PLANNING AHEAD FOR MARS SAMPLE SCIENCE IN THE HUMAN EXPLORATION ERA

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Introduction: NASA recently requested that MEPAG evaluate the scientific objectives that could/should be carried out by a potential human mission to Mars that, for planning purposes, is assumed to launch in 2035. One of the key working conclusions is that sample-based science stands out as one of the more important aspects of a potential overall science package (recognizing that there would additionally be other scientific aspects of such a mission that would not be sample-based).

The advantage of human explorers in sample-based studies: As shown by both ESA's ExoMars rover and NASA's M-2020 rover, samples can be collected from Mars by robotic missions, and these samples are expected to have enormous scientific value. However, for several reasons, the samples collected by human explorers could be even more powerful. First, an astronaut-geologist would have greatly improved ability to establish field context through activities like geologic mapping, and the ability to recognize cross-cutting relationships. This could lead to significantly better decisions on sample selection, which is absolutely central to many kinds of sample-based science. In addition, human explorers would have far better ability to collect samples of unequal size, mass, shape, durability, etc and to interact with target surfaces (turning rocks, scraping soils, gaining multiple view angles). For some kinds of sample science, unusual samples, and samples of opportunity (that were not planned for) are required/desired.

Categories of science that could be investigated: Our preliminary analysis is that sample studies making use of a human exploration implementation are likely to be essential in the areas of astrobiology and geology/geochemistry, and would even be important for certain kinds of questions related to atmospheric science (especially those involving interpreting the ancient atmosphere). We would value discussion about the kinds of sample-based investigations that would most benefit from this kind of approach, as well as the kinds of field instrumentation that could be used in sample selection/documentation.

The importance of an on-Mars habitat-based laboratory: A potentially very important attribute of a human mission to sample-based science would be the presence of a habitat-based laboratory. It could be extremely effective to have the astronaut-geologists collect an initial sample set, make certain measurements while at Mars, then use that information to refine the sampling strategy and to collect one or more follow-up sample suites. The iterative nature of this approach can have a very strong effect on optimizing the collection that might eventually be brought back to Earth for far more detailed analysis in the world's best laboratories. We would value some community discussion about the nature of the measurements to be planned for in the on-Mars laboratory to maximize its usefulness.