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Report of the COSPAR mars special regions colloquium

G. Kminek [a], J.D. Rummel [b], C.S. Cockell [c,*], R. Atlas [d], N. Barlow [e], D. Beaty [f], W. Boynton [g], M. Carr [h], S. Clifford [i], C.A. Conley [j], A.F. Davila [k], A. Debus [l], P. Doran [m], M. Hecht [f], J. Heldmann [k], J. Helbert [n], V. Hipkin [o], G. Horneck [p], T.L. Kieft [q], G. Klingelhoefer [r], M. Meyer [j], H. Newsom [s], G.G. Ori [t], J. Parnell [u], D. Prieur [v], F. Raulin [w], D. Schulze-Makuch [x], J.A. Spry [f], P.E. Stabekis [j], E. Stackebrandt [y], J. Vago [a], M. Viso [l], M. Voytek [j], L. Wells [z], F. Westall [aa]

[a] *ESA-ESTEC, Keplerlaan 1, 2200 Noordwijk, The Netherlands*
[b] *East Carolina University, East Fifth Street, Greenville, NC 27858-4353, USA*
[c] *Open University, Milton Keynes, MK7 6AA, UK*
[d] *University of Louisville, Louiseville, KY 40292, USA*
[e] *Northern Arizona University, Flagstaff, AZ 86011-6010, USA*
[f] *NASA Jet Propulsion Laboratory, Pasadena, 4800 Oak Grove Drive, CA 91109-8001, USA*
[g] *Lunar and Planetary Lab, University of Arizona, Tucson, AZ 85721, USA*
[h] *United States Geological Survey Pacific Science Center, 400 Natural, Bridges Drive, Santa Cruz, CA 95060, USA*
[i] *Lunar and Planetary Institute, 3600 Bay Area Blvd, Houston, TX 77058, USA*
[j] *NASA Headquarters, Washington, DC 20546-0001, USA*
[k] *NASA Ames Research Center, Mountain View, CA 94043, USA*
[l] *CNES, Agence Française de l'Espace, 18, Avenue Edouard Belin 31 401 Toulouse Cedex 9, France*
[m] *University of Illinois in Chicago, 845 West Taylor Street, Chicago, IL 60607, USA*
[n] *DLR, Inst. fuer Planetenforschung, Berlin, Germany*
[o] *Canadian Space Agency, 6767 Route de l'Aéroport, Saint-Hubert, Quebec, Canada J3Y 8Y9*
[p] *DLR, Linder Höhe, 51147 Köln, Germany*
[q] *New Mexico Tech, 801 Leroy Pl., Socorro, NM 87801, USA*
[r] *University of Mainz, 55131 Mainz, Germany*
[s] *University of New Mexico, Albuquerque, NM 87131-0001, USA*
[t] *IRSPS, Universita d'Annunzio, 65127 Pescara, Italy*
[u] *University of Aberdeen, Aberdeen, AB24 3UE, UK*
[v] *University of Brest, Brest, France*
[w] *CNRS and Universités Paris, 61 Avenue du Général de Gaulle, F-94010 Créteil Cedex, France*
[x] *Washington State University, Pullman, WA 99164-6376, USA*
[y] *DSMZ, Inhoffenstrasse 7B, 38124 Braunschweig, Germany*
[z] *University of Pennsylvania, Philadelphia, PA 19014, USA*
[aa] *CNRS, 45100 Orléans, France*

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Abstract

In this paper we present the findings of a COSPAR Mars Special Regions Colloquium held in Rome in 2007. We review and discuss the definition of Mars Special Regions, the physical parameters used to define Mars Special Regions, and physical features on Mars that can be interpreted as Mars Special Regions. We conclude that any region experiencing temperatures > -25 °C for a few hours a year and

* Corresponding author. Tel.: +44 1908 652588; fax: +44 1908 858022.
E-mail address: c.s.cockell@open.ac.uk (C.S. Cockell).

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a water activity > 0.5 can potentially allow the replication of terrestrial microorganisms. Physical features on Mars that can be interpreted as meeting these conditions constitute a Mars Special Region. Based on current knowledge of the martian environment and the conservative nature of planetary protection, the following features constitute Mars Special regions: Gullies and bright streaks associated with them, pasted-on terrain, deep subsurface, dark streaks only on a case-by-case basis, others to be determined. The parameter definition and the associated list of physical features should be re-evaluated on a regular basis.

Keywords: Special regions; Mars; Planetary protection; Forward contamination; Low temperature; Water activity

1. Introduction

Preventing terrestrial biological contamination from becoming established and widespread on Mars is essential to our ability to protect high-priority science goals on Mars. The search for life, the understanding of the martian organic environment, and even the future use of martian resources, may be compromised if microbes carried by spacecraft grow and thrive on Mars.

Because Mars is cold, but not always, and extremely dry, but perhaps not everywhere, the concept of a Special Region on Mars was developed as a way to refer to those places where the conditions on Mars might be conducive to microbial growth. Based on data returned from the Mars Global Surveyor (MGS) and Mars Odyssey missions, showing evidence for more recent water flow and/or ice flow on the martian surface and the possibility of massive amounts of subsurface ice near the polar regions, it is thought likely that such places might exist—if not on the surface, then potentially underground.

The current definition of Mars Special Regions as discussed during the COSPAR Planetary Protection Panel in Warsaw, July 2000, and introduced to the COSPAR Planetary Protection Policy during the COSPAR/IAU Workshop on Planetary Protection in Williamsburg, April 2002, describes Special Regions as:

> "A region within which terrestrial organisms are likely to propagate, or a region which is interpreted to have a high potential for the existence of extant martian life forms."

As guidelines to identify Special Regions on Mars, it is stated that:

> "Given current understanding, this applies to regions where liquid water is present or may occur. Specific examples include but are not limited to:

- Subsurface access in an area and to a depth where the presence of liquid water is probable.
- Penetration into the polar caps.
- Areas of hydrothermal activity".

Subsequently, a NRC Study on Preventing the Forward Contamination of Mars (NRC, 2006) stated as one of their major findings that sufficient data are not available to distinguish between Special and non-Special Regions. As a consequence the report recommends that all Mars should be considered "Special" until proven otherwise.

In 2006, NASA initiated a Science Analysis Group on Mars Special Regions to specifically establish a quantitative approach to distinguish between Special and non-Special Regions (Beaty et al., 2006). The conclusion of this group was that sufficient data are available to distinguish between Special and non-Special Regions and that the guiding quantitative parameters to define such regions are temperature and water activity.

The intention of this COSPAR Mars Special Regions Colloquium was to use both reports and arrive to a consolidated definition for Mars Special Regions and report this for consideration to the COSPAR Planetary Protection Panel.

2. Colloquium organization

An organization committee was established under the leadership of the scientific organizers for this colloquium in 2007. The colloquium took place in Rome on 18–20 September 2007. Participation for the colloquium was based on the required scientific expertise to critically review the current understanding for the limits of terrestrial life and the Mars environment. The colloquium comprised plenary discussions and splinter group activities of the relevant scientific disciplines – biology, cryosphere – geology, atmospheric conditions.

This report describes the deliberations and conclusions of the individual scientific groups, consolidated in plenary discussions, and proposes a definition for Mars Special Regions.

3. Biology sub-group report

3.1. Introduction

Since 1958 attempts have been made to define the envelope for survival, metabolism and growth of microorganisms under martian conditions. Motivated by a desire to prevent the contamination of Mars by terrestrial microorganisms, these studies have used a variety of Mars simulation chambers and extreme environments on Earth to understand the limits of microbial life both in the laboratory and in the field. An extensive review of