ASSESSING PHOTOGEOLOGIC MAPPING TECHNIQUES IN RECONSTRUCTING THE GEOLOGIC HISTORY OF MARS. K. L. Tanaka[1], L. A. Crumpler[2], James M. Dohm[3], Trent M. Hare[1], and James A. Skinner, Jr.[4]; [1]U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, AZ 86001, ktanaka@usgs.gov, [2]New Mexico Museum of Natural History and Science, 1801 Mountain Road NW, Albuquerque, NM 87104, [3]University of Arizona, Dept. of Hydrology, Tucson, AZ, [4]Environmental Geomatics, 719 New Road, Raleigh, NC 27608

Introduction: New datasets of enormous volumes being acquired by a host of Mars missions currently and in the future provide a basis for enhanced efforts to reconstruct the geologic history of the planet through mapping of material units and geologic features. Many geologic models are tied to rate histories and correlations of geologic materials and events; geologic mapping often constitutes a test of such hypotheses. Yet, how accurate and precise are relative-age determinations of martian materials and tectonic and erosional features based on geologic mapping and crater densities? Moreover, sample-return missions eventually will provide rocks that can yield ages of igneous crystallization that in turn will be used to constrain temporal aspects of martian geologic histories based on geologic mapping. Thus, we must be prepared to reconstruct and interpret martian geologic history accurately and efficiently with a good feel for the reliability of given techniques and approaches using available data sets.

We can address such issues by applying photogeologic methods to Mars-like terrestrial analogs with data simulating available Viking, Mars Global Surveyor, and Mars Odyssey datasets. Terrestrial locations where field mapping and age-dating studies exist would be ideal. Blind tests performed by geologists experienced in both Mars photogeologic and terrestrial field mapping could assess the accuracy of geologic history reconstructions made on Mars and compare the effectiveness of various mapping approaches.

Approach: We are first selecting areas on Earth that have similarities with terrains on Mars that are sites of geologic significance and having potential for future exploration. Three of us (Tanaka, Crumpler, and Dohm) are selecting volcanic regions modified by tectonic deformation and fluvial erosion in Arizona and New Mexico, where we individually have field and research experience. Volcanic rocks provide the best radiometric ages and thus would likely be a prime target on Mars for sample return to pin down the cratering history of the planet [1]. Also, the ages of such materials can be used to constrain ages of tectonic and fluvial features, which has been done extensively on Mars [e.g., 2-4]. On Earth, such features may have complex, long-lived histories that include diverse styles of activity. For example, fault reactivation caused by differing stress orientation, intensity, and build-up rates has resulted in multiple offsets and styles of deformation associated with a single fault or fault system. In the desert Southwest, present-day fluvial activity is commonly governed by flash floods and spring runoff, whereas more sustained precipitation would have been characteristic of the same region during the Pleistocene. In addition, another site (chosen by Skinner) will be a coastal subaerial and marine environment where sedimentation and various coastal aqueous and geologic processes control surface morphology. Such an area should be pertinent to assessing mapping of the northern plains boundary (currently underway by Tanaka, Skinner, and Hare) [5, 6] and potentially of highland areas where fluvial dissection transitions to deposition (e.g., Gusev crater).

Skinner and Tanaka have also been discussing the merits and application of allostratigraphic (or unconformity-bounded) units to Mars geologic mapping in comparison with traditional, rock-stratigraphic mapping [7, 8]. For example, Mars units commonly consist of multiple and/or uncertain lithologies, yet unconformities that define periods of geologic activity can be mapped. Additional discussion about unit-mapping approaches occurred during the 2003 Planetary Geologic Mappers meeting held at Brown University. We will also evaluate the circumstances where particular mapping approaches provide better results.

Each site expert provides the coordinates of his chosen site for production of imaging and topographic datasets into a GIS (by Hare). We are using Shuttle Imaging Radar topography to simulate Mars Orbiter Laser Altimetry data, aerial photos and Landsat data for Viking, Mars Orbiter Camera, and Thermal Emission Imaging System images. The data are being resampled to match available resolutions on Mars. The data are then sent to the other team members to perform the geologic mapping, which is then returned to the site expert for evaluation.

Expected results: We plan to have initial results of the terrestrial blind-test mapping to present at LPSC 35. These studies will provide an assessment on the reliability of inferences made for standard relative-age relations based solely on unit overlap and embayment relations and structural and fluvial histories based on cross-cutting relations.

Future work: Mars provides us with an additional clue for determining relative ages—crater densities. We can simulate having crater densities for given units by converting their radiometric age information in a systematic fashion. For example, a unit incorporating multiple lava flows with radiometric ages can be assigned a hypothetical crater age based on the area-weighted mean of the radiometric ages. We also would like to consider other martian analog terrains on Earth that may be conducive to photogeologic studies as described herein. We will also consider terrains on Earth that may have complex surface histories where surface ages may be deceptive, mimicking exhumed surfaces on Mars where crater ages are misleading.

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