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Washington, D.C. 20546

Dear Michael,

With this letter the Mars 2020 project conveys to you its revised short list of candidate landing sites for the mission. Jezero Crater and NE Syrtis are the top candidates, with Columbia Hills retained for further evaluation as described below.

At the third Mars 2020 Landing Site Workshop (Monrovia, CA February 7-9, 2017), eight candidate sites were considered: Columbia Hills, Eberswalde, Holden, Jezero, Mawrth, Melas, NE Syrtis, and Nili Fossae. The presentations for these sites were of uniformly high quality and stimulated a great deal of discussion among the 200+ participants in the workshop. At the conclusion of the workshop, participants were asked to assess five criteria for each of the sites. The workshop organizers will transmit those criteria and the averaged results to you separately.

Following the workshop, the Landing Site Steering Committee and the Mars 2020 Project Science Group met to make the site down-selection (hereafter we refer to this combined group as "the committee"). Also in attendance were several Mars 2020 engineers to provide their insight to engineering considerations related to site selection. Key inputs that informed committee deliberations were the discussions and assessments from the workshop, project-internal evaluations from the Returned Sample Science Board and the science team's Landing Site Working Group, and for some sites, engineering factors related to predicted operational efficiency.

Mars 2020 has a distinct and diverse set of goals that requires the mission to select a site that optimizes across a variety of factors: in situ investigations, preparation of a scientifically worthy sample cache for possible Earth return, seeking the signs of ancient life, and investigating non-biological aspects of Mars geology, climate, and planetary history. The ambitious set of Mars 2020 objectives also places a premium on sites that minimize challenges to efficiency of engineering and science operations, including drive distance, traversability, and temperature extremes. Extreme temperatures affect in situ exploration by limiting time available for driving and for the use of scientific instruments under optimal performance conditions. High surface temperatures may also lead to some sample degradation as the cache awaits potential Earth return on the martian surface. The committee used these considerations in identifying its preferred sites.

The committee was enthusiastic that all eight sites had strong virtues that make them attractive potential landing sites, however clear distinctions by which to choose the very best sites for Mars 2020 and potential Mars sample return were identified.

Sites the committee felt offered lower overall potential for mission success, and were therefore removed from further consideration, include the following:

1) Holden – relative to the other sites, especially broadly similar crater lake settings, Holden was found to lack a compelling diversity of scientific targets. Holden is also the site most challenged by temperature extremes and long traverse distances over difficult terrain.

2) Melas – like Holden, Melas was found inferior to broadly similar crater lake sites. In particular, the lack of evidence for mineralogical and lithologic diversity, especially the absence of compelling igneous rocks to explore and sample within the landing ellipse, were notable weaknesses. Melas is thought to be the youngest of the crater lake sites under consideration, which some members of the committee argue makes it less compelling from the perspectives of astrobiology and planetary evolution.

3) Nili Fossae –the presence of an undisputed igneous unit correlatable to the Syrtis lavas was a strong attraction to this site, but the astrobiological potential of the site was considered by the committee to be inferior to that available at other potential landing sites.

4) Eberswalde – this crater lake site was found less compelling than the broadly similar, but significantly older, Jezero site. While Eberswalde offers an attractively compact distribution of scientific targets, like Holden, it suffers from temperature extremes that reduce operational efficiency.

5) Mawrth – the central attraction to this site is its extraordinary accumulation of phyllosilicates, and its great antiquity. This site was considered favorably by the Mars 2020 science team and the community assembled at the workshop. The committee deliberated further about the merits of Mawrth for Mars 2020, and strong concerns were raised about a) the uncertain origin of the phyllosilicates, b) the strong dependence on different models for phyllosilicate formation and alteration for the astrobiological relevance of the site and c) the perceived degree of difficulty that the science team would have in establishing a robust geologic context at the site during surface exploration. Taken together, these concerns were deemed important enough by the committee to drop the site from further consideration.

The next two sites were ranked substantially higher than all others, and therefore are included on the short list:

1) Jezero Crater – this site was strongly endorsed by the Mars 2020 Landing Site Working Group and by the workshop attendees. Jezero offers a well-defined delta environment including the finest-grained facies deemed most favorable for organic concentration and preservation, a large and geologically diverse headwaters region emptying into an open, deep lake, and an intriguing carbonate-bearing unit that may preserve a record of the

ancient martian carbon cycle. Jezero is clearly Noachian in age and the oldest of the candidate lake sites. On the negative side, the mafic crater floor unit has a young age as estimated by crater counts (~1.4 Ga) and lacks unambiguous evidence for a volcanic origin, thus potentially limiting its applicability for returned sample science.

2) NE Syrtis – This site was also ranked very highly by both the Landing Site Working Group and by workshop attendees. A key attraction of NE Syrtis is lithologic diversity spanning a broad interval of early Mars in clear and readily accessible stratigraphic context throughout the landing ellipse. Units of scientific interest include large, well-exposed blocks of megabreccia probably emplaced by the ~4 Ga Isidis impact, abundant phyllosilicates, and a high concentration of carbonates that could harbor evidence of past climate and of possible life (e.g. in an ancient, subsurface aquifer and serpentinizing system). Similar to Jezero, a widespread mafic capping unit present in the ellipse could provide important stratigraphic context, but only if determined to be of igneous origin. Highly desirable Syrtis lava flows and sulfates have been identified in the region, but at a distance of 20 to 30 km from the landing ellipse may be beyond the range of any extended mission.

Although ranked lower than either Jezero or NE Syrtis, the committee agreed to retain the Columbia Hills site after lengthy discussion. Given the contrary initial position of the Landing Site Working Group and the middling assessment from the workshop, we elaborate on this decision:

3) Columbia Hills – this site was visited by NASA's Spirit rover, which explored a range of potentially attractive targets for Mars 2020 to investigate. Most notable among these is a putative hydrothermal sinter deposit that some scientists, by analogy to Earth, suggest is an excellent target for seeking evidence of possible ancient Martian life. An additional attraction is a diverse suite of volcanic rocks. This site was ranked highly by the Returned Sample Science Board based on the potential of samples from these targets to generate significant new findings if returned to Earth.

Considerable time in the workshop was spent evaluating the evidence supporting a hot spring origin for the key target at this site, and whether a surface mission could adequately test the hypothesis. The committee recognizes these uncertainties, and is further concerned with the possibly limited potential to make fundamental scientific discoveries at a site already investigated by a capable rover, especially if the hot spring interpretation turns out to be incorrect.

In the end, the committee agreed to retain this site to allow the nascent understanding of its geologic setting to be further developed and tested, and to allow time for the project to more deeply study the site's science value and potential engineering challenges (including sampling of the observed sinter with the drill). We emphasize that unlike the sites removed from further consideration, important changes in our assessment of this site might emerge in the coming months. Absent such revision, this site compares unfavorably to both NE Syrtis and Jezero. The Mars 2020 project will brief you as our assessment of this site progresses.

As an unintended but advantageous outcome of the selection process, the three remaining candidate landing sites are thought to represent each of the three environments most commonly considered favorable for detecting possible ancient life on Mars: fine-grained sediments and chemical precipitates deposited in lakes (Jezero), deep crustal settings in which water interacts with rock (NE Syrtis), and surficial hot springs (Columbia Hills).

As we move to a final short list, we look forward to furthering our understanding of these sites and their potential to permit Mars 2020 to make fundamental contributions to our understanding of Mars, the solar system, and life.

Sincerely,

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(Mars 2020 Project Scientist)

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