Mars Exploration Plan B. W Alan Delamere, Delamere Space Sciences, Boulder CO USA, (alan@delamere.biz)

Introduction: The current Mars Exploration program is yielding phenomenal results but the future program is dominated by return of samples. [1, 2] The cost of returning samples has soared in recent years to the detriment of the overall Mars program. To ensure that truly worth samples are returned, it is recommended that Mars is further explored and that key new technologies are developed.

Current Program: Three spacecraft and one rover continue to provide a flow of detailed Martian data for analysis. The data return from Mars is providing inspiration to hundreds of young scientists throughout the world. The Mars Science Lander will be launched later this year and will explore sites, carefully mapped from orbit, for interesting mineralogy. The Mars Scout mission, MAVEN, will be launched in 2014 and will explore the loss of the Martian Atmosphere. The ESA mission Mars Trace Gas Orbiter will look for gases in the atmosphere that give understanding of earlier atmosphere composition and look for release of gases from surface vents

Finding Valuable samples: With the cost of sample return escalating, how do we make sure that the samples that are returned are worth the expenditures? Currently, we have Martian samples that have been ejected from Mars and have landed on Earth. The problem is we did not select the samples and so do not know where they came from. On earth a geologist walks the terrain, selects a rock, breaks it open, sniffs and licks it and throws it away most times! We have to do the same process robotically. For MSL, we are doing an excellent job of selecting the landing site with the potential of reaching the interesting rocks. Does MSL have enough instrumentation to select the rock, break it open, sniff and lick it? Whatever else happens, we will learn from the MSL experience on how to do the selection better. The real jewel of a sample is one with some fossils in it. If there are fossils on Mars, where do we find them? An easy question to ask and a difficult one to answer without more data.

New Measurements needed: MRO instrumentation has opened our eyes to the Martian surface and subsurface. HiRISE has provided surface morphology at the meter scale, CRISM mineralogy at the 30m scale and SHARAD the sub-surface at the 20km scale to depths of about 1km.

These measurements are excellent for the MSL mission so why is this not enough? HiRISE color channels are showing mineral variation at the meter scale. [3] To find the right sample return site we need mineral data at the meter scale. A Mineralogical Explorer with 2 to 5m scale resolution and a very high signal to noise ratio will enable recognition of minerals at the meter scale using sub-pixel un-mixing technology. [4, 5]

MARSIS and SHARAD instruments have given tantalizing glimpses of the Mars sub-surface. Unfortunately both instruments are flying on spacecraft that dramatically limit their performance. This type of instrumentation needs to fly on a dedicated spacecraft to map buried ice, rivers and liquid layers.

Both these missions would help identify sites with the potential of long term development of life forms.

New Technology needed: Mars exploration is currently limited by the use of the “Viking” aeroshell and the resulting landing ellipse.

The MAX C mission as planned could only land at below 1km and between latitudes 30 N and 30S. This limitation only provides 7% of Mars for finding our “valuable sample” site.

Two technologies can enable us to land anywhere on Mars, a different aeroshell and pin point landing. Use of a shuttle-like aeroshell (mid L/D) will enable flying through the atmosphere to enable a pinpoint landing. [6]

Plan B An Alternative Mars Program: The basic assumptions are that we will continue to systematically explore Mars as financial resources become available and that sample return is at some undefined time in the future.

- Analyze the existing and future Mars data to optimize future exploration. (Give our bright young scientists the opportunity to have a long term research career)

- Fly a Mineralogical Explorer. CRISM-type imaging spectrometer with 2 to5 m/pixel spatial resolution and very high signal to noise performance. 2020?

- Fly a Sub-surface Sounder Mission to map buried ice, rivers and liquid layers. 2022?

- Demonstrate the technology to land a heavy payload next to a given rock in the southern highlands. (Can this be done at very low cost? Lead brick? X-prize? Shuttle aeroshell at Mars?) 2024?

- Develop a second generation of sample analysis instrumentation based on MSL experience. 2016-2024?

- Complete data analysis and **then** plan a sample return mission 2025?

Human Exploration of Mars?: The cost of Mars human exploration is well beyond the current NASA budget.[7] In order to get a major increase in the budget robotic exploration should continue to bring Mars exploration to the forefront of the public consciousness. The technology advances recommended here will aid future human exploration.

Summary: Plan B must stay within NASA budget allocation so the Mars program should be sized to fit.

1. Forget about caching missions for the next decade
2. Implement the two suggested missions via the Mars Scout process
3. Replace the Viking aeroshell technology ASAP as it compromises landed missions.
4. Landed missions are really expensive so we need new technologies that make the landing of large payloads **cost less**
5. Prepare for a sample return mission in the late 20's.

References:

1. McEwen, A.S., 60 colleagues. The High Resolution Imaging Science Experiment (HiRISE) during MRO's Primary Science Phase (PSP). Icarus. 205 2-37
2. Murchie, S., 49 colleagues 2007. Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) on Mars Reconnaissance Orbiter (MRO). J. Geophys. Res. 112, E05S03.
3. Delamere, W.A., and 13 colleagues, 2009. Color imaging of Mars by the High Resolution Imaging Science Experiment (HiRISE). Icarus. 205 38-52
4. Goodenough, D.G., Han, Dyk. Comparing and validating spectral unmixing algorithms with AVIRIS imagery Canadian Journal of Remote Sensing, 2008, 34:(S1) S82-S91
5. Seelos, F.P et al, CRISM/HiRISE Correlative Spectroscopy, AGU P238-1714
6. NASA SMD/MEP De-Briefing to ESMD 7 February 2005
7. Delamere, W.A. McNutt, Human Exploration of Mars: Cost Reality. This conference June 2012