



COSPAR

Panel on Planetary Protection Colloquium Report Mars

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Background



Mars Special Regions have been established as a way to refer to those places where the conditions on Mars might be conducive to microbial growth because Mars is cold, but not always, and very dry, but not everywhere

A second set of reviews of the Mars Special Regions concept and definition started with a MEPAG study in 2013-14, followed by a ESF/NRC Joint Committee study in 2014 and has culminated in the COSPAR Panel on Planetary Protection Colloquium at the ISSI, Sept. 2015

The Colloquium was organised by the COSPAR Panel on Planetary Protection and supported by the COSPAR Scientific Commissions B and F

The report of the Colloquium will be published in the April 2015 issue of the COSPAR's Information Bulletin Space Research Today

The update of the COSPAR Planetary Protection Policy will be discussed during the COSPAR General Assembly 2015 and recommendations submitted to the COSPAR Bureau and Council for adoption



Temperature Parameter

Since the last update of the Mars Special Regions in 2007 more data has confirmed cell division at -15°C and literature not identified in the 2006-2007 review demonstrated cell division down to -18°C .

The colloquium participants **recommend** maintaining a margin of 10°C .

Consequently, the colloquium participants **recommend** to set the new lower temperature limit for parameters defining Mars Special Regions to -28°C .

As more experiments are published and knowledge and confidence improves, the margin of 10°C may be relaxed in the future, if deemed appropriate by expert review.



Additional Requirement

The MEPAG-SR-SAG2 has critically reviewed the timing of available liquid water and sufficiently high temperatures to allow replication. Due to the lack of experimental data, the limited understanding of microenvironments and disequilibrium conditions, and known abiotic and biotic process to capture and retain liquid water, the colloquium participants **recommend** the following addition to the current requirements for Mars Special Regions:

When the environmental conditions set by the above parameters (lower limit for temperature and water activity) occur, but do not occur simultaneously, the evaluation (as to whether a region is special or not) must include an assessment of the extent to which the temperature and water activity parameters specified for Special Regions are separated in time.



Gullies and Caves

In line with the MEPAG-SR-SAG2 report and the ESF/NRC Joint Committee report, the colloquium participants **recommend** that Gullies of taxon 2 through 4 must be treated as Special Regions until proven otherwise. The definition of the various taxon's is based on the MEPAG-SR-SAG2 report.

In line with the MEPAG –SR-SAG2 report and the ESF/NRC Joint Committee report, the colloquium participants **recommend** that caves and subsurface cavities must be treated as Special Regions until proven otherwise.

Recurrent Slope Lineae (RSL)



In line with the MEPAG-SR-SAG2 report and the ESF/NRC Joint Committee report, the colloquium participants **recommend** that confirmed and partially confirmed Recurrent Slope Lineae (RSL) must be treated as Special Regions until proven otherwise.

The colloquium participants **recommend** that candidate Recurrent Slope Lineae (RSL) must be evaluated on a case-by-case basis.

The colloquium participants **recommend** the following definition of observational evidence for Recurrent Slope Lineae (RSL), adapted from McEwen et al, ref.:

Confirmed: observed simultaneous incremental growth of flows on a warm slope, fading, and recurrence of this sequence in multiple Mars years

Partially confirmed: observed either incremental growth or recurrence

Candidate: slope lineae that resemble RSL but observations needed for partial confirmation are lacking

Methane



The colloquium participants agreed that it is appropriate that special consideration be given to methane, recently detected near the surface of Mars (Webster *et al.* 2015). Methane is considered an organic compound of special interest. The lack of knowledge about the source(s) and sink(s) of methane requires that its sources, if identified, be evaluated to determine whether they should be designated as non-special, uncertain or special regions.

In line with the ESF/NRC Joint Committee report, the colloquium participants **recommend** that “sources of methane” be added to the list of sites that must be treated as Special Regions until proven otherwise.



Maps and Landing Sites

The colloquium participants support the concern of the ESF/NRC Joint Committee with respect to the use of maps and **recommend** that maps should be dated and only used to illustrate the general concept of Special Regions but cannot be used to delineate their exact location.

The colloquium participants **recommend** the following additions to the current requirements for Mars Special Regions:

Planned 3-sigma pre-launch landing ellipses must be evaluated on a case-by-case basis as part of the (landing) site selection process, to determine whether the mission would land or come within contamination range of areas or volumes meeting the parameter definition for Special Regions or would impinge on already described morphological features that must be treated like Special Regions.

Such an evaluation must be updated during the mission whenever new evidence indicates that the landing ellipse or the operational environment contains or is unacceptably close to areas or volumes meeting the parameter definition for Special Regions or already described morphological features that must be treated like Special Regions.



Human Missions

The colloquium participants **recommend** a modified and stronger wording of the principles:

“The intent of this planetary protection policy is the same whether a mission to Mars is conducted robotically or with human explorers. Accordingly, “the stated COSPAR Planetary Protection Policy must” not be compromised to accommodate a human mission to Mars.”

In addition, the colloquium participants **recommend** to delete the following implementation guideline:

“Neither robotic systems nor human activities should contaminate “Special Regions” on Mars, as defined by this COSPAR policy.”

And replace it with the following statement:

Requirements for human activities must be imposed to control the contamination of Mars in general and of Mars Special Regions, specifically, in line with the COSPAR Planetary Protection Policy.



Future Research

To reduce the uncertainties and also excessive conservatism in the requirements the colloquium participants **recommend** to investigate the following issues through laboratory experiments, modelling, observations from Mars orbit and on the surface of Mars:

- Propagation in the absence of liquid water (i.e. using atmospheric water vapour)
- Time-delayed storage and utilisation of water or energy for growth and reproduction
- Water activity in pore spaces
- Methane production and localization
- Translocation of viable biological contamination on Mars

Summary



Given current understanding of terrestrial organisms, Special Regions are defined as areas or volumes within which sufficient water activity AND sufficiently warm temperatures to permit replication of Earth organisms may exist. The physical parameters delineating applicable water activity and temperature thresholds are given below:

- Lower limit for water activity: 0.5; Upper limit: 1.0
- Lower limit for temperature: -28C; No Upper limit defined
- Timescale within which limits can be identified: 500 years

When the environmental conditions set by the above parameters (lower limit for temperature and water activity) occur, but do not occur simultaneously, the evaluation (as to whether a region is special or not) must include an assessment of the extent to which the temperature and water activity parameters specified for Special Regions are separated in time.

Summary



Observed features that must be treated as Special Regions until proven otherwise:

- Gullies (taxon 2-4)[†], and bright streaks associated with gullies
- Caves and subsurface cavities
- Subsurface below 5 meters
- Confirmed and partially confirmed Recurrent Slope Lineae (RSL)[‡]

Features, if found, that must be treated as Special Region until proven otherwise:

- Groundwater
- Source of methane
- Geothermal activity
- Modern outflow channel

Observed features that require a case-by-case evaluation:

- Dark streaks
- Pasted-on terrain
- Candidate RSL[‡]

Summary



Planned 3-sigma pre-launch landing ellipses must be evaluated on a case-by-case basis as part of the (landing) site selection process, to determine whether the mission would land or come within contamination range of areas or volumes meeting the parameter definition for Special Regions or would impinge on already described morphological features that must be treated like Special Regions.

Such an evaluation must be updated during the mission whenever new evidence indicates that the landing ellipse or the operational environment contains or is unacceptably close to areas or volumes meeting the parameter definition for Special Regions or already described morphological features that must be treated like Special Regions.

Last comment



Some of the members of the previous ESF/NRC Joint Committee provided comments after the deadline; these comments will be addressed before publishing the colloquium report