Europa Landing Site Analog: Lidar Surveys Of Devil's Golf Course As A Pathological Case For The Surface Morphology Of Europa. D. F. Berisford[1], K. P. Hand[1], S. M. Skiles[1], E. R. Duffy[1], M. L. Richardson[1], Kathryn J. Borman[1], and T. H. Painter[1], [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, 91109, daniel.berisford@jpl.nasa.gov.

Introduction: Potential sites for landing a spacecraft on the surface of Europa are likely to contain a mixture of ice and evaporate salts. [1-3] Due to the unknown fine-scale topography of Europa and long communications lag time to Earth, a Europan lander would perform most of its Entry, Descent, and Landing autonomously. The lander, therefore, must accommodate unknown and potentially rough surface morphologies. [4]

As a pathological case for an evaporate-dominated surface morphology, we examine the terrain of Devil's Golf Course (DGC) in Death Valley National Park, CA, USA. The terrain features in DGC present a challenging case for a lander, which must be able to touch down, self-level, and acquire a surface material sample with little feedback control.

We have performed an aerial LiDAR survey over a portion of DGC, and generated high-resolution Digital Elevation Models (DEM's) and 3D-printed plastic models for use in preliminary development of lander hardware for the JPL Europa Lander concept feasibility study.

Devil's Golf Course Survey Area: The surveyed terrain in DGC (Figure 1) consists of irregular salt-evaporite pillars, spanning a scale range of roughly 0.1m to 0.6m. The surveyed region is approximately bounded by the following GPS coordinates (WGS84):

36.33538ºN, 116.86943ºE
36.34011ºN, 116.85623ºE
36.26245ºN, 116.82401ºE
36.26713ºN, 116.81094ºE

The survey consisted of 4 flight lines with approximately 170m spacing, flown at 300m height above ground elevation (Figure 1). Each flight line was flown twice, once each in opposite directions.

Mission Equipment and Instrumentation: The area was flown by NASA JPL's Airborne Snow Observatory (ASO) flight team. [5,6] The ASO platform consists of a Riegl LMS-Q1560 scanning LiDAR unit with an Applanix POS AV 501 GNSS/IMU system running RTX real-time error correction service. This system achieves terrain measurement accuracies less than 5cm in x-y and less than 10cm in the z-direction. The system is flown aboard a King Air A90, operated by Dynamic Aviaion, LLC.

The LiDAR uses a dual laser source, with 28º fore/aft angular offset between the two lasers, and a 58º effective lateral field of view. This produces a swath

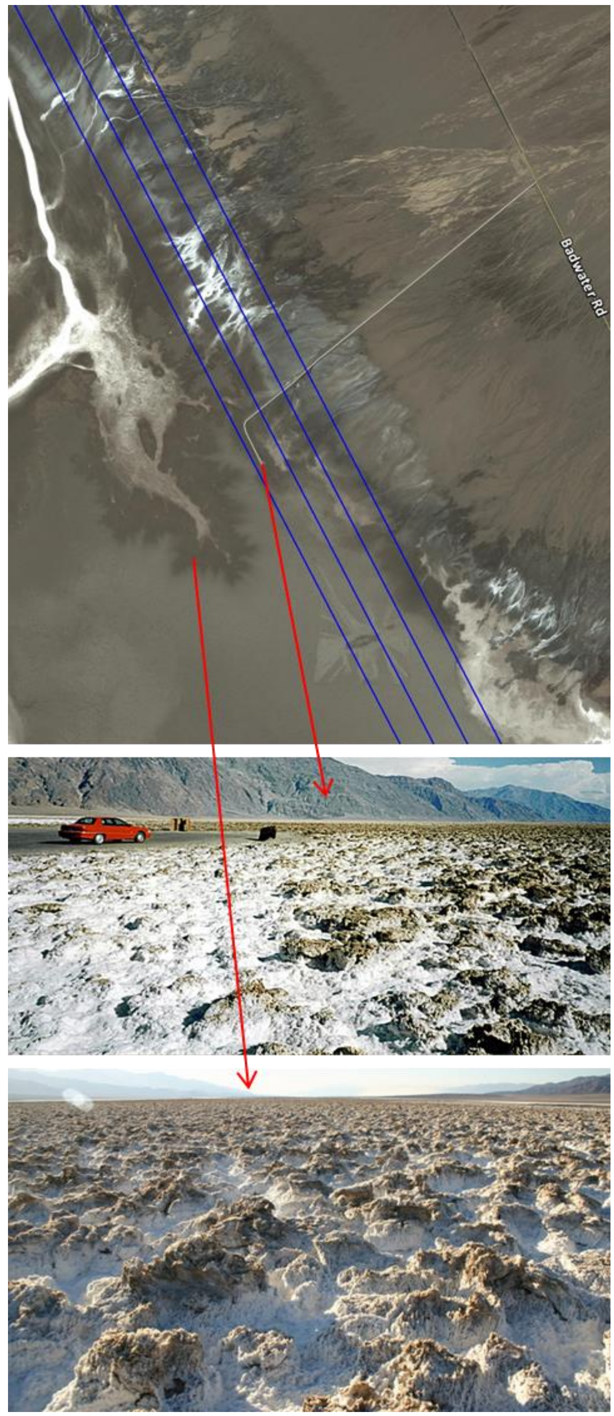
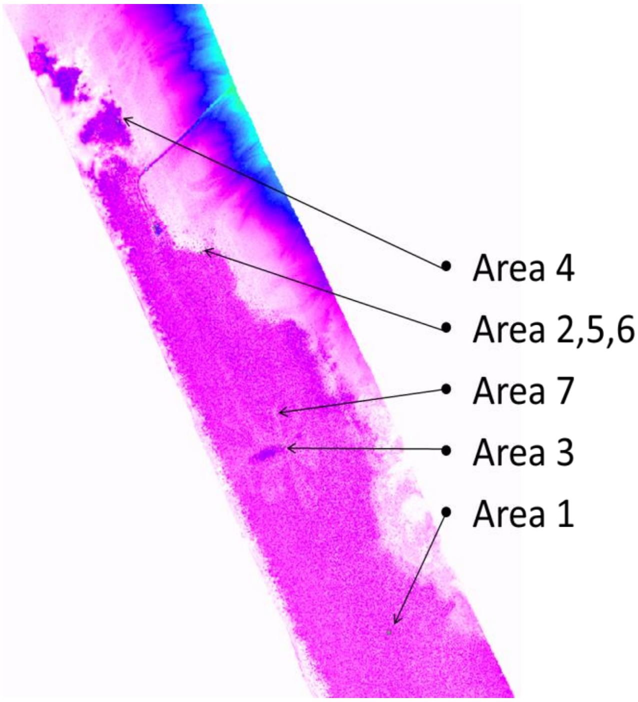


Figure 1: Google Earth Imagery and photos of Devil's Golf Course survey area.



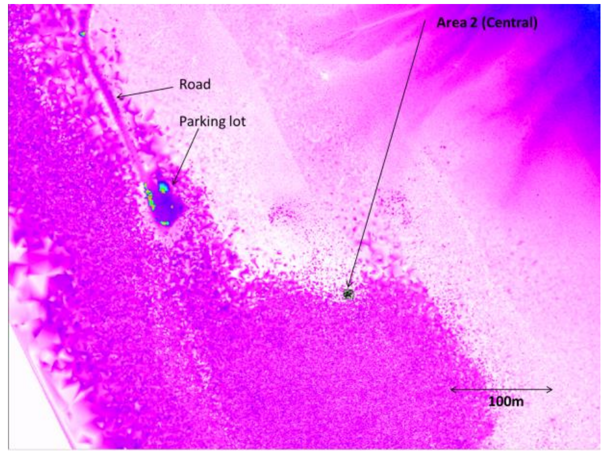


Figure 2: (Above and Left) LiDAR dataset showing subset areas chosen for CAD modeling and 3D printing. Areas were chosen to generate a variety of terrains available within the dataset.

width of 400m for this mission, which provides double overlap between adjacent flight lines. In areas with maximum overlap, this results in a maximum point density of approximately 60pts/m^2, and a minimum of 20pts/m^2 in areas of only single overlap.

Data Processing: The ASO team processed the LiDAR data using proprietary Riegl software and in-house filtering algorithms to remove isolated atmospheric returns and reduce the data to 0.2m and 0.15m resolution DEM's using QT Modeller for the DEM rendering. [6] We then converted 10m square subsets of select areas within these DEM's into Solidworks CAD models, and subsequently produced plastic 10cm square 3D printed terrain models.

Results: Figure 2 shows LiDAR data of a portion of DGC, and Figure 3 shows a CAD image of a conceptual Europa Lander superimposed to scale on one of the CAD model terrain subsets. These models are currently used for early visualization and brainstorming collaboration between teams as part of the Europa Lander concept study. The models and the full dataset will continue to be of use as new concepts develop and the Lander project matures.

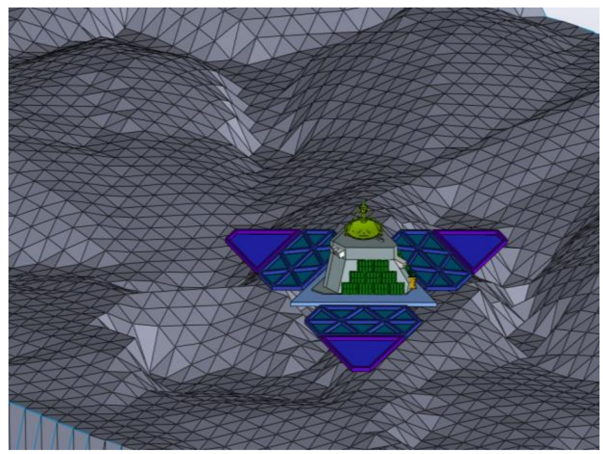


Figure 3: CAD model showing Europa Lander concept scaled 1:1 with LiDAR – generated terrain.

References:

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