GLOBAL GEOLOGICAL MAP OF VENUS: PRELIMINARY RESULTS. M. A. Ivanov, Vernadsky Institute, RAS, Moscow, Russia (Mikhail_Ivanov@brown.edu).

Introduction: The Magellan SAR images provide sufficient data to compile a geological map of nearly the entire surface of Venus. Such a global and self-consistent map would serve as an important document to address many key questions in the geologic history of Venus. 1) What units/structures characterize the surface [1-3]? 2) What volcanic/tectonic regimes do they represent [4-7]? 3) Did these regimes occur globally or locally [8-11]? 4) What are the relative time relationships among the units [8]? 5) Are these relationships consistent regionally or globally [8-10]? 6) What is the absolute timing of formation of the units [12-14]? 7) What is the history of the long-wavelength topography and geoid? 7) What model(s) of heat loss and lithospheric evolution [15-21] does this history represent? The ongoing USGS program of Venus mapping has already resulted in a series of published maps at the scale 1:5M [e.g. 22-30]. These maps have a patch-like distribution, however, and are being compiled by authors with different mapping philosophy that are not always in agreement with each other in terms of mapped units and their relationships. Here the preliminary results of global geological mapping of Venus at the scale 1:10M is presented, representing the current status of a global mapping project. The map represents a contiguous area extending from 82.5°N to 22.9°S and comprises ~70% of the planet. The new map permits one to address some of the questions raised above.

Mapping procedure: For the initial mapping analyses, images of high resolution (C1-MIDR and F-MIDR) were used to define units [1,9,11]. The map was then compiled on C2-MIDR sheets, the resolution of which permits identifying the basic characteristics of previously defined units. The higher resolution images were again used during the mapping to clarify geologic relationships. When the map was completed, its quality was checked using published USGS maps [e.g., 22-30] and the catalogue of impact craters [31]. The results suggest that the mapping on the C2-base provided a high-quality map product.

Units and structures: A set of material units and tectonic structures describes the geological configurations throughout the map area (Fig. 1). The complete stratigraphic column consists of the following units (from older to younger): *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.

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 rt). The tessera-forming structures and ridge belts predate vast plains units such as psh and rp_1. 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.

Crater statistics: Two factors, the atmosphere screening [32-34] and the observational bias [35], appear to affect the statistics of the smaller (8-16 km) craters. For the larger craters these factors are negligible and craters >8 km were used to estimate the crater density on mapped units. The shape and size of occurrences of units may also affect the crater statistics on Venus where the total number of craters is small. To minimize influence of this factor the crater density on large and contiguous units that have quasi-equidimensional occurrences was estimated. Sometimes, the small total number of craters on Venus impels to combine some units into one in order to increase reliability of the crater statistics. The generally similar nature of units t, pdl, pr, and gb (heavily tectonized) and their consistent relationships with the vast plains units (embayed) permit to combine them into one, the tectonized terrains unit. Both sub-units of regional plains were also united into one. Thus, craters were counted on five units: tt (tectonized terrains: t+pdl+pr+gb), psh, rp, pl, and rt that make up ~95.8% of the map area. The mean densities (craters per $10^6 km^2$) of craters on these units are as follow: <u>tt</u> 1.70 (±0.27, two σ); <u>psh:</u> 1.62 (±0.28); <u>rp:</u> 1.63 (±0.18); <u>pl:</u> 0.84 (±0.29); <u>rt:</u> 0.98 (±0.40). The mean density of craters (>8 km) in the map area (all units) is 1.56. If the mean crater density corresponds to the mean surface age, T [19], then the ages of the above units as fractions of T are: <u>tt:</u> 1.09

(±0.17, two σ) T, psh: 1.04 (±0.18) T, rp: 1.05 (±0.12) T, pl: 0.54 (±0.19) T, rt: 0.63 (±0.26) T.

These results are consistent with the mapped stratigraphic relationships and indicate that there are two groups of units: The older units (from t to rp) are densely clustered around 1.06 T and the younger units (pl, rt) were formed around 0.59 T. The exposed area of the older units is ~81.7% of the map area (the true area must be larger) and the younger units cover ~14.1% of the surface. Depending upon the estimates of the absolute value of T (from 750 Ma [36] through 500 Ma [37] to 300 Ma [38]), it is possible to estimate the duration of specific periods in the observable geologic history of Venus. The older units appear to form during a relatively short time, from 300 m.y (T = 750 Ma) to 120 m.y (T = 300 Ma). The minimum integrated resurfacing rate (both volcanic and tectonic) at this time was from ~1.2 to ~3.1 km^2/y. The younger units spanned the longer time interval and the integrated resurfacing rate during their formation was from ~0.2 to ~0.4 km^2/y. The distinct age clustering of units from both groups significant drop in the resurfacing rates suggest that the older and the younger units correspond to two different geodynamic regimes that were probably related to different patterns of mantle convection and lithospheric properties.

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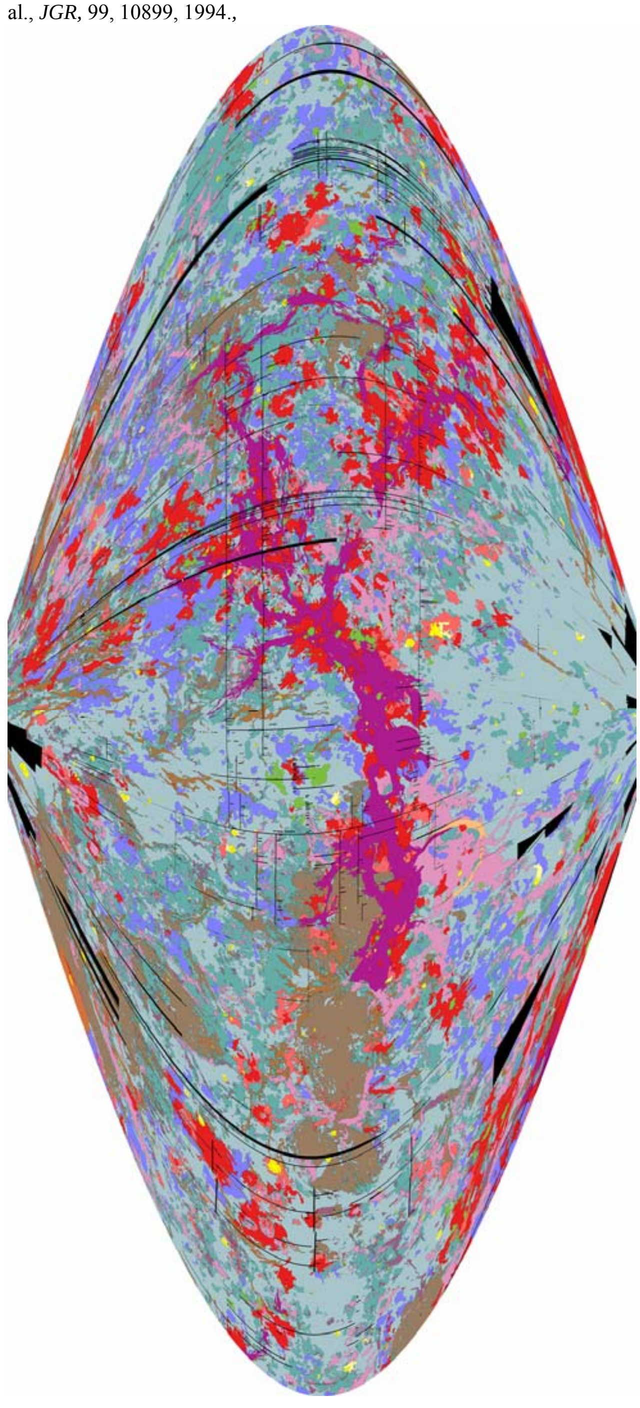

Fig. 1. Geological map of Venus. Scale is ~1:10M; Lambert equal-area projection