GEOLOGY AND RADIOPHYSICAL PROPERTIES OF THE VENERA AND VEGA LANDING SITES. C. M. Weitz, Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109; A. T. Basilevsky, Brown University, Dept. of Geology, Providence, RI, 02912, Permanent affiliation: Vernadsky Institute, Russian Academy of Science, 117975 Moscow.

Introduction: We have produced geologic maps for all seven Venera and Vega landing sites. Because the radius of error for each landing site is 150 km, we have mapped the entire landing circle centered about the estimated landing point. We found correlations between the Magellan imagery and the lander TV panoramas and geochemical measurements made at the landing site. Radiophysical properties, including backscatter cross-sections, altimetry, emissivity, and rms slopes, were determined for each landing circle. After mapping the geology of the landing circles, we mapped the regional geology of the seven sites and determined the geologic history of these large regions.

Geology of the Landing Sites: Geologic mapping of the seven Venera/Vega landing sites has shown that the dominant type of terrain at these sites is plains. The Venera 8 site contains ridged and fractured plains and a younger plains-forming volcanic complex [1]. A 23-km-diameter pancake dome and several smaller steep-sided domes were also identified within the landing circle. Geologic mapping of the Venera 9 site, which is located on the eastern slope of Beta Regio, has shown the geology of this area to be dominated by fractured plains with complex ridge terrain (CRT) units located both inside and outside the landing circle. A large trough oriented transverse to Devana Chasma cuts through the plains and a lava channel in the plains. The Venera 10 site contains an elder and a younger plains unit and the same CRT mapped at the Venera 9 site. The younger plain unit consists of lava flows from a gentle-sloped 60-km-diameter dome. Concentric fractures in the plains to the northeast indicate uplift of some of the CRT and adjacent plains to the west of the fractures. The Venera 13 site is dominated by plains that are radar-dark in the SAR imagery because of a mantling of fine debris. At least four steep-sided domes surround the landing circle. A 200-km coronalike feature and its associated flows are located in the southeast of the landing circle. A lineament belt trending NW-SE from a large CRT unit to the west cuts through the plains and domes in the site and lava flows from volcanism to the west both embay and are disrupted by the lineament belt. This lineament belt continues to the southeast where it disrupts the Venera 14 site. The Venera 14 geology shows a site dominated by radar-bright and -dark lava flows from a 75-km-diameter gentle-sloped volcano. Heavily fractured terrain, possibly representing CRT, has been embayed and infilled by the plains. Concentric fracture systems can be identified to the west and south of the volcano. Geologic mapping of the Vega 1 site has shown that the site consists of ridged radar-bright and -dark plains covered by debris and wind streaks. The Vega 2 site contains similar (and probably the same) radar-bright and -dark plains. The plains here, however, do not have the debris visible at the Vega 1 site but the Vega 2 site is disrupted by numerous lineations resulting from activity associated with Dali Chasma to the south.

Magellan and Lander Correlations: Based upon Magellan data and the lander geochemical [2] and TV panoramas [3], we have been able to suggest the most likely material in the Magellan imagery sampled by the landers. Lamprophyrelike lavas, silicic ash beds, or the pancake dome are the most likely material sampled at the Venera 8 site [1]. At the Venera 9 site, the sampled tholeiitic material most likely represents fractured plains. Plains from either the gentle-sloped dome or from earlier volcanic activity are the most probable tholeiitic material sampled at the Venera 10 site. Lavas from a steep-sided dome or a coronalike feature at the Venera 13 site might match the nontholeiitic composition measured by the lander. Basalts erupted from a gentle-sloped volcano represent the most likely tholeiitic material sampled by the lander at the Venera 14 site. At both the Vega 1 and 2 sites, the landers measured the tholeiitic composition of the radar-bright or -dark plains at these sites.

At the Venera 8 and 13 sites, where a non-tholeiitic composition was measured for the surface material, the Magellan imagery revealed that both these sites have unusual volcanic features associated with them, such as steep-sided domes and coronalike features with flows. Unusual volcanic activity was not observed inside the landing circle at the other five sites and at these sites the landers measured geochemical signatures of tholeiitic basalts. This correlation indicates that the geochemistry measured by the landers correlates well with the morphology seen in the Magellan imagery. A strong correlation also exists between the SAR imagery and the TV panoramas taken by the Venera 9, 10, 13, and 14 landers. The Venera 9 panorama showed cobbles on a sloped landing surface. The SAR imagery shows a fractured plain for the Venera 9 landing site. Both Venera 10 and 13 TV panoramas showed soil on the plains and the SAR imagery shows radar-dark debris on the plains. The Venera 14 TV panorama showed a plain with almost no debris and the SAR imagery of the site shows mottled lava flows with no debris covering the flows.

Radiophysical Properties: Backscatter cross-sections, altimetry, emissivity, and rms slopes were calculated for each Venera/Vega landing circle. The minimum, mean, and maximum values for each radiophysical parameter are shown in Table 1. Most of the variations in backscatter, emissivity, and rms slopes reflect variations in roughness at each site. The Venera 8 and Vega 1 and 2 sites consist predominantly of plains so the radiophysical

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properties within the landing circle are typical values for the venusian plains. The Venera 9 site has the highest backscatter cross-sections, altimetry, emissivity, and rms slopes of all the sites because it is located on the eastern slope of Beta Regio and the uplift associated with Beta Regio has caused the site to become elevated and heavily fractured. In addition, CRT within the landing circle is also a cause of the high radiophysical parameters within the landing circle. Altimetry data for the Venera 9 site shows that the lava channel does not follow the W-E slope associated with Beta Regio so this indicates that the uplift of Beta post-dates the emplacement of the plains. The Venera 10 site also has high backscatter, altimetry, emissivity, and rms slopes within the landing circle because it contains CRT. The plains within the landing circle appear quite smooth in the SAR so this is why the emissivity, backscatter, and rms slopes are lower than at the Venera 9 site. The Venera 13 site has some of the lowest radiophysical properties for all the sites because the landing circle contains plains that are covered by a layer of debris that has decreased the backscatter and emissivity at the site. The lava flows from the Venera 14 volcano have large variations in backscatter and emissivity. The Venera 14 and the Vega 1 and 2 sites have emissivity variations that do not correlate to variations in backscatter, unlike the other four sites. This indicates that there may be compositional and/or differences in vesicularity in the lava flows at these three sites.

Conclusions Geologic mapping of the Venera/Vega site and their regional geology has enabled us to determine a geologic history for these sites and the larger regions that contain them. Complex ridge terrain, complex terrain, and some heavily fractured plain represent the oldest geologic units at all the sites. Vast plains from regional-scale volcanism later embayed all three geologic units. Disruption of the plains by both extension and compression caused fractures and ridges to disrupt much of plains. Volcanism from local volcanic sources (i.e. steep-sided domes, coronae, rifting) post-date the vast plains. Lineament belts associated with both rifting and uplift from mantle upwelling have caused severe disruption of the older geologic units. The plains at the Venera 9 and Vega 1, 2 sites represent vast outpourings of lava associated with regional-scale plain-forming volcanic eruptions. Both the Venera 9 and Vega 2 sites have an elder plains that has been heavily fractured by major rifting and uplift adjacent to these two sites. The plains at the Venera 8, 10, 13, and 14 sites represent more restrictive flows that formed "spots". The volcanic activity associated with the Venera 8, 10, 13, and 14 sites is probably the result of hot-spot, plume-driven volcanic activity.

The geology of the Venera 9 site confirms earlier observations that Rhea Mons represents pre-existing CRT uplifted and then later disrupted by Devana Chasma [4]. Identification of a lava channel at the Venera 9 site that does not follow the topography associated with the uplift of Beta Regio to the west indicates that the plains formed before the uplift of Beta. Geologic mapping of the Venera 10 site has shown that there has been uplift and fracturing of CRT and older plains. Lineament belts in the Venera 13 and 14 sites extend between major sites of volcanic activity (i.e. volcanoes, rifting, coronalike features) on both the plains and CRT. This suggests that lineament belts in this region represent extensional zones associated with mantle upwelling. Geologic mapping of the Vega 1 and 2 sites and their regional geology indicates that the CRT has been embayed and infilled by vast eruptions of plains volcanism. The large volcanoes in Atla Regio and Sapas Mons post-date these vast plains. Dali Chasma and its associated activity to the south have caused severe disruption of the surrounding plains.

References: [1] Basilevsky et al., *JGR*, **97**, E10, 16,315-16,335, 1992; [2] Surkov, Cosmochemical exploration of planets and moons, Moscow, Navda Press, 1985; [3] Basilevsky et al., *Bull. Amer. Geol. Soc.*, **96**, 137-144, 1985; [4] Senske et al., *JGR*, **97**, E8, 13,395-13,420.

TABLE 1. Minimum, Maximum, and Mean Radiophysical Properties at Each Landing Site

Landing Site	Incidence Angle (deg)		Backscatter (DN)			Altimetry (km)			Emissivity			Rms Slope (deg)		
	Min	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Venera 8	41	42	92	111.2	129	6051.4	6051.85	6052.3	0.805	0.834	0.855	1.0	2.88	7.3
Venera 9	41	42	88	120.8	164	6051.4	6052.89	6053.7	0.82	0.857	0.89	1.3	4.03	10.6
Venera 10	45	45	81	112.5	157	6051.1	6052.02	6053.3	0.785	0.825	0.88	0.4	2.24	9.0
Venera 13	42	43	87	106.7	146	6051.9	6052.25	6053.5	0.775	0.811	0.84	1.0	2.61	5.3
Venera 14	40	42	85	116.6	155	6051.0	6052.29	6053.1	0.77	0.810	0.84	1.3	3.11	9.3
Vega 1	45	45	90	107.5	135	6051.0	6051.32	6052.0	0.825	0.852	0.875	1.0	2.25	5.8
Vega 2	42	43	94	115.9	148	6052.1	6052.60	6053.2	0.82	0.851	0.885	0.8	2.13	7.1