

SAMPLING BY THE NASA PERSERVERANCE ROVER FOR MARS SAMPLE RETURN

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Introduction: A primary goal of the NASA Mars 2020 Perseverance rover mission is to collect and document a suite of scientifically return-worthy martian samples for return to Earth by future missions [1]. Perseverance is currently exploring Noachian-aged Jezero Crater, once the site of a habitable delta-lake system. Perseverance carries 38 identical sample tubes designed for rock cores or regolith, and five “witness tubes” for characterizing contamination from the rover. The Sampling and Caching Subsystem (SCS) [2] enables the collection of sealed sample tubes.

As of May 2023, the mission has completed the Crater Floor and Delta Front campaigns, and has embarked on the Upper Fan campaign. In the process, the mission has sealed 22 tubes: 16 rock cores, 2 regolith samples, one tube that contains a serendipitous sample of ~5 μmol of ambient atmosphere, and three witness tubes.

A diverse suite of samples: The solid samples include a suite of igneous rocks from the crater floor [e.g., 3, 4-6], sedimentary rocks from the delta [e.g., 7, 8, 9], and samples of an aeolian bedform (“regolith”) [10]. Details of all of these samples are documented by Initial Reports on the PDS. The three witness tube assemblies (WTAs; see [2] for details) include the witness tube from the Bit Carousel (WTA1; sealed on Sol 120), and tubes sealed after sampling of sedimentary rocks at Skinner Ridge on Sol 499 (WTA2), and Amalik on Sol 586 (WTA3).

The Crater Floor samples consist of a suite of igneous rocks that have similarities to lithologies within martian meteorites but with notable differences [4, 5]. The Delta Front samples represent the first ever sedimentary and regolith samples for return to Earth. Many of the samples collected thus far – both igneous and sedimentary – contain components deposited and/or altered by water and thus have high biosignature preservation potential.

The Three Forks Sample Depot: In January 2023 ten tubes were placed in a depot in a location known as Three Forks, on the crater floor at the base of the delta front [11, 12]. Included in this depot are representative samples from the Crater Floor and Delta Front campaigns (in which pairs of samples were collected), including four igneous samples, three sedimentary samples, one regolith, as well as the Roubion serendipitous atmospheric sample, and WTA3. This depot is a contingency, although the study of the samples contained within it would significantly advance the goals of Mars Sample Return. Pairs of each rock and regolith sample, plus two singleton samples from the Delta Front and Upper Fan, and WTA1 and WTA2 remain on board.

Current and Future Sampling: Perseverance is currently in the Upper Fan Campaign, characterizing and sampling the sedimentary rocks that may represent the river system that fed the Jezero Delta. At least one additional sample is planned as part of this campaign. Exploration of the margin of Jezero Crater and Nili Planum beyond comprise the future objectives of the mission. Ultimately, the mission seeks to deliver an expanded collection of ~30 samples to a sample return mission, a suite of samples that would address the astrobiological, geological, and in situ resource utilization objectives of Mars Sample Return [13].

References: [1] Farley K.A. et al. (2020) *Space Sci. Rev.*, 216. [2] Moeller R.C. et al. (2021) *Space Sci. Rev.*, 217. [3] Farley K.A. et al. (2022) *Science*, 377: eabo2196. [4] Liu Y. et al. (2022) *Science*, 377:1513-1519. [5] Udry A. et al. (2022) *JGR: Planets*, e2022JE007440. [6] Simon J.I. et al. (2023) *JGR: Planets*, e2022JE007474. [7] Stack K.M. et al. (2023) *LPS LIV*, Abstract #1422. [8] Benison K.C. et al. (2023) *LPS LIV*, Abstract #2570. [9] Williams A.J. et al. (2023) *LPS LIV*, Abstract #1652. [10] Hausrath E.M. et al. (2023) *LPS LIV*, Abstract #2379. [11] Maki J.N. et al. (2023) *LPS LIV*, Abstract #2875. [12] Czaja A.D. et al. (2023) *LPS LIV*, Abstract #2523. [13] Beaty D.W. et al. (2019) *Meteoritics & Planetary Science*, 54:S3-S152.