USING BOUNDARY-BASED MAPPING PROJECTIONS FOR MORPHOLOGICAL CLASSIFICATION OF SMALL BODIES. C.S. Clark[1] and P.E. Clark[2]. [1]Chuck Clark architect, 1100 Alta Avenue, Atlanta, GA 30307 (leftbasicbuilding@yahoo.com); [2]Catholic University of America, at NASA/GSFC, Greenbelt, MD 20771 (Correspondence: pamela.e.clark@nasa.gov).

Purpose: We present a systematic approach to interpreting asteroid shape and surface morphology [1,2,3,4,5,6,7,8,9] using Constant Scale Natural Boundary (CSNB) map projection applied to Deimos, Phobos, Eros, and Ida. With the CSNB projection, the ridges and troughs, 'event horizons' acting as encoders of asteroid history, can be prominently featured as map edges at constant scale. For consistency and orientation, we locate the blunt 'nose' in the center of all maps in the equatorial plane, because most asteroids are elongated along the equatorial axis, and the blunt nose is a recognizable feature, but less morphologically complex than the 'sharp' end. The external boundaries then become the ridges connecting 'peaks', which typically run parallel to the equator, and troughs connecting 'basins', which typically separate the promontories. Three maps, two ridge-bound and one trough-bound, exist for each object (Figure on next page). Segmented maps (right column) show separation of the surface into geodesic 'facets', preserve resolution, and fold to a 3D facsimile of the asteroid. Compact maps (left colums) preserve orientation and are suitable for use as continuous maps with physical meaning to their edges.

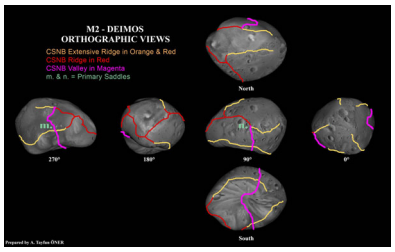
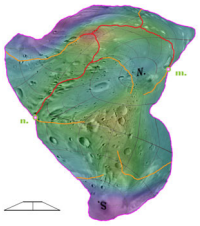
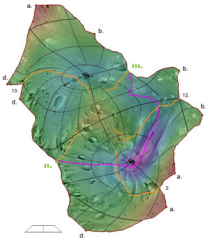
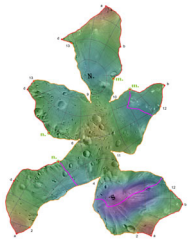
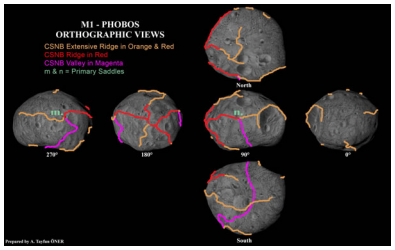
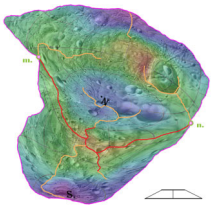
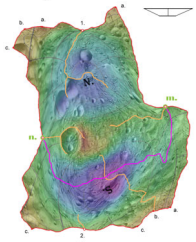
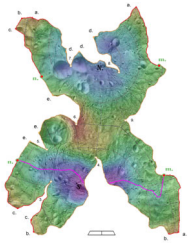
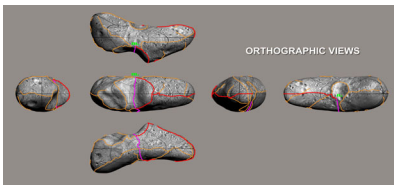
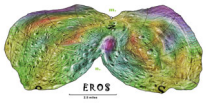
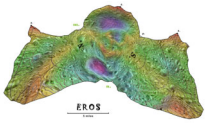
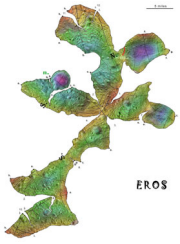
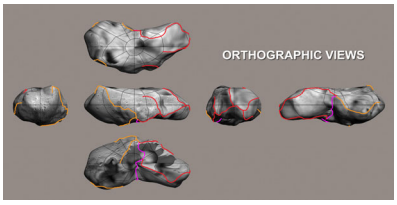
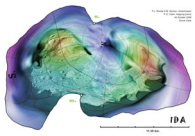
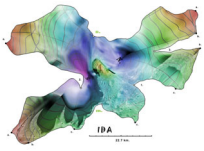
CSNB Map Comparison to other Projections: Understanding morphological patterns requires minimizing the distortion in important features. Simple cylindrical and mercator maps, although familiar and instantly orientating, produce great distortions, particularly for irregular objects and particularly at higher latitudes [9]. 3D mosaics require more than one view to illustrate what CSNB and conformal projections show in flat maps. CSNB projection combines the best features of 3D mosaics and conformal maps, emphasizing highly irregular faceted shape in one view, with minimal distortion, on a flat map. CSNB maps are designed to be conformal for antipodal areas and to preserve proportions in map interiors. The CSNB map shows the crater distribution, as well as the radial distribution of albedo and morphological features relative to the most prominent features, on one map. 'Segmented' CSNB projections preserve resolution as well. A disadvantage in use of the less traditional segmented CSNB projection is the vigilance required to keep track of features to allow orientation.

Asteroid Morphology: Morphological parameters manifested in CSNB map shape include E/W and N/S distribution of segments, roughness of boundaries associated with each segment, and aspect ratios for each segment. Based on comparison of these parameters (see table below), Phobos and Deimos, are more spherical and regular than Eros or Ida, implying a more disruptive history for the latter two asteroids. Phobos is composed of considerably elongated segments, due to network of radial grooves extending from the Crater Stickney on the nose. Deimos and Eros show considerably greater asymmetry in the N/S directions. Eros and Ida both exhibit considerably more roughess on segment boundaries indicating that Deimos and Phobos, with their less disruptive facet boundaries, may be somewhat shielded from bombardment by the planet Mars. Asymmetry in Deimos shape is caused by the sharp, southward hooking nose in the equatorial region and the cavity, presumably formed by an impact event, near the south pole.

References: [1] Clark C.S. (2002), LPS XXXIII, #1794; [2] Clark C.S. (2003) ISPRS, 34, XXX; [3] Clark P.E and Clark C.S. (2005) LPS XXXVI, #1423; [4] Thomas P. et al (2002) Icarus, 155, 1, 18-37; [5] http://near.jhuapl.edu; [6] Cheng A. and Barnouin-Jha O. (2002), LPS XXXIIII, #1522; [7] Oner A.T., http://www.solarviews.com/eng/asteroid.htm; [8] Stooke P., http://www.ssc.uwo.ca/geography/ space-map/contents.htm; [9] Krantz S. (1999), American Scientist, 84, 436.

Table of CNSB Derived Asteroid Parameters

Asteroid (size, km)	E/W Symmetry N/S Symmetry	Boundary Roughness Segmentation	Aspect Ratio for Segments length:width
Deimos 15x12x10	E/W 2.5:2.5 N/S 3:2	11-12/facet 5 facets	1 (.5-2)
Phobos 27x22x19	E/W 2:3 N/S 2:3	15-27/facet 5 facets	2.4 (1-3)
Eros 33x13x13	E/W 5:4 N/S 7:2	10-31/facet 9 facets	1.2 (1-3)
Ida 54x24x15	E/W 3:4 N/S 4:3	7-24/facet 7 facets	1.7 (1-3)

Asteroid 3D Model		CSNB Valley-Bounded Compact	CNSB Ridge-Bounded Compact	CSNB Ridge-Bounded Segmented
Deimos				
Phobos				
Eros				
Ida				

Map Projections of Deimos, Phobs, Eros, and Ida (from top to bottom), illustrating (left to right) 3D models with CSNB boundaries indicated, CSNB valley (trough) bounded compact maps, ridge bounded compact maps, and ridge bounded segmented maps. Backgrounds on CSNB maps are shaded relief with topography indicated in color.