The Project "Analogs for VENus' GEologically Recent Surfaces" (AVENGERS): A Comprehensive Database of Terrestrial Active Volcanoes for the Analysis of Ongoing Volcanism on Venus.

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Introduction: The recently selected missions to Venus [1-4] have opened a new era for the exploration of the Earth's twin planet. As the Venus decade approaches, it is crucial to set the science goals for the future orbiting and in-situ investigations.

One of the key science targets on Venus is certainly represented by the young topographic rises [5], which can be defined as the surface expression of underlying mantle plumes [6]. These areas can be considered as the geologically youngest regions of Venus, being characterized by recent volcanic and tectonic activity [7-14].

Studying areas of active volcanism and tectonism on Venus is crucial because it can reveal clues on the geologic past of the planet, as well as provide information about the volatile content of its interior and about the formation of its dense atmosphere.

To this regard, the Project "Analogs for VENus' GEologically Recent Surfaces" (AVENGERS) aims to build a database of Terrestrial analog sites for the analysis and identification of recent and possibly ongoing volcanic as well as tectonic activity on Venus to be investigated by the future missions [15].

The Project AVENGERS will be a powerful tool for allowing a more efficient exploitation of the wealth of data to be provided by the future investigations of Venus during the upcoming decade.

Criteria of selection of the Project AVENGERS: Sites of ongoing volcanic activity on Earth will be a priority target in the project.

Indeed, the infrared and Raman spectral laboratory analysis (under Venus conditions) of lava flow samples from currently active volcanoes on Earth can help to test and identify the compositional similarities with regions of active volcanism on Venus and provide an estimate of absolute age through the oxidation rate.

Moreover, radar interferometry over volcanically active areas on Earth can be used to evaluate changes in topography and in the areal extent of the lava flows in short amounts of time because of possibly ongoing eruptions. The comparative analysis of the radiometric properties of Terrestrial lava flows of known composition can also allow inference of composition and relative age of the observed lava flows on Venus.

Another important parameter to be considered is the ease of access. Easily accessible volcanic sites on Earth can be used as test areas for drilling operations and in situ elemental analyses to be performed in preparation of the future missions to Venus.

Mount Etna and other possible analog sites: In consideration of the listed selection criteria, we selected Mount Etna as a first analog site for the Project AVENGERS [16].

Mount Etna (37° 30′ to 37°55′ North, 14°47′ to 15°15′ East, fig. 1) located in Sicily, Italy is the largest and most active volcano in Europe [17]. It is a composite volcano characterized by multiple phases of effusive and explosive volcanism [17].For these reasons, Mount Etna offers the unique opportunity to study at the same time a wider range of possible eruptive styles, both helping us in the identification and study of active effusive volcanism and possible occurrence of pyroclastic activity on Venus.

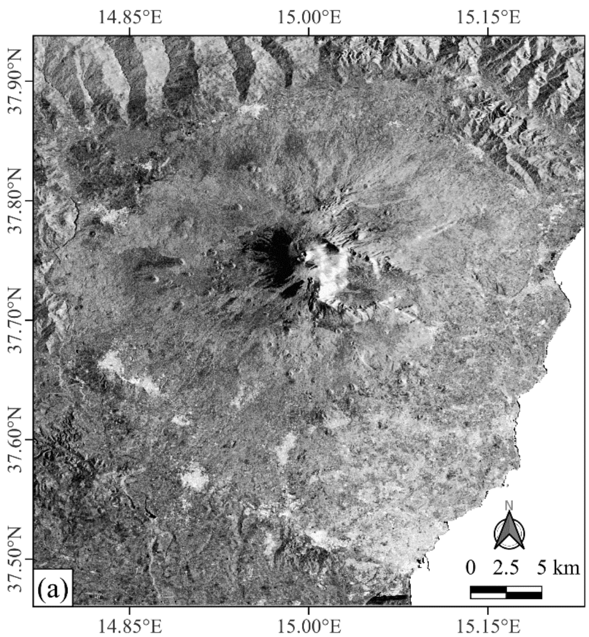

Figure 1: Mt. Etna, Sicily, Italy. ESA Sentinel-1 C-Band, GRDH SAR Ascending, with resolution of ~75m (downsampled using a bi-linear interpolation for consistency with the nominal resolution of Magellan SAR data).

We are currently using Mount Etna as a Venusian analogue for laboratory studies, extracting Raman and infrared spectra from a number of lava flow samples, as well as for radar interpretation (fig. 2).

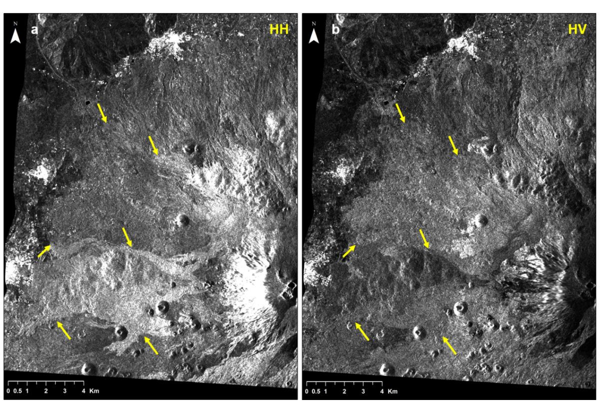

Figure 2: RISAT-1A C-band SAR data of Mt. Etna region shown here in a) HH, b) HV polarizations at 4 m/pixel resolution. Arrows highlight the extents and boundaries of historical and recent lava flows that have a suite of textures (a'a to pāhoehoe). Notice the high degree of unit discrimination in the HV-pol data compared to the HH-pol data, since the HV-pol echoes are more sensitive to surface roughness at all incidence angles.

Given its ease of access, Mount Etna also represents a suitable landing site analog area for the preparation of the drilling operations and in-situ elemental analyses to be performed by future Venus landers.

Besides Mount Etna, several suitable analog volcanic sites will be analyzed. For example, another suitable area is represented by the East African Rift System (EARS) (10° North, 40° East), an active rift zone located in East Africa with multiple volcanoes that could be potential analogues. Given its particular volcano-rift interaction, the EARS can help us to better study the mechanism behind the formation of volcano-rift systems, which are considered to be the most recently active areas on Venus.

In addition, we are working on a list of 43 volcanic areas on Earth that have the same major-element geochemistry as reported by the Venera-13, Venera-14, and Vega-2 missions.

Other suitable analog sites may be represented by submarine volcanoes. Indeed, submarine eruptions under high pressures on Earth can be considered as an interesting comparison for Venusian eruptions, as they occur under high atmospheric pressures.

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