A MORE TOPOLOGICAL PLANETARY CARTOGRAPHY: WORLD MAPS WITH CONSTANT SCALE NATURAL BOUNDARIES (CSNB). C.S. Clark¹, P.J. Stooke², P.E. Clark³, R.A. De Hon⁴. ¹Chuck Clark architect, 1100 Alta Avenue, Atlanta, GA 30307; rightbasiccbuilding@yahoo.com. ²Geography Dept., U. of Western Ontario, London, ON N6A 5C2. ³Code 695, NASA/GSFC, Greenbelt, MD 20771. ⁴Dept. of Geosciences, U. of Louisiana at Monroe, LA 71209.

Introduction: Modern flattening transform procedures have evolved from algebraic considerations of projection geometry and developable surfaces, while the underlying Renaissance era theoretical concept—perspective—remains fundamentally unaltered even in our topologically conscious and digitally capable era [1]. World maps in service to the planetary sciences community, divided arbitrarily by choice of bounding graticule lines, encourage a focus on localities and regions at the expense of overall structure and pattern [2]. For spherical worlds, this often manifests just as a choice of map center or latitude boundary with separate polar insets. For irregular shapes like asteroids, any arbitrary boundary conflicts seriously with the natural boundaries of ridges and facets on such worlds, distorting perceptions of real forms.

A more topological mapping paradigm: World maps with constant scale natural boundaries (CSNB) replaces the cartographic orthodoxy of precise and unambiguous coordinate point systems enclosed by an amorphous border with, instead, an amorphous collection of point sets [3], within a precise and unambiguous border. Traditional methods begin with distorted sheets, the interruption secondary[4]. CSNB, like topology, reverses this ordThe stipulation, apparently novel, of constant scale at map edge, combined with the stipulation, previously studied, of natural boundaries [5] begets world maps intrinsically vested in both topological parameters and physical features, and novel properties arise: A) simplicity; B) a library of 3-D forms; C) a continuum of construction; D) intelligible edges and unvarying peripheral relative size; and E) maps composable to illustrate theory or depict context.

In sum, CSNB maps may reveal global patterns and structure difficult if not impossible to discern in conventional systems [6, 7, 8, and 9].

Figure 1 illustrates this mapping précis on Mars [10], drawing out two independent depictions—a dale and a hill [11]—of its planetary watershed directly from critical boundaries, without appeal to abstract or algebraic mathematics. Note left map’s edge marked by colored line on right map, and vice versa.

Figure 2 illustrates the CSNB continuum of map construction, whereby enlarging or limiting the scope of critical boundaries leads to either highly interrupted (upper maps), or highly compact (lower) maps.

Figure 3 illustrates how defining a map by only its edges can steer it to a wide variety of specific uses.

Top row shows maps [7] matched to tectonic theories: left map is suited to explain plate tectonics’ “Wilson Cycle”—imagine ridge push inwards from the map edge—wherein the inexorable, if slow, growth of a relatively young Atlantic ridge will eventually push the intervening land masses to close the Pacific basin (yellow line: edge of right map); right map is a map bound by the opposite notion, the fastest mid-ocean ridge (orange line: edge of left map).

Note that CSNB, like all world maps, is a neutral advocate for theories, although it can help identify internal contradictions. Merely because a map clearly depicts a plausible theory does not make the theory true.
Bottom row shows a highly interrupted tectonic map, with subsurface trenches and ridges appended, foldable to a globe that is responsive to touch in mimicry of plate tectonic theory. In what might be called origami engineering, folded trenches are stiffened by radial interlocking, and mid-ocean ridges are softened by circumferential interweaving.

Figure 4 illustrates the use of CSNB as a tool for characterizing asteroids: a very interrupted map folds to a shape model. Note the precursor tree, a simple stick figure from which the map and model are made, may also serve as a novel geometrical method of shape compression [13].

Figure 5 illustrates the differences in distortion and overall visual sensibility between topographic-bound CSNB maps and the same data displayed in familiar simple cylindrical format [2, 13 adapted, and 14].

Conclusions: Just as we may choose to map Earth’s oceans contiguously for marine studies or its landmasses for population studies, we may divide any world in any geologically or topographically meaningful manner to suit a particular purpose. CSNB maps provide a uniquely conformal and bandwidth efficient way of doing this. The results may seem surprising at first, perhaps giving the impression of being weakly controlled, but they may illustrate particular themes better than conventional methods. Folding globes of asteroids, for example, may have great educational value and power as a visualization method. As Stooke [15] and Berthoud [16] have shown, novel methods can produce meaningful maps of worlds poorly suited to traditional cartography. CSNB maps appear to be an optimal way to portray and demonstrate genetic relationships between structures as global systems [6,7,8,9,17].


Figure 3: Making CSNB maps fit purpose

Figure 4: Capturing asteroid Eros shape-model with CSNB

Figure 5: Comparing CSNB and conventional maps