USING BOUNDARY-BASED MAPPING TO DETERMINE UNDERLYING STRUCTURE FOR ITOKAWA AND OTHER SMALL BODIES. C.S. Clark[1] and P.E. Clark[2]. [1]Chuck Clark architect, 1100 Alta Avenue, Atlanta, GA 30307 (rightbasicbuilding@gmail.com); [2]Catholic University of America, at NASA/GSFC, Greenbelt, MD 20771 (Correspondence: pamela.e.clark@nasa.gov).

Purpose: Having already utilized Constant Scale Natural Boundary (CSNB) mapping to characterize the shape and surface morphology of a range of asteroids as a key to understanding and comparing their underlying structure and history [1,2,3,4,5,6,7,8,9,10], we apply this technique to Itokawa, a very small, low density, and rough object interpreted as a rubble pile [11].

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. How prominent, distinctive, and globally interconnected will such features be for a ‘rubble pile’?

Methodology: 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. Typically, we create three maps, two ridge-bound and one trough-bound, for each object. Ridge-bound maps are either segmented, showing separation of the surface into geodesic ‘facets’, preserving resolution, and folding to a 3D facsimile of the asteroid, or compact, preserving orientation and suitable for use as continuous maps with physical meaning to their edges.

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.

Itokawa Morphology in Context: 25143 Itokawa (See Figures below) is an asymmetrically bimodal tiny asteroid covered predominantly by rough boulder-bearing terrain and to a lesser extent by smooth, in-filling dusty terrain [11]. The latter terrain includes quasi-circular dust-filled depressions, or ponds, without rims and troughs, as observed on Eros. Some of these may be craters penetrating the shallow regolith. The dominant morphological feature is a band or trough forming the ‘neck’. This feature and less obvious shelves or shoulders at both ends, as well as small ridges running from nose to nose have most likely resulted from loss of material during dynamic interactions. Ridges and troughs are often locally prominent, but not continuous, and not clearly associated with other impact features. Migration of debris to low-lying areas exposes material and occurs on a more rapid scale than space weathering [11].

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 preliminary comparison of these parameters among the asteroids systematically studied to date (Eros, Ida, Phobos, Deimos, and Itokawa), Itokawa is the most irregular, and the most clearly bimodal, implying the most disruption. Itokawa also exhibits the most asymmetry in the N/S and E/W directions.

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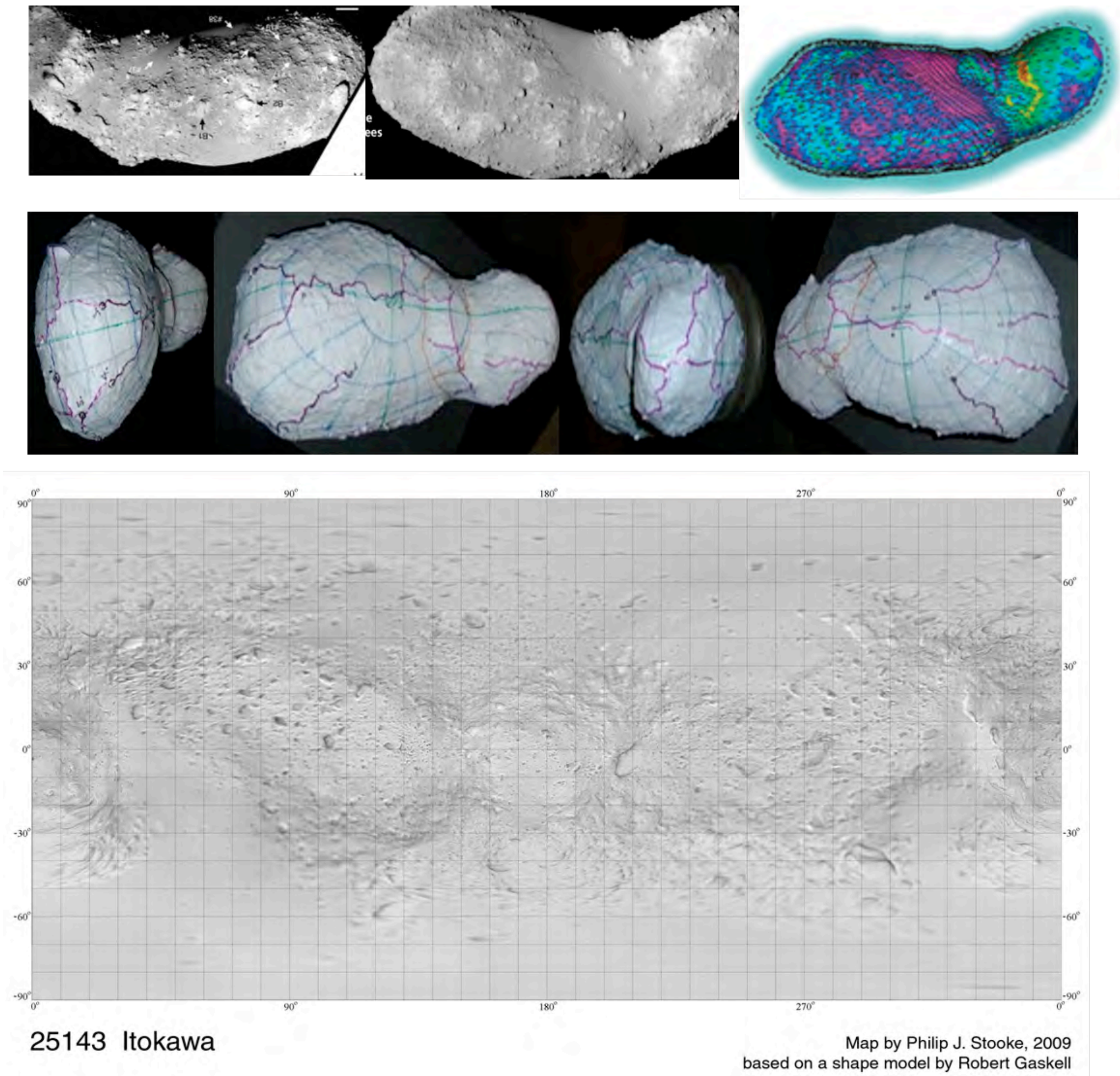

Itokawa (top) rotated images of east and west hemispheres [11] along with downslope model roughly equivalent to topography for adjacent hemisphere [13]; (middle) rotated model with ridges and troughs drawn on in preparation for creation of CSNB map; Simple Cylindrical projection of asteroid [12].