MAPPING THE DAVINCI PROBE DESCENT IMAGING CORRIDOR AND TOUCHDOWN ZONE: ALPHA REGIO, VENUS.
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Introduction: With similar size, density, and distance from the Sun as Earth, Venus's climate may have in its earliest history been habitable [1,2]. Venus's high deuterium-to-hydrogen (D/H) ratio suggests that it has lost a significant amount of water since it first formed [3]. It is possible that a liquid water ocean once existed on the planet for billions of years [4]. Covering ~8% of what is presumed to be an almost entirely volcanically resurfaced planet, the tesserae are the oldest identifiable terrain that may record Venus's early crustal and climate history [5]. The tesserae may be more felsic (silica-rich) in composition than the surrounding plains material based on relatively low near-infrared (NIR) emissivity values measured in previous Venus missions [5,6]. The target area for the DAVINCI in situ probe, Alpha Regio, is an example of a region of tesserae that preserves these lower emissivity values and may contain morphological and/or compositional evidence of water-rock interactions from Venus's ancient past. Here we create a high-resolution map of the Alpha Regio tessera terrain, over which the DAVINCI mission will collect descent image data during its trajectory to the surface. Such descent imaging will include both composition and relief information at scales finer than a few meters.

Current understanding of the surface geology of Alpha Regio comes almost exclusively from Magellan radar imagery at ~100 m resolution [7]. The Venus Descent Imager (VenDI) onboard DAVINCI is capable of imaging the surface of Venus at a much higher resolution of ~ m/pixel scale from about an altitude of 35 km to the surface beneath the cloud deck [8]. VenDI includes two channels in the NIR (0.74-1.04 μm and 0.98-1.04 μm), that will allow the discrimination of compositional units on the tesserae. VenDI will increase the scale and precision at which we can study the tesserae terrain in Alpha Regio, provide surface composition measurements, and have the capability to create digital elevation models (DEM) for morphologic and structural observations [9].

Here we report upon detailed geological mapping of Alpha Regio using Magellan data. Our goal is to provide context for images that will be taken during the DAVINCI mission. The DAVINCI team are also working on a pseudo-topography model (PTM) of Alpha sampled on a 1 km x 1 km grid using the 3 best Arecibo Earth-based radar observations and controlled by Magellan ARCDR topographic footprints.

Data: The basemap is the Global Left Look Magellan mosaic at ~75 m/pixel resolution is clipped to the Alpha Regio region and augmented thus far by the Global Topography data at 4641 m/pixel scale resolution. The publically-available datasets are downloaded from Map-A-Planet 2 (https://astrogeology.usgs.gov).

Geologic Mapping: Mapping is performed manually in ArcGIS Pro. We report here the results for a ~65 km x 115 km section (Fig. 1) within the DAVINCI target descent imaging corridor ellipse (~100 x 350 km).

Map Units: Map units are identified based on varying levels of radar backscatter and deformation patterns including the type, size, spacing, orientation and order of structure(s), according to USGS guidelines [10]. The relative timing and order of units is determined by examination of cross-cutting and embayment relationships and superposition. Contacts are generally defined by embayment relationships between materials with different backscatter properties, where termination of structures can help in contact recognition.

Mapping of Structures: Structures are classified as either graben, ridge, trough, or lineament. Grabens are mapped in the left-looking radar image where a steep, dark-toned slope is seen on the left wall and a brighter-toned wall is found parallel on the opposite side. Ridges and troughs are mapped as alternating radar bright (ridge) and dark (trough) features that typically run perpendicular to the grabens and are long and sinuous. Topography data and the foreshortening of intersecting grabens was used to infer ridge and trough topography. Lineaments are assigned to any prominent features that are not otherwise categorizable.

Results: The topography of the region is dominated by NW/SE trending ridges and troughs indicating NE/SW compression. We have identified seven units in the study area and describe them here in stratigraphic order. The *tectonized* unit has pervasive fabric of ridge-parallel lineaments cut by perpendicular lineaments, some of which can be confirmed to be of extensional origin. *Complex material* is defined by multiple randomly intersecting lineaments, ridges and grabens. The complex and tectonized units are spatially associated with, and likely preserved atop of, the NW – SE trending ridges. These units are embayed by all units with which they are in contact. The *densely and moderately lineated* materials display parallel lineations

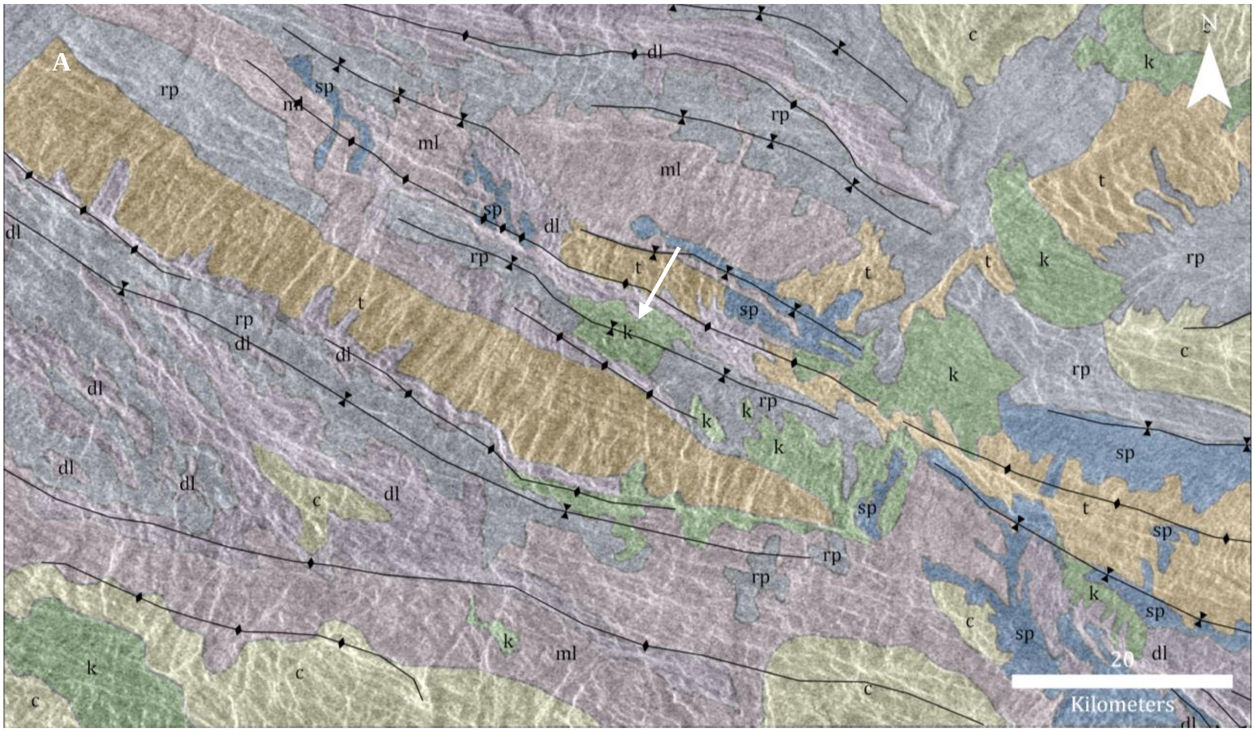
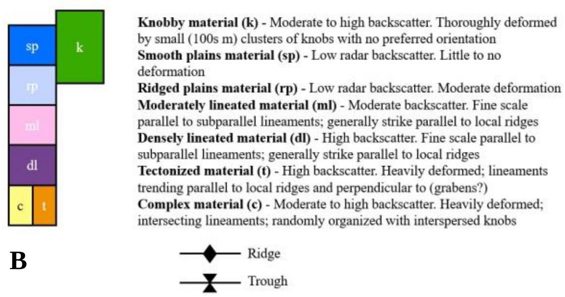


Figure 1. (A) Preliminary geologic map of a section of the target area of the DAVINCI probe in Alpha Regio. Arrow indicates location of possible landslide deposit. (B) Definition and stratigraphic column of defined units.



that are themselves parallel to local ridges. The densely lineated materials have a higher backscatter than the moderately lineated. Both units embay the complex and tectonized units where they are in contact.

Two plains units are defined by having low backscatter, flow morphologies and little to no structural deformation. The *ridged plains* appear to be flows embaying all the older units and have undergone a moderate amount of deformation. The *smooth plains* subsequently embayed the ridged plains and other surrounding units. They are characterized by being the least deformed unit on the map, and are generally found in the troughs.

Lastly, the *knobby materials* consist of closely but irregularly spaced knobs (~100s m) amidst materials of moderate backscatter. The stratigraphic position of these materials relative to the plains units is unclear. Their morphology is consistent with rubble associated with impacts, small volcanoes or mass wasting deposits. One example of a possible landslide is seen in the center of Fig. 1, where the knobby unit is found along the walls at the base of a trough and separates two regions of ridged plains. Continued mapping is required to determine if knobby materials have a common origin.

Conclusions: This sub-area of Alpha Regio shows evidence of many episodes of emplacement and deformation at the 5-100 km scale. An early ridge forming phase preserves deformed materials, which are embayed by multiple units that are themselves deformed. The boundaries of the post-ridge forming units are sinuous (typical of embayment) and, in many places, thick enough to cover preexisting structures. Late-stage plains materials occupy structural troughs. We identify at least one recent landslide deposit, ~ 10 x 10 km, associated with steep topography. New PTM data can be combined with this analysis to further the geologic interpretations.

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