INTRODUCING THE "ANALOGS FOR VENUS' GEOLOGICALLY RECENT SURFACES" INITIATIVE: AN OPPORTUNITY FOR IDENTIFYING AND ANALYZING RECENTLY ACTIVE VOLCANO-TECTONIC AREAS OF VENUS TROUGH A COMPARATIVE STUDY WITH TERRESTRIAL ANALOGS

P. D'Incecco[1], J. Filiberto[2], J.B. Garvin[3], G.N. Arney[3], S.A. Getty[3], I. López[4], R. Ghail[5], P. Mason[6], L. M. Zelenyi[7], L.V. Zasova[7], M.A. Ivanov[8], D.A. Gorinov[7], J. Brossier[9], S. Bhattacharya[10], S.S. Bhiravarasu[10], D. Putrevu[10], C. Monaco[11,12], S. Branca[12], D. Trang[13], J.R. Crandall[14], S. Aveni[15], G.L. Eggers[16], N. Mari[17], M. Blackett[18], G. Komatsu[19], A. Kosenkova[20], G. Di Achille[1]

[1] *National Institute for Astrophysics – Astronomical Observatory of Abruzzo, Teramo, Italy, piero.dincecco@inaf.it*
[2] *Astromaterials Research and Exploration Science Division, NASA Johnson Space Center, Houston, TX, 77058, USA*
[3] *NASA Goddard Space Flight Center, Greenbelt, USA*
[4] *Departamento de Biología, Geología, Física y Química Inorgánica. Universidad Rey Juan Carlos, Madrid, Spain*
[5] *Earth Sciences, Royal Holloway, University of London, Egham, United Kingdom*
[6] *Department of Earth Science and Engineering, Imperial College London, Prince Consort Road, London, United Kingdom*
[7] *Space Research Institute RAS, Moscow, Russia*
[8] *Vernadsky Institute of Geochemistry and Analytical Chemistry RAS, Moscow, Russia*
[9] *National Institute for Astrophysics – Institute for Space Astrophysics and Planetology, Rome, Italy*
[10] *Space Applications Centre, Indian Space Research Organization, Ahmedabad, India*
[11] *Dipartimento di Scienze Biologiche Geologiche e Ambientali, Università di Catania, Catania, Italy*
[12] *Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Etneo — Sezione di Catania, Italy*
[13] *Hawai'i Institute of Geophysics and Planetology, University of Hawai'i at Mānoa, Honolulu, USA; Space Science Institute, Boulder, USA*
[14] *Eastern Illinois University, Department of Geology and Geography, Charleston, IL, USA*
[15] *Department of Civil, Constructional and Environmental Engineering, Sapienza University of Rome, Italy*
[16] *Lunar and Planetary Institute, USRA, Houston, TX, USA*
[17] *Department of Earth and Environmental Sciences, University of Pavia, Pavia, Italy*
[18] *Centre for Agroecology, Water and Resilience, Coventry University, United Kingdom*
[19] *Università G. d'Annunzio, Pescara, Italy*
[20] *Bauman Moscow State Technical University, Moscow, Russia*

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INTRODUCTION:

Several missions to Venus have been recently selected for launch [1–6], opening a new era for the exploration of the planet. One of the key questions that the future missions need to address is whether Venus is presently volcanically active [7–15]. Studying areas of active volcanism and tectonism on Venus is crucial to reveal clues about the geologic past of the planet, as well

as provide information about the volatile content of its interior and the formation of its dense atmosphere. The "Analogs for VENus' GEologically Recent Surfaces" (AVENGERS) initiative aims to build a comprehensive database of terrestrial analog sites for the comparative study of recent and possibly ongoing volcanic activity on Venus. Besides its scientific relevance, the AVENGERS initiative also acts as a bridge for international scientific collaboration, including the leadership and/or team members from the currently selected missions to Venus.

MAIN OBJECTIVES OF THE AVENGERS INITIATIVE:

COMPARATIVE STUDY THROUGH GEOLOGIC MAPPING AND STRATIGRAPHIC RECONSTRUCTION AT REGIONAL LEVEL OF THE SELECTED VOLCANIC STRUCTURES:

Using GIS tools, we are performing morpho-structural mapping and topographic analysis of the selected volcanic structures both on Earth and on Venus. For the geologic interpretation and mapping, we are using radar images of both terrestrial and Venusian volcanoes.

DATING VENUSIAN VOLCANIC ACTIVITY USING ALTERATION OF TERRESTRIAL ANALOG SITES:

Orbital spectroscopy of weathered versus fresh lava flows, specifically the 1-micron absorption band in nighttime emissivity, has been suggested as a tool for age dating lava flows [refs]. Therefore, several lava flow samples of different age, texture, and alteration state have been and will be retrieved during the field trips on easily accessible volcanic structures, such as Mount Etna or Kīlauea. The retrieved samples from Mount Etna are currently being analyzed with the infrared spectrometer of the laboratories at the Lunar and Planetary Institute (TX, USA) (Eggers et al.).

RADIOMETRIC PROPERTIES AND INTERFEROMETRY (CHANGE DETECTION) ANALYSIS ON ACTIVE VOLCANOES ON EARTH AND ON VENUS:

The analysis of the radiometric properties (i.e., radar emissivity, dielectric constant) can also inform about composition and relative age of volcanic surface deposits [11–13]. For this reason, we will use variations in radar emissivity on active volcanoes on Earth as a further parameter to identify areas of possibly ongoing volcanism on Venus.

CRITERIA OF SELECTION OF THE AVENGERS INITIATIVE:

In the project, three main criteria of selection will be considered: a) Sites of ongoing volcanic activity on Earth, b) Ease of access, and c) Applicability of bulk composition.

ANALOG SITES ON EARTH FOR THE IDENTIFICATION AND STUDY OF RECENT VOLCANO-TECTONIC ACTIVITY ON VENUS:

At the present state, we selected four active volcanoes on Earth that may represent suitable "end-member" analogs for covering a good part of the spectrum of possible types of active volcanism and volcanic products on Venus that may be identified with the new datasets from the future missions.

MOUNT ETNA: A SUITABLE ANALOGUE FOR ITS VARIETY OF VOLCANIC PRODUCTS AND ITS EASE OF ACCESS:

Mount Etna (37°30' to 37°55' N, 14°47' to 15°15' E) located in Sicily, Italy is the largest and most active volcano in Europe (i.e., [18–19]). It is a composite volcano characterized by multiple phases of effusive and explosive volcanism (i.e., [18–19]). For these reasons, Mount Etna offers the unique opportunity to study at the same time a wider range of possible eruptive styles. 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's landers.

KĪLAUEA: A SUITABLE TERRESTRIAL END-MEMBER FOR THE STUDY HOTSPOT-LIKE VOLCANISM ON VENUS:

Kīlauea (19° N, 155° W, Figure 1) located in Hawai'i, USA, is an active shield volcano fed by a magma reservoir arriving up to 60 km depth. Kīlauea is an example of terrestrial hotspot volcanism, thus not related to the interaction between the tectonic plates. The hotspot style of volcanism has been fre-

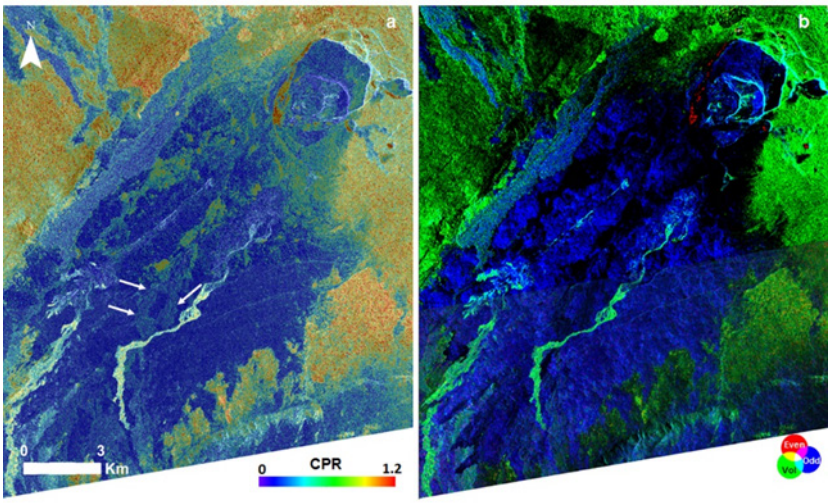

Fig. 1. Kīlauea region shown here in a) circular polarization Ratio (CPR) and b) NNED images. These polarimetric products are generated from RISAT-1A C-band SAR data at a resolution of 7 m/pixel. The CPR image is stretched to a colour scale and overlaid on HV-pol data and the colour wheel in the decomposition image *(*b) highlights the colours for each scattering regime (red: even bounce; blue: single (odd) bounce; green: volume/diffuse scattering). Notice the December 1974 pāhoehoe flows (indicated with arrows in (a)) that have a CPR contrast with the background and are not readily visible from other polarization images

quently used to describe volcanism on Venus, since this planet does not show clear evidence of Earth-like plate tectonics. For this reason, active hotspot volcanoes, such as Kīlauea, can be used as a suitable terrestrial analog for identifying active volcanism on Venus. Moreover, Kīlauea is also easily accessible, so that it is possible to retrieve lava flow samples for laboratory analyses.

EAST AFRICAN RIFT SYSTEM AS A SUITABLE ANALOG FOR VOLCANO-RIFT SYSTEMS ON VENUS:

Another suitable area is represented by the East African Rift System (EARS) (10° N, 40° E, Figure 7), an active rift zone located in East Africa with multiple volcanoes that could be potential analogues. The EARS is a divergent plate boundary, where the African plate is being split into two parts. Given its structural frame, the EARS can help us to better study the mechanism behind the formation of the volcano-rift systems, which can be considered among the most recently active areas on Venus.

MOUNT MERAPI: AN OPPORTUNITY FOR STUDYING PLUME-INDUCED "CRUSTAL-RECYCLING" VOLCANISM ON VENUS:

Mount Merapi (7° S, 110° E) in Indonesia is also a terrestrial analog site that we intend to investigate. It is the most active stratovolcano of Indonesia, and it is the youngest of a group of volcanoes situated in southern Java. It is located at the "subduction zone" where the Indo-Australian plate is subducting under the Sunda plate. Despite Venus the lack of evidence of Earth-like plate tectonics today, some spatially limited plume-induced crustal recycling activity cannot be excluded on Venus [20]. For this reason, it is also important to analyze an active subduction zone explosive volcano like Mount Merapi.

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