LINKED PLUME-RELATED RIFTING AND REGIONAL LATERAL DISPLACEMENTS AND INDENTATION TECTONICS ON VENUS INTERPRETED FROM BOUGUER GRAVITY AND RADAR — IMPLICATIONS FOR AN ARCHEAN EARTH WITHOUT PLATE TECTONICS.

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Introduction: Venus is dominated by upwelling and downwelling mantle plumes within a stagnant lid or transitional convection regime. Magellan radar images do not show any evidence for single-sided subduction zones, spreading ridge-transforms, nor arcuate volcanic chains that typify present-day plate tectonics on Earth and there is general agreement that plate tectonics does not occur on Venus. In comparison, there is considerable ongoing debate as to when plate tectonics started on Earth and whether Archean granite-greenstone terrains (i) represent exotic, subduction-related oceanic and continental arcs and oceanic plateaus, accreted through modern plate tectonic processes, or (ii) are the products of plume-related rifting and oceanic plateaus, accreted and deformed though cratonic mobilism [1].

Despite the absence of plate tectonics, radar images of Venus portray structures indicative of regional crustal shortening, including (i) brittle-ductile shear zones and folds on the margins of 'craton-like' plana (e.g. Lakshmi Planum, where shear zones imply northwards indentation and eastward-directed lateral escape similar to the Himalayan-Indochina system on Earth [2]), shear zones cross-cutting and offsetting plana (e.g. between Ovda and Thetis regiones [3]) and offsetting rifts within plains [3], and (ii) thrusts and regional-scale refolded folds (e.g. Ovda Regio [2]). Does Venus therefore represent an analog for an Archean Earth without plate tectonics?

Venus gravity interpretations: Magellan Bouguer gravity data (separated into long and short wavelength components) and horizontal gradient edges support the model derived from radar interpretation [2] for northward 'drift' and indentation of Lakshmi Planum and portray hitherto unrecognized regional-scale crustal structures on Venus. Belts of high Bouguer gravity and thinned crust (comparable to the Midcontinent Rift in N America [3]) suggest underplating of denser, mantle-derived material beneath areas of extended crust. Rifts are offset by transcurrent faults and flank a zone of mantle upwelling between collinear, upwelling mantle plumes S of Lakshmi Planum. The large displacements of continent-like plana (where Bouguer lows suggest felsic crustal constituents) are interpreted to result from mantle tractions/pressure acting against their deep 'keels' commensurate with horizontal outflow from upwelling plumes which produced adjacent rifts.

Comparisons with the modern Earth: Continent-like 'drift' on Venus resembles the westward translation of the Americas and the pre-collisional acceleration and continued northward displacement of India, both attributed to mantle flow tractions and plume-push (respectively) acting upon the deep Precambrian cratonic keels of N. America and India.

Implications for the Archean Earth: The geometry and scale of structures in the Abitibi subprovince, Superior craton, Canada, resembles interpreted structures N of Lakshmi Planum, Venus [2]. Reversal of displacement senses along major regional transcurrent shear zones and fold and thrust overprinting documented in Archaean terrains on Earth (e.g. Yilgarn craton, Australia [4,5]) also took place on Venus (e.g. between Ovda and Thetis regiones [3]. From our interpretations of Venus radar and gravity data, we therefore contend that subduction-related accretion and collision tectonics is not required to produce structures in Archean granite-greenstone terrains on Earth. Venus thus provides an analog for an Archean Earth without plate tectonics, where mantle flow against deep cratonic keels is the driving force for terrane assembly, regional shortening and deformation.

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