Crater Identification and Incidence Angle: A Preliminary Look Through the Eyes of CosmoQuest's Citizen Scientists. J. A. Grier[1], M. Richardson[1], P. Gay[2], S. Robbins[3], C. Lehan[2], I. Antonenko[4] and the CosmoQuest Team, [1]Planetary Science Institute (jgrier@psi.edu), [2]Astronomical Society of the Pacific, [3]Southwest Research Institute, [4]Planetary Institute of Toronto, Canada.

Introduction and Motivation: The CosmoQuest Citizen Science Platform brings together astronomical research projects and their scientists with interested members of the general public. The scientists and the CosmoQuest team provide the scaffolding, research goals, and educational context for the citizens to conduct meaningful work on planetary data. The citizens bring their desire to learn, to join community, as well as their time and effort in annotating images.

Tailoring citizen science efforts to produce valuable scientific data presents several challenges unique to this endeavor. Of concern are the approaches to and lessons learned from: (1) engaging and retaining citizens to do image annotation, (2) challenges to coding and presenting appropriate images and software for image annotation, and (3) examining if citizen produced data and subsequent results support the current thinking on a given topic, or not, and why. This poster will focus primarily on the third issue, with the specific topic of investigating crater identification and measurement at different incidence angles.

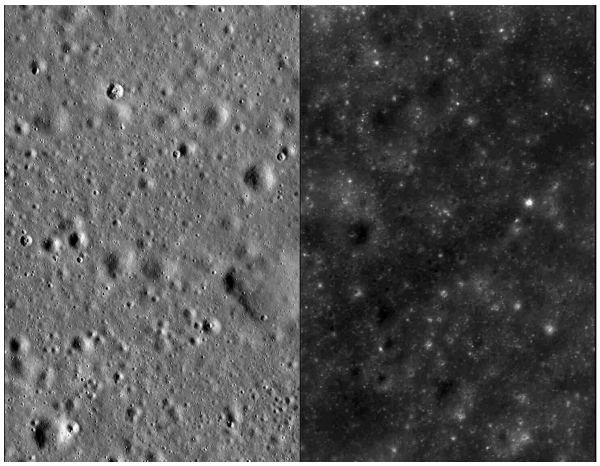

Figure 1: LROC image examples of high versus low incidence angle. Images are of nearby (not identical) regions of the Moon. Small craters are easily identifiable at high incidence angle (left), while crater ejecta does not stand out. At low incidence, albedo differences are easily identifiable, including crater rays, however the identification of craters and their rims becomes more challenging.

Previous work suggests that incidence angle will effect crater counts and size measurements done by experts. Is this reflected in the citizen scientist experience at CosmoQuest? Why or why not? This poster presents our preliminary look at the answers to these questions.

Scientific Context: Small lunar impact craters are most easily identified by their round "bowl" shaped depressions, and if relatively fresh, their raised rims. Such features are topographic in nature, rather than related to surface albedo. It has therefore been considered a boon to be able to view surfaces at high incidence angle (i.e. with the solar illumination nearer the local horizon) when searching for impact craters [1]. At high incidence angles topographic features such as mountains, ridges, and troughs appear to be more distinct [2]. Early work [3] suggested that this effect would create a difference in how many craters would be identified in a given image. The work of [4] offered concern that small craters might be lost in the shadows of larger craters at high angles.

Subsequent work addressed this issue quantitatively, citing differences both in the number of craters counted and the measured diameter of those craters [5, 6, 7]. [7] states "Using Apollo Metric and LROC NAC images, we determined that incidence angle affects reliable identification of (small) craters on a mare surface." Also, "Crater measurements at several resolution scales show that incidence angle … will affect the small crater population counts and crater equilibrium diameter estimate for a count area."

The Project: "Moon Mappers" is CosmoQuest's original Citizen Science Project as described in [8]. This project gathers crater data using LROC NAC images with incidence angles from 27 degrees to 83 degrees. Images are 'sliced' into standard sizes and scales for the citizens. They use CosmoQuest's specially designed interface created through the Citizen Science Builder software. They are only presented with the annotation tools (like marking crater diameter) needed for that specific project.

Citizens as a whole approach counting differently than experts – for example, they may choose to annotate only one image, or may do 100 or more. Some citizens are more attentive when measuring diameters than other citizens. Many of these concerns were investigated by [9] who showed that the results of a large number of citizens will approximate that of

scientific experts. We require that 15 citizens have annotated an image to ensure high quality in the averaged data.

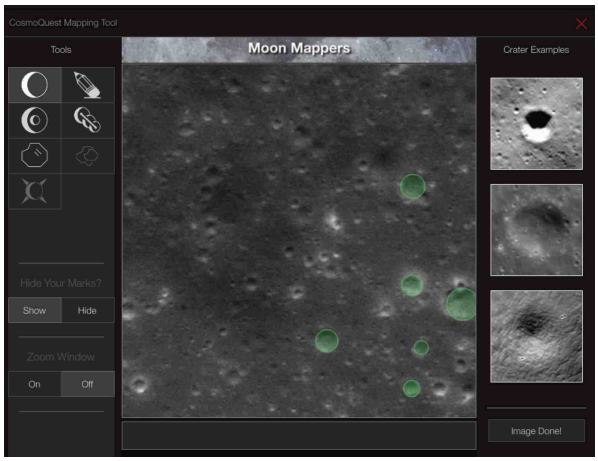

Figure 2: Screenshot of the Citizen Science interface for Moon Mappers. Citizens only annotate craters above a suggested size – they do not try to pick out all the very smallest in an image. Note that examples of craters in various stages of degradation are given as reference during annotation.

In our present phase we are searching through our substantial database of annotated images for those that have (1) overlapping surface area, (2) differing phase angle, and (3) a minimum of 15 different citizens that have annotated that image. We have begun to compile crater statistics for number/diameter to verify our image selection techniques. This poster will present our preliminary look at how the Citizen Scientists responded to images at different incidence angle, and if we could detect this, as others have with expert counters. We will present plans for ongoing work, and our next steps.

References: [1] Bierhaus et al., (2002) AAS DPS #34, 119. [2] Head and Lloyd, (1972) NASA Sp. Paper 289, 25-95. [3] Soderblom, (1972) NASA Sp. Paper 289, 25-87. [4] Moore, (1972) NASA Sp. Paper 289, 25-92. [5] Young, (1975) Proc. Lunar Sci. Conf. 6th, 2645. [6] Wilcox et al., (2005) MAPS 40, 695. [7] Ostrach et al., (2011) Proc. Lunar Sci Conf. 42nd, 1608. [8] Robbins, S.J., Antonenko, I., Lehan, C., Moore, J., Huang, D., Gay, P.L., 2012. Lunar Science Forum, 5. Abstract #602. [9] Robbins, Stuart J.; Antonenko, Irene; Kirchoff, Michelle R.; Chapman, Clark R.; Fassett, Caleb I.; Herrick, Robert R.; Singer, Kesi; Zanetti, Michael; Lehan, Cory; Huang, Di; Gay, Pamela L. 2014. Icarus, Volume 234, p. 109-131

Additional Information: Are you interested in working with citizen scientists through research, podcasts, blog posts, online forums, and more? Contact CosmoQuest PI Pamela Gay pamela@astrosociety.org or Science Lead Jennifer Grier jgrier@psi.edu.

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