GLOBAL GEOLOGIC MAP OF VENUS: A RESOURCE FOR VENUS EXPLORATION PLANNING AND SITE SELECTION. M.A. Ivanov[1,2], J.W. Head[2], and A.T. Basilevsky[1,2] [1]Vernadsky Institure, RAS, 119991 Moscow, mikhail_ivanov@brown.edu, [2]Brown Uniwersity, Providence RI 02912, USA,.

Introduction: The history of geological mapping of the Earth and planets illustrates the importance of utilizing the *dual stratigraphic classification* approach to geological mapping. The development of the dual stratigraphic classification emphasized two distinctive stratigraphic units: (1) definition and mapping of rock units based on an objective description of their observable characteristics *independent of a broader interpretative paradigm*, and (2) groupings of strata distinguished on the basis of their position in geologic time. This approach was the basis for compilation of a global geologic map of Venus at a scale of 1:10M.

Units and structures mapped: Using Magellan radar image and altimetry data, supplemented by Venera 15/16 radar images, we identified fifteen distinctive units on the surface of Venus and a series of structures and related features. Images of higher resolution (C1-MIDR and F-MIDR) were used to define units [1-3]. The following material units and tectonic structures (in order from older to younger) describe the geological configurations throughout the map area (Fig. 1): *Tessera (t)* displays multiple sets of tectonic structures. *Densely lineated plains (pdl)* are dissected by numerous subparallel narrow and short lineaments. *Ridged plains (pr)* commonly form elongated belts of ridges. *Mountain belts (mt)* resemble ridge belts and occur around Lakshmi Planum. *Shield plains (psh)* have numerous small volcanic edifices on the surface. *Regional plains* were divided into the *lower (pr_1)* and the *upper (pr_2)* units. The lower unit has uniform and relatively low radar albedo; the upper unit is brighter and often forms flow-like occurrences. *Shield clusters (sc)* are morphologically similar to psh but occur as small patches that postdate regional plains. *Smooth plains (ps)* have uniform and low radar albedo and occur near impact craters and at distinct volcanic centers. *Lobate plains (pl)* form fields of lava flows that are typically undeformed by tectonic structures and are associated with major volcanic centers. Materials related to impact craters were divided into two units: *crater materials, unit c*, which includes floor, wall, rim, and contiguous ejecta of craters; *crater flows, unit cf*, which includes radar-bright flows from impact craters.

Specific structural assemblages accompany the material units: Tessera-forming structures (ridges and grooves), ridge belts, *groove belts (structural unit gb)*, wrinkle ridges, and *rift zones (structural unit rz)*. The tessera-forming structures and ridge belts predate vast plains units such as psh and rp1. Groove belts postdate tessera and ridge belts. Shield plains and regional plains mostly embay groove belts. In places, groove belts appear to form contemporaneously with the vast plains units. Wrinkle ridges deform all material units predating smooth and lobate plains. Rift zones appear to be contemporaneous with sc, pl, and ps and cut older units.

Global stratigraphy: Units that make up the surface of Venus and portrayed in the global map are arranged in repeating age sequences that can be traced from small areas to regional and global scales. Consistent relationships of relative ages permit construction of the local to regional stratigraphic columns, their correlation by the most extensive and ubiquitous units, and, finally, compilation of the local stratigraphic sequences into a global stratigraphic column characterizing entire planet. On the basis of unit superposition and stratigraphic relationships, we interpret the sequence of events and processes recorded in the global stratigraphic column.

The earliest part of the history of Venus (Pre-Fortunian) predates the observed surface geological features and units, although remnants may exist in the form of deformed rocks. We find that the observable geological history of Venus can be subdivided into three distinctive phases. The earlier phase (Fortunian Period, its lower stratigraphic boundary cannot be determined with the available data sets) involved intense deformation and building of regions of thicker crust (tessera). This was followed by the Guineverian Period. Distributed deformed plains, mountain belts, and regional interconnected groove belts with most of coronae formed during this time. Fortunian Period and the first half of Guineverian Period correspond to Global tectonic regime (Fig. 2) when tectonic deformation dominated [4]. The second part of the Guineverian Period (Global volcanic regime [4], Fig. 2) involved global emplacement of vast and mildly deformed shield and regional volcanic plains. The third phase (Atlian Period, which corresponds to Network rifting-volcanism regime [4], Fig. 2) involved the formation of prominent rift zones and fields of lava flows (lobate plains) that are often associated with large shield volcanoes and, in places, with earlier-formed coronae. Atlian volcanism may continue to the present [5-7]. About 70% of the exposed surface of Venus was resurfaced during Global tectonic and volcanic regimes and only about 16% during Network rifting-volcanism regime. Estimates of model absolute ages suggest that the Atlian Period was about twice as long as the Guineverian and, thus, characterized by significantly reduced rates of volcanism and tectonism. The three major phases of activity documented in the global stratigraphy and geological map, and their interpreted temporal relations, provide a basis for assessing the geodynamical processes operating earlier in Venus history that led to the preserved record.

Conclusions: The Magellan SAR images provide sufficient data to compile a global geological map of Venus. This global map can serve as a resource for planning future exploration and as an important document to address vital questions of the geologic history of Venus. 1) What units/structures characterize the surface [1,8,9]? 2) What volcanic/tectonic processes do they represent [10-13]? 3) Did these processes operated globally or locally [2,3,14,15]? 4) What is the relative/absolute timing of these processes and related units [16-18]? 5) What model(s) of heat loss and lithospheric evolution [19-25] do these processes/units represent?

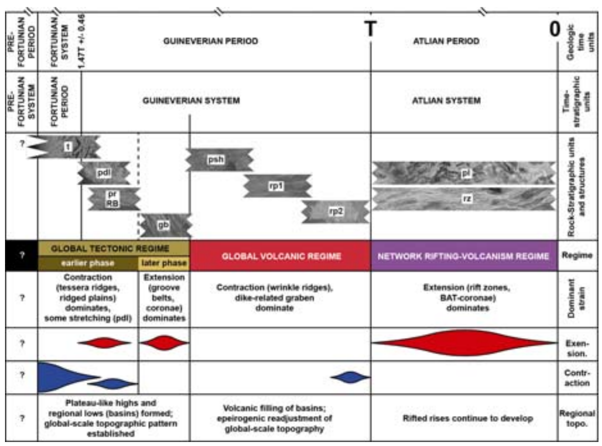

Fig. 2. Resurfacing regimes

Answering these questions requires the future orbital and lander missions to Venus. The global geological map serves as a guide for selection of key regions for detailed study and in-situ sampling.

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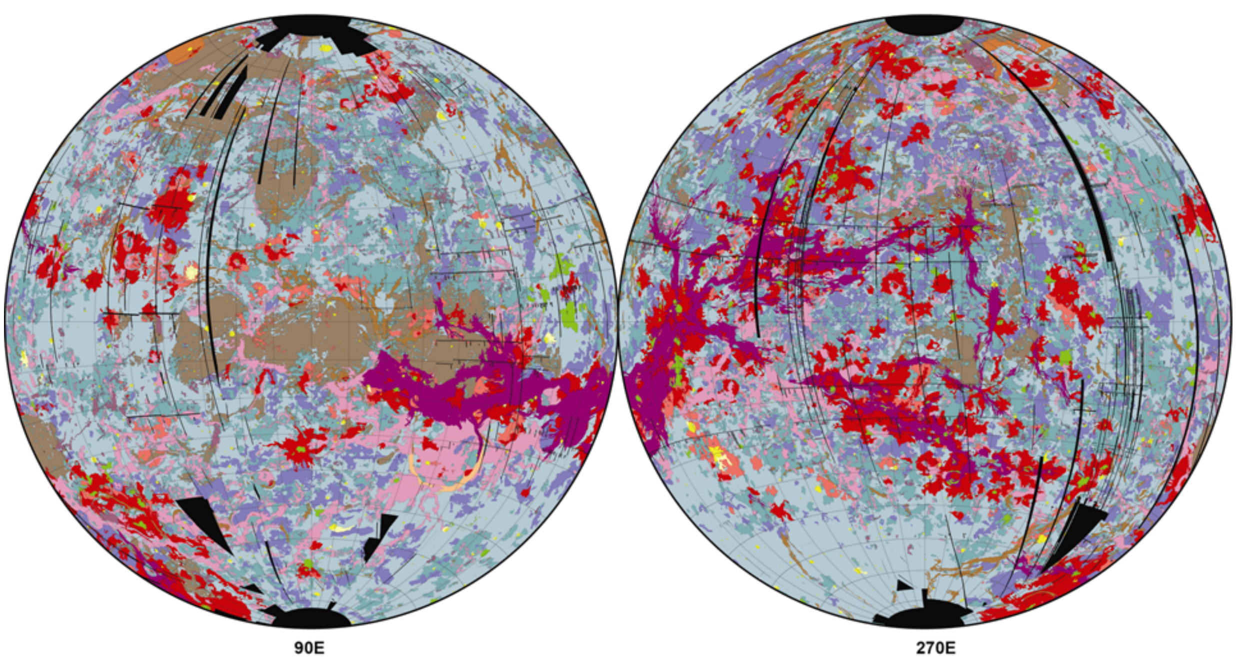

Fig. 1 Global geological map of Venus.