FORMATION OF VENUSIAN CHANNELS IN A SHIELD PAINT SUBSTRATE. N.P. Lang[1] and V.L. Hansen[1], [1]Department of Geological Sciences, University of Minnesota-Duluth, Duluth, MN 55812 (lang0604@tc.umn.edu)

Introduction: Venusian channels are globally distributed and are categorized as simple, complex, and compound based on their morphology [1, 2]. Although morphological differences exist, many of the more than 200 identified Venusian channels share broad characteristics including more or less constant width to depth ratios, meanders, and cutoffs. Many channels have indeterminable source and terminal regions [1, 2] and have been argued to form via constructional and erosional processes [e.g. 1, 2, 3, 4, 5]. Proposed mechanisms for channel formation include low viscosity, rapidly emplaced lavas [e.g. 1, 2, 3, 4], water laden sediment [5] and tube-fed lava flows [6]. In this abstract, we provide a new hypothesis for channel formation where channels form by mafic lavas thermally eroding a substrate composed of material sourced from small shields. This material, known as shield paint, potentially represents shallow point source melting of a once-upon-a-time hydrated Venusian crust [7].

Previous hypotheses: Channel morphology strongly indicates fluids played a role in their formation, but speculation as to the fluid type has resulted in a wide range of hypotheses to explain their formation. Baker et al. [1] proposed alkaline mafic silicates, sulfur, and carbonatites as potential channel-forming fluids. They proposed that these last two fluids are the most attractive because of their low melting points and water-like viscosities, which would explain the great lengths, fluvial-like characteristics, and longitudinal uniformity of the channels [1].

Komatsu et al. [3] built upon Baker et al.'s work [1] and modeled channel formation through erosion by tholeiitic basalts, carbonatites, and sulfur. Their results showed that tholeiitic basalt could not be the channel forming liquid because it would crystallize before eroding the substrate. Komatsu et al. [3] hence concluded that channel forming fluids must be either carbonatites or sulfur lavas because they would be able to stay molten for longer periods due to their low melting temperatures when compared to basalt.

Gregg and Greeley [6] argued that carbonatite and sulfur flows will rapidly boil away and sublime on the Venusian surface and therefore could not be potential channel forming liquids. Instead, mafic and ultramafic flows are more likely. Gregg and Greeley [6] calculated that mafic and ultramafic flows could extend for great distances on Venus if a lava crust insulated them. This suggests that channels were tube-fed [6]. Their models also revealed that thermal erosion should be less efficient on Venus compared to Earth, suggesting that channels are either the product of mechanical erosion or constructional processes.

Williams-Jones et al. [4] argued that because of the fluvial characteristics of channels, mechanical and thermal erosion were the only two means of potentially forming channels. Williams-Jones et al. [4] calculated that thermal erosion via a basalt or komatiite is only possible if they were turbulent for long distances, which is unlikely to occur for distances of most channels. Hence, they concluded that mechanical erosion via halogen-rich, alkali carbonate and sulfur lavas are the most efficient means to form channels [4].

Jones and Pickering [5] proposed that channels formed by sediment-laden water instead of forming by lava. They pointed to apparent avalanches along channel margins that appear to have been removed by subsequent flows in the channels. Jones and Pickering [5] suggest that if standing bodies of water were present early in Venus' history, processes similar to those at terrestrial submarine channels may have operated. Channels would have ceased to form when surface water disappeared [5].

New observations: As a first step in testing the validity of these hypotheses, we are mapping channels in the Sedna, Helen, Nsomeka, Guinevere, and Vellamo planitiae using full-resolution (~75 m/pixel) inverted and normal Magellan Synthetic Aperture Radar (SAR) imagery. Although our morphologic observations of channels are consistent with previous workers, we make some new observations regarding channels, which are summarized below. Implications for these observations are given in the next section.

1) Channels occur in regions where small shields and their erupted products are abundant.

2) Channels appear to easily cut through what we interpret as pre-existing wrinkle ridges. We find no evidence for ponding of the channel fluid against the wrinkle ridge.

3) There is an absence of braided segments for many of the channels. Although the terminus of some channels occurs as a braided segment, the apparent heads and trunks of channels do not contain braided segments.

4) Where channel termini are observed, there are apparently only small quantities of material deposited.

Implications of new observations:

Channels in shield terrain: Shields are small (<1-~15 km diameter) volcanic constructs that occur across much of the Venusian surface, particularly in the lowlands. Shields occur in two forms: 1) clusters ~100-300 km diameter called shield fields [8], which are typically associated with larger volcanic constructs and 2) shield plains [9], which cover millions of km^2 (We use the term shield terrain instead of shield plains because the descriptor 'plains' holds a range of meanings). Hansen [7] initially noted that shield deposits coalesce into a relatively coherent layer, which forms a volcanic veil with lace-like discontinuities obscuring the previously deformed underlying terrain. These deposits, referred to as shield-paint, possess a mechanical strength that can be subsequently extensively fractured or deformed into wrinkle ridges with regionally coherent patterns [7]. Hansen [7] further discussed that shield paint may represent shallow point source partial melting of a hydrated basaltic crust potentially triggered by amphibole dehydration that may have occurred on ancient Venus when the surface temperature exceeded 1000K [10] and water was potentially present [11]. If the shield paint is a product of partial melting of hydrous basalt, it should be more siliceous than the basaltic crust and therefore have a lower melting temperature.

Absence of braided segments: The meandering nature and absence of braided segments at the heads and along the trunks of channels implies a more or less constant and low flow rate through the channel. Absence of braided segments at the channel head may also imply that only small amounts of material were transported through the system.

Transported material: If our observations of the small amounts of channel-transported material are correct, then previous interpretations that large amounts of material and sustained effusion rates are necessary for channel formation may be incorrect. The amount of transported of material is difficult to quantify due to difficulties in calculating deposit thickness. Also, radar properties of the deposited materials could potentially be similar to surrounding units obscuring their lateral distribution.

Cooling of flows: The rate of heat loss from lava affects the formation of a crust and influences flow extent [e.g. 6]. Gregg and Greeley [6] calculated that flows would cool, and hence form a surface crust, more quickly on Venus than Earth because of Venus' denser atmosphere. They argue that the denser atmosphere facilitates highly efficient convective heat transfer for Venus compared to Earth [6]. However, Snyder [12] showed that the denser CO_2-rich Venusian atmosphere would actually impede convective heat transfer. Snyder argued that the atmospheric CO_2 would absorb the radiated heat from lava ultimately reducing the flow's heat loss. Hence, lavas on Venus will cool 30-40% more slowly than previously believed [12]. This implies that Venusian flows can extend for great distances without the thermal protection of a lava crust [7].

New hypothesis: Based on the implications of our new observations, we propose a new hypothesis for channel formation. We propose that channels represent the eruption of a mafic lava (probably basaltic) from an opening (i.e. vent or tube) that interacts with, and thermally erodes, the more siliceous shield paint. Because the shield paint has a lower melting temperature than the mafic lava and Venusian lavas have an impeded rate of heat loss, we believe thermal erosion should be possible for considerable distances (i.e. ~100's of km). If our hypothesis is correct, then the channel-wrinkle ridge observation noted earlier implies that the shield paint should be easily thermally eroded.

Discussion: Our current work has been qualitative in order to define a base from which future numerical models of channel formation may be developed. Our hypothesis is a hybrid in that ties together various aspects earlier hypotheses of channel formation, but it is unique in that introduces the idea of shield paint as a substrate that facilitates thermal erosion. Further, our hypothesis has potential implications for Venusian petrology since it does not require 'exotic' lavas for channel formation [e.g. 3, 4]. Instead, channels may result from the simple interaction of basalt and a more siliceous material. Our next step is begin numerical modeling of this process.

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