Geological fieldwork on space expeditions

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Objectives

The aim of geological fieldwork simulations at analogue terrains is to determine what is necessary in terms of knowledge and equipment plan a successful mission and to perform planetary geological fieldwork efficiently.

- Investigate feasibility of manned missions
- Identify potential problems
- Test equipment
- Set-up and test geological sampling procedures

Recommendations

During planetary geological fieldwork there is only a one-shot chance to investigate. It is essential to plan and simulate preliminary missions on Earth.

Required are:

- Qualified and multidisciplinary crew
- Crewmembers with individual responsibilities
- Systematic, but interactive, procedures

A greater amount of information will be gathered upon arrival at the landing site, that cannot be seen on aerial and/or satellite photographs. Due to time constraints other plans might need to be cut when unexpected problems come up or plans need to be changed when making new discoveries. A balance must be maintained between keeping to the planned traverses and timelines, and the possible revision of the plan.

Crewmembers need to be creative and qualified to make quick decisions. These are skills a robot lacks.

Field documentation, such as writing, sketching, and drawing (used in traditional field geology), is difficult with gloved hands and a helmet. With planetary geological fieldwork the focus lies more on pictures, video, and audio-recordings. A camera on the spacesuit helmet is very useful and a computer with a digital map with tracking system, checklists, scales, colour chart, encyclopaedia, and a grid for images.

For specific site planning, maps of 1:50.000 or a detailed aerial or satellite photograph (minimum of 1 meter per pixel). A scale of 10cm per pixel is preferred during fieldwork and a camera/video resolution of 1920x1080 pixels is necessary in order to be able to identify mm-scale minerals. A geologist works from large scale (km) stepwise towards smaller scales (from 10m outcrop to dm-scale sample), adding the results in context. A scale reference and indicating direction of view are very important (*Figure 3*).

In the field, adapted geological fieldwork tools are needed and a system to carry instruments and samples. Samples need to be fresh (*Figure 4*), labeled and stored systematically, indicating sample location. The X-Ray Fluorescence (XRF) Analyzer might be more useful than the Raman spectrometer for measuring bulk rock composition. It is possible to make an automatic rock drill and to develop thin sections.

Important things to consider for real missions are the effects of space weathering on the rocks, the interaction of certain materials with electronics and temperature differences, and the effect of rock splinters from hammering on the spacesuit.

Field expeditions

- Eifel volcanic park (Germany)
  September 2009

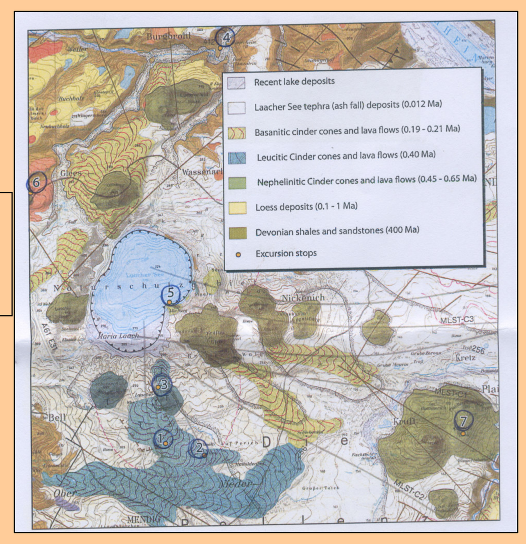


***Figure 1.** Geological map of the Mendig region in the Eifel (Boogaard & Schminke 1990). Site 3 is the Winterbergwand where we performed the simulations.*

- Mars Desert Research Station (Utah, USA)
  February-March 2010

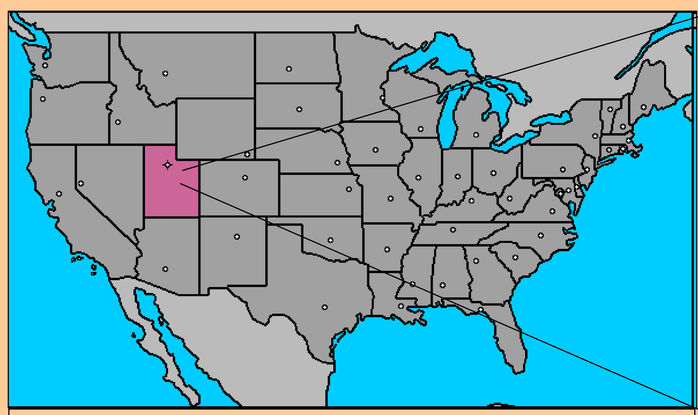


***Figure 2.** Location of Utah, USA. The star indicates Salt Lake City, three hour drive from MDRS (see closed-up picture to the right).*

Sampling procedures were tested during Extra-Vehicle Activities (EVA's), in full spacesuit, in analogue Moon Mars sites, resulting in detailed geological (sampling) procedure flowcharts (*Figure 5*).

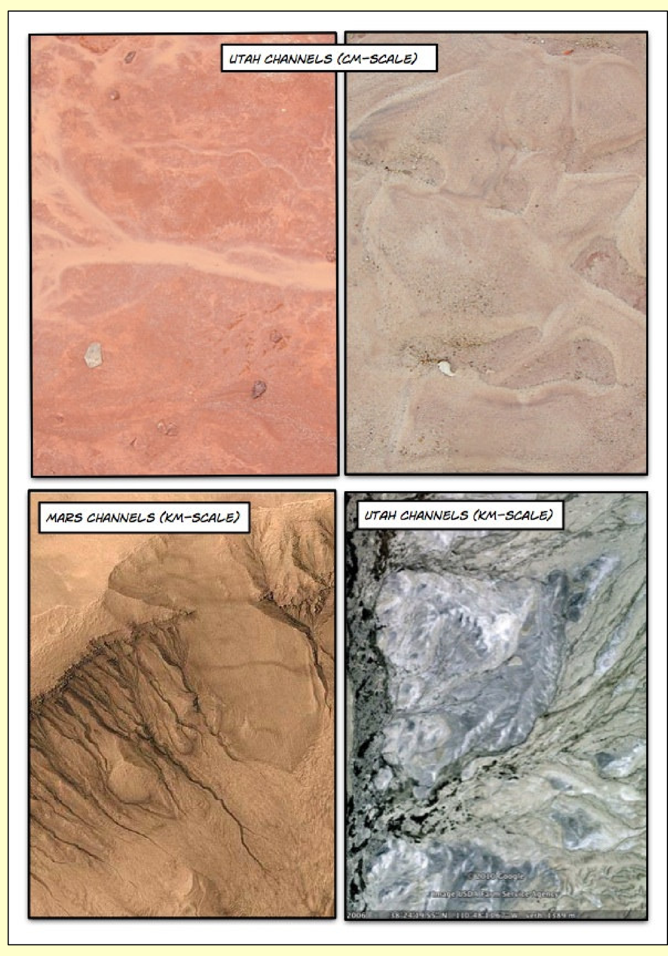


***Figure 3**. The importance of scale.*

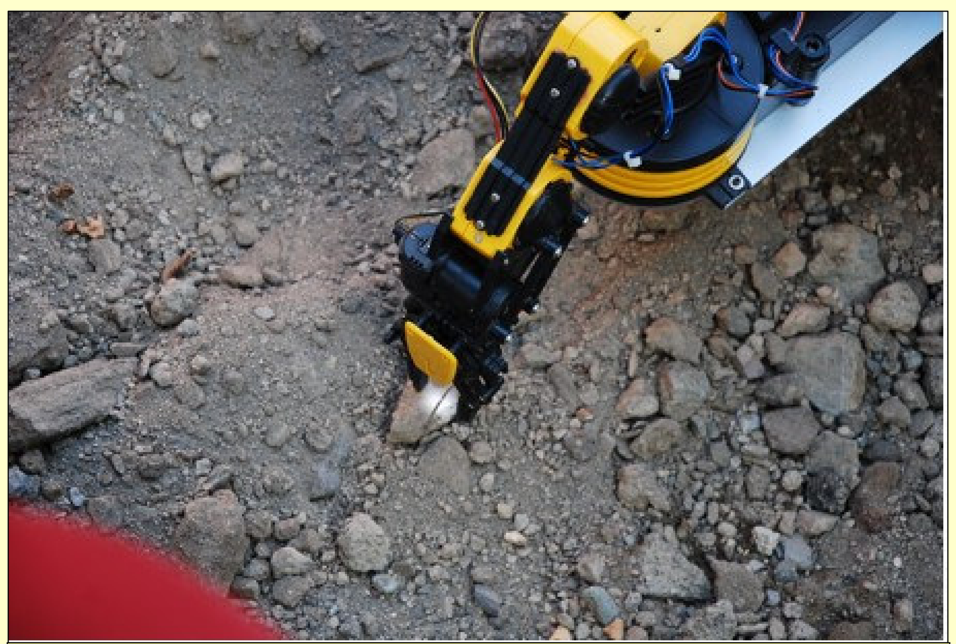
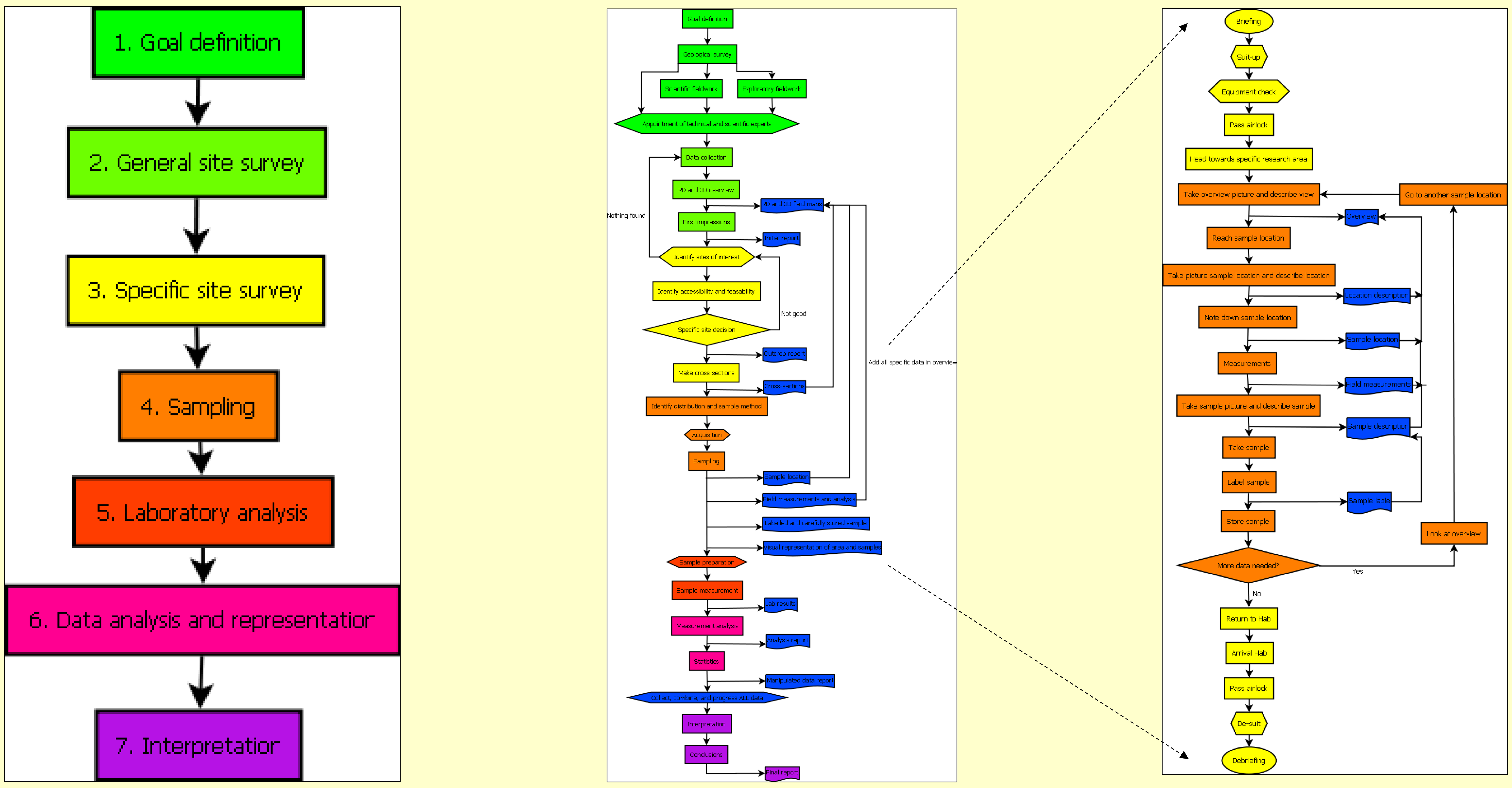


***Figure 4**. Rover picks up loose rock. An example of a not-fresh sample.*

***Figure 5**. The resulting flowcharts of geological sampling procedures, extensively tested in analogue terrains. From left to right: increasing in detail.*



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