Landing sites workshop:
17-21 January 2011 in Leiden (Holland)

Organized by T. Zegers, A. Chicarro, R. Koenders

Presented by N. Mangold (LPGNantes, France)

Goals:

1/ Kick off meeting for landing site studies on the European side.

2/ Discuss objectives, criteria and feasibility of landing sites for future rovers/landers.

3/ Identify potential problems and propose how to solve them.

Plenary sessions intermixed with working groups on different missions

<u>5 missions were considered by the working groups</u>

1) Mars 2016 Demonstration lander
Mission type: technology driven
Chairs: Angelo Rossi, Leila Lorenzoni

2) Mars 2018 Exomars rover
Mission type: Science/Astrobiology driven
Chairs: Frances Westall, Damien Loizeau

3) Mars Sample Return (in general, not MAX-C especially)
Mission type: Science and technology driven, global exploration program
Chairs: Nicolas Mangold, John Bridges

4) Lunar X-prize
Mission type: commercial, non-agency mission
Chairs: Erik Laan, Maria Sovago, Wim van Westrenen

5) Asteroid/Phobos
Mission type: small body

ExoMars landing site group

F. Westall (Chair)
D. Loizeau (Chair)

L. Jourdier
M. Van Winnendael
E. Hauber
P. Ehrenefreund
P. Martin
A. Keresztur
E. Valasco
G. De Viliers
C. Budney
J. Vago
M. Golombek

MSR landing sites group

N. Mangold (Chair)
J. Bridges (Chair)

A. Chicarro
D. Fernandez-Remolar
M. Kleinhans
E. Kuijpers
M. Melwani
C. Orgel
W. Poos
S. Schwenzer

US Guest Star: M. Golombek

1. Discuss science objectives
2. Define criteria for landing site selection
3. Discuss a combined 2018 site selection

(an anticipation of what happened 2 months after…)

ExoMars goals implications for landing site selection

1. The search for traces of past or present life

→ Likehood of finding visible traces of life in rock materials is low (but not necessarily non-existant; potential biosignatures probably too small to be visible with CLUPI)

→ Past life more likely

ExoMars goals implications for landing site selection

2. Characterization of the habitability/geological context of the landing site

→ Problem of linking interpretation of habitability from orbital measurements (10^{-2} to 10^{3} km habitability on a microbial scale (10^{-1} to $10^{3}/10^{4}$ µm)

→ Concept of habitability for the origin of life

(10^{4} to $>10^{6}$ y versus habitability for extant life (<1 day – years)

- Need a site indicating long-term presence of stable water 10^{4} to $>10^{6}$ y
- Sites showing evidence of presence of stable water on shorter time scales may still preserve traces of life

ExoMars Summary

→ Landing site that indicates the prolonged existence of a stable body of water

→ Noachian/Hesperian materials are most likely to contain traces of past life (and maybe even present life in miraculous circumstances)

→ Ideally the science objectives will be best served by fresh exposures (such as by impact) of ancient material

MSR science goals and implications for landing sites

By order of interest :
Exobiology (include aqueous sediments or hydrothermal areas)
Planetary Evolution (include fresh volcanic flows and primitive crust)
Diversity (Impact breccia and other breccia)

- Selected sites must be consistent with a high **exobiological** potential, but exobiology alone should not drive the overall landing site selection.

- Non-altered rocks such as **crustal igneous rocks, well defined volcanic units, and possible mantle xenoliths** or outcrops **MUST** be included in the list of objectives.

- Impact breccia or sedimentary pebbles are welcome, but in place rocks would be better for interpretation of lab measurements.

Conclusions consistent with E2E group conclusions, as far as I know

Criteria to include in selection from orbital data: *(non exhaustive list)*

- **Hydrated minerals** are favored as indicators of exobiological and aqueous processes:
  - Phyllosilicates are preferred, but **diversity in hydrated minerals** is welcome (including sulfates, salts, etc.).
  - **Smectites in fine-grained sediments** are favored for organic preservation, even if a lacustrine origin cannot be established.
  - Terrains with hydrated minerals should be **ancient, preferably Noachian**.

- A **lacustrine morphology** coupled to hydrated minerals identification is of the highest interest, but:

(1) a long term duration of lakes should be established to avoid short-lived lakes due to catastrophic events;

(2) a Noachian (or possibly Early Hesperian) age should be determined to optimize the role of a potential warmer early Mars.

- **Carbonates** are interesting targets to sample, even if they may be due to hydrothermal alteration rather than weathering, but with a lower priority than smectites.

Combined site selection for MAX-C/MSR and Exomars

- Exomars requires a **non-go to sites with aqueous sediments**, or rocks showing **long-term interaction with water**, with a high exobiological potential and a well-known geological context.

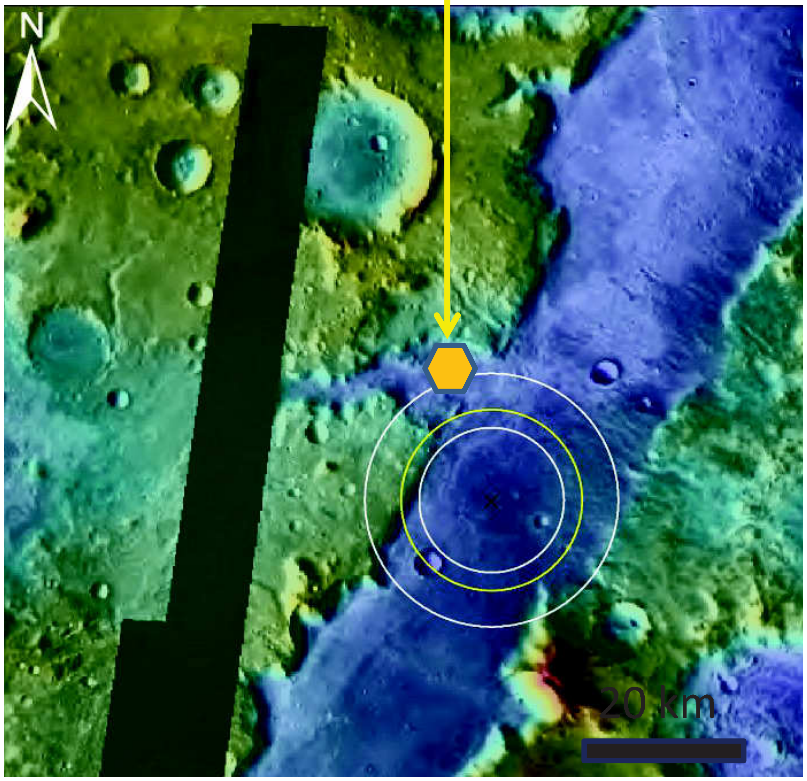
- MAX-C requires a site with more **diversity**, including a variety of altered and fresh rocks, not only sediments.

- At minimum, a common site would require a site with non-go to sediments or altered rocks of excellent exobiological potential (hydrated minerals, etc.) for Exomars, with potential igneous rocks accessible with MAX-C longer lifetime.

- A site on igneous rocks with “go to” sediments good for exobiology is not recommended due to Exomars smaller lifetime.

Nili Fossae (as proposed for MSL)

Assumed Exobiological interest



Land on well defined volcanic unit.
Access to exobiological site of interest: 10-15 km

Having two opposite goals such as **exobiology and igneous rocks requires a strong mobility**

Such site would have been difficult for Exomars initial lifetime

Having one rover instead of two simplifies the site selection, but the variety of objectives requires a high mobility and lifetime

Potential impact of 2016 Trace Gas Orbiter for 2018 MSR mission

Discoveries of the **2016 TGO orbiter** (e.g. localized methane vents) could impact the site selection one year before the 2018 mission launch.

A **present life** opportunity with methane vents could also increase the difference in objectives between Exomars and MAX-C/MSR.

Should a **flexibility** in site selection be introduced to include this possibility? For example, to minimize risks, a possibility is to keep in the downselection process one or two sites that are located in putative methane plumes (e.g. Nili Fossae).

⇒ **This question should be solved before site selection begins**

Conclusions from this meeting for combined 2018 mission:

- MAX-C/MSR lands together Exomars (*now changed to a single rover*).

$\Rightarrow$ Strong impact on site selection because of **variety of objectives**.

$\Rightarrow$ Selection MUST be common between NASA and ESA from the beginning. **Collaborations should begin ASAP (especially with MRO data).**

- The **level of priority of igneous rocks** sampling for MSR has a strong impact on landing site selection.

- The question of introducing new sites from findings by the 2016 TGO mission should be solved before the 2018 site selection process begins.

Conclusions consistent with E2E group conclusions, as far as I know

More general take away messages of the workshop

Recommendations for agencies:

DONE

Landing site selection activities for the Mars 2018 mission need to begin ASAP because currently active orbiter missions (MRO, Mars Express) providing critical landing site data are already in their extended missions and may have a limited remaining lifetime.

All landing site selection processes in the framework of ESA-NASA cooperative programs be conducted in a joint manner.

Recommendations for ESA:

Maintain and develop a coordinated forum through which scientists and engineers can communicate on these topics.

⇒ Should facilitate the convergence of the currently fragmented expertise present in the European planetary community

⇒ Implement a funded European data analysis to exploit ESA mission data in preparation for planetary missions.