BLOCK TECTONICS ON VENUS. Paul K. Byrne[1], Richard C. Ghail[2], A. M. Celâl Şengör[3], Christian Klimczak[4], and Sean C. Solomon[5], [1]Planetary Research Group, Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University, Raleigh, NC 27695, USA (paul.byrne@ncsu.edu); [2]Department of Civil and Environmental Engineering, Imperial College London, London, SW72AZ, UK; [3]Department of Geology, Faculty of Mines and the Eurasia Institute of Earth Sciences, Istanbul Technical University, 34469 Maslak, İstanbul, Turkey; [4]Department of Geology, University of Georgia, Athens, GA 30602, USA; [5]Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY 10964, USA.

Introduction: Considerable lithospheric extension and shortening has occurred on Venus. In places, tectonic deformation has been broadly distributed spatially, for example, at tesserae. In other areas, strain has been concentrated into narrow curvilinear zones [1].

Bands of shortening structures that accommodate crustal thickening correspond to orogenic belts and are typically manifest as broad, linear rises a few hundred meters tall, tens of kilometers in width, and many hundreds of kilometers long [2]. The extensional counterparts to the orogenic belts are long rift zones [2], which host normal faults that form gräben and half gräben that show sub-parallel and anastomosing surface ruptures as well as evidence for fault linkage.

Belt-bound Crustal Blocks: In many instances, orogenic and rift belts delimit low-lying areas that are infilled with lava flows. These flows are themselves deformed by sets of wrinkle ridges, but the interiors of the lows do not otherwise appear tectonically deformed. Distributed across Venus, some belt-bound lowlands extend laterally as much as 1200 km, whereas others are but a few hundred kilometers across. Intersecting belts also define multiple low-lying areas across a region, such as at Lavinia Planitia, where numerous orogenic belts form the polygonal boundaries of irregularly shaped lows. Other sets of belt-delineated lowlands occur near Artemis Corona, at Vedma Dorsa in the eastern hemisphere, and at about 40° S, 260° E.

Evidence for Lateral Shear: Many of these orogenic and rift belts have accommodated lateral shear in addition to crustal extension or shortening. For example, some orogenic belts boast secondary sigmoidal ridges arranged in en echelon patterns. Further, rift belts are frequently associated with smaller fractures that curve into the main system, appearing to have been dragged into parallelism with the belt, as well as lozenge-shape gräben that are similar to pull-apart basins at releasing bends in strike-slip settings.

Terran Analogues: Geometrically similar low-lying regions in continental interiors on Earth may offer insight into how these Venusian lowlands formed. The Sichuan Basin in southeastern China is delineated by the Sichuan fold belts to the south and the Longmenshan Mountains to the northwest; the basin interior is relatively undeformed and of generally uniform crustal thickness [3]. The Tarim Basin, in northwestern China, is demarcated by the Tian Shan range to the northwest and the Altin Tagh range to the southeast. The basin interior is largely intact and has behaved as a single coherent block akin to a rigid piece of oceanic crust [e.g., 4]. The Altin Tagh mountains are underlain by the Altyn Tagh fault, a major left-lateral strike-slip system [5], and the Beichuan fault beneath the Longmenshan has a right-lateral strike-slip component [6].

Lateral Motion on Venus: The common occurrence of restraining and releasing bends within orogenic and rift belts on Venus implies that these narrow zones of deformation are often transpressive or transtensive. Under this interpretation, many of the low-lying regions that the belts enclose have behaved as rigid blocks that experienced considerable lateral motion. This behavior is similar to that inferred for the rigid crustal blocks that constitute, for example, the lithosphere of continental China [4]. Of note, strike-slip faulting has been reported elsewhere on Venus, including within Lavinia Planitia [1], at Ovda and Thetis Regiones [e.g., 7], at Lakshmi Planum [8], and at Artemis Chasma [9].

The horizontal movement of crustal blocks on Venus may have been driven by mantle convection [e.g., 10], mantle overturn [8], or rejuvenation of the mantle portion of the planet's stagnant lithospheric lid through thinning and recycling [11]. Whatever the driving force, lateral motion on Venus has likely been facilitated by a relatively shallow brittle–ductile transition (BDT) [e.g., 11], a result of the planet's high surface temperature.

The shallow BDT on Venus and the density contrast between crust and mantle preclude these blocks from subducting, and so their fate is to shorten, lengthen, or retain their geometry at the expense of adjacent blocks. This behavior, then, may be analogous to plate-tectonic-driven deformation of at least some continental interiors on Earth.

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