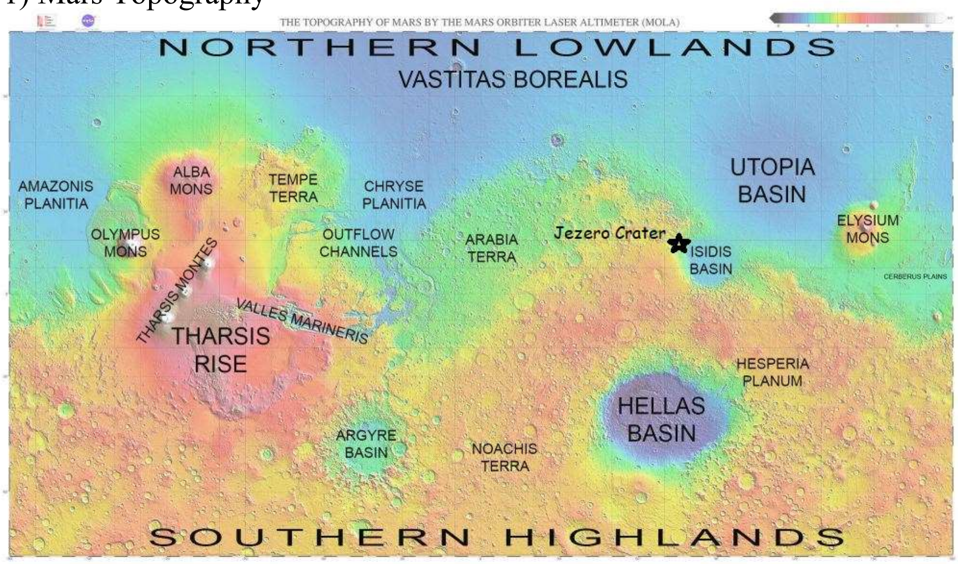
OCESS Mission Hindsight 2020

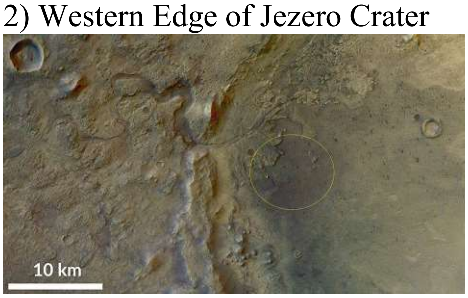
The OCESS mission for 2020 is set to explore an abandoned river channel on Mars. The channel is part of a system of channels that emptied into a shallow lake that filled Jezero Crater on the northwest margins of Isidis Basin which is on the edge of Mars' northern lowlands. This mission's goals are to gather supporting evidence for NASA's Mars 2020 mission to Jezero Crater.

The goal of NASA's Mars 2020 mission is to study a 3.7 billion-year-old river delta system in the lake that existed in Jezero crater at the time. An accessible summary of the mission goals can be found in the November 20, 2018 report of the Planetary Society (We're Going to Jezero!) (https://www.planetary.org/blogs/emily-lakdawalla/2018/jezero-landing-site-mars-2020-rover.html) as well as more technical sources such as Goudge, T.A., et al., Assessing the mineralogy of the watershed and fandeposits of the Jezero crater paleolakesystem, Mars; Journal of Geophysical Research: Planets American Geophysical Union; (https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2014JE004782)

1) Mars Topography



2) Western Edge of Jezero Crater



<u>OCESS Hindsight 2020 Primary Mission Goals</u>

One of the main questions for NASA's mission is for how long a time was this river system active. Was this a single flood associated with some catastrophic event such as a volcanic eruption or asteroid impact or were the river and delta system active over a long period of time, perhaps tens of millions of years? Answering this question will be the primary goal of OCESS's mission Hindsight 2020 (February 2020). OCESS's mission will study one of the river channels for geological evidence for the duration of fluvial activity. The goal is to provide a better-defined context for NASA's subsequent investigation in Jezero Crater. This primary activities for the OCESS mission will consist of a detailed study of sedimentary features by direct field observation, sample collection and analysis onboard, coring, and shallow reflection seismic imaging.

Specific goals are as follows.
1) Sediment mineral content will be characterised so as to give NASA's subsequent mission the chance to determine how prolonged aqueous submergence of mineral grains might have chemically altered the minerals in their study area. This is important to understand how long the lake existed and what the nature of its water chemistry.

2) Detailed observation of sediments and sedimentary rocks in the river channel to look for evidence of multiple generations of river channels. Such evidence, especially evidence of younger channels incising into sedimentary rocks units from prior river channel deposits, would suggest a long period of fluvial activity. The data from shallow seismic imaging will supplement the surface observations. Observations of surface geomorphic features also will be made to better understand the final stages of river activity before the system dried up. These observations also will help mars geographers understand how the subsequent 3.7 billion years of mars weather has modified the geomorphic structures from mars' early wet period.

3) Mineral content of different river channel deposits, if they are present, will be compared to the mineral content of different upstream regions. If the mineral content of different channel deposits match different source regions, this would suggest a long period of time for river channels to shift their paths. Sedimentary rock samples from drill core will be the primary source of material for analysis. Analysis of upstream highlands for mineral content will be conducted using reflectance spectroscopy from orbit and suborbital passes before landing at the main site.

4) Sedimentary deposits from associated environments such as eolian (wind-blown) sand structures, flood-plain deposits, and evaporite mineral deposits will be looked for to better understand the environment that the rivers existed in.

Secondary Mission Goals

Secondary goals for OCESS Hindsight 2020 are: 1) search for present-day water in the region; 2) search for any evidence of past or present-day life; 3) assess the soil perchlorate mineral content for a source of oxygen gas generation and as a toxicity hazard for surface exploration; and 4) an assessment of the risks posed by dust devil storms to surface habitation structures in future long-term human exploration.

Secondary goals 1 and 2 will be carried out as part of geological observations that are part of the primary investigation. Heating of sediment from surface samples and core samples will be carried out to drive off water. In addition, the shallow seismic imaging may show evidence of subsurface water through its effect of seismic wave speed. Goal 2 also will involve culturing sediment samples to see if biological activity results.

Secondary goal 3 will involve processing sediment samples from the primary investigation site as well as locations in other regions of the planet. Machinery to safely process sediment samples will be designed and constructed before departure.

Secondary goal 4 will involve deploying remote weather monitoring packages from the spacecraft in the path of active dust devils during the first or last days of the mission.

Mission Profile

Transfer Orbits

The transfer orbit to Mars will be a high energy hyperbolic orbit using the AYSE main drive unit at near continuous 10 g thrust with a peak solar velocity of 20000 km/s during a short turnaround period. The current relative positions of Earth and Mars allow for transfer orbits that do not require passage within Earth's solar orbit. The mission also coincides with the Hohmann return transfer orbit launch window. This safety feature allows for a low-fuel, low-thrust return transfer orbit should the AYSE drive unit experience a malfuction during the surface exploration period. Barring this unlikely circumstance, the return transfer orbit also will be a high-energy continuous thrust profile.

The details of the flight profile are still under development, but should be completed before the end of January 2020.