TubeX Metadata

This is the data archive of the 2017-8 TubeX expedition to Lava Beds National Monument (LBNM), added to TubeX (tubexproject.github.io). This document outlines the structure and contents of this archive. This work was funded by the NASA-PSTAR program.
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1. Citation

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2. Trip summary:

Objectives: Collect GPR, GPS, LiDAR, hXRF, Magnetic, Seismic and Gravity over (and in cases inside) lava tubes. The data was collected over two separate field campaigns in two consecutive years. The first year field campaign was held in April-May 2017 and the second took place in September 2018.

Site Location: Lava Beds National Monument, located in Tulelake, North California.

Expedition Dates: April 24 – May 2, 2017 and September 5 – 15, 2018.

Participants and Science Points of Contact:
Expedition Lead: Kelsey Young
GPR team members:
Sub-Team Point of Contact: Sarah Kruse, skruse@usf.edu
Sanaz Esmaeili
Sajad Jazayeri

LiDAR team members:

Sub-Team Point of Contact: Patrick Whelley, patrick.l.whelley@nasa.gov
Brent Garry
Jacob Richardson

3. Site Bounding Coordinates:

Modoc Crater (consists of Skull, Incline, Ship & Dinghy caves)

Name	lat_max	lat_min	lon_max	lon_min
Modoc Crater	41.74	41.725	-121.496	-121.541

Cave Loop (consists of Indian Well, Hercules Leg and Natural Bridge caves)

Name	lat_max	lat_min	lon_max	lon_min
Cave Loop	41.715	41.7	-121.505	-121.52

Valentine cave

Name	lat_max	lat_min	lon_max	lon_min
Valentine	41.7165	41.708	-121.472	-121.479

4. Data Archive Structure:

Files in this archive are organized into a series of subdirectories below the top-level directory. Directories are organized first by subsite and then by measurement type. Subsequent sub-directories further define the specific measurement type. Detailed descriptions of the measurement and data types contained in the directories are provided in Section 5. If no data were collected for a specific measurement type, then a directory for that measurement type will not appear. The general archive layout for each subsite is as follows:

Contains data collected at LBNM (general)

GPR: Contains data collected from ground-penetrating radar (GPR) instruments. The corresponding GPS positions to each GPR file are stored in 'locationLINEXXXX.xls' files. The GPR data subdirectory includes three separate folders with the 'YAADayBB_<SubSite>CCCC' names. AA is the number of the field campaign year (1 or 2), BB is the number of the data collection day and CCCC is the data collection location (Surface: over the ground or Inside: Inside the tube void).

Based on this layout, this archive contains the following subdirectories:

LBNM
Modoc_Crater
- Incline: Contains data collected at Incline cave.
  - GPR
- Ship&Dinghy: Contains data collected at Ship & Dinghy caves.
  - GPR
- Skull: Contains data collected at Skull cave.
  - GPR
  - LiDAR

Valentine_cave: Contains data collected at Valentine cave.
- GPR

Cave_Loop
- HerculesLeg: Contains data collected at Hercules Leg cave.
  - GPR
- IndianWell: Contains data collected at Indian Well cave.
  - GPR
- NaturalBridge: Contains data collected at Natural Bridge Well cave.
  - GPR

Modoc Crater – Skull: This directory contains data collected at Skull cave.

GPR: Contains data collected from ground-penetrating radar (GPR) instruments. The corresponding GPS positions to each GPR file are stored in '*locationLINEXXXX.xls'* files. The GPR data subdirectory includes three separate folders with the 'YAADayBB_SkullCCCC' names. AA is the number of the field campaign year (1 or 2), BB is the number of the data collection day and CCCC is the data collection location (Surface: over the ground or Inside: Inside the tube void).

LiDAR: The LiDAR point clouds for the surface and in tube scans are accessible through https://doi.org/10.13016/oxyt-vg4c

Modoc Crater – Incline This directory contains data collected at Incline cave.

GPR: Contains data collected from ground-penetrating radar (GPR) instruments. The corresponding GPS positions to each GPR file are stored in '*locationLINEXXXX.xls'* files. The GPR data subdirectory includes a separate folder with the 'YAADayBB_Incline' names where AA is the number of the field campaign year (1 or 2), BB is the number of the data collection day.

Modoc Crater – Ship&Dinghy: This directory contains data collected at Ship & Dinghy caves.

GPR: Contains data collected from ground-penetrating radar (GPR) instruments. The corresponding GPS positions to each GPR file are stored in '*locationLINEXXXX.xls'* files. The GPR data subdirectory includes a separate folder with the 'YAADayBB_Ship&Dinghy' names where AA is the number of the field campaign year (1 or 2), BB is the number of the data collection day.

Valentine cave: This directory contains data collected at Valentine cave.

GPR: Contains data collected from ground-penetrating radar (GPR) instruments. The corresponding GPS positions to each GPR file are stored in '*locationLINEXXXX.xls'* files. The GPR data subdirectory includes four separate folders with the 'YAADayBB_ValentineCCCC' names. AA is the number of the field campaign year (1 or 2), BB is the number of the data collection day and CCCC is the data collection location (Surface: over the ground or Inside: Inside the tube void).

Cave Loop – HerculesLeg: This directory contains data collected at Hercules Leg cave.

GPR: Contains data collected from ground-penetrating radar (GPR) instruments. The corresponding GPS positions to each GPR file are stored in '*locationLINEXXXX.xls'* files. The GPR data subdirectory includes four separate folders with the 'YAA_DayBB_HerculesLegCCCC' names. AA is the number of the field campaign year (1 or 2), BB is the number of the data collection day and CCCC is the data collection location (Surface: over the ground or Inside: Inside the tube void).

Cave Loop – IndianWell: This directory contains data collected at Indian Well cave.

GPR: Contains data collected from ground-penetrating radar (GPR) instruments. The corresponding GPS positions to each GPR file are stored in '*locationLINEXXXX.xls'* files. The GPR data subdirectory includes four separate folders with the 'YAA_DayBB_IndianWell' names, where AA is the number of the field campaign year (1 or 2), BB is the number of the data collection day.

Cave Loop – NaturalBridge: This directory contains data collected at Natural Bridge Well cave.

GPR: Contains data collected from ground-penetrating radar (GPR) instruments. The corresponding GPS positions to each GPR file are stored in '*locationLINEXXXX.xls'* files. The GPR data subdirectory includes four separate folders with the 'YAA_DayBB_NaturalBridge' names, where AA is the number of the field campaign year (1 or 2), BB is the number of the data collection day.

5. Data Collection, Device, Notes

GPR (Ground-Penetrating Radar):
All the GPR data collected at LBNM was collected using a 100 MHz unshielded PulseEkko antenna from Sensors and Software Inc with an Ultra receiver in the 2018 campaign. The format of the data is dt1 (standard binary format of S&S data). The GPS data was collected using a boom that mounted a Trimble R10 RTK (Real-Time Kinematic) GPS on the center of GPR antennas rig above the midpoint between transmitter and receiver antennas but ~1.5 m above to avoid noise interference. The transmitter- receiver antenna separation is 1 m. The header files of the GPR data contain the meta data on how they are collected using an odometer or otherwise. Furthermore, the distance between traces are provided in each file.

In total +8370 meters of GPR data were collected in this project. Due to extreme surface vegetation on unpaved roads and mostly on uneven sandy terrain covered with dry bushes, using an odometer wheel or moving along straight lines was not practically possible on most of the data collection lines. Therefore, in the off-trail settings we attempted to acquire a trace approximately every 20 cm and recorded the GPS position each second and merged GPR traces and GPS locations based on time. A pre-processing step to merge the GPR and GPR is needed, and one should use the ‘time’ i.e. the clock information for both devices to perform appropriate merge. The merger tool (MATLAB code) developed by Sanaz Esmaeili is provided alongside this document.

Please note that on some of the GPS positions acquired by our instruments, we observed a constant offset in the elevation, i.e. z-direction, while matching the acquired positioning information with LiDAR data. This offset remained constant and the relative values of the point locations were reliable.