ARE THERE STRUCTURAL LINEAMENTS ON ITOKAWA? O.S. Barnouin[1,2], J.L. Noviello[2], and C.M. Ernst[1], [1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, USA (olivier.barnouin@jhuapl.edu); [2]Department of Earth and Planetary Sciences, Johns Hopkins University, Baltimore, MD 21218, USA.

Introduction: Several studies [1, 2] have suggested that Itokawa might possess some structural lineaments, limited to the longer body of the asteroid (Figure 1). On other asteroids, lineaments take the form of grooves, shallow and flat-floored troughs, ridges, and pit chains. These structures, when present on a global scale, have been used to argue that other asteroids (Eros, Vesta, Gaspra, Ida and Lutetia) possess internal structurally integrity [e.g., 3–5]. The confirmation of large scale lineaments on any portion of Itokawa therefore could provide similar clues to the internal structure of this rubble pile asteroid that may be important for understanding its formation and evolution. In particular, confirmation of any structural integrity to Itokawa may be important to recent evolutionary scanerios proposed for Itokawa [6], and internal density estimate derived by evaluating YORP effects [7]. Both are more easily accounted for by the presence of some significant coherent and high density cores located non-unformly across the asteroid. This study attempts to confirm or deny the presence of any such structural lineaments, and evaluates the implication of their presence or lack thereof.

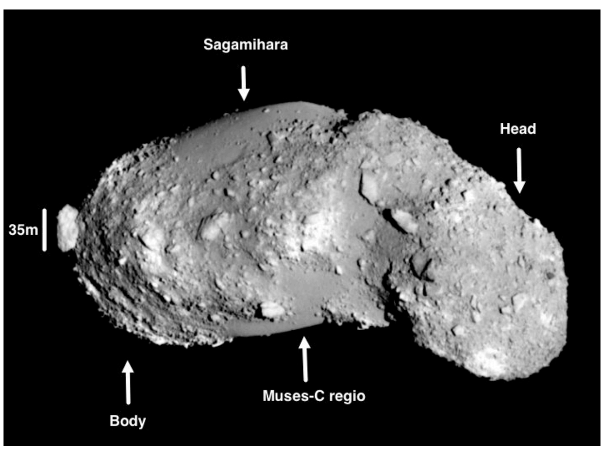

Figure 1. The asteroid 25143 Itokawa (image number st_2420855658_v).

Approach: Plausible lineaments were mapped on the surface of Itokawa using the Small Body Mapping Tool (SBMT), an asteroid geographical information system available at sbmt.jhuapl.edu [ref Kahn LPSC?].

To be identified as a lineament, a feature had to be found in two or more high-resolution narrow angle camera (AMICA) images collected by the Hayabusa mission. A lineament had to be viewed with differing geometries and lighting conditions within these images. Experience with similar analyses on 433 Eros [ref?] has shown that making use of just one image can often lead to erroneous interpretations of the presence of any structural lineaments.

To map a potential lineament, every image employed was overlain on a high resolution (> 3 million plates) shape model of the asteroid [8]. This allowed the verification that a lineament seen in one image corresponded to another feature seen in another image. Further, we used both this shape model as well as laser altimetry data collected by the Hayabusa mission [9] to assess whether or not a candidate lineament had a topographic signature.

Due to the difficulty of identifying lineaments, we followed a procedure similar to that used by [10] for identifying craters and associate confidence numbers for the lineaments that range from 1 to 4. A lineament that is easily identified in several images and possesses a topographic expression was given a 4. A plausible lineament seen in just two images and which possessed no obvious topographic signal was given a 1.

In past studies, we have found that fitting planes to lineaments and comparing the orientation of their normal vector allows to identify the presence of global zones of weakness or fault planes within an asteroid [refs eros and vesta]. These weakness zones have typically, but not always, been associated with source craters [e.g., 11]. A similar analysis will be done with the results from our investigation. If there is a large-scale internal structure influencing the lineaments, we expect a semi-global orientation preference. If the asteroid is composed of many smaller fragments, no preferred orientation of planes is expected.

Preliminary Results: We have identified 27 candidate? lineaments (Figure 2). Only 9 lineaments possess confidence levels ≥3. The rest of the candidate lineaments may be present, but with limited confidence.

The most plausible lineaments usually consist of an alignment of blocks that are sometimes associated with faults observed on some of the bigger rocks located on the surface. These features often possess a slow rise in topography on one side of the ridge, followed by a more sudden drop in topography on the other side. The best candidate lineaments are usually found around the equator of the asteroid on its body, plausibly cutting the body in two. This result might indicate that the body of Itokawa is composed of two large cores, covered by a layer of loose blocks and coarse regolith.

Very few if any lineaments are observed on the head of the asteroid, which may indicate that the head is not very cohesive and could be composed of many smaller blocks that cannot withold stress over long distances. However, such an inference might be not be consistent with the the presence of facets on the head that could indiciate structural intergrity, as argued by some for similar features on Eros [3]. These facets could also be craters [10].

Conclusion: Itokawa possess some lineaments on its surface. These are primarily confined to the body of the asteroid, and could indicate some coherence there. Additional analysis is required for confirmation of any semi-global structures, but two main rock cores could compose the body of Itokawa. The head may be a composed of smaller blocks, although a larger single block with facets cannot be ruled out. The presence of one or two large cores in the body of Itokawa faciliates accretion scenarios derived from block analyses [7]. It may also provide supporting evidence for the possibility of important density variations across the asteroid [8].

References: [1] Cheng, et al., 2007. *Geophys. Res. Lett.* 34, L09201. [2] Barnouin-Jha, O.S. et al., 2008 *Icarus* 198, 108–124. [3] Thomas, P.C. et al., 2002. *Geophys. Res. Lett.* 29, 46–41. [4] Jaumann, R. et al., 2012. *Science* 336, 687–690. [5] Thomas, N. et al., 2012. Planet. Space Sci. 66, 96–124. [6] Mazrouei, S. et al., 2014. *Icarus,* 229, 181-189. [7] Lowry, S.C. et al., 2014, A & A, in press. [8] Gaskell, R., et al., 2008. Gaskell Itokawa Shape Model V1.0. *NASA Planetary Data System* 92. [9] Mukai, T., et al., 2007. Advances in Space Research 40, 187–192. [10] Hirata, N., et al., 2009. *Icarus* 200, 486–502. [11] Buczkowski, D.L., et al. 2008. *Icarus* 193, 39–52.

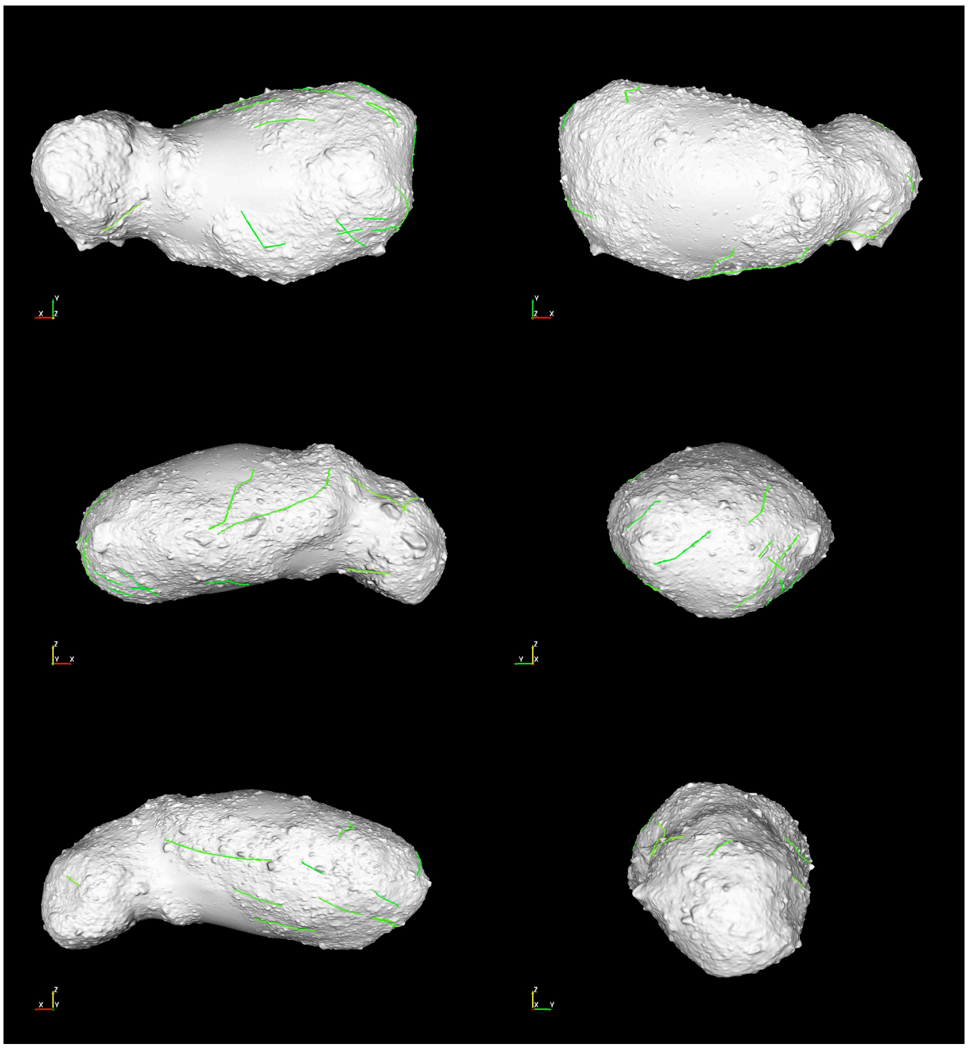

Figure 2. Observed distribution of all plausible lineaments on 25143 Itokawa overlain on high resolution shape model.