

THEMATIC MAP OF HAZARDS AND REGIONS OF INTEREST FOR ASTEROID BENNU. C. A. Johnson¹ and D. N. DellaGiustina¹, ¹Lunar and Planetary Laboratory, University of Arizona, Tucson AZ 85721. Email: carinaj@orex.lpl.arizona.edu

Introduction: The Origins, Spectral Interpretation, Resource Identification, and Security-Regolith Explorer (OSIRIS-REx) mission's driving goal is to rendezvous with primitive asteroid (101955) Bennu, retrieve a surface sample, and return it to Earth for in-depth study [1]. To aid in the selection of sites for potential sample acquisition, the OSIRIS-REx team has introduced a new cartographic data product. The thematic map of Hazards and Regions of Interest ("hazard map") is a map that highlights all hazards (objects greater than 21cm), regions of exclusion ("ROEs", i.e. craters, linear features), and regions of interest ("ROIs", i.e. regions with few to no hazards). These areas will be classified using a bi- or tri- color scheme layer that is registered directly to a base map (i.e. a global panchromatic mosaic). The hazard map can be converted into a mask for the binary decision-making that may be required during the creation of the Sampleability map, which quantifies the probability that a sample can be successfully collected from any point on the surface Bennu.

Production: The hazard map will be constructed using images taken by the OSIRIS-REx CAMera Suite (OCAMS) [2]. The proposed technique includes using a suite of human-trained and untrained automated classification algorithms including machine learning routines for clustering, saliency, and texture classification. In this context, the term "texture" is used in the computer vision sense to mean statistical patterns of image pixels. These numerical signatures can distinguish between geologically relevant elements such as roughness, regolith characteristics, differential weathering, etc., [3] with the aid of human training. Similarly, "saliency" algorithms characterize the conspicuity of each pixel probabilistically using properties like color, depth, orientation, curvature, size, intensity, topology, etc. [4].

Additionally, manual hazard counting will occur using both an internet-based citizen science platform and in-house experts. The hand counting will serve as verification of the automated results and will also refine the map as previously undetected features can be highlighted as they are identified.

Before launch the OSIRIS-REx image processing team will quantitatively assess the ability of each automated classification routine or group of routines on a variety of images of planetary surfaces. These will include images from previous missions to small bodies, as well as artificial images designed to mimic the

predicted surface features, texture, and albedo of Bennu.

Predictions: By automating much of the process of feature and hazard classification, OSIRIS-REx will ensure the hazard map is available quickly during a period in operations when timing is critical. An early version of the map will serve as a valuable tool helping to inform and speed up the production of the Sampleability map. Using automated techniques with manual counting will ensure the thematic map has full and accurate coverage with improved fidelity, increasing the scientific value of the product as more hand counted data becomes available.

References: [1] Lauretta D. S. (2015) *Hndbk of Cosm. Hzrds. & Planet. Def.*, 543-567. [2] Smith P. H. et al. (2013) *LPS XLIV*, abstract #1690. [3] Thompson D. R. et al. (2013) *LPS XLIV*, abstract #2209. [4] Yeomans B. et al. (2015) *Proc. of 13th Sym. on Adv. Space Tech. in Rob. & Autom.*, abstract # 92153.

Fig. 1 – Example of a hand-classified, tri-color thematic map of Hazards and Regions of Interest on Asteroid Itokawa. In this example red represents large hazards, yellow represents regions of exclusion (ROE) and green represents regions of interest (ROI).

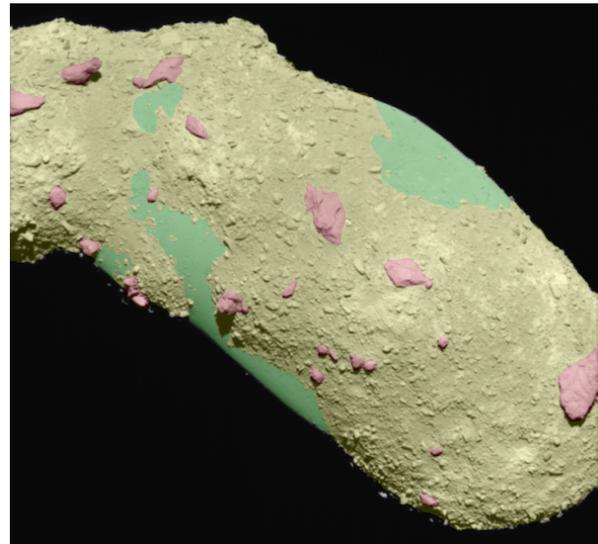


Fig. 2 - Example of a tri-color thematic map of Hazards and Regions of Interest on Asteroid Itokawa generated from a texture classification algorithm using a human-generated training set.

