**Introduction:** NASA-ESA are jointly planning to collect and transport a set of martian samples from Mars to Earth for the purpose of scientific investigation, based on the highest priority recommendations of the international science community. The samples are being collected by NASA’s Mars 2020 Perseverance Rover [1,2] and consist of a variety of rocks, regolith, and atmospheric gas.

Analogue samples, representing various properties of the Mars 2020 samples, are needed for engineering, science, and planetary protection developments, and testing in the context of Mars Sample Return (MSR). Depending on the activity for which the analogue sample material will be used, different properties or groups of properties of the analogue sample may be important, including but not limited to geophysical, geochemical, geomechanical, or mineralogical properties.

**Analogue Sample Collection Field Campaign 2023:** In late 2022 an external expert science group, the “Rock Sample Team”, was appointed by the MSR Joint Science Office (JSO) for various project needs. They were tasked to recommend terrestrial analogue sites for four different lithologies based on the samples placed in the first sample depot on Mars at Three Forks Depot. The four lithologies can be divided into: 1) Olivine cumulate (Séítah Formation), 2) holocrystalline augite basalt (Maáz Formation), 3) Jezero Delta sediment and 4) granular material/regolith. The sites recommended by the Rock Sample Team were rated based on the desired analogue properties (physical, geochemical, mineralogy, organic), the accessibility of the field site and the quantity of material that could be acquired. Subsequently, the recommended sites by the Rock Sample Team were down-selected to five analogue sites:

1) Salton Sea, CA, USA (terrestrial analogue sample for the Jezero Delta sedimentary rocks)
2) Ridge Basin, CA, USA (terrestrial analogue sample for the Jezero Delta sedimentary rocks)
3) Lambahraun, Iceland (terrestrial analogue sample for Martian regolith/granular material)
4) Isle of Rum, Scotland (terrestrial analogue sample for the Séítah Formation; olivine cumulate/wehlrite)
5) Hart Mountain, OR, USA (terrestrial analogue sample for the Maáz Formation; augite basalt)

The analogue samples were collected during dedicated field trips from May to October 2023. Each field team was comprised of representatives from the MSR Campaign Science Group (MCSG) and/or members of the JSO, experts in local geology, representatives from the Mars 2020 team, and in some cases technical support personnel or media and outreach colleagues.

**Salton Sea and Ridge Basin sedimentary rocks:** The sedimentary analogues were selected to imitate the grain size, general depositional environment, and cement composition of delta front sedimentary samples in order to provide an analogue for the physical and textual properties of the returned samples. However, they are poor mineralogical or geochemical analogues for Mars.

**Salton Sea Sandstone:** The Salton Sea Sandstone was selected as an analogue for the paired cores Hazel-top (on Perseverance) and Bearwallow (at Three Forks Depot), which were initially interpreted as sulphate-cemented siltstones in the Shenandoah formation, deposited in an evaporitic deltaic or fluvio-lacustrine environment.

**Ridge Basin Sandstone:** The Ridge Basin planar laminated Sandstone was selected as an analogue for the paired cores Shuyak (on Perseverance) and Mageik (at Three Forks Depot), which were initially interpreted as planar laminated siltstones in the Shenandoah Formation, with a number of possible depositional environments but likely fluvio-lacustrine or deltaic.

![Figure 1. View of sedimentary layers at Salton Sea in the sample region. The yellowish sandstone layer near the left side of the image was sampled.](image-url)
included a wind ripples, granule patches, and low-relief hummocks.

Figure 2. A close-up view of the sand sheet from the Iceland regolith study site.

Isle of Rum olivine cumulate/wehrlite: The Rum Layered Intrusions were chosen as an analogue site for the Sétah formation because previously published literature [5] suggested the presence of wehrlitic units within both the eastern and western layered intrusion. The collected rocks are clinopyroxene- and olivine-rich rock with intergranular plagioclase, corresponding to the paired cores Robine (on Perseverance) and Malay (at Three Forks Depot), as well as Salette (on Perseverance) and Coulettes (at Three Forks Depot).

Hart Mountain basalt: The Steens Basalt at Hart Mountain was selected as a holocrystalline basaltic lava analogue site for the Máaz formation samples. The basaltic lavas consist of plagioclase, augite, and red altered olivine and can be divided into two types: Hart Mountain Aphyric (HMA) and Hart Mountain Phyric (HMP). HMA is a massive grey, holocrystalline basalt, containing ~1 mm grains of olivine, clinopyroxene and plagioclase. Olivine grains are pervasively iddingsitized and red in colour. HMA exhibits textures and mineralogy like the Bellegarde abrasion patch and corresponding Montagnac (on Perseverance) and Montdenier (at Three Forks Depot) samples collected at the Rochette outcrop.

HMP is a massive, holocrystalline basaltic lava, containing fine-grained olivine (up to 2 mm) and clinopyroxene (~1 mm) with giant plagioclase crystals up to 2 cm. Olivine occurs as inclusions in feldspar or as glomerocrysts with feldspar and are pervasively iddingsitized and red in colour. Large plagioclase crystals are abundant in the HMP, similar to the Alfalfa abrasion patch and corresponding Hahonih (on Perseverance) and Atsah (at Three Forks Depot) samples collected at the Sid outcrop.

Figure 3. The sampled blocks were already present by the side of the road, having been removed from the cliff-forming unit presumably during road construction.

Ongoing Work: Planetary Instrument for X-ray Lithochemistry (PIXL) breadboard scans were collected for the Rum olivine cumulate, as well as the Hart Mountain basalts [6]. The characterization of analogue samples, storage and allocation of analogue samples is described in [7]. Potential future analogue sample collection campaigns would be planned based on the needs for additional analogue.

Disclaimer: The decision to implement Mars Sample Return will not be finalized until NASA’s completion of the National Environmental Policy Act (NEPA) process. This document is being made available for informational purposes only.

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