INTRODUCTION TO AN UPDATED ANALYSIS OF PLANETARY PROTECTION "SPECIAL REGIONS" ON MARS. D.W. Beaty[1], J.D. Rummel[2], L.M. Pratt[3], and the MEPAG SR2-SAG. [1]Mars Program Office, JPL/Caltech, [2]East Carolina University, [3]Indiana University.

Introduction: Since the beginning of human activity in space science and exploration, there has been an appreciation of the negative consequences of transferring life from one planet to another. Given the unknown consequences of contact between two life forms and the fundamental value of studying a new form life, thoughtfulness and caution are warranted. Those are reflected in both the UN Space Treaty of 1967 [1] and in the International Council for Science's Committee on Space Research (COSPAR) Planetary Protection Policy [2] that serves as an international consensus standard for avoiding harmful biological contamination under that treaty. The "special regions" concept is a component of the COSPAR Planetary Protection Policy for Mars. These are regions "within which terrestrial organisms are likely to replicate" as well as "any region which is interpreted to have a high potential for the existence of extant martian life." Robotic missions planning to have direct contact with such special regions are given planetary protection categorization (IVc), with stringent cleanliness constraints on the portions of the mission contacting such regions (equivalent to the cleanliness standards successfully demonstrated by the two Viking landers in 1975). The avoidance of the contamination of special regions is also the focus of the "Principles and Guidelines for Human Missions to Mars" [2] given in COSPAR's policy.

While the original COSPAR definition of "special regions" [3] conveyed the concept in qualitative terms, its proposed translation into (mostly) quantitative terms was accomplished by a two-step process that occurred over the course of two years, with face-to-face meetings in Long Beach, California (February 2006) by the Mars Exploration Planning and Analysis Group's (MEPAG's) Special Regions Science Analysis Group (SR-SAG) [4] and by COSPAR's Panel on Planetary Protection in Rome, Italy (September 2007) [5]. This two-step process resulted in the acceptance of the current special region (SR) definition by COSPAR at the Montreal Assembly in July 2008. The COSPAR report of the Rome meeting [5] recommended that the quantitative definitions be reviewed on a 2-year cycle (but this current study will be the first such review).

This study: MEPAG has been asked to review and update the technical information that underlie NASA's and COSPAR's definition of special regions on Mars, enabling interpretations of when and where they could occur. The reasons for undertaking the review at this time are because it is timely and because relevant new data are now available. The 2005-7 activity was based on Mars Global Surveyor (MGS), Odyssey (ODY), initial Mars Express data, Mars Exploration Rover (MER) data, and Viking results. Now, however, a new body of highly relevant data exists from the Mars Reconnaissance Orbiter (MRO) and Phoenix, further data have been by Mars Express and MER, and initial results are available from the Mars Science Laboratory (MSL). In addition, considerable research has been carried out in the form of ground based, laboratory, analogue, and International Space Station (ISS) studies. Some of these results provide a marked extension of the information available in 2005-7, and can provide the basis for innovations that could result from this review.

MEPAG has been asked to consider the following topics in its evaluation:

1. Prepare updates in the following areas:
   a. Reconsider information on the known physical limits to life on Earth, particularly experimental results and environmental observations, including (but not limited to) those :
      i. At low water activity and low temperature, including adaptation to transient or periodic variability in both (via diurnal or annual cycling, etc.),
      ii. Associated with biological capture and use of vapor-phase water,
      iii. Relating to survival over very long time scales with extremely short growth periods.
   b. Evaluate new (i.e., since 2006) observational data sets and new models from Mars that could be relevant to our understanding of the natural variations on Mars of water activity and temperature. Specifically consider at least:
      i. Recurring slope lineae (RSLs) discovered (and still actively being mapped) by MRO
      ii. The physics of mixed-salt brines, including those resulting from the subsurface or condensation-mediated introduction of less-salty water

iii. Post-2006 thinking on the processes associated with the martian gullies (and especially those at mid-latitude.
iv. The discoveries from geomorphology, direct observation in recent craters, and by the MARSIS and SHARAD radars related to the distribution of surface and subsurface ice, and also any evidence that the radar investigations bring to bear on the presence or absence of deep martian liquid water.
v. Atmosphere-regolith exchange processes and the non-steady-state effects of surface-atmosphere temperature differences and local (to micron-scale) availability of water or water vapor.

c. Consider mineral and amorphous material water content and its potential biological availability, the observed and theoretical effects of mineral deliquescence, and its applicability to naturally occurring or spacecraft-induced special regions
i. Consider the potential biological implications of the liquid formed by deliquescence
ii. Evaluate the observations made by Mars Phoenix in 2008 of relevance to this
iii. Evaluate the physical effects of deliquescence on transport processes related to microbial contamination.

d. Reconsider the parameters used to define the term "special region;" propose updates to the threshold values for temperature and water activity, as needed; the minimum time-period (episodic or continuous) for the existence of a special region, especially if tied to a diurnal- or other short-period cyclic phenomenon; and the spatial scale at which criteria used to recognize "special" and "not special" regions should be applied. Mars is heterogeneous at many different scales, and our ability to develop practical distinctions depends on the scale at which the intent of the term "special" applies.

2. Prepare an updated description of the following in both text form, and as appropriate, in map form:
a. Mars environments that are judged to be "special"
b. Mars environments for which there is a significant (but still unknown) probability that the threshold conditions for a special region would be exceeded within the assumed 500-year limit. In the current policy, these are treated for planetary protection purposes as if they are special and the SAG should assume that this will be the case in any revised policy language.
3. To help guide future planning, prepare a preliminary analysis (e.g., <5 pages) of the kinds and amounts of water-related resources on Mars of potential interest to the eventual human exploration of Mars, and evaluate the planetary protection implications of attempting to access/exploit them. (A detailed analysis of this would require its own SAG, and this may be needed in the future).

Members of the community who have information on any of these topics are encouraged to contact one of the authors of this abstract.

References: [1] United Nations, Treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies, U.N. Doc.A/RES/2222/(XXI) 25 Jan 1967; TIAS No. 6347 (1967). [2] COSPAR: Planetary Protection Policy (revised 24 March 2011). COSPAR, Paris, France, (2011). [3] Rummel, J. D., et al. Report of the COSPAR/IAU Workshop on Planetary Protection, COSPAR, Paris, France. (2002). [4] Beaty, D.W., K.A. Buxbaum, M.A. Meyer, Barlow, N.; Boynton, W.; Clark, B.; Deming, J.; Doran, P. T.; Edgett, K.; Hancock, S.; Head, J.; Hecht, M.; Hipkin, V.; Kieft, T.; Mancinelli, R.; McDonald, E.; McKay, C.; Mellon, M.; Newsom, H.; Ori, G.; Paige, D.; Schuerger, A. C.; Sogin, M.; Spry, J. A.; Steele, A.; Tanaka, K.; Voytek, M., Findings of the Mars Special Regions Science Analysis Group. Astrobiology 6, 677-732. (2006) doi:10.1089/ast.2006.6.677. [5] Kminek, G., J.D. Rummel, C.S. Cockell, R. Atlas, N. Barlow, D. Beaty, W. Boynton, M. Carr, S. Clifford, C.A. Conley, A.F. Davila, A. Debus, P. Doran, M. Hecht, J. Heldmann, J. Helbert, V. Hipkin, G. Horneck, T.L. Kieft, G. Klingelhoefer, M. Meyer, H. Newsom, G.G. Ori, J. Parnell, D. Prieur, F. Raulin, D. Schulze-Makuch, J.A. Spry, P.E. Stabekis, E. Stackebrand, J. Vago, M. Viso, M. Voytek, L. Wells, F. Westall. Report of the COSPAR mars special regions colloquium. Advances in Space Research 46: 811–829. (2010).