FUTURE ORBITING AND IN-SITU EXPLORATION OF VENUS: MOUNT ETNA AS TERRESTRIAL ANALOG. P. D'Incecco[1,2], J. Filiberto[3], G. Eggers[4], I. Lopez[5], N. Mari[6], C. Monaco[7], G. Leone[8], D. Gorinov[9], G. Di Achille[1], A. Martynov[10], P. Pisarenko[10], M. Cardinale[1] [1]National Institute for Astrophysics (INAF) Astronomical Observatory of Abruzzo, Teramo, Italy (piero.dincecco@inaf.it) [2]Arctic Planetary Science Institute (APSI), Rovaniemi, Finland [3]NASA Johnson's Space Center, Houston, TX, USA [4]Lunar and Planetary Institute, USRA, 3600 Bay Area Boulevard, Houston, TX 77058, USA [5]Departamento de Biología, Geología, Física y Química Inorgánica. Universidad Rey Juan Carlos, Madrid, Spain [6]Department of Earth and Environmental Sciences, University of Pavia, 27100 Pavia, Italy [7]Dipartimento di Scienze Biologiche Geologiche e Ambientali, Università di Catania, Italy; [8]Instituto de Investigación en Astronomía y Ciencias Planetarias, Universidad de Atacama, Copiapó, Chile; [9]Space Research Institute of the Russian Academy of Sciences, Moscow, Russia [10]Lavochkin Association, Khimki, Russia.

Introduction: The exploration of Venus will soon experience a new golden era thanks to the recently selected NASA Deep Atmosphere of Venus Investigation of Noble gases, Chemistry and Imaging (DAVINCI) mission, NASA Venus Emissivity, Radio Science, InSAR, Topography & Spectroscopy (VERITAS) mission, and ESA EnVision mission [1]. The DAVINCI mission will focus on the analysis of the the atmospheric vertical structure and composition of Earth's twin planet and on the geologic structure of a tesserae terrain. The VERITAS mission will investigate the geologic features of its surface as well as geodynamic characteristics of the subsurface, providing high-resolution emissivity data, a global radar map at an approximate resolution of 30 meters/pixel, and estimation of the gravity anomaly of the shallow crust of the planet [1]. The ESA EnVision mission will be complementary to the two NASA missions, providing high resolution 0.8-2.5 micron emissivity data, Synthetic Aperture Radar (SAR) data, and Subsurface Radar Sounder (SRS) data [2]. Beyond those, the proposed Roscosmos-NASA Venera-D mission will also be equipped with an orbiter that will investigate the atmospheric composition and circulation, as well as a lander that will analize the in-situ chemical composition and the surface-atmosphere interactions [1].

While preparing for the new missions being selected and proposed on Venus, it is crucially important to select analogue areas on Earth that may be suitable for a direct comparison with orbiting and in-situ surface data to be retrieved in the near future from the future missions to Venus. We recently proposed active volcanic areas of Venus, in particular Imdr Regio with its major volcanic structure Idunn Mons (figure 1), as the likely most suitable target area for future orbiting and in-situ investigations on Venus [3]. In this regard, we started the analysis and classification of the spectral features as well as chemical chararacteristics of the lava flow samples from potentially comparable terrestrial analogue locations, such as the Mount Etna composite volcano [4] (figure 2).

Mount Etna and other terrestrial volcanic structures as suitable analogue sites for the identification of active volcanism on Venus: Idunn Mons (figure 1) was recently identified as a potentially active volcano of Venus; this volcano was classified as a large volcano from previous works immediately following the NASA Magellan mission [5]. However, this classification is mainly based on the morphological features of the volcanic structures, and it is not related to the genetic processes connected to the formation of the volcanic structure or to the chemical composition of the associated lava flows.

Volcanism on Venus is generally considered to be associated to hotspot-like activity [6], though the possible occurrence of pyroclastic activity has been recently proposed (e.g., [7]). Idunn Mons (as well as other peculiar volcanic structures) on Venus is characterized by a flat topped summit and multiple caldera collapses and by radar bright and radar dark associated volcanic deposits [5,8], which may be linked to the textural characteristics of the fows: 'a'ā (relatively rougher) and pahoehoe (relatively smoother) lava flow eruptions, respectively.

Mount Etna is approximately 40 km in diameter, located along the Ionian coast of eastern Sicily, Italy [9] (figure 2). Mount Etna is characterized by multiple top caldera collapses and by an alternation of 'a'ā and pahoehoe lava flows, which may be comparable to radar bright and radar dark lava flows associated to Idunn Mons on Venus. The presence of these types of lava flows in the stratigraphic sequence of Mount Etna indicates the alternation of volatile-poor and volatile-richer eruptions during the volcanological history of this volcano [10].

Infrared spectral analysis: Idunn Mons and Mount Etna: The ESA Venus Express mission revealed high 1 micron emissivity anomalies on Idunn Mons, indicating chemically unweathered lava flows consisntent with recent volcanic activity over the top and the eastern flank of the volcanic structure [3,6,8]. While models have proposed an approximate age of about 500

thousand years for the most recent volcanic activity on Idunn Mons [11], more recent laboratory analyses on igneous minerals have better constrained such estimates, indicating that the highest emissivity anomalies may indicate lava flows not older than a few months to a few years [12,13].

We decided to first extract the near-infrared spectral features of a number of pahoehoe and ʻaʻā lava flow samples retrieved during a geological field trip to Mount Etna and compare them to the corresponding spectral signature of Idunn Mons, as observed by the VIRTIS instrument. The results are relatively consistent with the experimental results suggesting formation of alteration mineral coatings that mask the unweathered interior in the hundreds of years timeframe [4]

Outlook on future investigations: As a potential terrestrial analogue site for future Venus exploration, we propose Mount Etna and we will look for other Terrestrial basaltic stratovolcanoes as potential analogues, for both orbiting tests and in-situ investigation analysis, as well as to pursue safety checks for the Venera-D landing site selection.

References:

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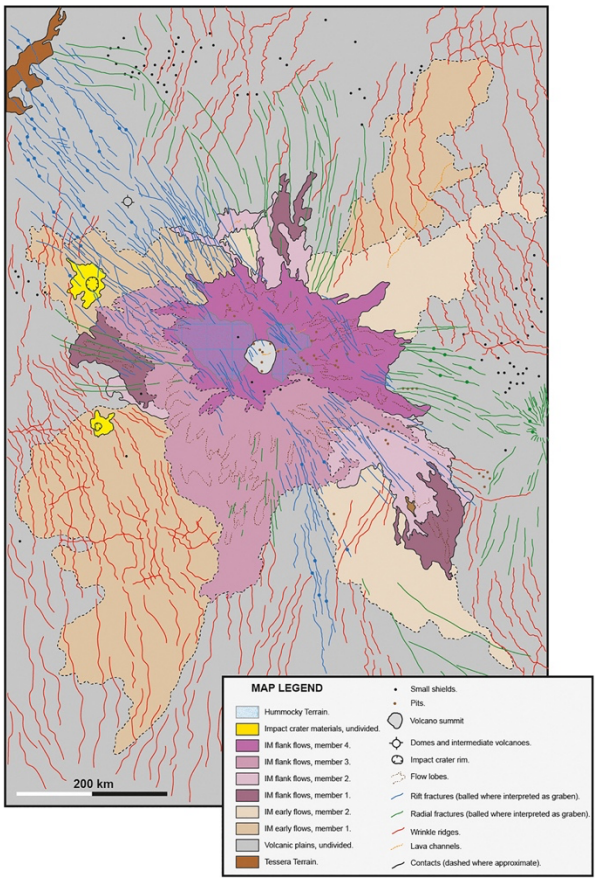

Figure 1- Structural map of Idunn Mons [5].

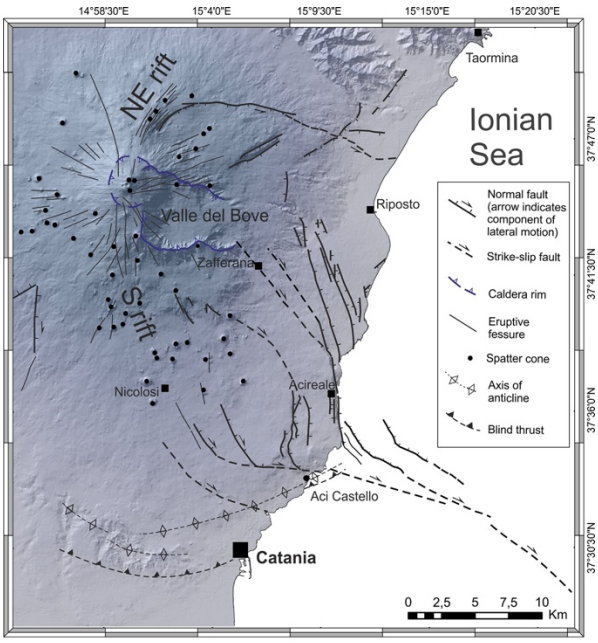

Figure 2 – Structural map of Mount Etna.