MORPHOLOGIC IDENTIFICATION OF VENUSIAN LAVAS: IMPLICATIONS FOR EMPLACEMENT OF LONG LAVA FLOWS; Barbara C. Bruno (Dept. of Earth Sciences, The Open University, Walton Hall, Milton Keynes MK7 6AA, UK) and G. Jeffrey Taylor (Hawaii Institute of Geophysics and Planetology, 2525 Correa Road, Honolulu, HI 96822, USA).

INTRODUCTION. In this work, we analyse selected Venusian lava flows using two different methods: fractal analysis and radar analysis. Each method uses independent criteria to identify lavas as a'a, pahoehoe or transitional basalts. We show the two techniques produce similar categorisations of flow type and thus independently confirm each other. Such morphologic identification can lead to a better understanding of eruption rates and eruption and emplacement styles of lava flows. A'a lavas are emplaced in channels and generally reflect high volumetric flow rates, whereas tube-fed pahoehoe flows tend to be associated with low eruption rates [1]. Our fractal analysis of the long lava flows of Mylitta Fluctus suggests emplacement as a'a flows, which has implications for emplacement of large lava plateaux in general.

METHODS. The fractal technique, exploiting our observation that pahoehoe flow margins are more convoluted than a'a margins, uses fractal dimension (D) to distinguish these flow types [2,3]. The radar technique, based on systematic differences in small-scale surface roughness, uses Magellan radar data to distinguish a'a and pahoehoe morphologies [4, 5]. The radar technique can be applied only at incidence angles $\geq 30°$, which corresponds to Magellan Cycle 1 coverage of latitudes 54°N to 34°S [4]. First we examine the radar and fractal properties of only those flows suited for study by both techniques and show there is an excellent agreement between the two categorisations. This suggests that the fractal technique is valid, and can be used to identify those flows which cannot be studied with the radar technique.

DATA. We measured the fractal properties of 30 lava flow margins from Magellan radar images at resolutions of 75 - 225m using equivalent rod lengths between 140 m and 36 km. In selecting suitable lavas for measurement, we used the same criteria as Bruno et al. [3]. Of these 30 flows, 21 are located within the latitudinal range 54°N to 34°S, and can thus be independently checked by the radar technique. Among those located south of 34°S and hence not suitable for study by the radar technique are three flow margins of Mylitta Fluctus.

RESULTS. Of the 30 flow margins measured, most (27, or 90%) are fractal over the range of scale measured. Based on the terrestrial analogy, fractal behaviour indicates basaltic composition and D can be used to distinguish basaltic flow types [2,3]. Assuming the terrestrial ranges of D apply to Venusian lavas, we make the following interpretations: 8 lavas are a'a (D: 1.04-1.09); 17 are pahoehoe (D: 1.13-1.24), and 2 are transitional (D: 1.10-1.12). The three lavas found to be non-fractal are interpreted to be topographically-controlled basalts. Using the methodology of Campbell and Campbell [4], we examine the radar-backscatter signal of those lavas that are both fractal and located between 54°N and 34°S. Based on the level of this signal, we categorise these lavas into a'a (high), transitional (intermediate), and pahoehoe (low) basalts. Figure 1 compares the radar and fractal categorisations of these 18 flows. Four are identified by both techniques as a'a and ten are identified by both as pahoehoe. Three flows are identified by the radar technique as having both transitional and pahoehoe morphologies. The corresponding D (1.10, 1.12, and 1.14) are in the transitional or low end of the pahoehoe range. In only one of 18 cases is there an obvious disagreement between the two techniques. This is excellent evidence that Venusian basalts have the same ranges of D as their terrestrial counterparts, suggesting we can use D to distinguish a'a, pahoehoe and transitional flows on Venus.

As part of this fractal analysis, we studied three flow margins of lavas in Mylitta Fluctus, a flow field comparable in size to the Columbia River Plateau, a terrestrial flood basalt province. The three measured margins correspond to Episode 4 lavas having lengths of ~100-200 km, fairly uniform widths of ~20-30 km and thicknesses of ~10-30 m [6]. There has been much debate regarding the emplacement of such extensive lavas, particularly on the relative importance

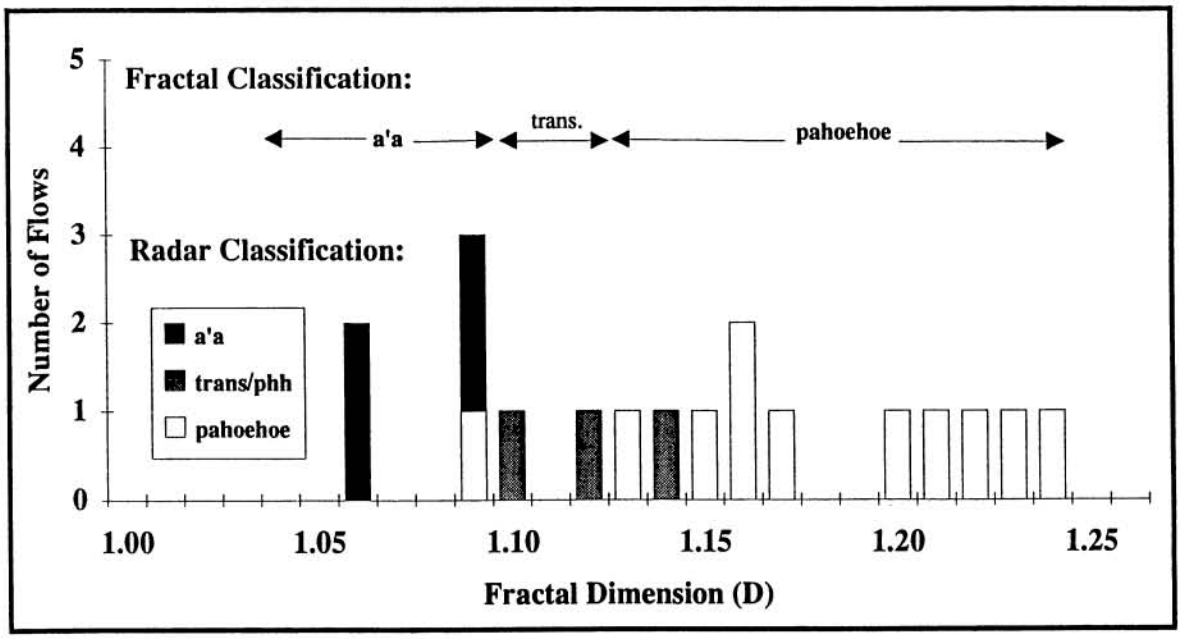

Fig. 1. Comparison of fractal and radar classifications of 18 Venusian lavas.

of effusion rate, eruption volume, eruption duration, and the role of lava tubes [e.g., 7-11]. Possible explanations for the long lavas of Mylitta Fluctus (and other long lava flows) include: (1) channel-fed lavas associated with unusually high effusion rates (analogous to terrestrial a'a flows) or (2) tube-fed lavas, possibly generated by low or moderate emplacement rates over unusually long eruption durations (analogous to terrestrial pahoehoe flows). Fractal analysis of the three margins studied revealed a'a-like fractal dimensions, favouring the former explanation and suggesting that at least this episode of Mylitta Fluctus was emplaced at high flow rates.

For comparison, we also performed a fractal analysis on morphologically-similar Martian flows: the long lavas in Elysium Planitia. Like the Mylitta Fluctus Episode 4 lavas, these flows are long (~100-200 km) and narrow (~10 km) and have fairly uniform widths [12]. Recent photoclinometric measurements yielded typical flow thicknesses of ~30-50 m [13]. These flow margins have D ranging from 1.04 to 1.08, again indicating a'a morphologies [14].

These a'a-like D indicate that these long lava flows are emplaced in open channels, probably at high flow rates. Even if an underground tube system is present, as suggested by Mouginis-Mark [12] based on earlier work of Self et al. [11], their emplacement is vastly different from pahoehoe emplacement. The low D indicate the absence of the branching tube system that characterises terrestrial pahoehoe flow fields and results in a convoluted flow margin [14,15]. Instead, most of the lava appears to be transported along one main pathway, resulting in a flow of uniform width with a linear flow margin.

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