Earth Science Outside – Geology and Heritage Tooele County -

EARTH'S SYSTEMS!! What an amazing place to witness interactions of geosphere, hydrosphere, and atmosphere (3 of the 4 subsystems of Earth systems).

Stockton Ball Park – Stockton UT – East side of town, south end of Silver Ave.
October 9, 2019 – WEDNESDAY

Details: Silver Ave runs east from route 36. Silver Ave is the street for Stockton City Hall. A Sinclair gas station is opposite Silver Ave at route 36. NOTE: Weather may be a challenge. Audio available on Earth Science Education's website.

Credit: Earth Science Education, www.earthscienceeducation.org Genevieve Atwood and Peg Alderman, leaders.

Photo: ESE-byAlderman-y18-Stockton Bar Looking North From Stockton Ball Park.

Photo: ESE-byAlderman-y18-Stockton Bar Looking South fromTooeleValley.

This year we focus on the Fifth Grade Earth Science curriculum.
We revisit it again and again.
EARTH'S SYSTEMS...
PATTERNS of Earth's features are due to processes of TECTONICS and EROSION.

GOALS of today's session.
BIG CONCEPT… JOY to be outside on a beautiful Fall 2019 day.
JOY to see Earth systems outside!
JOY to see contrasting patterns of evidenc of shoreline deposits of Lake Bonneville (wave processes) versus evidence of flash floods along Bald Mountain Road (Soldier Canyon)..

For everyone! and especially for Utah's fifth grade teachers
Strand 5.1 - Earth's Systems.

AT STOCKTON BALL PARK.

Exercise 1. Where am I? Sense of Place. Landmarks.

Exercise 2. Earth's Systems
Geosphere = Solid Earth
Hydrosphere = Water Earth
Atmosphere = Gaseous Earth
Biosphere = Living Earth… including humans.

Exercise 3. Interactions of Geosphere – Hydrosphere (and hydrosphere – geosphere). CLIMATE and WEATHER NOW.(May have lake effect precipitation in October!!)

Exercise 4. Visualize paths of rain water after it falls on Bald Mountain.
Some rain that falls on Bald Mountain travels to Rush Valley / Rush Lake or Great Salt Lake via groundwater.
Some rain that falls on Bald Mountain may travel down the canyon as a flash flood.
Patterns that result from EROSION (deposits and features) provide evidence of processes of EROSION.
This is an awesome place to enjoy patterns and appreciate big concepts

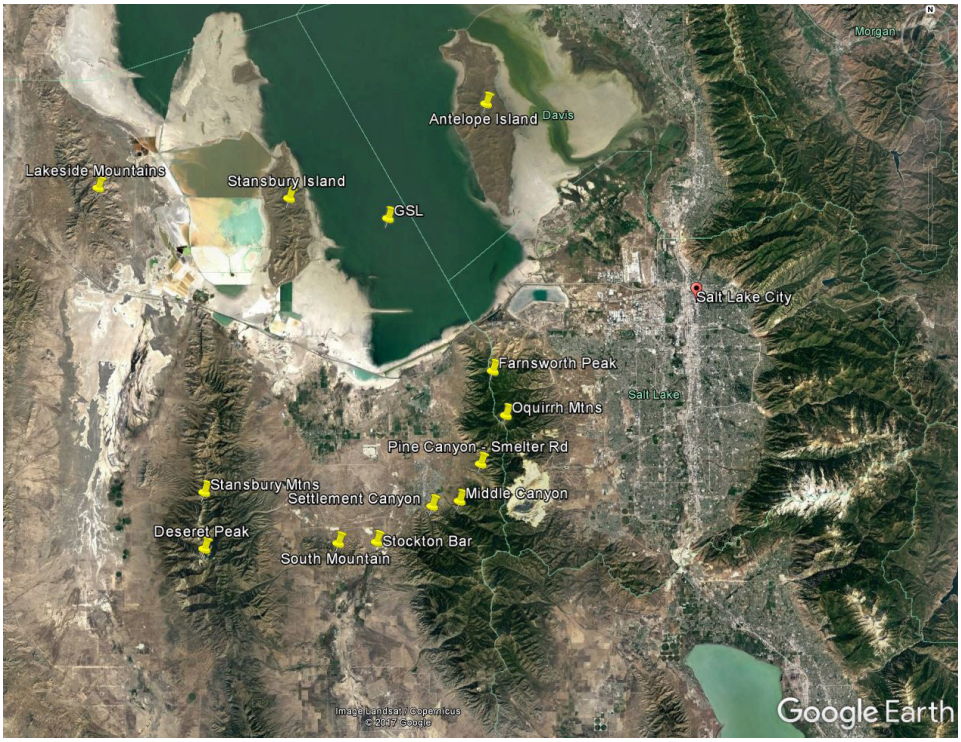
Exercise 5. ROAD TRIP!! with stops. AUDIO!! Compare sediments (the product of EROSION) - loose material deposited by wave processes of Lake Bonneville versus sediments from Soldier Canyon and its drainages (we'll travel to the Jacob City Trailhead). THAT's today's field experience... with some optional additions...

Appreciate why the Stockton Bar, a favorite feature of Earth's scientists.
It's amazing, large, consisting of millions of tons of sand and gravel deposited in less that 1000 years by Lake Bonneville. It is the best preserved history of Lake Bonneville at the Bonneville level.
Its detailed structures tell us about lake current and the energy of waves of Lake Bonneville. and interactions among the geosphere (topography and Earth materials), the hydrosphere (the lake), and the atmosphere (wind, climate)... and more.

SUCCESS is when... teachers feel joy of Earth science as a pathway not only to principles of Earth systems but to fundamental concepts of phyics, chemistry, meteoroalogy (lake effect), and biology!!

PATTERNS are evidence of PROCESSES. PATTERNS of SEDIMENTS (the product of EROSION) tell us that Lake Bonneville left the sand and gravel of Hickman Road gravel pit and flash floods left the evidence of at the Jacob City trail head.

THAT's the trip! Because teachers may want more about Great Salt Lake and Lake Bonneville, we'll travel to the crest of the Stockton Bar, stop at Lookout Point atthe Bauer Gravel Pit entrance and "do" Lake Bonneville.



Exercise 1. Where am I?
GOAL: encourage a sense of place.
Familiar landmarks can enhance a sense of direction AND they can encourage a sense of place.

EXERCISE 2. Repeat to remember... remember to repeat.

1. SYSTEMS… surround us! Exercise 1… I spy with my little eyes… systems!
2. EVIDENCE of Earth processes.
3. INTERACTIONS between two of Earth's four systems (geosphere – hydrosphere)
4. PATTERNS of Earth's features associated with EROSION and TECTONICS… example of flows of materials due to processes acting on Earth's surface.

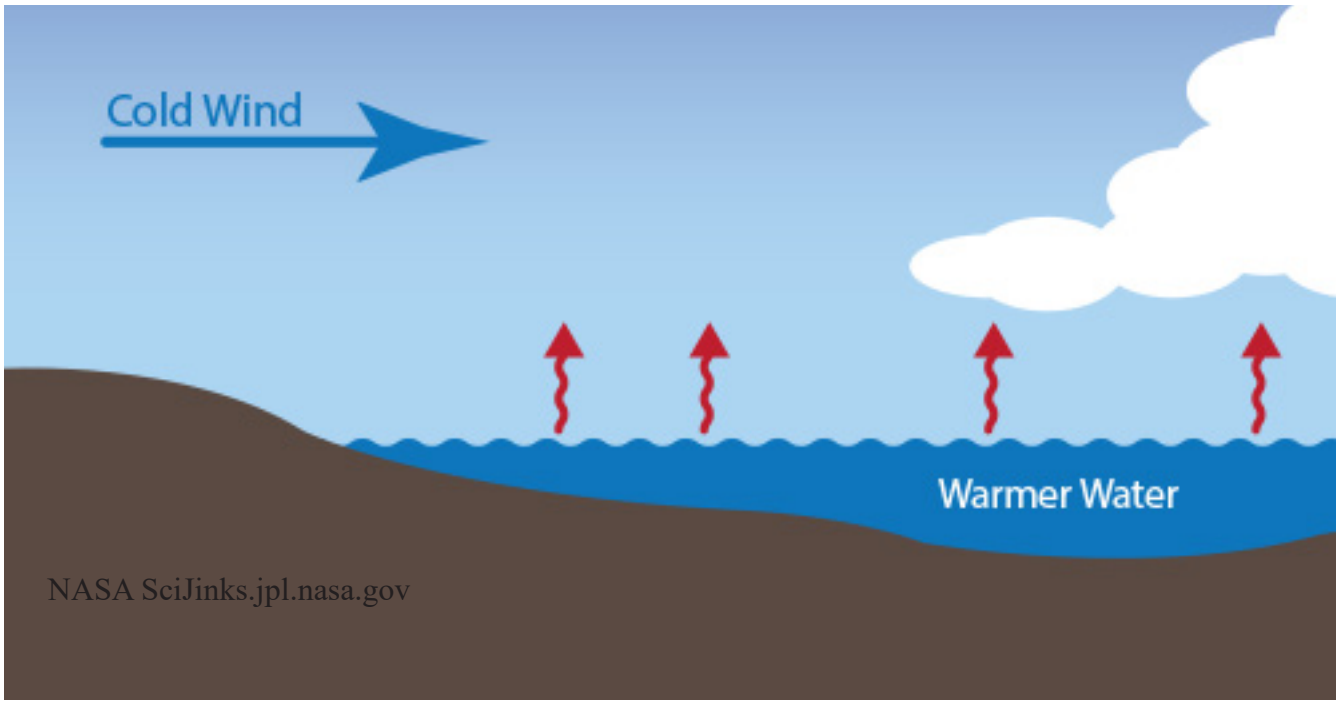
One way to do this exercise with students...
First: ask students to say what they see, to just look around and notice... near and far. Often this will be vegetation, also clouds and colors. Some oberservations may be smell and what they hear as well as what they see.

Second: remind them that Earth is a system (like a car, or computer, or house, or...) and the four subsytems are:
the geosphere - solid Earth
hydrosphere - water Earth
atmosphere - gaseous Earth
biosphere - living Earth (including humans)

EXERCISE 3. All systems have subsystems that interact.
Based on students' observations... list four or five observations for each... geo hydro atmo bio.

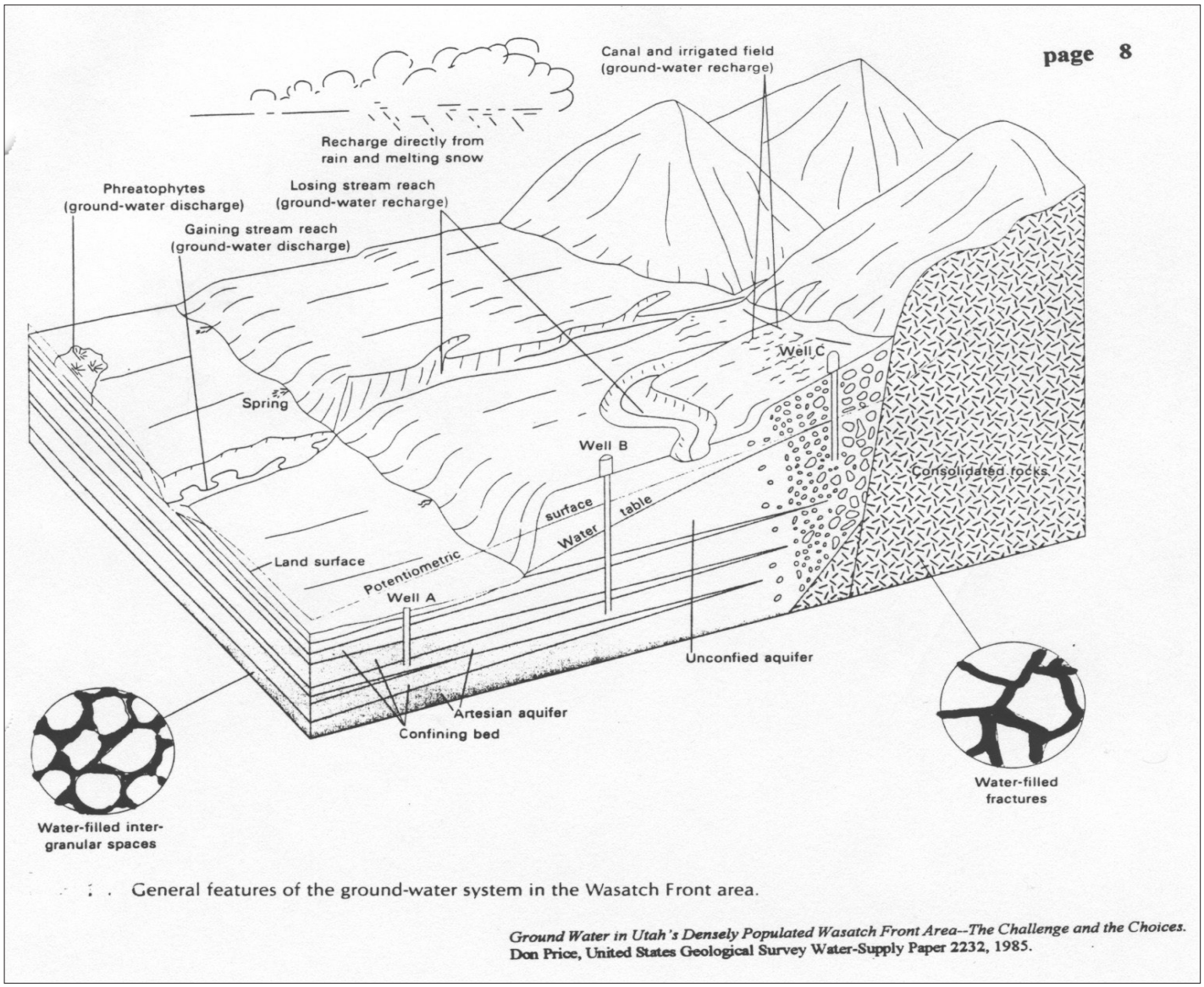
Draw arrows that show interactions.

Today is October 9, 2019. We may witness interactions of geosphere, hydrosphere, and atmosphere - lake effect and wonder what role the Stockton Bar has for local weather and Earth's processes.



Look east.
Exercise 4. Visualize paths rain may take after it falls on Bald Mountain.

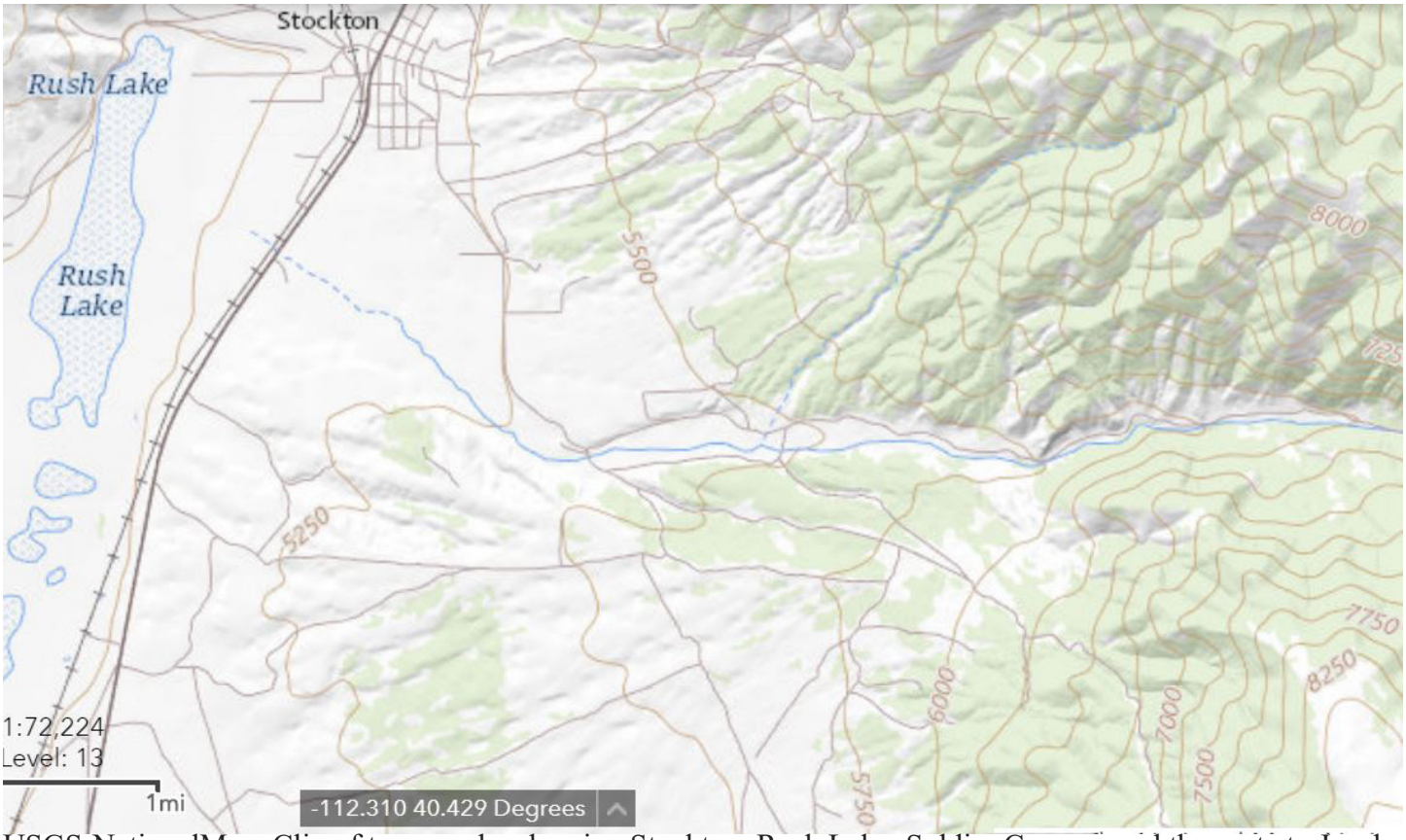
Some raindrops that fall on Bald Mountain travel to Great Salt Lake.
Some raindrops that fall on Bald Mountain don't travel very far at all.
Some rain that falls on the flanks of Bald Mountain rushes as flash floods.
Patterns of deposits on Bald Mountain and in its drainages provide evidence of processes.



General features of the ground-water system in the Wasatch Front area.

Ground Water in Utah's Densely Populated Wasatch Front Area--The Challenge and the Choices.
Don Price, United States Geological Survey Water-Supply Paper 2232, 1985.

DRIVE from Stockton Ball Park to Jacob City Trailhead.
AUDIO to and from trailhead and back and of this adventure are downloadable from
www.earthscienceeducation.org . to be filed under Resources for Teachers... Places... Tooele County...



USGS-NationalMap. Clip of topography showing Stockton, Rush Lake, Soldier Canyon, and the route to Jacob City Trailhead.

BIG CONCEPTS:
Patterns result from Processes.
The two huge processes (simplified almost too much) that drive Earth's systems are driven by Earth's two sources of energy... from the sun... and from Earth's interior. TECTONICS is driven by uneven heating due to uneven distribution of heat in Earth's interior. EROSION (shorthad for... weathering, entrainment (pick it us like getting on a train), transport and depostion) is driven by uneven distribution of heat in Earth's atmosphere.

This trip ... focus on EROSION... The effect of EROSION is that matter has been taken away and deposited somewhere else. Land features and Earth materials have changed. Think... conservation of matter. Think .... conservation of energy. Think... continuity of time.

This can be joyous if NOT over thought!! Embrace the links to basic science... gravity, mass, time.
AVOID jargon. Earth systems can be almost intuitive... particularly if one lives in Tooele County, UT.

IMAGES along and at the Hickman Road Gravel Pit 0.2 mi south of Stockton Ball Park.
We'll visit the gravel pit exposures on our way back, after we have observed patterns of features and materials along the way to the Jacob City Trailhead.

There's room here for a photo of yours.

PATTERNS... Consider noticing the shape and slope of features, such as how level or steep.
Notice patterns of materials: size shape and sorting.

Have you ever witnessed a high-energy beach such as at an ocean. Have you a family story about wave processes? What happened? Can you personalize this for your students? Could you "feel" the energy... What was it like... Imagine it here! Lake Bonneville was huge lake... similar to Lake Superior. Imagine hat environment here. Where would the most energetic waves come from and why? Would you want to be here during a storm? Perhaps saber-toothe kittens played here on a sunny day?

IMAGES from the Jacob City Trailhead, up canyon, south and east of Stockton.
PATTERNS... consider noticing the shape and slope of features.
Noticing materials: size shape and sorting.

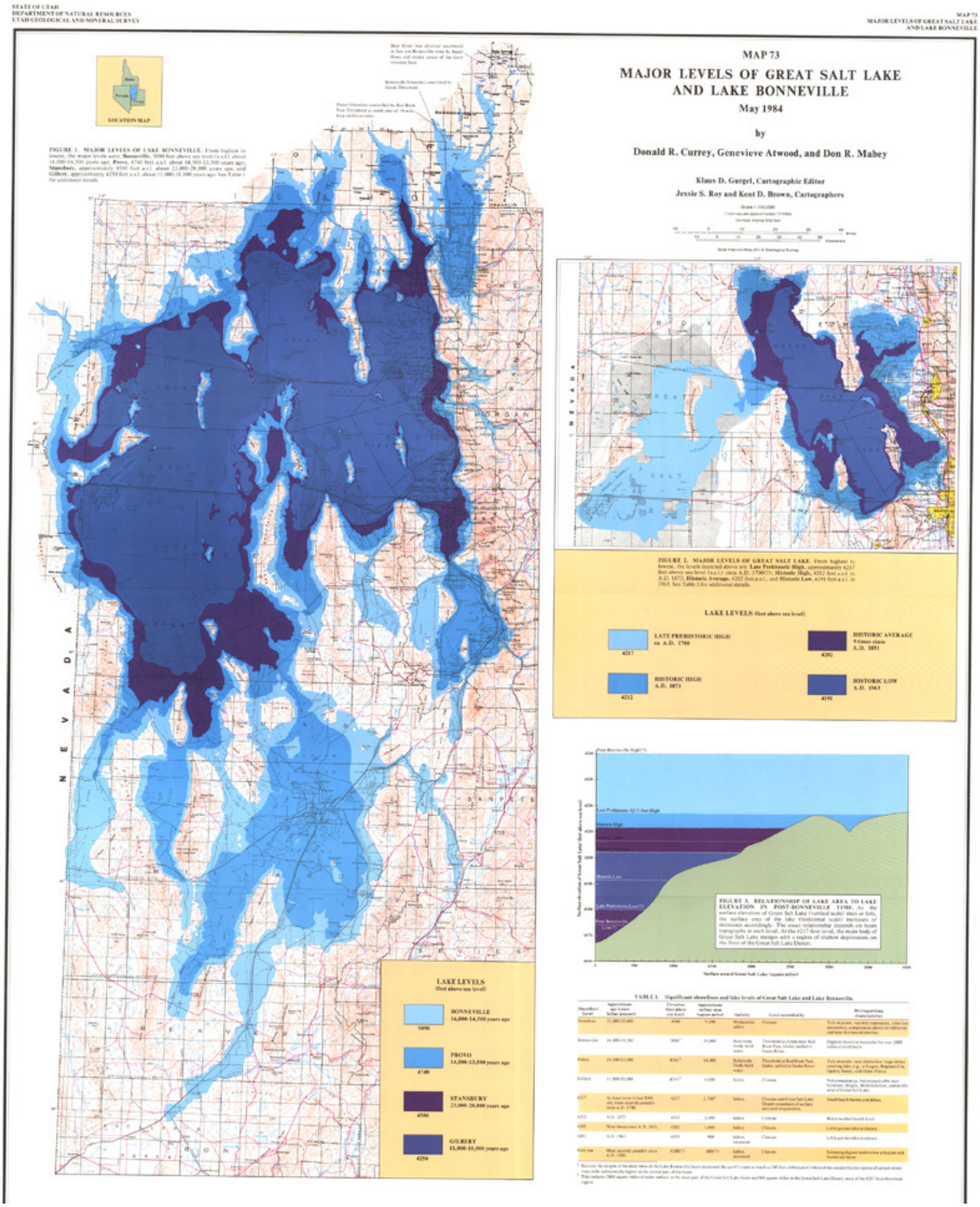
Have you ever witnessed a flash flood. Have you a family story about a flash flood? What happened? Can you personalize this for your students? Could you “feel” the energy...

Photo by PAlderman-y19-TooeleCounty-nearJacobCityTrailhead.

OPTIONAL...
Introduction to Lake Bonneville - Great Salt Lake system.

Think EARTH'S SYSTEMS... BIG CONCEPTS
All systems have subsytems... and those interact.
Geosphere, Hydrosphere, Atmosphere, and Biosphere.

Please, just because I've given LOTS of content... don't "kill" and interest in science by overloading students.
What does it take to have a lake? A basin and water. And to have a BIG lake....



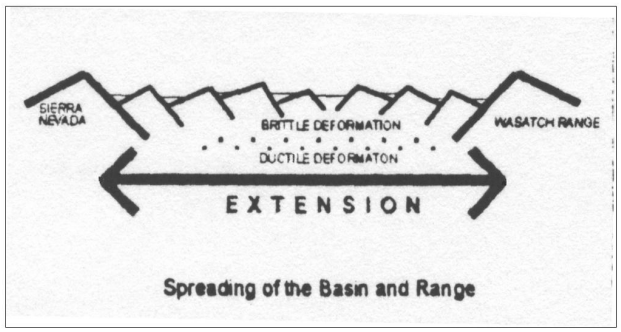
Utah Geological Survey Map 73. This map was created during the 1980s as Great Salt Lake rose and treatened infrastructure. Note how the latitude of the two maps is the same. Find Stansbury Island. Find Stockton Bar.

BIG CONCEPTS

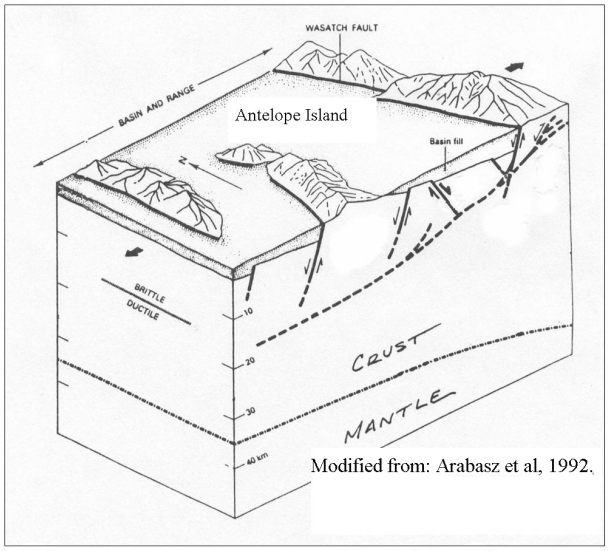
#1 -Tectonics rules!! Extensional tectonics has created the classic features of the Basin and Range… such as Tooele Valley, Rush Valley (basins) and the Oquirrh Mountains and Stansbury Mountains (ranges).

LOCATION, LOCATION: why Great Salt Lake is located where it is.

Tectonics. Extensional tectonics of about the past 20 million years has stretched and continues to stretch western North America, creating the topographically closed basins of the Great Basin and the topography of the Basin and Range physiographic province. Great Salt Lake is located where it is because of down-dropping along normal faults of the eastern Basin and Range, most significantly, along the Wasatch Fault Zone. Great Salt Lake occupies the lowest places in the Bonneville basin. Its shape and location are evidence of fault activity.



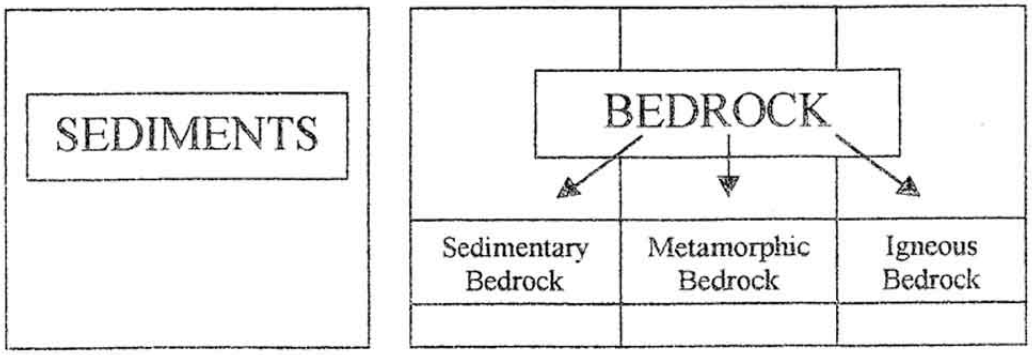
Antelope Island is a range in the Basin and Range physiographic province. As with similar ranges, east-west extension along north-south faults results in north-south trending blocks. To the east and west of Antelope Island are down-dropped blocks, basins with thousands of feet of sediments.



Modified from: Arabasz et al, 1992.

Streams transport runoff from the Uinta and Wasatch mountains to Great Salt Lake where water escapes by evaporation. Streams carry sediments into the lake, gradually burying islands with sediments. Erosion from Antelope Island contributes only a minor portion of the sediments accumulating around the island. Streams also carry dissolved solids into the lake where they precipitate as calcium carbonate and salts. Lake-bed sediments and shorezone sediments are historians of environmental conditions at the time of their deposition.

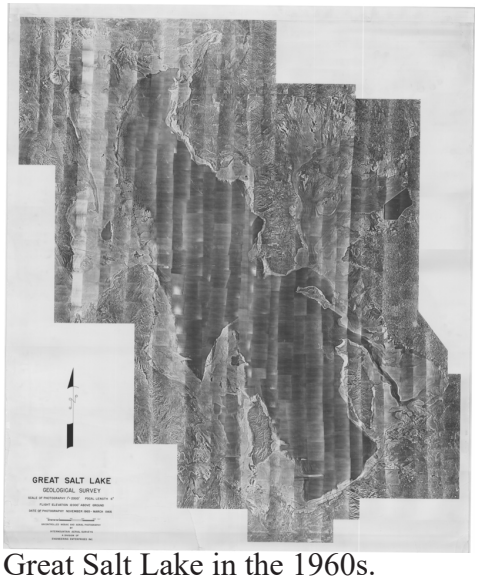
#2 – Earth materials: Sediments tell the story (geologic history) of the present. Bedrock tells the story of the past. The cobbles, gravels, and sands of Stockton Bar tell the story of the highest levels of Lake Bonneville.



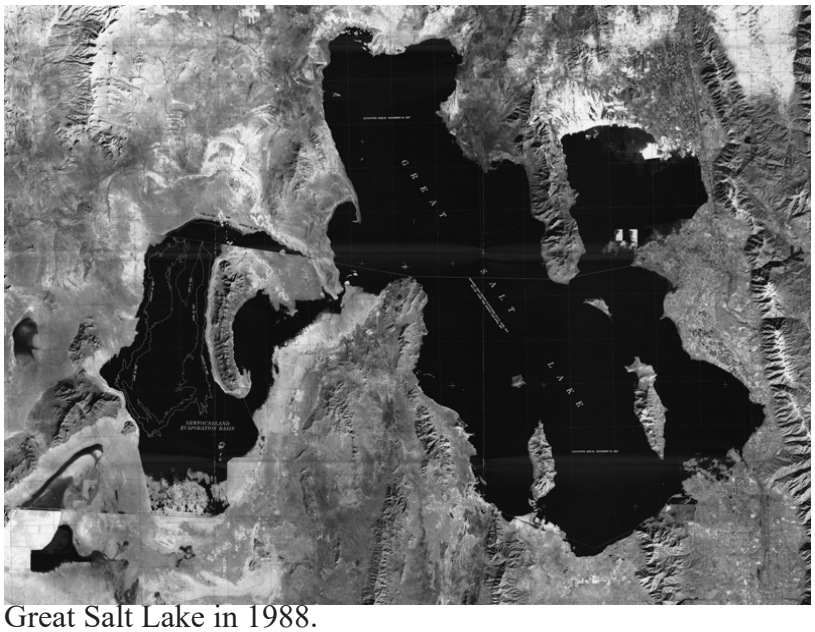
Earth's subsystem interact.
Geosphere = Solid Earth
Hydrosphere = Water Earth
Atmosphere = Gaseous Earth
Biosphere = Living Earth… including humans.

Think about change over time, for example, the changes of the past decades due to:
Hydrosphere acting on Geosphere
Biosphere acting on Geosphere
Atmosphere acting on Geosphere.
AND Geosphere action on hydrosphere, atmosphere, and biosphere.

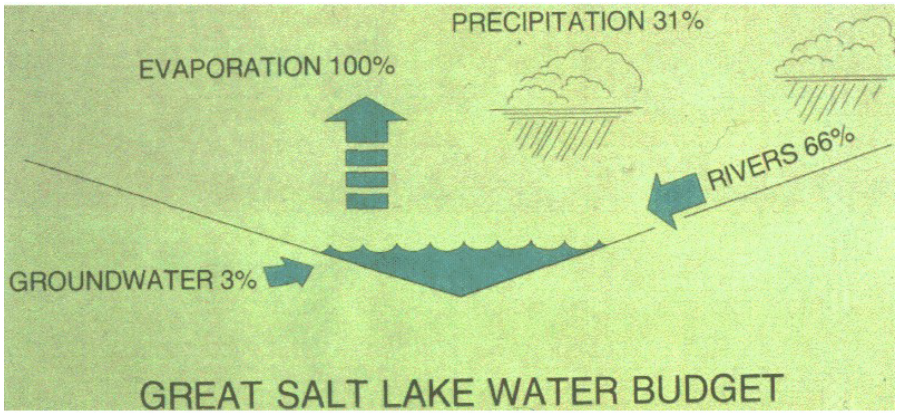
How has Great Salt Lake changed in the past few decades?

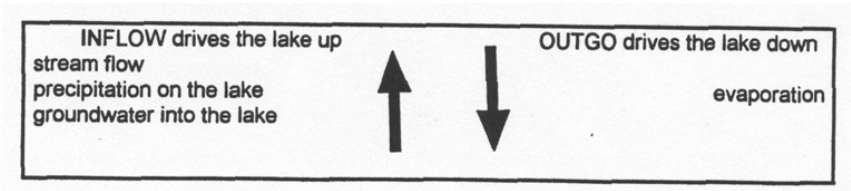


Great Salt Lake in the 1960s.

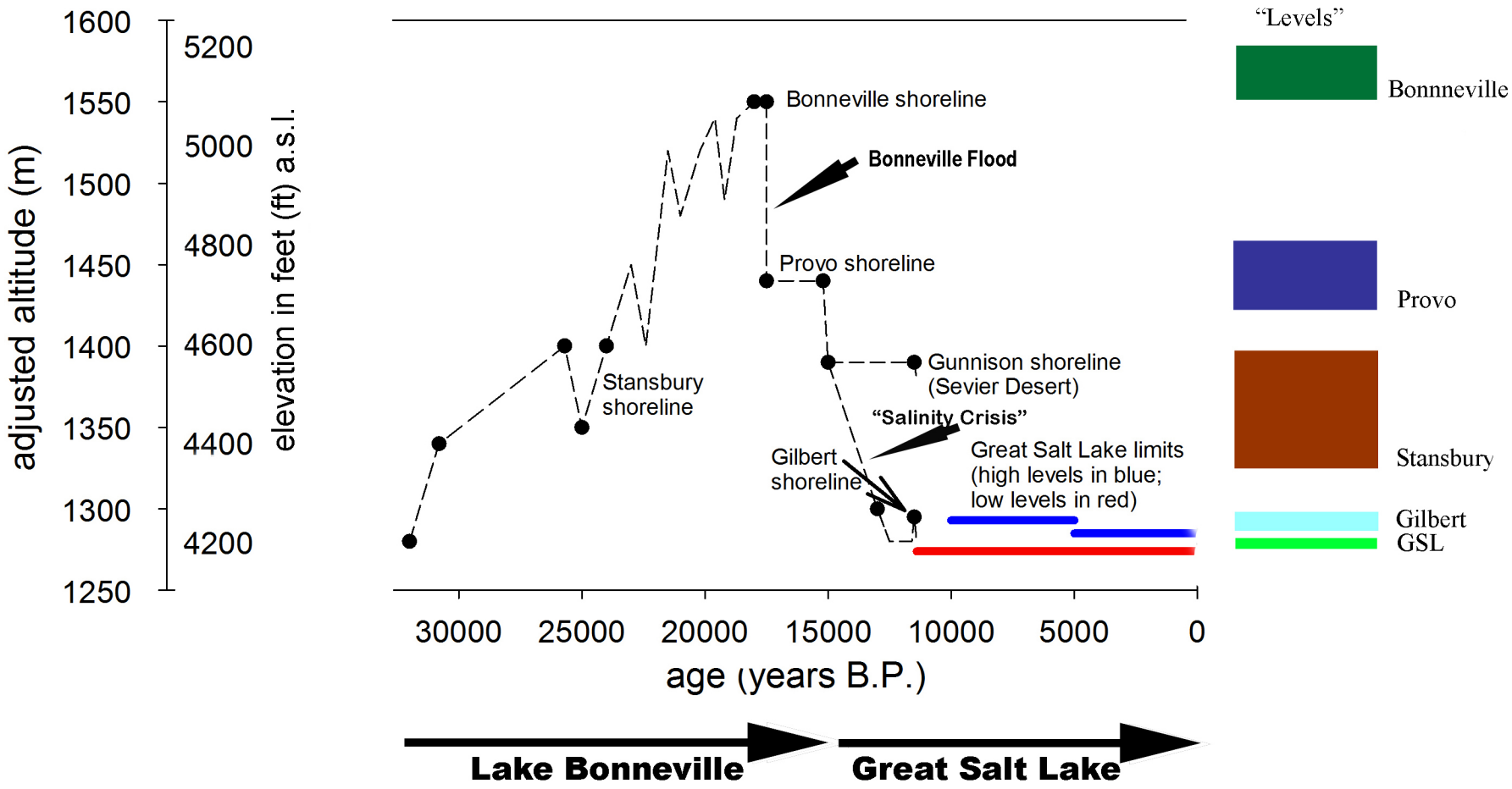


Great Salt Lake in 1988.



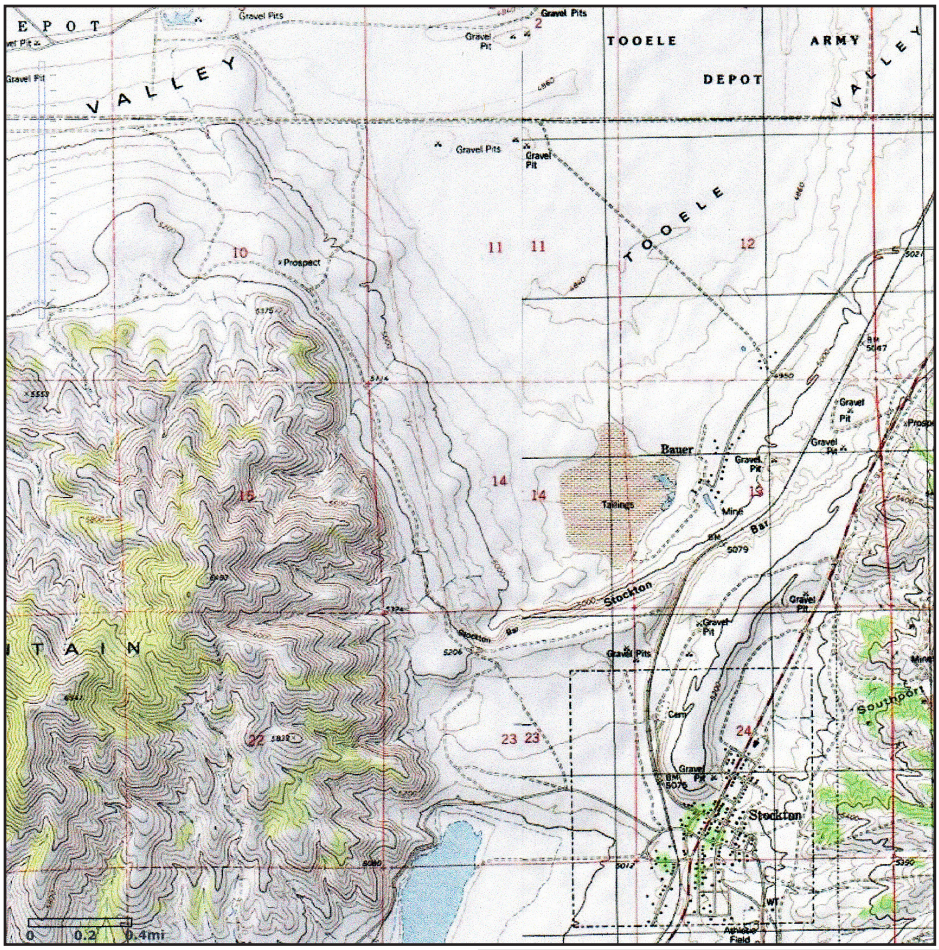


Lake Bonneville and Great Salt Lake hydrograph



black dots are firmly dated points;
dashed line is uncertain lake-level between dated points
altitudes adjusted for differential isostatic rebound in the basin

"Levels" are the ranges where shoreline evidence is found.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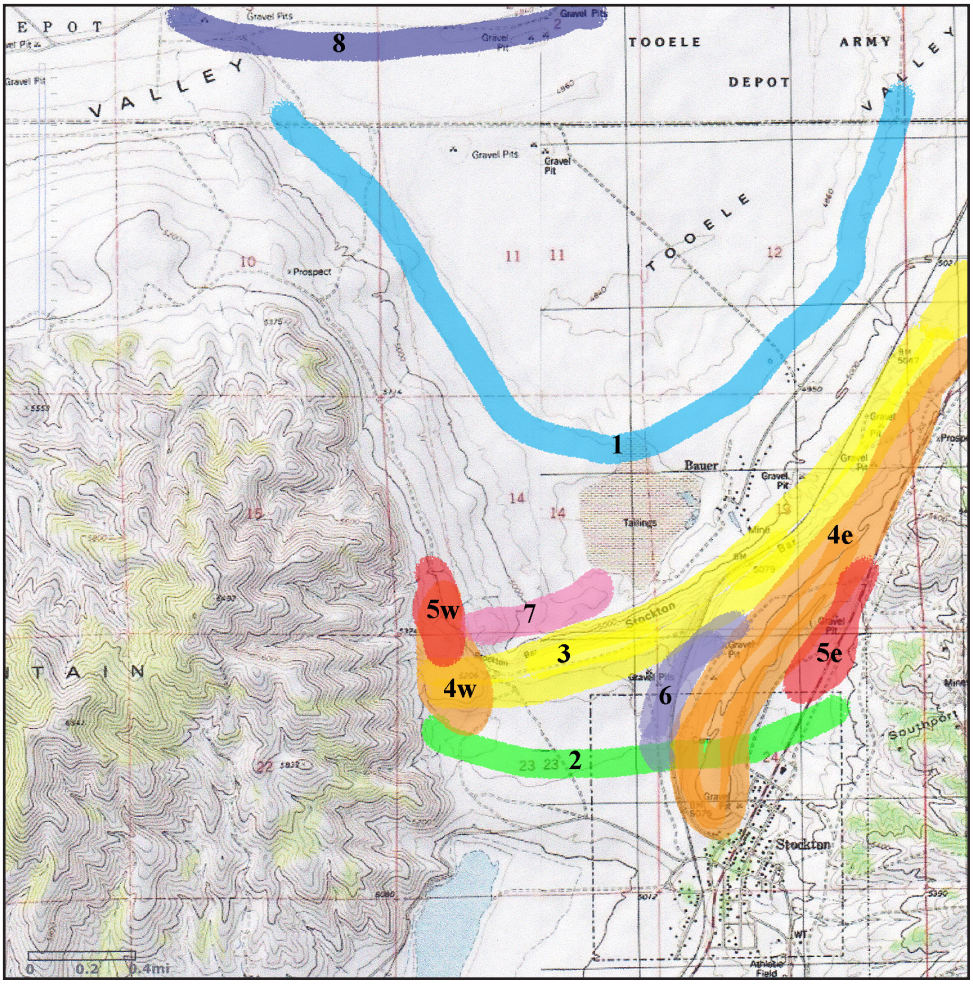
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Lake Bonneville Story of Climate Change at Stockton Bar
Based on UGS Map 73: Major Levels of Great Salt Lake and Lake Bonneville
The elevation of the Town of Stockton baseball park is about 5200 ft a.s.l.

About 30,000 years ago, before the last Ice Age, right here where this park would be, where this picnic area is now, a lake very similar to Great Salt Lake existed just about where Great Salt Lake is now. The climate was hot and dry, pretty much the way it is now. Of course, the topography has changed because 30,000 years is enough time for erosion and deposition to modify the landscape at least a little, and for tectonics to adjust major features like lakes and islands and mountains just a little. The lake that existed back then was salty because it had no outlet, just as Great Salt Lake has no outlet today. Why don't we call the lake that was here then "Great Salt Lake"? Because so much has happened since then that we don't want to call it by the name of today's lake. It would be like calling you by your grandmother's name!

Here's the story of what happened here at today's Town of Stockton ballpark. But back then there was no ball park… no people here, either. Early North Americans weren't here until about 13,000 years ago… but there were neat animals. .

About 35,000 years ago and before 25,000 years ago, climate changed. The changes were worldwide. It was the Ice Age. Our region became much colder and wetter. So the lake rose. This is the beginning of Lake Bonneville. I could tell you about glaciers growing in the Wasatch Range, a few in the Oquirrhs, and some right near Deseret Peak in the Stansbury Mountains. I could tell you about how streams had much more water in them. I could tell you how saber toothed tigers and enormous bears lived in Tooele County… but I won't tell you those stories. Because the story I'm telling is the story of what happened here … at Stockton's now ball park.

Some time in the early history of Lake Bonneville, the lake level rose and flooded what's now Lakeside. The gas station complex would have been like a sandy beach with lagoons. The lake kept rising. It kept flooding lands. Climate was like that of Lake Superior's today. The story is pretty simple. The water got deeper and deeper for thousands of years of global glacial conditions. In the lake, on the lake bottom clay particles drifted from above and became muddy layers. Along shore there were sandy beaches.

Above lake level such as right here in what would become Stockton, land eroded although not as easily as today because there was abundant vegetation. Again, think the conditions of the Great Lakes today. We know there were pines and scrub oak from pollen in lake sediments. Bones have been found along shorelines of giant sloths, bears, and musk ox as well as snails in wetlands, algae in the lake, and fish fossils. Occasionally there'd be a rush of water with some sand or gravel when a landslide or debris flow came into the lake. Most of the time, only particles of clay rained down from above. Bottom feeding critters that don't need light or oxygen ate what they could find. But it was pretty slim pickings. The lake had fish but probably not a diverse fauna because the lake was still brackish, meaning saltier than fresh water.

About 15,500 years ago, Lake Bonneville was a thousand feet deep and its shoreline was right here. The lake had risen so high that it spilled over the rim of the Great Basin near Red Rock Pass in southern Idaho. That changed the lake and surely changed the scenery here. It changed the lake because, at the Bonneville level, the lake flushed most of its salt to the Pacific Ocean and was almost fresh. Ice formed across the lake in winter. In springtime the lake "turned over" and totally circulated due to density and temperature differences in the deep lake. The lake bottom had different life forms than when the lake had been salty. Freshwater fish lived in the lake including Bonneville cut-throat trout that had swam upstream from the Columbia River. Here at Stockton Bar it was amazing. How terrain changed! It might have been beautiful and similar to today's shore of Lake Michigan. There would have been beaches and beautiful summer days. There would have been wild waves of storms that made spits and bars of gravel and stones. There were deltas constructed where drainages entered

the lake. Right here at Stockton, Lake Bonneville built the biggest boldest set of sand and gravel deposits of the Bonneville level. Indeed Tooele County as a whole and the Town of Stockton have The Best Record of Lake Bonneville at the Bonneville level as anywhere. That means, it is among the very best records of climate of the Ice Age of all of North America. Lakes are historians of environment and Great Salt Lake and Lake Bonneville are The Best Historians of climate change in western continental North America.

Why were the deposits of sand and gravel at Stockton so massive? There are probably several reasons but here are a couple that are agreed upon and one that G. Atwood adds as a process. Every one agrees that the location of Stockton is in geology that is easily eroded into perfect size chunks to be made into an amazing pile of materials. In addition, it's agreed that the lake although controlled by the overflow in Idaho, was getting deeper where it was deepest. How could that be? It's called isostasy and means that the crust of the Basin and Range floats on tooth-paste like material below it (the lithosphere floats on the asthenosphere). A thousand foot deep lake is a lot of weight and the lake became deeper because some of the asthenosphere moved outward… and allowed accommodation space for the Great Bar at Stockton. In addition, according to G. Atwood, ice as well as waves carried masses of material downwind. Shore-fast ice is an awesome agent of erosion. So… at least four and as many as seven sequences of Bonneville sediments were laid down at Stockton.

Two ways that lakes drop are (a): by lowering their threshold and (b) by changed climate. The Bonneville Flood happened about 14,500 years ago when Lake Bonneville broke through sediments near Red Rock Pass, Idaho. The lake fell almost 400 feet. Immediately, here at Stockton, the bar was exposed, a lake in Rush Valley was trapped south of the bar. There probably were ground failures such as along the far west, north side of the bar. Land was exposed with its former shorelines. It was still Ice Age climate but the shoreline was where Tooele is now.

Then, WOW, climate changed big-time. This time climate went from wet and cool to dry and hot. Lake Bonneville evaporated fast and the lake level dropped way below the threshold at Red Rock Pass. It was amazing. We still don't know how fast it happened. The lake became salty. Fish couldn't survive. About 13,000 years ago, for the first time in 20,000 years, lake level dropped to about its present level. Here at Stockton, conditions were much like today's… some centuries were hotter, some cooler. It was land! Birds sang. Grass grew. It was very dry. Some sediments laid down as mud in Lake Bonneville oxidized, turned red, eroded, and were swept into the remnant lake.

For a few centuries, along came another change in climate, just a short one. The lake rose to what is called the Gilbert level. The Gilbert shoreline can be seen today at Benson Mill. Those waterways were lagoons.

You guessed it. Climate reverted to today's conditions. About 10,000 years ago settled in to dry and hot. Over the past 10,000 years, climate has sometimes been a little drier or a little wetter. But pretty much like now. Not like during Lake Bonneville time. Researchers are still working out the details, studying shorelines and sediments. Evidence shows that Great Salt Lake has gone up and down less than 100 feet during the past 10,000 years. It has gone up and down less than 20 feet during the past 150 years of historic record. Even 20 feet was very upsetting during the 1980s when lake water threatened Interstates, airports, and sewage lagoons built on the lakebed. But only twenty years before, in the 1960s, people walked from the mainland to the island across dry lakebed of Farmington Bay and mainland and island ecosystems were connected.

It's just as interesting here today as during Lake Bonneville time. There are birds and bugs. Even school kids come and play, right here where only 15,000 years ago it was lake front property.

"THE END"… oops not the end at all, just THE PRESENT.

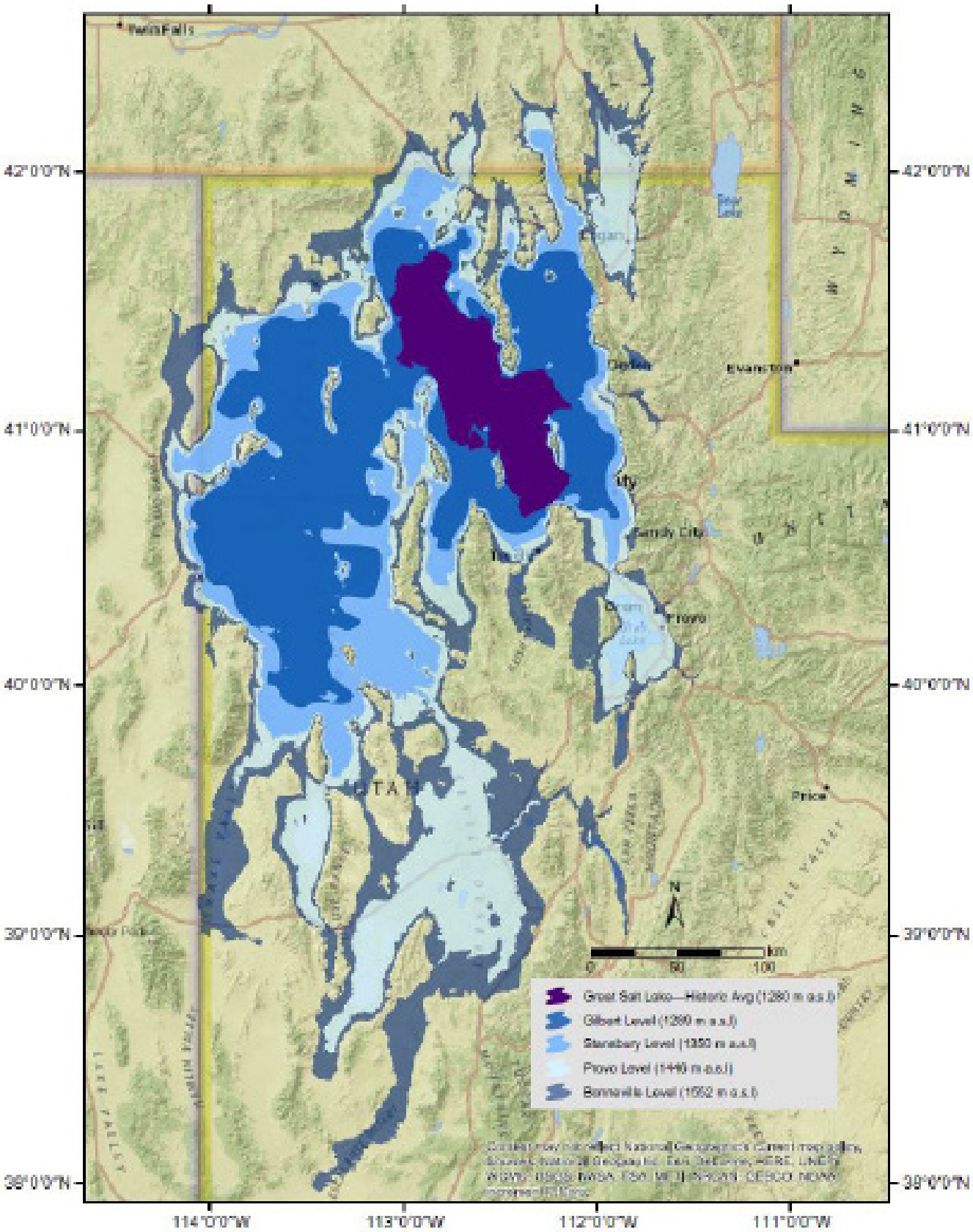
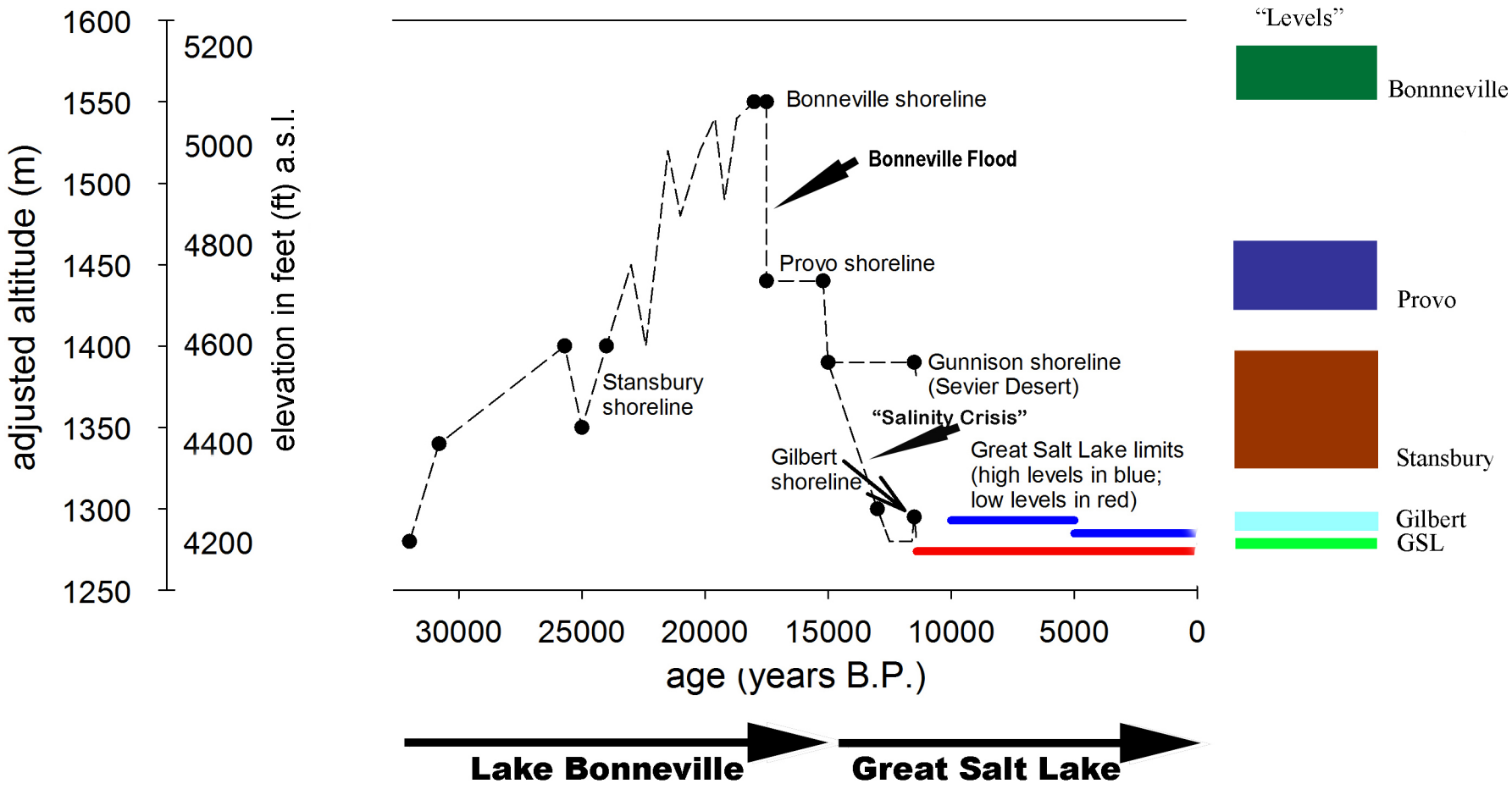


FIG. 1.2 Extent of major levels of Lake Bonneville and Great Salt Lake.

PATTERNS: Shorelines are evidence of climate change in the relatively recent past. Native Americans arrived in Utah after Lake Bonneville (the global glacial lake) fell to the level of Great Salt Lake (global interglacial lake). Tooele County has the best record of climate change for the past hundreds of thousands of years for continental North America. Why would that be? (Tectonics rules!!)

Lake Bonneville and Great Salt Lake hydrograph



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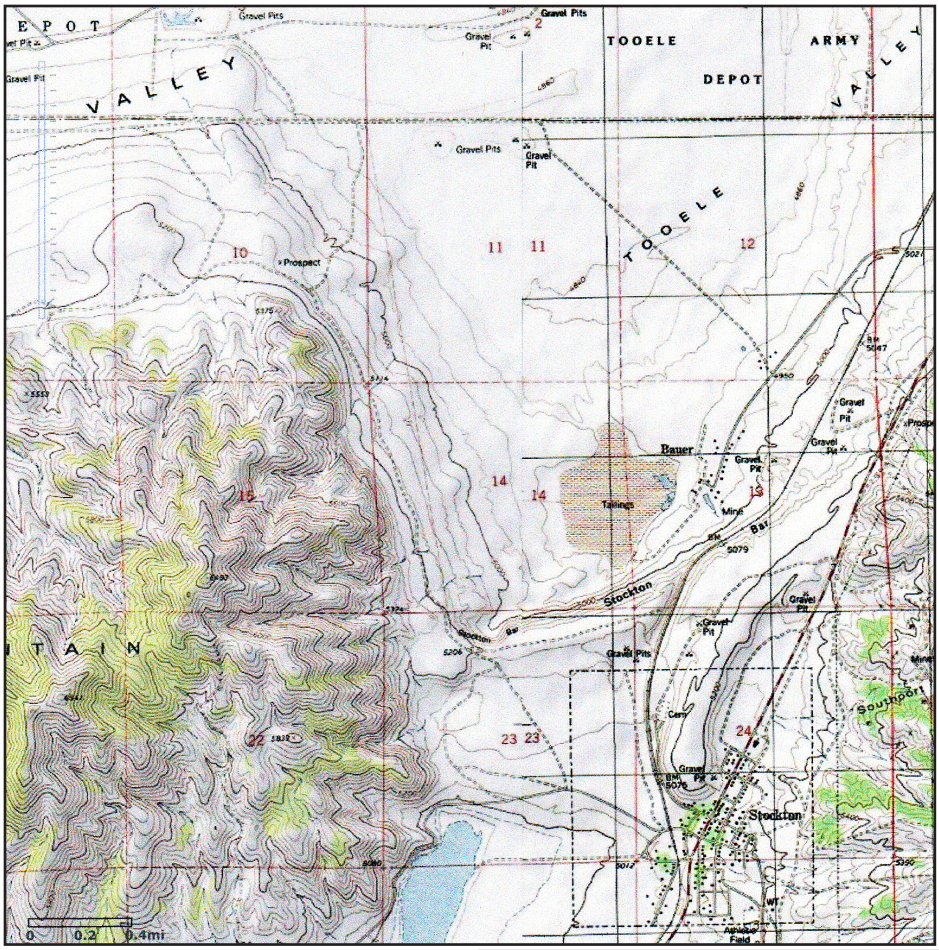
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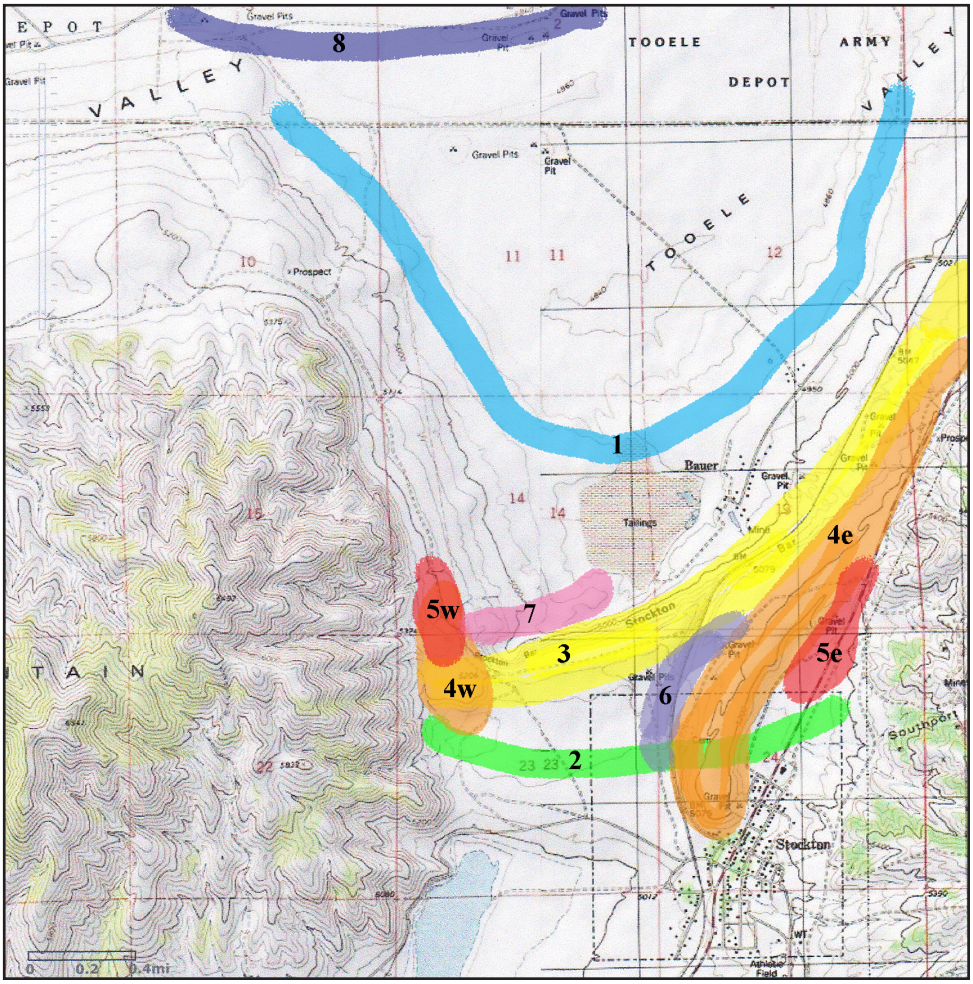
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