The Tablelands Ophiolite of Newfoundland: A Mars analogue site of present-day serpentinization

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Introduction: The Tablelands Ophiolite (N49° 27' 58.9", W 57° 57' 29.0") is a Mars analogue for the altered ultramafic rocks with Mg-carbonate and serpentine signatures of the MSL proposed landing site, NE Syrtis Acidic-Alkaline transition. The presence of these rock types suggest that serpentinization may have occurred on Mars at this location. The Tablelands Ophiolite is a location of past and present-day continental serpentinization. Present-day continental occurrences of serpentinization are rare. On the West coast of Newfoundland in Gros Morne National Park, uplifting of an ancient sea bed during the collision of the continents ca. 470 million years ago revealed underlying ultramafic rocks of Earth's mantle creating the Tablelands Ophiolite. Weathering due to recent glaciations has left large areas of unaltered ultramafic rock at the surface and created fissures for fluid flow. As a result serpentinization is occurring as fresh water penetrates the rock. Multiple ultrabasic reducing springs bubbling with gases characteristic of present-day serpentinization have been identified in the Tablelands Ophiolite (1;2). Serpentinization creates conditions amendable for both abiogenic and microbial synthesis of organic compounds. Therefore this analogue site is ideal for testing the detection of abio- and biosignatures. This project has a series of long-term goals: 1) to develop and test methods under high pH and low microbial biomass conditions characteristic of sites of serpentinization that are being prepared for space flight and contribute to the scientific goals of the Mars Sample Laboratory (MSL), the 2018 ExoMars Rovers Mission, and the Mars Exploration Program Analysis Group (MEPEG); 2) to put in situ measurements in context of carbon source and reaction pathways (biogenic and abiogenic) and to determine microbial communities that thrive in the ultrabasic reducing groundwater at sites of serpentinization; and 3) to determine preservation of abio- and biosignatures in carbonate rocks indigenous to sites of serpentinization.

Mission Description: The Tablelands Ophiolite is an analogue of the MSL NE Syrtis Acidic-Alkaline transition proposed landing site where there are altered ultramafic rocks with Mg-carbonate and serpentine signatures. The detection of these rock types suggest that serpentinization may have occurred on Mars, and therefore conditions amendable for both abiogenic synthesis and microbial chemosynthesis of hydrocarbons, such as methane, may have existed at the NE Syrtis Acidic-Alkaline transition proposed landing site. Studying past and present-day serpentinization at the Tablelands will answer questions about the habitability of sites of serpentinization, the potential of abiogenic production of hydrocarbons, and the preservation of

biosignatures; therefore, contribute to the scientific goals of the Mars Sample Laboratory (MSL), the 2018 ExoMars Rovers Mission, and the Mars Exploration Program Analysis Group (MEPEG).

Science Merit Related to Mission Objectives: In the Tablelands Ophiolite there are ultrabasic reducing groundwater springs emerging from highly altered ultramafic rocks containing serpentine minerals. Mg- and Ca- carbonate fluff, and travertines are precipitating where the groundwater emerges. Older travertines have also been identified in association with less more oxic springs, suggesting that these are sites of past serpentinization. Both types of springs are being studied to determine the habitability of sites of serpentinization, the potential of abiogenic production of hydrocarbons, and the preservation of biosignatures.

Most Important Question Answered by Site: Studying past and present-day serpentinization at the Tablelands will answer questions about the habitability of sites of serpentinization, the potential of abiogenic production of hydrocarbons, and the preservation of biosignatures.

Logistic and Environmental Constraints: The Tablelands Ophiolite is located in Gros Morne National Park, which is a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site. A permit is required to perform research there. The closest airport is in Deer Lake, NL, which is about an hour's drive from the Tablelands. There are roads through Gros Morne. The springs located thus far are at most a 45 min walk from the road. The terrain can be unsafe; it is sometimes steep and consists of unstable talus slopes. Very little vegetation can grow on the ultramafic rock of the Tablelands. The Tablelands can be snow covered until early summer.

Standard Information Required for Analogue Sites:

Table 1: Tablelands Ophiolite, Gros Morne National Park, NL, Canada

Site Name	Tablelands Ophiolite, Gros Morne National Park, NL, Canada
Center Coordinates Latitude, longitude	N49° 27' 58.9", W 57° 57' 29.0"
Elevation	0.25 - 0.7 km
Areal Extent	83.2 Km^2 – Oval shape, see Figure 1
Prime Science Questions	Habitability of sites of serpentinization, the potential of abiogenic production of hydrocarbons, and the preservation of biosignatures
Distance of Science Targets from nearest road or airstrip	All springs are located within 45 min hike from the nearest road
Environmental characteristics	Max temp: 22°C (average high) Min temp: -11°C (average low) Precipitation: 1300 mm/yr Vegetation coverage: sparse
Previous studies at analogue site	See 1 and 2 in reference list
Primary Landing Site Target	MSL NE Syrtis Acidic-Alkaline transition.

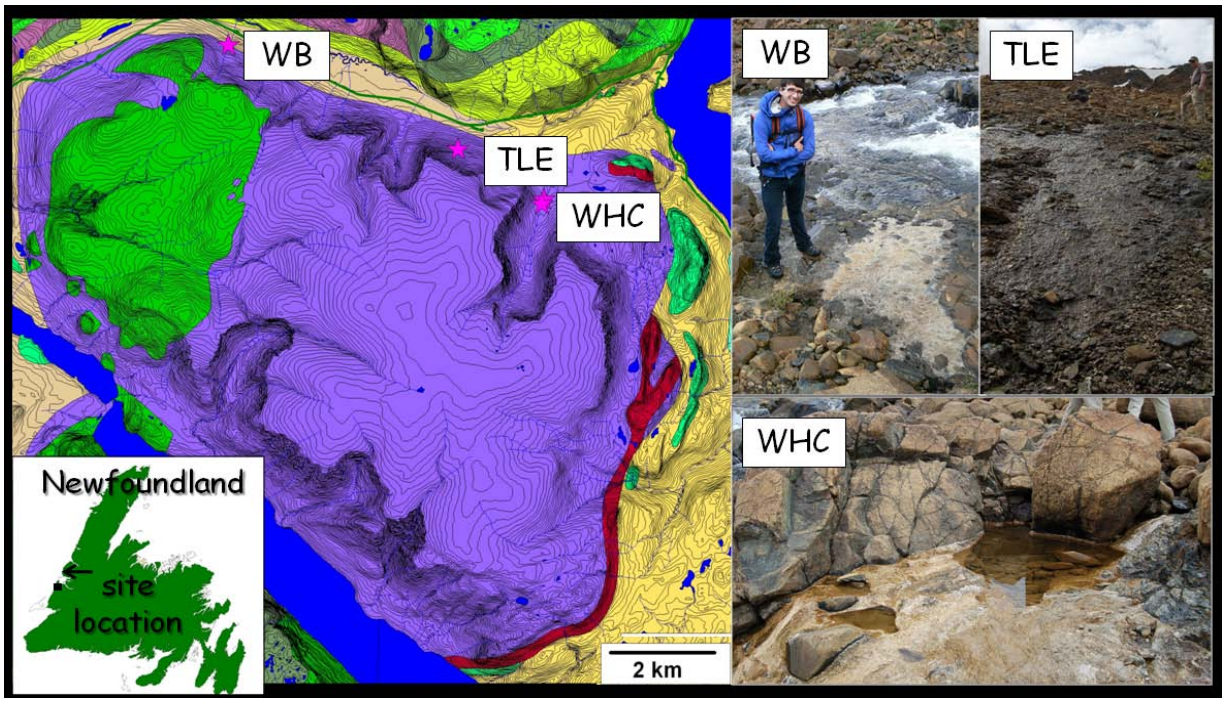

Figure 1: Geologic and topographic map of the Tablelands Ophiolite in Gros Morne National Park, Newfoundland, Canada (N49° 27' 58.9", W 57° 57' 29.0"). The prime science targets are ultra-basic reducing groundwater springs emerging from the ultramafic rock. These groundwaters have been modified by the water-rock reaction known as serpentinization. Three complexes of ultra-basic reducing springs have been located and are labeled as Winter House Creek (WHC), Tablelands East (TLE), and Wallace Brook (WB). WHC has the most ultrabasic reducing conditions, and it is the primary site of interest.

References:

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