VENUS CRUSTAL TECTONICS ANALOGOUS TO JOSTLING PACK ICE. R. C. Ghail[1], B. Holman[1], H. Lawrence[1], P. J. Mason[1], P. K. Byrne[2], C. Gordon[3] and S. Mikhail[3], [1]Imperial College London (*r.ghail@imperial.ac.uk*), [2]North Carolina State University, [3]University of St Andrews.

Introduction: Tectonically, much of the Venus surface resembles the terrestrial continents [1,2,3], as expected on the basis of their similar strength profiles [4,5]. One area of Venus, here referred to as Nuwa Campus, is similar in size and shape to the Tarim Basin, an exotic continental terrane in NW China. Despite these similarities, detailed mapping of these two terranes reveals important differences consistent with a thinner crustal thickness on Venus: if Earth's continents are analogous to drifting icebergs, then the Venus crust would be a sea of pack ice.

Crustal Blocks: In its simplest definition, a terrane is a fault-bounded block that may be considered a crustal-scale allochthon, or a continental microplate. It usually denotes a stratigraphically distinct accreted continental fragment (called an exotic terrane); the 1500 × 600 km Tarim Basin is a distinctive example of an accreted exotic terrane.

In the absence of oceanic plate tectonics, blocks on Venus are unlikely to be exotic or accreted, and so in this strict sense the concept of terranes may be limited to highland plataeux [6]. However, in its simpler meaning, fault-bounded crustal blocks are almost ubiquitous [2]; here we assign the Latin term *campus* (lit., a field or plain; pl. *campi*) in describing these landforms.

Rather than being transported across the planet by plate tectonics as exotic terrains, campi are inferred to be locally mobile, jostling with their neighbors in response to subcrustal stresses [7,8], but remaining within the same geographical area.

Comparative Tectonics: To understand the geomechanical nature and tectonic behavior of Venusian campi, two unrelated examples, Nuwa and Lada, are mapped and compared with Sentinel-1 SAR images of the Tarim Basin, at both original resolution and degraded to Magellan resolution (Figure 1).

Tarim Basin, Earth. Assembled 900 Ma ago from older fragments, the Tarim microcontinent was incorporated into Asia 300 Ma ago as one of a series of terranes accreted during the closure of the Tethys Ocean. Blind thrusts in the interior belie its apparent rigidity, indicating inversion of ancient structures across the block, but nonetheless, the main response to Himalayan compression has been at its north and south margins. The Kunlun and Tian Shan ranges both exceed 5 km elevation within 50 to 100 km of the basin and accommodate >25% shortening on major thrusts compared to <2% in the basin interior.

These ranges close at the east and west margins to create the Tarim's distinctive lozenge shape and are dissected by drainage channels that partially obscure structural relationships. The basin interior is filled with sheet sands supplied by alluvial fans and fluvial systems on the basin margins.

Nuwa Campus, Venus. Named after the Chinese mother goddess and defined as the 2400 × 1500 km region east of Artemis Chasma, this campus is bound by Diana Chasma in the north and by Colijnsplaat-Bona coronae in the south. Approximately twice the size of the Tarim Basin, it is perhaps the most recognizable campus on Venus and and offers clues as to how a campus interacts with its neighbors.

Nuwa is bounded to the north and south by rift systems and their associated coronae, and to the east and west by compressional systems. Shear fabrics occur along all margins, some with significant cumulative displacements of more than 100 km. The interior is dominated by smooth plains, likely ejecta deposits from three prominent impact craters, but flow deposits are important in the north and east, along with substantial fracturing, which is mainly strike-slip and extensional in nature.

Lada Campus, Venus. Occupying the western half of Lada Terra, this 1500 × 1700 km campus is not as clearly demarcated as Nuwa Campus. It is bounded by Eithinoha Corona in the west and Ekhe-Burkan Corona in the east, and may be more similar to fragmented microcontinents such as Avalonia, NW Europe. We assess it here to understand the processes by which campi may be destroyed, or otherwise so altered as to be unrecognizable.

Cocomama Tessera, in the middle of the campus, has a central depression flooded with plains material that appear to have entered via a channel on its western margin. Successive flows can be discerned, with younger examples partially covering fractured older flows. Numerous volcanic features are present across the campus, displaying a wide range of morphologies consistent with both primitive and evolved magmas, implying crustal heterogeneity and fractional crystallization.

The periphery is dominated by extensional structures and coronae that are likely the source of much of the magmatism. There is no obvious genetic sequence, indicative of a syntectonic relationship between the coronae and extensional deformation. Compressional structures primarily manifest as distributed wrinkle ridges, indicative of limited shortening (inversion), but more significant shortening is evident in old ridge belts on tesserae margins and at the boundaries of several coronae. Shear fabrics are ubiquitous but mainly associated with accommodation of extensional and compressional structures.

Interpretation: Although there is a gross similarity between Nuwa Campus and the Tarim Basin, there are some key differences that are solely a result of an extensional regime at Nuwa versus a compressional regime at the Tarim. Strain is widely distributed at Nuwa, both at the margins and across parts of the interior, especially near the eastern and western margins. It is unclear whether extension along the northern and southern boundaries is compressing the interior and driving lateral expansion, or vice versa, but the net result is considerable internal deformation that is transforming the shape of the campus.

In contrast, the Tarim Basin appears much stronger and more rigid, with a greater partitioning of strain to its exterior, and minimal internal deformation. These differences may reflect mechanically weaker material, but a difference in crustal thickness is probably more important. Yield stress profiles imply a weak zone at ~12·5 km depth at Nuwa [7] but at 52 km depth at Tarim [9]. The extensional core strength is ~500 MPa in both cases, but compression and its slightly smaller size makes the Tarim stronger still, enabling this terrane to act as a stiff buttress. Although similarly rigid, Nuwa is mechanically thinner and so more easily fragmented under extensional stress. Fragmentation appears close to completion at Lada Campus, which is being extended in almost all directions.

Conclusion: The ultimate fate of campi appears to be fragmentation and volcanic burial, destroying its surface expression. If Earth's continents may be likened to drifting icebergs, the Venusian crust would be a sea of pack ice.

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Figure 1. Magellan radar mosaics of Nuwa Campus (*right*) and Lada Campus (*below*) on Venus and Sentinel-1 radar mosaic of the Tarim Basin (*below right*) on Earth. Sentinel-1 data are normalized using an empirical Muhleman-like fit, to generate comparable images.
Major structures are outlined: extension in red; compression in blue; and strike-slip in green.