LARGE SHIELD VOLCANOES ON VENUS: DISTRIBUTION AND CLASSIFICATION; J. W. Head, L. S. Crumpler, and J. C. Aubele, Dept. of Geological Sciences, Brown University, Providence RI 02912.

Introduction: Magellan data have provided the opportunity to compile a global census of volcanic landforms and deposits (1). As known from pre-Magellan data (2), large shield volcanoes are one of the most prominent of the volcanic features seen on the planet; this contribution outlines the characteristics and distribution of the population of large volcanoes and presents a preliminary classification scheme of major types, features, and associations.

Definition and Distribution: Large volcanoes are defined as volcanic centers ≥100 km in diameter characterized by a dominance of radial lava flows and centered on a region of positive topography (1). Large shield volcanoes are distinguished from very large topographic rises (exceeding several thousand kilometers in diameter) with associated individual volcanoes and radial flows, such as Western Eistla, Atla, and Beta Regions (3). Large shield volcanoes are also distinguished from a wide variety of intermediate-scale features in the 20-100 km diameter size range (1). The primary criteria for interpreting these features as volcanoes is the presence of distinctive radial patterns of lava flows and the frequent association of positive topography. The size-frequency distribution of the 141 large shield volcanoes mapped on Venus to date (Fig. 1a) shows a variable, but relatively flat distribution between 100 and 700 km diameter, with only a few volcanoes in excess of 700 km. Minor peaks are observed at 150-200, 300-350, 400-450, and 500-550 km. The global distribution map (Fig. 1b) shows that large volcanoes are not evenly distributed across the planet; they cluster in Atla Regio, Beta-Atla-Themis Regions, and along Eistla Regio. Large volcanoes are almost totally absent in the tesserae, and are sparsely scattered in the lowland and rolling upland plains. Plains areas with abundant ridge belts (Atalanta and Lavinia Planitiae) are particularly lacking in large shields. Large volcanoes preferentially occur at higher elevations, particularly in the broad rises and tectonic junctions (4) on the Equatorial Highlands. This correlation with elevation may be related to primary formation factors (thermal uplift associated with rising magma, or altitude-related effects on neutral buoyancy zones and edifice growth (5), or to preservation factors (post-formation subsidence and covering by plains).

Preliminary Classification Scheme: A preliminary classification scheme of major large shield volcano types, features, and associations is shown in Fig. 1c. These types emphasize individual features and associations and are not mutually exclusive; one volcano may be characterized as a composite of these types. Simple large shields (Type I) are characterized by relatively symmetrical outline and distribution of radial flows extending away from a summit region. Calderas and associated flanking structures are absent or not prominent. An example of this type is a large volcano 520 km in diameter about 1000 km west of Devana Chasma, Beta Regio (-27°, 10°). Many volcanoes (Type II) contain central calderas which are morphologically distinct in images; volcanoes containing central topographic depressions with no morphologic evidence of their presence are not classified as calderas, although their distinctive properties are noted. Sif Mons contains a large caldera approximately 40 km in diameter, in the range of about 10% of the total edifice diameter (3). Type III volcanoes contain one or more flanking rift zones that are arrayed generally radially to the edifice (e.g., NW quadrant of Sif Mons), similar to the flanking rift zones seen on terrestrial volcanoes such as Kilauea. These are distinguished from the large regional rift zones (illustrated by Gula Mons and Guor Linea) or through-going rift zones (well illustrated by Theia Mons and Devana Chasma) that are typical of Type VII volcanoes. Some volcanic edifices (Type IV) have elongated summits (the source volcano for Mylitta Fluctus (6)), often with multiple caldera-like features (Gula Mons (3)). Occasionally large shield volcanoes display multiple morphologic and topographic summits (Type V); for example, Sapas Mons contains twin peaks with small edifices and distinct central depressions associated with each, although the volcano itself is not markedly asymmetrical (7). Some large shield volcanoes (Type VI) contain an exterior set of fractures that generally appear to be radial to the volcanic edifice. These commonly predate many of the flow units making up the edifice as a whole. Radial fractures are also seen in the inner part of some volcanoes (Type VIII), usually forming an inner zone with a very high density of fractures that both radiate from the central zone and cross the interior. In some cases, flanking flows clearly emerge from those radial fractures (8). These features are similar to nova-like features (9); the high concentration of radial fractures in the inner zone distinguishes them from Type III and VII volcanoes. Some large shield volcanoes have corona-like interiors, where the corona-like structure comprises 50% or more of the volcano diameter, but still do not obscure the distinctive radial flow-like features that fit our definition of large shield volcanoes. There is clearly a morphologic transition between some of the large volcanoes and coronae (1, 9). This transition in part may be related to the larger than average magma reservoirs expected in the Venus environment due to initial mantle plume formation and to behavior and growth of magma reservoirs (5). We are presently assessing the associations of different types, their areal distribution, and their correlation with altitude to assess factors that are important in the formation and evolution of large shield volcanoes on Venus.


Fig. 1. a. Size frequency distribution; b. Global distribution (1); c. Classification scheme.