The development of fractures at regular length scales is a widespread feature of Venuvian tectonics. Models of lithospheric deformation under extension based on non-Newtonian viscous flow and brittle-plastic flow [1,2] develop localized failure at preferred wavelengths that depend on lithospheric thickness and stratification. The characteristic wavelengths seen in rift zones and tessera can therefore occur at twice the depth to the base of the upper mantle lithosphere. The model boundary introduces features of the crustal structure that are about twice the thickness of the brittle crust. Longer wavelength features being about twice the thickness of the brittle crust. Longer wavelength features occur at twice the depth to the base of the upper mantle lithosphere. The model boundary undergoes a prescribed rate of uniform extension. Integration of strain rate over time to overall strains of 10% produces conjugate patterns of faulting and rifting. Larger amounts of strain generally exceed the range of applicability of quadrilateral FE's.
BRITTLE DEFORMATION ON VENUS: Neumann, G.A. and M.T. Zuber

The pattern of normal faults and sloping terraces (Figure 1) indicates a fairly realistic simulation of the behavior of layered brittle-ductile rheology. Localized faulting develops when the initial perturbation wavelength is less than about 8 times the total thickness of the lithosphere (base of brittle mantle). Longer wavelength perturbations produce stable extension of the crust, and brittle-plastic necking of the mantle lithosphere. Perturbations at wavelengths of less than twice lithospheric thickness produce a single pair of conjugate normal faults meeting at the base of the crustal lithosphere. The growth of fault-like zones indicates a mechanism for the development of linear features at multiple scales due to extension in a Venus lithosphere with a variable-thickness crust. We plan to use this model to investigate the relationship between deformation patterns, wavelength of perturbation, and strength envelopes.


Figure 1. Finite element model with assumed flow laws and thermal structure. Original crustal structure is 50 km wide, 15 km deep, with ±5% variation in crustal thickness, greatest at the center. Density of crust is 2900 kg/m$^3$ and mantle is 3300 kg/m$^3$. The center of the grid is a symmetry axis, with periodic boundary conditions on the sides. The bottom boundary at 50 km depth has no vertical displacement, and is stress-free. The grid shown has undergone a total extension of 6%. Regions of high strain rate are shown on the left by the darkly shaded regions. Regions on the right are shaded where the Coulomb brittle failure envelope is locally exceeded. Dynamically produced topography at the surface reflects the perturbation wavelength as well as finer scales of faulting generated by the interaction of crustal and mantle lithosphere.