SCALLOPED MARGIN DOMES: WHAT ARE THE PROCESSES RESPONSIBLE AND HOW DO THEY OPERATE ? M H Bulmer, J E Guest (Univ. London Observatory. NW72QS, UK), G.Michaels, S Saunders (JPL 230-225 Pasadena CA 91109)

Studies of scalloped margin domes (SMD) indicate the scallops are the result of slope failure. SMD's have similar but smaller average diameters (26.5 km) to unmodified domes (29.8 km), and the majority plot at altitudes ranging from 0.5-4.7 km, (figure 1) relative to the mean planetary diameter. A range of morphological types exist from those least modified to those that show heavy modification. Of the 200 SMD's examined, 33 have clearly discernible debris aprons. Examination and comparison of debris aprons with mass movement features on the Moon, Mars and in sub-aerial and submarine environments on Earth[1] using H/L against area (km^2), suggests there are three main types of failure; debris avalanche, slumps and debris flow.

The five examples (figure 2) representing the morphological range within the SMD's, show the different modified forms and the different types of slope failures that have occurred. A large percentage of SMD's have narrow "flutes" on their perimeters possibly resulting from failures similar to those that give "block and ash" type flows on Earth. Radar bright material at the base of edifice appears analogous to crumble breccia around terrestrial domes. There is evidence that breaching on the flank causes material inside to flow out. This suggests that the failure in some cases occurred contemporaneous with the main eruptive phase. Evidence for sector collapse can be seen where a large part of the edifice has been removed and radar bright hummocky terrain lies at its base and on the surrounding plains. Such large failures occur on all the examples in the morphological range characterised by collapsed topography with a wide opening to one side of the edifice that forms a well defined amphitheatre. The existence of more than one amphitheatre gives the edifice the appearance of being scalloped. The hummocky nature of the collapsed material is a typical feature of dry volcanic debris avalanche deposits, each hummock consisting of one or more megablocks. The maximum run-out distance ranges from 12-55 km, the maximum width from 5-52 km and the maximum area from 52-2140 km^2. More coherent failures situated close to the base of the edifice have characteristics of slump-type landslides. A well defined backscar is often visible and the deposits remain as a semi-coherent mass with a number of large blocks. One of the steep sided conical examples has a slump complex which contains blocks that may have undergone rotation. The maximum run-out distances of these deposits ranges from 8-34 km, the maximum width from 3-36 km and the maximum area from 77-375 km^2.

Other processes of modification include magma withdrawl which results in a downsag seen most frequently on the lower domical structures. This may have occurred at the end of the main eruptive phase as a result of withdrawl or loss of volume through vesicle collapse. The existence of steep sided calderas suggest withdrawl also occurred catastrophically. The evidence of explosive activity remains uncertain but the existence of pits on the edge of a number of domes may be related to such activity. Heavily modified domes with only a fraction of the edifice remaining suggests topographic relaxation over time takes place.

The global distribution of domes[1,2] shows that many of the least modified domes are situated close to the margins of basins. From examination of seven unmodified domes it is suggested they show the shape expected for an axisymmetric gravity current spreading unimpeded over a horizontal surface[3]. Other forms of domes found away from these areas may have had a different rheology resulting in them undergoing modification. It is therefore necessary to examine the eruptive conditions under which domes form. There are a number of key factors that control dome formation: the effusion rate, rheological properties of the magma, thickness of the carapace, oversteepening of the margins, cooling rates, atmospheric effects and explosive activity.

These factors are being studied using theoretical models and laboratory experiments.

References: (1) Bulmer et al. in press. (2) Pavri et al. (1992) J. Geophys. Res., 97, 13,445-13,476. (3) McKenzie et al. (1992) J. Geophys. Res., 97, 15,967-15,976.

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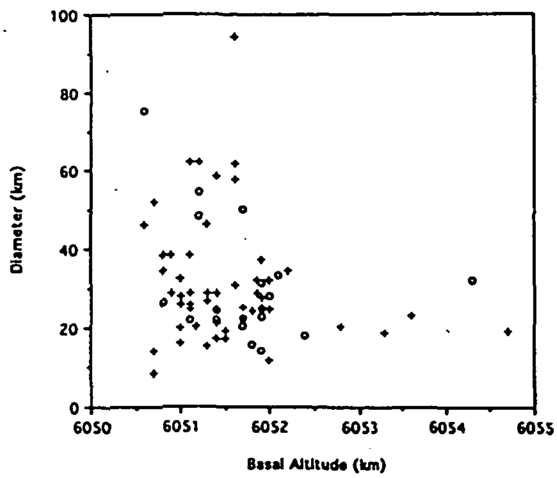

Figure 1 Plot of basal altitude with dome diameter for scalloped margin domes and unmodified domes.

o Scalloped margin domes
+ Unmodified domes

Figure 2 Schematic representation of the formation of different types of scalloped margin domes.