USING BOUNDARY-BASED MAPS TO ILLUSTRATE THE ROLE OF EXTERNAL AND INTERNAL PROCESSES IN MERCURY'S SURFACE FORMATION C.S. Clark[1] and P.E. Clark[2]. [1]Chuck Clark architect, 1100 Alta Avenue, Atlanta, GA 30307, [2]Catholic University of America, Institute for Astrophysics and Computational Science@NASA/GSFC, Greenbelt 20771 (Correspondence email: Pamela.Clark@Flexureengineering.com).

Purpose: We are applying the Constant Scale Natural Boundary (CSNB) approach [1] to mapping Mercury to provide additional insight on its surface formation processes.

Constant Scale Natural Boundary Mapping: The Constant Scale Natural Boundary (CSNB) mapping method produces maps that are markedly different from those produced by more traditional methods. Whereas traditional maps can be expressed as outward-expanding formulae with well-defined central features and relatively poorly defined edges [2,3], CSNB maps begin with well-defined boundaries.

For a given body and timeframe, internal, external, or combined processes may dominate in shaping global high or low relief surface features, which act as constant-scale boundaries or 'edges' in this approach [1]. On entirely impact-dominated surfaces, such as those of most asteroids, we anticipate that morphological boundaries would represent radial and concentric features formed during crater formation, whereas on tectonically driven surfaces, such boundaries would be surface expressions of tectonic plates or cells. Where volcano-tectonic processes play major roles, morphological boundaries would represent crustal disruptions occurring as a function of time, such as plate boundaries on Earth, or hot spot progressions on Mars. When surface modification processes occur on a rapid timescale, such mapping techniques will give insight on processes shaping the most recent events.

Mercury Context: Mercury has apparently been shaped by both external processes (impact) and internal processes (core-formation and tidally-driven episodes of crustal expansion and contraction) [4,5,6,7]. As elsewhere, impact-driven resurfacing rate has slowed historically due to the decrease in size and frequency of bombardment. Extensive volcanic resurfacing is associated with two episodes of plains formation, the early most extensive of which followed core formation and crustal expansion. Networks of orthogonal (NE/SW and NW/SE trending) fractures, now apparent only as 'palimpsests', should have occurred during tidal despin followed by crustal expansion during core formation. The global network of north-south trending thrust fault scarps is associated with crustal contraction. The largest visible impact feature on Mercury is Caloris, although the ubiquity of craters across the range of smaller sizes indicates that the ordinary 'erosion' process on Mercury is bombardment, as on the Moon. The dearth of impact events may be due to extensive volcanic resurfacing during Mercury's plains formation episode.

As on the Moon, the earliest tectonic and impact events should continue to exert a palimpsestlike influence over later events.

CSNB Map of Mercury: We have applied the CSNB approach to Mercury, identifying units based on the enhanced color mosaic map supplemented by topography information available in the northern hemisphere [4,7]. Two major units derived from the mosaic are 'blue', indicating older terranes including intercrater plains, and 'orange', indicating younger volcanic plains and pyroclastics. The boundaries themselves are bright and typically subdued in relief. Some are obviously tectonic features and others are impact features, for which the quasi-'ray's apparently reactivate and follow pre-existing tectonic features. The blue terrane corresponds to high to moderate regions except for Caloris and more recent impact features in the northern hemisphere. Medial axes of the two complementary terranes generate two similarly complementary world maps of Mercury: one depicting orange terrane in terms of (framed by) blue terrane, and vice versa.

CSNB Implications for Planetary Modeling: The CSNB projection has now been used to produce global maps of bodies lying on a continuum between externally and internally driven control of surface morphology. For the Earth and Mars, representing the internally driven extreme, ridge and trough boundaries are apparently associated with internal activity cells, thus CSNB maps allow greater understanding of, for example, the pattern of gravity and magnetic anomalies. For asteroids, representing the externally driven extreme, irregular facet edges become boundaries of a 'splat' map and allow insight into bombardment history. Mercury, massively resurfaced by volcanic plains with regional- to global-scale tectonic features representing internal processes related to core formation, is mapped in chronologically complementary terrains representing major volcanic episodes. Without global-scale topography, global mapping based on tectonic features alone, which are often of low relief, is not possible. Mapping the Moon thusly, rather than as a splat map [ref], depicting highlands framed by volcanic basins, might also portray its volcanic history in a new light.

References: [1] P.E. Clark and C.S. Clark (2013) SpringerBrief, 122 p.; [2] Krantz (1999) American Scientist, 84, 436; [3] Stooke, http://www.ssc.uwo.ca/geography/space-map/contents.htm; [4] Smith et al (2013) Science, 333, 093011; [5] Clark et al (1988) Mercury, U Arizona Press; [6] Gonzalez et al (2012) Plan Space Sci, 60, 193; [7] Mercury enhanced color global mosaic (2013) at spaceref.com.

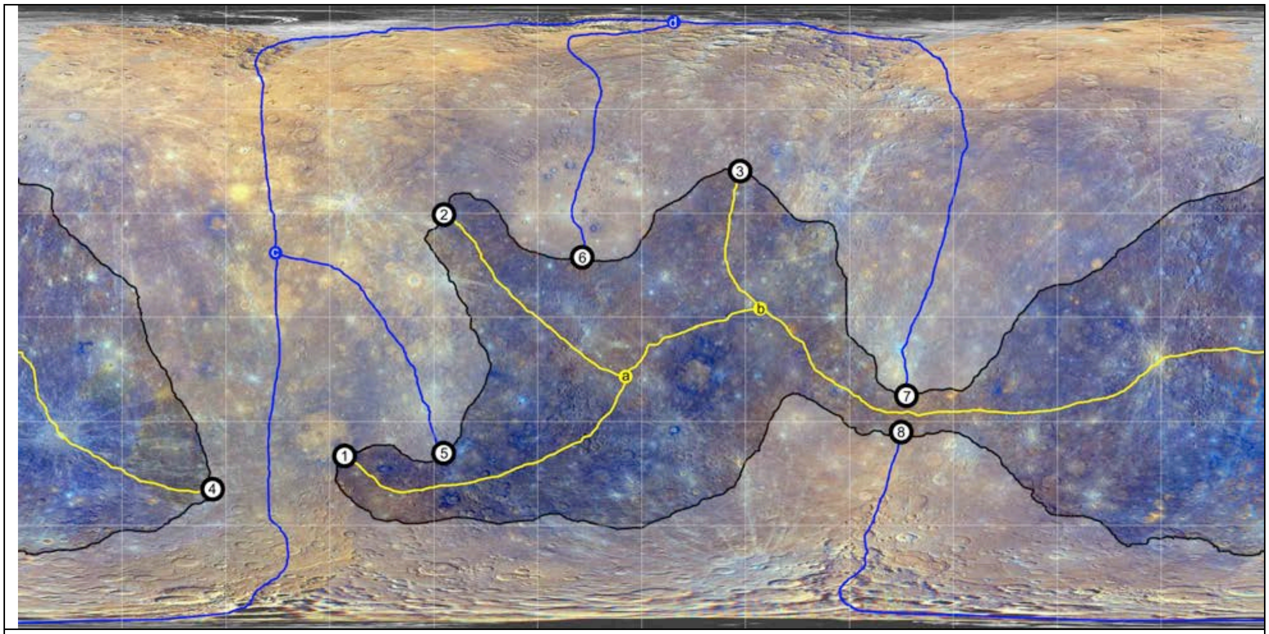

Figure 1: Mercury map. Blue terrane highlighted; orange terrane shown pale. Blue terrane's topological network shown as yellow line, which is the edge of map in Figure 2; orange terrane's topological network shown as blue line, which is the edge of map in Figure 3.

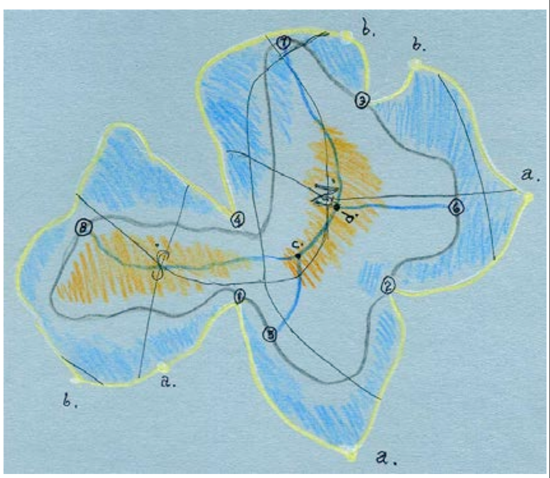

Figure 2: Constant-scale natural boundary map sketch of Mercury composed to feature orange terrane in terms of blue terrane. (See Poster for completed CSNB map.)

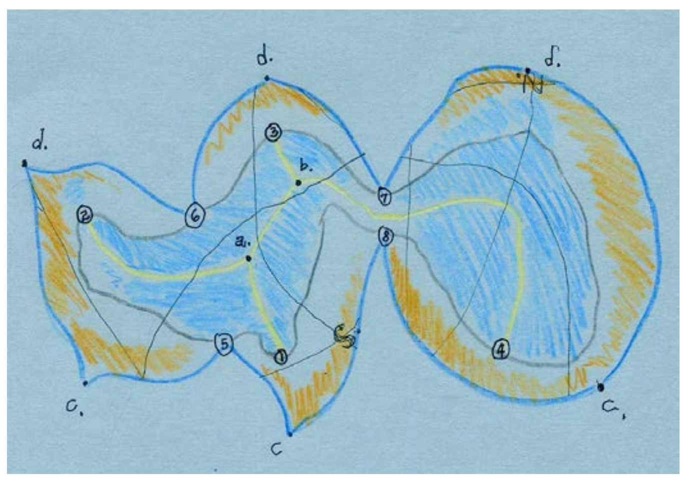

Figure 3: Constant-scale natural boundary map sketch of Mercury composed to feature blue terrane in terms of orange terrane. (See Poster for completed CSNB map.)