VENUS: ESTIMATES OF ABSOLUTE TIME DURATION OF ASTRA-NOVAE ACTIVITY. A.T. Basilevsky[1], M. Aittola[2], J. Raitala[2] and J.W. Head[3], [1] Vernadsky Institute, Moscow, Russia atbas@geokhi.ru, [2] Astronomy, Oulu University, Finland, [2] Dept. of Geological Sciences, Brown University, Providence, R.I., USA

Introduction: Astra (single Astrum, another term Nova, Novae) are radial (stellate) fracture centers typically 100–300 km in diameter identified in early analysis of the Magellan images of Venus [e.g., 1-3]. They are often present as an internal part of coronae and considered by some researchers as a possible phase of corona formation and/or evolution [e.g., 4-8]. Astra often show evidence of associated volcanism and are considered to form (like coronae) as a result of the emplacement of hot mantle diapirs into the lithosphere [e.g., 2, 4]. Many astra (again like coronae) show evidence that they started to form early in the morphologically recognizable part of the geologic history of Venus (before the emplacement of wrinkle-ridged regional plains) and continued their evolution into post-regional-plains time [8-10].

In this work we try to estimate semiquantitatively the absolute lifetime of several astra from the most ancient recognizable phases of their evolution up to the most recent ones. For this analysis we use two kinds of absolute time markers. One is the estimate of the mean age of the wrinkle-ridged regional plains which was found by Basilevsky and Head [11, 12; see also discussion in [13] to be close to the mean surface age of Venus (**T**) estimated as ~ 0.5-1 b.y. [14-16]. Another time marker used is the degree of preservation of crater-associated radar-dark halos. It was shown in a number of studies that craters having radar-dark parabolas (DP) are the youngest and formed more recently than ~0.1-0.15**T** ago, craters having a clear (but not parabolic) halo (CH) formed more recently than ~0.5**T** ago (but before 0.1-0.15**T** ago) and craters having a faint halo (FH) or no halo (NH) formed before ~0.5**T** ago [e.g., 17-21]. In our study we undertook morphologic analysis using Magellan F-Map images and for the DP-CH-FH-NH crater classification we used the database prepared when work on Basilevsky and Head [20] and Basilevsky et al. [21] was undertaken.

Observations and analysis: In this study we were searching for astra showing clear age relations of their most ancient phases with surrounding regional plains AND having in their vicinities craters which have been crosscut by astrum-related faults. If we saw evidence that an astrum started to form before or close to the time of emplacement of regional plains, we concluded that its activity started before or close to ~0.5-1 b.y. ago. If we saw that astrum-related faults cut craters with an associated clear halo (CH) or dark parabolas (DP) we concluded that its activity continued through the time of ~250-500 m.y. ago and ~50-150 m.y. ago respectively. The combination of these two observations gave us an estimate of the time duration of the astrum evolution studied. We did not study the age relations of young astra faults with FH and NH craters because this does not put significant constrains on the duration of astrum evolution.

In these analyses we studied images of all 78 astra listed by [5, 7-9] and studied images of all 49 DP craters and images of all 114 CH craters with diameters ≥ 15 km. If we did find that a crater is cut by fault(s) we traced the source of the fault(s). This procedure resulted in finding 2 DP and 5 CH craters (see below) cut by faults radiating from 7 astra and for those astra we were able to determine that their early faults predated emplacement of wrinkle-ridged regional plains (6 cases) or postdated emplacement of regional plains but predated emplacement of wrinkle ridges (1 case). In the first 6 cases we concluded that these astra started to form before the time T. In the seventh case we concluded that this astrum started to form close to time T, because as it was shown by McGill [22] and Basilevsky and Head [13] the emplacement of wrinkle ridges happened within the first 10-15% of the time following the emplacement of the plains. Figures 1 and 2 show two examples of astrum-crater relations..

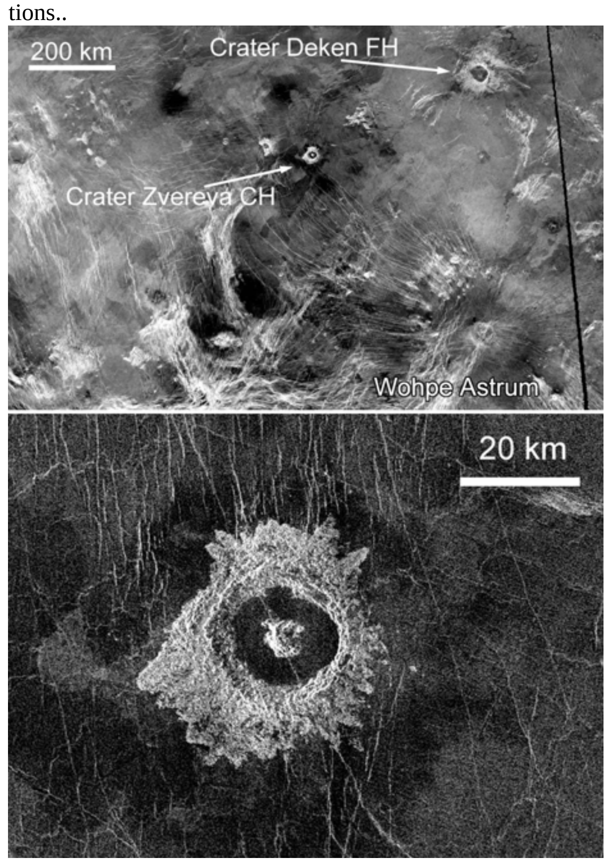

Figure 1. CH crater Zvereva cut by fault radiatng from Wohpe Astrum. See description of the geology of that region in Basilevsky and Head [23].

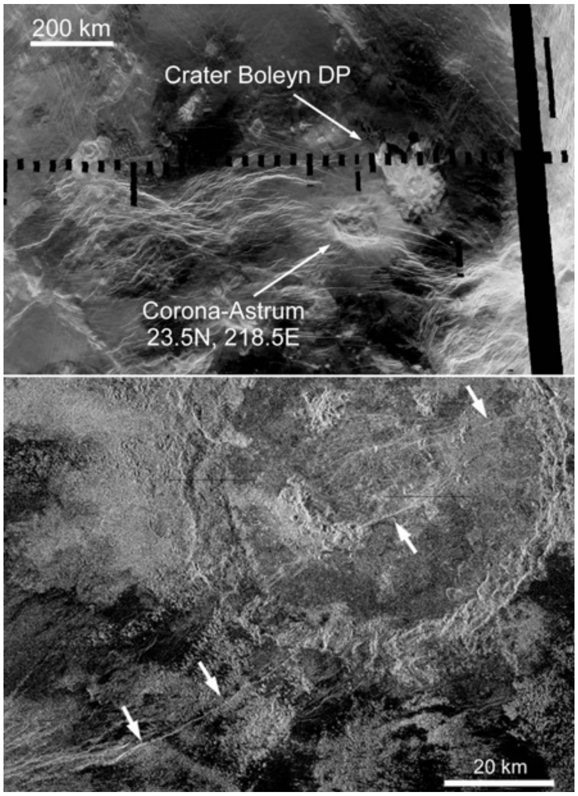

Figure 2. DP crater Boleyn cut by faults radiating from an unnamed astrum centered at 23.5 N, 218.5 E.

We found seven astra with relations to DP and CH craters indicative of the duration of astrum activity:

1) Corona Audhumla Astrum, centered at 47^{o} N, and 12^{o} E; its most ancient faults are embayed by wrinkle-ridged regional plains, while younger faults radiating from it cut the CH crater Kemble.

2) Wohpe Astrum, centered at 41.5^{o} N, 288^{o} E; its most ancient faults are embayed by wrinkle-ridged regional plains, and a young fault radiating from it cuts the CH crater Zverева.

3) Corona Junkgowa Astrum, centered at 37^{o} N, and 257^{o} E; its most ancient faults are embayed by wrinkle-ridged regional plains, while a young fault radiating from it cuts the CH crater Gentileshi.

4) Becuma Mons Astrum, centered at 34^{o} N, 22^{o} E; its faults cut wrinkle-ridged regional plains, but their older part obviously controlled emplacement of wrinkle ridges. The floor of the neighboring DP crater Noreen is cut by faults whose orientation is parallel to the Becuma faults and thus considered as part of the latter.

5) Astrum centered at 23.5^{o} N, 218.5^{o} E; its most ancient faults are embayed by wrinkle-ridged regional plains, while young faults radiating from it cut the DP crater Boleyn.

6) Astra of Jokwa Linea chain are at 17 to 20^{o} S, and 198 to 210^{o} E; their most ancient faults are embayed by wrinkle-ridged regional plains, while a young fault radiating from one of them cuts the CH crater Fouquet.

7) Corona Gertjon Astrum, centered at 30^{o} S, and 276^{o} E; its most ancient faults are embayed by wrinkle-ridged regional plains, while a young fault radiating from it cuts the CH crater Kitna.

Figure 3 summarizes the interpreted age durations for these seven astra.

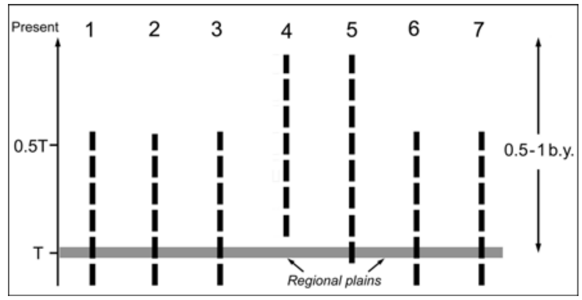

Figure 3. Diagram showing estimated durations of activity of the seven astra.

Conclusions: For seven of 78 known astra (novae) it was possible to estimate the duration of their geologic activity from the older phases of their tectonism (fracturing) through their younger ones. It was found that the activity lasted for several hundred million years. This is longer than the duration of activity of several ongoing large-scale mantle plumes of Earth: e.g., the Kerguelen plume (116 m.y.), the Tristan plume (~140 m.y.), the Reunion plume (65 m.y.) [24].

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