R.E.V.E.A.L. (RESEARCH EXPERIENCES AND VIRTUAL EXPLORATION FOR ACTIVE LEARNING) THE GEOSCIENCES BY DISCOVERING THE LATE PLEISTOCENE LAKE BONNEVILLE, UT

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Abstract

The geosciences are inherently a field and lab-based science; however, COVID-19 and other financial, logistical, or physical barriers has caused the instruction of courses that once had field and lab components to move to the online realm. In addition, the field and lab components of these courses are often barriers for students who are limited in time and/or for students who have physical/mental disabilities. Our institution also does not have the personnel or fiscal resources to take many of our introductory students into the field. However, providing field experiences as an undergraduate has been shown to aid in the recruitment and retention of geoscience students and in student understanding of complex concepts. Therefore, in order to remove these barriers to learning, provide more active learning opportunities, and to improve inclusion within our courses we are constructing a series of virtual geological field trips (VFTs) regarding the geology of Utah that can be used in our online, hybrid and face-to-face Earth Science courses. The R.E.V.E.A.L. the Geosciences (Research Experiences and Virtual Exploration for Active Learning) project is a collaborative mentorship with faculty and undergraduates from our Earth Science, Digital Media, and Education departments. We are producing these VFTs within virtual and augmented reality and integrating Gigapans, 3D photography/video, drone imagery/video, 3D models of outcrops/hand-samples, with other geological data (i.e. thin sections, chemical data, stratigraphic sections, cross-sections, etc..). The initial phase of the project focuses on the creation of VFTs regarding the geological history of Lake Bonneville by taking the user to many geological sites around the Bonneville Basin. The VFTs will provide engaging activities in our courses that can be used in a variety of course settings and introduce students to field areas that may be difficult for the students to physically visit. The VFTs will not only aid students in our future classes but will also provide students with both field and lab experience that they will need in their future careers.

Objectives

The initial phase of the project will focus on the geological history of the ancient Late Pleistocene Lake Bonneville by taking the user to many famous (but often remote) sites around the Bonneville Basin.

1) provide on the job-training for undergraduate students within the Earth Science and Digital Media Departments at UVU.

2) aid in the retention and recruitment of geoscience students by improving critical and spatial thinking skills via real-world applications and localities.

3) provide opportunities for students who cannot attend field excursions due to physical disabilities, time constraints, and/or financial or safety concerns.

4) the VFTs will be provided to the general public as a database for teaching the geological diversity of Lake Bonneville and the Rocky Mountain West.

Site Background

The Four Main Locations

Stansbury Island - Both transgressive and regressive shorelines can be seen as terraces that were cut into the mountains and hills from wave action. Gravels and Marls deposited on top of each other indicate oscillations of the Stansbury Lake level.

Zenda, ID – Site of the collapse of the alluvial dam that initiated the Bonneville Flood.

Little Cottonwood Canyon – Location that shows both glacial and tectonic interaction the lake.

Pahvant Butte – Site of a volcanic eruption from underneath the lake at the height of the lake's history, 15,000 years ago.

Other visited sites on the map include:

Hogup Mountains – Gravel and sand deposits, shorelines, spits, and bars during both the transgressive and regressive phase of the Lake.

Stockton Bar - Iconic geomorphic feature that separates Rush and Tooele valleys. It is made of several sand bars and spits stacked on each other.

Old Riverbed – The pass that connected the Sevier basin with the main Bonneville basin.

Rio Tinto Kennecott Smelter – North end of the Oquirrh Mountains that shows distinct shorelines, wave platforms, and tufa deposits close to Salt Lake City.

Antelope Island – Shows distinct shorelines of both the transgressive and regressive phases of the lake.

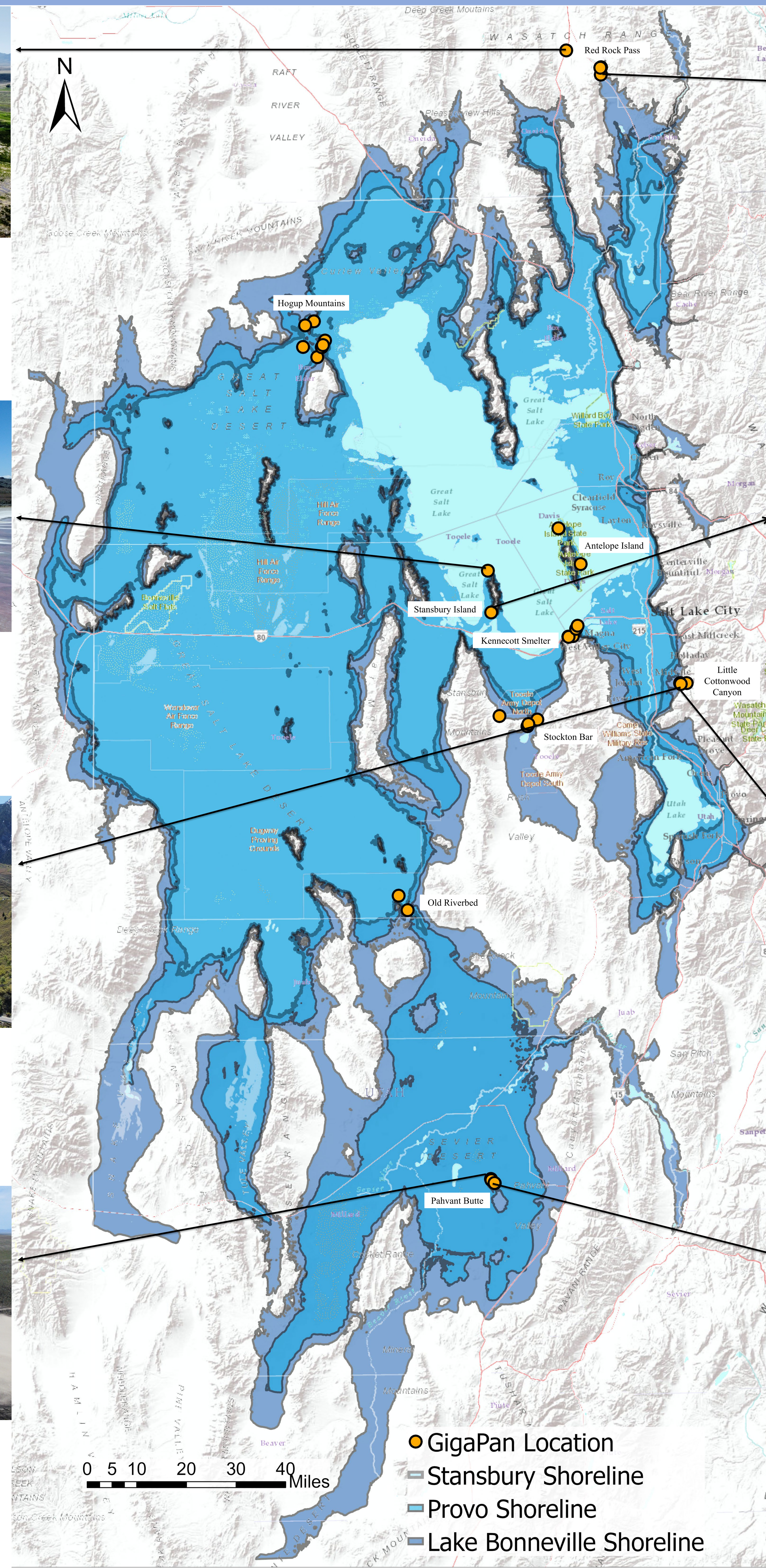
Data Collection and Visualization

Located in southern Idaho, Marsh Valley has a large river channel that was formed due to the Lake Bonneville flood that occurred about 14,500 years ago. Zenda is the site where the breach occurred, and Red Rock Pass shows evidence of the flood. Two ancient alluvial fans met at this point and due to seepage gave way to the rushing waters of Lake Bonneville. The flood lowered the level of Lake Bonneville by 351 ft to the Provo lake stage. The volume of the flood is estimated to be ~ 1,200 cubic miles of water. Scour marks, due to the fast and large amount of water that moved through the area, can still be found today.

Stansbury Island is the second largest island in the Great Salt Lake behind Antelope Island. Lake Bonneville, Provo and Stansbury Shorelines can be easily seen here. Stansbury Island is the site of excellent evidence for the Stansbury Shoreline Oscillation. This island also provides great views of hypersaline portions of the modern Great Salt Lake. The water is red here due to a railroad causeway that was built with few pathways for water to circulate between sides. Thus, more salt gets trapped on one side, creating a hypersaline condition, in which red algae thrive in.

Little Cottonwood Canyon is located in the Wasatch Mountains just east of Salt Lake City, Utah. This canyon was formed due to a large glacier that carved the "U" shape valley. This glacier was present during the peak of Lake Bonneville and flowed into the lake. There is a large lateral moraine on the south side of the valley but but there is no terminal moraine since it has been impacted by the interaction of the lake. The popular ski resorts of Alta and Snowbird are located up this canyon.

Pahvant Butte is a dormant volcano located in the Sevier Desert in south-central Utah. This volcano formed, and was active, during peak Lake Bonneville about 15,500 years ago. It erupted from the bottom of the lake probably creating large waves and ash clouds. Located on the northwest side of the volcano is a vertical cliff called Lace Curtain which was formed due to wave action. Evidence of ripple marks in the ash layers can be found all around the volcano.



Red Rock Pass, Zenda, Marsh StoryMap

Stansbury Island StoryMap

Little Cottonwood Canyon StoryMap

Pahvant Butte StoryMap

Methods

The first part of our project involved choosing areas where Lake Bonneville left behind prominent geomorphic features. These features include bars, spits, deltas, shorelines, terraces, and wave-cut cliffs.

We documented the landforms by taking images in the field, stitching them together and annotating them using drone images, GigaPan, GIGAmacro, and Agisoft Metashape.

ArcGIS Pro was used to create a map of Lake Bonneville and the points of interest in it.

ArcGIS Story Maps were created for Stansbury Island, Zenda Valley, Little Cottonwood Canyon, and Pahvant Butte.

GigaPan is a stitching software that creates gigapixel panoramas. The camera is placed on a robot head that pivots on top of a tripod. The Camera swivels up and down taking dozens of pictures depending on the field of view. The images are then aligned on the computer and stitched to create panoramas with extreme detail.

GIGAmacro is software used to take high-resolution images that can be annotated and easily linked with GigaPan images.

Agisoft Metashape is software that creates 3D models used to view all sides of a rock or structure.

SketchFab is where 3D models of outcrops and hand samples that were created in Agisoft.

Derek Ashliman and Taylor Benson doing field work at Red Rock Pass, Pahvant Butte, and the Hogup Mountains area

Future Work

Faculty and students from the UVU digital media department will be assisting the Earth Science undergraduates to help create a more immersive and user-friendly experience.

Faculty and students from the UVU Education department will also be working with the Earth Science students to create activities that will help engage at different age levels and to analyze the effectiveness of the VFT's.

A Map Series will be made to create an interactive map where each point will take you to the sites story map

We still need to complete and enhance many of the sites that we have visited. In addition, we will be visiting some additional sites in the basin. Some of these additional story map sites include:

- Cutler Narrows - site that has record both Bonneville and pre-Bonneville sediments
- Leamington – location of delta into the Bonneville Basin from Sevier River.
- Wah Wah Mountains – location of many key intermediate shorelines
- Fish Springs National Wildlife Refuge
- Silver Mountain
- Bonneville Salt Flats

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