# Learning Objectives - Lecture 3

Tuesday, January 24, 2023 1:48 PM

## Learning Objectives

1. Learn the basic operation of Google Earth
2. Know how to download LiDAR data from Open Topography
3. Know how to display LiDAR data in Google Earth
4. Know how to display active faults in Google Earth
5. Know how to produce an AutoCad contour map from LiDAR data

# Learning Objectives - Lecture 3

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## Assignment 2

Using Google Earth and AutoCad, make the following maps for the Little Cottonwood Canyon Area near Granite Utah.

1. Map 1 from Google Earth - LiDAR topography (hillshade.kmz) from Open Topography and the Google Earth satellite image as background (20 points).
2. Map 2 from Google Earth- Earthquake fault map with the active faults shown for the Wasatch Fault in Salt Lake City and Google Earth image as background. Use the qfaults.kmz file obtained from the United States Geological Survey (USGS Website) (see the lecture notes for the USGS link) (20 points).
3. Map 3 from Google Earth - Combined map showing both LIDAR topography (i.e., hillshade.kmz) from problem 1 and qfaults.kmz from problem 2 and Google Earth image as background. (20 points)
4. Map 4 from Google Earth - Geologic map using utgeol.kmz from the Utah Geological Survey (see the lecture notes for the link) and qfaults.kmz and Google Earth image as background. (20 points)
5. Map 5 - Make a AutoCad Contour map of the zone using the dxf file generated in Open Topography using a contour interval of 1 meter. (20 points)

The figure below shows the area that you should select in Open Topography.

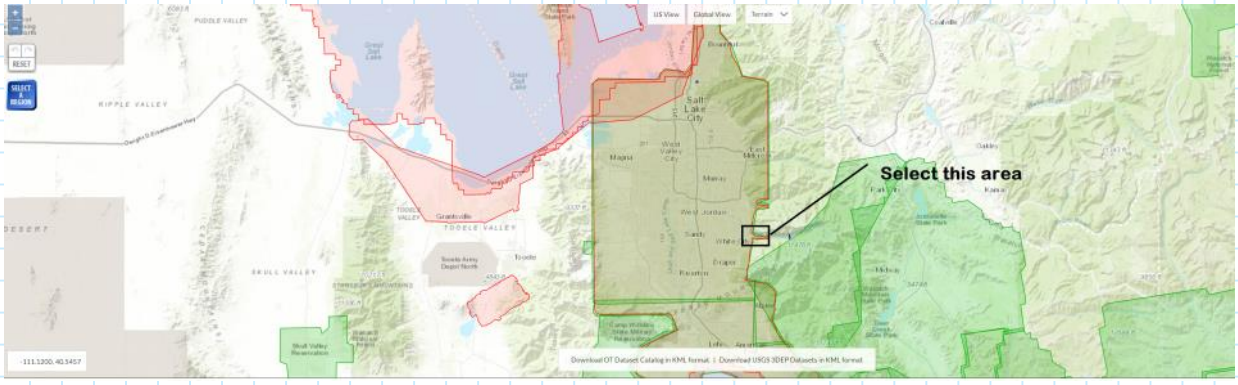


*Figure 1. Reference map of Little Cottonwood Canyon near Salt Lake City, Utah.*

# Introduction

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**Light Detection and Ranging (Lidar)** (also called **LIDAR**, **LiDAR**, and **LADAR**) is a surveying method that measures distance to a target by illuminating the target with pulsed laser light and measuring the reflected pulses with a sensor. Differences in laser return times and wavelengths can then be used to make digital 3-D representations of the target. The name *lidar*, now used as an acronym of *light detection and ranging*[1] (sometimes *light imaging, detection, and ranging*), was originally a portmanteau of *light* and *radar*.[2][3]

Lidar sometimes is called **3D laser scanning**, a special combination of a 3D scanning and laser scanning. It has terrestrial, airborne, and mobile applications. Lidar is commonly used to make high-resolution maps, with applications in geodesy, geomatics, archaeology, geography, geology, geomorphology, seismology, forestry, atmospheric physics,[4] laser guidance, airborne laser swath mapping (ALSM), and laser altimetry. The technology is also used in control and navigation for some autonomous cars.[5]

From <https://en.wikipedia.org/wiki/Lidar>

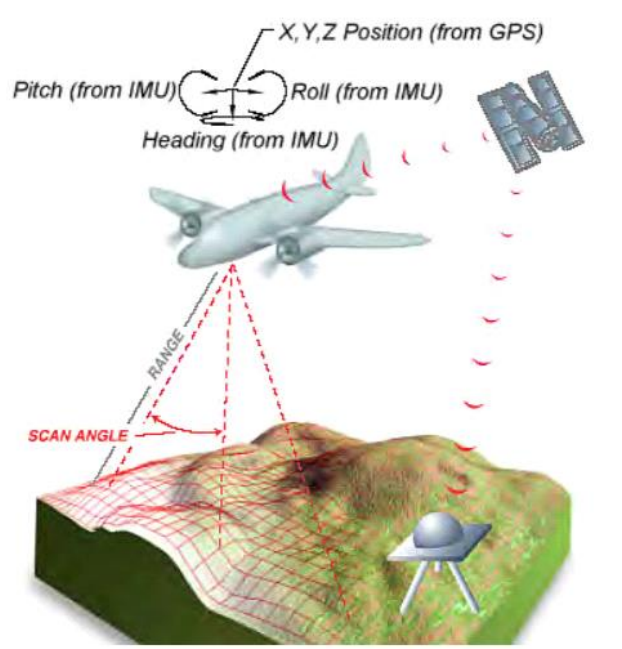


**Figure 1-1. Airborne LiDAR technology is used to measure topography using a laser beam directed towards the ground with GPS and IMU systems providing the location and orientation of the airborne platform.**

# LiDAR Methods

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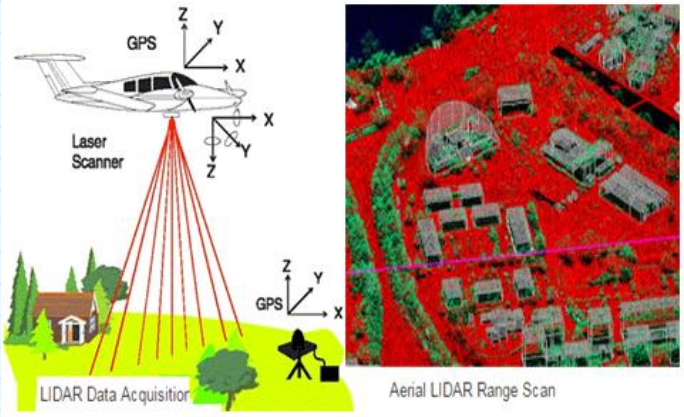
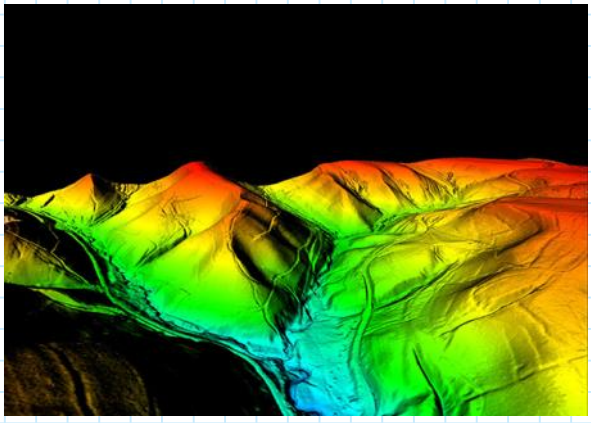
https://www.dronezon.com/learn-about-drones-quadcopters/introduction-to-uav-photogrammetry-and-lidar-mapping-basics/



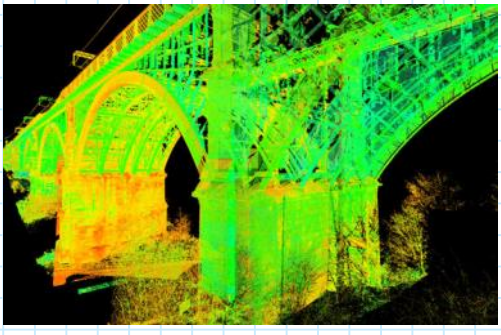

Airborne System


Drone Mounted LiDAR



Topography from Airborne Systems

Land or Terrestrial Scanners



Bridge Scanned by Terrestrial LiDar

# OpenTopography

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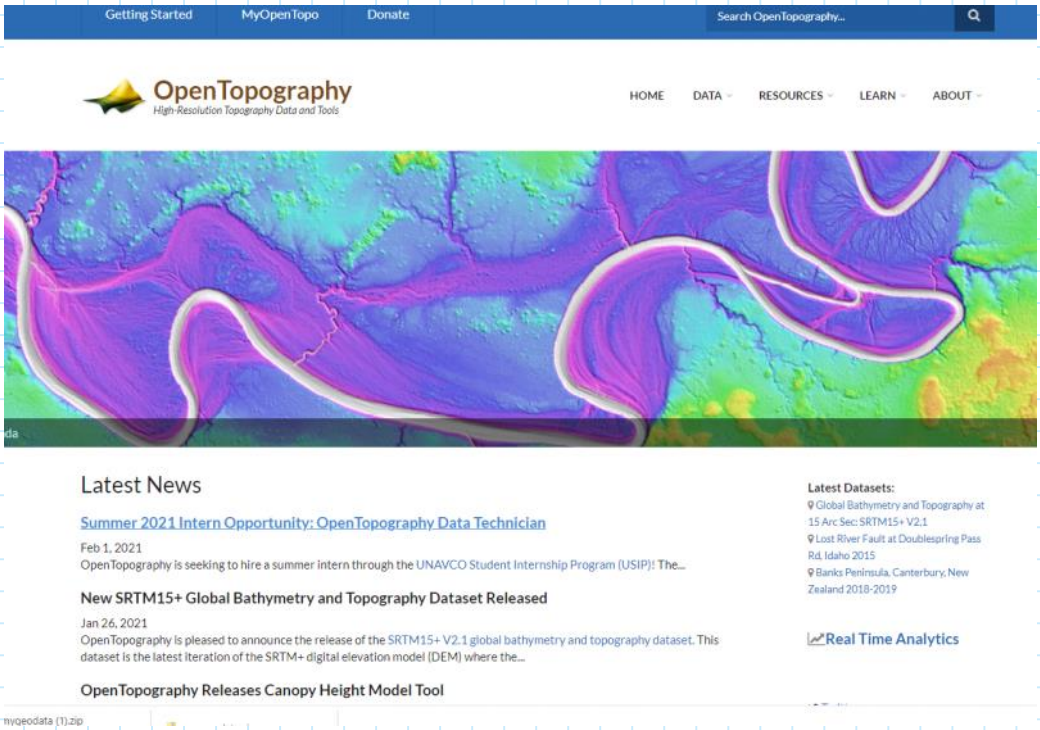
https://opentopography.org/




**Motivations and Philosophy:**

Over the past decade, there has been dramatic growth in the acquisition of publicly funded high-resolution topographic and bathymetric data for scientific, environmental, engineering and planning purposes. Because of the richness of these data sets, they are often extremely valuable beyond the application that drove their acquisition and thus are of interest to a large and varied user community. However, because of the large volumes of data produced by high-resolution mapping technologies such as lidar, it is often difficult to distribute these datasets. Furthermore, the data can be technically challenging to work with, requiring software and computing resources not readily available to many users. OpenTopography aims to democratize access to high-resolution topographic data in a manner that serves users with varied expertise, application domains, and computing resources.

From <https://opentopography.org/about>

# OpenTopography (cont.)

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**OpenTopography data access levels:**

***Google Earth:***

**Google Earth** provides an excellent platform to deliver lidar-derived visualizations for research, education, and outreach purposes. These files display full-resolution images derived from lidar in the Google Earth virtual globe. The virtual globe environment provides a freely available and easily navigated viewer and enables quick integration of the lidar visualizations with imagery, geographic layers, and other relevant data available in KML format.

***Raster:***

Pre-computed raster data include digital elevation model (DEM) layers computed from aerial lidar surveys and raster data from the Satellite Radar Topography Mission (SRTM) global dataset. DEMs from aerial lidar surveys are available as bare earth (ground), highest hit (first or all return), or intensity (strength of laser pulse) tiles. Some datasets also have orthophtotographs available. The DEMs are in common GIS formats (e.g. ESRI Arc Binary) and are compressed (zipped) to reduce their size.

***Lidar point cloud data and on-demand processing:***

This aspect of OpenTopography allows users to define an area of interest, as well as subset of the data (e.g. “ground returns only"), and then to download the results of this query in ASCII or LAS binary point cloud formats. Also available is the option to generate custom derivative products such as digital elevation models (DEMs) produced with user-defined resolution and algorithm parameters, and downloaded in a number of different file formats. The system will also generate geomorphic metrics such as hillshade and slope maps, and will dynamically generate visualizations of the data products for display in the web browser or Google Earth.

From <https://opentopography.org/about>

# OpenTopography - How to Use

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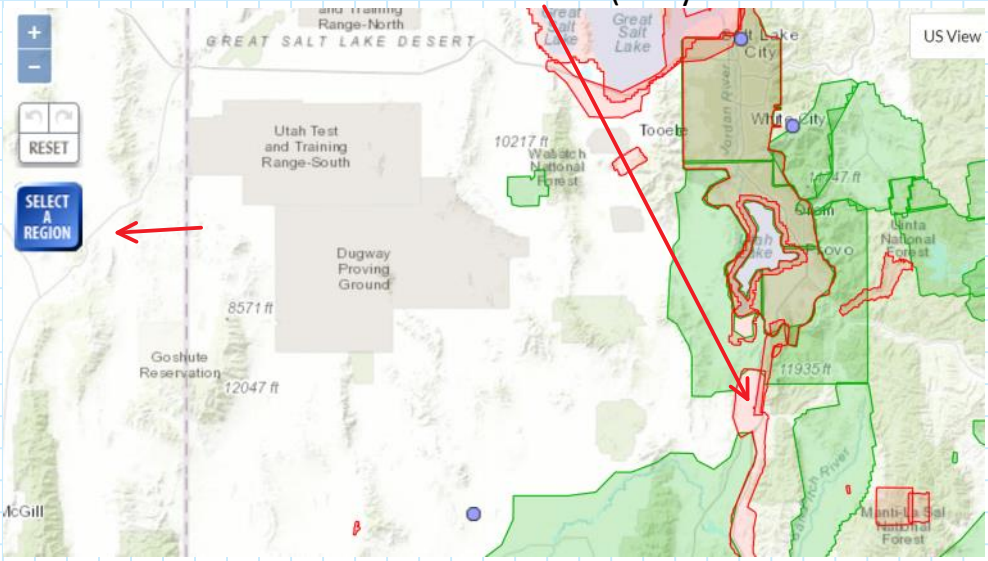
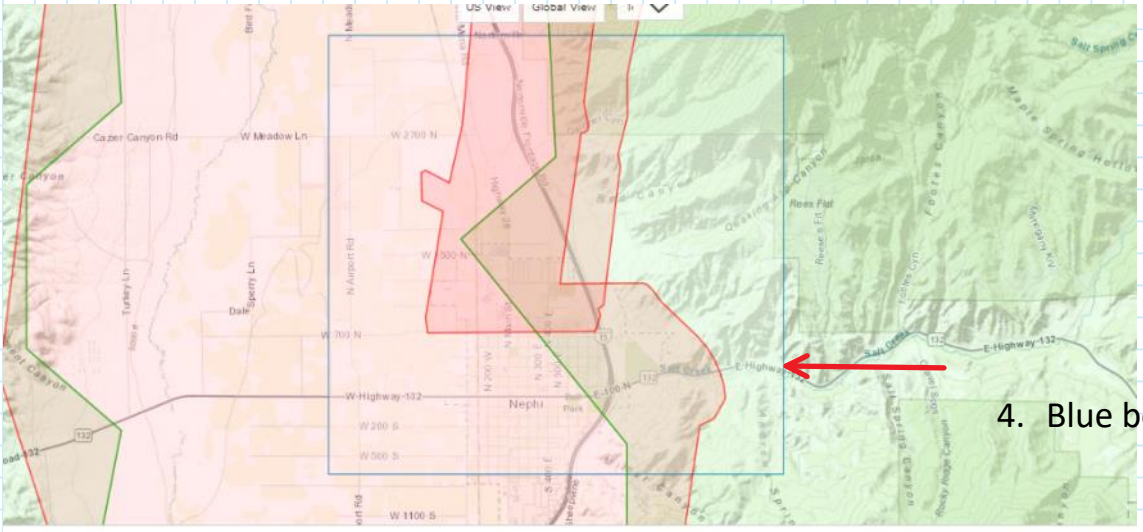
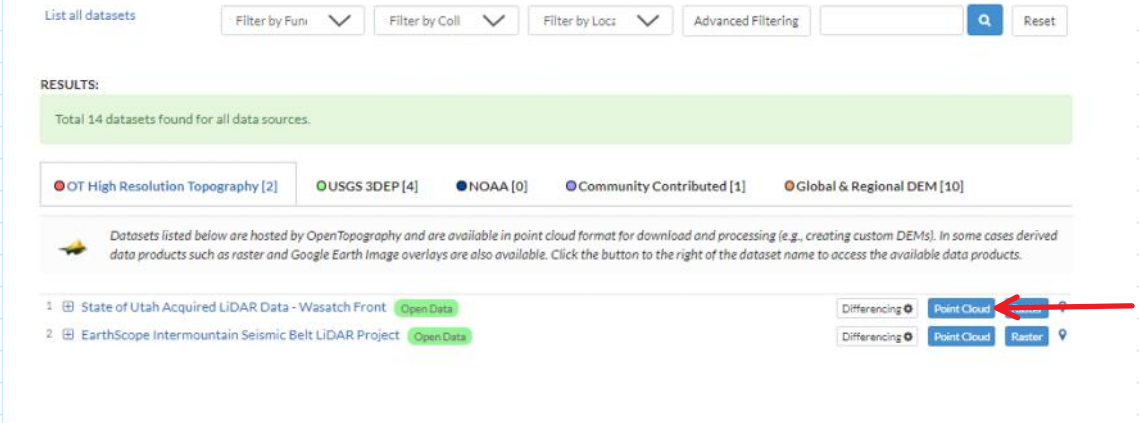
1. Go to Open Topography / My Open Topo/ Create Account
2. Go to https://portal.opentopography.org/datasets
3. Zoom in on the area shown below. (roll your mouse wheel to zoom)




4. Click the Select A Region Button




4. Blue box




5.

5. Select State of Utah Data - Point Cloud

Check this to make sure that the selected data area is not too large. If you area is too large, this will be red.

# OpenTopography - How to Use

Tuesday, January 24, 2023 1:48 PM

1. Go to Open Topography / My Open Topo/ Create Account
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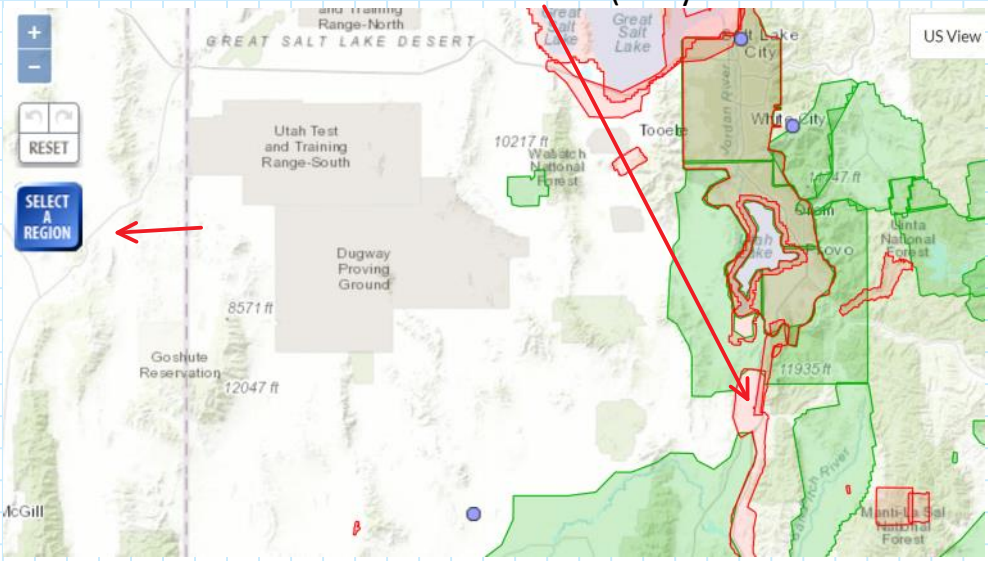
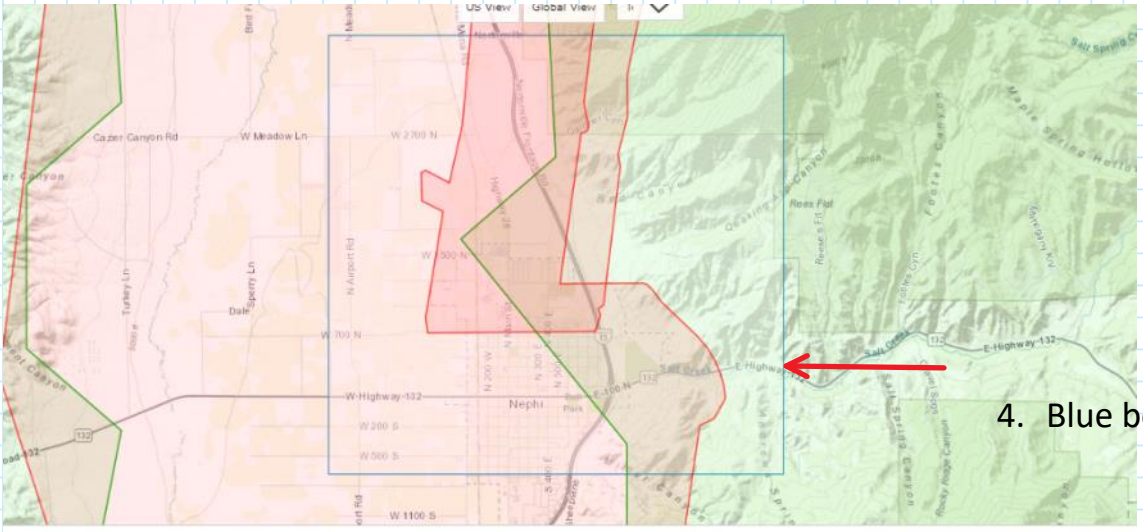
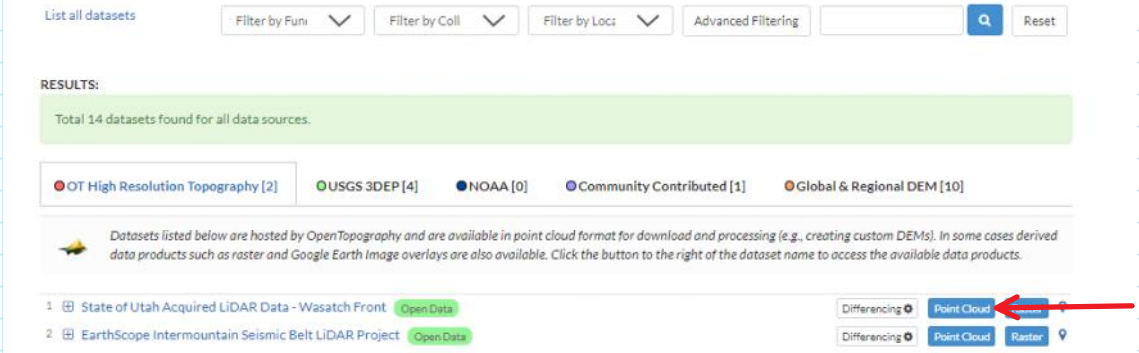



4. Click the Select A Region Button




4. Blue box

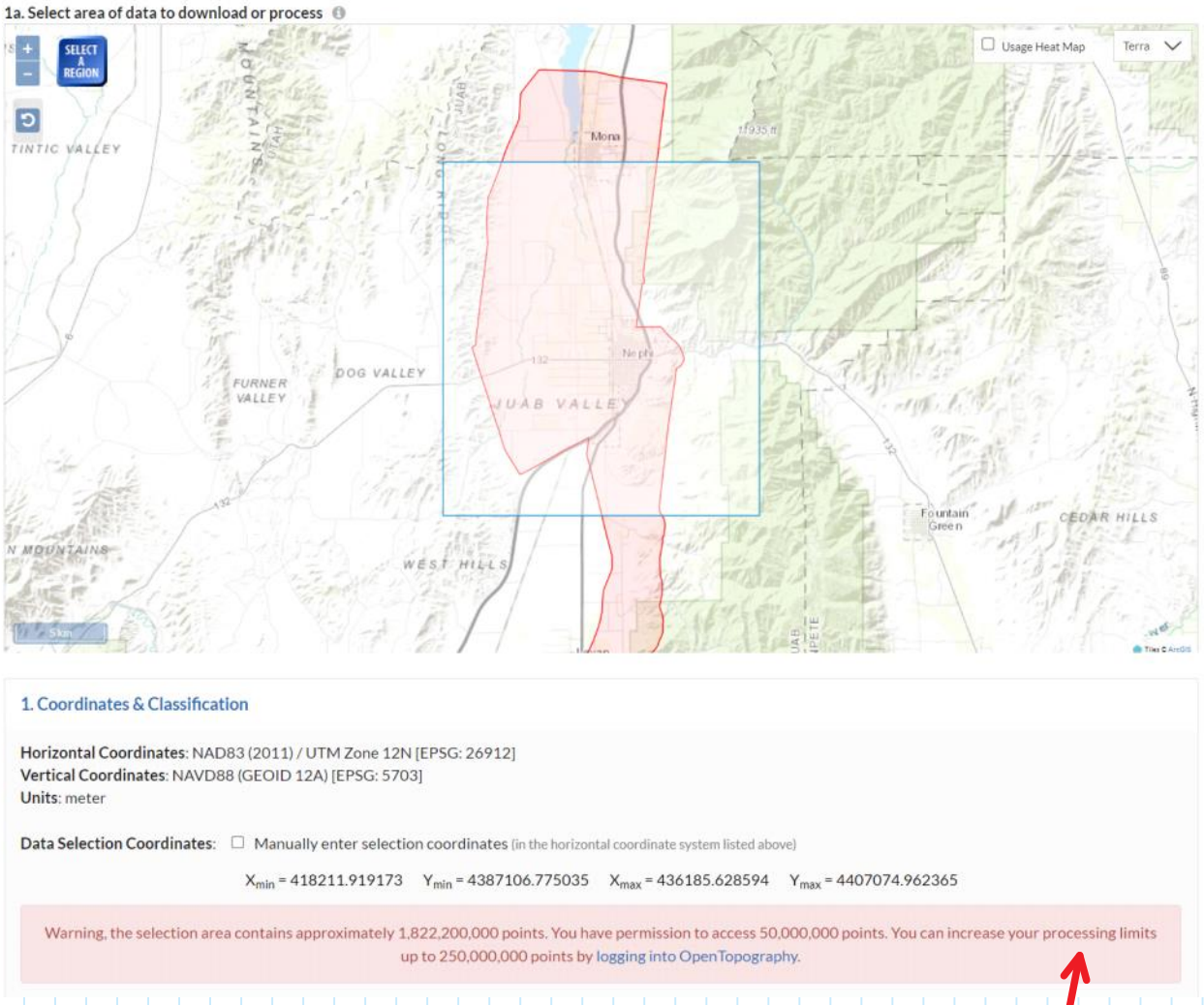



5.

5. Select State of Utah Data - Point Cloud

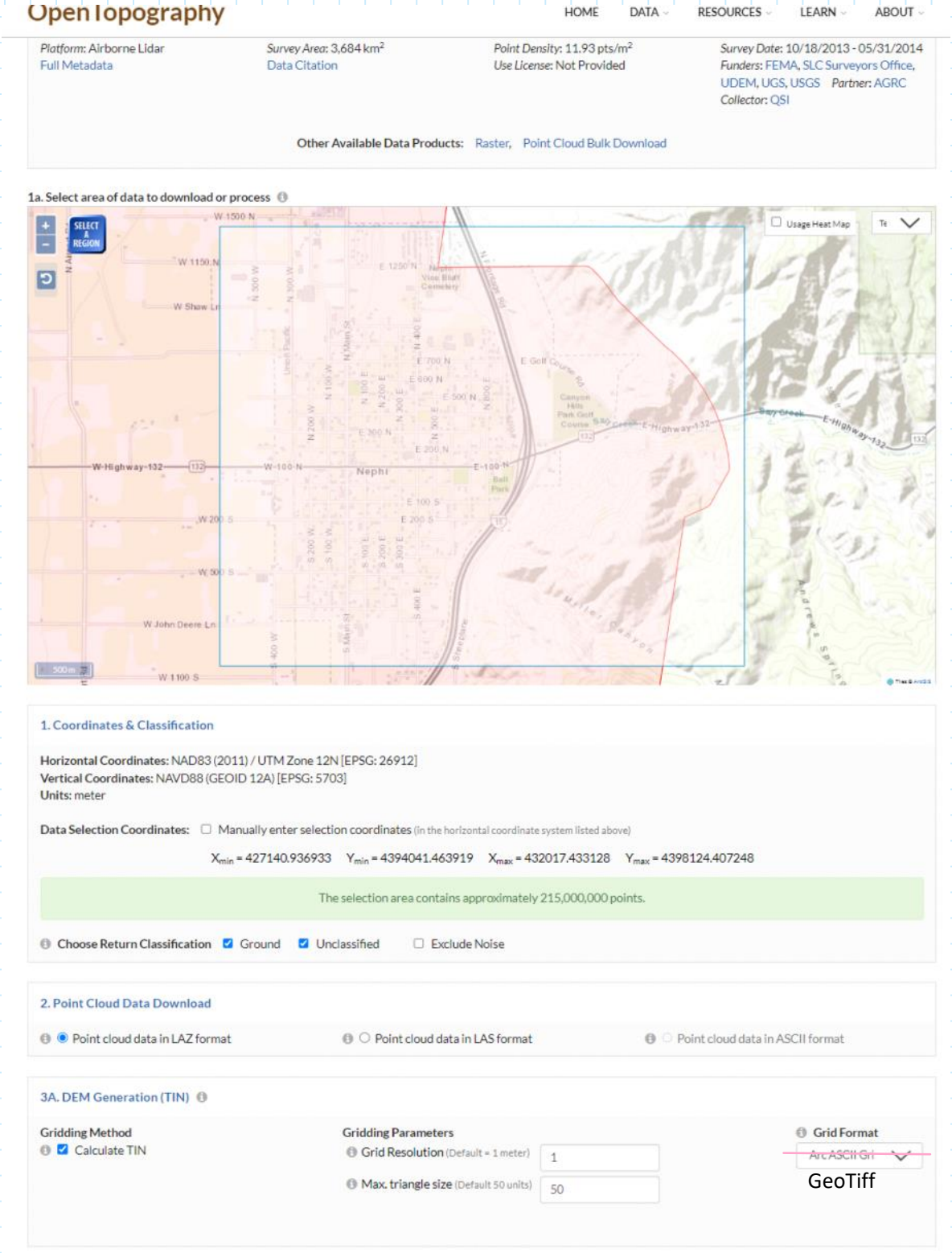
# OpenTopography - How to Use

Tuesday, January 24, 2023 1:48 PM




Check this to make sure that the selected data area is not too large. If you area is too large, this will be red. You need to decrease the size of your region (i.e., the size of the blue box). You can increase your access to more data points (250,000,000) by creating an account (free). Once you have done this, resize the box, so that it does not exceed 250,000,000 points.

7. Complete the information on the screen as shown below.



# OpenTopography Output Options

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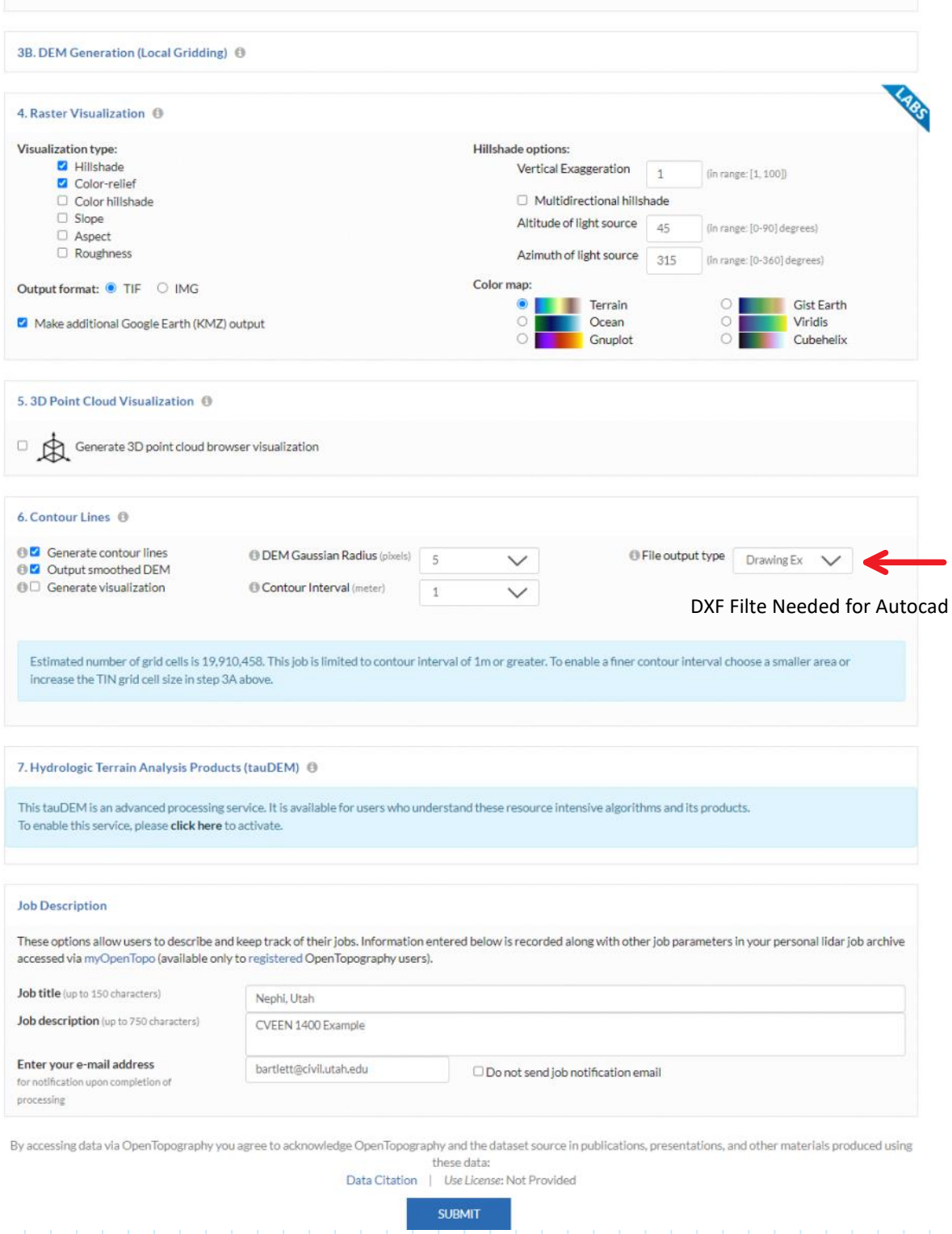

# OpenTopography (processing of results)

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## Point Cloud Job Results

Welcome Steven Bartlett ( Sign Out )

Modify and resubmit this job
Full job metadata

Download job metadata
View job configuration

**Dataset Citation**: State of Utah Acquired LiDAR Data - Wasatch Front. Distributed by OpenTopography. https://doi.org/10.5069/G9TH8JNQ . Accessed: 2024-01-22

**Use License**: Not Provided

| Job Id | Dataset | Title | Submission | Completion | Duration | Num. Points | Last Service Update |
|---|---|---|---|---|---|---|---|
| pc1705967956850 | UGS_Wasatch | Nephi, Utah | 2024-01-22 23:59:17 | N/A | N/A | 0 | LasSelectService |

**Querying**: Extracting point cloud data for the area of interest
**TIN**: Generating Digital Elevation Model (DEM) from point cloud
**Raster Visualization** (TIN): Generating hillshade images and Google Earth files from DEMs
**Contour Lines** : Generating contour lines products from DEMs

Depending upon the size of your job and system load, your job may take greater than an hour to complete. You may close this page at any time. Status of running jobs can also be monitored through Point Cloud Jobs. You will receive an email notification once the job is complete.

### Download Data

Data download is not yet available.

# OpenTopography Outputs

Tuesday, January 24, 2023 1:48 PM

## Point Cloud Job Results

Welcome Steven Bartlett ( Sign Out )

Modify and resubmit this job
Full job metadata

Download job metadata
View job configuration

**Dataset Citation:** State of Utah Acquired LiDAR Data - Wasatch Front. Distributed by OpenTopography. https://doi.org/10.5069/G9TH8JNQ . Accessed: 2024-01-22

**Use License:** Not Provided

| Job Id | Dataset | Title | Submission | Completion | Duration | Num. Points | Final Status |
|---|---|---|---|---|---|---|---|
| pc1705956961462 | UGS_Wasatch | Nephi Utah | 2024-01-22 20:56:01 | 2024-01-22 21:11:03 | 902 secs | 229,397,614 | Done ✔ |

### Download Data

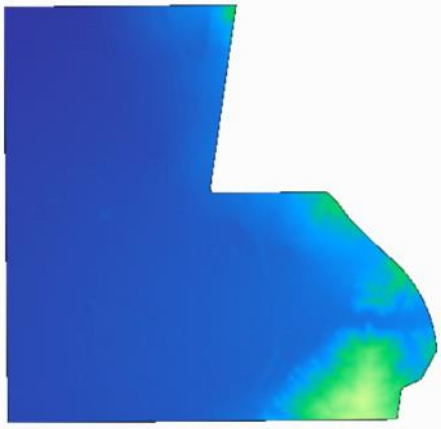
| | |
|---|---|
| Point Cloud Results | • Download point cloud data in LAZ format points.laz (855.4 MB) |
| DEM Results | • Download DEM (TIN) output.tin.tar.gz (48.5 MB) |
| Visualization Products | • Download Visualization Products (TIN) viz.tar.gz (20 MB) |

### Visualization Products

Tin grid

**Hillshade**
- Download KMZ file viz.tin_hillshade.kmz
- View on map

**Color-relief**
- Download KMZ file viz.tin_color-relief.kmz
- View on map



Share Job Results

To open the compressed *.gz files, use the following link to download the extractor. https://www.7-zip.org/

**OR**

you can extract in Windows using the command line

# Tar File Extraction - Windows

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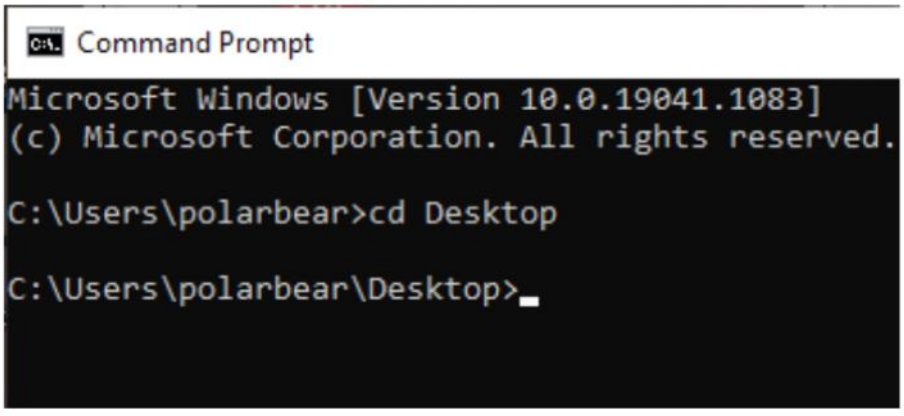
How to open a tar file on Windows

A TAR file (.tar) is a special file that contains a collection of multiple files combined into one single file. SeaBASS data orders are delivered as a single TAR file which consists of all the different data files, documentation, and related associated files. After you finish downloading the file, you can open it and unpack the tar contents to recreate the file and folder structure as the data were archived in SeaBASS.

TAR files are common on Linux and Mac systems but can also be opened on Windows systems. There are two different approaches for extracting .tar files described below. By default, Windows does not recognize how to open .tar files if you double click them, but this can be solved by downloading a 3rd-party program. Alternately, Windows 10 comes with ability to unpack .tar files from the built-in command prompt.

1) Open TAR file using Command Prompt

1. Type **cmd** in Windows search and select Command Prompt
2. Navigate to the location of your tar file using the **cd** command. For example, the following command might be appropriate if the .tar file is in the polarbear user's Desktop:




3. Run the following tar command (replace requested_files_1.tar with your exact file name, if it is named differently):

   **tar -xf requested_files_1.tar**

4. Your TAR file will be extracted into a new folder in the same location

2) Open TAR file using a third-party solution

# Tar File Extraction - Windows (cont.)

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By default, Windows typically does not recognize how to open a .tar file and you will be prompted to pick what software to use. Third-party software is available that will allow Windows to open a .tar file just by double-clicking on it.

NASA does not endorse third-party software; however, at the time of writing examples of programs capable of opening .tar files include 7-Zip or WinRar. If you choose to research and install a third-party program, follow its instructions for how to extract a .tar file. Typically, one or more of the following approaches will work to initiate the .tar file extraction:

1. Double-click the file
    1. Windows will now automatically recognize how to open the .tar file if you double-click the file
    2. Windows won't automatically recognize how to open a .tar file and will prompt you to find the name of your new third-party software from a list; after that the file should extract
2. After installation, some third-party solutions will appear as extract options if you right-click the .tar file

# Google Earth Installation

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Use Google Earth to open KML files

- You can view most simple KML files with Google Earth for Chrome (version 9) or in the Google Earth app on your mobile device.

- If you're unable to view complex KMZ files, use Google Earth for desktop (version 7), which supports all KMZ features.

Import this info from KML files

- Placemarks, lines/paths, and polygons
- Image overlays (ground overlays)
- Simple network links
- Super-overlays
- Simple KML tours without audio

Tips:

- Some custom icons and overlay images hosted on other websites won't work.
- For more information on how to use KML features, go to KML support in Google Earth.

From <https://support.google.com/earth/answer/7365595?hl=en&co=GENIE.Platform%3DDesktop>

# Geologic Map Data

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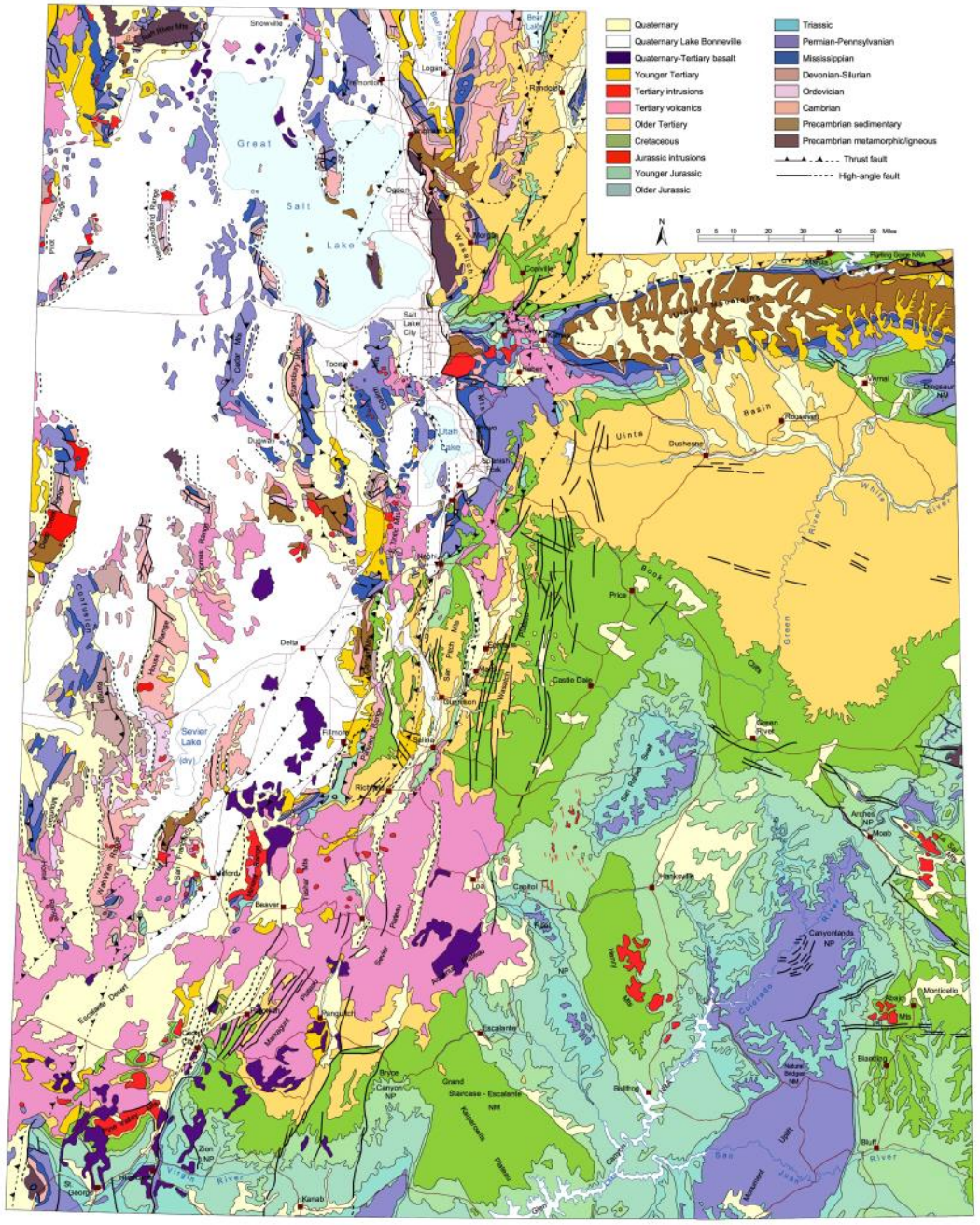
The geologic map for the State of Utah is found in utgeol.kmz in the Files Folder of Canvas.

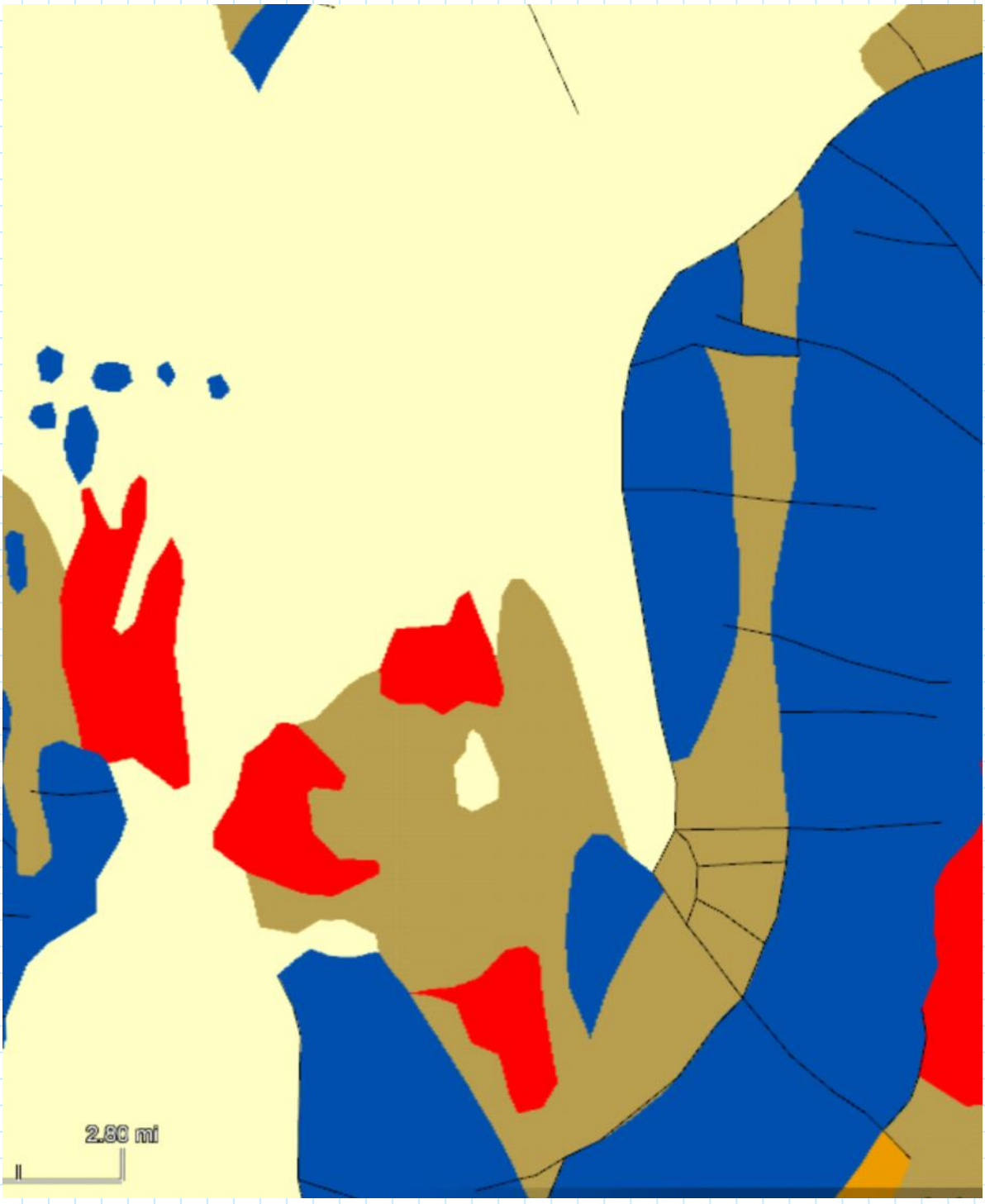
This can also be found at:

https://mrdata.usgs.gov/geology/state/state.php?state=UT



# Geologic Map

Tuesday, January 29, 2019 1:48 PM



# Faults from United States Geological Survey

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This file is available in the Files Folder of Canvas: qfaults.kmz

https://www.usgs.gov/programs/earthquake-hazards/faults

## Interactive Fault Map

**View interactive fault map.**

This database contains information on faults and associated folds in the United States that demonstrate geological evidence of coseismic surface deformation in large earthquakes during **the Quaternary (the past 1.6 million years)**. Links to descriptions and citations are accessible through the Database Search or Interactive Fault Map.

In order to maintain a current and relevant dataset, effective January 12, 2017, the USGS will maintain a limited number of metadata fields that characterize the Quaternary faults and folds of the United States. Archived reports are accessible from the abbreviated record.

- Database Search
- Download Data:
  - KML (Google Earth) Files (13 MB KMZ)
    - includes 5 fault layers: Historic, Holocene to Latest Pleistocene, Late Quaternary, Mid-Late Quaternary, Quaternary
  - GIS Shapefiles (16 MB ZIP file)
- Background - history, help, personnel and references

# Google Image with Faults

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# LiDAR Data for Locating Active Earthquake Faults

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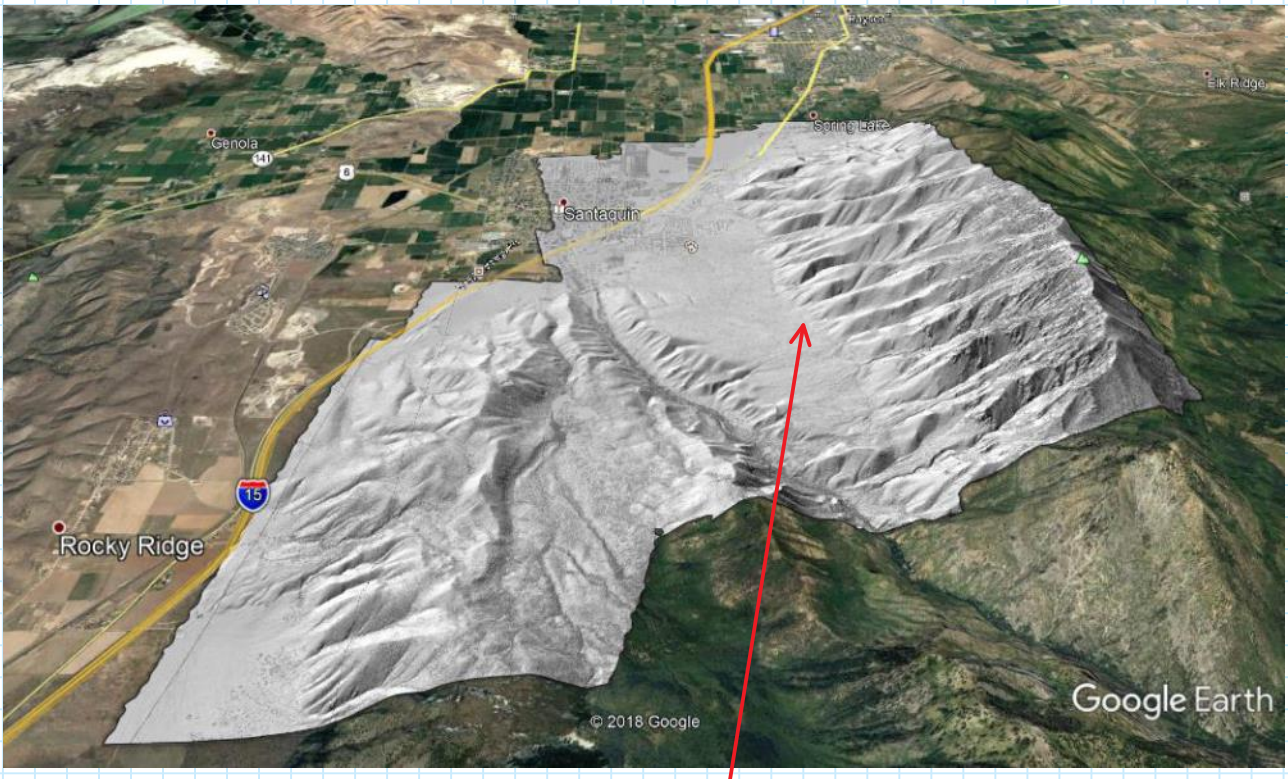
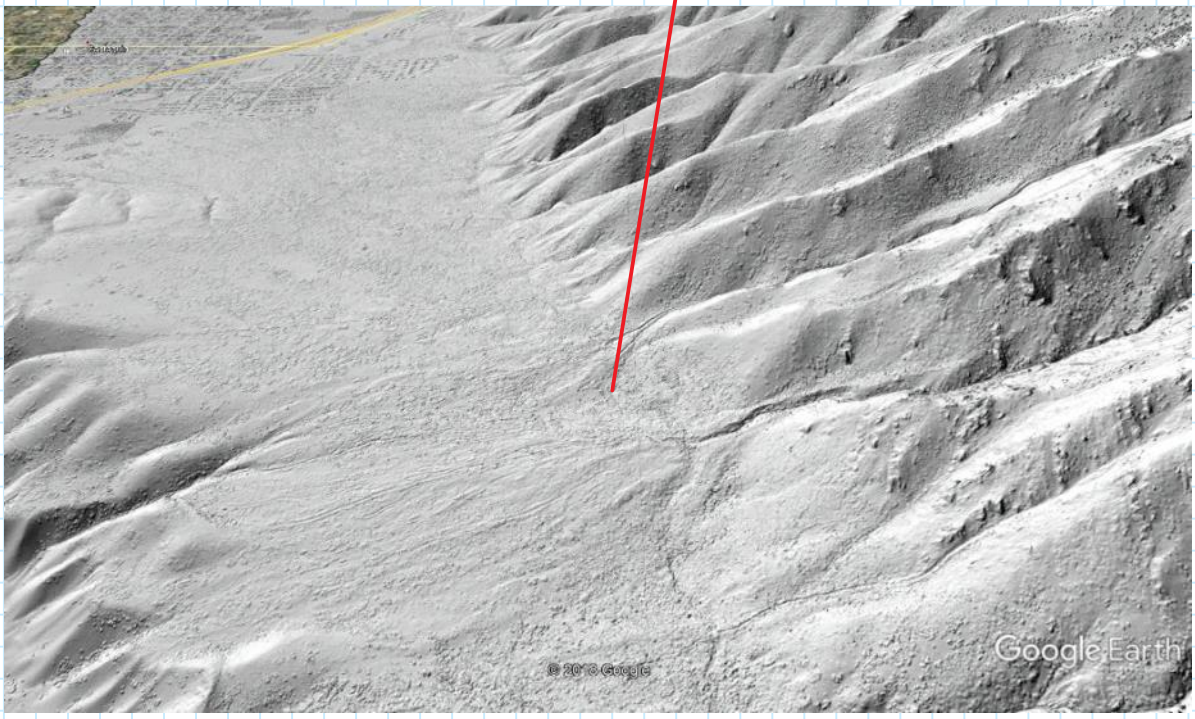



LiDAR data is in grey shade



# LiDAR Data for Locating Active Earthquake Faults (cont.)

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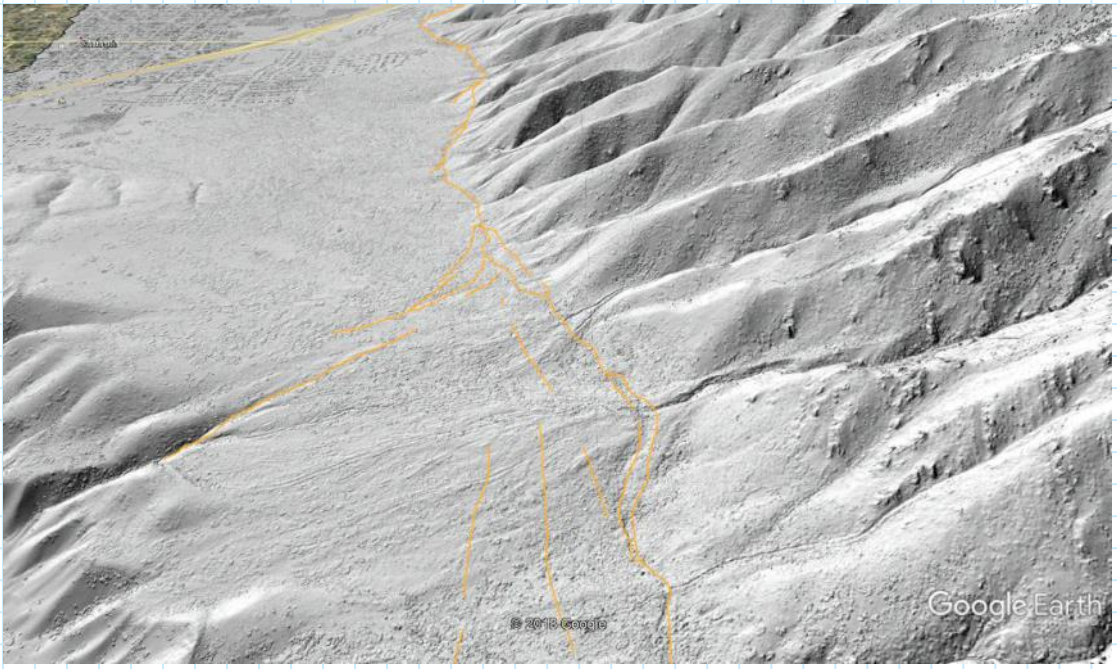
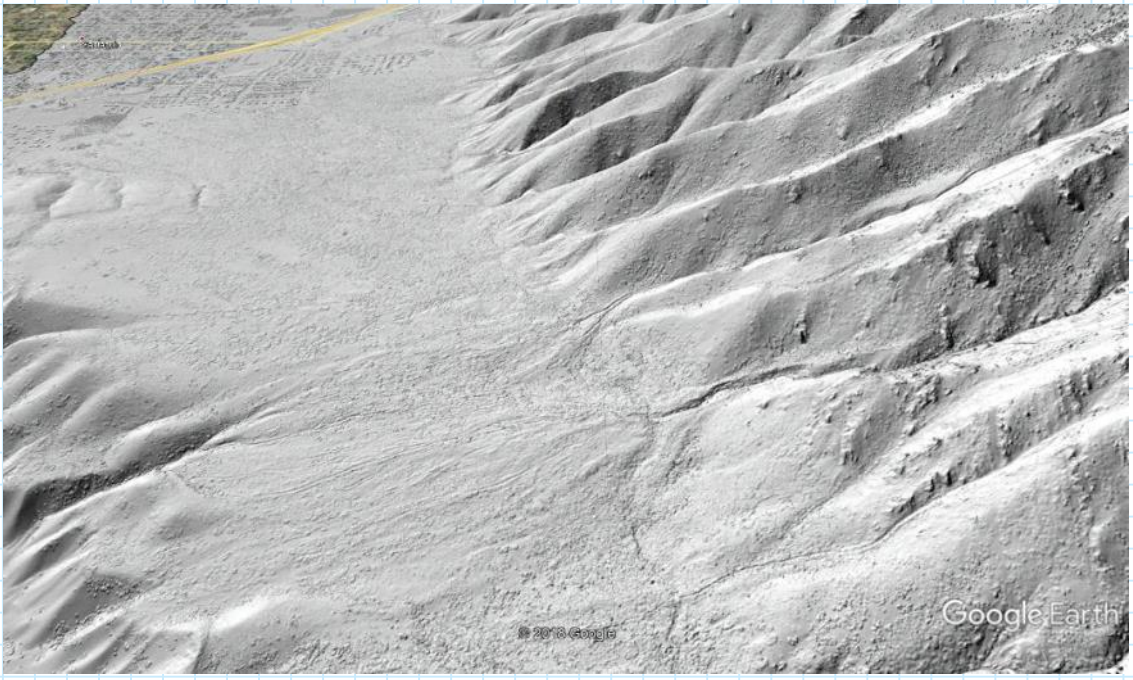



Wasatch Fault Zone - Faults are in orange



# Combine Geologic and Satellite Map

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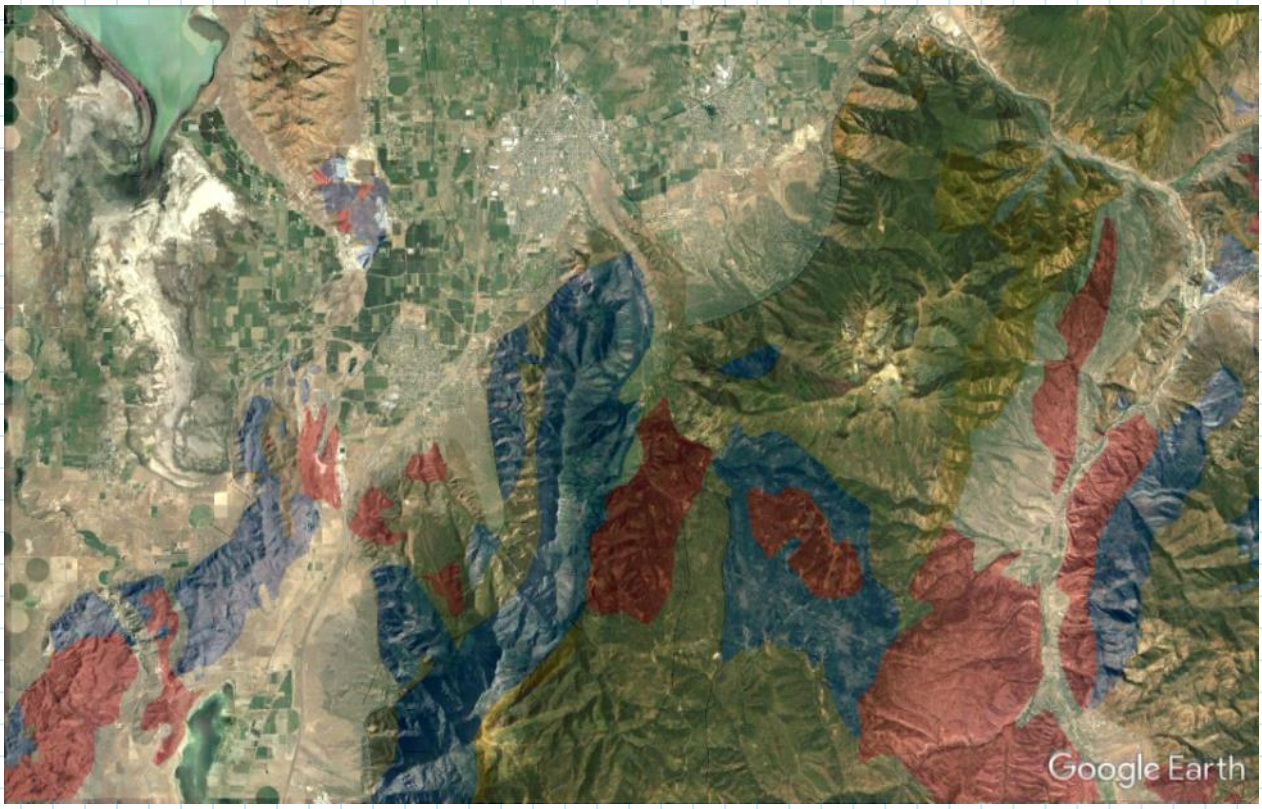


This type of image can only be generated using Adobe Photo Shop and the layers feature. You are not required to produce this image.

# Another Example LiDAR - Weber Canyon, Utah (continued)

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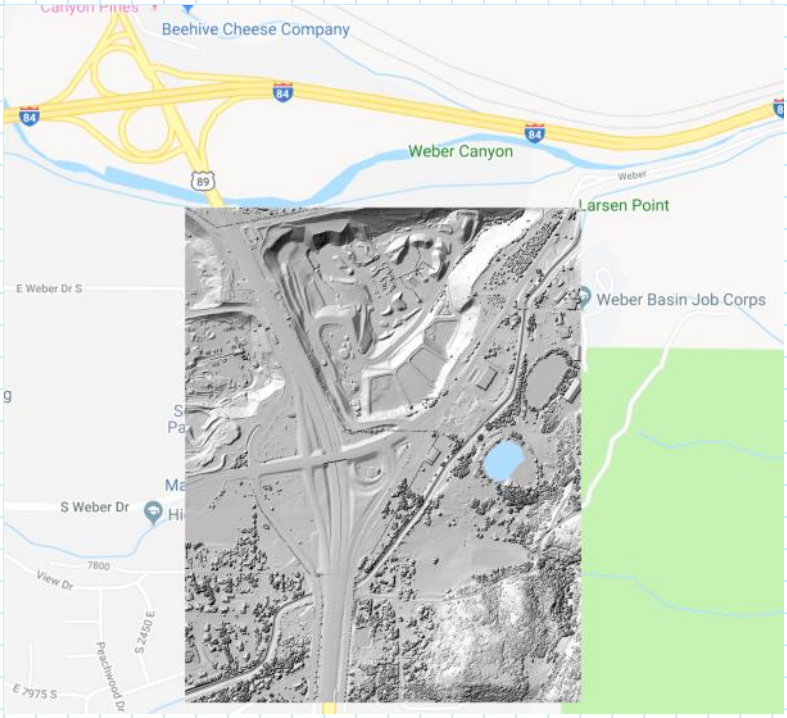


# Another Example LiDAR - Weber Canyon, Utah

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# 7-Zip Extraction

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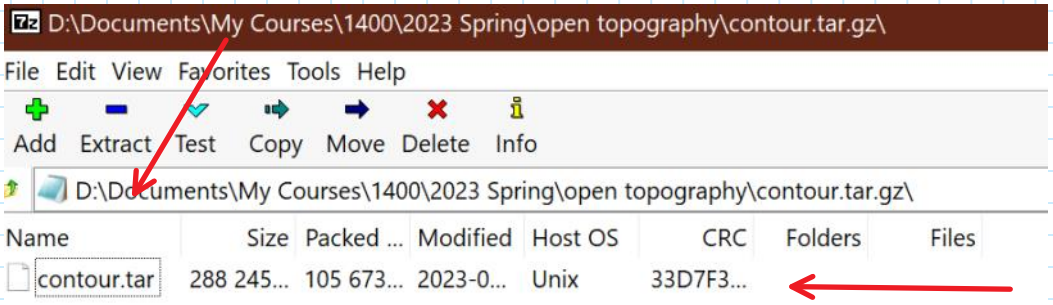
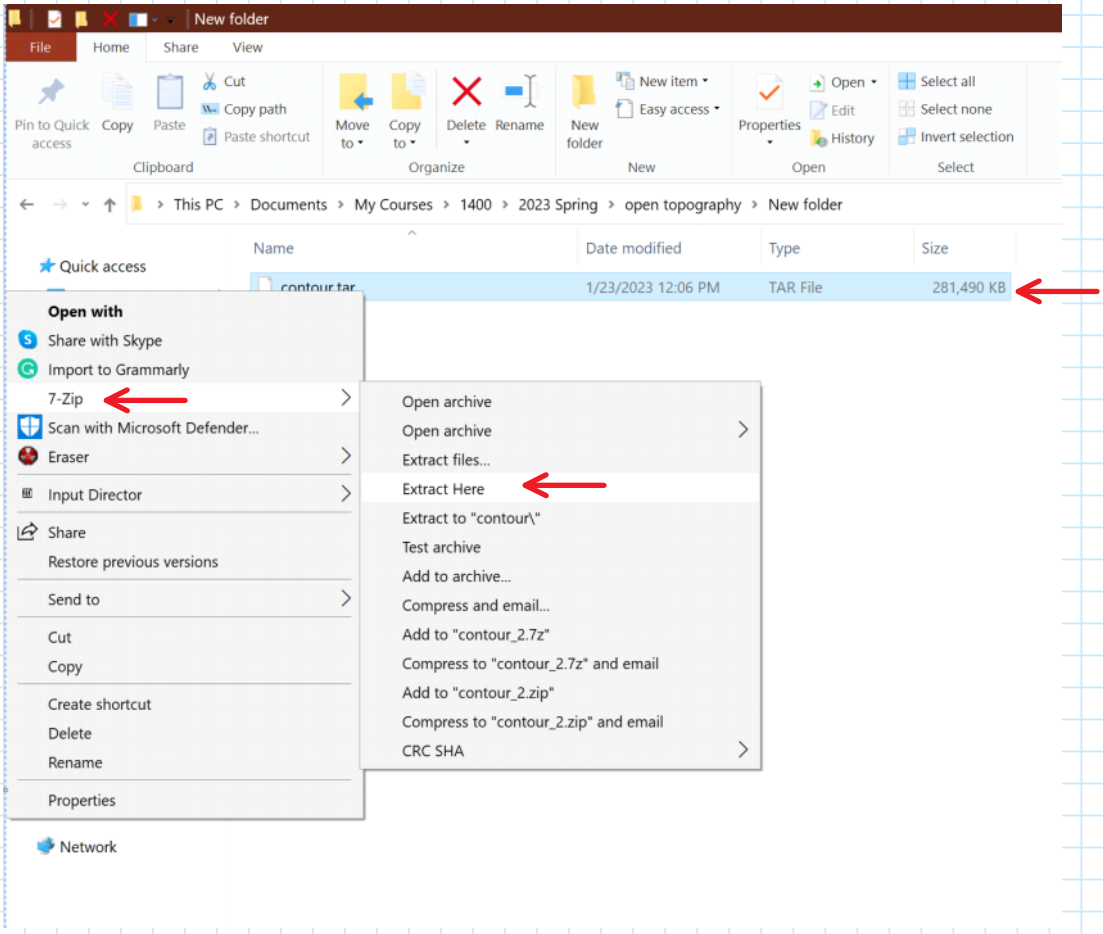



The extracted folder will be contour.tar




To see the contents of the extracted folder, do the following

1. Select the file
2. Right click your mouse
3. Select 7-zip, Extract Here. (This will place the extracted files in the current folder
4. **REPEAT THIS PROCESS FOR ALL *.tar files (see next page)**

# 7-Zip Extraction (cont.)

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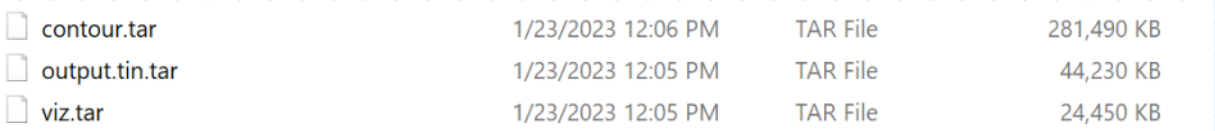
## Tar files




## Extracted Files


*.dxf = AutoCad File with contour map

*.kmz = Google Earth Files - keyhole markup language zip file for importing into Google Earth

# DEM - Contour Map

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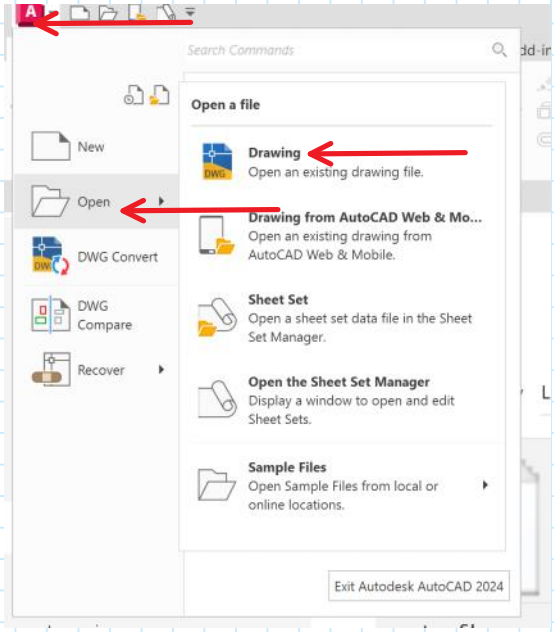
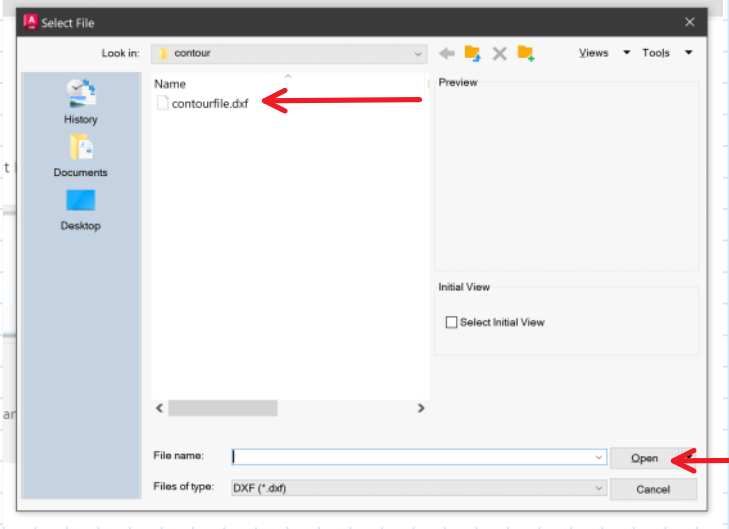
The contour map generated by Open Topography is found in the contour.tar.gz file. Note that this is a compressed file that can be opened using 7-zip file manager. Once you have uncompressed the file, the AutoCad file is named:

contourfile.dxf

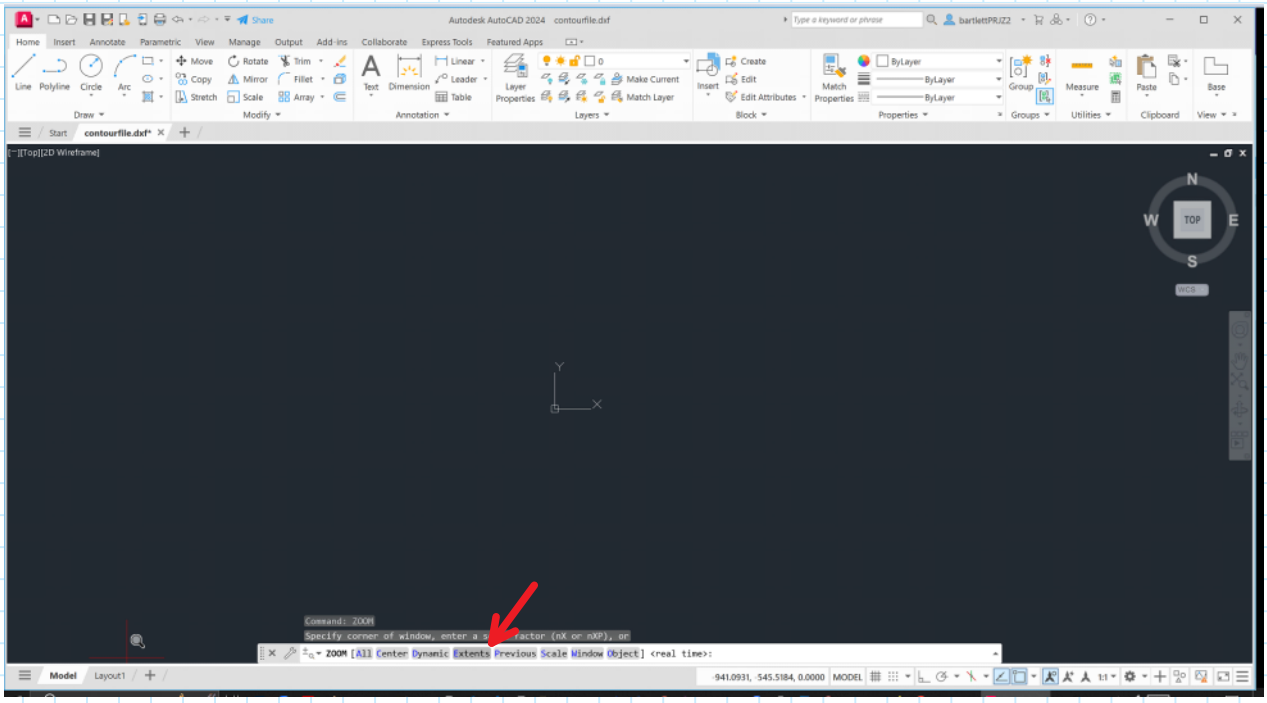
Launch AutoCAD (2024) in Windows



# DEM - Contour Map (cont.)

Tuesday, January 29, 2019 1:48 PM




Go to the command line and type Zoom. Select Extents.


Contour Map from OpenTopography