Plate 1. Overview over the four formation hypotheses.

<table>
<thead>
<tr>
<th>A. Mantle downwelling</th>
<th>B. Mantle upwelling</th>
<th>C. Pulving continents</th>
<th>D. Lava pond and bolide</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short definition</strong></td>
<td>Crystal accretion due to sub-solidus flow or lithospheric accretion.</td>
<td>Periodic subduction events lead to thickening of crustal plateaus driven by tectonic compression and extensional collapse.</td>
<td>Progressive solidification and deformation of a large lava pond of similar size to a crustal plateau.</td>
</tr>
<tr>
<td><strong>Primary driving mechanism</strong></td>
<td>Convective down flow within the mantle or sinking of a portion of colder, dense lithosphere.</td>
<td>Using mantle plume with magmatic underplating.</td>
<td>Formation and solidification of a lava pond.</td>
</tr>
<tr>
<td><strong>Involving layers</strong></td>
<td>Crust and mantle</td>
<td>Upper crustal material and shallow mantle fed by plume from core boundary.</td>
<td>Topmost layer and upper mantle.</td>
</tr>
<tr>
<td><strong>Initial setting</strong></td>
<td>Layered structure with brittle upper layer, ductile lower crust, strong upper mantle and weaker substrate.</td>
<td>Low density crust with relatively thick lithosphere which survived global subduction.</td>
<td>Initially hot lithosphere, hot environment.</td>
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<tr>
<td><strong>Starting mechanism</strong></td>
<td>Convective flow within the lithosphere leading to thinning of the crust.</td>
<td>Initial contractual tectonic thinning of crustal plateau terrain and creates a wide range of structural wavelengths features.</td>
<td>Impact of a large bolide with sufficient velocity to create a 200-300km diameter crater.</td>
</tr>
</tbody>
</table>

**Stages: How does it evolve over time?**

- Downwelling causes a initially downward, low-speed flow of mantle material with small-scale, distributed contractional features.
- Denser lower crust material is pulled toward the downwelling region.
- A region of thickened crust starts to form.
- As thickening continues contractual structures form.
- The center spot above downwelling represents a weak zone within the lithosphere and a barrier between mantle flow and contractual structures.
- Contractual structures are then focused on the edges of the crustal plateaus creating a ring of high topography.
- The center of thickened crustal flow spreads under its own weight and structural blocks are created in a radial pattern.
- Additional local extension can be attributed to localized relaxation of the material.

**Effects on the model**

- Size of the area initiating the downwelling and conditions of the cold spot.
- Lithospheric thickness.
- Size of upwelling plume.
- After global subduction the ratio between crustal and lithospheric mantle thickness.
- 1. Venus’s supercritical CO2 atmosphere could affect solidification. Allowing longer ductility.

**Deformation mechanisms (stresses)**

- Downwelling creates contractual stresses.
- Upwelling creates tensional stresses.
- Initial ratio between lithospheric and crustal thickness determines collapse or rising of plateau.
- Ductile and brittle modes of deformation all over the entire crustal plateau.

**Intra-plateau stresses**

**Spatial (area) distribution & strain**

- Distribution of structures is covering a similar area to initial surface.
- Higher ratio of contractual and extensional features in center of the plateau.
- Margins are dominated by contractual stresses.
- Structures exceed the initial upwelling surface.
- Mostly extensional structures, disrupted shortening (folds) over the surface.
- Size of plateau depends on initial size of low density continental material that gets compressed.
- Vicarim at all levels (post compression).
- Contractile thrusts and folds.
- Area extend depends on size of lava pond.
- High contiguity of patterns, but widespread structures of the entire terrain.
- Continuous deformation causes flow-like patterning.

**Temporal Evolution**

- Early stage contractual stresses.
- Evaluated by radial pattern of extensional structures.
- Early extensional (ribbon) faults.
- Graben.
- Caused by an increase in BDT.
- Early contractual (anti-equilibrium) structures.
- Late extensional features.
- Accompanied by late stage flooding.
- Early short-wavelength contractual stresses (ribbon) & progressive increase in wavelengths.
- Flooding occurs throughout deformation (basin fill).

**Wavelengths**

- All wavelengths present.
- All wavelengths present.
- All wavelengths present.
- Large intermediate and short wavelengths.

**Distribution of impact craters**

- N/A.
- Craters on plateau undeformed or only affected by late graben.
- Approximately equal to lowlands, which means crustal plateau formation and lowland volcanic plains are linked.
- Some older craters might remain but most of them will be overprinted by lava pond.
Plate 2. Left-look SAR image and geologic map of southern Tellus Regio. Long-wavelength folds dominate the plateau margin and southern area, parallel intermediate-wavelength folds extend across the entire terrain, depicting some structural fluidity. Generally ribbon structures and graben trend NE in the southern portion and NW in the northern portion of the plateau. Intratessera basins dominate the plateau, filling topographic lows of structural elements with low viscosity deposit material. Wrinkle ridges occur in intratessera basins and surrounding lowlands. Four impact craters occur in the southern and eastern margin of the plateau. Intermediate- and short-wavelength folds (not depicted due to resolution), and ribbons occur on the crests, limbs and troughs of long-wavelength folds. Graben generally postdate all previous structures.
Plate 3. Overview over southern Tellus Regio structural suites. Map a depicts southern Tellus Regio left-look SAR with the divisions that are discussed: central, south-central, and the eastern and western margins. Map b highlights all structural elements and material units across the map area, map c highlights structural features, such as intermediate- and long-wavelength folds, intratessera basins, pit chains in the south-eastern portion, craters and shields throughout the lowlands. Map d focuses on: ribbon structure trends, graben complexes, intratessera basins, pit chains, and craters.
Plate 4. Left-look SAR image, geologic map, history, and 2D bulk strain description of window A (see Figure 3 for location). Area dominated by two basins, host to parallel short- and intermediate wavelength folds, trending generally W. NNW-trending ribbon structures are orthogonal to folds. Flood deposit material occurs in troughs of short- and intermediate-wavelength folds, ribbons and extend as finger-like embayments towards the larger basin fill. Wrinkle ridges and circular ridges deform the basins. The interpreted history (Plate 4c) begins with early short-wavelength fold formation, followed by, or coinciding with ribbon formation. Concentric ridges predate intermediate-wavelength folds and are followed by wrinkle ridge formation. Plate 4d depicts the 2D bulk strain over window A, indicating only little variation over time. See text for discussion.
Plate 5. Left-look SAR image, geologic map, history, and 2D bulk strain description of Window B (see Figure 3 for location). Area B is dominated by intermediate-wavelength folds and their respective finger-like fold-trough basins in the NE and E; extensive short-wavelength folds occur along limbs of intermediate-wavelength folds. N-trending ribbon structures and a suite of NW-trending graben complexes with parallel fault scarps occur throughout the map area. Basin fill in this window is limited to basins within the troughs of intermediate-wavelength folds unit fbb and basins within short-wavelength fold troughs unit fba. The relative timing for window B (Plate 5c) is interpreted as: short-wavelength fold and ribbons structures formed early, followed by intermediate-wavelength formation and formation of late graben complexes and fault scarps. Plate 5d depicts 2D bulk strain for the map area, showing early similar orientations during formation of short- and intermediate-wavelength folds and ribbons, but near-opposite 2D bulk strain during formation of late graben complexes. See text for discussion.
Plate 6. Left-look SAR image, geologic map, history, and 2D bulk strain description of window C (see Figure 3 for location). Window C is split into two regions (Plate 6b), western and eastern region which are separated by a N-trending basin. Both regions are dominated by parallel short and intermediate-wavelength folds, and orthogonal ribbon structures, however both regions show near-opposite orientations. NW-trending graben complexes and fault scarps cross the entire region. Basin fill material occurs in troughs of all structural wavelengths and in the central basin. The relative timing for window C (Plate 6c) is interpreted as: early short-wavelength fold and ribbon structures formation, followed by intermediate-wavelength formation and formation of late graben complexes and fault scarps. Plate 6d depicts 2D bulk strain for the map area, depicting early opposite 2D bulk strain between both regions, and later more coherent bulk strain across the map area, indicating early structural fluidity that ceased over time. See text for discussion.
Plate 7. Left-look SAR image, geologic map, history, and 2D bulk strain description of window D (see Figure 3 for location). Window D is divided into three regions (Plate 7b), NW, central and NE. The central region hosts NW-trending long-wavelength folds with intermediate-and short-wavelengths preserved on crests and limbs and long and narrow basins in the long-wavelength fold troughs and parallel graben complexes; the SW and NE regions are host to W-trending short-wavelength folds and orthogonal ribbons of similar orientation. The relative timing for window D (Plate 7c) is interpreted as: early short-wavelength fold and ribbon structures formation, followed by intermediate- and long-wavelength formation and late formation of graben complexes, fault scarps and wrinkle ridge formation in the basins. Plate 7d depicts 2D bulk strain for the map area, depicting early variable 2D bulk strain for all regions for short-wavelength and ribbon formation, more coherent bulk strain across the map area for intermediate-and long-wavelength formation, followed by nearly-opposite bulk strain during graben complex formation, indicating early structural fluidity that ceased over time. See text for discussion.
Plate 8. Left-look SAR image, geologic map, history, and 2D bulk strain description of window E (see Figure 3 for location). The area is dominated by a suite of NE-trending long-wavelength folds with respective troughs filled with flood deposit material. Long-wavelength fold crests are host to orthogonal short-wavelength folds and parallel ribbons along the long-wavelength fold crests. Short- and intermediate-wavelength folds also occur in the NW region. One graben complex trends parallel to long-wavelength folds. The relative timing for window E (Plate 8c) is interpreted as: early short-wavelength fold and ribbon structure formation, followed by intermediate- and long-wavelength formation and late formation of graben complexes and wrinkle ridge formation in the basins. Plate 8d depicts 2D bulk strain for the map area, depicting variable 2D bulk strain for regions of short-, intermediate-, and long-wavelength and ribbon formation. The late graben complex shows a similar bulk strain to other regional maps. See text for discussion.
Plate 9. Left-look SAR image, geologic map, history, and 2D bulk strain description of window F (see Figure 3 for location). Window F is dominated by three major basins, creating regions dominated by deformation and regions that lack deformation (in the basins) (Plate 9b). NW-trending long-wavelength folds are host to parallel intermediate-, short-wavelength folds and orthogonal ribbons. Basins are host to wrinkle ridges and few pit chains. Suites of short- and intermediate-wavelength folds occur with variable trend. The relative timing for window D (Plate 9c) is interpreted as: early short-wavelength fold and ribbon structures formation, followed by intermediate- and long-wavelength formation and late formation of graben complexes, fault scarps and wrinkle ridge and pit chain formation in the basins, accompanied by flood material deposition. Plate 9d depicts 2D bulk strain for the map area, depicting early variable bulk strain for all regions for short- and intermediate-wavelength fold and ribbon formation, more coherent bulk strain across the map area for long-wavelength fold formation, followed by nearly-opposite bulk strain during graben complex formation. See text for discussion.