THE ORIGIN OF VENUSIAN CHANNELS: MODELLING OF THERMAL EROSION BY LAVA; D.B.J. Bussey, S-A. Sørensen, J.E. Guest, University of London Observatory, University College London, London, NW7 2QS, U.K.

Magellan imagery has revealed that channels, apparently volcanic in origin, are abundant on the surface of Venus [1]. There has been much debate about the origin of these channels. Are they the result of erosional (either thermal or mechanical) or constructional processes?

A common characteristic of the simple sinuous channels (described by Baker as 'canali' [1]) is that they show evidence of erosion near their source and then become purely constructional, forming levees and in some cases roofing over completely [2].

One method of showing that thermal erosion is capable of producing the type of channels seen is to use computer modelling incorporating the physical conditions on Venus and the physical characteristics of the different types of lava that may have been erupted.

It is possible to calculate, relatively easily, two channel parameters. The first is the erosion rate, which combined with eruption duration, gives depth. The second is for how long after leaving the source the erupted lava will continue to be capable of thermal erosion before constructional processes dominate. Making assumptions about the rheology of the lava (e.g. assume it behaves as a Bingham plastic) along with the slope angle yields a flow velocity and therefore a distance over which thermal erosion will take place.

Due to the resolution (both vertical and horizontal) of the Magellan altimetric data, the distance from the source that the channel is erosional can be much more accurately measured than the depth of the channel. This will remain the case until stereo imagery becomes available for large areas of the planet.

Until a solid crust is formed on top of the lava, heat is lost by radiation and convection to the atmosphere. At the same time heat is transferred to the underlying rock by conduction. This heats up the rock until its solidus temperature is reached. At this point latent heat must be supplied before the rock actually enters the liquid phase, whereupon the melted rock is amalgamated into the lava and removed. Loss of heat at the top of the lava by radiation and the bottom of the lava by conduction leads to heat flow within the lava by both convection and conduction. Of the two however, convection has a much shorter time scale and is therefore much more effective.

Once a crust has formed heat loss by convection stops and heat loss by radiation is much reduced due to the crust being at a lower temperature than the liquid lava. Lava then loses heat by conduction into the crust which gradually thickens. As the lava loses internal energy, by melting the ground rock, it is itself cooled. Eventually the lava will be cooled to such an extent that it will no longer have enough internal energy to continue to melt the rock. At this point the channel becomes purely constructional in nature.

As mentioned previously there are two different quantities to be modelled. The erosion rate and the distance from the vent that the lava retains its erosional capability. In the first approximation this can be accomplished using a simple one dimensional model of temperature distribution as a function of time at various distances from the vent. The model is solved by using the principle of finite differences. Preliminary findings for erosion rate near the source for a komatiite lava flowing over a basalt ground rock are shown in figures 1 & 2. Figure 1 represents Venusian flow whilst figure 2 is for Earth. The graphs show vertical distance eroded against time. The present model predicts an erosion rate of approximately 25 cm a day on Venus and 16 cm a day on Earth. The value for Earth is significantly lower than that predicted by Huppert [3].

ORIGIN OF VENUSIAN CHANNELS: D.B.J. Bussey et al.

Even with this lower rate the preliminary quantitative results presented here indicate that even for short eruption durations thermal erosion can be an important process, given the right conditions, in the production of channels.

REFERENCES:

[1] Baker V.R. et al. (1992) *JOURNAL GEOPHYSICAL RESEARCH* **97** pp 13421 - 13444.
[2] Bussey D.B.J. et al. (1992) *INTERNATIONAL COLLOQUIUM ON VENUS* **LPI Contribution No. 789** pp 18 - 19.
[3] Huppert H.E. et al. (1984) *NATURE* **Vol 309** pp 19 - 23.

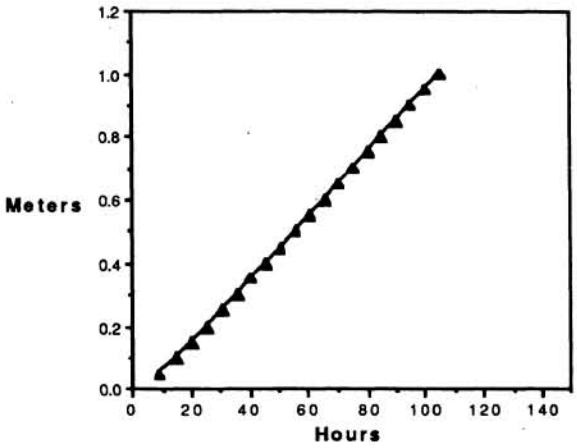

Fig. 1. A plot of vertical distance eroded versus time on Venus.

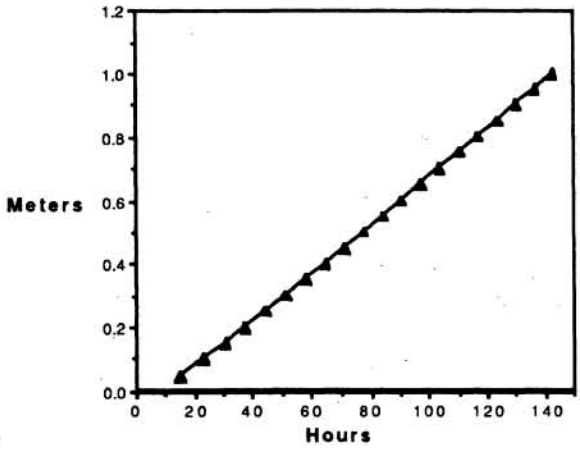

Fig. 2. A plot of vertical distance eroded versus time on Earth.