ORIGIN OF FLAT-TOPPED VENUSIAN SHIELD VOLCANO SUMMITS: A CASE STUDY OF IDUNN MONS. I. López[1], P. D'Incecco[2], G. Komatsu[2] and J. Filiberto[3]. [1]Departamento de Biología y Geología, Física y Química Inorgánica. Universidad Rey Juan Carlos, 28933 Móstoles, Spain (E-mail: ivan.lopez@urjc.es), [2] International Research School of Planetary Sciences, Università d'Annunzio, Viale Pindaro 42, 65127 Pescara, Italy, [3]Lunar and Planetary Institute, USRA, 3600 Bay Area Blvd., Houston, TX 77058.

Introduction: Idunn Mons is a large shield volcano located in Imdr Regio. Recent studies using emissivity data from ESA's Venus Express Mission, together with experimental laboratory studies on the alteration of volcanic materials on Venus conditions, suggest that Idunn Mons is a site for very recent or even ongoing volcanism [1,2,3,4,5]. Idunn Mons presents a flat-topped summit that can be observed in Magellan left- and right-looking images (Figure 1). Other large Venusian volcanoes also display this type of summit (e.g., Sapas Mons) but this structure is more common in smaller edifices such as domes and ticks. In this work, we discuss the different hypotheses for the origin of flat-topped volcanoes and propose a working hypothesis to explain the morphology on Idunn Mons.

Origin of flat-topped volcanoes: Formation of flat-topped volcanoes on Earth is an object of debate, which includes constructional and erosional formation hypotheses. The constructional hypotheses suggest: a) emplacements of a ring dyke that is the source of the flow that form the summit of the volcano [6]; b) infilling of a collapsed caldera; and formation of lava lakes on top of a volcanic edifice [7]. The erosional hypothesis suggests the flat-topped morphology of these volcanoes as the result of a multi—staged and complex history that involves alternating effusive and erosional episodes [8]. In the second theory, the erosion of the volcano produced the formation of a stepped topography over which late volcanic effusive materials are emplaced, mimicking the flat and stepped topography that resulted from the previous erosional stage.

Discussion of the flat-topped morphology of Idunn Mons: Idunn Mons summit lacks evidence of having circular fractures on its summit that would be an indication for the presence of ring dykes under the surface, as is the case for other Venusian and Martian volcanoes. A study of the volcano summit also discards the existence of infilled calderas or former lava lakes, making it difficult to explain the flat summit of the volcano as result of constructional processes.

Erosive processes are not exempted of problems, as a lack of surface water would prevent significative erosional processes on Venus. Nevertheless, an alternative mechanism to modify the volcano summit could be the occurrence of flank collapse-related events that would result in stepped-sided volcano edifice morphologies. In some volcanic edifices this steep-sided morphology is accompanied by the presence of a debris avalanche deposit on the volcano flanks, but in other cases these collapse-related deposits are postdated and covered, totally or partially, by late volcanic flows, but still preserve the flat-topped or steep-sided morphology [9].

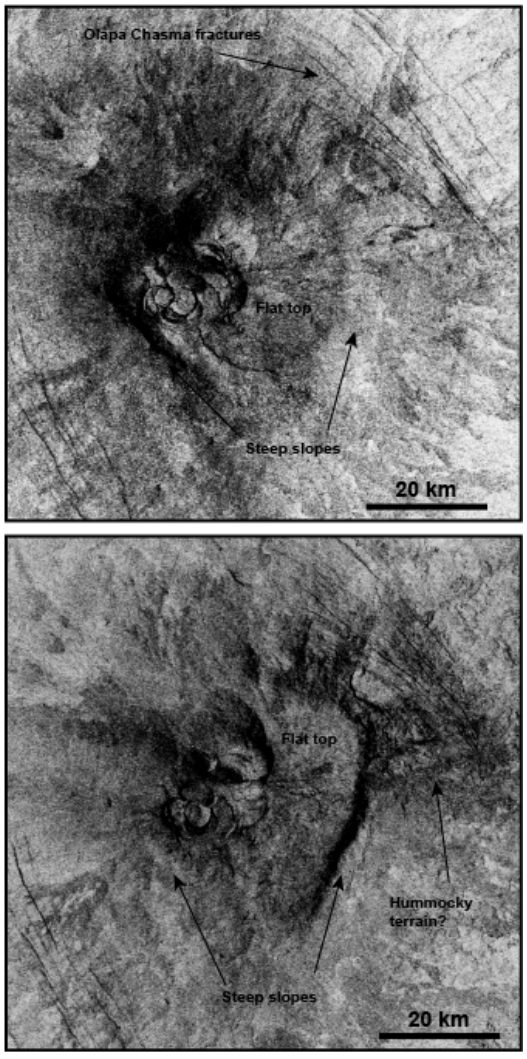

Figure 1. The Idunn Mons flat top or steep-sided summit. a) Inverted left-looking Magellan radar image. b) Inverted Right-looking Magellan radar image.

In the case of Idunn Mons no clear collapse-related deposits can be observed at the base of the summit, but right-looking radar images of the eastern part of the summit show the presence of high backscatter materials that could be interpreted as an embayed hummocky terrain related to a previous lateral flack collapse event (Figure 1b). There is also a small horse-shoe amphitheater in its eastern lower summit (Figure 1b) that could have resulted from a small lateral flank collapse event or is possibly a lateral parasitic vent partially embayed by younger flows sourced in the summit or in fractures in the lower volcano apron.

The existence of collapse events in the history of Idunn Mons could be closely related to the tectonic setting of the volcano. The history of Idunn Mons is contemporaneous with the formation of Olapa Chasma; flows of the volcano postdate fractures of the rift zone, but rift fractures also postdate the flanks and the summit of the volcano [2, 3]. This syn-tectonic character of Idunn Mons could explain the existence of local tectonic-related instabilities and lateral flank collapse events during the volcano evolution.

These lateral collapse events would predate the younger digitate flows that emanate from the summit and fractures on the volcano flanks, which have been interpreted as recent un-weathered materials [1,2,4,5]. These younger digitate volcanic flows may have draped over the previous flat-topped morphology of the volcano, resulting in the final morphology of this large shield volcano (Phases III and IV in Figure 2).

This working hypothesis suggests that the evolution of Idunn Mons is analogous to that of oceanic island volcanoes on Earth, with volcanic constructive phases that alternate with flank collapse episodes, resulting in a large volcanic shield with a flat-topped summit morphology.

If, as suggested by its emissivity, geologic and experimental data [1,2,3,4], Idunn Mons is an active volcano located in a possible active tectonic setting its evolution is far from being over, making of Idunn Mons an attractive study target for future missions such as EnVision and VERITAS [10,11], aiming to constrain the current volcanic and tectonic activities on Venus.

Acknowledgments: Magellan SAR data used in this work include Cycle 1 left-looking radar images and Cycle 2 right-looking radar images that are available online from the USGS Map-a-planet website (https://astrocloud.wr.usgs.gov/),

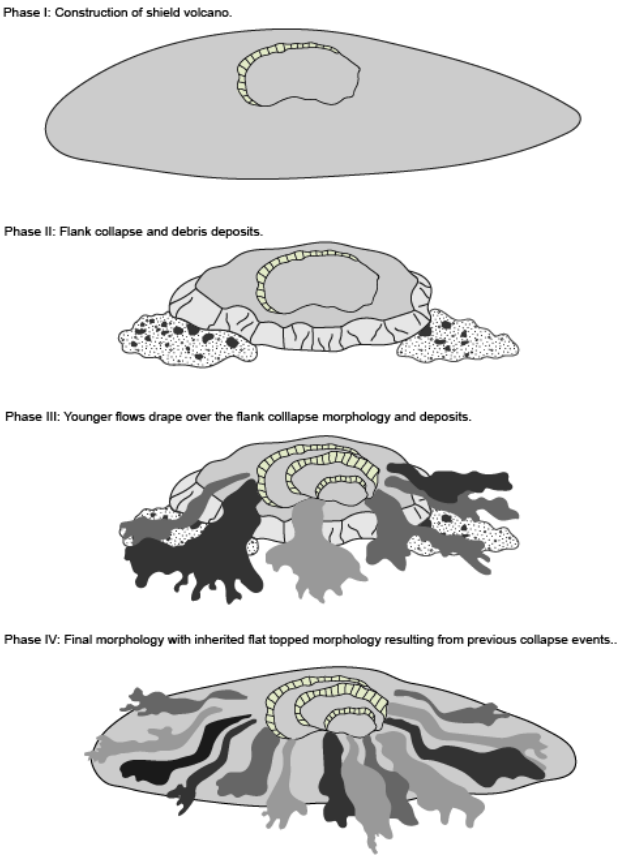

Figure 2. Model for the origin of flat-topped shield volcanoes on Venus. The resulting flat-topped summit would be a consequence of alternating phases of construction by volcanic flows and destruction of parts of the edifice by lateral flank collapse (After Rowland et al., 1994).

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