GEOLOGY AND STRUCTURE OF BETA REGIO: RESULTS FROM NEW ARECIBO DATA. D. A. Senske[1], J. W. Head[1], E. R. Stofan[2], and D. B. Campbell[3], 1) Department of Geological Sciences, Brown University, Providence, RI 02912, 2) Jet Propulsion Laboratory, Pasadena, CA 91109. 3) NAIC, Cornell University, Ithaca, NY 14853.

Introduction. Recent studies of Beta Regio have concentrated on analyses of the tectonic and volcanic history of Devana Chasma (1,2,3). These studies propose that the high topography and rifting are associated with either a simple hotspot (3,4), or a hotspot and lithospheric extension (2). The recent acquisition of earth-based radar image data from the Arecibo Observatory has provided the first high resolution (1.5- to 2.0-km) coverage of a contiguous region covering 12.8 x 10^6 km^2 extending eastward from 270° W into the lowlands of Guinevere Planitia, and south from 45° N to Phoebe Regio (Fig. 1) (5). Using both the Arecibo image and Pioneer Venus topography data we have identified six major geologic subdivisions. On the basis of this mapping, we study the relationships between map subdivisions and list the major characteristics of Beta Regio that must be addressed in any models for its origin.

Geologic Characteristics. Beta Regio, a domal highland 2300 km x 2000 km, rises to an elevation of 4.0 km above a planetary radius of 6051.4 km. Located on the crest of this upland is the 1.0 km deep rift valley, Devana Chasma, on which are located two volcanic peaks, Theia and Rhea Montes (1,2). In the vicinity of Theia Mons the rift forms a tectonic junction (6), splitting into two arms, one extending to the south toward Phoebe Regio and the other SSW toward Atla Regio. A second region of high topography, not previously imaged, is located on the eastern flank of Beta. This elevated region is separated into two distinct upland plateaus (7) (marked A and B in Fig. 1), each possessing properties suggesting that they are tessera-like (6,8). The northern plateau rises to an elevation of 0.5 km and is separated from a higher southern plateau (2.5 km) by a 0.5 km deep valley between A and B.

Six geologic subdivisions have been mapped (Fig. 1b), the most abundant being Plains. Plains on the Beta rise are typically radar-dark, while bright plains are restricted to the lowlands of Guinevere Planitia and are associated with a variety of cones and domes; both the bright and dark plains are interpreted to be volcanic in origin (5). Peaks with Lobate Deposits correspond to Theia Mons and Rhea Mons. Both mountains are located on the western edge of Devana Chasma. Deposits associated with Rhea extend radially for distances of 50- to 100-km, while those associated with Theia Mons form a butterfly pattern and extend for distances of 300- to 400-km from the summit of the mountain (5). Three zones made up of radar-bright lineaments are mapped. The system of Narrow Spaced Parallel Lineaments are confined to the 60- to 200-km zone of Devana Chasma and are interpreted to be scarps associated with normal faulting (1). The scarps range in length from 100- to 300-km and have a spacing of 5- to 10-km. To the north of Rhea Mons the scarps splay and die out into the surrounding lowlying plains. The Wide-Spaced Parallel Lineament zones are 100- to 200-km wide, located within topographic depressions on the eastern flanks of Beta, and are characterized by lineaments ranging in length from 100- to 600-km with a spacing of 20- to 50-km. These systems of structures are perpendicular to the strike of Devana Chasma, forming an orthogonal pattern with it. The Interbraided Lineament zones are associated with elevated topography (~0.5 km), possess characteristics similar to ridge belts (9), and have lengths between 10 and 50 km with a spacing of 5 km or less. One segment has a NNE orientation while another has a NNW orientation. The set of lineaments is generally oriented 45° to the orthogonal trends of the Devana/Wide-Spaced Lineament zones. This Interbraided Lineament zone extends further to the east and is part of a zone of disruption extending from Beta to Eisila Regio (10). Three regions possessing characteristics similar to Tessera have been mapped in the vicinity of Beta (Fig. 1b). The northernmost area (9) is centered near 44° N, 300° W. Ridges within this unit have a NNE orientation, parallel to structures in the unit of Interbraided Lineaments which lies 500 km to the south. The zone possesses topographic relief of less than 500 m and is extensively embayed by plains, suggesting that it predates the plains. The second and most extensive region of tessera-like material is associated with the east flanking topographic rise (A and B, Fig 1a). The eastern edge of the tessera forms a scarp rising 0.5 km above the surrounding plains while the western contact of the tessera is embayed by radar-dark plains material. Ridge orientations in the larger southern block of tessera (B in Fig. 1a) are generally north-south and parallel to Devana Chasma and its internal structure, while those in the smaller northern block (A in Fig. 1a) are more chaotic. At the intersection of the southern block and the southern Wide-Spaced Parallel Lineament zone (Fig. 1b), a number of lineaments extend into the tessera forming a cross-cutting relation, and disrupt the unit of tessera, suggesting that some of the lineaments are faults. The third region of tessera-like material occurs in the vicinity of Rhea Mons, flanking Devana Chasma. Ridges within the unit on the western flank of the rift possess a general NNE orientation (11), while those on the eastern flank are oriented in a north-south direction. A second, less abundant, set of lineaments orthogonal to Devana Chasma are also present.

Models: Models proposed to explain the formation and evolution of Beta Regio must explain the following observations and characteristics: 1) broad domal rise (~2000 km in diameter); 2) large positive gravity anomaly [apparent depths of compensation (ADC) from LOS acceleration data suggest a depth of 330 km for Beta (12)]; 3) central rift zone, 4) narrow (< 300 km wide) topographic high flanking the rift zone; 5) volcanoes associated with the rifting; 6) distributed plains volcanism; 7) tectonic junction; 8) polygonal outline of topography; 9) plateau-like nature of Beta topography; 10) relatively steep bounding slopes of plateau 13); 11) occurrence of tessera and its positive correlation with topography; 12) Wide-Spaced Parallel Lineament zones oriented normal to Devana Chasma and the tessera fabric; 13) interbraided lineament zones; 14) variation in orientation of the tectonic fabric from northern to southern parts of Beta.

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At the present time we are evaluating the following models for the origin and evolution of Beta, all three of which involve a mantle plume or hot spot to account for the very great ADC (12): 1) Mantle Plume/Passive Crust Model: An upwelling mantle plume simply disrupts preexisting structure producing rifting and volcanism (4). Either thick crust forms an insulating layer setting up a convection cell or the region is simply the passive site of a mantle plume. In this model the surface geology and structure are largely unrelated to the plume. 2) Mantle Plume/Active Crust Model: In this case, the upwelling plume causes underplating and uplift to account for the topography, and gravity sliding and/or other subcrustal mechanisms to account for the tessera fabric. Rifting is localized to Devana and extension is limited. 3) Mantle Plume/Crustal Spreading Model: In this case, the mantle plume is accompanied by rifting and crustal spreading, the tessera patterns represent analogs to abyssal hills (14) and their plateau-like topography is related to regions of thicker crust (15, 16). The orthogonal wide-spaced lineaments represent fracture zone-like structures.

We are presently using the LOS acceleration and topography data, as well as the geologic relations determined from the new Arecibo data, to examine models which combine both components of crustal thickness and dynamic support to account for the large amplitude gravity anomaly associated with this part of the planet. Data from Magellan will help determine important detailed relationships and the characteristics of regions to the west in the vicinity of Asteria Regio and their relation to the Beta highland.

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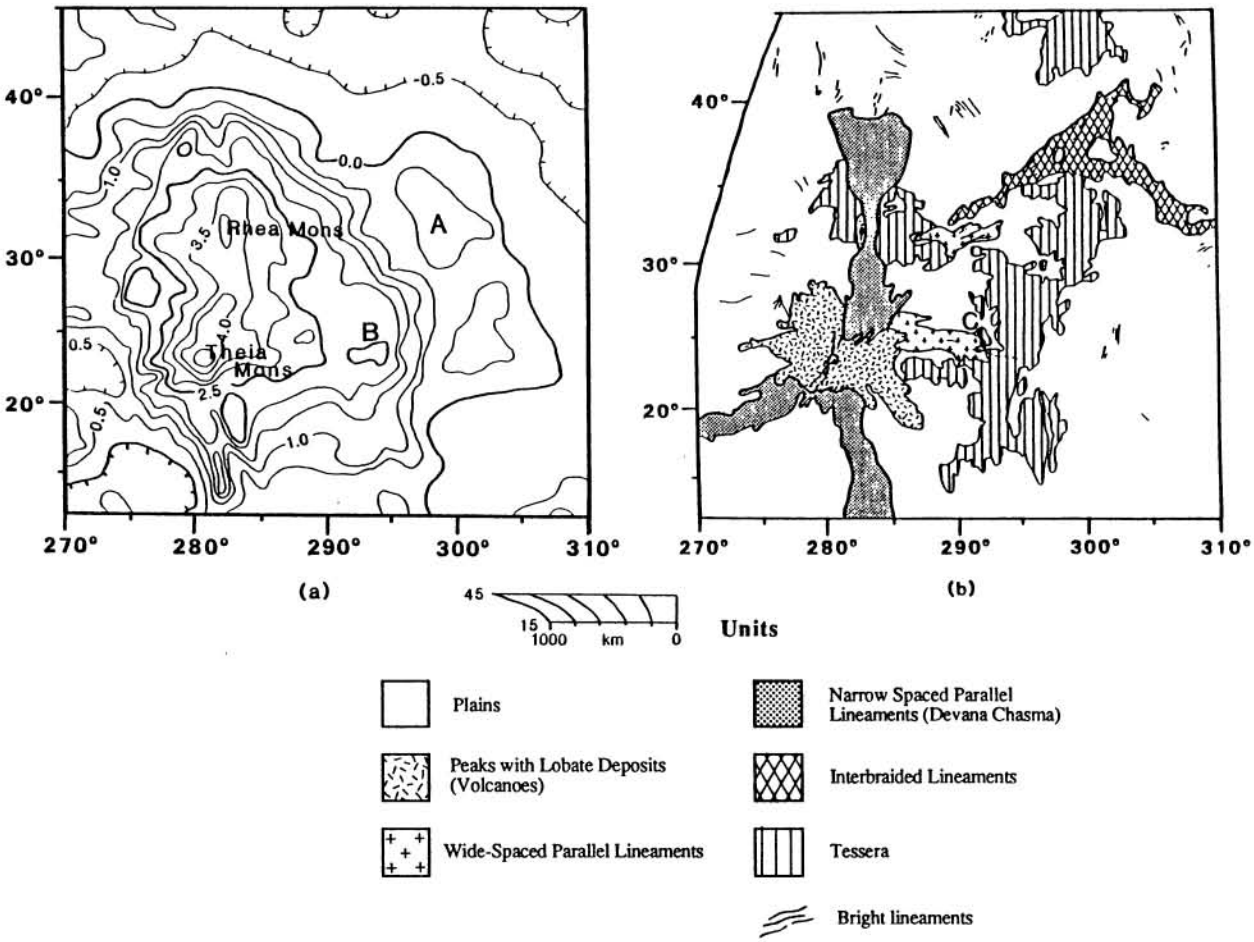

Figure 1. a) Pioneer Venus Topography of Beta Regio referenced to a planetary radius of 6051.4 km; contour interval is 500 m. The east flanking upland plateau is divided into a northern section labelled A and a southern section labelled B. b) Geologic subdivisions mapped on Beta. The intersection of lineaments from the Wide-Spaced Parallel Lineament unit and the east flanking region of tessera is labelled C.