LIFE IN THE ATACAMA – YEAR 2: GEOLOGIC RECONNAISSANCE THROUGH LONG-RANGE ROVING AND IMPLICATIONS ON THE SEARCH FOR LIFE:

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Introduction: The "Life in the Atacama" (LITA) project included two field trials during the 2004 field season, each of which lasted about a week. The remote science team had no prior knowledge of the local geology, and relied entirely on orbital images and rover-acquired data to make interpretations. The sites for these trials were in different locations, and are designated "Site B" and "Site C" respectively. The primary objective of the experiment is to develop and test the means to locate, characterize, and identify habitats and life remotely through long-range roving, which included field testing the rover, named Zoe. Zoe has onboard autonomous navigation for long-range roving, a plow to overturn rocks and expose near-surface rock materials, and high-resolution imaging, spectral, and fluorescence sampling capabilities. Highlights from the experiment included characterizing the geology in and near the landing ellipse, assessing pre-mission, satellite-based hypotheses, and improving the approach and procedures used by the remote and field teams for upcoming experiments (also see [1-3]) through combined satellite, field-based, and microscopic perspectives and long-range roving (e.g., Figs. 1-3).

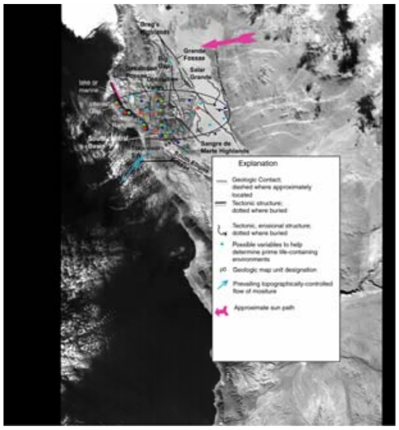

Fig. 1. Schematic map of Site B showing pre-mission, satellite-based information.

Fig. 2. Panorama taken from the high-resolution imager onboard the rover.

Fig. 3. RGB visible light reflectance image taken from the rover showing rock characteristics (image is 10 cm wide).

Methodology/Strategy: The primary strategy for this experiment was to identify, map, characterize, and sample prime candidate sites that have the greatest biological potential within and surrounding the landing ellipse through combined satellite-, field-, and microscopic-based perspectives, and long-range roving. **Pre-traverse Satellite Reconnaissance:** the pre-traverse, satellite-based reconnaissance included mapping: (a) the geology and geomorphology in and surrounding the landing ellipse such as distinct map units (e.g., fan, basin, fluvial, etc.), geomorphic characteristics (valleys and valley networks), and tectonic structures (faults and structurally-controlled basins), since these may be representative of potential habitats (geology often correlates with biology, (b) specific mineralogic signatures identified using thermal emission spectra, which may indicate ancient/recent aqueous activity, including weathering and secondary mineralization, (c) geologic materials exposed at the surface with both high reflectance in the near infrared and relatively low reflectance in the visible wavelength spectra using VNIR, which may suggest the presence of chlorophyll and/or evaporite minerals (e.g. gypsum) (also see [2]), (d) locales, which may be influenced by topographically-controlled flow and deposition of atmospheric water vapor (both marine and radiative); for example, structurally-controlled topographic basins, valleys, and highs as barriers where moisture may collect, enabling life in arid regions where surface water may otherwise not be available, (e) features associated with surface and/or possible ground water flow (e.g., individual valleys and valley networks, ancient basins, sites of potential groundwater seeps including ancient/recent geothermal activity and/or groundwater migration along basement structures and geologic contacts), which increase the potential of identifying prime life-bearing environments because of the presence of ancient/recent hydrologic/hydrogeologic activity, and (g) solar insolation (a function of location time of year, local atmospheric conditions, and micro- to macro-topography), which may highly influence habitability (certain locations may benefit from increased insolation while others may benefit from shade such as many non-polar desert ecosystems). **Field-based Assessment**: at the locales of special interest, the Science Team collected data to assess the potential for habitat and life, including local environment (e.g., weather: cloud/fog cover in and near the locale), geology (rocks and structure), geomorphology (valleys and topographic lows), and petrologic, spectral, and biologic characteristics of rock materials at macroscopic and microscopic scales using plowing and visible imaging, spectral and fluorescence instruments (e.g., Figs. 2 and 3).

Results: The experiment resulted in the characterization of the geology in and near the landing ellipse for Sites B (e.g., Fig. 1) and C, including the following primary interpretations: **Site B -** (1) the dissected materials in and near the landing ellipse are interpreted to be materials possibly of lacustrine (or marine) origin with materials emplaced locally by fluvial, alluvial, and eolian processes (dark materials particularly noted in the topographic lows). Based on spectral analysis, materials may include gypsum, calcite, hematite, volcanic detritus (e.g., pyroxene and feldspar/clay), and hematite, (2) the alluvial fan deposits, which are of varying age and diverse lithology (e.g., igneous, metamorphic, and sedimentary), are separated from the highly dissected materials by a drainage that courses to the northwest to the ocean, and (3) a region that records magmatic, tectonic (basement structures), hydrologic/hydrogeologic (flooding, ponding to form bodies of water, and groundwater-related phenomena, including evaporites), and wind-related activity (e.g., deflation and transport of fines). **Site C** (1) the light-toned and dark-toned rock material in and near the landing site are mostly derived in situ and/or locally. The white materials appear to be an evaporite (resulting from standing body(s) of water and/or hydrogeologic activity), while the dark materials may be igneous or evaporitic (lacustrine or marine) derived from local outcrops. In addition, fine-grained materials may also include aeolian deposits and/or volcanic airfall/pyroclastic materials. Based on spectral analysis, materials may be evaporitic (gypsum), alteration minerals (talc), and/or hematite. Some of the white materials could include volcanic materials such as ash flow/ignimbrite materials. The geomorphic expression of the landscape indicates past aqueous activity (e.g., possible bodies of water, surface drainage, and groundwater movement, all of which may be conducive to life), (2) smooth-plains forming materials along the eastern margin of the primary south-southeast-trending drainage with a spaceborne-spectral signature of quartz may mark a floodplain (e.g., a mantle overlying materials of (1), (3) a primary drainage contains white rock materials and to a lesser extent black rock materials; spectral-based analysis indicates that there are felsic volcanics (rhyolites?, ignimbrites?, etc.), though a greater diversity of rock types may exist (e.g., evaporites, clays, igneous, etc.) derived from fluvial, lacustrine, and eolian activity, (4) various lines of evidence (field-based and microscopic) collectively indicate that local igneous outcrops may be poking up through a less competent cover, and (5) the region records magmatic, tectonic (basement structures), hydrologic/hydrogeologic (flooding, ponding to form bodies of water, and groundwater-related phenomena), and wind-related activity (e.g., deflation and transport of fines).

The geological, morphological, topographical, and mineralogical mapping led to the localization of potential habitats where the remote science team performed *in situ* measurements [see 1 and 3, this LPSC].

References: [1] Cabrol et al. (2004) This conference. [2] Piatek et al. (2004) This conference; [3] Weinstein S., et al., (2004), This conference