Troughs, pits, pit chains, and tapering sinuous rilles are absent in Freyja and Itzpapalotl. Danu is characterized by these features, but lacks any form of internal volcanic plain. The history of Freyja, thus, includes compression, with possible underthrusting, and melting and volcanism north of the montes. Danu, meanwhile, may have undergone compression then extension possibly due to gravitational relaxation. The troughs in Danu, formed normal to the compressional ridges, may represent failure and extension with the least compressive stress parallel to the ridges, leading to limited volcanism possibly linked to dike intrusion.

References: (1)L.S. Crumpler, J.W. Head, and D.B. Campbell (1986), *Geology*, 14, 1031.(2)J.W. Head, (1990), *Geology*, 18, 99. (3)S.C. Solomon, and J.W. Head, (1989), *LPSC XX*, 1032. (4)J.D. Burt, and J.W. Head, (1990), *LPSC XXI*, 149.

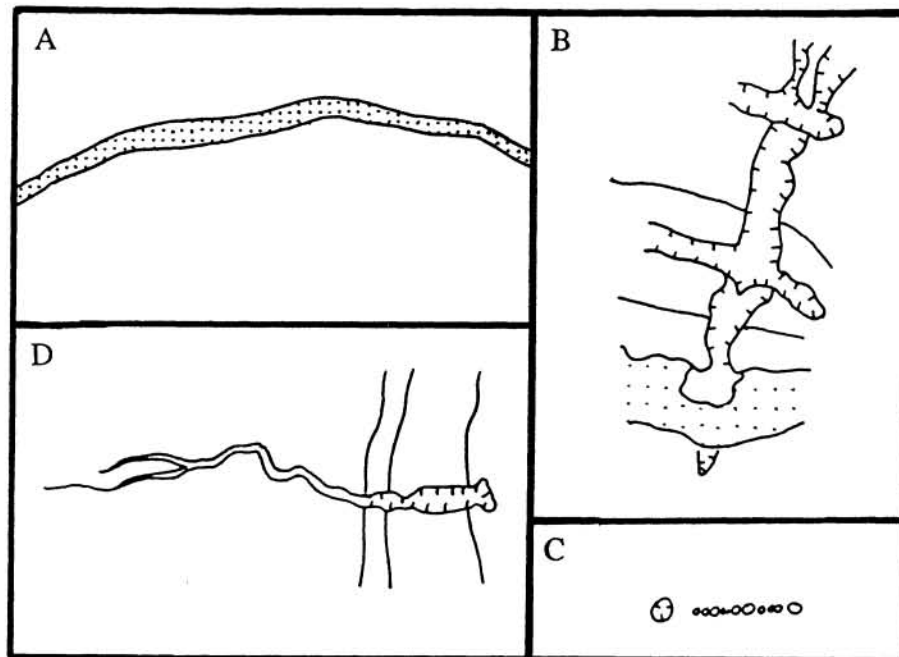


Figure 1. Schematic diagrams of: A) a sinuous rille: Itzpapalotl Tessera; B) troughs; C) a pit chain; D) a sinuous rille: Danu Montes.

