Science Camp #170802.8

02-04 August 2016 @ the Condo, the Nelson Cabin, and surrounding area

Advisors

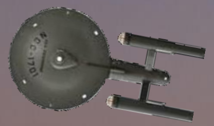
H. Roice Nelson, Jr., Andrea S. Nelson,
Paul F. Nelson, Benjamin B. Nelson

Attendees

Ethan E. Nelson, Grant M. Nelson, Colby C. Wright,
Taylor R. Wright, Ella D. Nelson, Halle N. Wright,
Bobbi Sophia Waldron, Dallin Spencer Nelson,
Avalyn Ashby Wright, Rachel Lee, & Ian Lee

Past Science Camp Themes & Sites Visited

1. Nelson Cabin, Fishing, Condensation, Water Coloring, and Music
    1. Nelson Cabin
    2. Panquitch Lake
    3. Swimming at Cedar City Aquatics Center
2. Mining Range, Frisco, Silver Reef, Iron Town, Astronomy at Frisco Peak, Archery
    1. Nelson Cabin, Kolob Reservoir, Silver Reef, Snow Canyon, Volcano
    2. Parowan Gap, Rack Range Mines, Frisco, Frisco UU Telescope
    3. Iron Mine, Iron Town
3. Geocaching, Mammoth Cave, Cascade Falls, and Cedar City Cemetery
    1. Nelson Farm, Fiddler's Canyon,
    2. Boys to Mammoth Cave, Cascade Falls and Girls to St. George and Pottery Making
    3. Cedar City Cemetery
4. Volcanoes, Classy Closets, Maps, Surveying, Sand Painting, and Genealogy
    1. Condo, Snow Canyon Volcanoes, Classy Closets, Fiddler's Canyon
    2. Nelson Farm to survey, Nelson Cabin
    3. Cedar City 24th of July Parade
5. Patterns, Horse Riding, Internet, Be-a-man-campout
    1. Dust Devil Ranch, InfoWest, Fiddler's Canyon
    2. Nelson Cabin
    3. Cedar City July 4th Parade
6. Music & Spoken Word, SilencerCo, Indian Tribes & Archaeology, Solar Astronomy
    1. Family Discovery Center, Sophie & Dallin's Baptism, SilencerCo, Music & Spoken Word, UU Science Museum
    2. Freemont Indian Museum, Boulder Anasazi Ruins, Escalante Petrified Forest, Bryce Canyon
    3. Parowan Gap, Solar Astronomy, Nelson Cabin, Uncle Des' & Aunt Sara's, Swimming
7. Rock Cutting, SUU Museum, Computer Hardware and Software, Cabin
    1. 1st Annual Fun Run / Walk, rock collection Bloody Ridge, rock cutting and polishing
    2. HTML at SUU, and Lego Robots at Nelson Cabin
    3. Astronomy at Nelson Cabin, Bottle Rockets, and having a good time



8G Nelson Grandkids Summer Science Camp

1. Geography
2. Genetics
3. Genealogy
4. Grandma
5. Grandpa
6. Geology
7. Geophysics
8. Guitar

Good Times

- 8th Year of Science Camps
- 8 Bits in a Byte (1 computer word)
- Completion of First Word
- Hopefully each Grandchild will complete 8 words in your lifetime

Grandpa hopes for 2 more (age 83)
Grandma for 3 more (age 86)

Photos + 174 pages of slides posted at:
http://www.walden3d.com/photos/Grandkids_Science_Camps/170802-04_Science_Camp

Safety

- **<u>Never go anyplace alone</u>**.
- Exception is if one of you is hurt, then:
  - One of you stay and help the person hurt.
  - The other one run and get help.
- If you get lost stay put, we will find you.
- If you hear a rattlesnake do not move quickly, just slowly move away from the sound.
- Do not run with a knife open. Use knife safety.
- If you cut yourself, apply pressure to the wound to stop bleeding, and send for help.
- Never point an arrow in a cocked bow or a gun at any person.
- Drink lots and lots and lots of water.
- Do not go swimming unless an adult is with you.
- Do not start branches on fire and swing them around where others can be hurt.
- Have fun, use common sense, and **<u>think before you act</u>**.

Schedule Tuesday - Saturday

- Tuesday, 01 August 2017
  - Folks Arrive, Grandpa and Grandma Family History Center.
  - Horses, planning meals, purchasing food, sun dial, making bottle rockets, 4-wheelers, etc.
  - 7:00 Shakespeare Greenshow, fishing, 8:30 safety review and 8G introduction
- Wednesday, 02 August 2017:
  - Water Garden, Fun Run/Walk, Breakfast, Geography of farm, Iron Springs, Irontown
  - Genetics, Presentations on a Family Member, Genealogy at Family History Center
  - Cabin, Geology Slides, Guitar & Singing
- Thursday, 03 August 2017:
  - Zion: Angels Landing & Emerald Pools, Weeping Rock, Sinawava
  - Geophysics Slides - Seismic
  - Cabin, Guitar & Singing.
- Friday, 04 August 2017:
  - Geophysics Slides – Water & Lightning, Cascade Falls, Mammoth Cave
  - Marshmallow Guns, Water Rockets,
  - Scavenger Hunt in Cemetery, Swimming, Fishing, Ben & Bridget's Families Leave.
- Saturday, 05 August 2017:
  - Garden, Fishing, Horses, 4-Wheelers
  - Paul's Family & Sophie leave.

Job Chart

Tuesday evening, Grandma has macaroni salad, potato salad, and sandwiches and everyone makes their own.

Everybody picks up their own dishes!

Everyone cheerfully does what the are asked to do by Grandpa, Grandma, Uncle Ben, or Uncle Paul

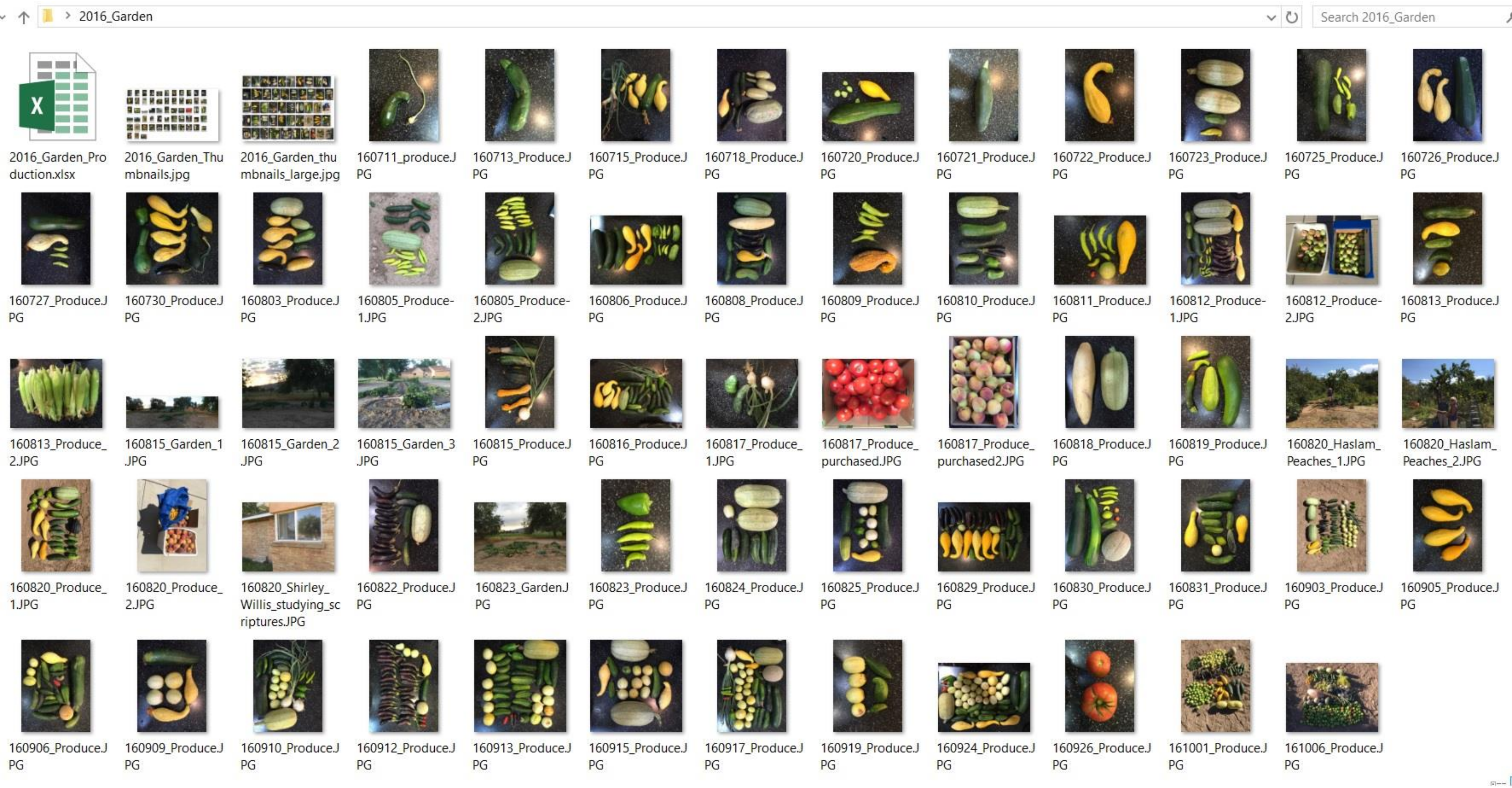
Wednesday	Thursday	Friday
Breakfast: Grandma cooks at the house	Breakfast: Early at cabin, bagels, bars, juice	Breakfast: Taylor, Halle, Avalyn, & Sophie Set-Up, Cook, & Clean-Up
Lunch: Aunt Sara & Uncle Des's house	Lunch: Purchased in Zion Canyon	Lunch: Everyone makes their own sandwiches and helps clean the cabin
Dinner: Colby, Ethan, & Ian Set-Up, Cook, & Clean-Up	Dinner: Grant, Ella, Dallin, & Rachel Set-Up, Cook, & Clean-Up	Dinner: Pizza in Cedar

Saturday Morning: Cold Cereal

Day 1: Wednesday, 02 August 2017

1. Water the Garden
2. Fun Run/Walk
3. Geography of Nelson Farm, Iron Springs, Irontown
4. Lunch with Aunt Sara & Uncle Des
5. Genetics and Genealogy
6. Grandkids Presentations
7. Cabin
8. Geology Slides
9. Guitar & Singing

Grandpa & Grandma's 2016 Garden



Award Certificate

Presented to

____

Second Annual Fun Run with my 67 year old Grandpa Nelson, or Fun Walk with my 62 year old Grandma Nelson at The 8th Annual Nelson Grandkids Science Summer Camp

____

Signed

02 August 2017

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6. Presentations

- Ethan ____.
- Grant ____.
- Colby ____.
- Taylor ____.
- Ella ____.
- Halle ____.
- Sophie ____.
- Dallin ____.
- Rachel ____.
- Ian ____.
- Avalyn ____.

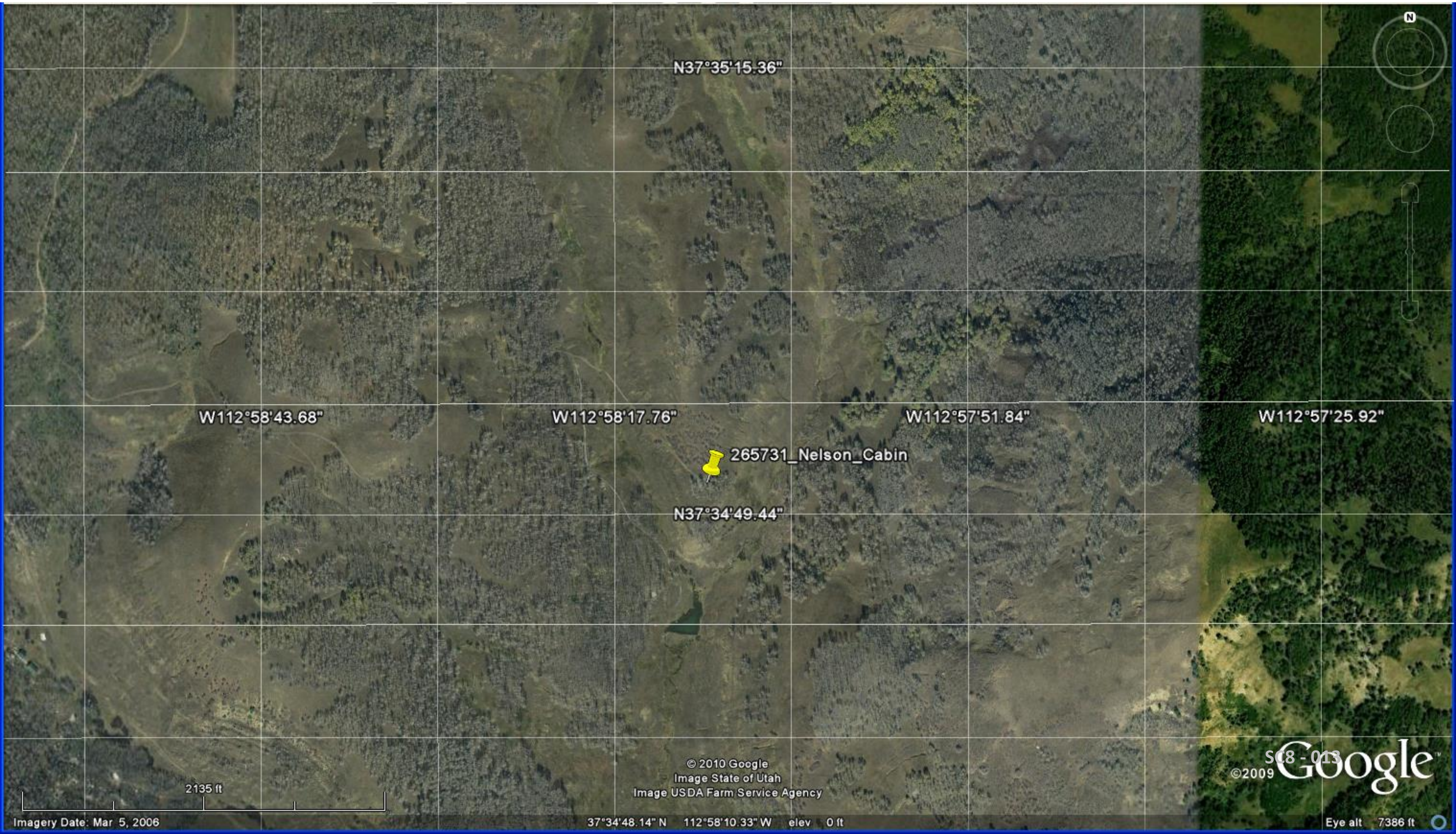
Day 2: Thursday, 03 August 2016

1. Up Early to Zion
2. Angel’s Landing – older cousins
3. Emerald Pools – younger cousins
4. Lunch
5. Geophysics Slides - Seismic
6. Guitar & Campfire Singing
7. Astronomy?

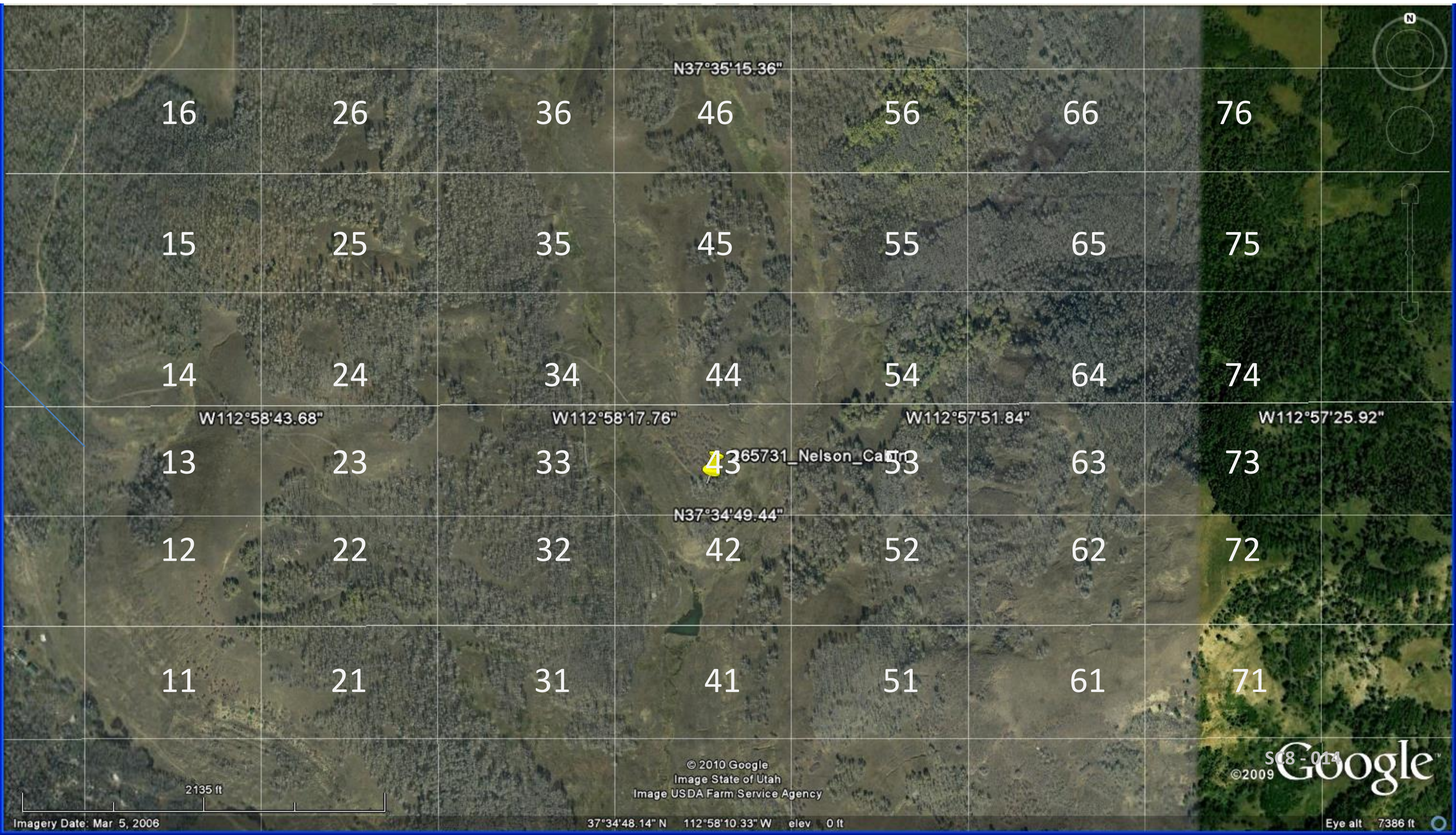
Day 3: Friday, 04 August 2017

1. Geophysics Slides – Water & Lightning
2. Marshmallow Guns
3. Races
4. Water Rockets
5. Revisit Favorite Site:
    1. Cascade Falls
    2. Mammoth Cave
    3. Cedar Breaks
6. Go to New Site
    1. Kanaraville Falls
    2. Spring Hill Canyon
    3. Taylor Creek
    4. Calf Springs Ranch
7. Swimming

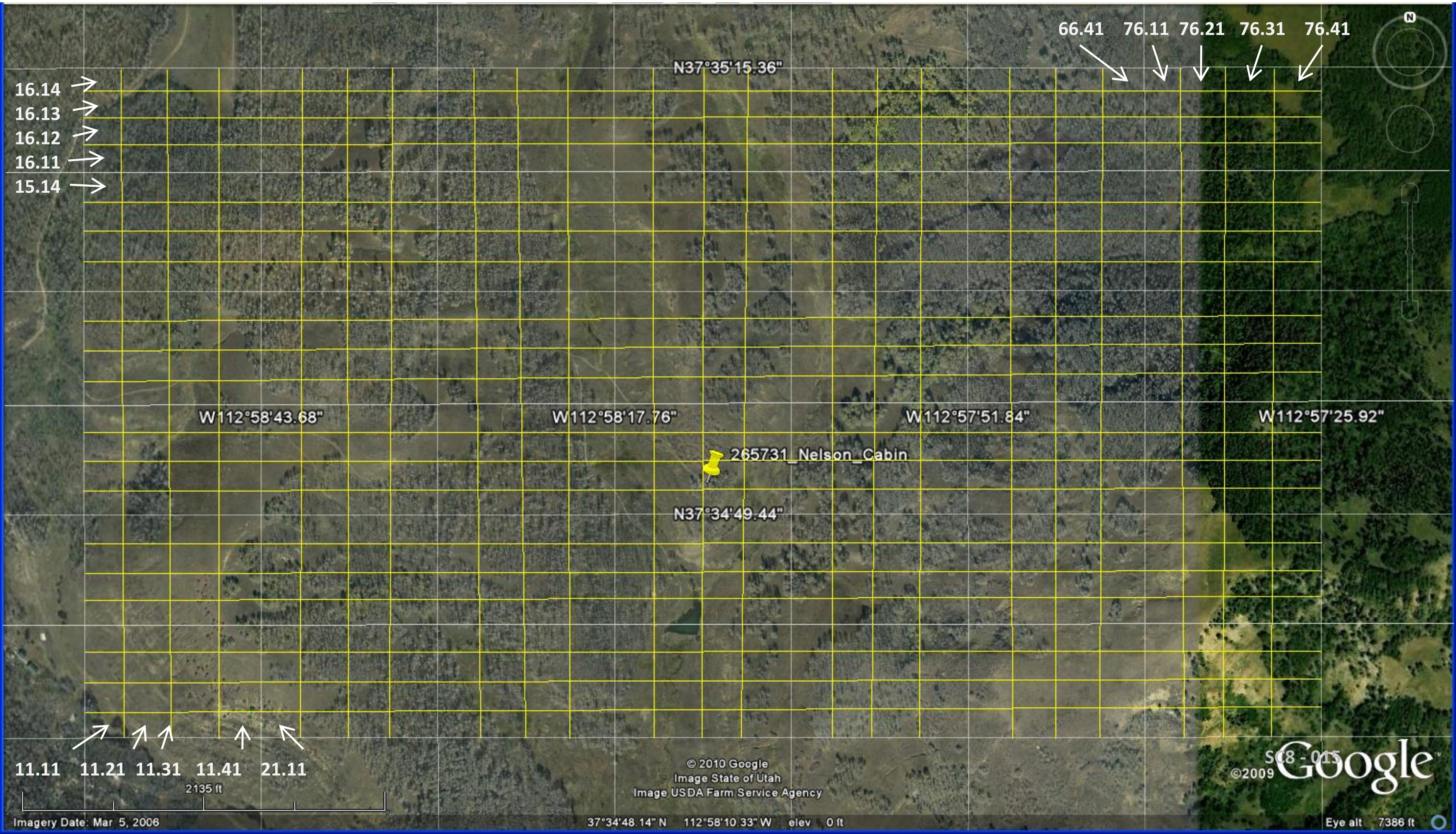
Nelson Cabin Map



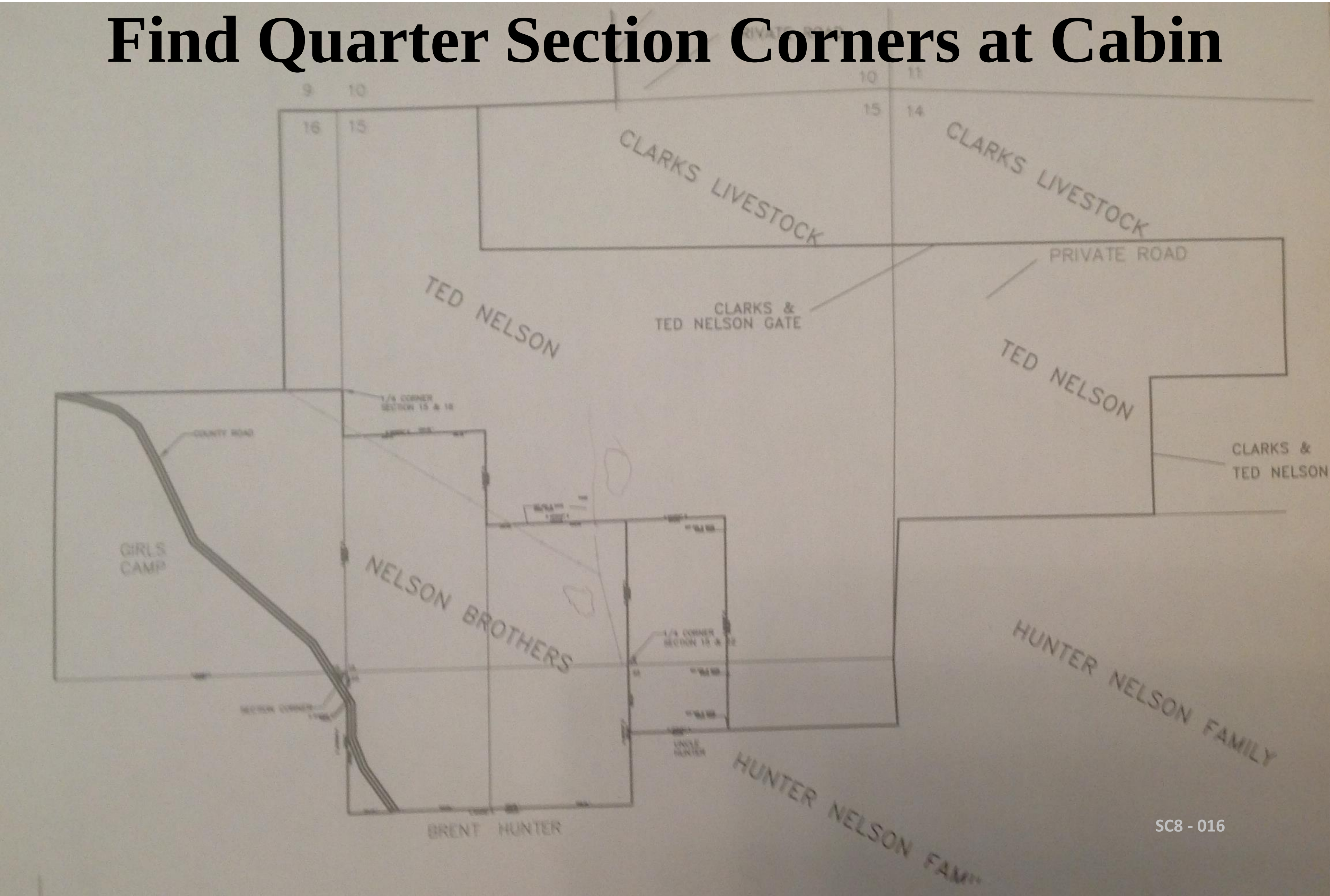
Reference Grid



More Detail Reference Grid



Find Quarter Section Corners at Cabin



Notes

1. Geography

A science that deals with the natural features of the earth and the climate, products, and inhabitants.

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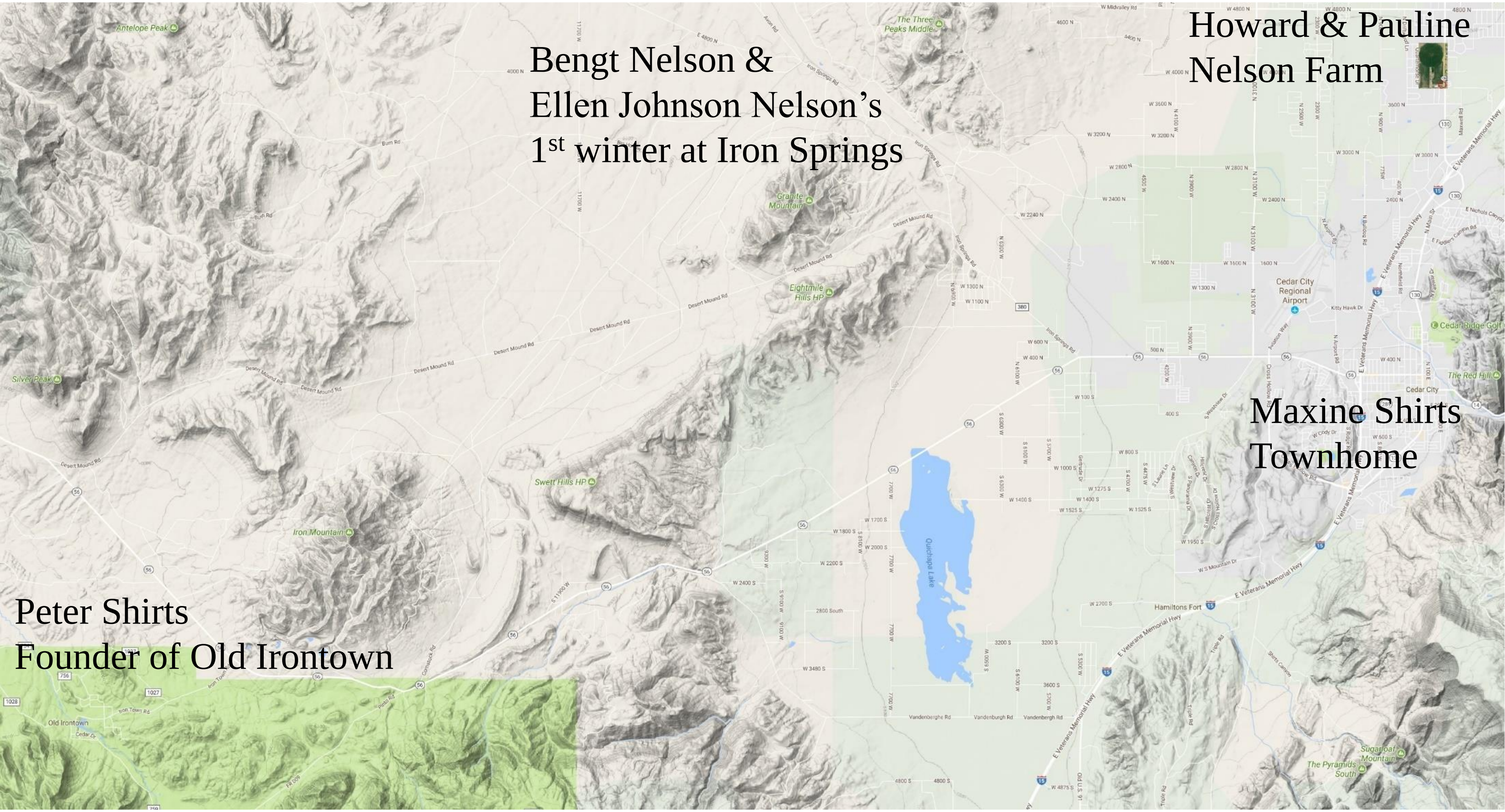
http://www.walden3d.com/photos/Grandkids_Science_Camps/170802-04_Science_Camp/1_Geography.pdf

Topography of Cedar Valley



Iron Springs – Bengt Nelson Dugout

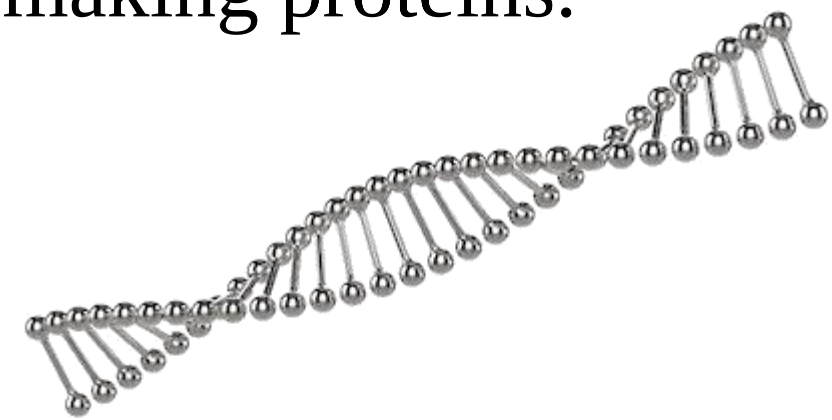
Old Irontown – Peter Shirts Legacy

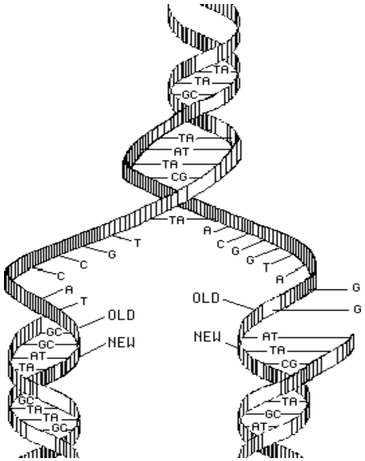
Notes

Wait not those Jeans!

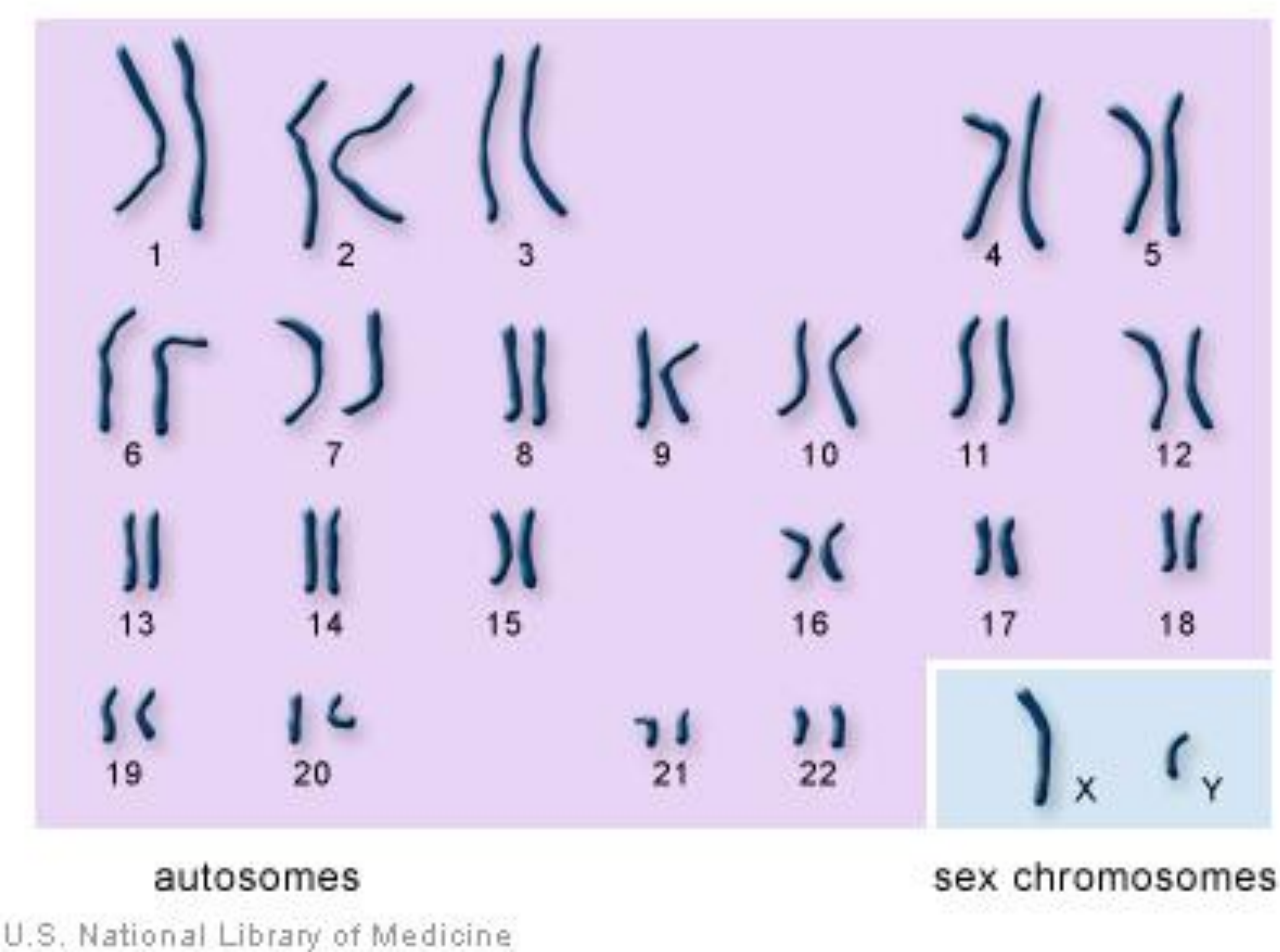
2. Genetics

The chemical code that is the basis of genetic inheritance and consists of triplets of three linked chemical groups in DNA and RNA which specify particular amino acids used to make proteins or which start or stop the process of making proteins.



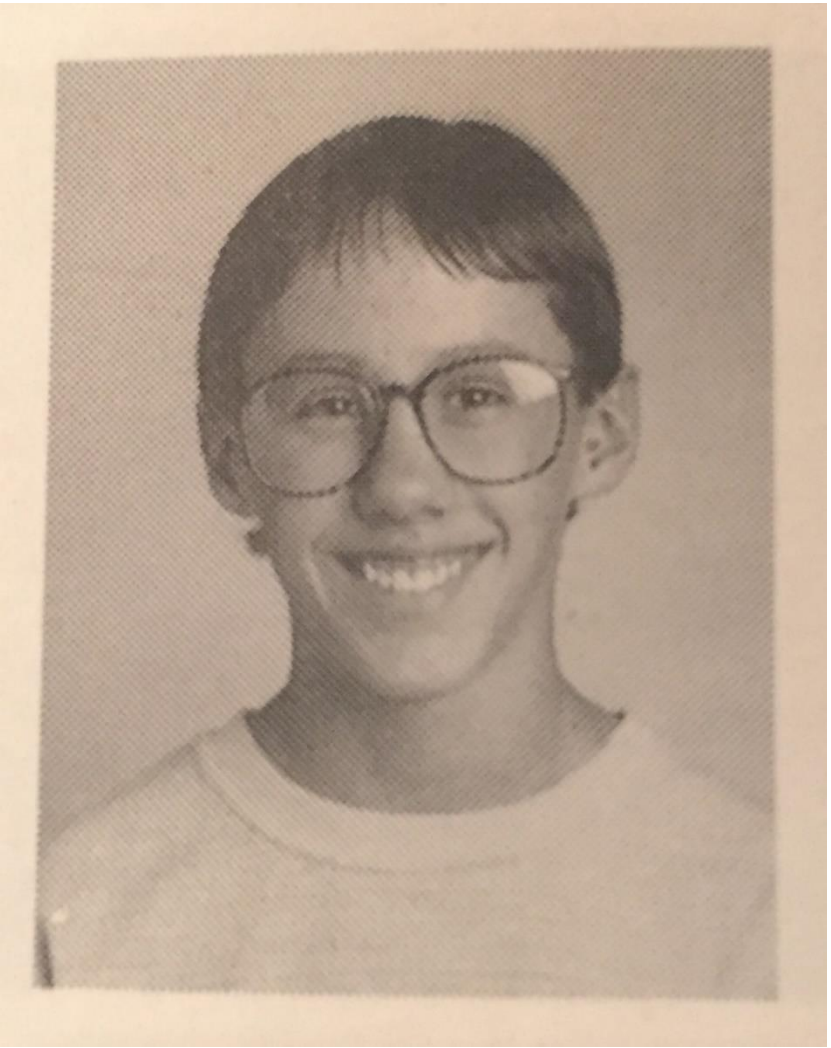


MY GENES and ME



https://youtu.be/ubq4eu_TDFc
https://www.youtube.com/watch?v=tJjXpiWKMyA

YOU ARE UNIQUE!
YOU BELONG!



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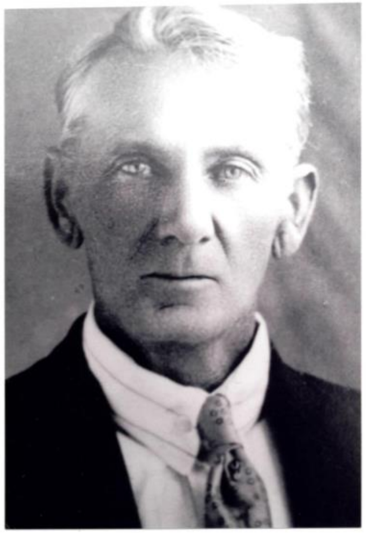
MINI ME'S




http://learn.genetics.utah.edu/content/basics/traits/

Dominant and Recessive Genes



Blue/light eyes can be passed down from generation to generation.

Dominant genes may be invisible.

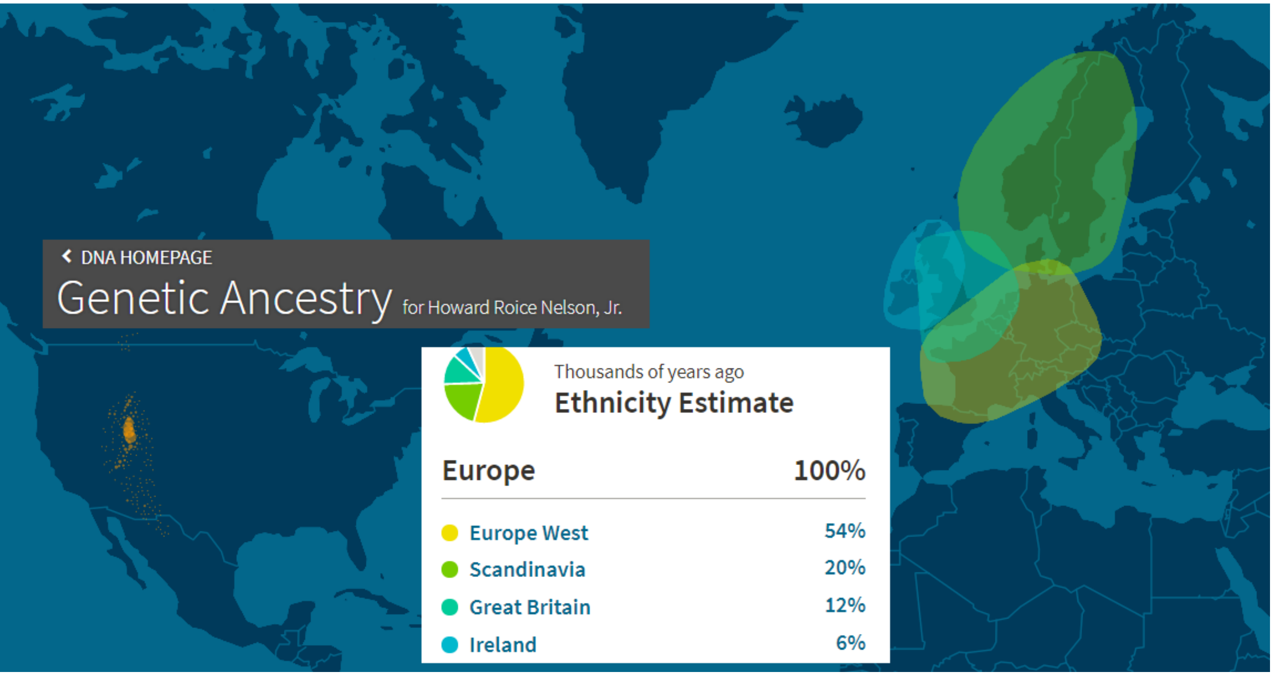
https://www.youtube.com/watch?v=mnSkz8s-b44

Where did Sophie get her blue eyes and blonde hair?

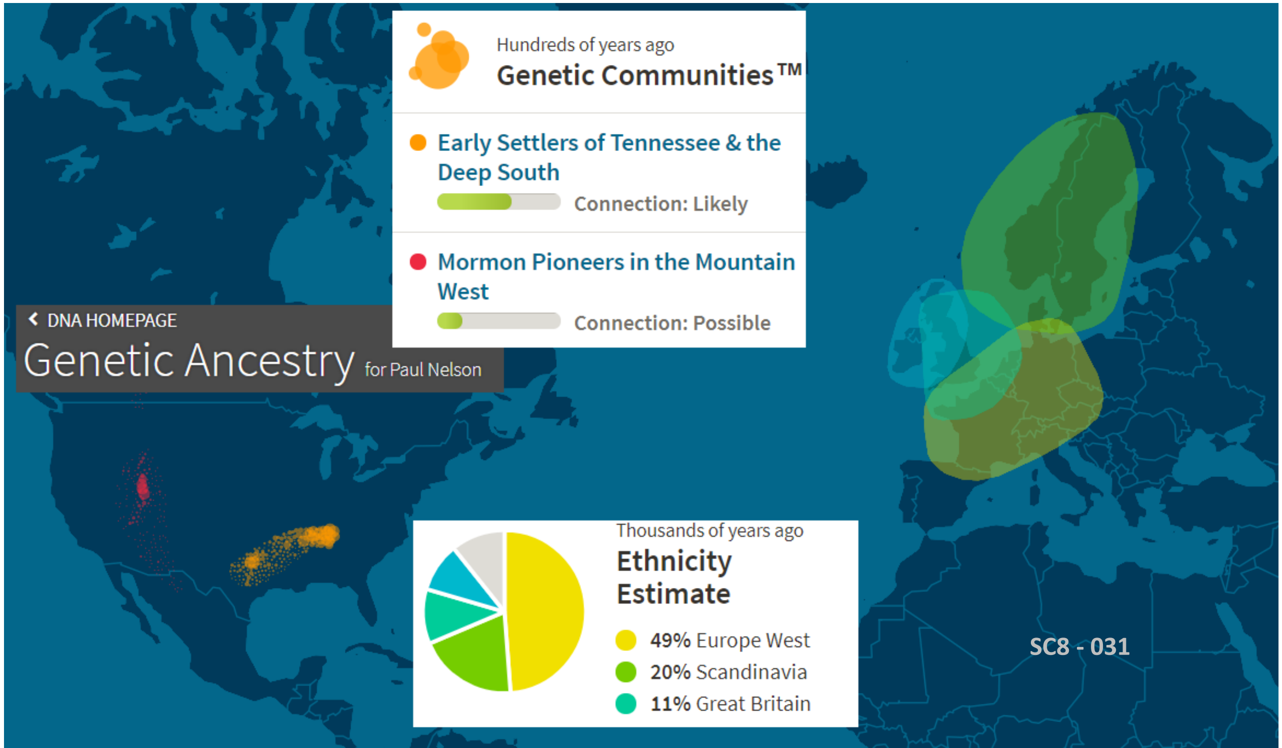
VARIANT'S

Mapping variances through genealogy can help in disease research.

Grandpa



Uncle Paul Nelson



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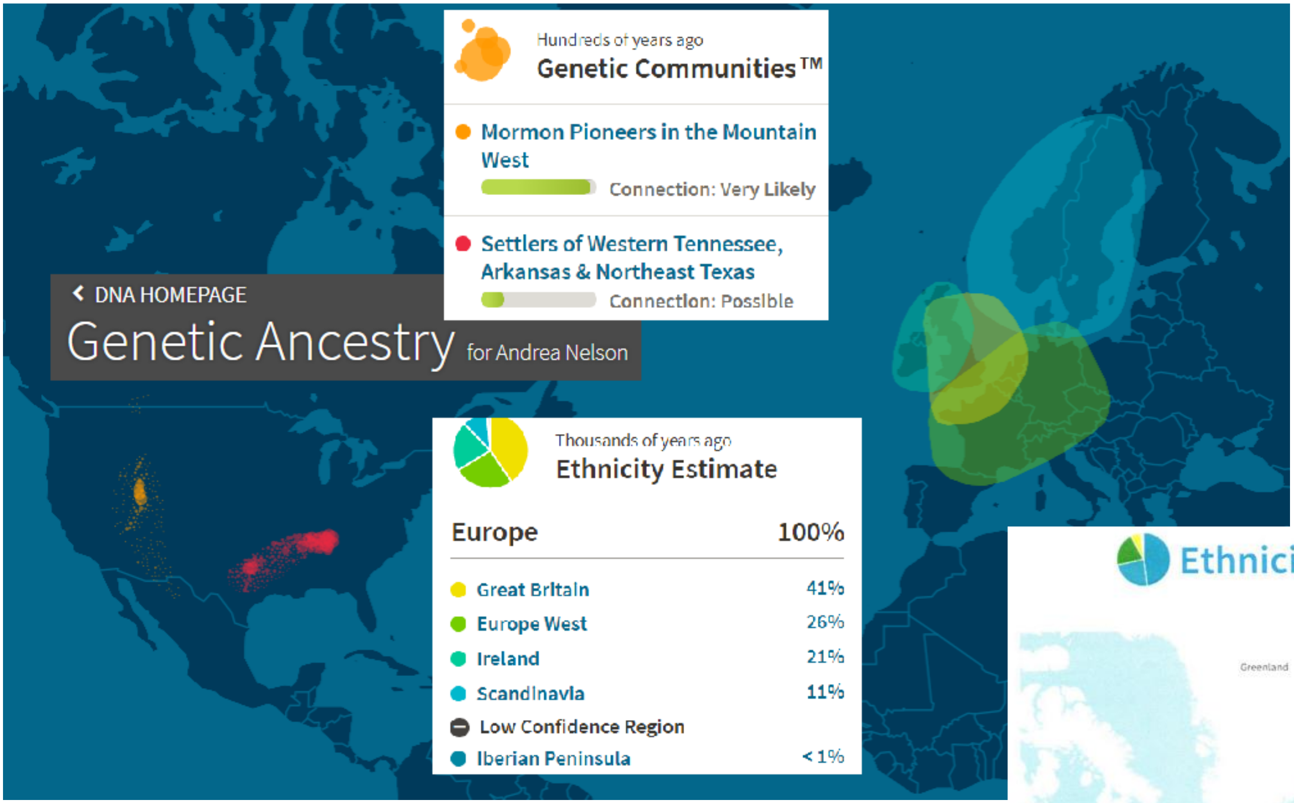
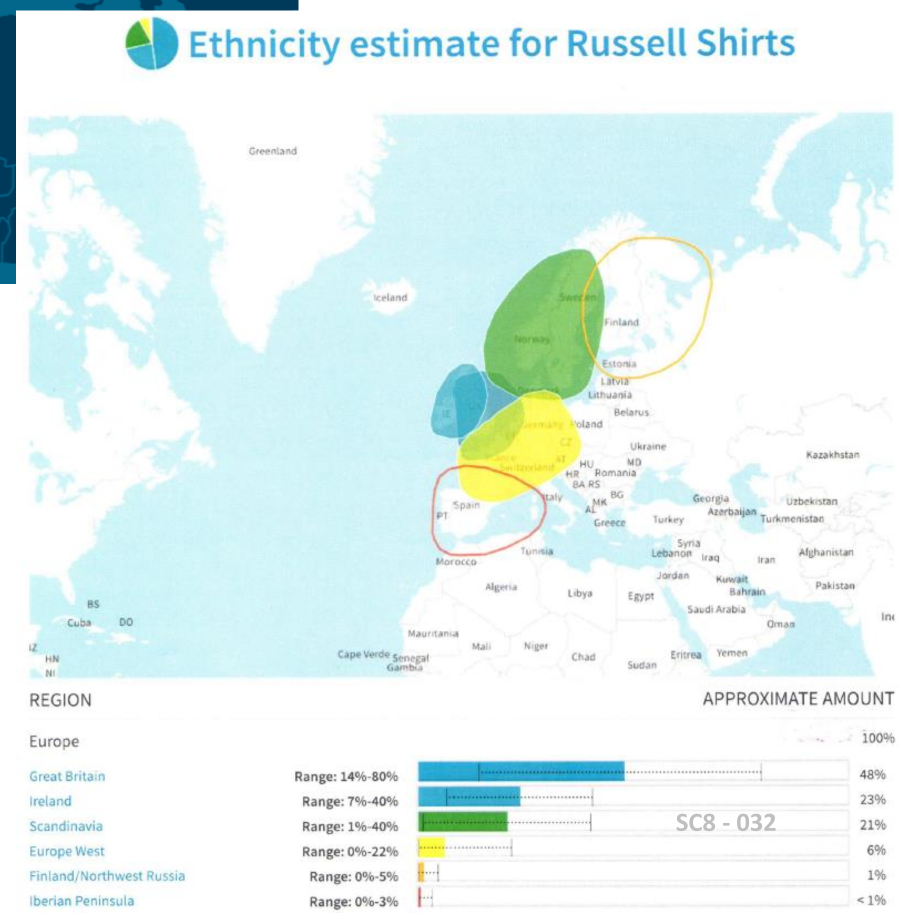
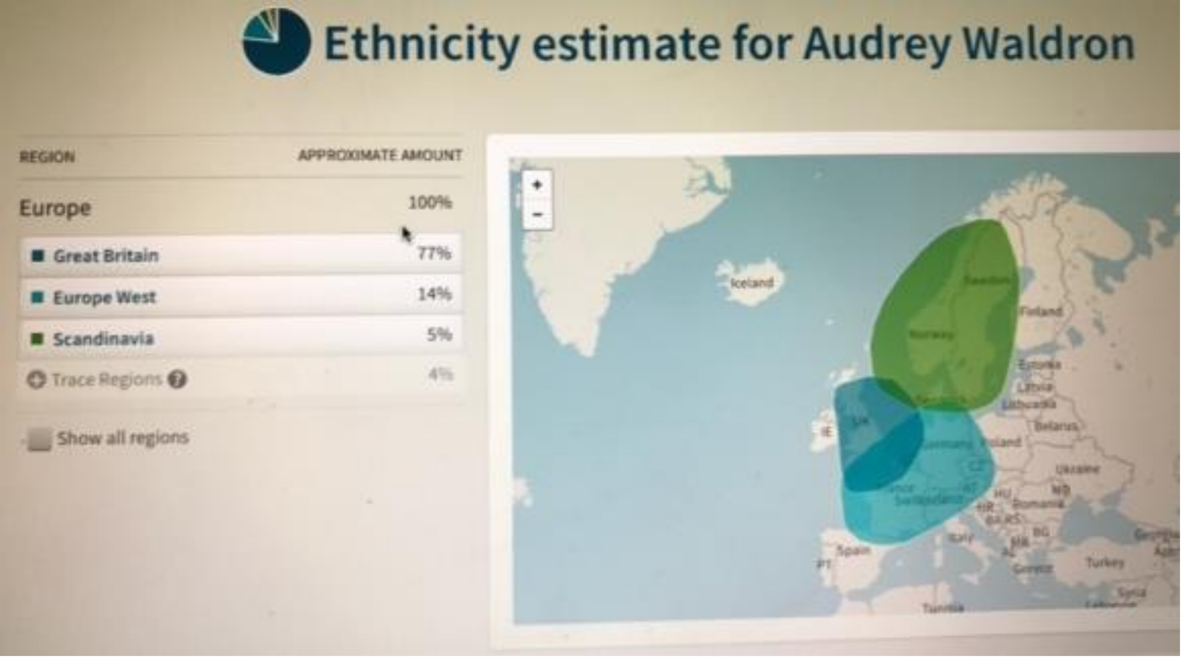


Grandma

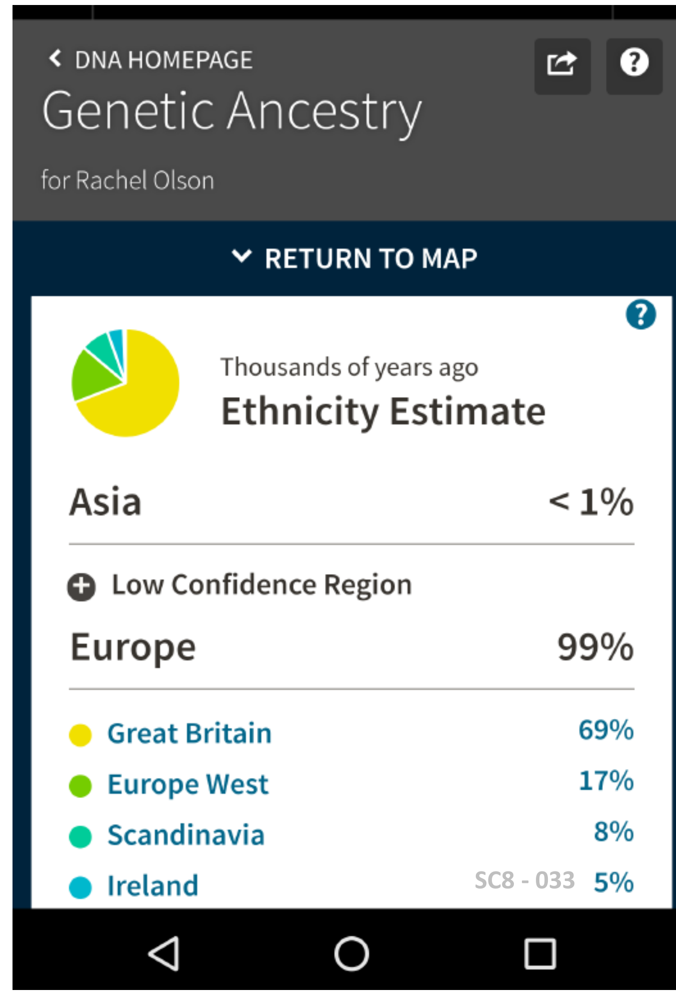


Uncle Russell Shirts



Aunt Audrey Waldron

Aunt Rachel Olson

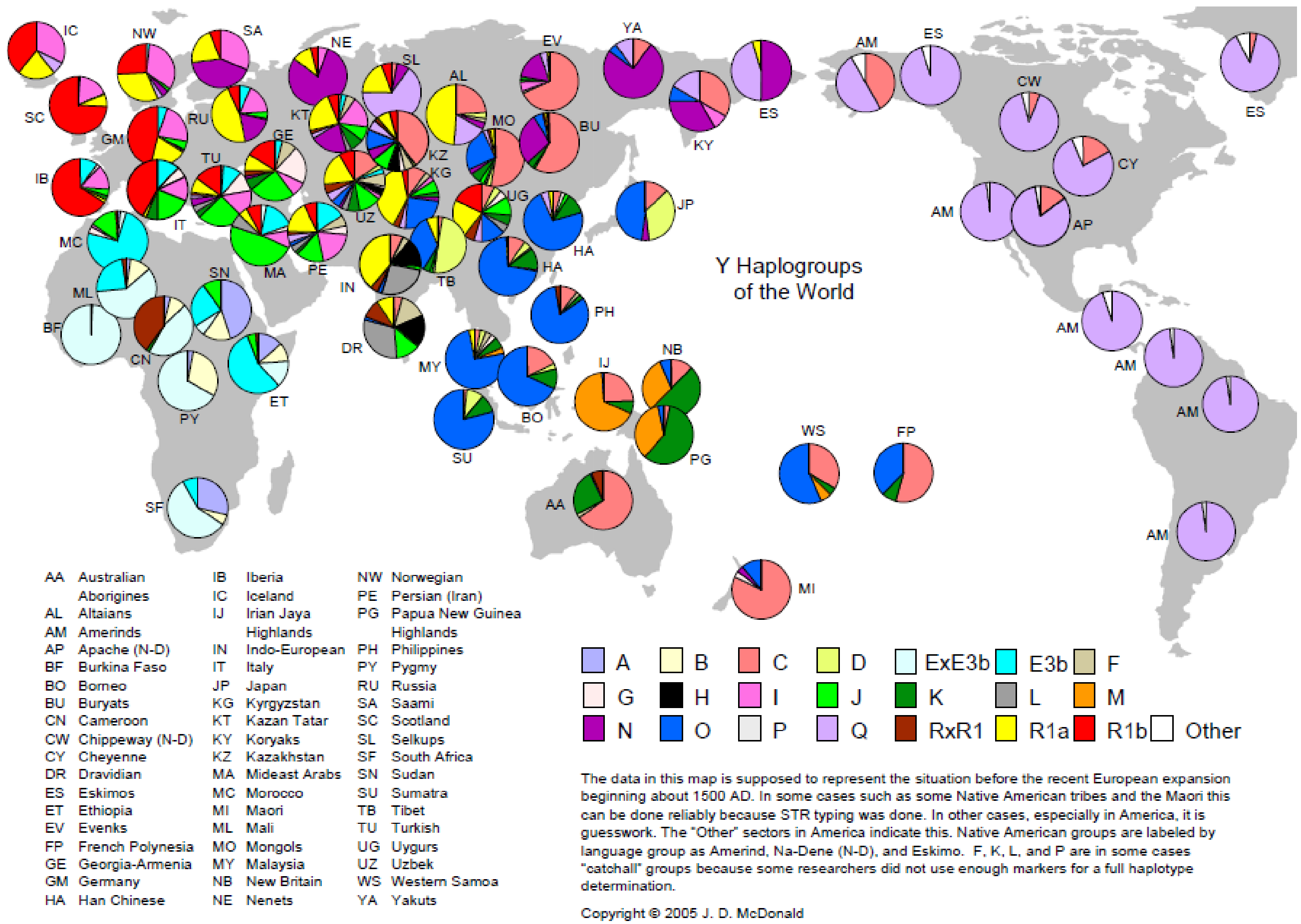


Summary

	Grandpa	Uncle Paul	Grandma	Uncle Russell	Aunt Audrey	Aunt Rachel
Europe West	54%	59%	26%	6%	14%	17%
Scandinavia	20%	20%	11%	21%	5%	8%
Great Britain	12%	11%	41%	48%	77%	69%
Ireland	6%	-	21%	23%	-	5%
Finland and NW Russia	-	-	-	1%	-	-
Iberia Peninsula	-	-	<1%	<1%	-	-

Genetics can help solve Genealogical problems

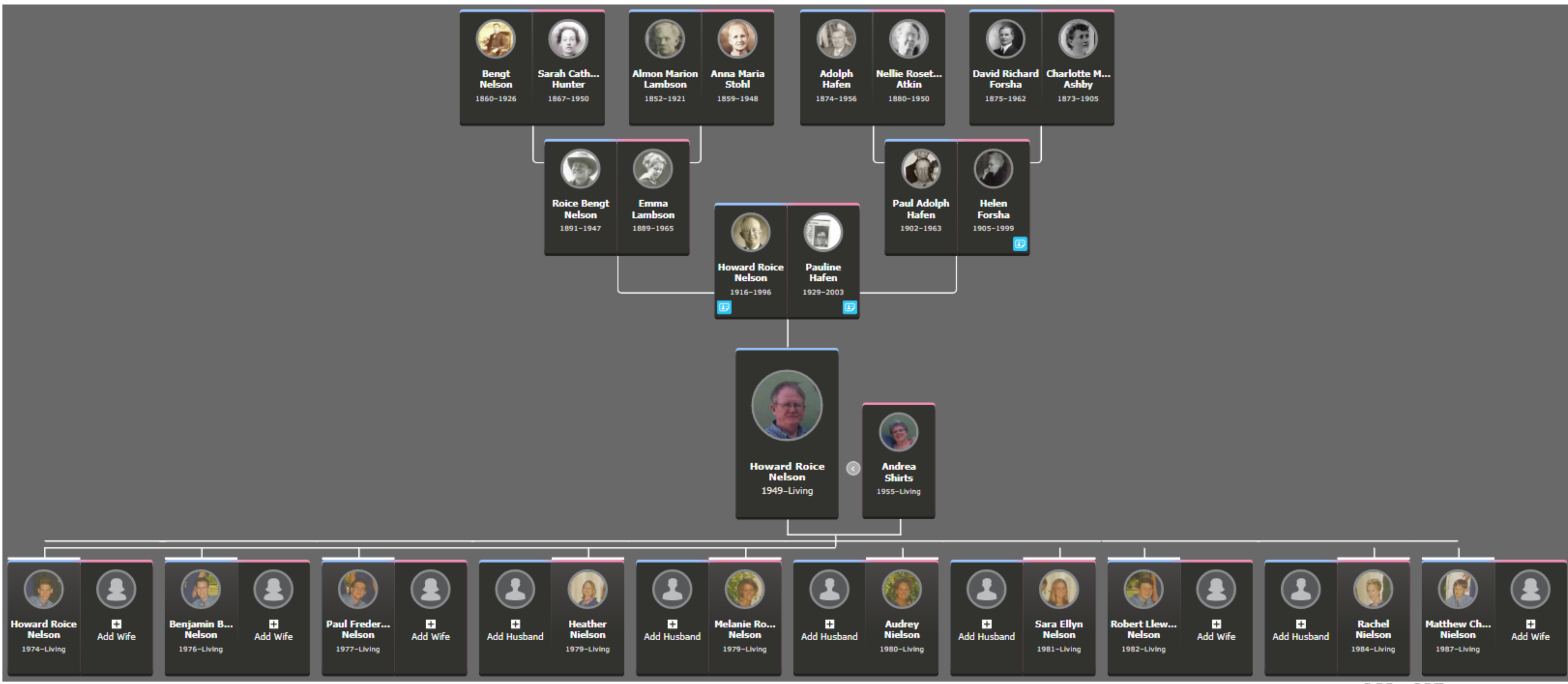
Baird solution - Rutledge problem



Notes

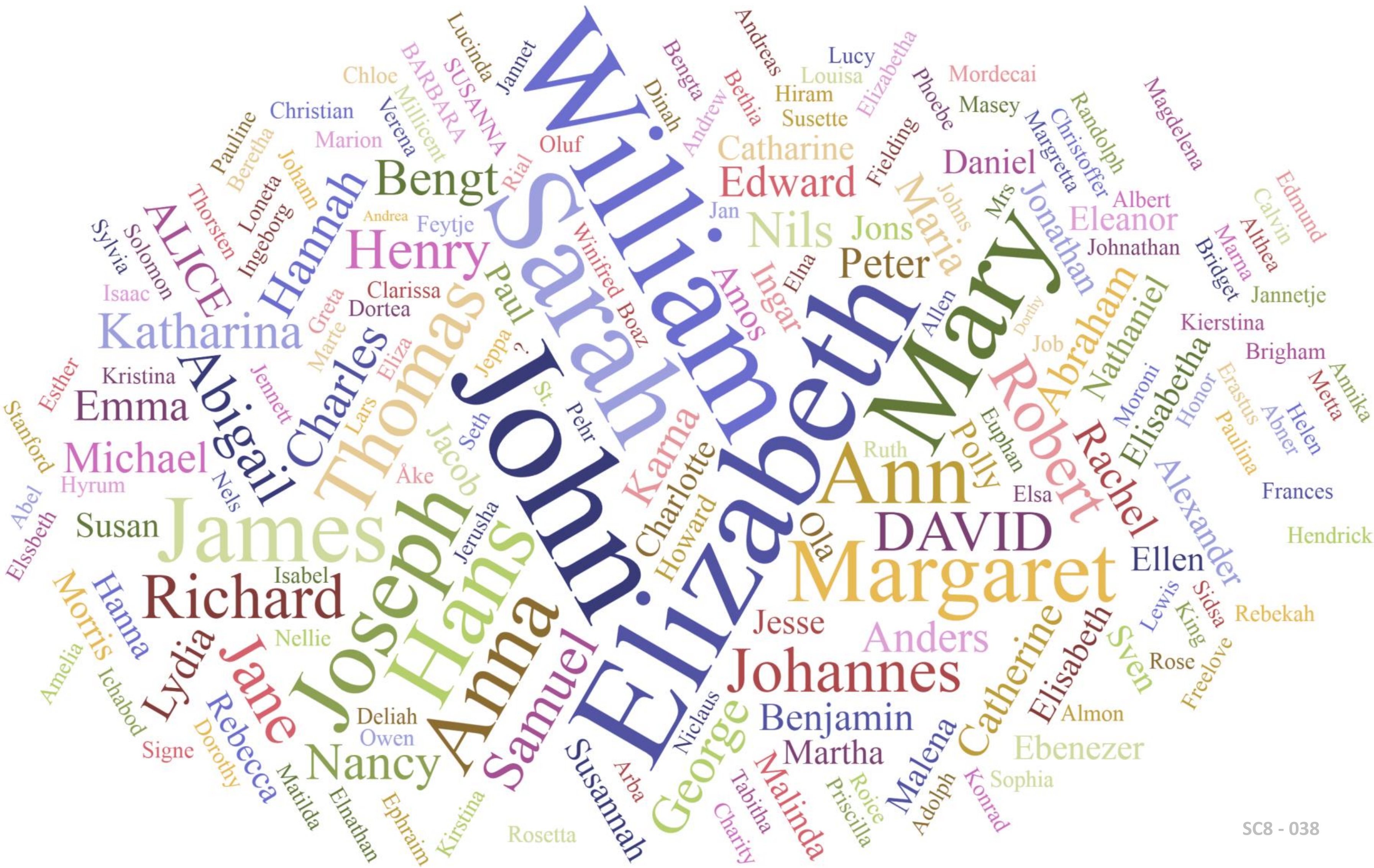
3. Genealogy

The study of family pedigrees.



http://www.walden3d.com/photos/Grandkids_Science_Camps/170802-04_Science_Camp/3_Genealology.pdf

Genealogy Cloud



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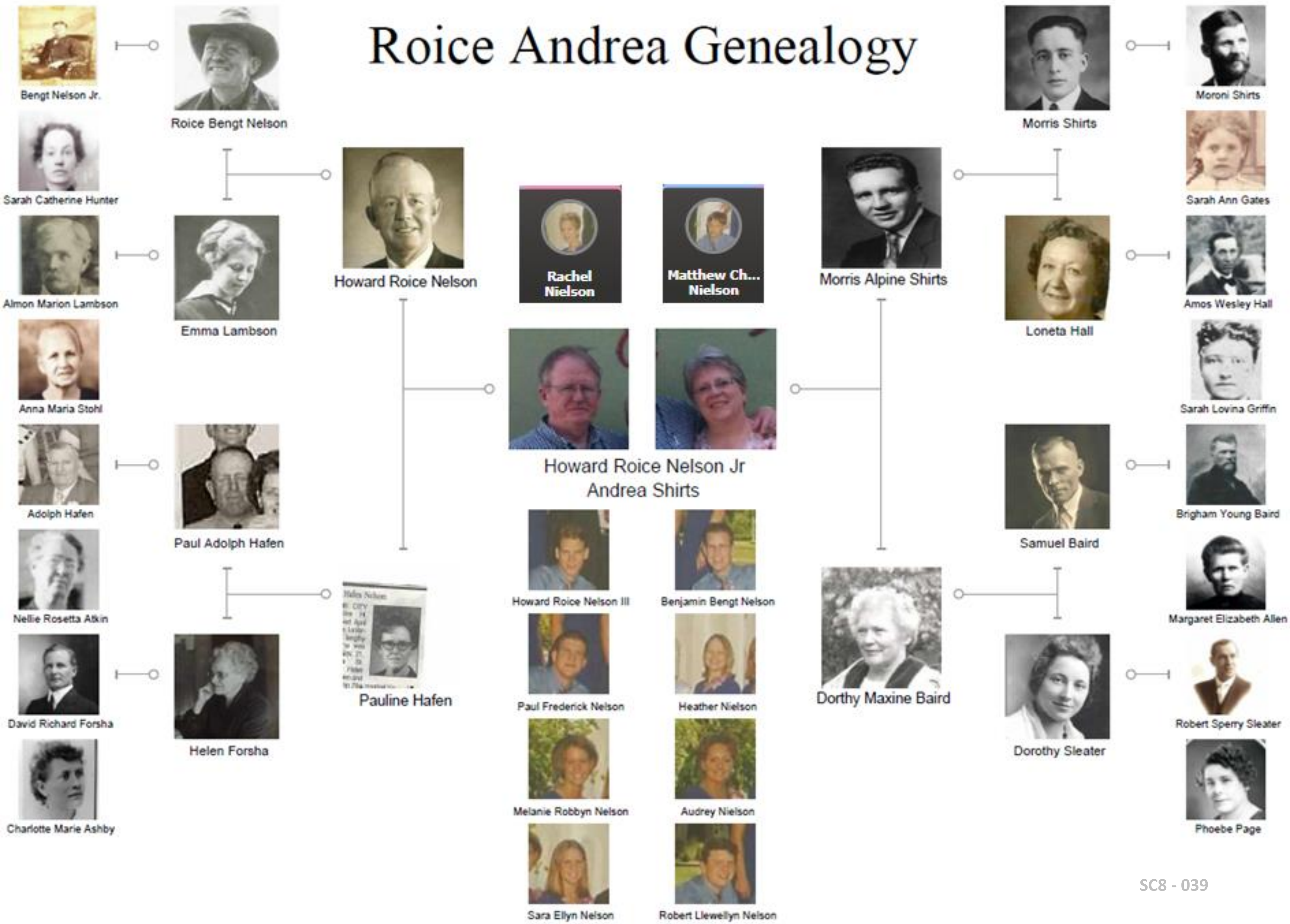
Roice Andrea Genealogy

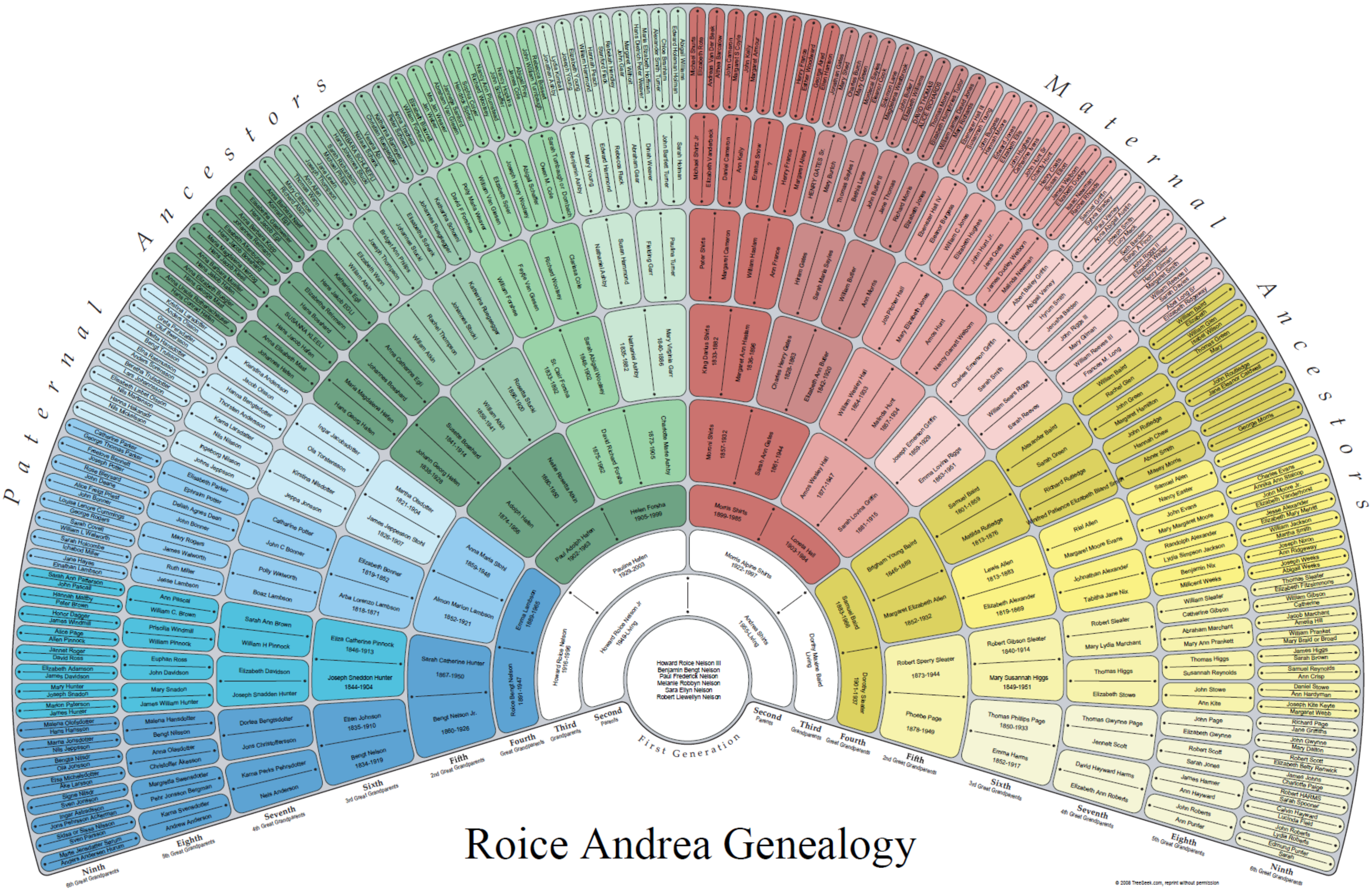


4. Grandma

The mother of one’s father or mother.

http://www.walden3d.com/photos/Grandkids_Science_Camps/170802-04_Science_Camp/4_Grandma.pdf

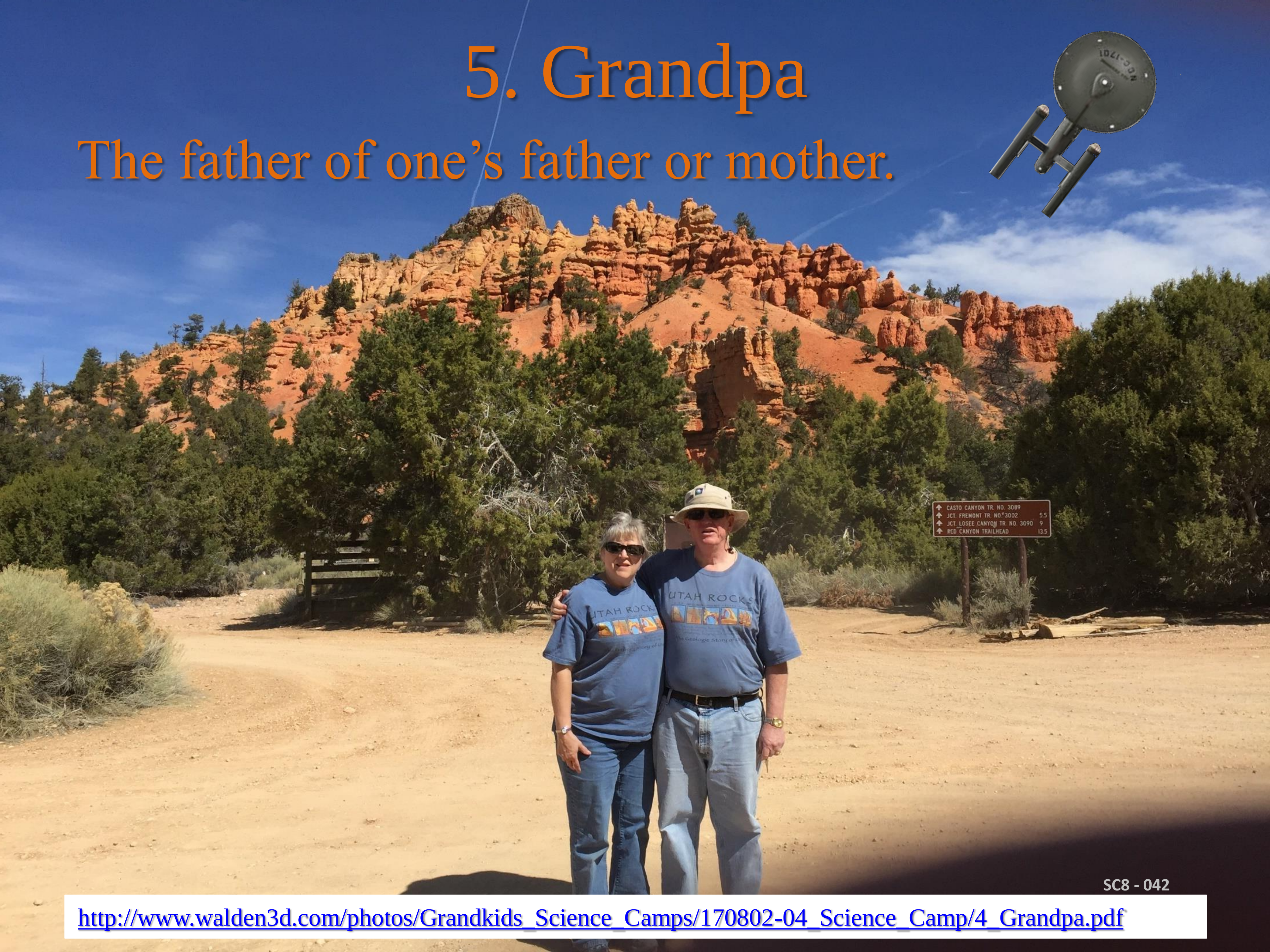
9-Generation Fan Chart



Roice Andrea Genealogy

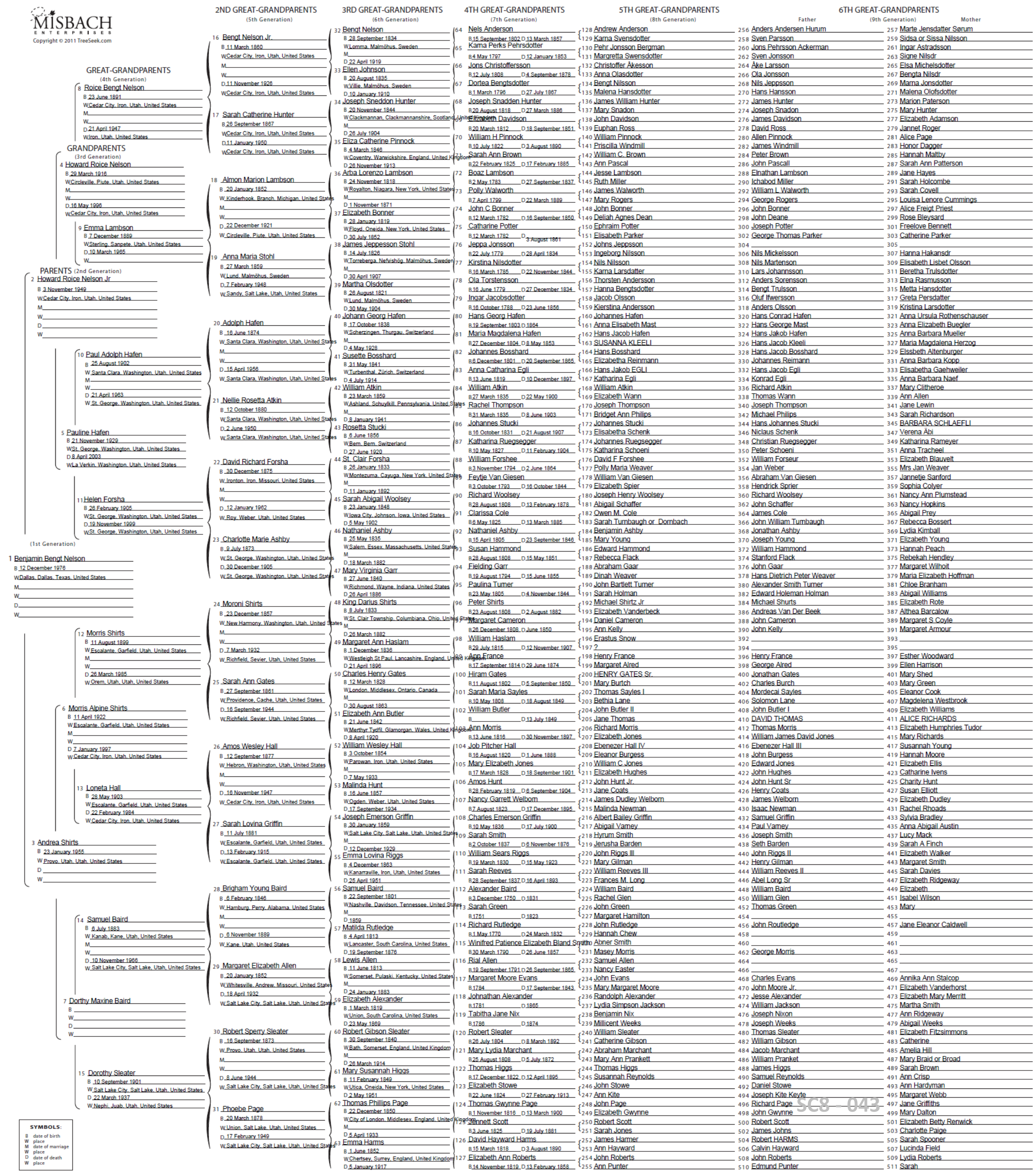
5. Grandpa

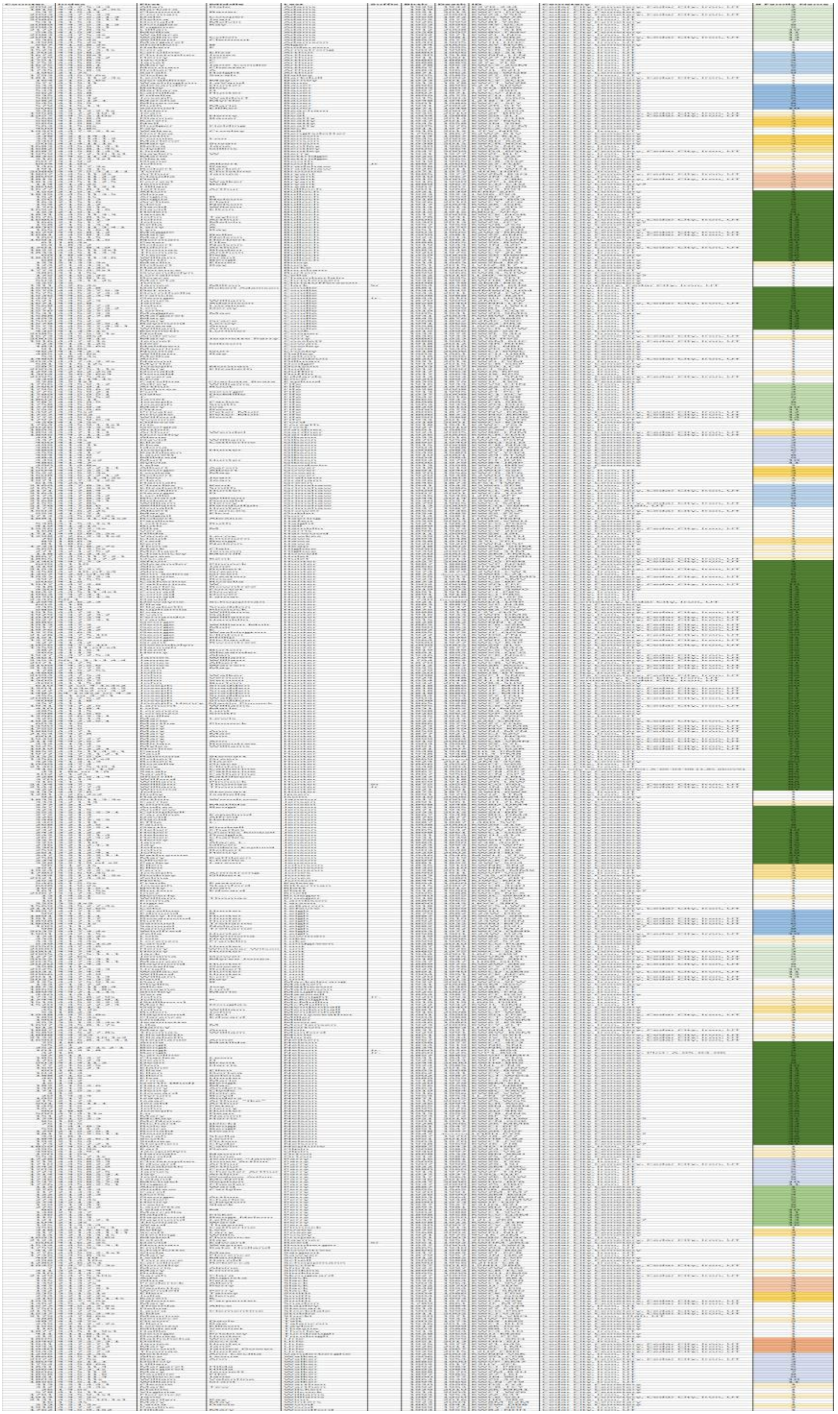
The father of one's father or mother.



http://www.walden3d.com/photos/Grandkids_Science_Camps/170802-04_Science_Camp/4_Grandpa.pdf

Nine-Generation Tree



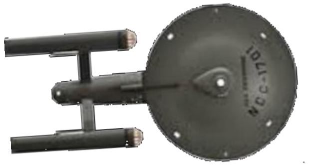


14, Adams
9, Arthur
9, Bauer
6, Bryant
28, Bulloch
17, Condie
15, Fife
11, Gibson
9, Grimshaw
91, Hunter
25, Jensen / Jenson
10, Leigh
13, Lunt
41, Nelson
11, Parry
16, Perry
6, Slack
6, Urie
11, Walker

556 of Grandpa's Cousins are buried in the Cedar City Cemetery

Notes

6. Geology



The science that deals with the history of the earth and its life especially as recorded in rocks.

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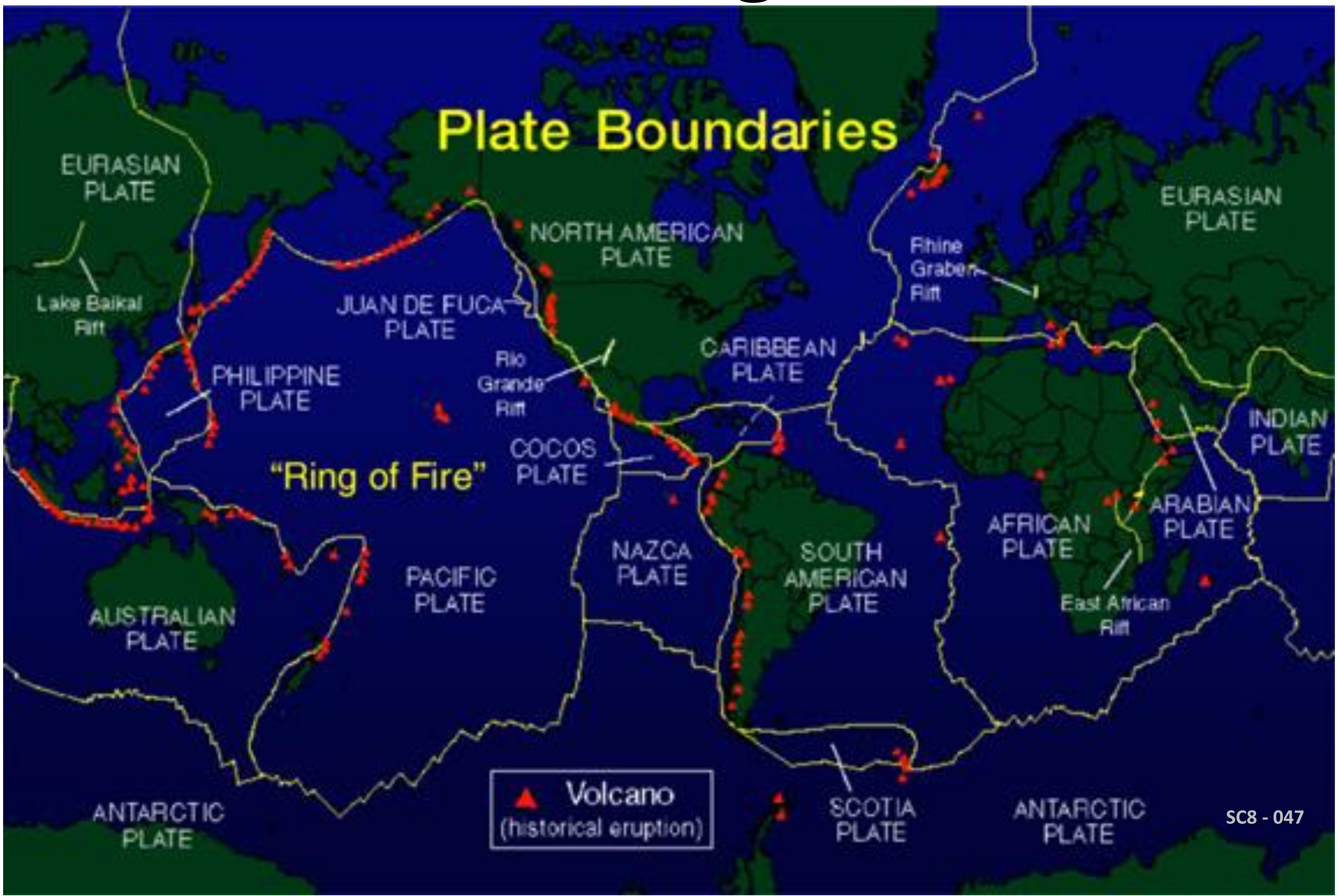
http://www.walden3d.com/photos/Grandkids_Science_Camps/170802-04_Science_Camp/6_Geology.pdf

Plate Tectonic Movements Control Geologic Growth



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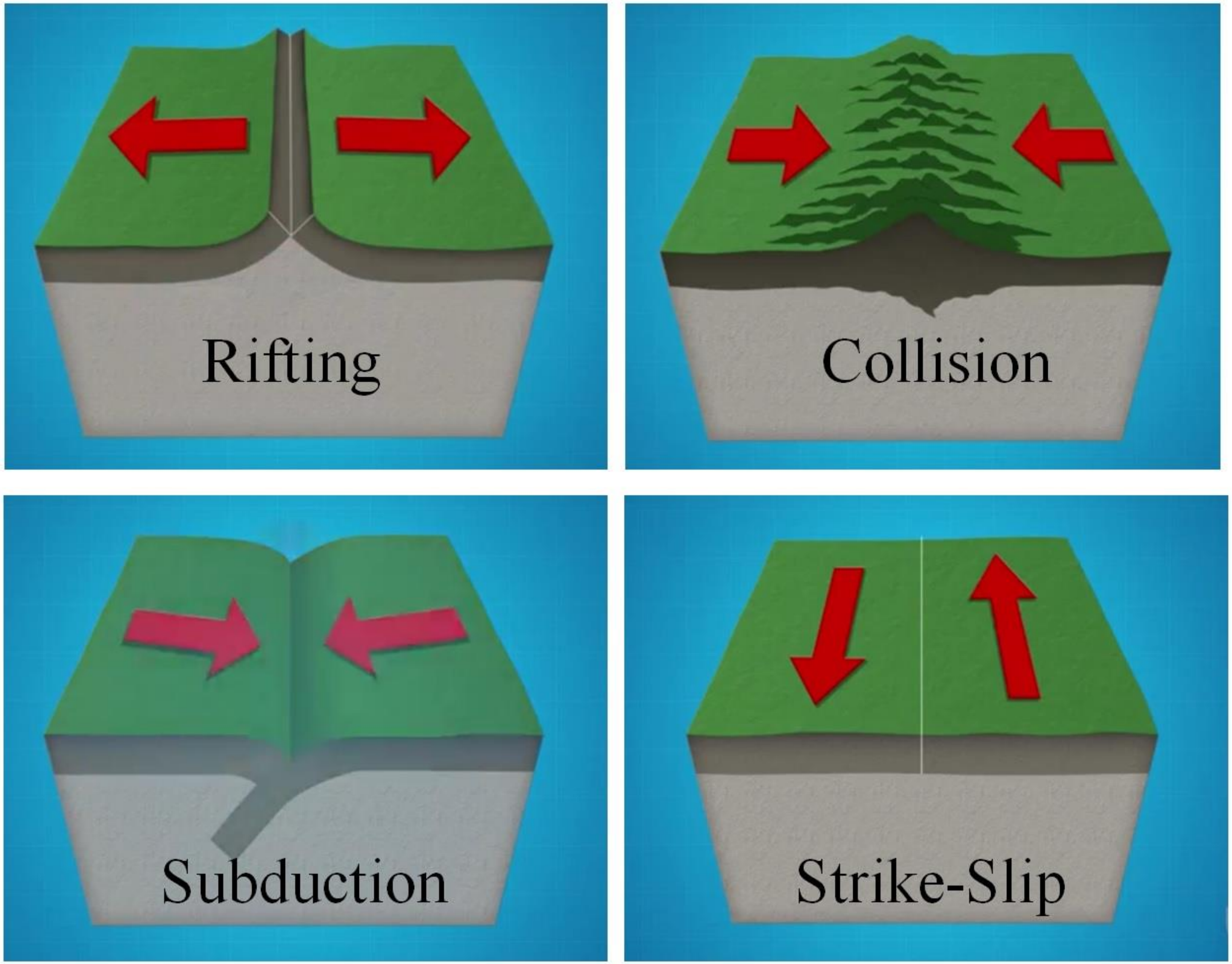
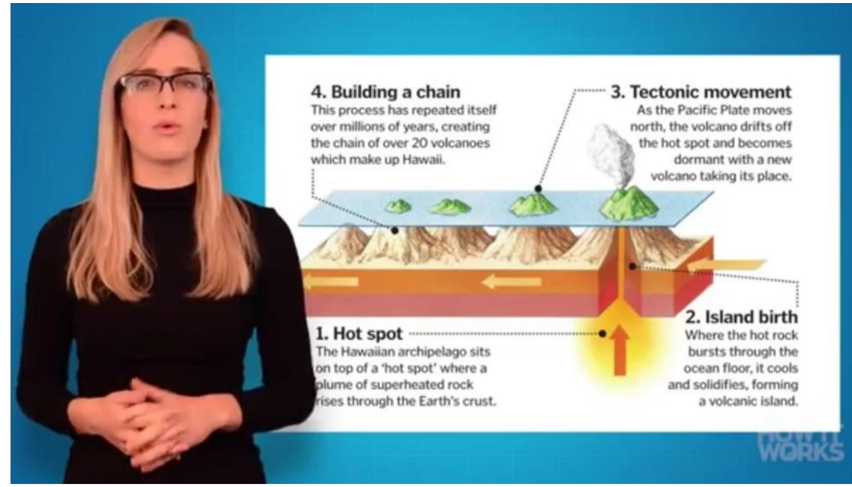
Types of Plate Movement

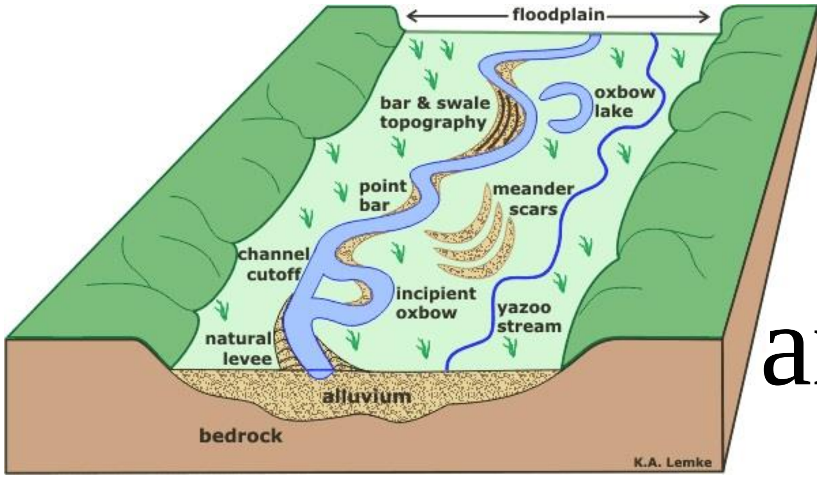


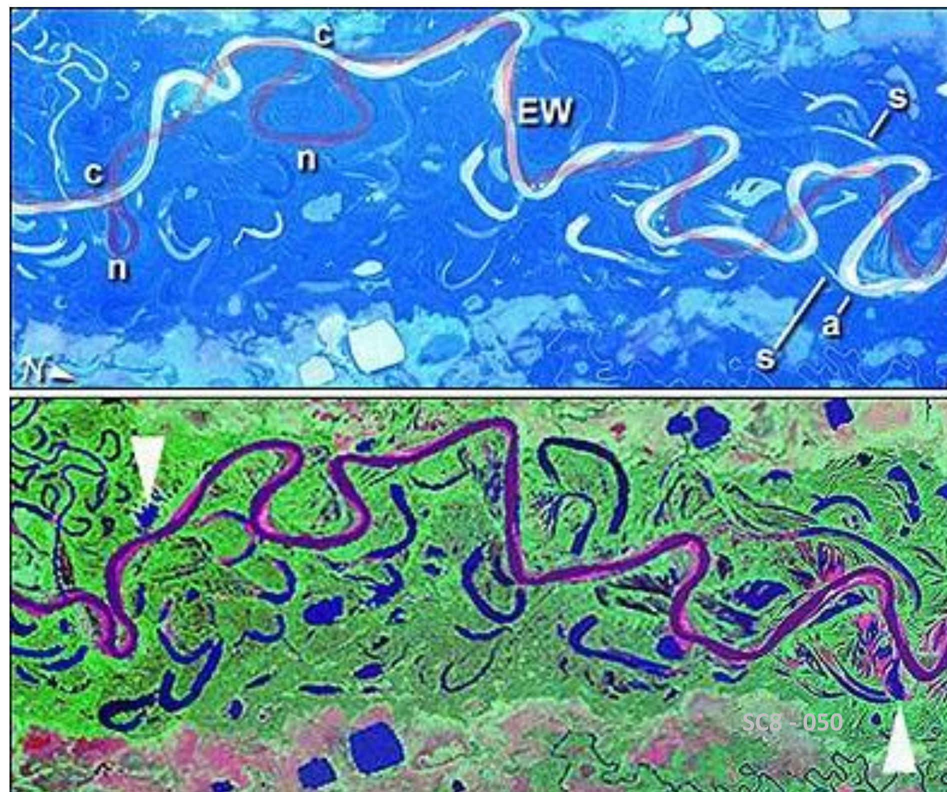
As Plates Move over Hot Spots Volcanic Islands Form



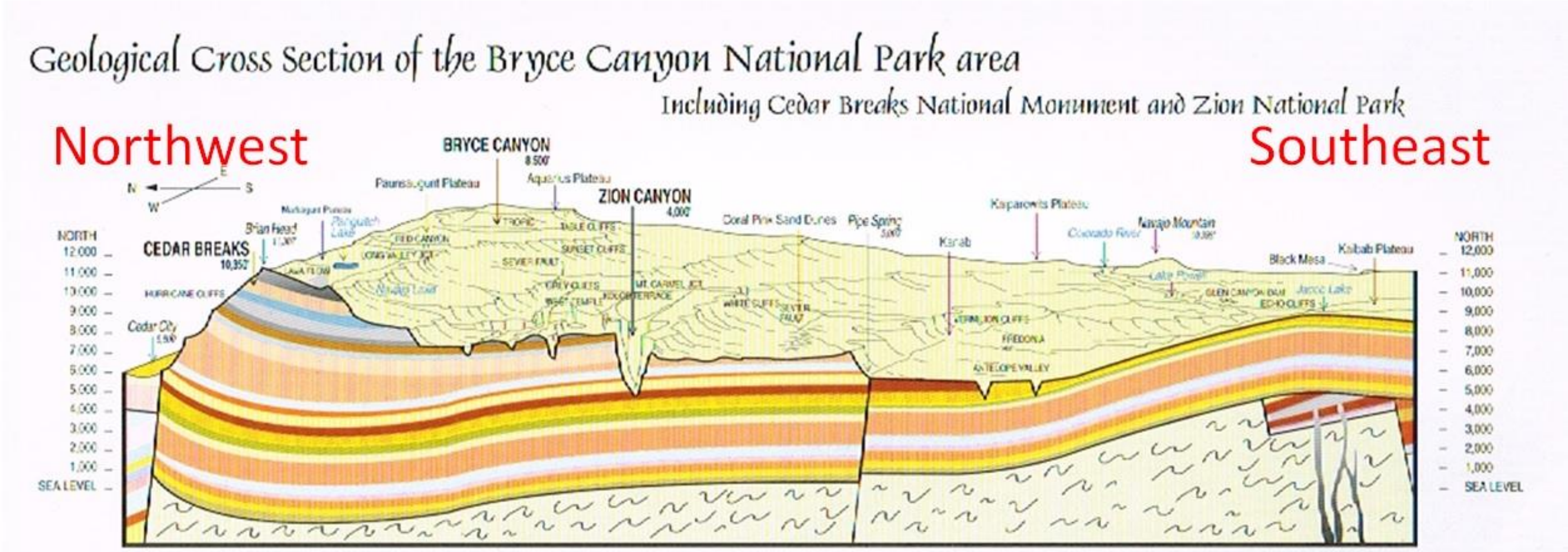
From: http://en.wikipedia.org/wiki/Santa_Clara_Volcano

As Mountains Erode, they form deltas, alluvial flood plains, and sedimentary layers

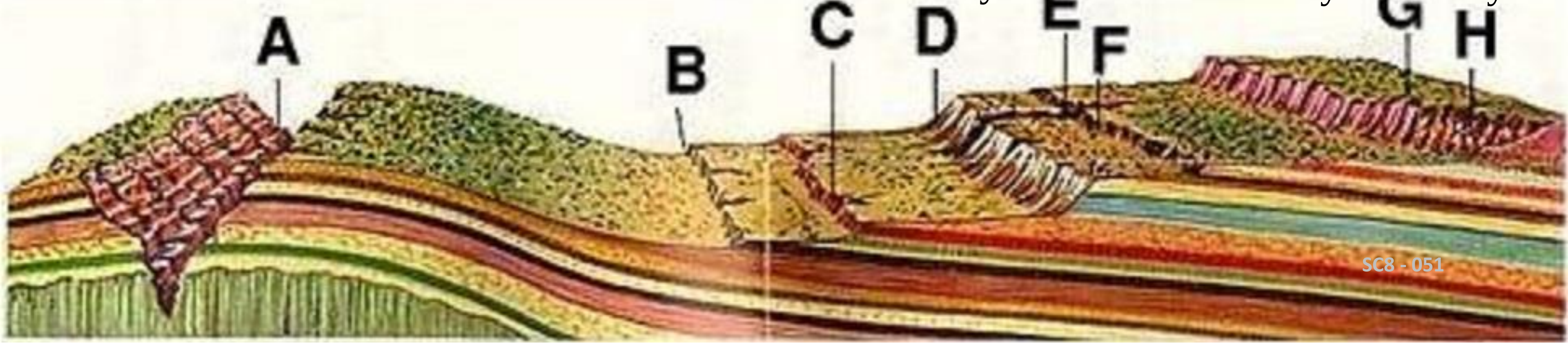




Layers define Southern Utah



A: Grand Canyon
B: Chocolate Cliffs
C: Vermilion Cliffs
D: White Cliffs
A: Zion Canyon
F: Gray Cliffs
G: Pink Cliffs
H: Bryce Canyon



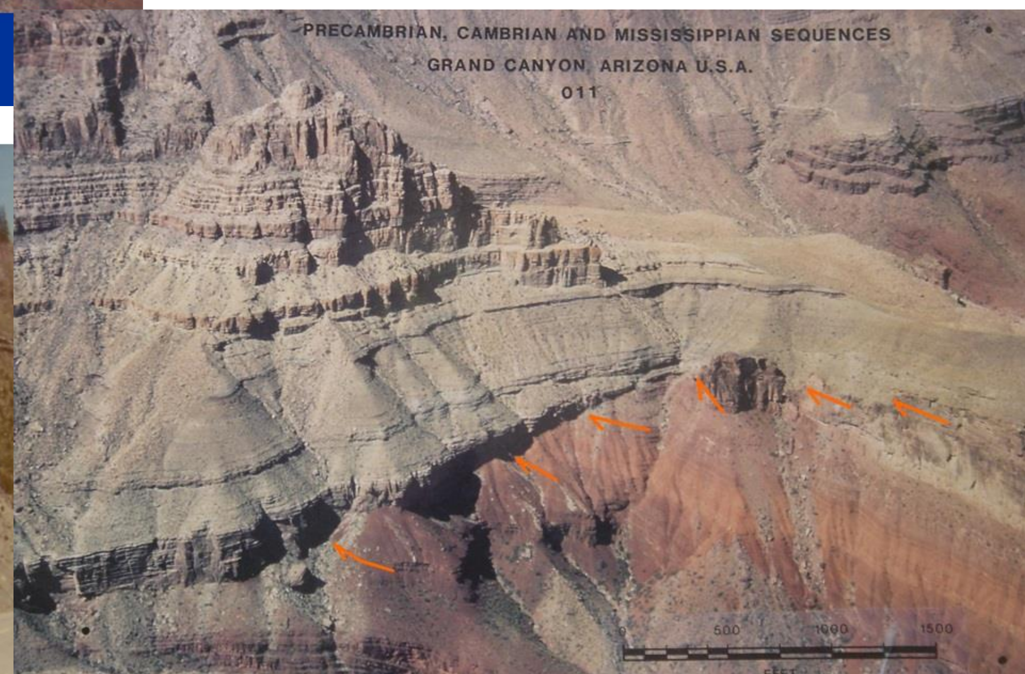
Layered Cliffs by The Glitter Pit

Layers Include Petrified Sand Dunes

Geologic Patterns, Like Sand Dunes Occur at Multiple Scales

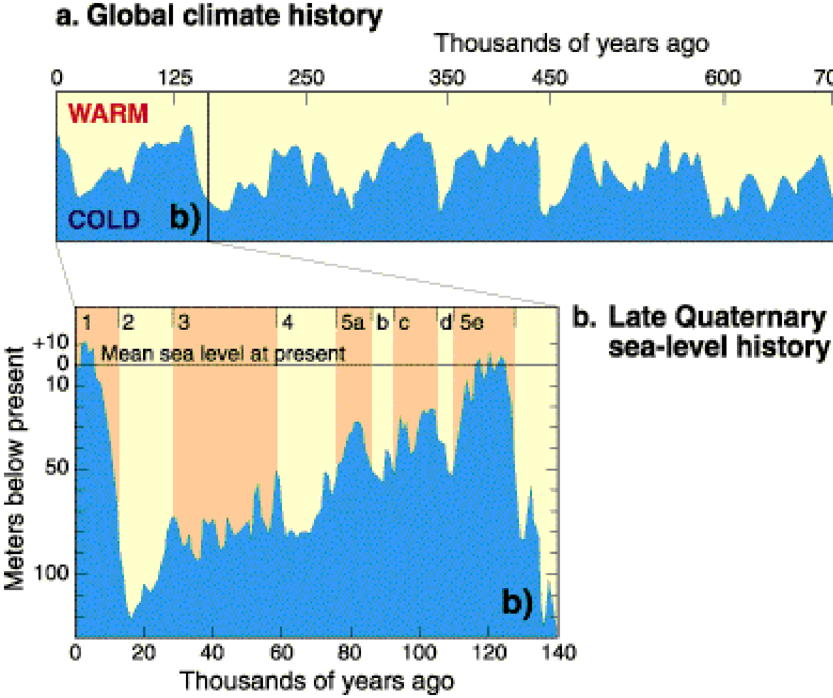
These Boundaries Define Major Geologic Change Like Sea Levels

Sequence Boundaries

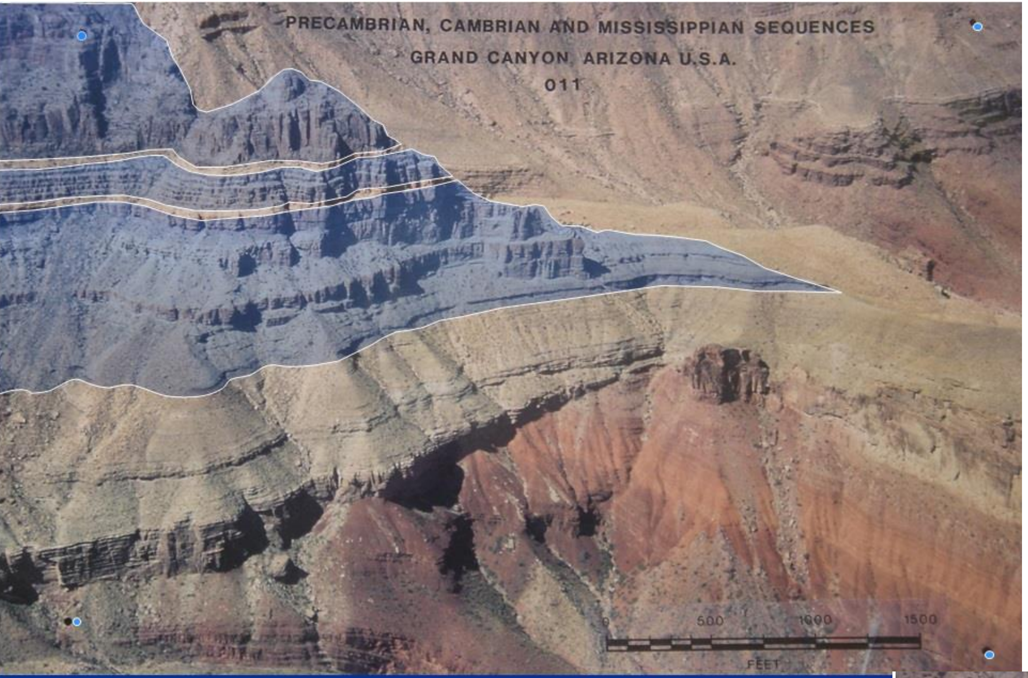


Truncations

As Sea Level Rises, Sands Are Deposited on Erosional Surfaces

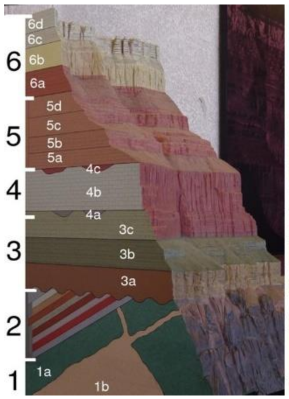


Basal Transgressive Sand

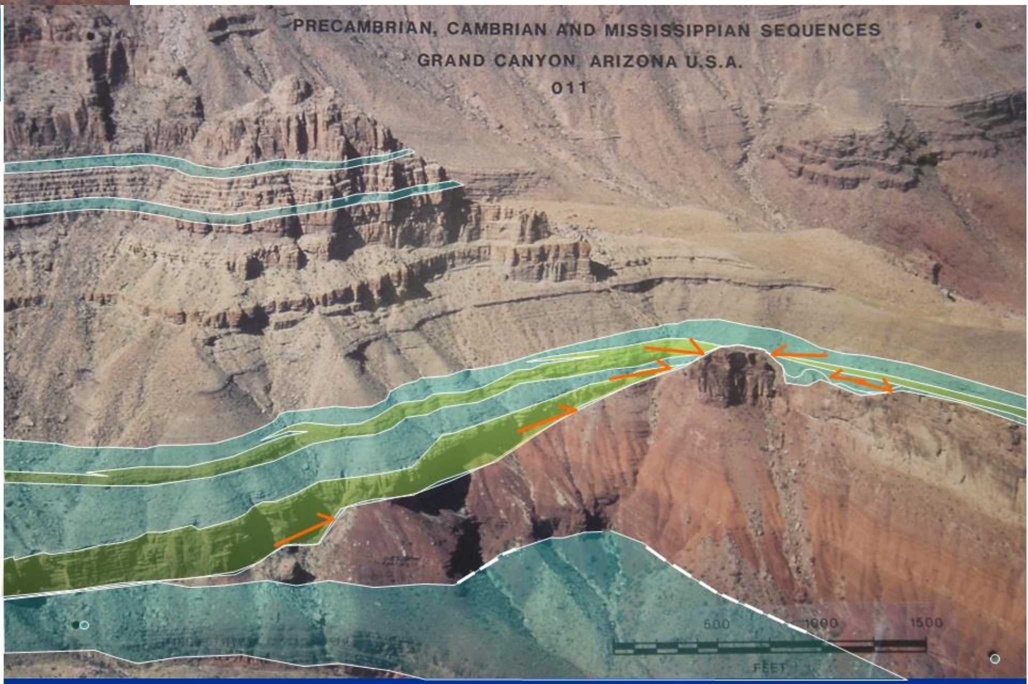


Inter-High Sea-Level Times Form Similar Geologic Layers

Shelf Carbonates



Worldwide, these layers are best studied in Southern Utah and at the Grand Canyon



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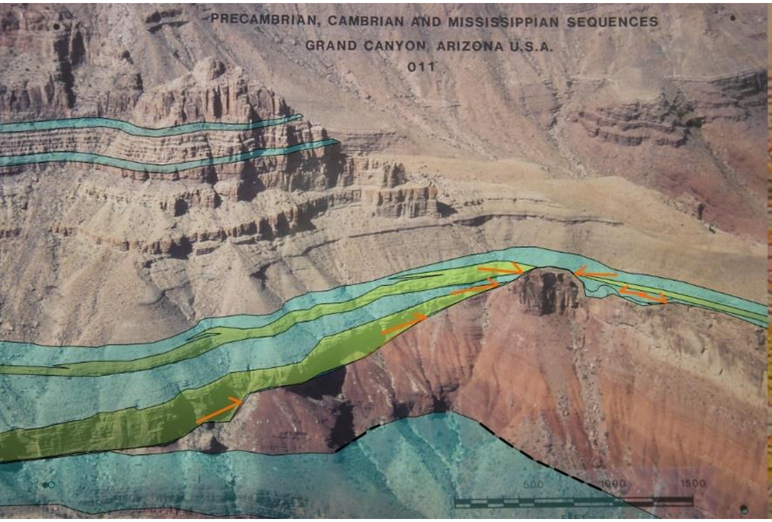
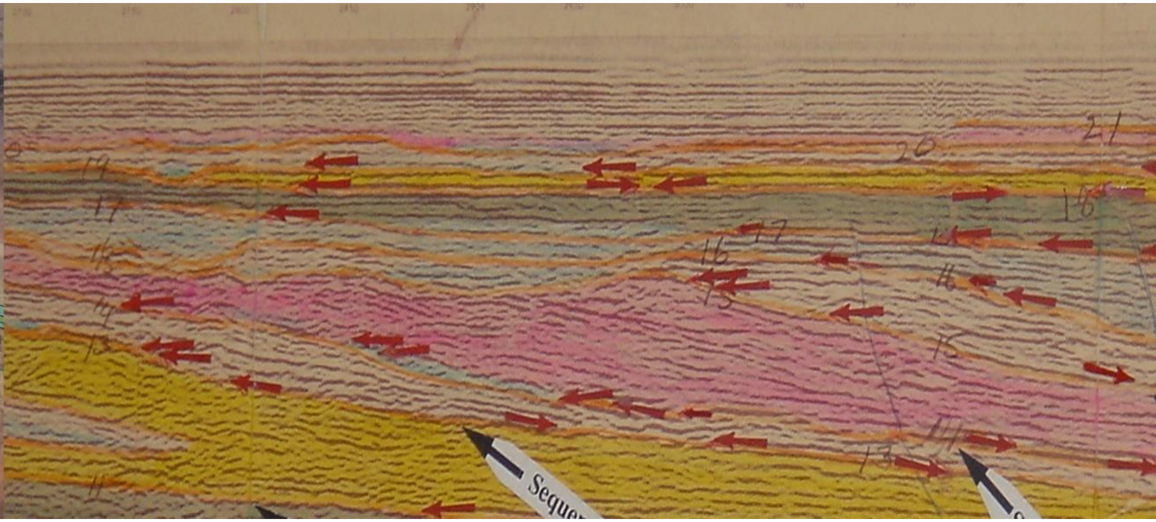
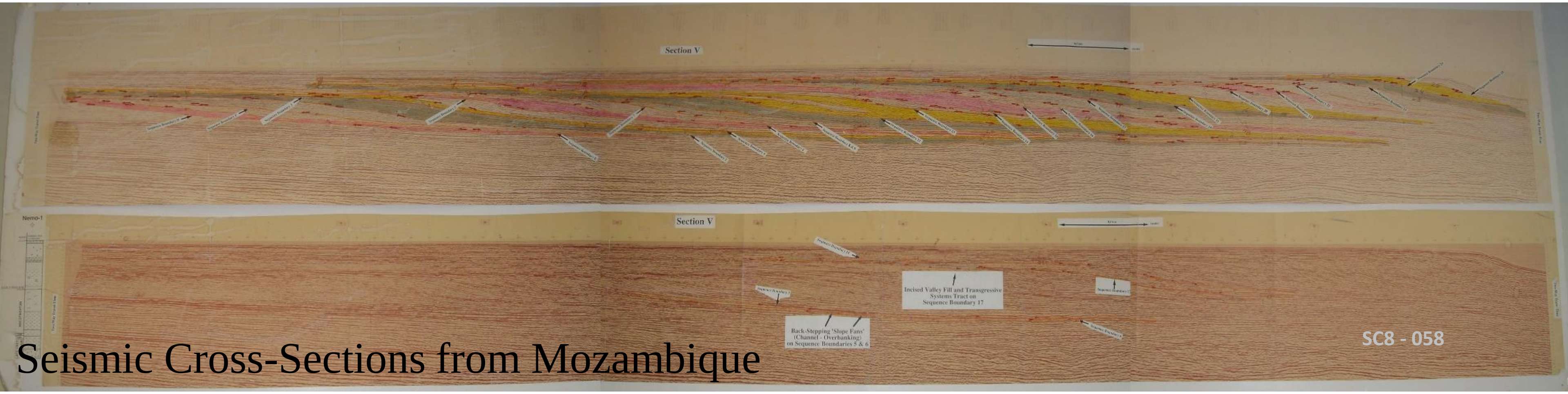
Transgressive Systems Tracts

Geologist Compare Outcrops to Seismic Cross-Sections

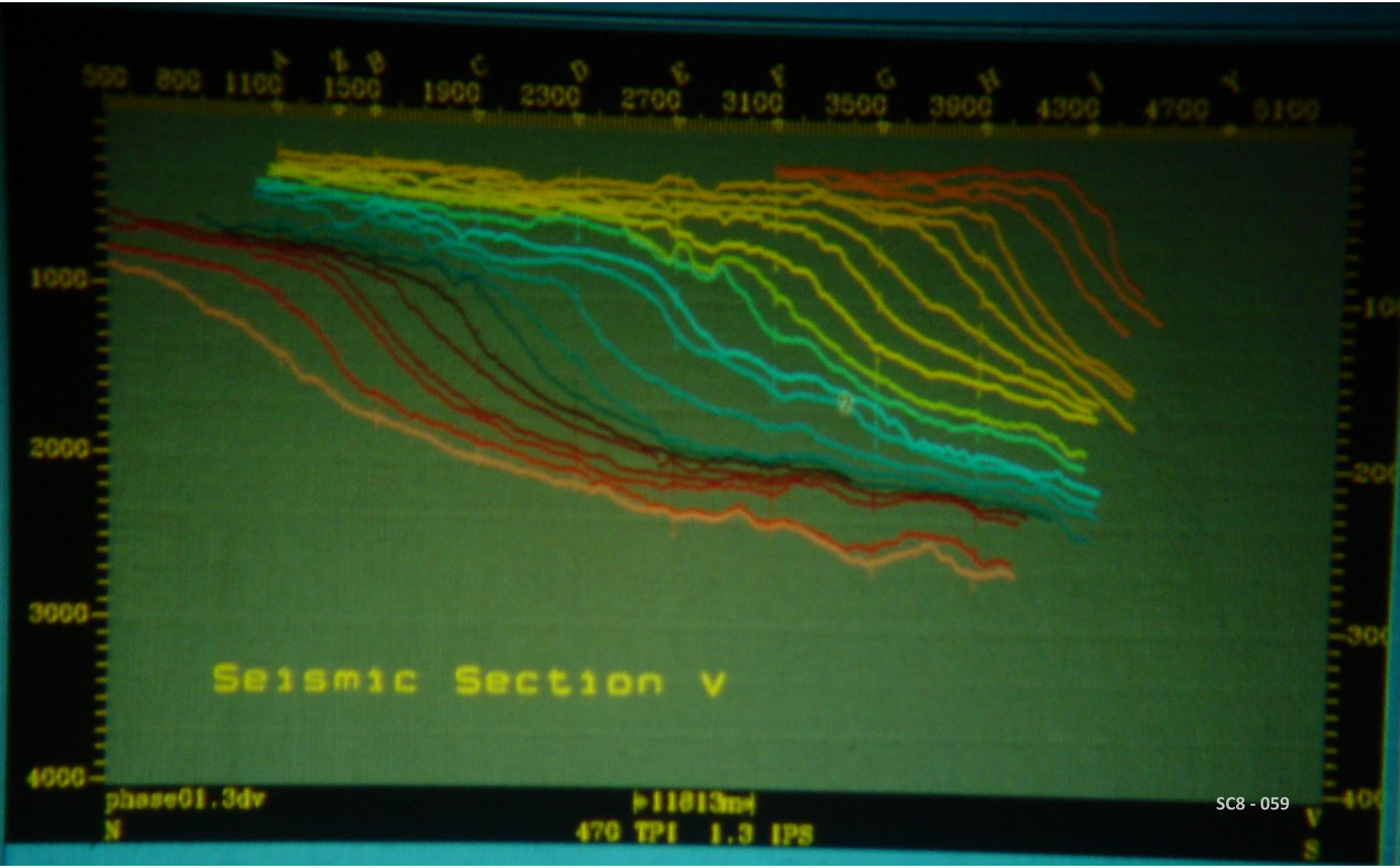




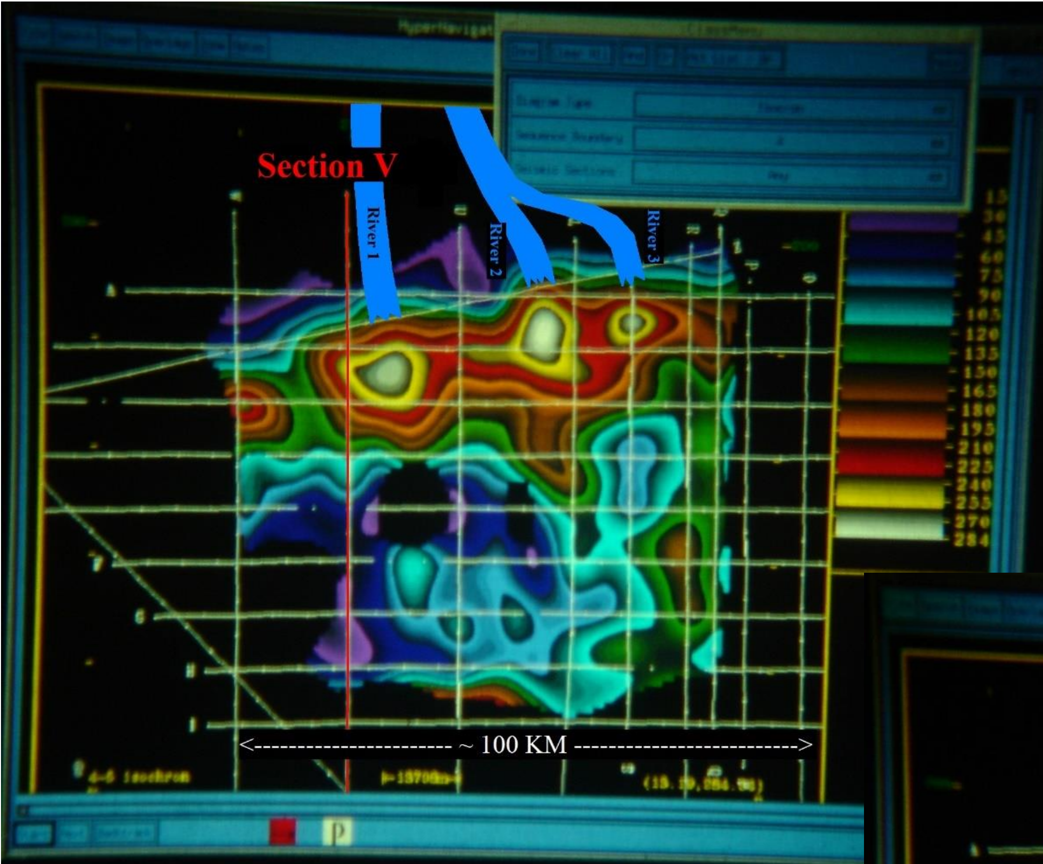


Seismic Cross-Sections from Mozambique

Screen Capture of Digitized Horizons

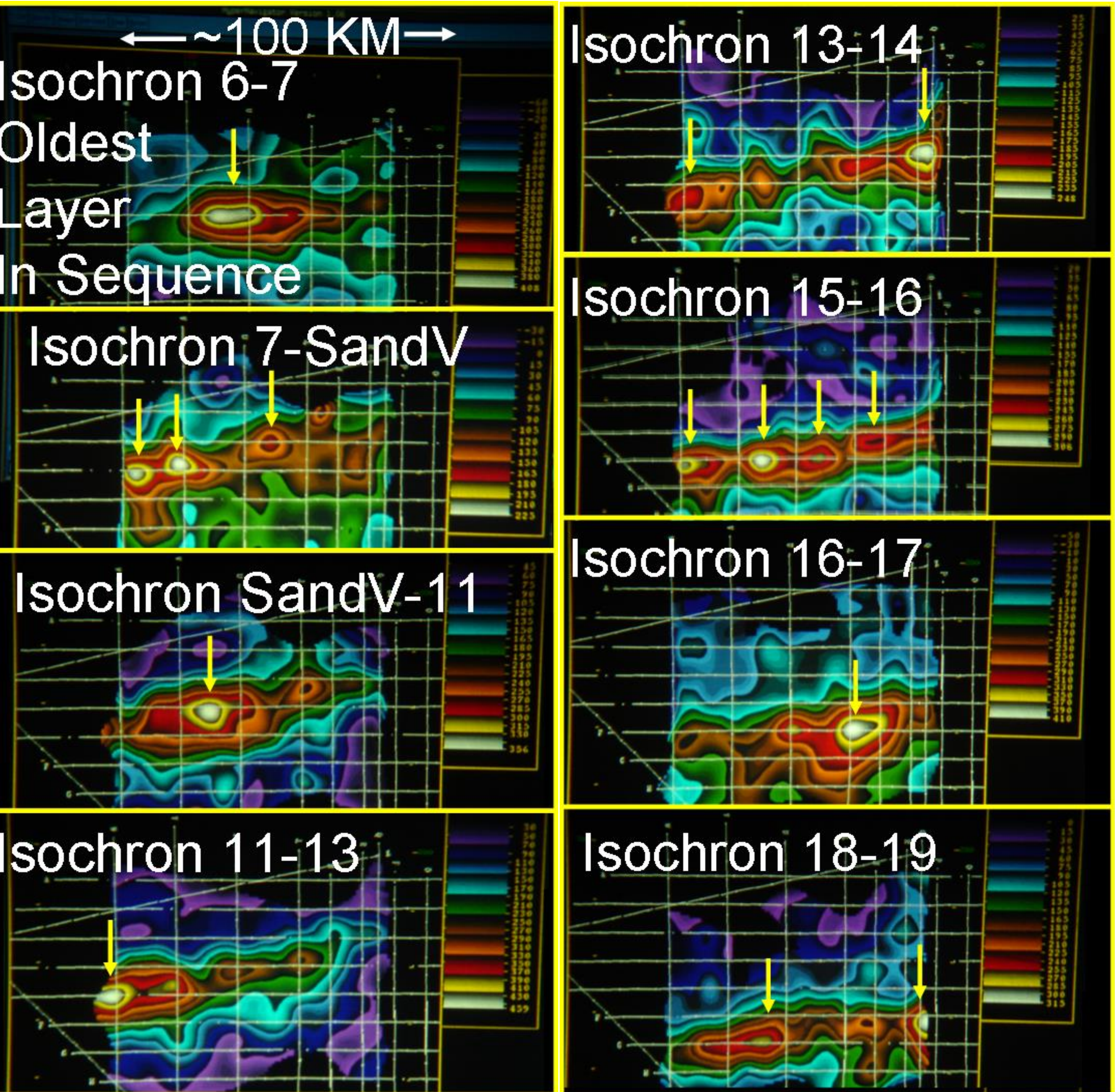


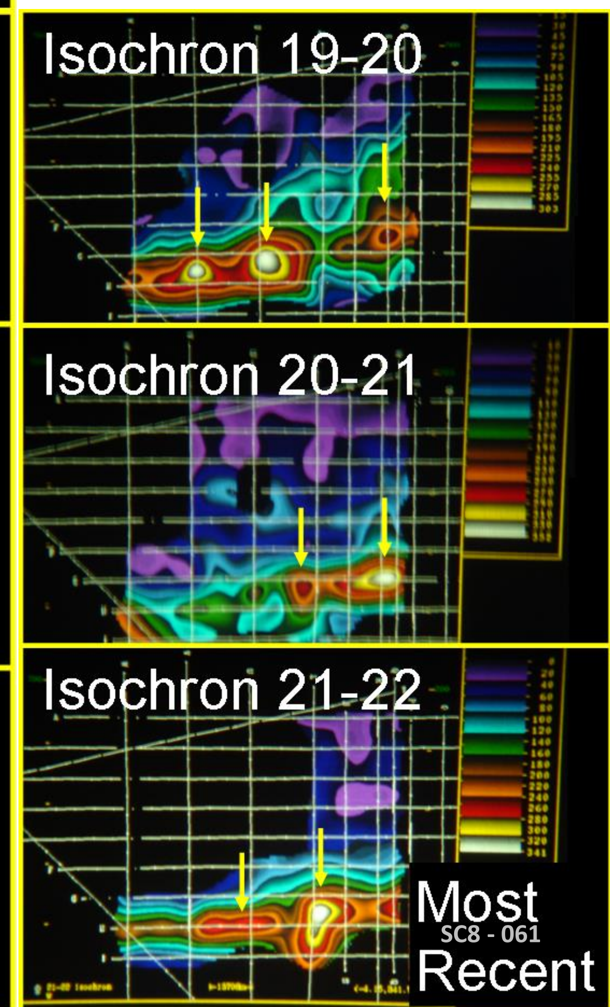
Maps of Sequence Thickness



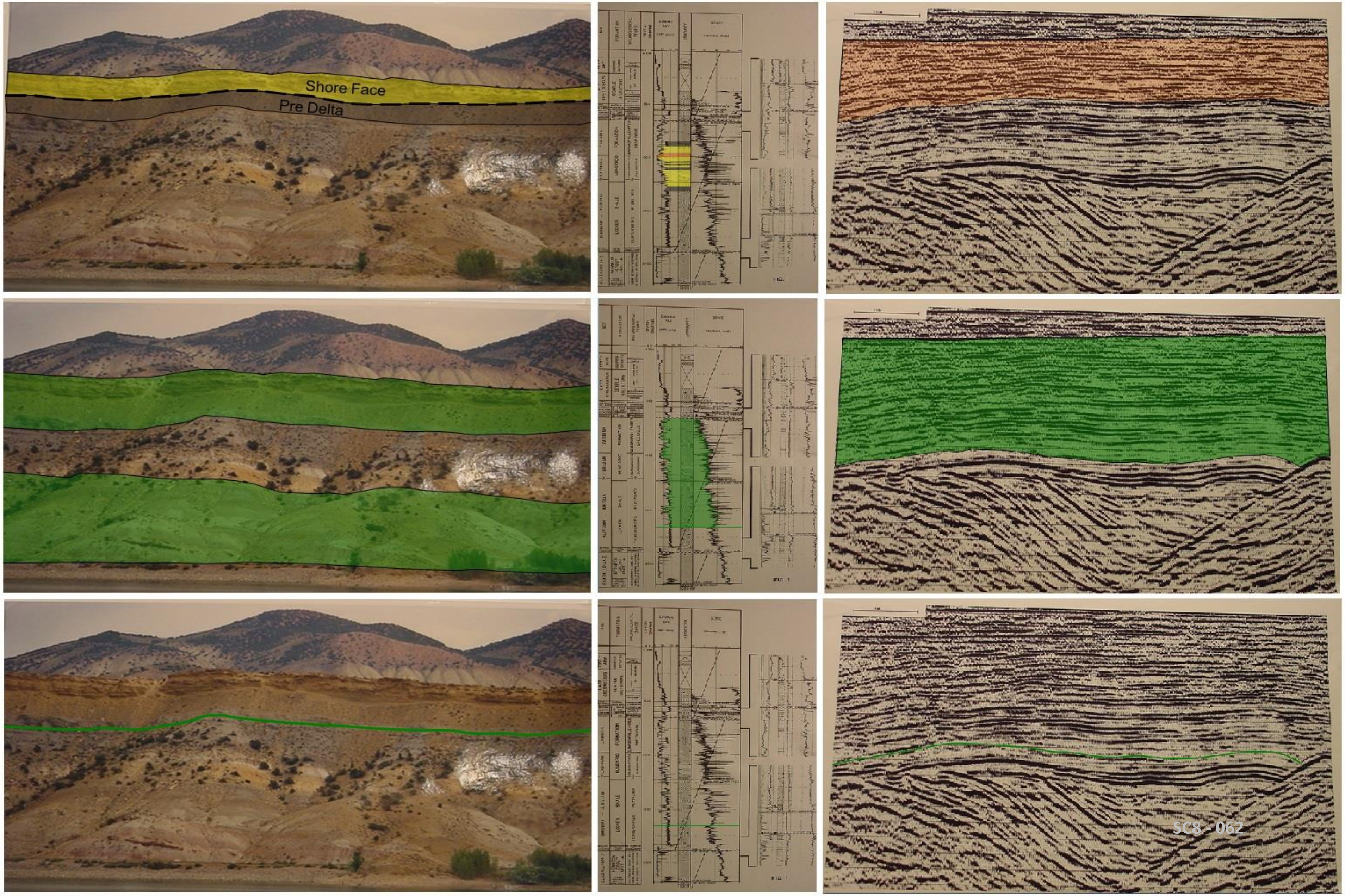
Explain Ancient River Locations

Isochron (Thickness) Maps Showing Zambizi River Mozambique Movement





Outcrop Log Seismic



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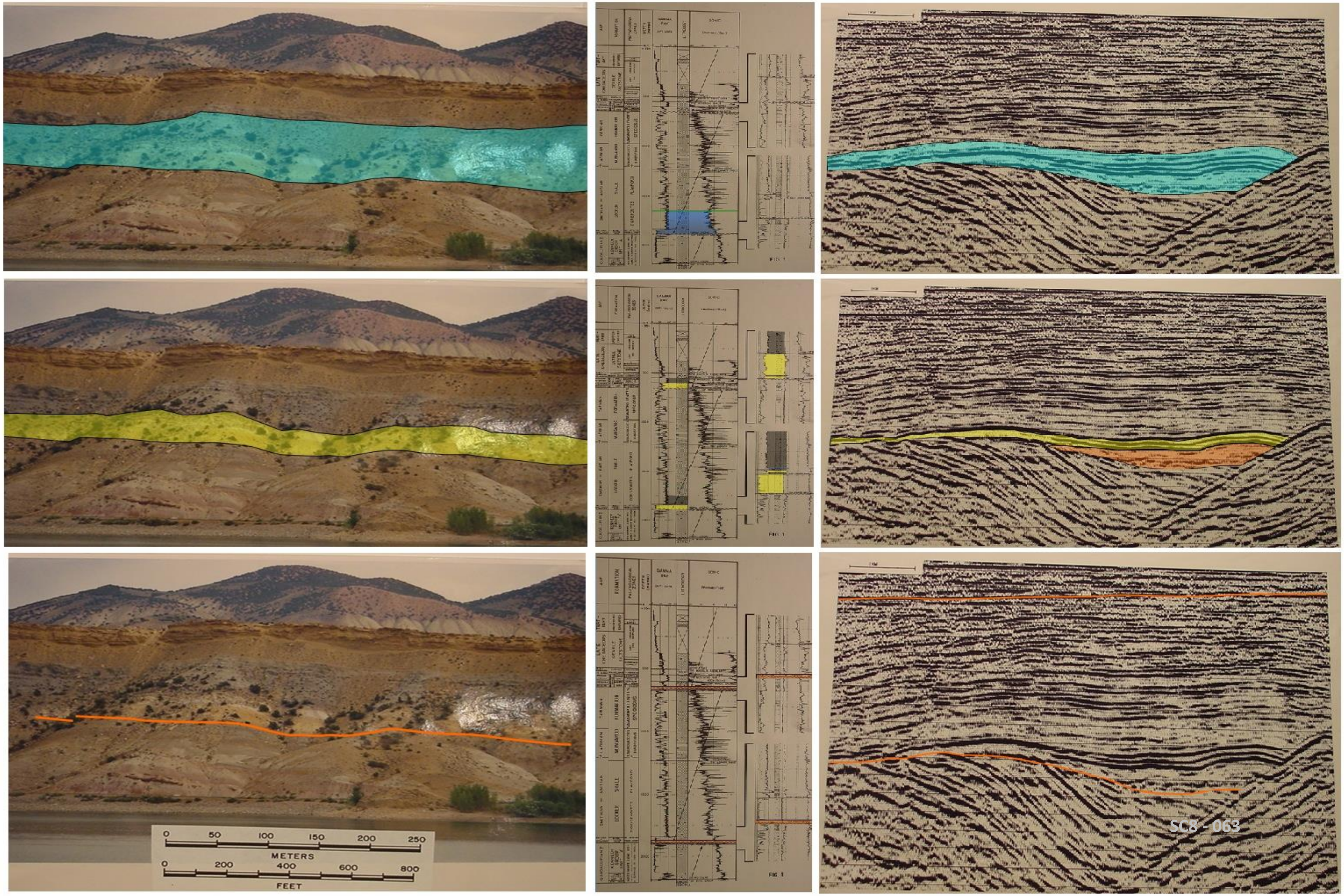
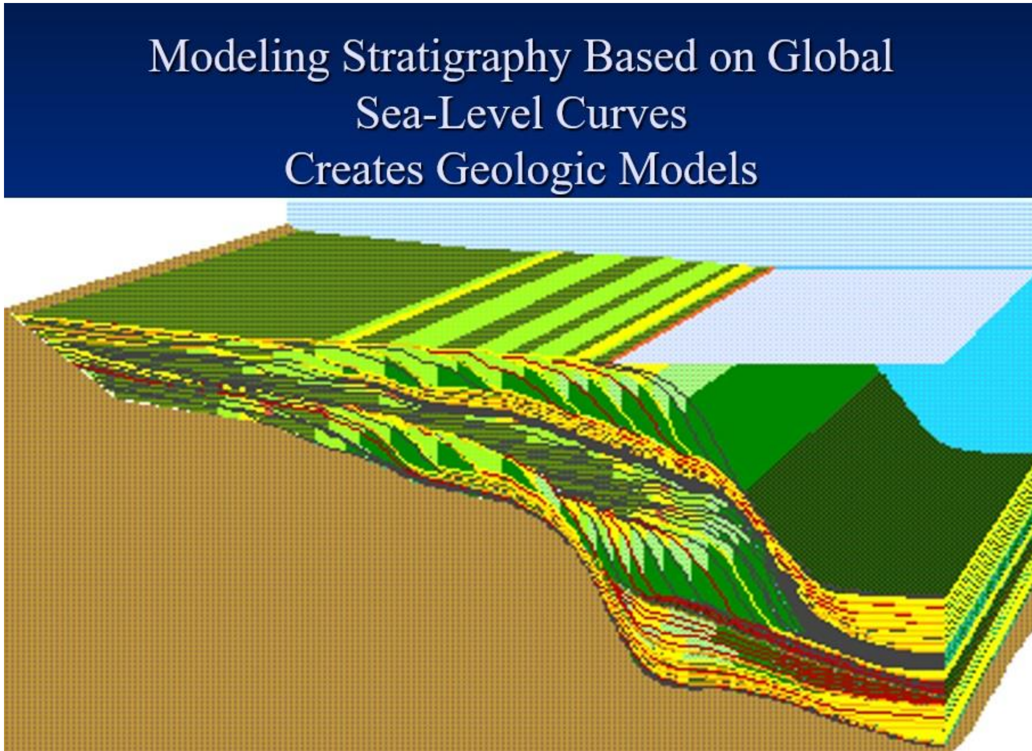


Impact of Sea Level Changes

Building a Sequence

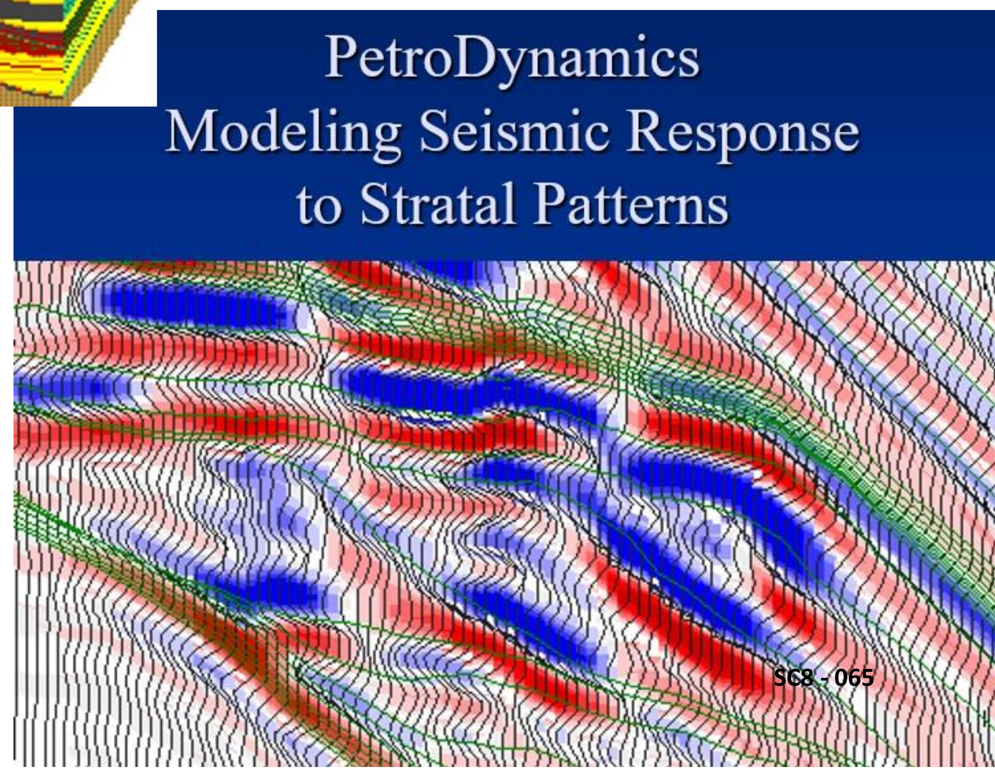
Presented by

TEXACO

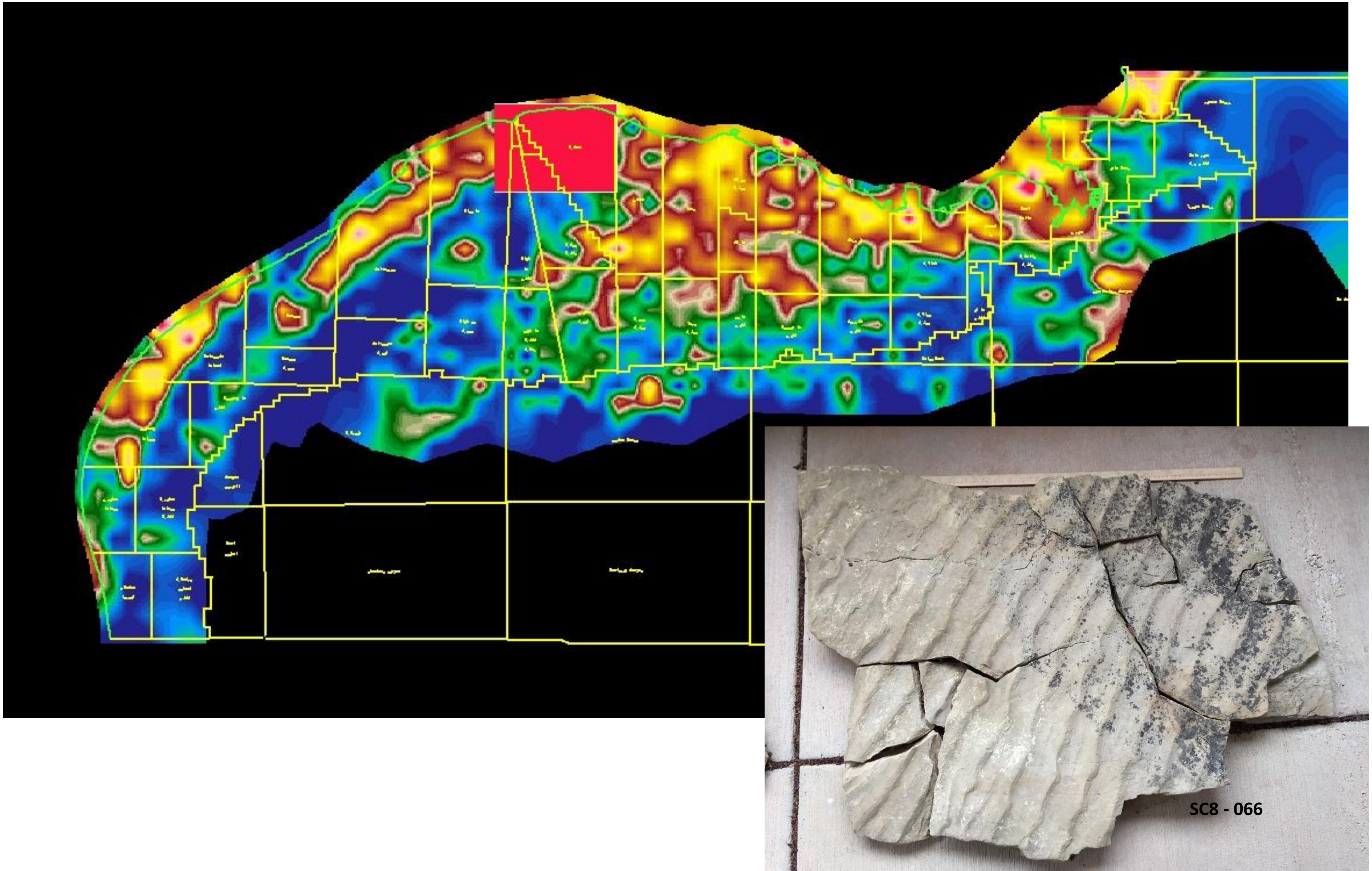


These Models Are Converted to Seismic Trace Models

Seismic Models Help Explain Seismic Data



Sand Thickness Map Gulf of Mexico



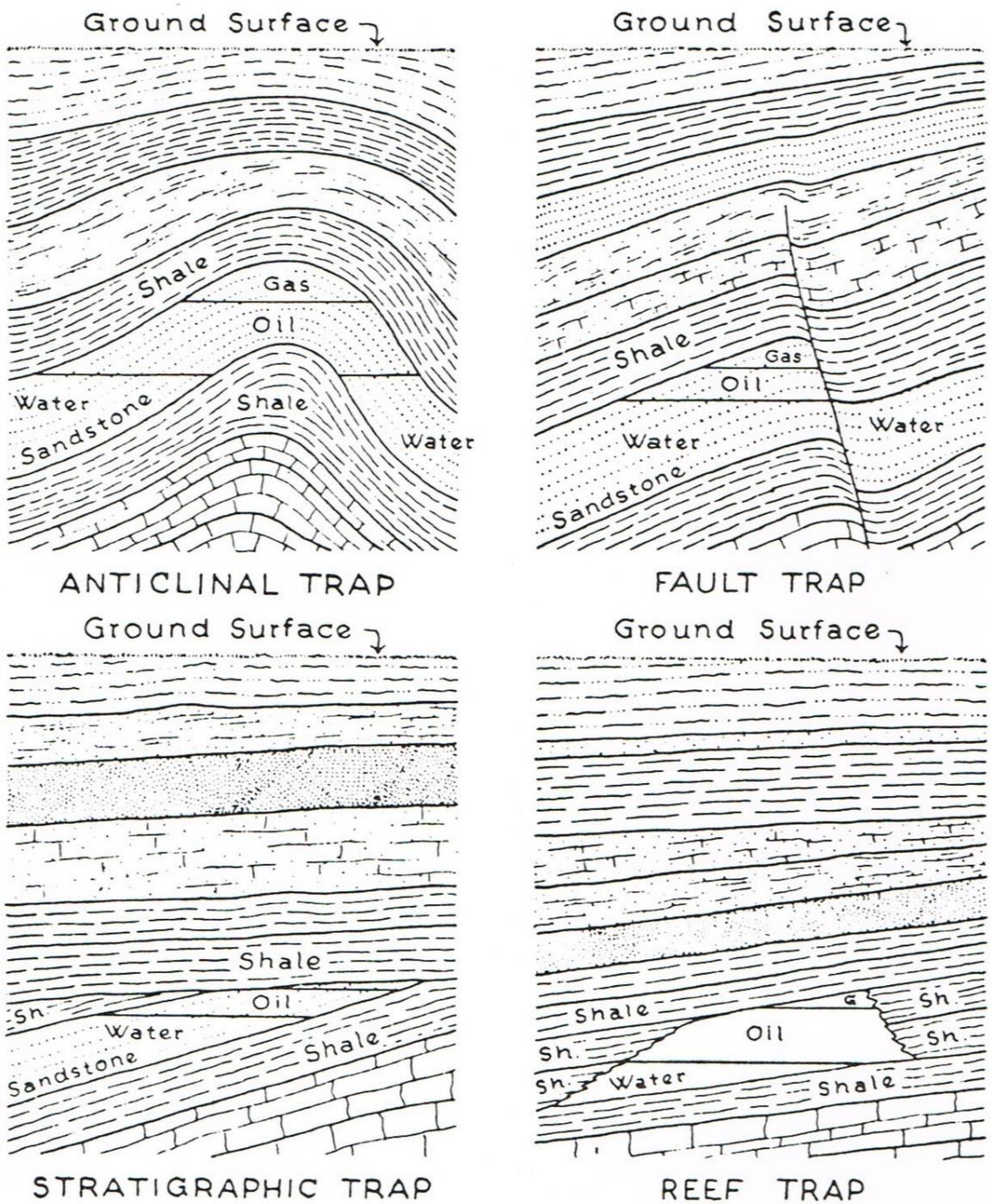
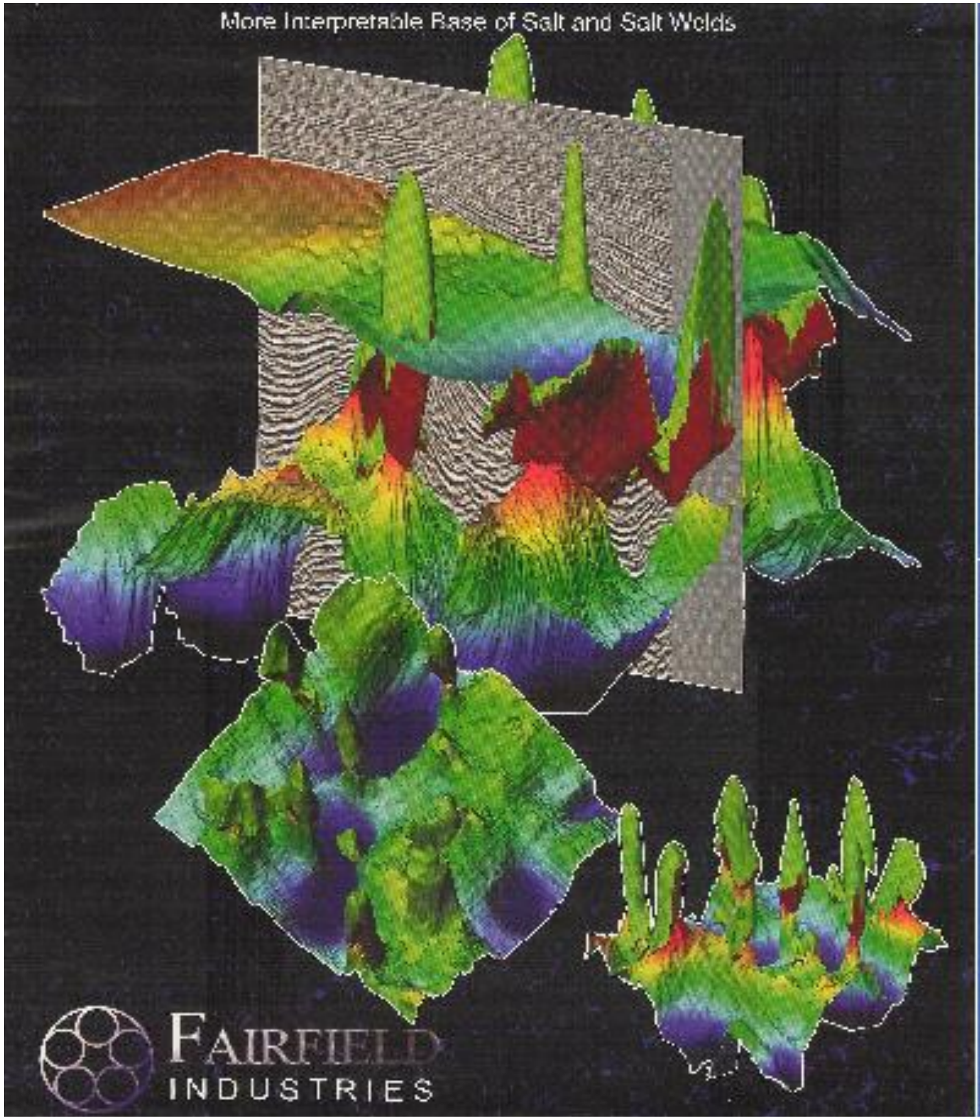


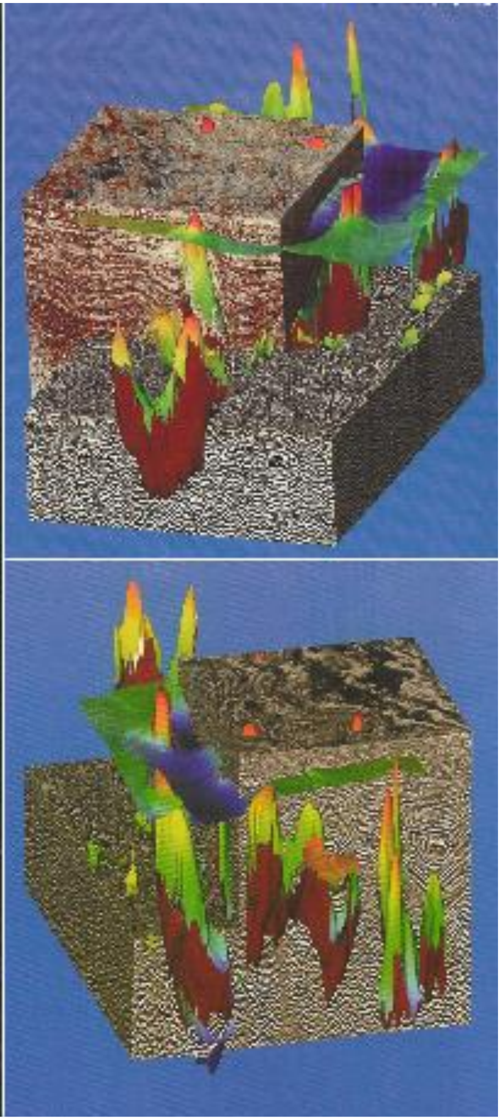
Figure 1-4. Typical examples of hydrocarbon traps. (After Dix.[10])

Geologic Layers have to be folded, faulted, eroded, or deposited to trap oil & gas

Notes

Salt Domes in the Gulf Coast Fold





SC8 - 069

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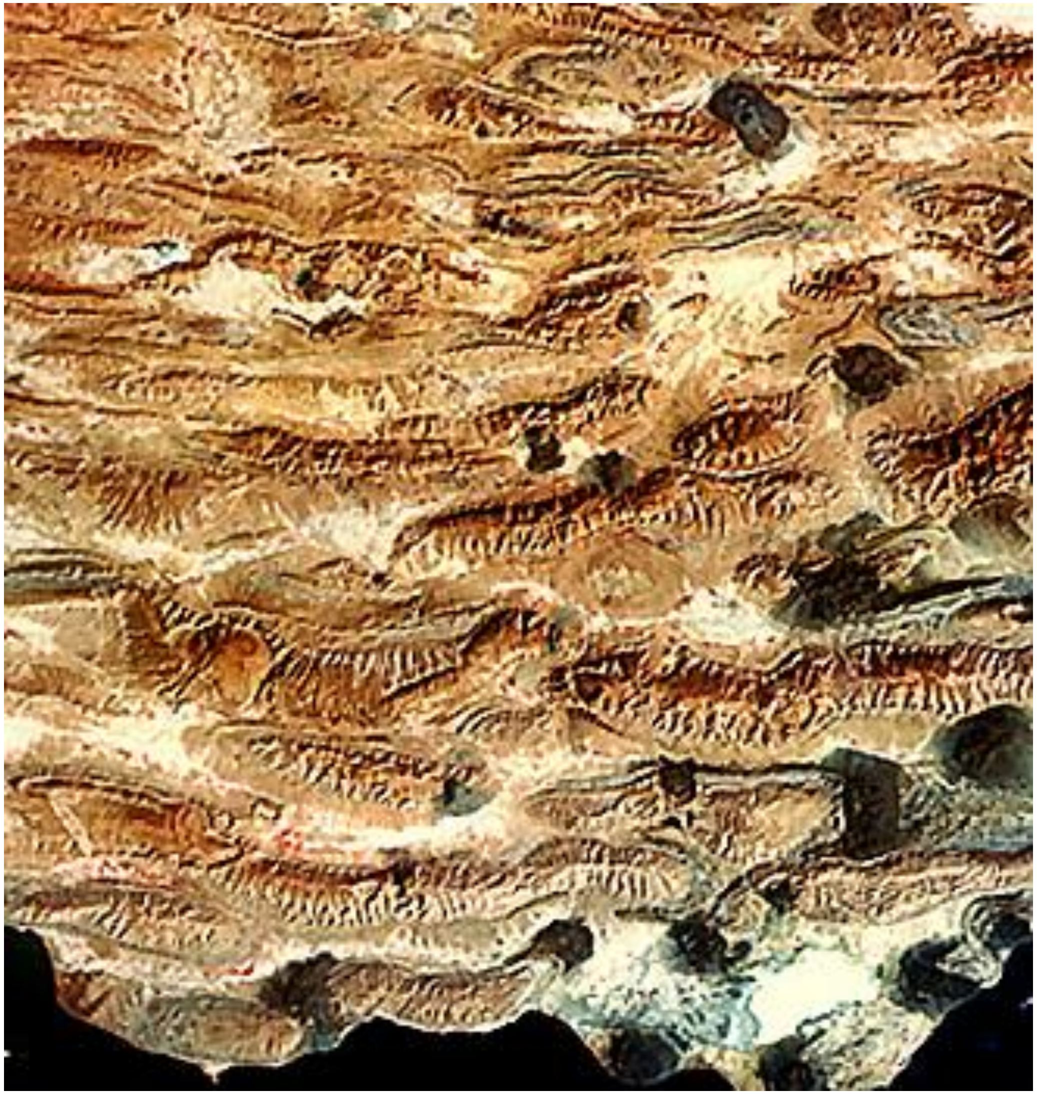
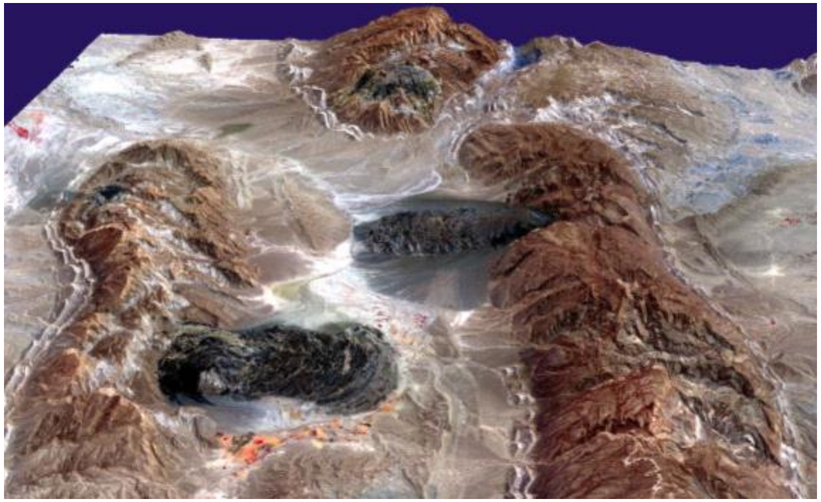
Bathymetry Gulf of Mexico

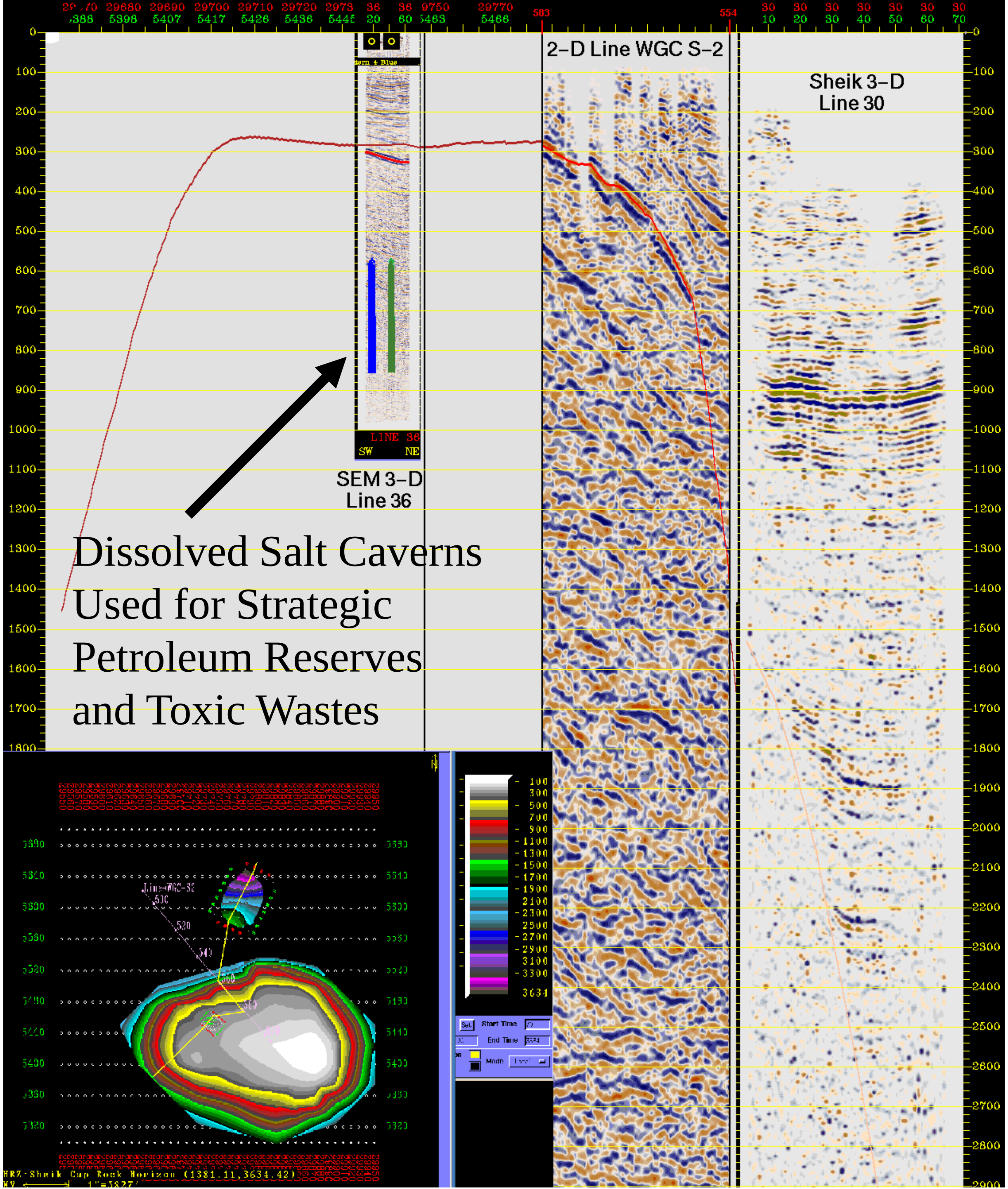
Controlled by Salt Domes

SC8 - 070

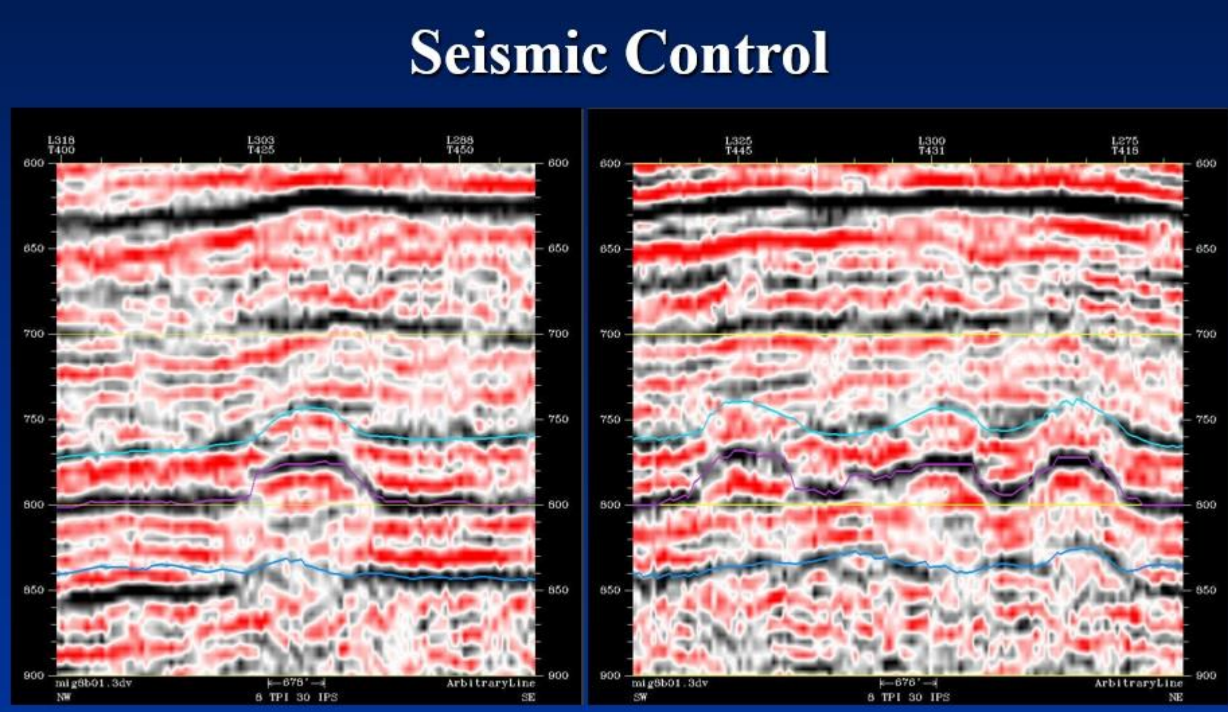
Topography Southern Iran Controlled by Salt Domes



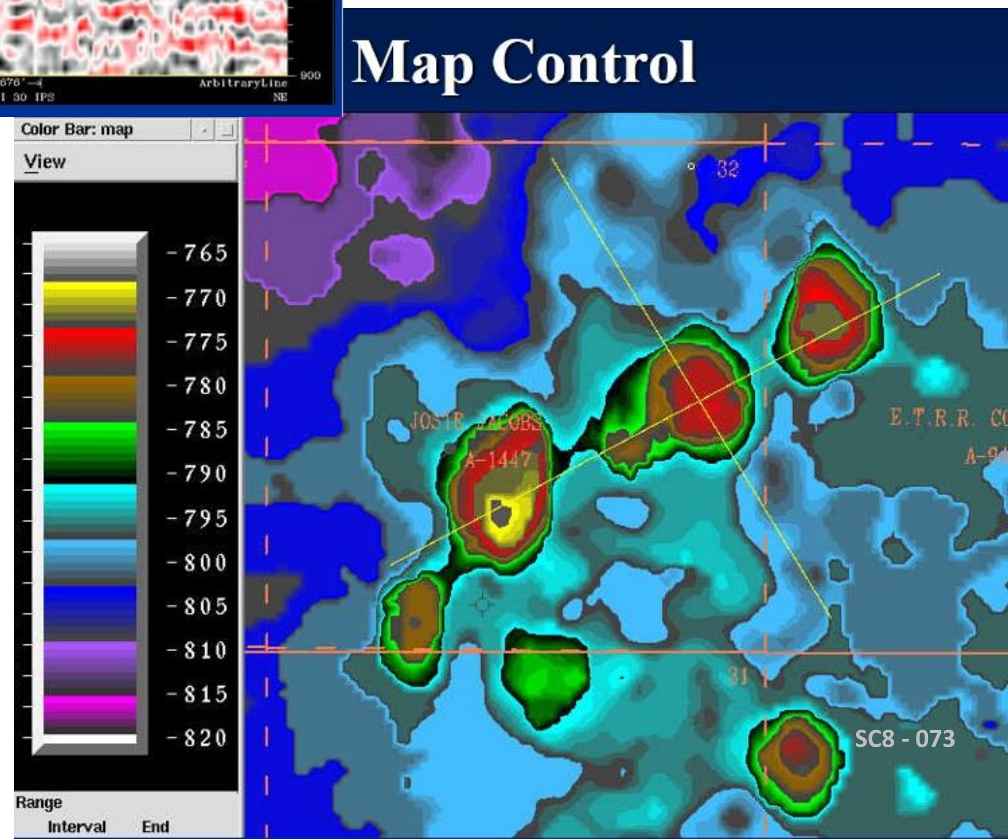




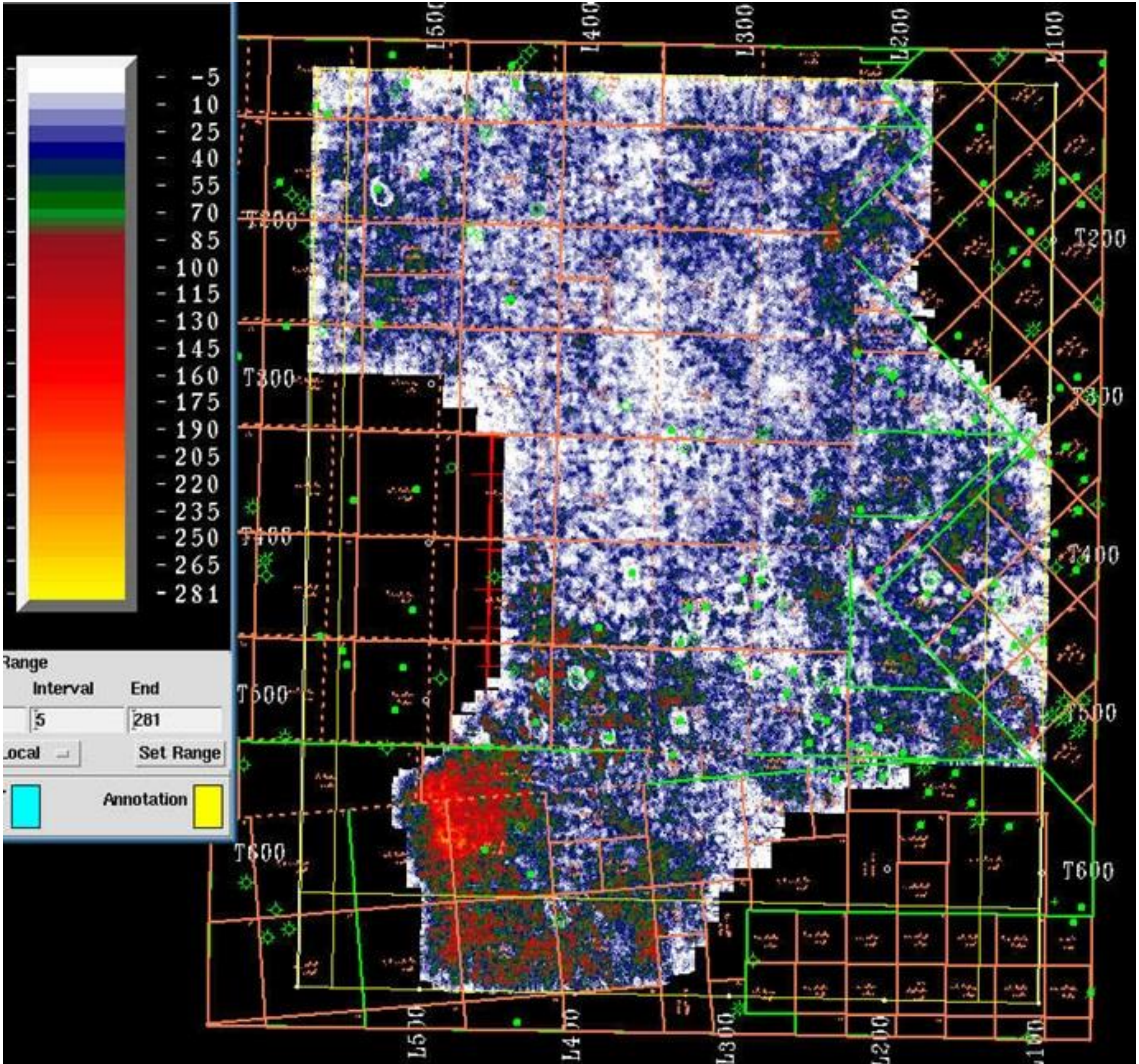
Cross-Section Through The Boling Salt Dome south of Katy, Texas



Reefs Also Impact Horizontal Layering



Project in Shackelford County, Texas where the Fandango is Located

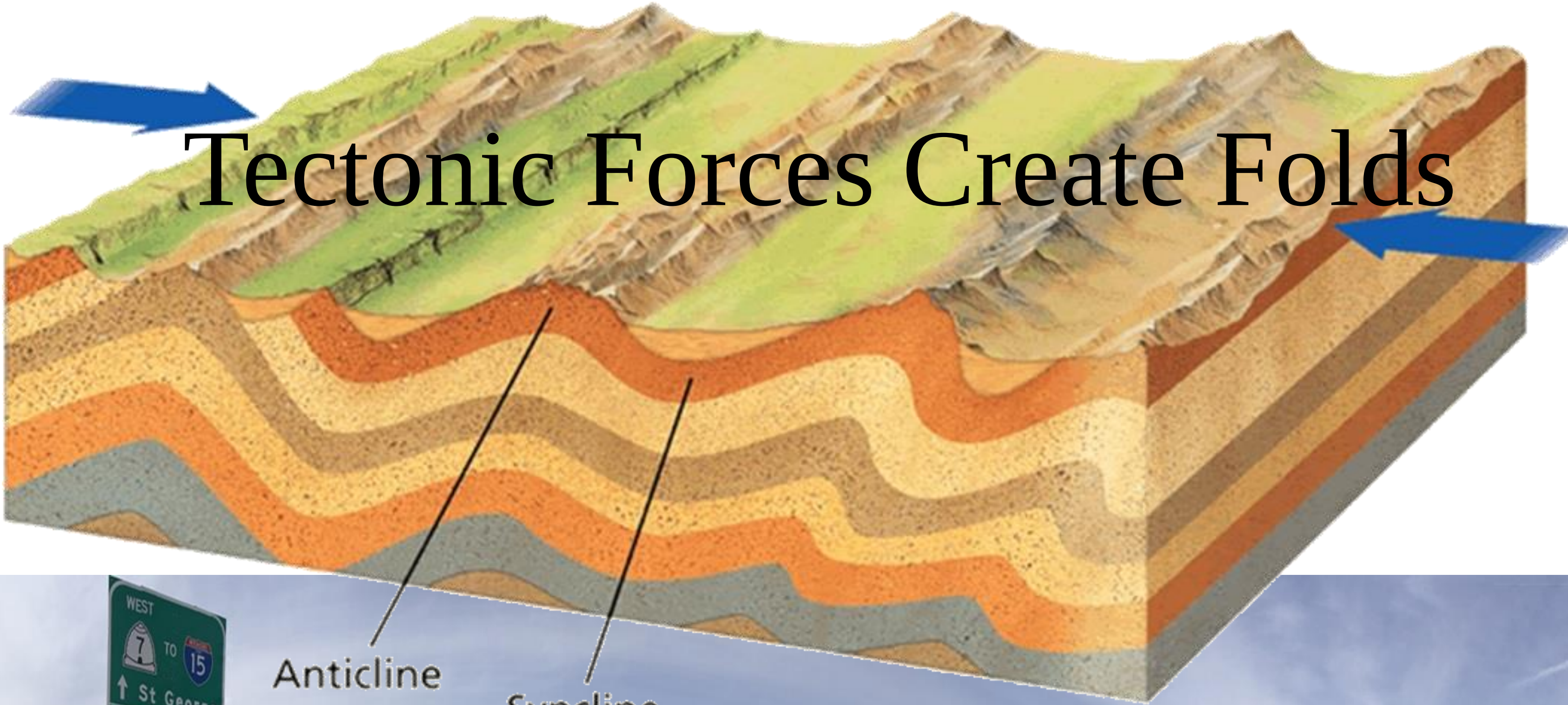


3-D Seismic Slice Shows

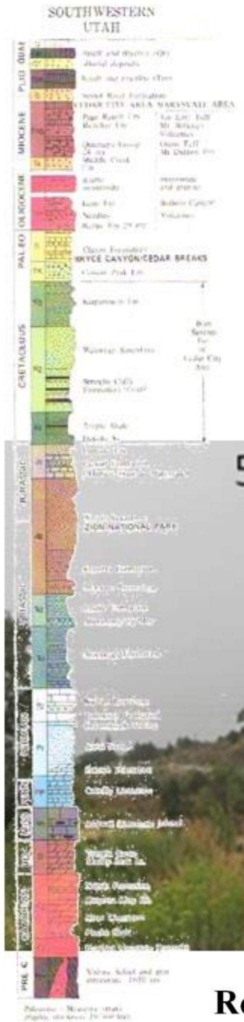
Production

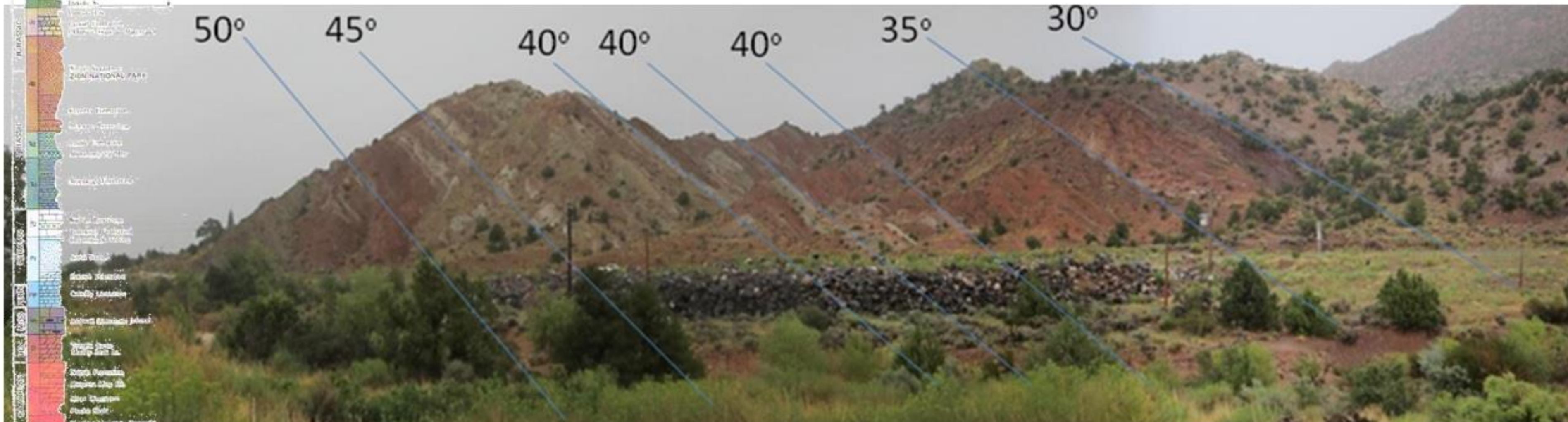
Halos and Rubble Beds

Tectonic Forces Create Folds

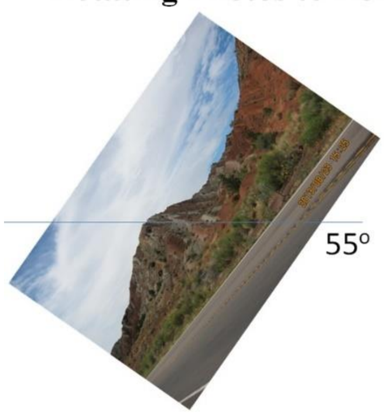


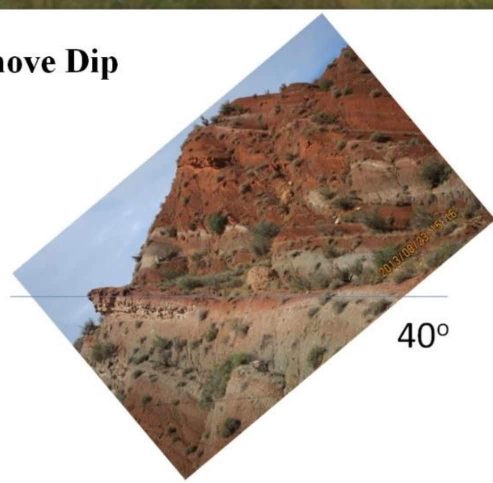
Cedar Canyon – Some of the Best Examples Worldwide of Folding and Faulting

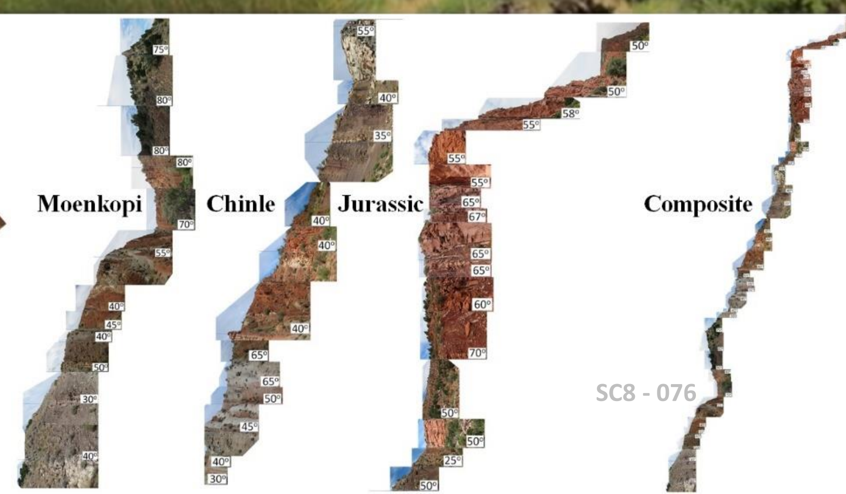




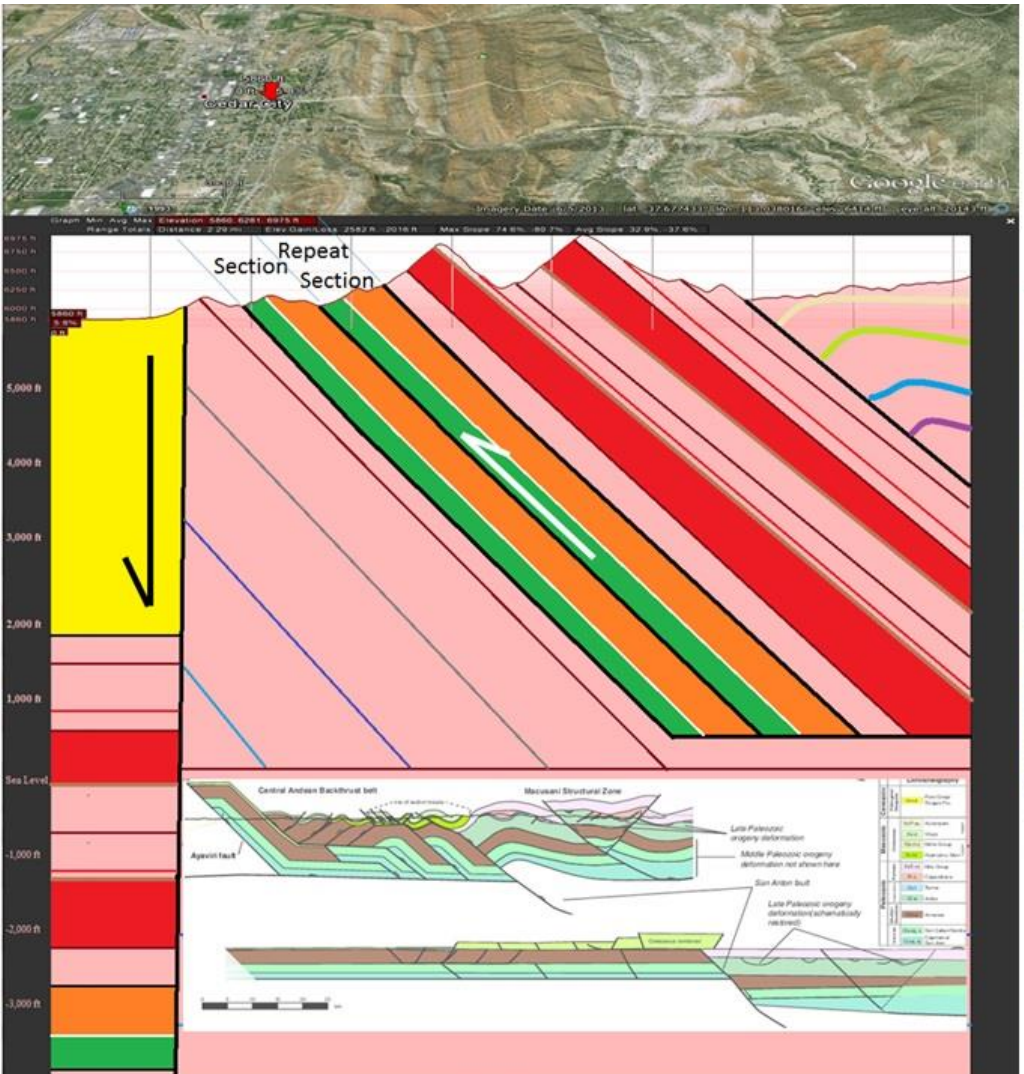
Rotating Photos to Remove Dip







Classic Back Thrust Example



Cedar's Red Hill

excellent example of backthrust

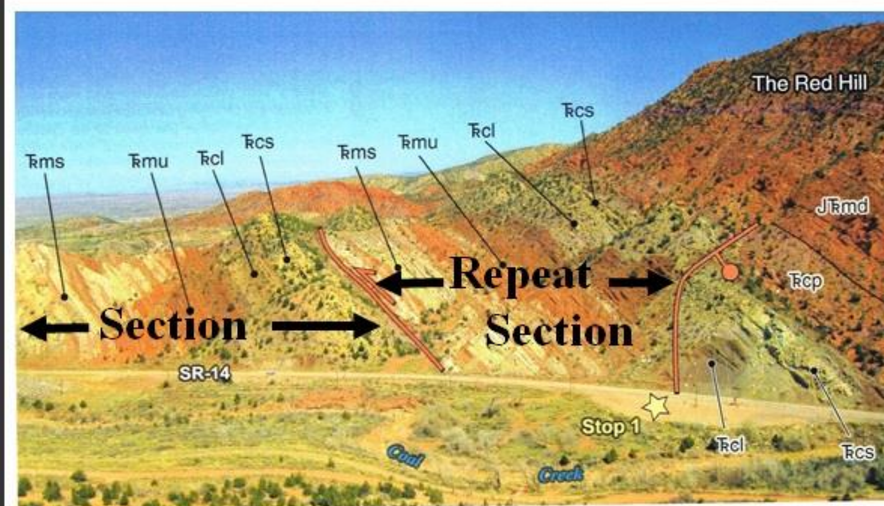
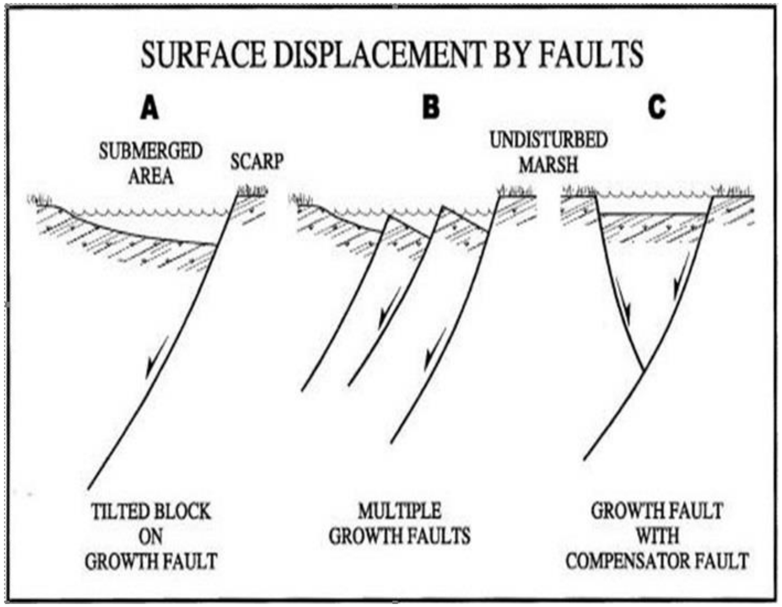


Figure 2. North-directed view of east-dipping Triassic and Jurassic strata near mouth of Cedar Canyon. Shnabkaib through Shinarump strata are repeated along a thrust fault. Bar and ball on downthrown side of normal fault. Ŧrms =Shnabkaib Member of the Moenkopi Formation, Ŧrmu =upper red member of the Moenkopi Formation, Ŧrcl =lower member of the Chinle Formation, Ŧrcs =Shinarump Conglomerate Member of the Chinle Formation, Ŧrcp =Petrified Forest Member of the Chinle Formation, JŦrcs =Dinosaur Canyon Member of the Moenave Formation. Photo courtesy of Tyler Knudsen.

MacLean, J.S., Biek, R.F., and Huntoon, J.E., editors



Structural Traps Key to Traditional Oil & Gas Exploration

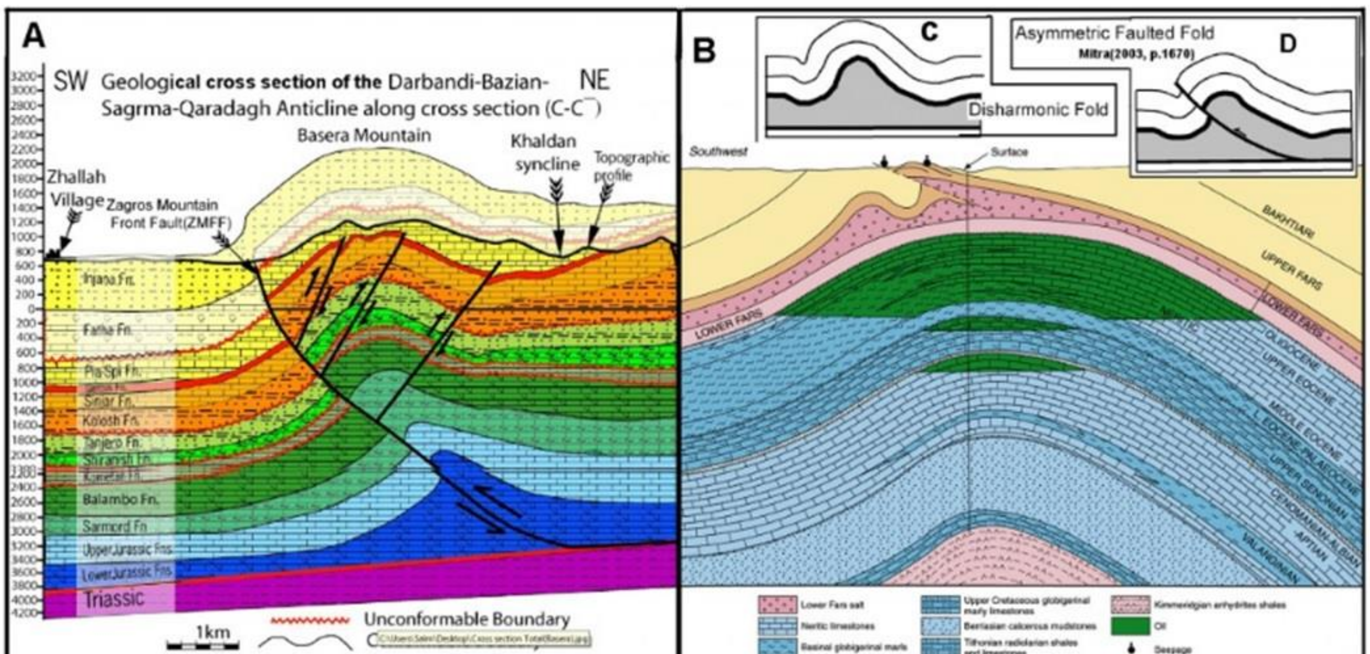
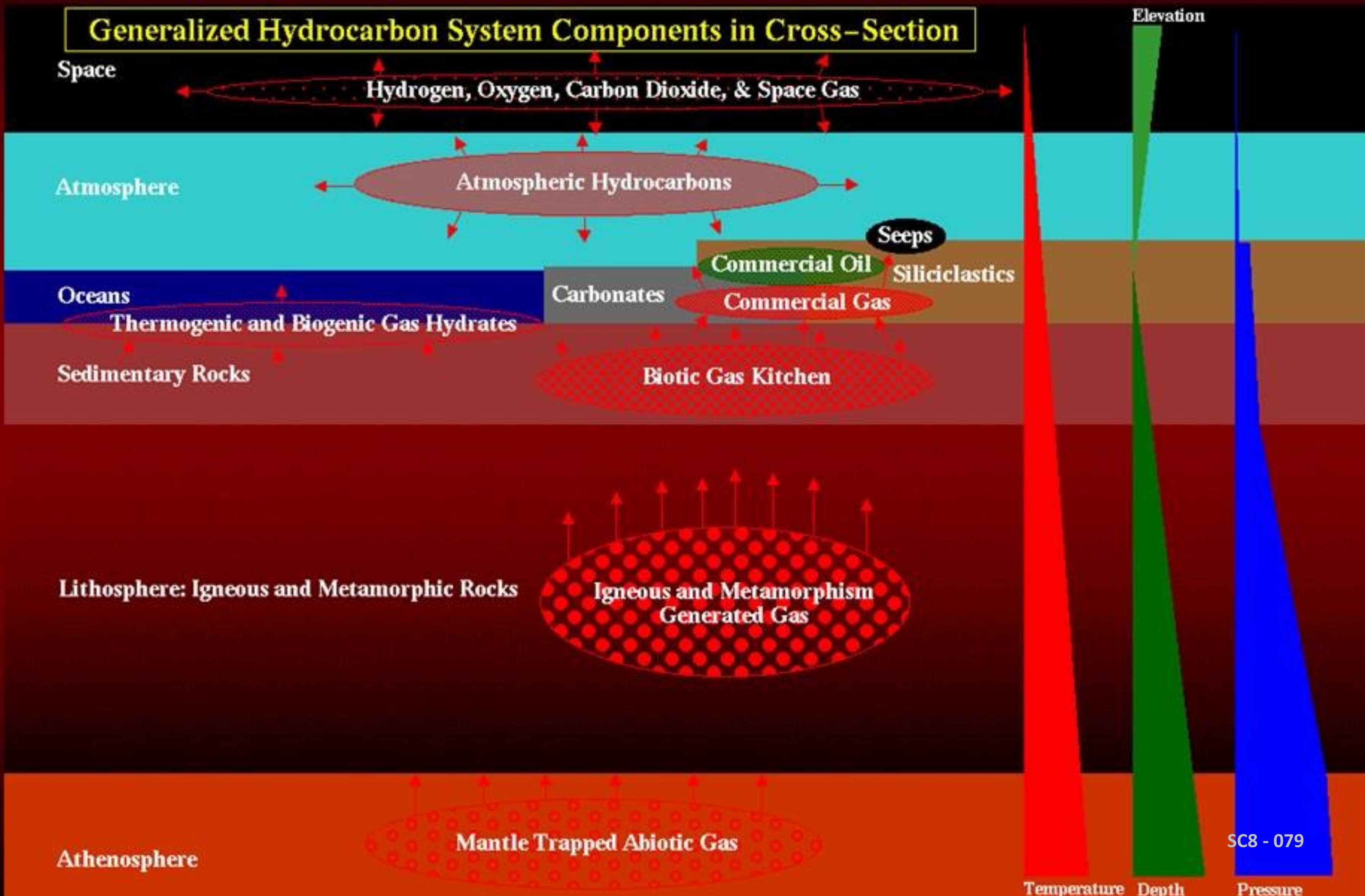


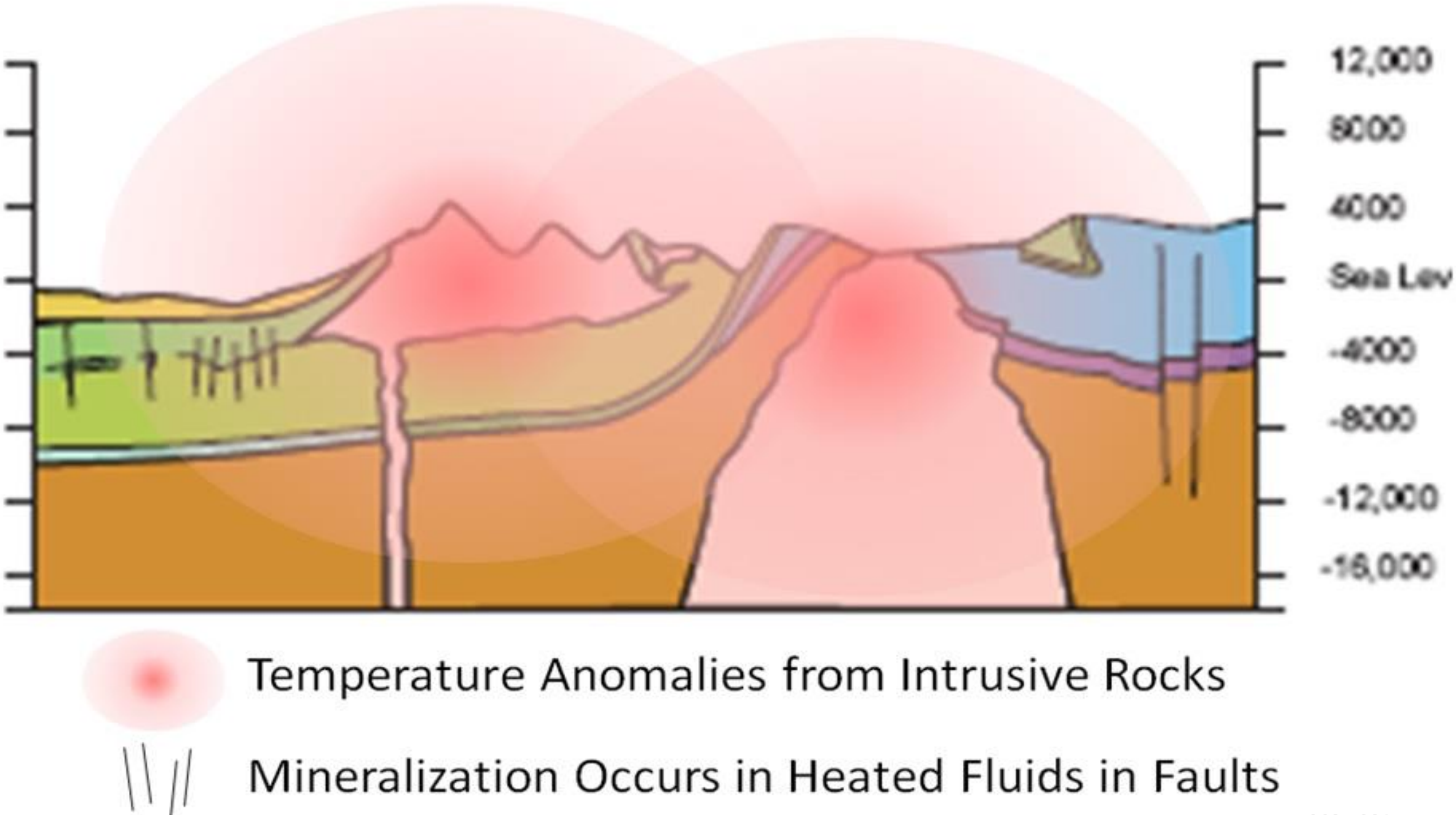
Figure 10. A) Geologic cross section of Sarma-Darbandi Bazian (Al-Hakari, 2011) and Omer et al. (2015) which assumed as fault propagation fault. B) Kirkuk anticline is detachment fold (disharmonic fold) formed by limb rotation not by Fault propagation fold. C) Disharmonic detachment fold (Mitra, 2003) which similar to Kirkuk anticline. D) Asymmetric faulted fold (Mira, 2003) which is similar to the faulted anticline near the crest of latter anticline

The Hydrocarbon Cycle



Notes

Temperature Cooks Off Hydrocarbons and Creates Mineralization



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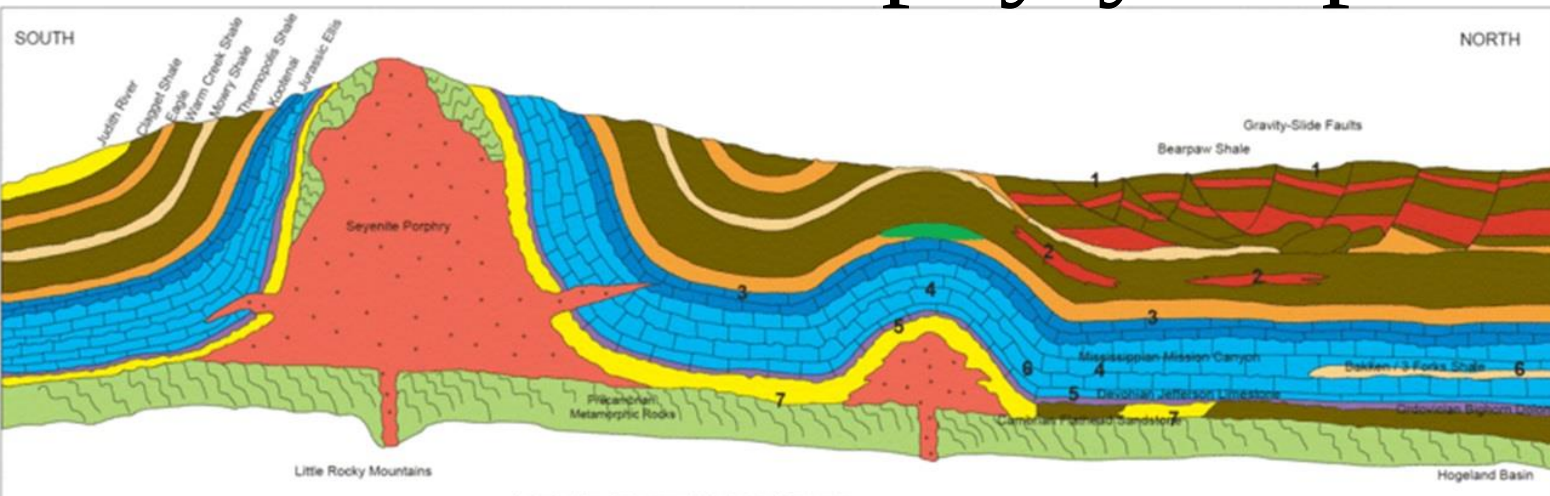
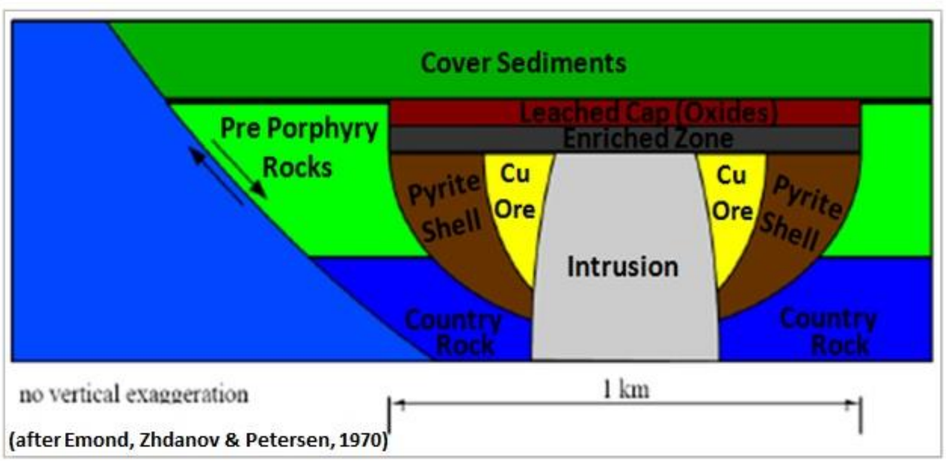
Intrusions and Porphyry Deposits

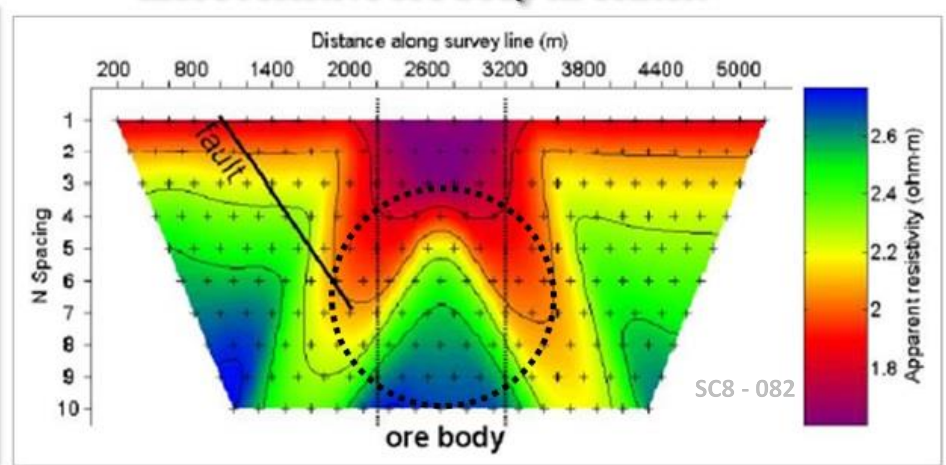


Simplified Porphyry Copper Deposit Model

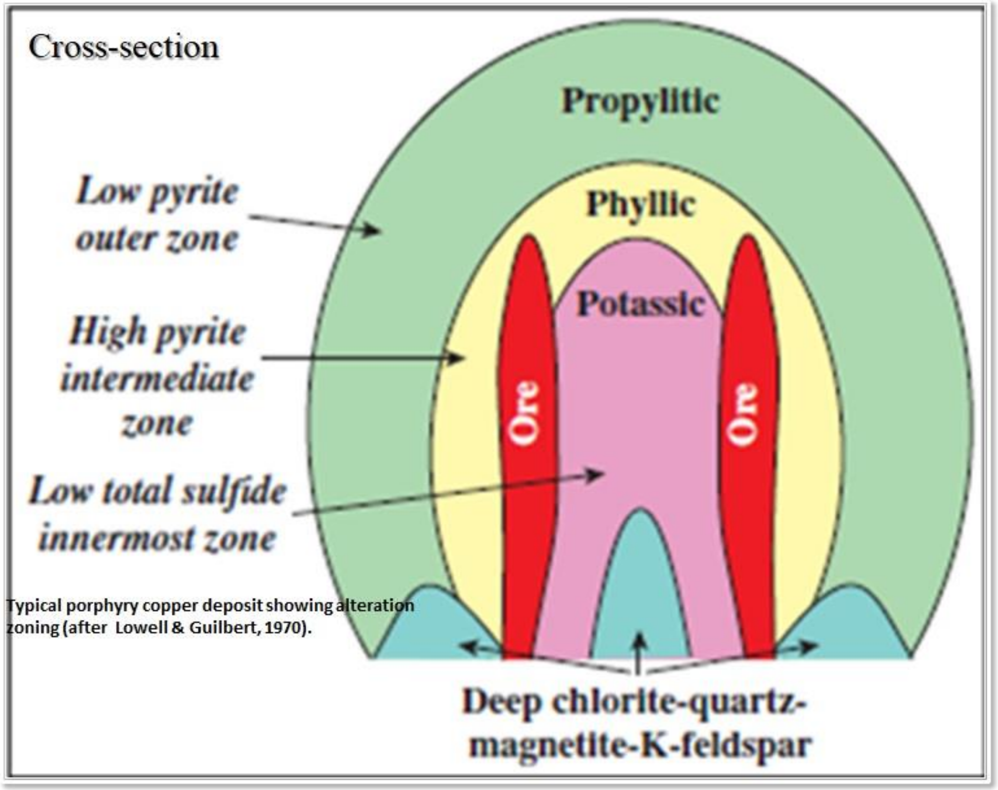
Typical Mineral Zones of a Porphyry Deposit

Conductivity anomaly surrounds more resistive ore body in center.

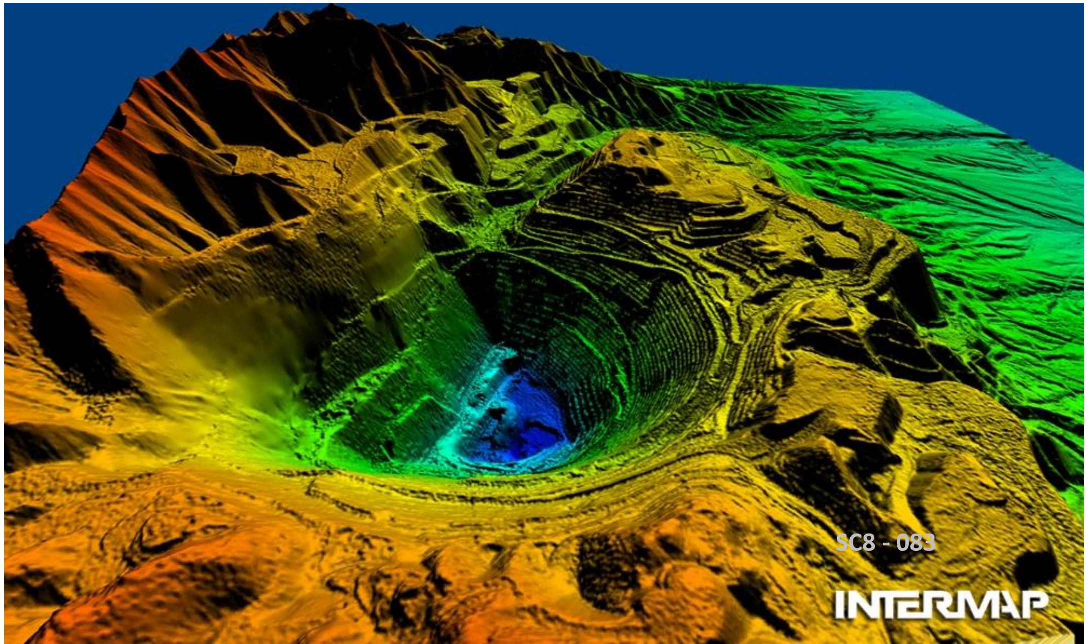




Kennecott Copper Mine is an Example of a Copper Porphyry Deposit



Typical porphyry copper deposit showing alteration zoning (after Lowell & Guilbert, 1970).



Sedimentary Rocks


Chalcedony, Glitter Rocks, & Obsidian

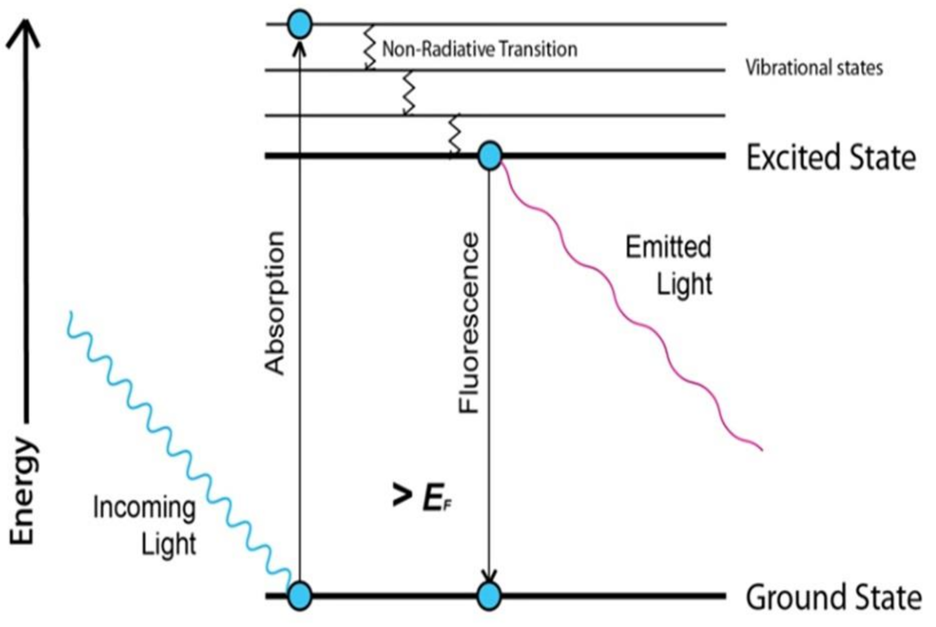

Red Rocks & Wonder Stone

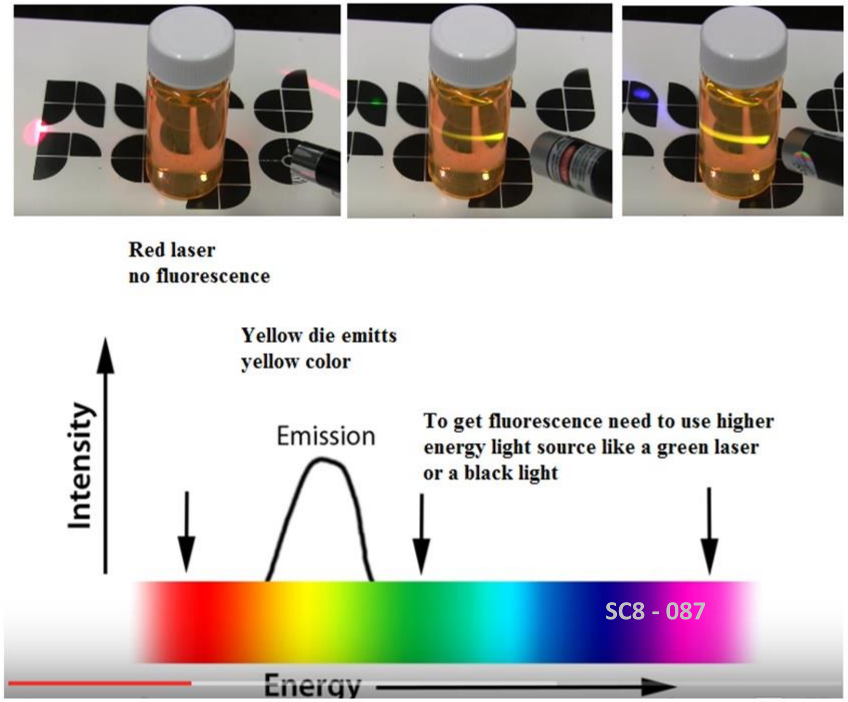

Temple Agates


Blue & Pigeon Blood Agates
SC8 - 085


Azurite & Malachite
Volcanic Rock & Gold Matrix
Pyrite
Moapa Volcanic Glass

Fluorescent Rocks

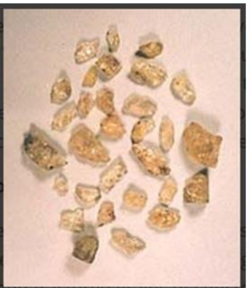





Is it an accident these rocks are here?

Sunstones and Topaz deposits are associated with lightning mappable underground geologic processes

Other Rocks In the Area



Sunstones collected at Sunstone Knoll, Millard County. 1 / 4

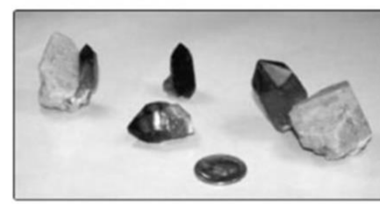
Topaz crystals. 1 / 7

One of the numerous pits that collectors excavated in their search for topaz and other minerals. 6 / 7

Smoky Quartz vugs tie hydrothermal alteration

Geologic information:

The Mineral Mountains, located in Beaver County, make up the largest exposed plutonic body in Utah. Rock compositions range from quartz monzonite in the northern half of the pluton to granite around Rock Corral Canyon in the south. Excellent crystals of smoky quartz and feldspar are found in vugs or cavities in the granite. They formed when cooling fractures in the granite were filled by late-stage pegmatites consisting of quartz, microcline, and plagioclase. Quartz occurs as clear to smoky, euhedral crystals up to three inches long while microcline is commonly found as euhedral, equidimensional crystals averaging approximately 0.75 inches in width. Occasionally, large pseudomorphs of limonite after pyrite can be found in these areas as well.



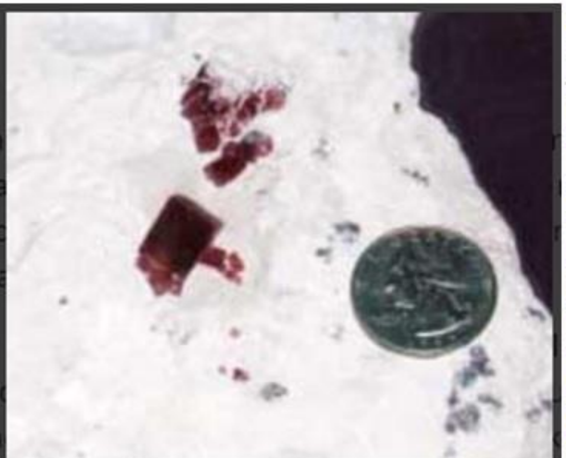
Trilobites

Abundant trilobite fossils, including Elrathia kingi shown here, can be found within the Wheeler Shale east of Notch Peak in the House Range. Many of the dry desert peaks of western Utah tell a story of shallow tropical seas. As much as 500 million years of deep burial, uplift, and erosion have changed layers of organic mud to cliffs and ledges of layered limestone. Closer inspection reveals abundant fossils, evidence of ancient sea life. Notch Peak, House Range, Millard County, Utah Photographer: Michael Vanden Berg 2 / 2

Cambrian-age shales from western Utah's House Range contain millions of fossilized trilobites, such as this specimen of Elrathia kingi. Trilobite, House Range, Millard County, Utah Photographer: Michael Vanden Berg 1 / 2

Very Rare Gems

Red & Green Beryl
are a direct result of hydrothermal alteration



Specimen of red beryl from the Ruby-Violet claims in the Wah Wah Mountains. U.S. quarter for scale.

THE GEOLOGY OF... **Emeralds**

Green Gold

Oh, what a little hot water can do to boring old shale

BY ROBERT KUNZIG

Before the Spanish conquest of what is now Colombia, people in the mountains north of Bogotá are said to have thrown emeralds into Lake Guatavita. Once a year the Indian ruler would cover himself with honey and gold dust and at daybreak have his men row him out into the lake. As he plunged into the water, offering the gold to his god, the crowd on shore would throw in their own offerings. The rich ones chucked in emeralds.

When the Spaniards finally found the Indian emerald mines after decades of bloody searching, the Old World went crazy for the New World's gems. Although the Egyptians had began mining emeralds near the Red Sea as early as 1650 B.C.—and emeralds had long been symbols of immortality, cures for dysentery, and preservers of chastity—the new Colombian gems were the clearest, biggest, and greenest anyone in Europe had ever seen. They still are: the same mines remain in operation, accounting for 60 percent of the world's production.

Emeralds are valuable because they are rare, rarer than diamonds. They are rare, says geologist Alain Cheilletz of the Center for Petrographic and Geochemical Research in Nancy, France, because they are a mixture of elements that don't ordinarily get a chance to mix: "They are a mineral that shouldn't exist at all."

For centuries emeralds were thought to cure dysentery and even preserve chastity

An emerald is a type of beryl, a mineral made of beryllium, aluminum, silicon, and oxygen. All those elements are common in the continental crust, so beryls are not rare. But whereas ordinary beryls are colorless, emeralds are green because a few of the aluminum atoms in their crystal structure have been replaced by atoms of chromium or vanadium. Neither of those elements has any reason to meet up with beryllium; they and it belong to two different chemical families that drifted apart billions of years ago.

Soon after Earth was born, when it was young and mostly molten, a lot of silicon and aluminum rose to the surface, like a kind of scum, then cooled, forming the first continents. Most of the iron stayed behind in the mantle or sank into the planet's core. Other elements chose one of those two fates, too, based on their weight and size.

Because of this parting of the elements, Earth's surface rocks are segregated into two realms, like yang and yin: light and dark, crust and mantle, continent and ocean bottom. Geologists call the light minerals felsic and the dark ones mafic. The paradox of the emeralds, as Cheilletz calls it, is that beryllium belongs to the light, felsic, continental side, whereas chromium and vanadium are from the dark, mafic, oceanic side. Emeralds, in other words, are yin and yang in a single crystal. "The whole problem in our research," says Cheilletz, "was to figure out the geologic conditions that could permit these two elements to meet at the same time and place."

A sparkling Colombian emerald born of the drabbest black shale.

The answer, they discovered, has to do with plate tectonics, the ceaseless shifting of Earth's crust that smashes continents together to build mountains. Every now and then, when an ocean disappears between two colliding continents, a chain of volcanic islands or a slab of seafloor gets beached on land. As a result, the continental crust has over the eons lost its original purity; it has become a patchwork that includes oceanic rocks, and thus traces of chromium and vanadium, along with the continental rocks that are laced with beryllium.

To make an emerald, though, those elements have to come together in a single hot liquid. The most common place for it to happen is underneath a young mountain

range. Where the edges of two colliding plates stack up, continental rocks can get dunked so deep into Earth that they melt again, liberating a great balloon of magma that rises back through the crust. At a depth of around six miles, the magma reaches its level of neutral buoyancy, stops, and begins to cool and solidify as granite. From the top of this cooling mass, streams of superhot, mineral-laden water—granite juice—migrate upward into fissures in the surrounding rock and begin to leach out elements.

Ninety-five times out of a hundred that surrounding rock is some ordinary bit of continent, and nothing terribly novel happens. "But if by chance the granite happens to hit a zone of mafic rock incorporated in the continental crust, then the chemistry will be completely different," says Cheilletz. "It will include iron, magnesium, and calcium—and traces of chromium and vanadium." When the felsic-mafic mixture finally freezes, the fissure will be filled with biotite, a kind of mica—black, flaky, and useless. But scattered through the mica, like green snowflakes, may be emeralds.

Most of the world's known emerald deposits, from the 3-billion-year-old ones in South Africa to the 9-million-year-old ones in Pakistan, were formed by granite intrusions. In the 1980s, Cheilletz and his colleague Gaston Giuliani studied deposits like that in Brazil. Then they went on to Colombia to have a look at the most renowned emerald mines—and soon saw that they didn't fit the standard picture. "In Colombia, geologists had been looking for granites but not finding them," Giuliani says. "When I arrived, I saw right away that the rocks were not the same."

Inside each emerald is a small pocket of fluid, called a garden. In the fluid is a crystal of salt. Often that microscopic evidence is the only way to tell a fake

Instead of granites intruding from below, in Colombia there are black shales laid down from above—sedimentary rocks deposited on the floor of a shallow inland sea during the Cretaceous Period, 100 million years ago. The sea must have been shallow, because the shales are sandwiched among layers of salt, which precipitated out of the water at times when it had all but evaporated. Black shales, besides being progenitors of oil fields (of which Colombia has a few), also contain everything that washed off the various rocks that made up the neighboring land. The Colombian shales contain, in dispersed form, all the ingredients of emeralds.

According to Giuliani and Cheilletz, those ingredients came together on two distinct occasions, 65 million and 38 million years ago. Surges in plate motions—the Atlantic Ocean was getting wider, pushing South America against the Pacific and raising the Andes—caused the thick stack of sediments under the shallow sea to buckle. Large sloping faults formed several miles down in the sediments, and hot water was squeezed out of them, escaping upward along the faults. Rising through layers of salt, the 570-degree water became extremely corrosive. Continuing through layers of shale, it dissolved out the emerald ingredients. Finally it pooled under a layer of especially impermeable shale until the pressure became great enough to shatter that layer explosively.

Then the hot solution shot up through empty cracks in the rock. As its temperature and pressure plummeted, emerald crystals snowed out of it immediately. It all happened so fast, says Giuliani, that the emeralds had no time to grow around grains in the surrounding shale. They grew unconstrained and pure, without the minerals that often cloud emeralds found in other parts of the world. That is why Europeans were so enraptured with the Colombian stones when they first laid eyes on them in the sixteenth century.

Like other emeralds, those from Colombia contain tiny pockets of fluid, typically no more than a hundredth of an inch across—gardens, as they're called in the gem trade. If you look at one of the Colombian gardens under a microscope, says Giuliani, you will see that it contains a crystal of salt, ordinary sodium chloride. The crystal is a trapped fossil of the brine from which the emerald itself crystallized, tens of millions of years ago.

Except for those inclusions, emerald manufacturers today are able to mimic natural processes so well that it can be difficult for a layman to tell synthetics from the real thing. Perhaps that's one reason emeralds don't pack the same emotive resonance for us that they did for bygone Indians and kings. We no longer see links to divinity or immortality in an emerald's limpid green depths. What we might imagine [illegible] the stones is history: the entire history of the planet distilled into a single miraculous (scientifically speaking) crystal. That's resonance enough for a rock. ■

Notes

7. Geophysics

The study o f the Earth by quantitative physical methods, especially by seismic reflection and refraction, gravity, magnetic, electrical, electromagnetic, and radioactivity methods.

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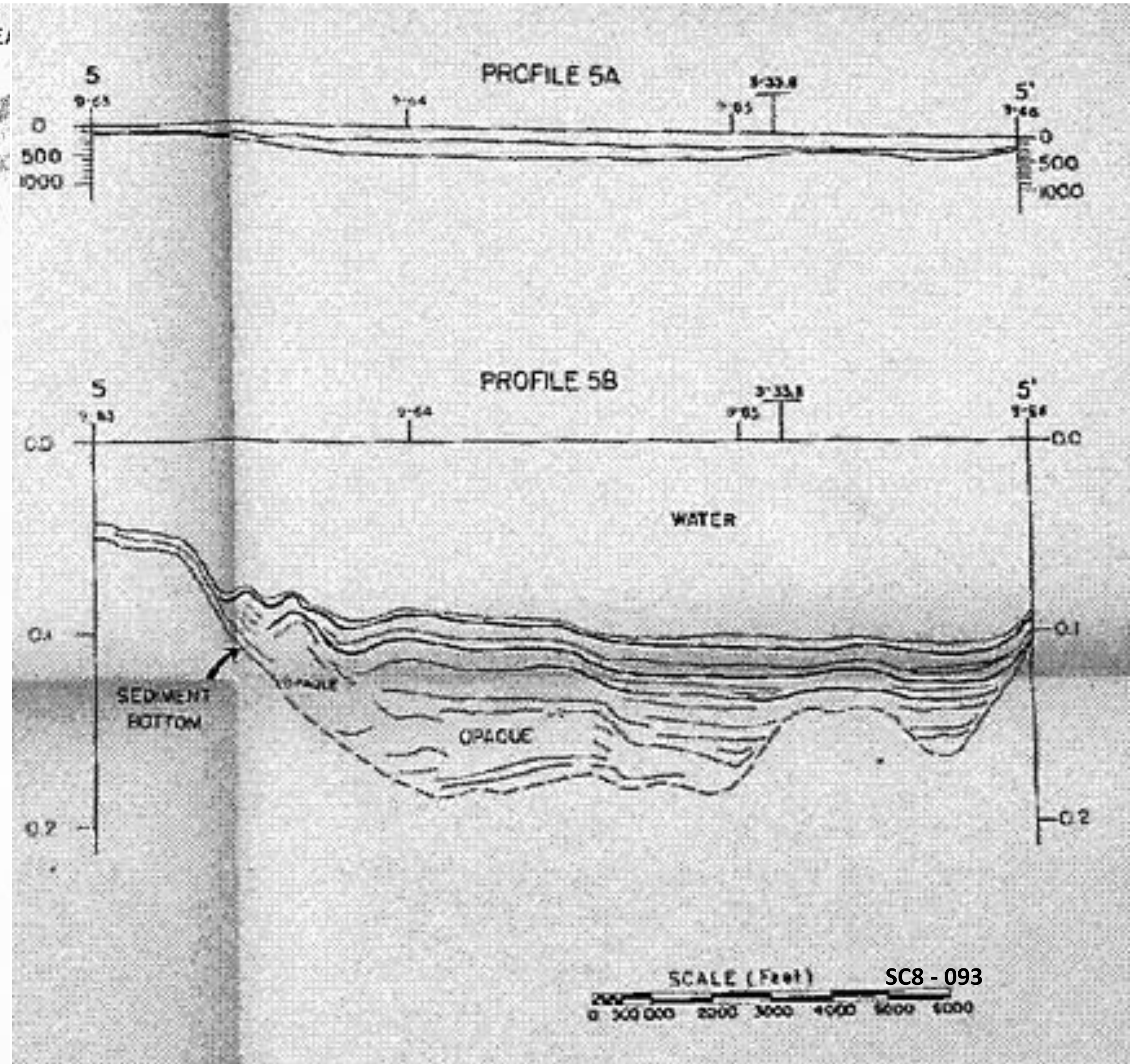
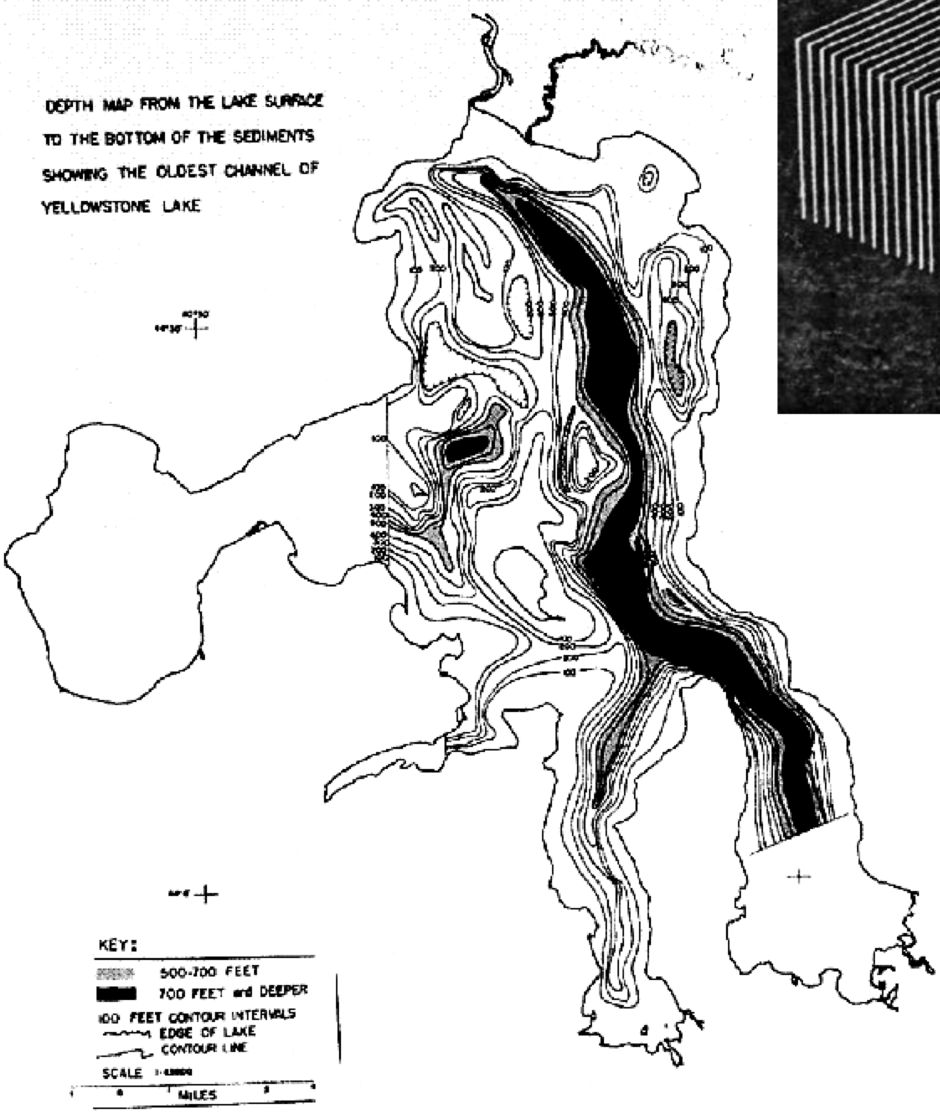
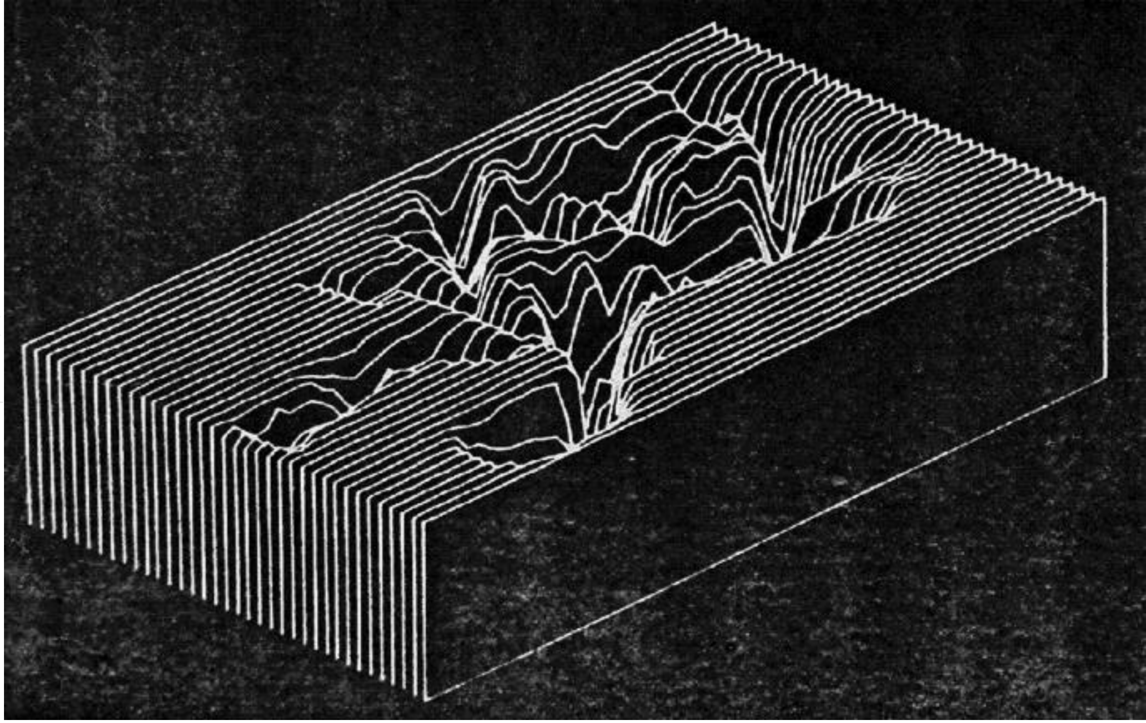
Yellowstone Lake Sparker Survey



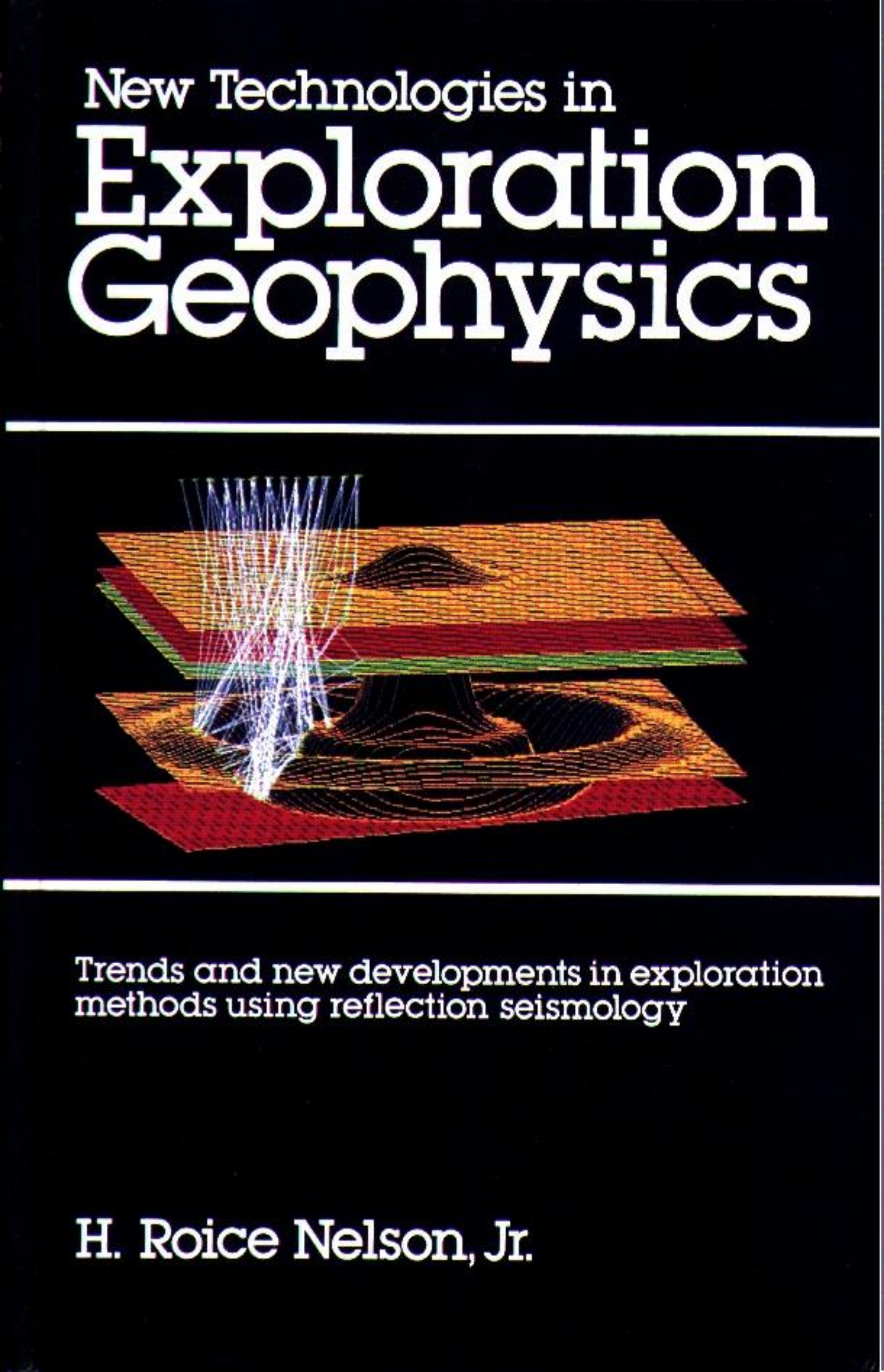
1972

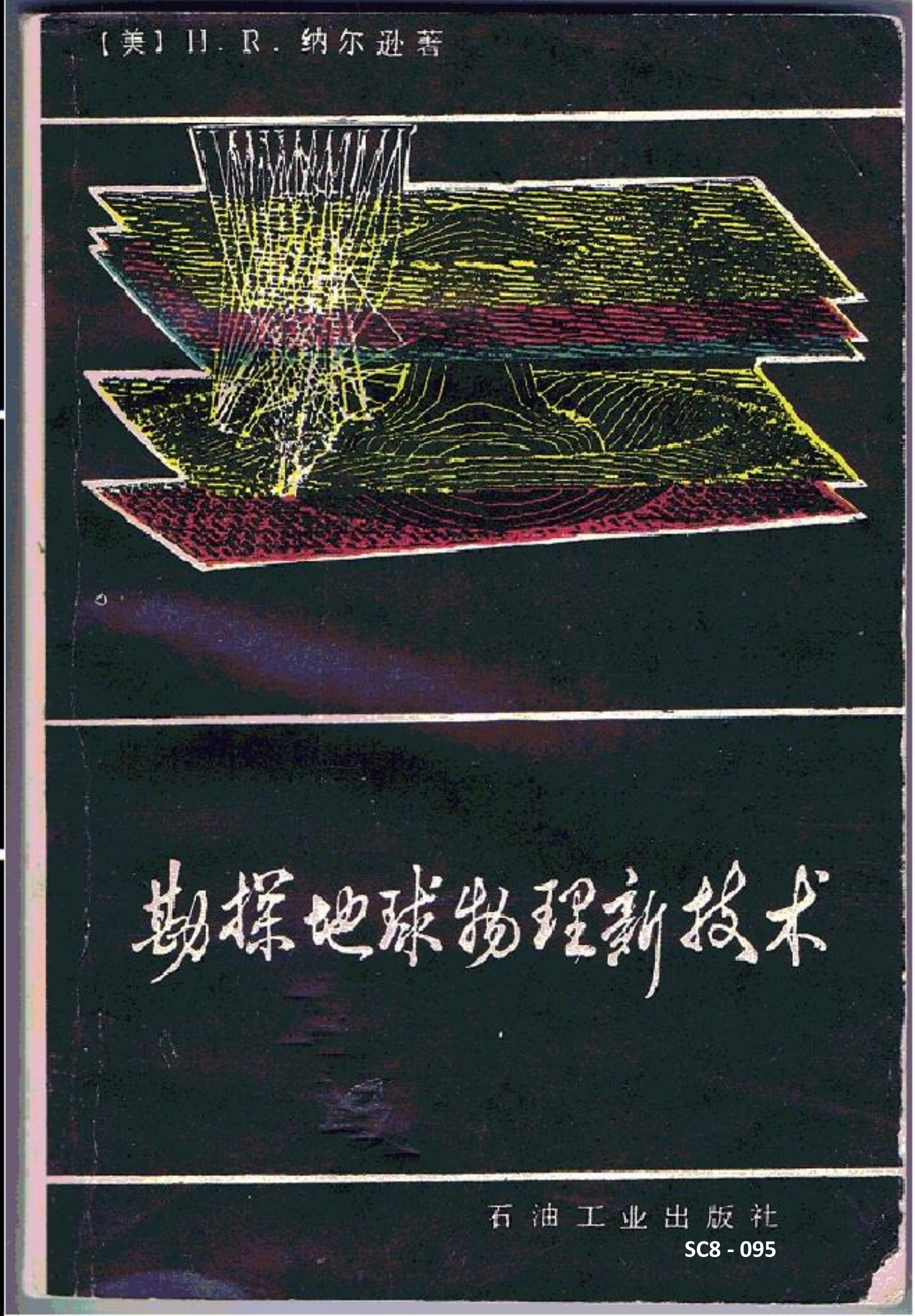
Base Quaternary Sediments Yellowstone Lake





Grandpa's Senior Thesis


New Technologies in
Exploration
Geophysics
Trends and new developments in exploration methods using reflection seismology
H. Roice Nelson, Jr.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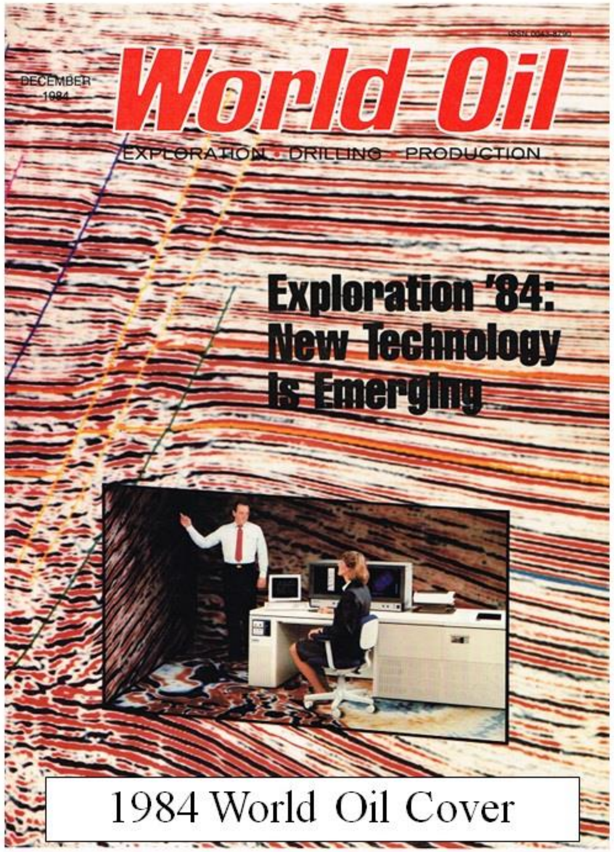
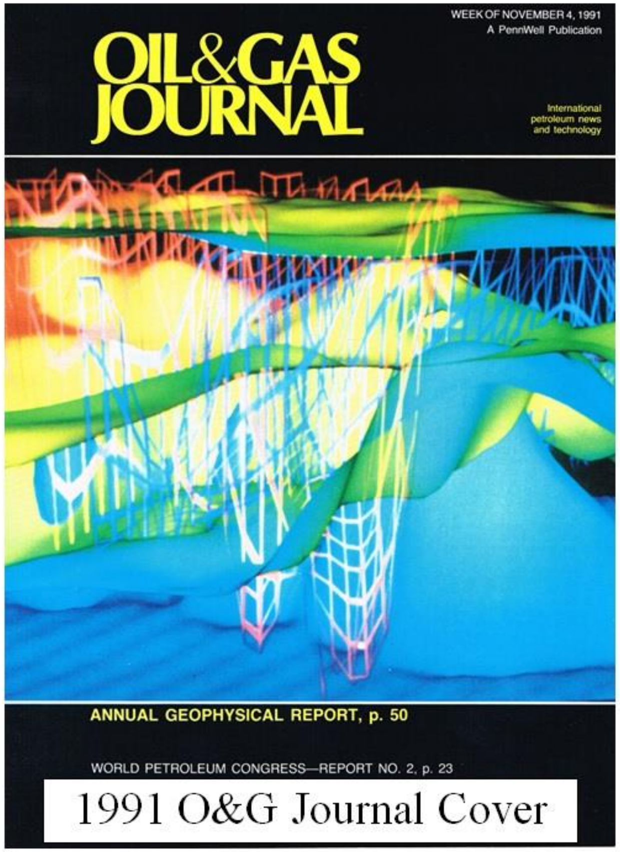
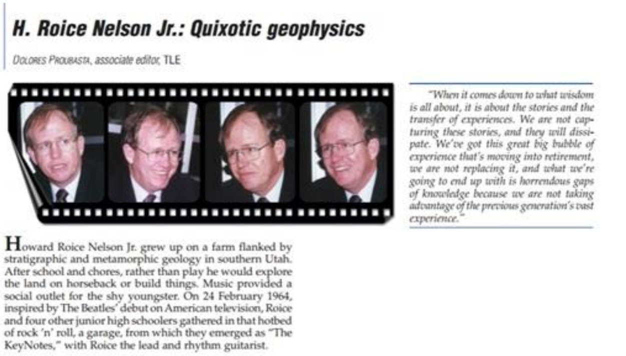


1984 World Oil Cover



1991 O&G Journal Cover



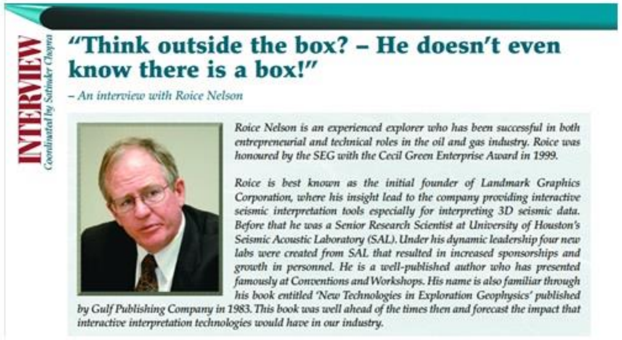
H. Roice Nelson Jr.: Quixotic geophysics

Dolores Proubasta, associate editor, TLE

"When it comes down to what wisdom is all about, it is about the stories and the transfer of experiences. We are not capturing these stories, and they will dissipate. We've got this great big bubble of experience that's moving into retirement, we are not replacing it, and what we're going to end up with is horrendous gaps of knowledge because we are not taking advantage of the previous generation's vast experience."

Howard Roice Nelson Jr. grew up on a farm flanked by stratigraphic and metamorphic geology in southern Utah. After school and chores, rather than play he would explore the land on horseback or build things. Music provided a social outlet for the shy youngster. On 24 February 1964, inspired by The Beatles' debut on American television, Roice and four other junior high schoolers gathered in that hotbed of rock 'n' roll, a garage, from which they emerged as "The KeyNotes," with Roice the lead and rhythm guitarist.

2003 The Leading Edge



INTERVIEW

Coordinated by Satinder Chopra

"Think outside the box? – He doesn't even know there is a box!"

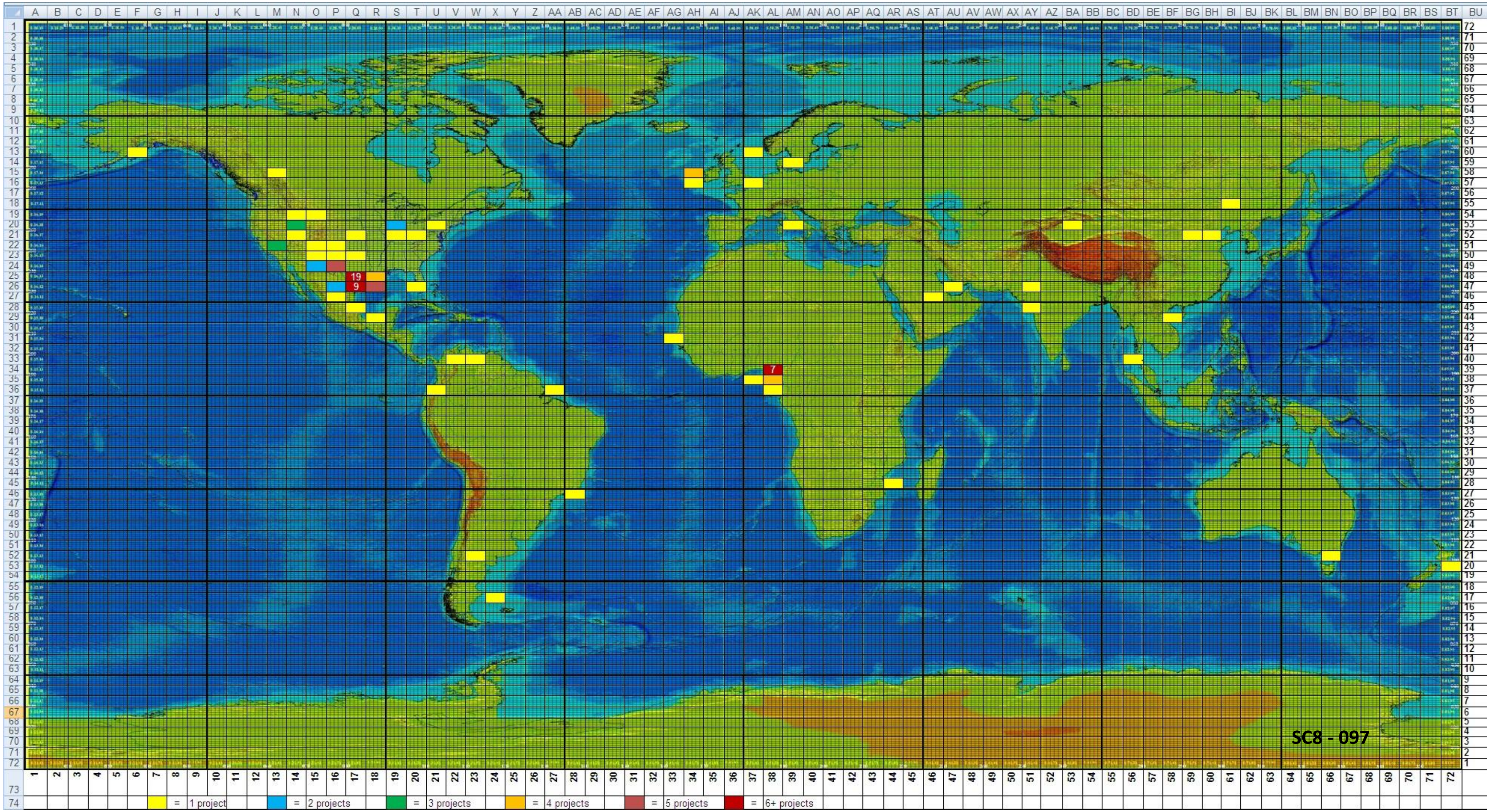
– An interview with Roice Nelson

Roice Nelson is an experienced explorer who has been successful in both entrepreneurial and technical roles in the oil and gas industry. Roice was honoured by the SEG with the Cecil Green Enterprise Award in 1999.

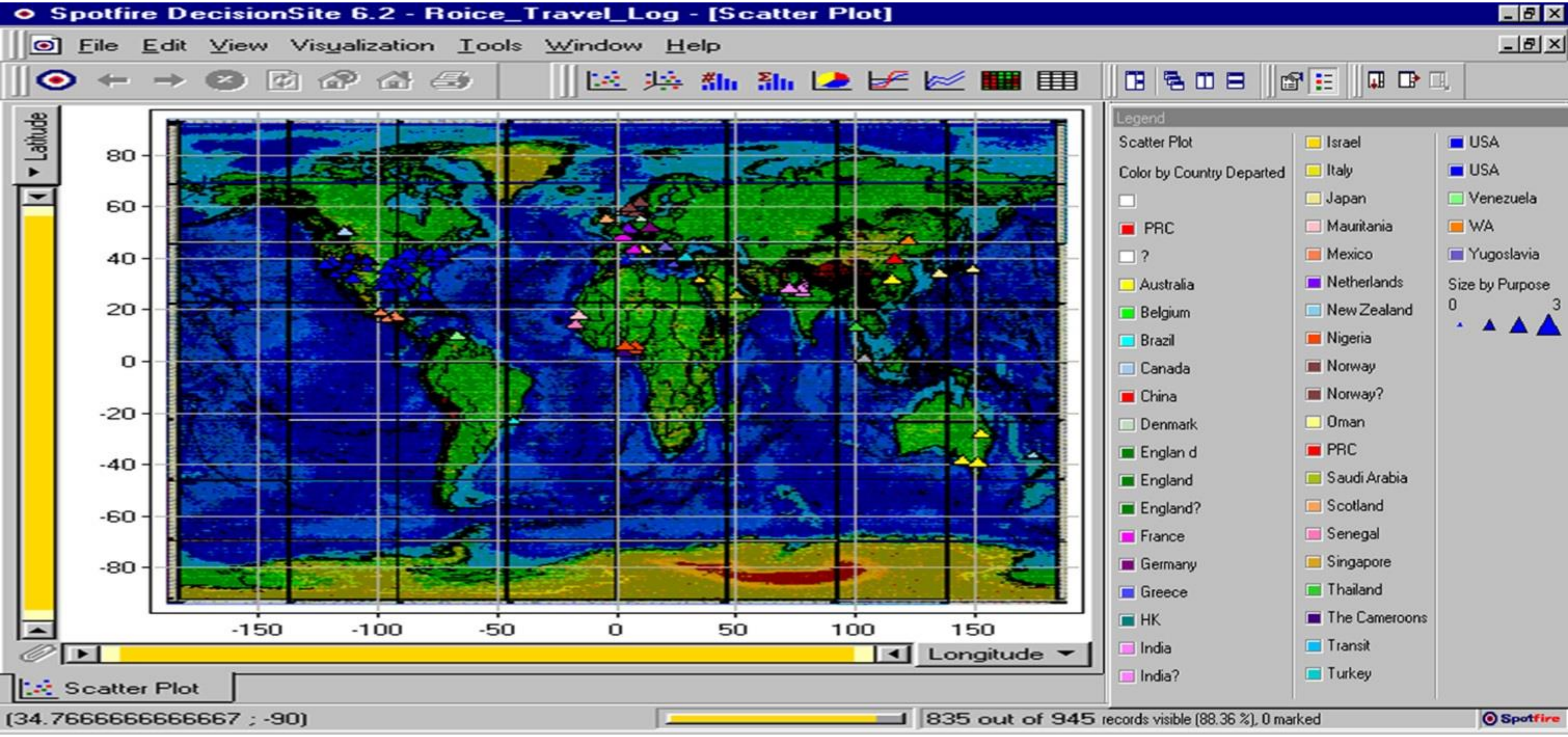
Roice is best known as the initial founder of Landmark Graphics Corporation, where his insight lead to the company providing interactive seismic interpretation tools especially for interpreting 3D seismic data. Before that he was a Senior Research Scientist at University of Houston's Seismic Acoustic Laboratory (SAL). Under his dynamic leadership four new labs were created from SAL that resulted in increased sponsorships and growth in personnel. He is a well-published author who has presented famously at Conventions and Workshops. His name is also familiar through his book entitled 'New Technologies in Exploration Geophysics' published by Gulf Publishing Company in 1983. This book was well ahead of the times then and forecast the impact that interactive interpretation technologies would have in our industry.

2008 CSEG Recorder

Where Grandpa Worked



Where Grandpa Travelled for Work



Notes

Seismic Acquisition

20 *New Technologies in Exploration Geophysics*

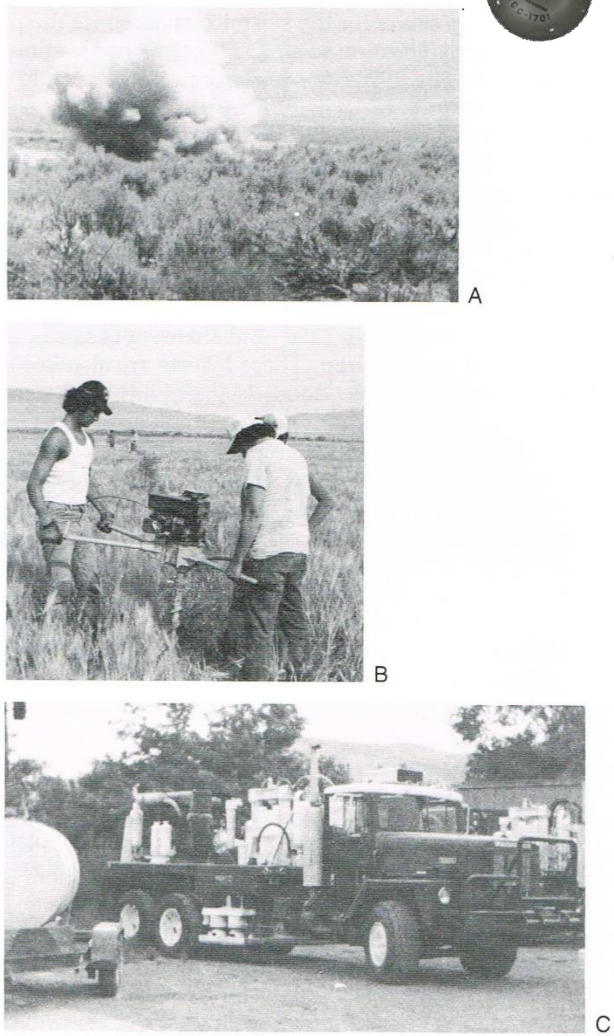


Figure 1-5. Typical land crew operations in southwestern Utah. (A) Surface shooting using ten 5-lb sacks of explosives on a primachord string. The environmental damage is temporary, but overshooting, like overgrazing, can cause long-term problems. (B) Shallow hole shooting of, say, 10 lbs of dynamite per shotpoint is better in agricultural areas. (C) The most common land seismic source is Vibroseis.™ Normally, four of these trucks vibrate in synchronization.

28 *New Technologies in Exploration Geophysics*

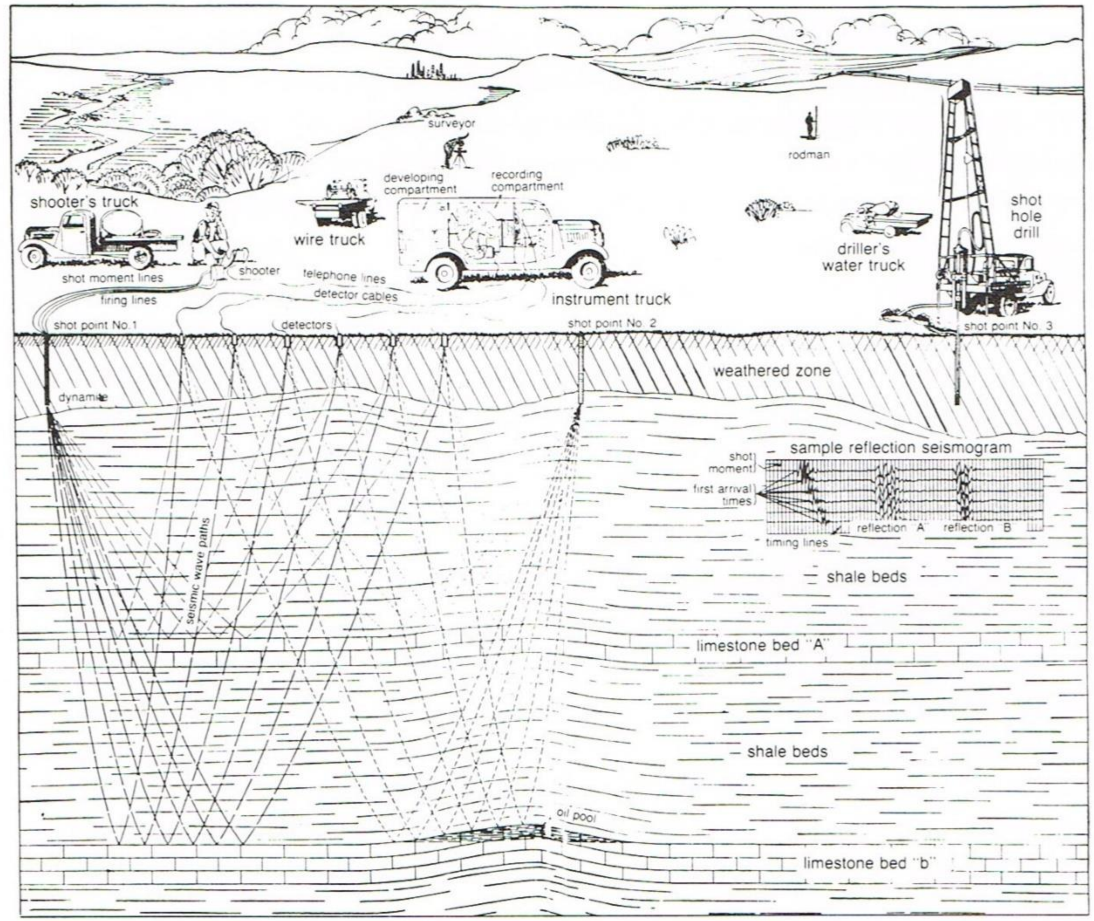


Figure 1-7. This diagram of a 1940s seismic shothole crew reflects the same basic configuration used today, except crews now use many more channels, various seismic sources, and sophisticated instrumentation. (After Nettleton.[2])

http://www.walden3d.com/photos/Grandkids_Science_Camps/170802-04_Science_Camp/7_2-D_Seismic.pdf

Reflection Seismology

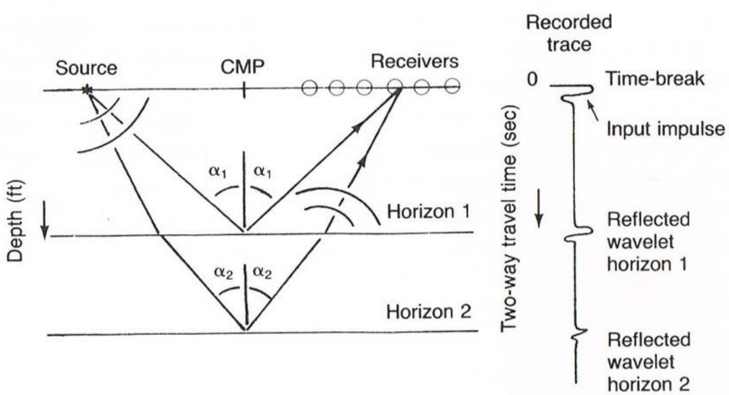


Figure 1-1A. This diagram shows the concept of common mid-point (CMP). Note that boundaries act as sources for new wavefront paths and that the angle of incidence equals the angle of reflection.

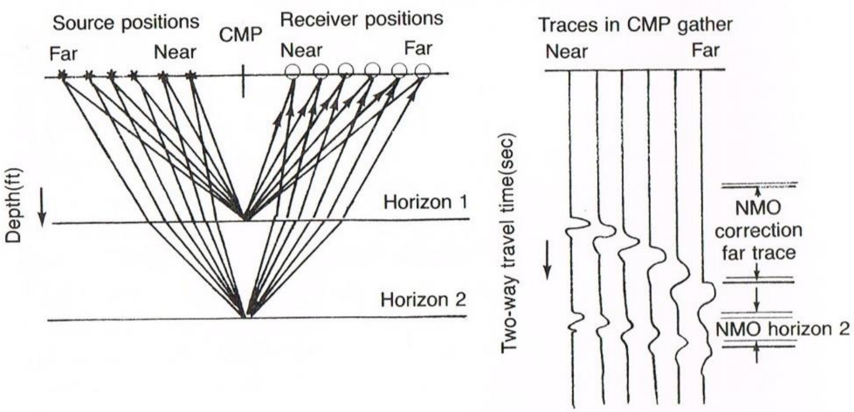


Figure 1-1B. In this CMP gather, reflections are recorded by six different sets of source/receiver locations. The data is sorted into a CMP gather during processing. Dispersion, or the widening of the wavelet with offset, is exaggerated in the traces drawn on the right.

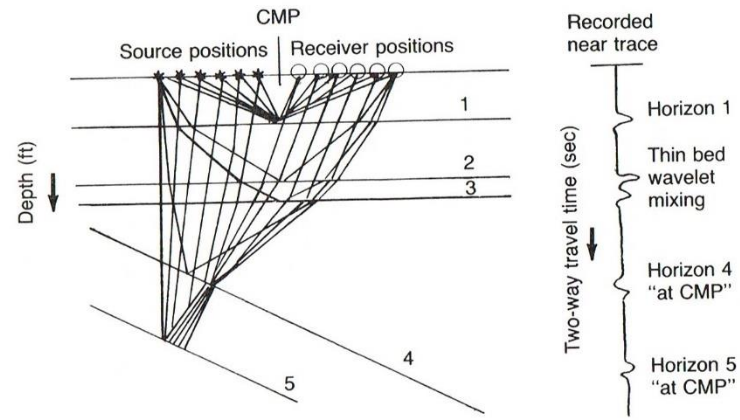


Figure 1-1C. A CMP gather over dipping beds shows one of the problems with the CMP method. Not only are the ray-traced reflection points at horizons 4 and 5 not located spatially at the CMP, but also note how the spatial locations of different source/receiver combinations move as a function of offset on horizon 5.

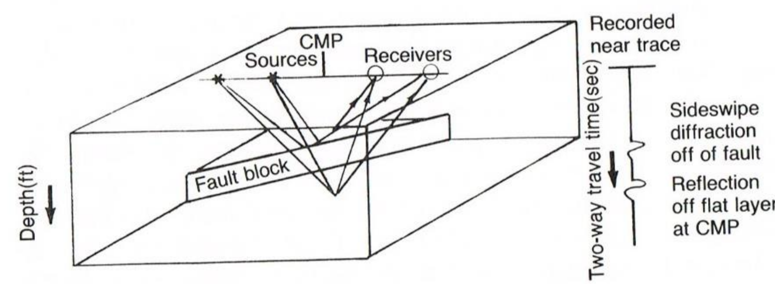


Figure 1-1D. Sideswipe reflections can come from steeply dipping layers. This example shows how diffractions from a fault block put out-of-plane events on a CMP trace.

Processing

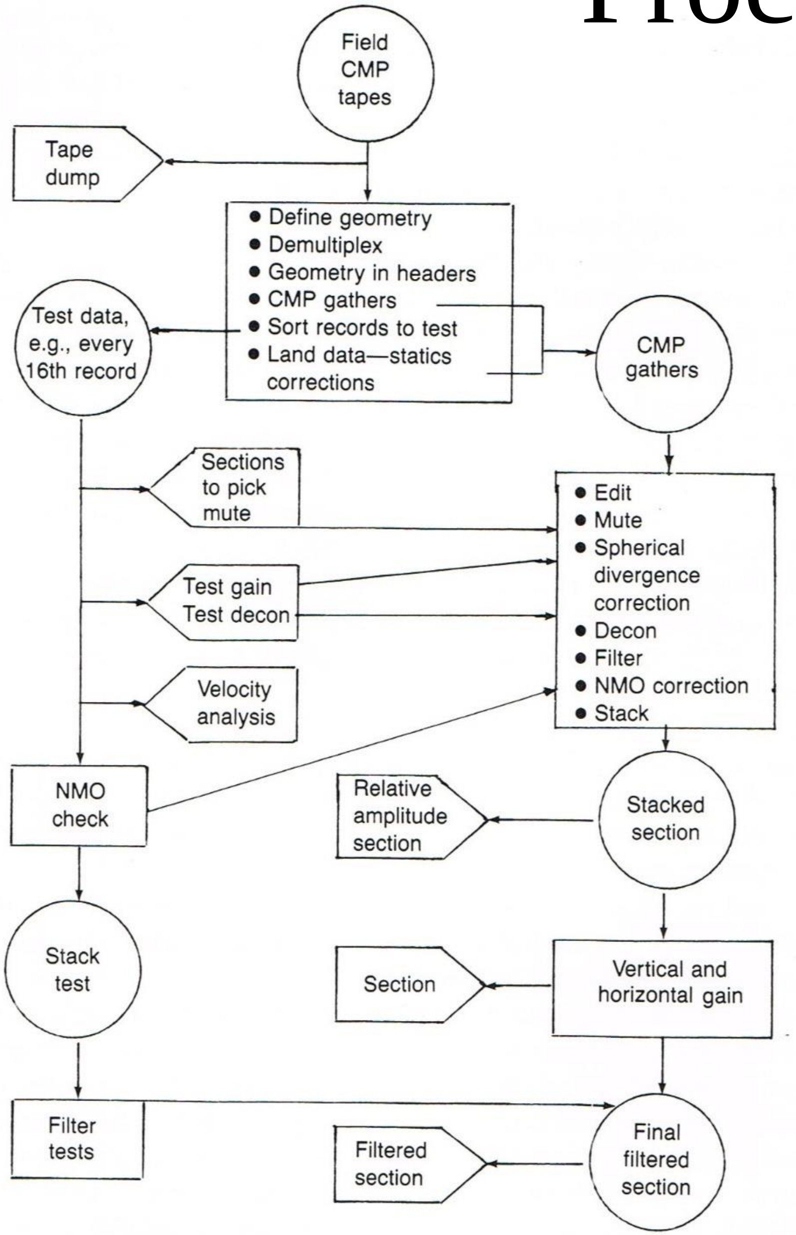


Figure 1-8. Flow chart of the processing steps involved in compositing CMP gathers into a stacked seismic section.

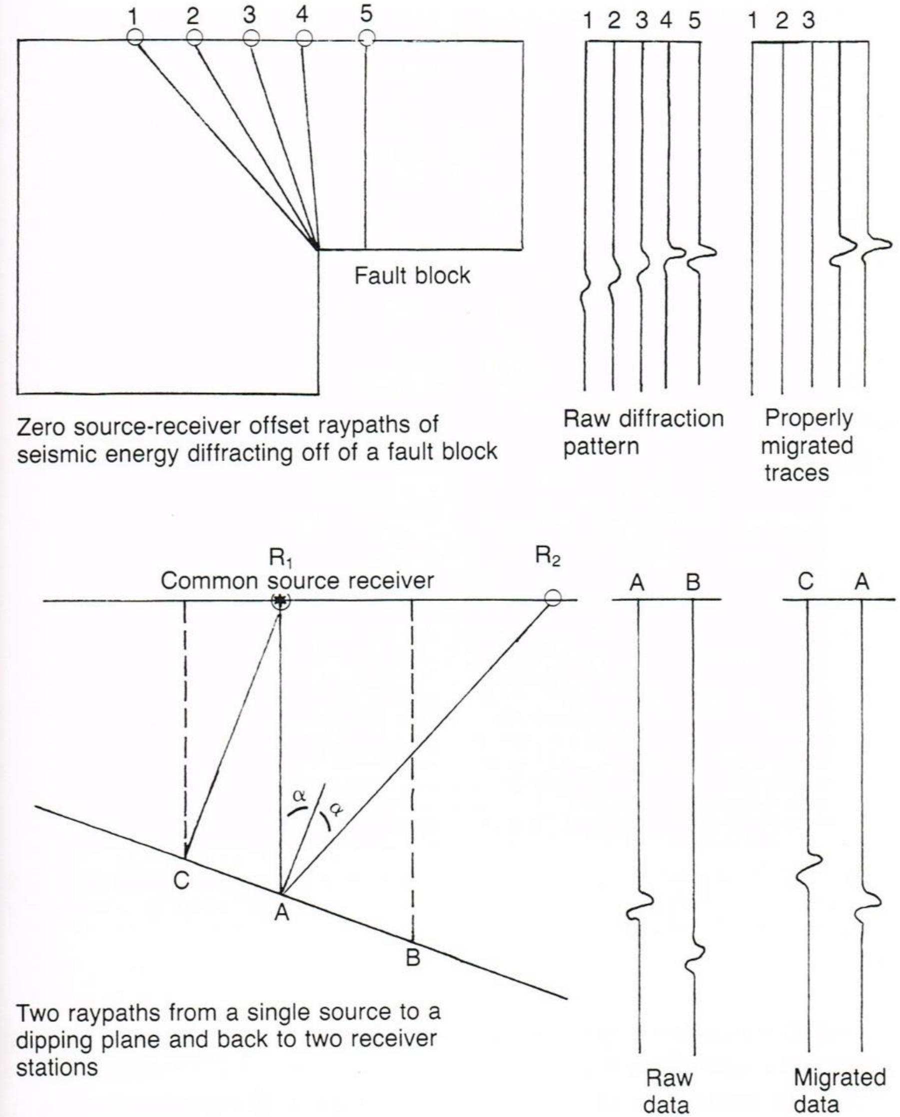


Figure 1-11. Migration is a mathematical, computer focusing procedure that collapses diffractions (top) and plots reflections from dipping layers in their actual spatial location instead of at the CMP (bottom).

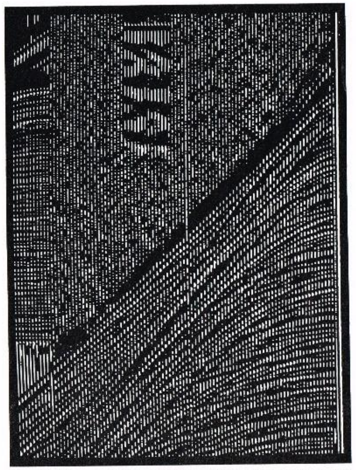
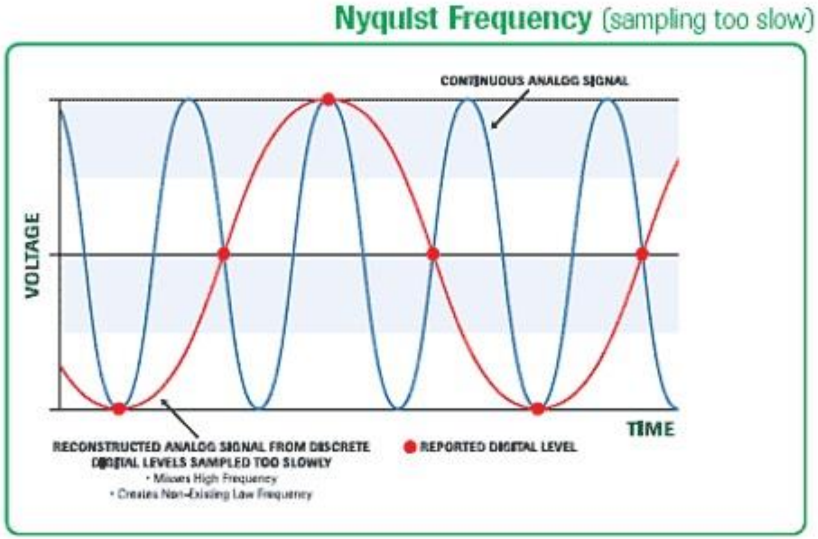


Figure 2-3. The seismic field record is displayed on a vector refresh graphics terminal. Seismic data displays require large amounts of trace data to be viewed simultaneously so that correlation between traces can be analyzed. (Courtesy Adage, Inc.)



Seismic Shot Gathers

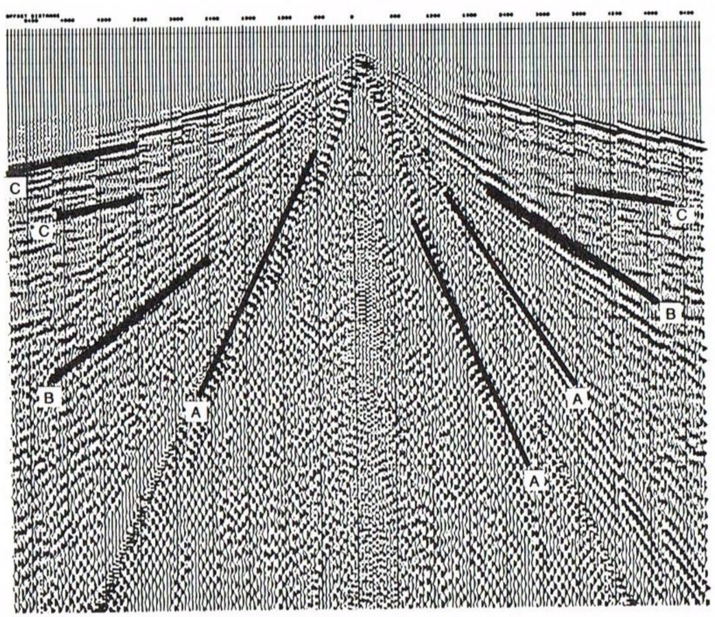


Figure 1-6A. A noise survey showing example air waves (A), ground roll (B), and reflections (C). The receivers were grouped at each of 12 receiver stations and the vibrators moved out to 8 source positions in each direction.

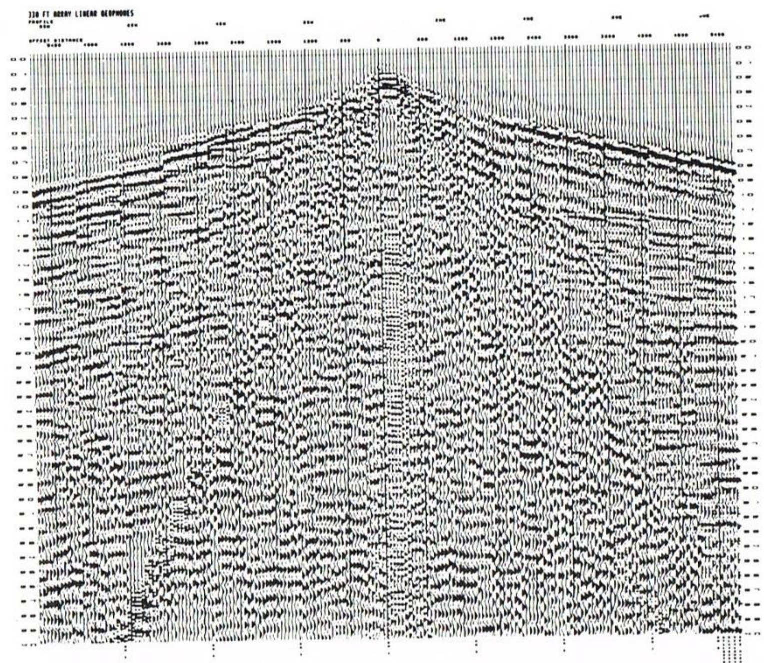


Figure 1-6B. A noise survey showing how a 330-ft linear receiver array cancels the strong air wave and ground roll. This same procedure can be done in processing if receiver stations are close enough together.

Seismic Interpretation

Reflection Seismology: An Introduction 53

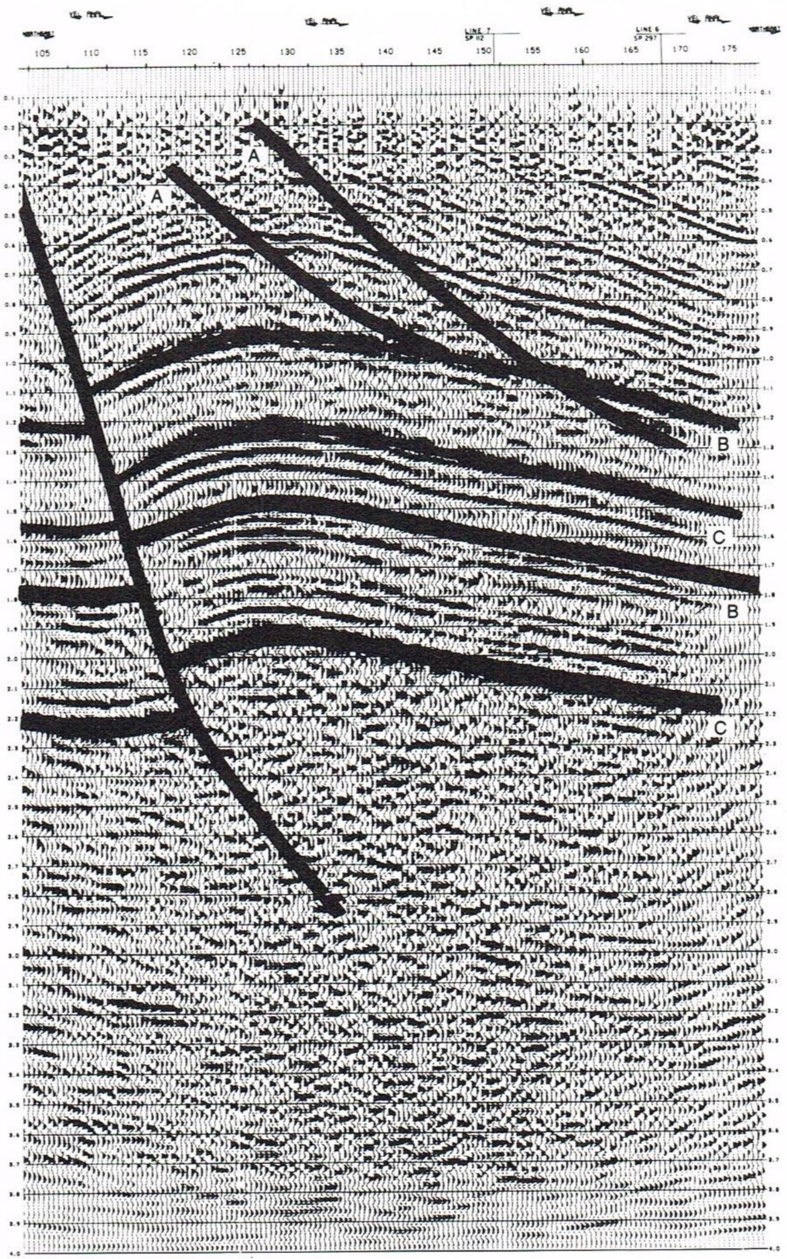


Figure 1-17. An interpreted seismic section across the Wind River Overthrust. (After Steiner.[36])

48 New Technologies in Exploration Geophysics

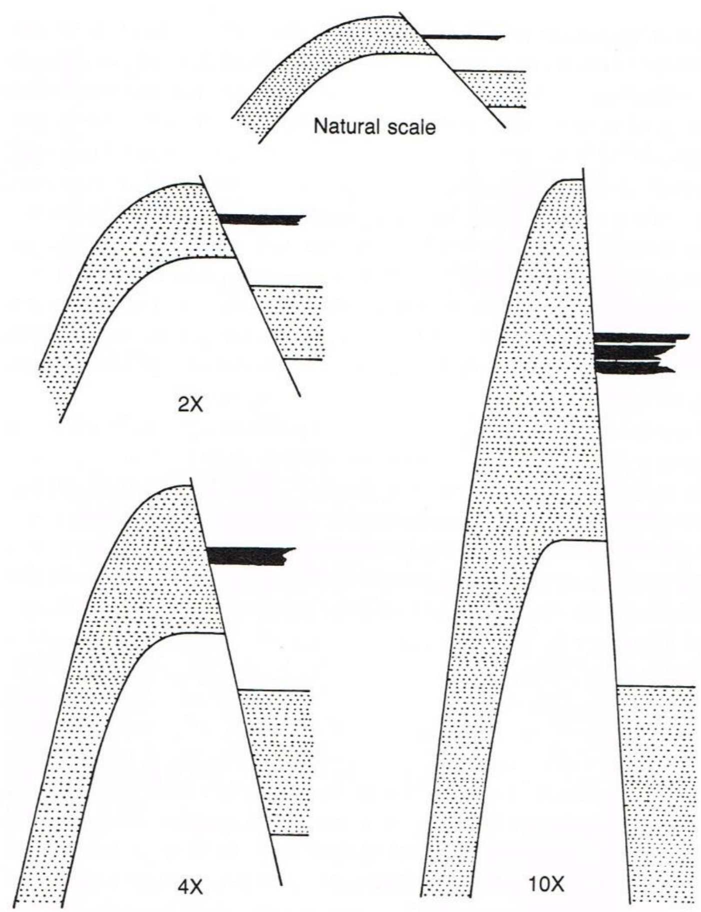


Figure 1-15. Vertical exaggeration allows one to see vertical and horizontal context, but severely distorts bed thickness, structural relationship, fault dip, etc. The vertical exaggeration on a seismic section varies as a function of the velocity of the rocks, but is typically within this range. (After Sheriff.[17])

Contouring and Seismic Attributes

54 *New Technologies in Exploration Geophysics*

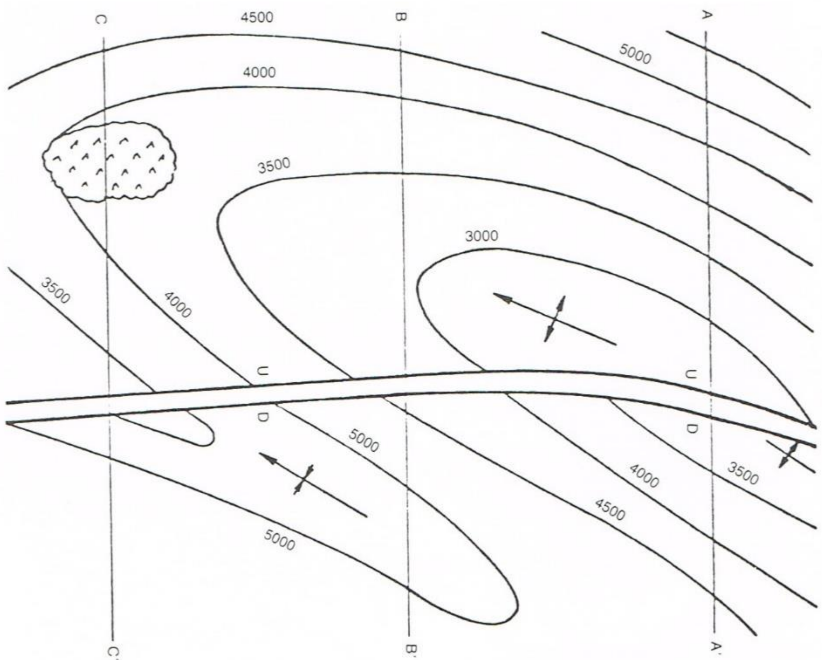
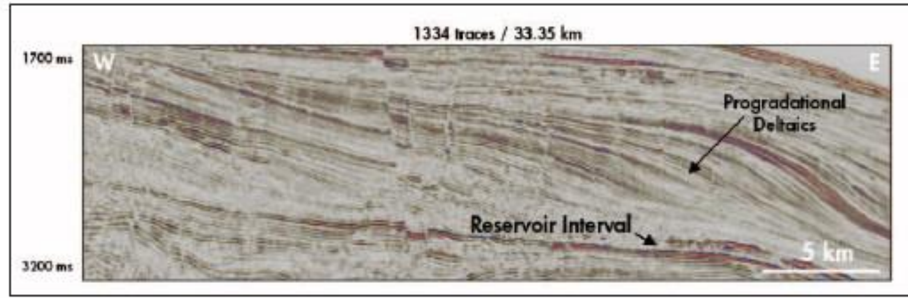
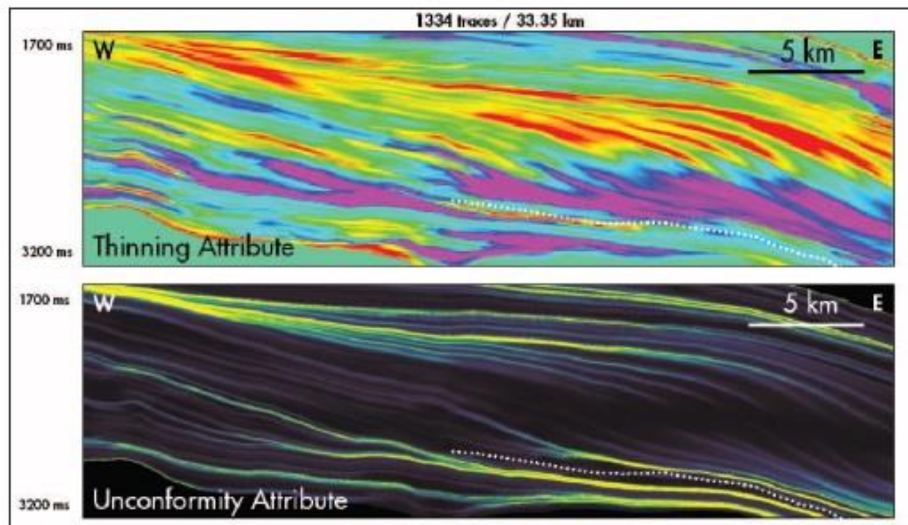


Figure 1-18. Contour map showing a fault, a salt piercement, and a basin. (After Sheriff.[17])



Barracuda Field seismic expression. Reservoir has single-cycle expression with relatively high negative amplitudes. Progradational deltaic packages, overlying reservoir interval, provide top seal. Faults offset feeder systems.



Barracuda geometric attribute expression. Thinning attribute demonstrates thinning to left in red and thinning to right in purple. Unconformity attribute: dark grey to black = areas of relatively parallel layers; yellow = areas of convergence. Reservoir interval is highlighted by dotted line in both images.

Notes

3-D Acquisition Design

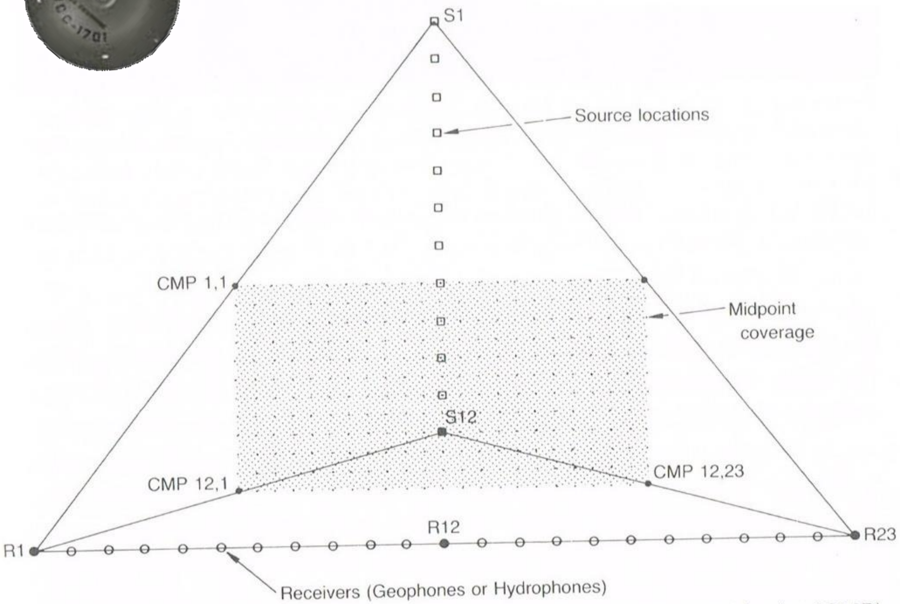


Figure 4-2. Cross-spread or T-spread data collection provides common mid-point (CMP) traces that cover an area. The T-spread is the simplest reduction of a 3D collection scheme, and can be expanded by running the receivers or sources in any arbitrary direction.

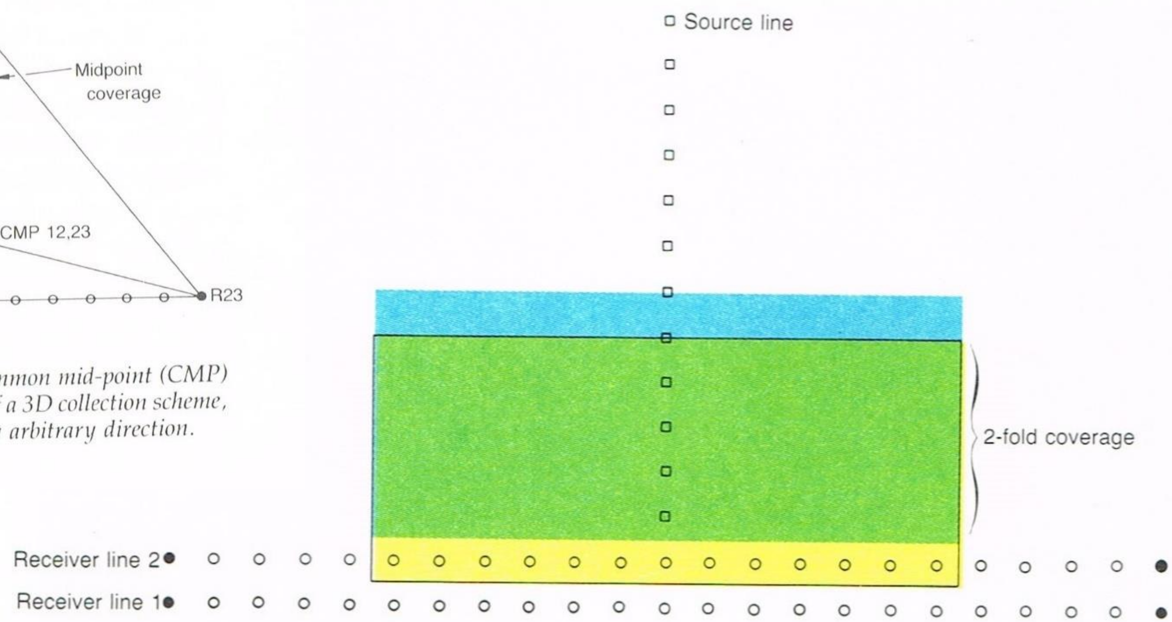


Figure 4-5. By shooting multiple source lines into the same receiver array, any desired CMP redundancy can be achieved. In the example above there is 2-fold coverage in the overlapped area and single fold coverage elsewhere. When there are two traces with different offsets at the same CMP, the data is referred to as 2-fold. Most 2D data collected today is 24, 48 or 96-fold, and by adding this redundant data together it improves the

http://www.walden3d.com/photos/Grandkids_Science_Camps/170802-04_Science_Camp/7_3-D_Seismic_Modeling.pdf

3D Acquisition Design & CMP Display

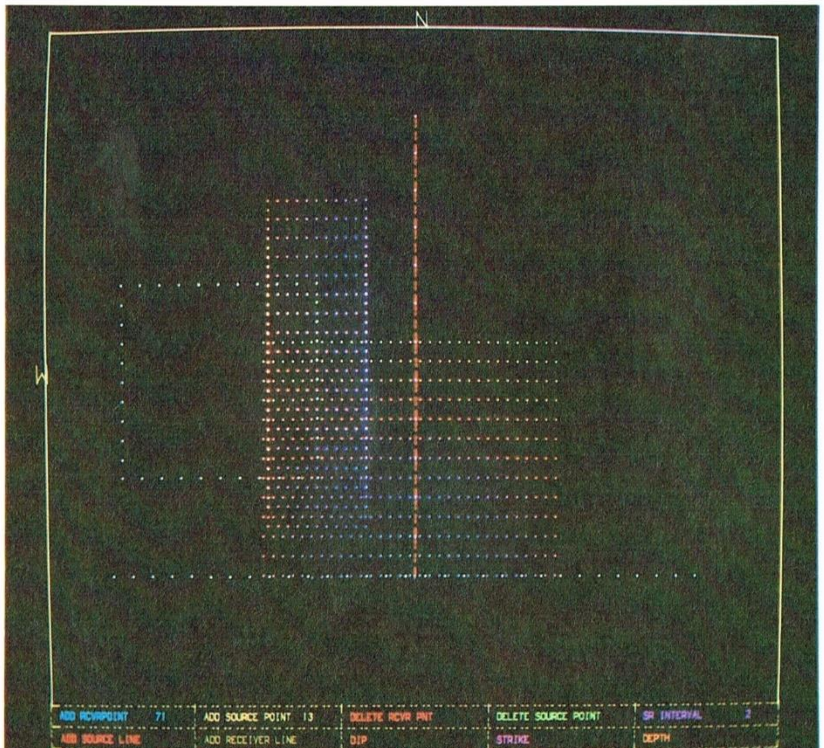


Figure 4-3. A map or aerial view of shot and receiver positions for a typical 3D survey shows the spatial relationship to generated CMP's. The shot points are marked in red along the vertical part of the X-spread. Receiver locations are marked in white, and are along both arms of the X-spread, as well as on the perimeter of a small square off to the north-west. The CMP's fall in between and are color coded by offset. (Courtesy Geosource, Petty-Ray Geophysical Division.)

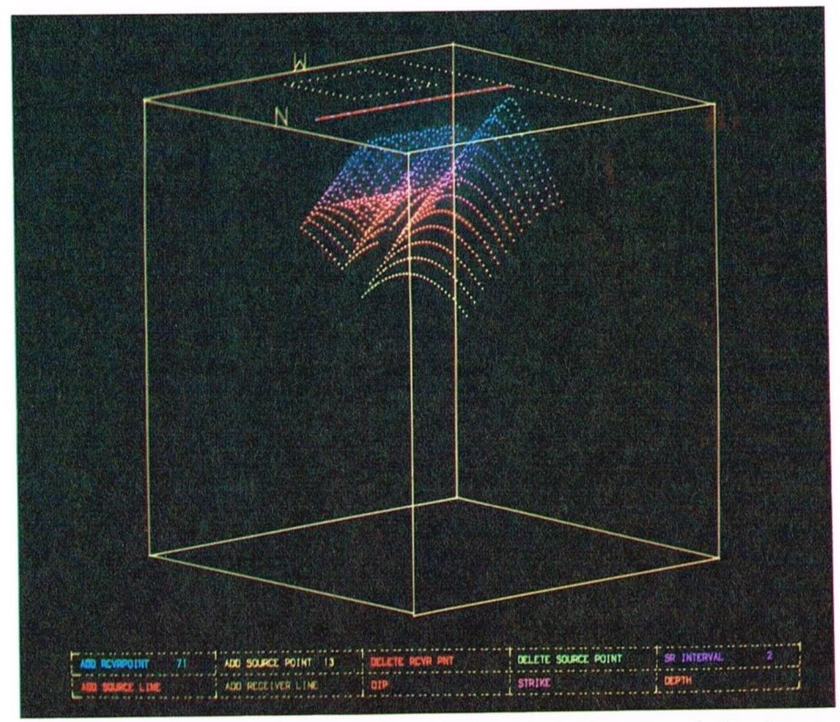


Figure 4-4. The offset differences for different CMP's are visually enhanced when the same information is displayed with offset shown as a function of required NMO correction along the z-axis. With an interactive display device, it is easy to rotate, translate, or scale this display to any desired orientation. (Courtesy Geosource, Petty-Ray Geophysical Division.)

Wedge Numerical and Physical Model

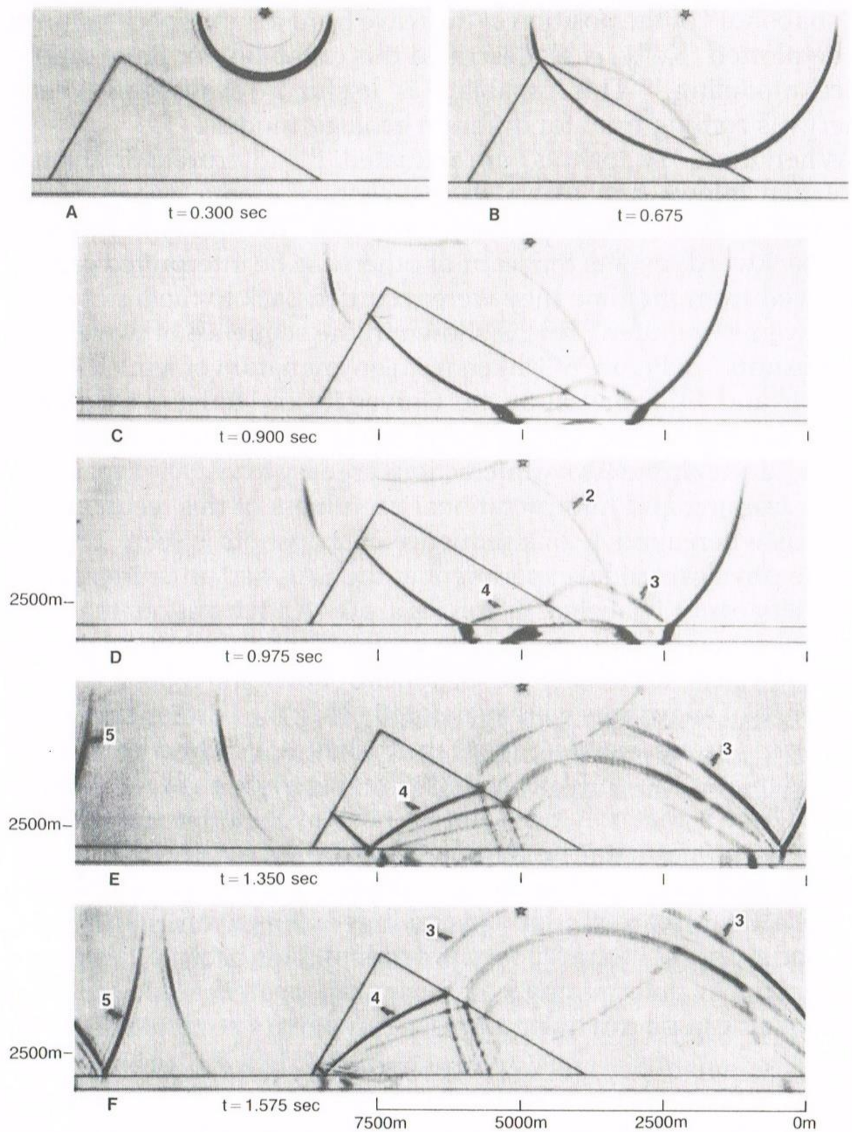


Figure 6-3. A sequence of wavefront "snapshots" calculated using the Kosloff, Baysal Fourier modeling technique. The pressure response is calculated at specific time steps and then the snapshots are "animated" to help interpret specific events. Event 2 is reflected energy off of the low-velocity wedge. Events 3 and 4 are reflected energy off of the high-velocity flat base. Event 5 is wrap-around due to the Fourier transforms used in this method. (After Kosloff and Baysal.)

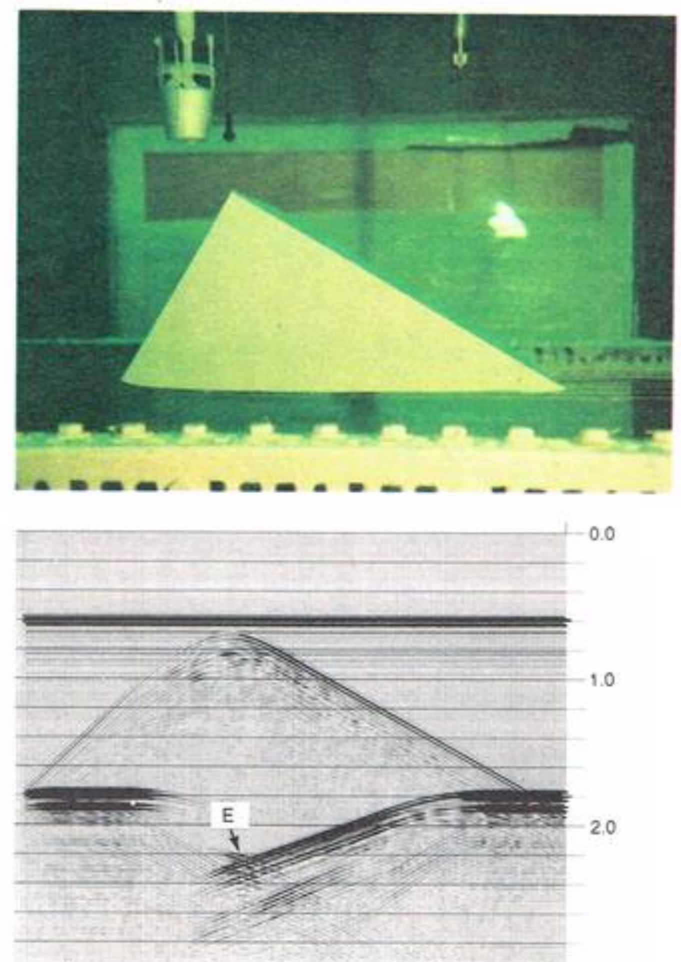


Figure 6-4. A 2D wedge physical model is shown accompanied by a seismic section across the model. Event E, the "mystery event on the physical model section, is the diffraction energy from the top of the wedge.

Fresnel & HCI Models

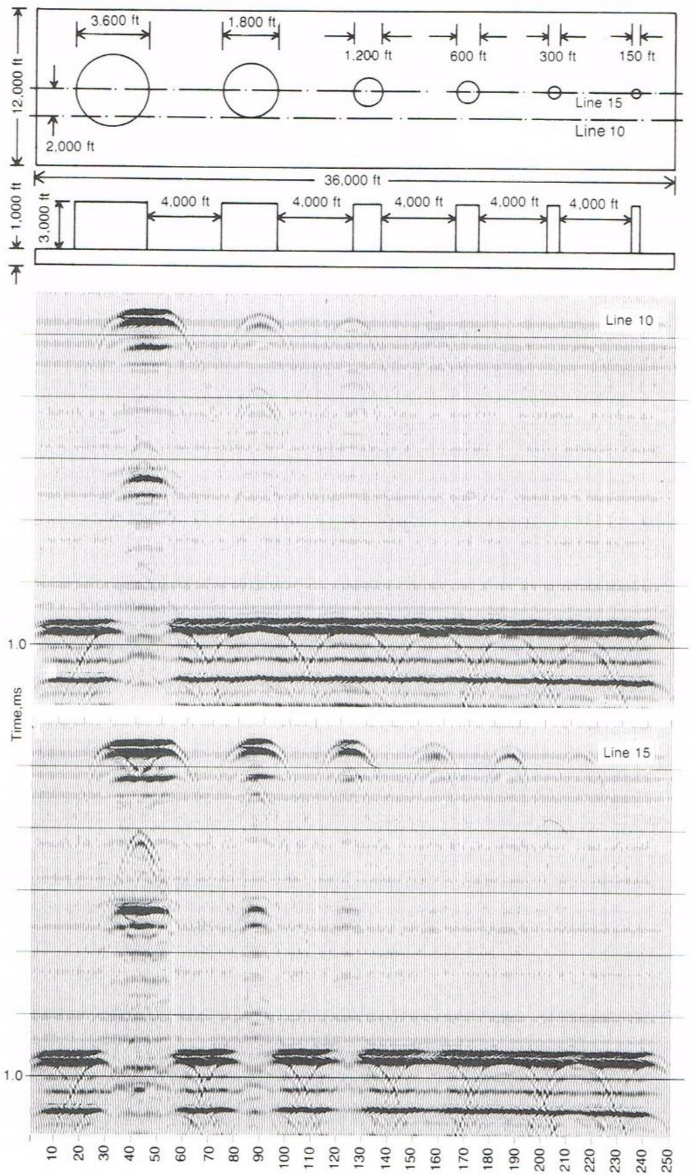
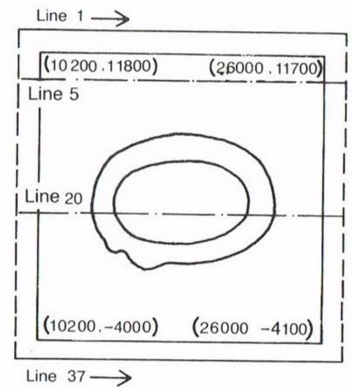


Figure 6-9. A map view (including section locations) and side view of physical model SALFRS is shown. Note the expected response on the seismic section for Line 15 as the cylinders get smaller. The 2,000-ft separation between the sections shows the importance of proper spatial sampling in order to see events that can indicate significant hydrocarbon prospects.[22]



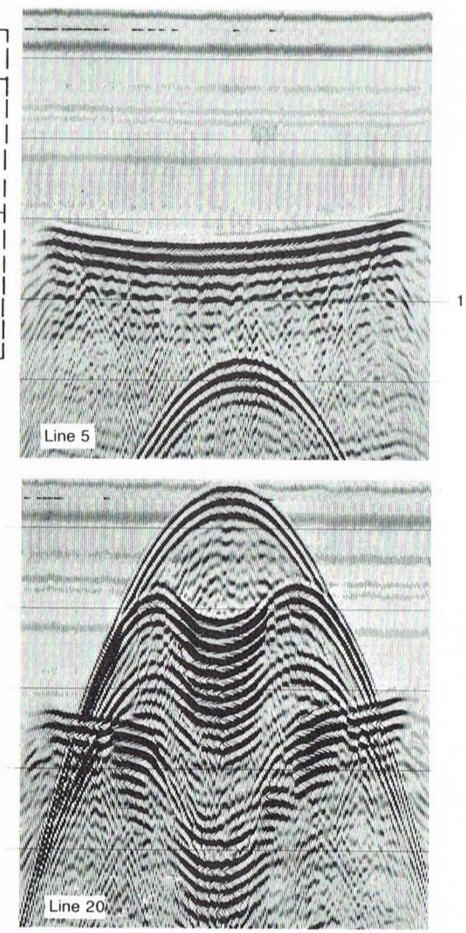


Figure 6-11. A map view of the SALHCI model is shown with two seismic lines referenced. Seismic sections for each of the lines are illustrated. Note the sideswipe from the model edge as indicated in the section for Line 5. The velocity push-down from the low velocity (gas) cap is shown in the section from Line 20.[23]

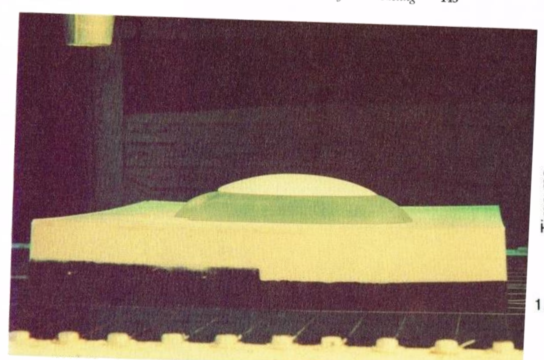


Figure 6-10. The 3D model SALHCI is shown in the water tank.

SALNEL
Alluvial Stream Model

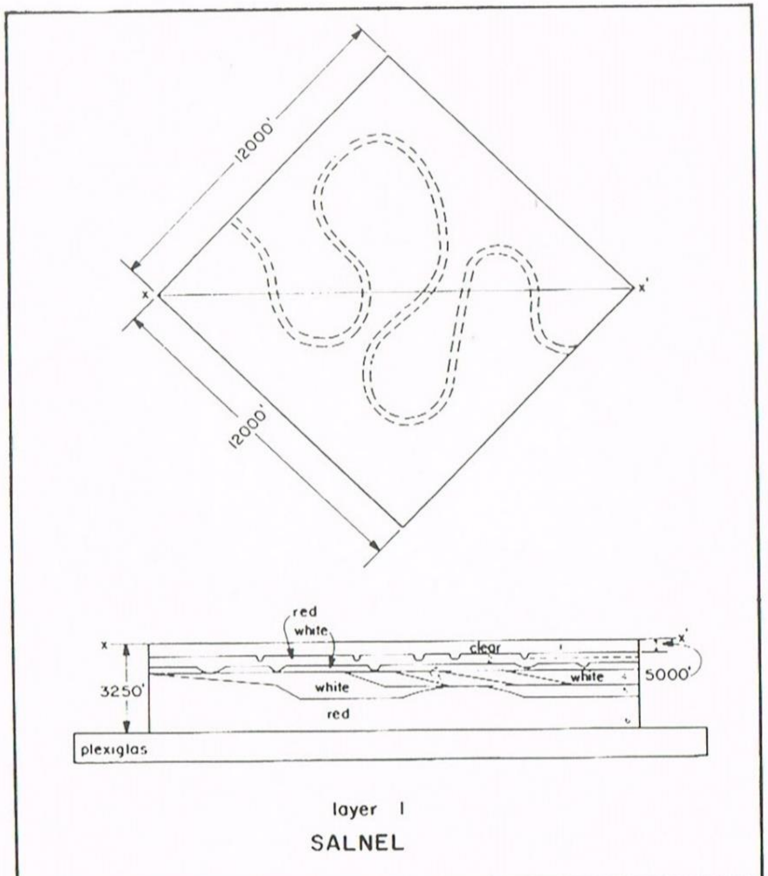


Figure 6-12A. Line drawing of SALNEL showing the six different layers represented by the model.[25]

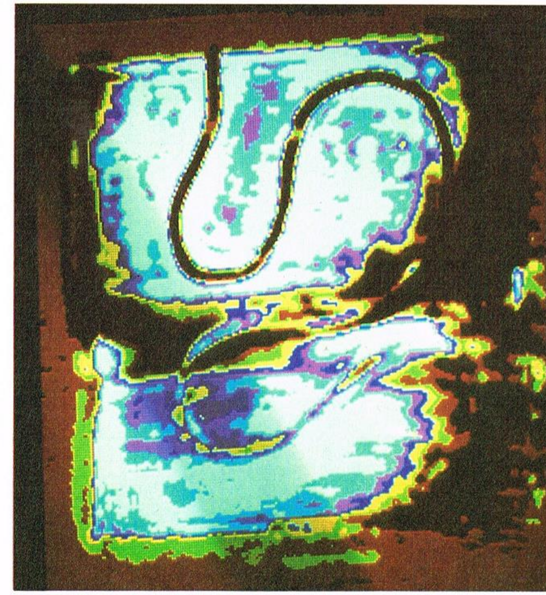


Figure 6-12B. Time-slice or horizontal section through the SALNEL meandering stream.

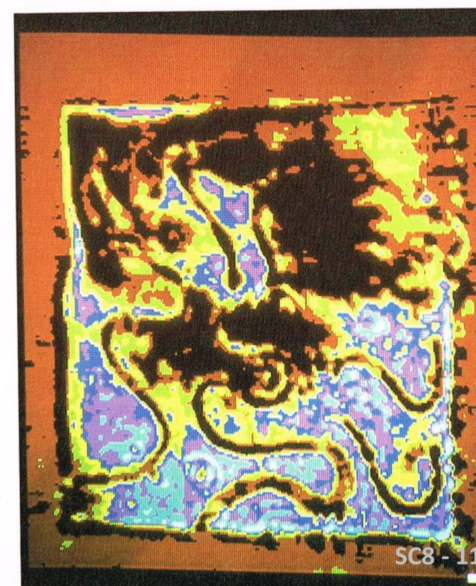


Figure 6-12C. Time-slice or horizontal section through the SALNEL braided streams.

3D Display & Migration Lens Model

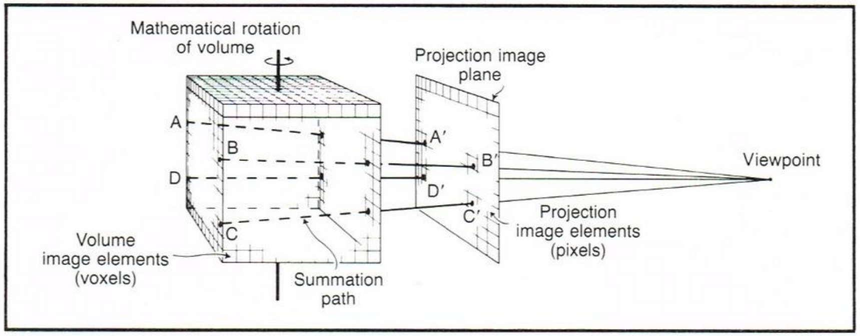


Figure 8-4. Picture elements (voxels) of the volume on the left are numerically summed along projection paths (four representative paths shown) to form the picture elements (pixels) of the two-dimensional projection image in the center. When the resulting digital image is displayed, it is as though the observer views the volume image from the viewpoint on the right. (Reproduced from SEG Reprint,[22] Courtesy L.D. Harris, "Identification of the Optimal Orientation of Oblique Sections Through Multiple Parallel CT Images," Journal of Computer Assisted Tomography)

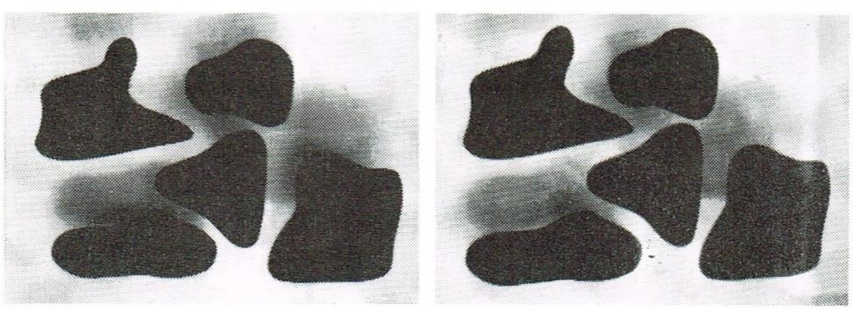


Figure 8-5. Stereoscopic photograph of a physical model with five plexiglass lenses raised above a plexiglass base. The highest lens is in the bottom right corner, they stairstep down to the top left corner lens, and the bottom left and top right lenses are lowest and are at the same elevation.[23]

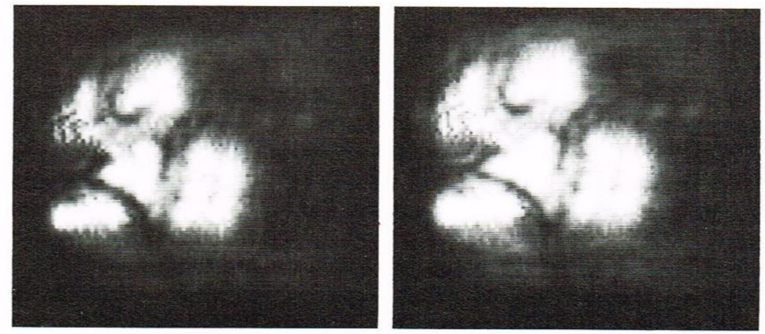


Figure 8-6. A stereoscopic projection of a volume of unprocessed seismic data over the physical model from Figure 8-5. Note the unfocused appearance caused by the diffractions.[23]

Figure 8-7. A stereoscopic projection of a volume of Hilbert Transformed 3D migrated data from the physical model in Figure 8-5. Note the focusing effect of migration compared to Figure 8-6.[24]

SALNOR Model of Norwegian North Sea Geology

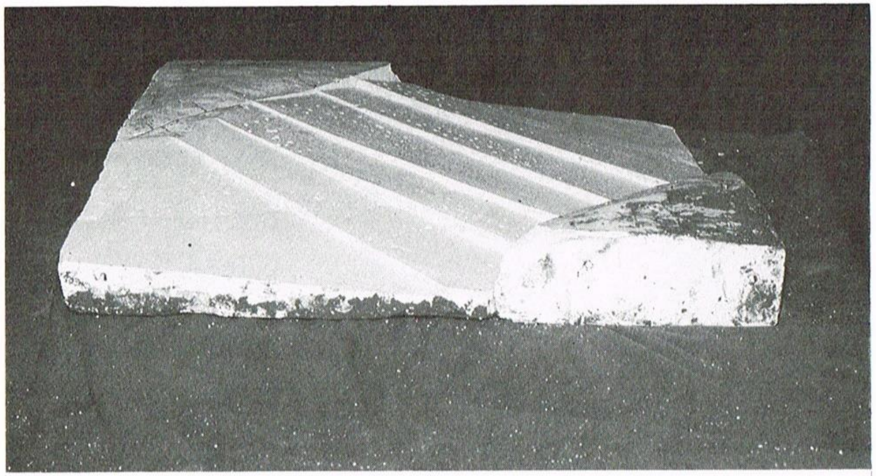


Figure 6-13B. A view of the SALNOR J-Unconformity plaster cast after it was shaved off to the Base Statfjord horizon.

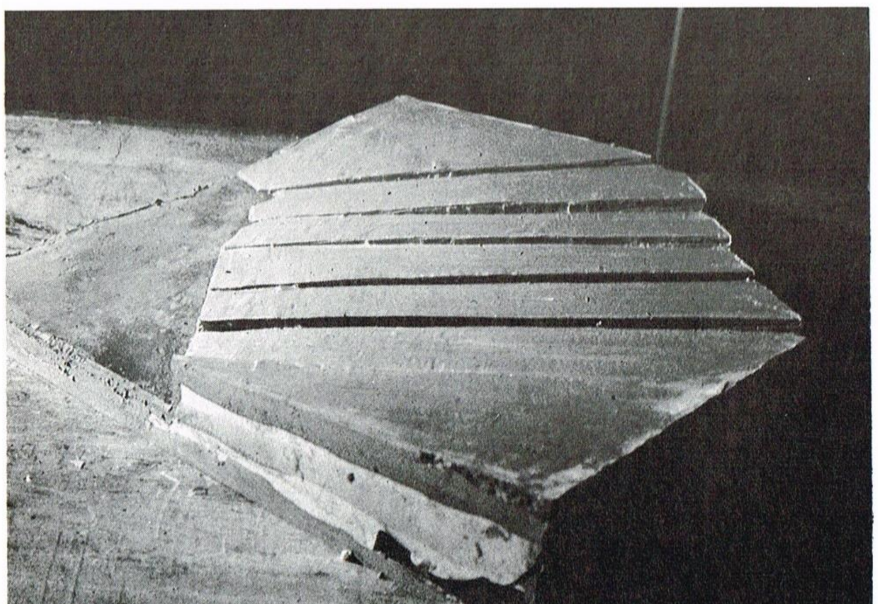


Figure 6-13C. The silicon rubber for deeper layers was added by pouring between the model and the plaster cast. This shows the SALNOR model after the Statfjord horizon had been poured.

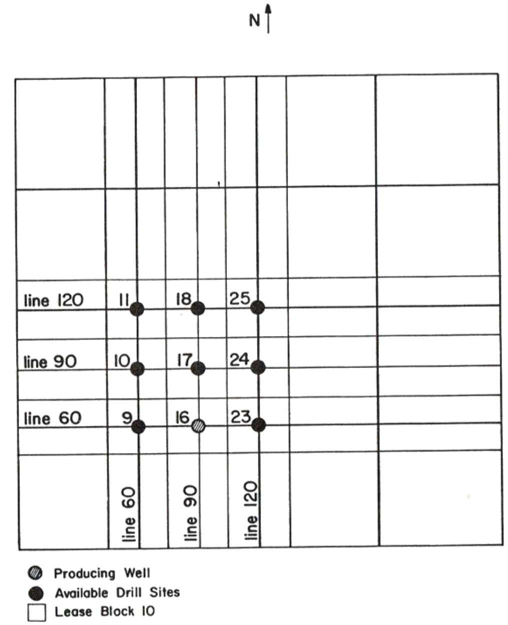


Figure 6–13F. A map showing the relationship of 7 north-south, 7 east-west, and 9 possible drilling locations. This is part of an interpretation training exercise.

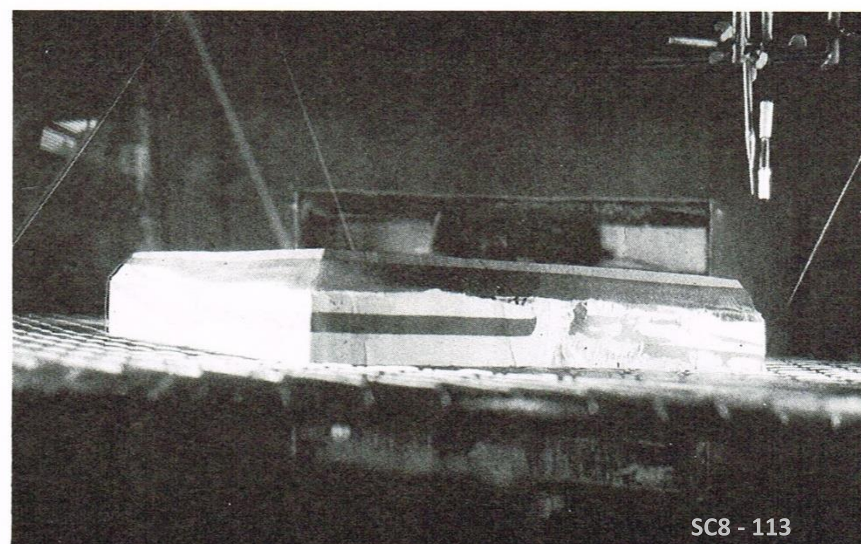


Figure 6-13A. The completed SALNOR physical model in the modeling tank.

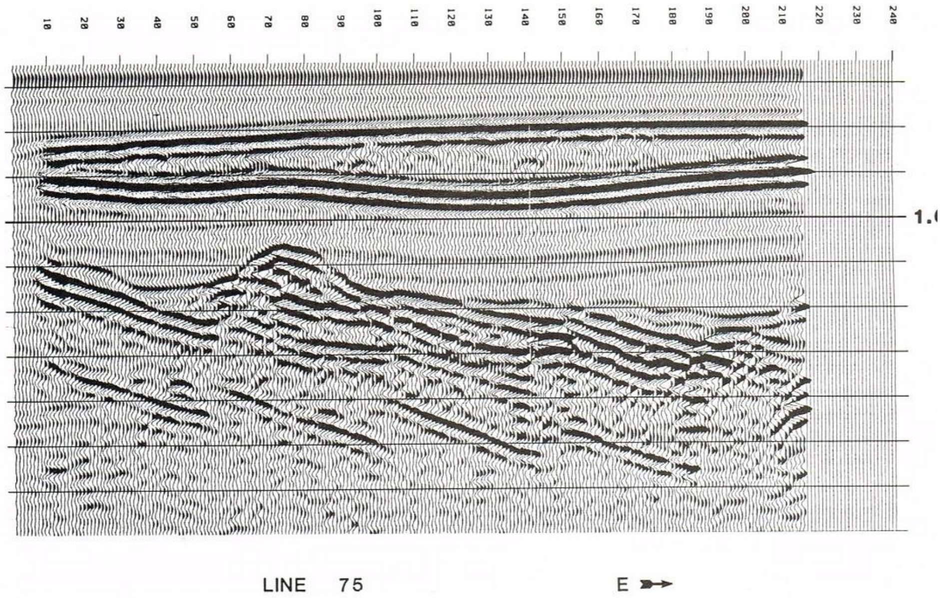


Figure 6–13D. An east-west vertical seismic section across the SALNOR model. The top three horizons represent the Top Paleocene, Top Cretaceous, and J-Unconformity. The other horizon easily recognized, which has four faults, is the Base Statfjord horizon.

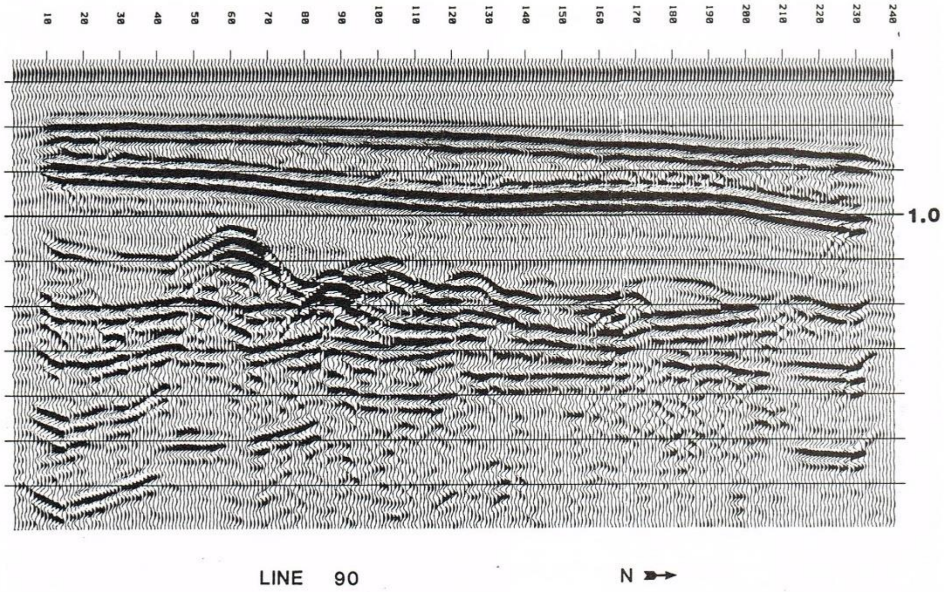


Figure 6–13E. A north-south vertical seismic section across the SALNOR model. The same horizons noted in Figure 6–13D can be recognized. On the left side, the Top and Base Brent and Top and Base Statfjord are also easily seen.

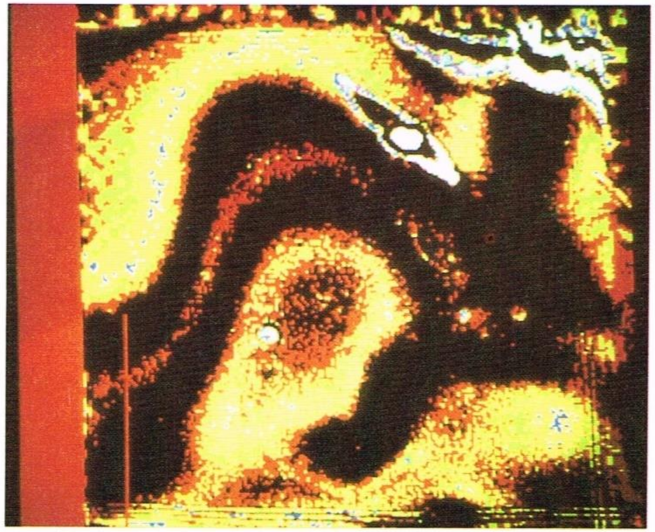


Figure 6–13G. A horizontal seismic section from a 3D survey collected across the North Sea physical model. The time-slice section is at 1.06 seconds and cuts the J-Unconformity structural highs.

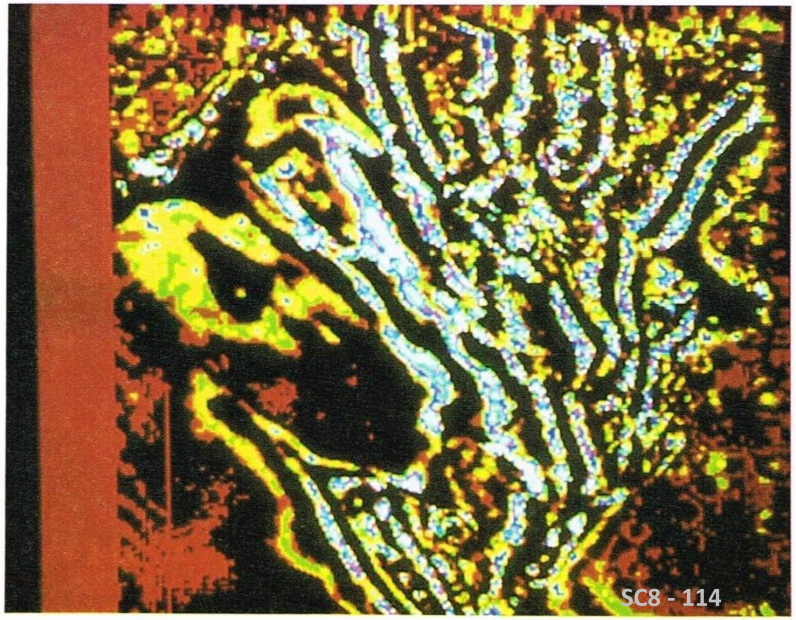


Figure 6–13H. A time-slice section from the same SALNOR 3D survey at time 1.22 seconds. At this depth the section cuts through the two dipping, producing Brent and Statfjord sandstones. The fault cuts are easily identified, especially when a sequence of time-slices are animated like a movie.

Notes

Volumetric Data Allowed Study of 3-Dimensional Geology

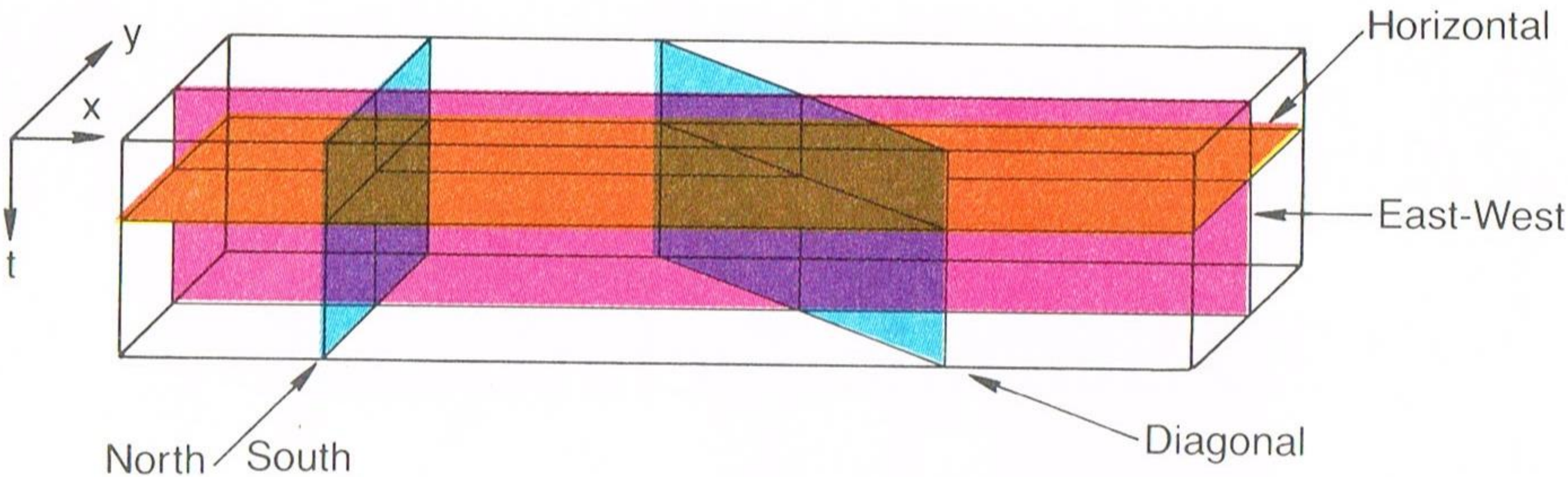


Figure 4-1. A 3D data volume allows for a much more complete evaluation of the subsurface. The data can be vertically sliced in any arbitrary direction to allow interpretation along the lines critical to an accurate evaluation. Horizontal sections can also be generated from a data volume.

http://www.walden3d.com/photos/Grandkids_Science_Camps/170802-04_Science_Camp/7_3-D_Display.pdf

GSI & E&S 3-D Displays

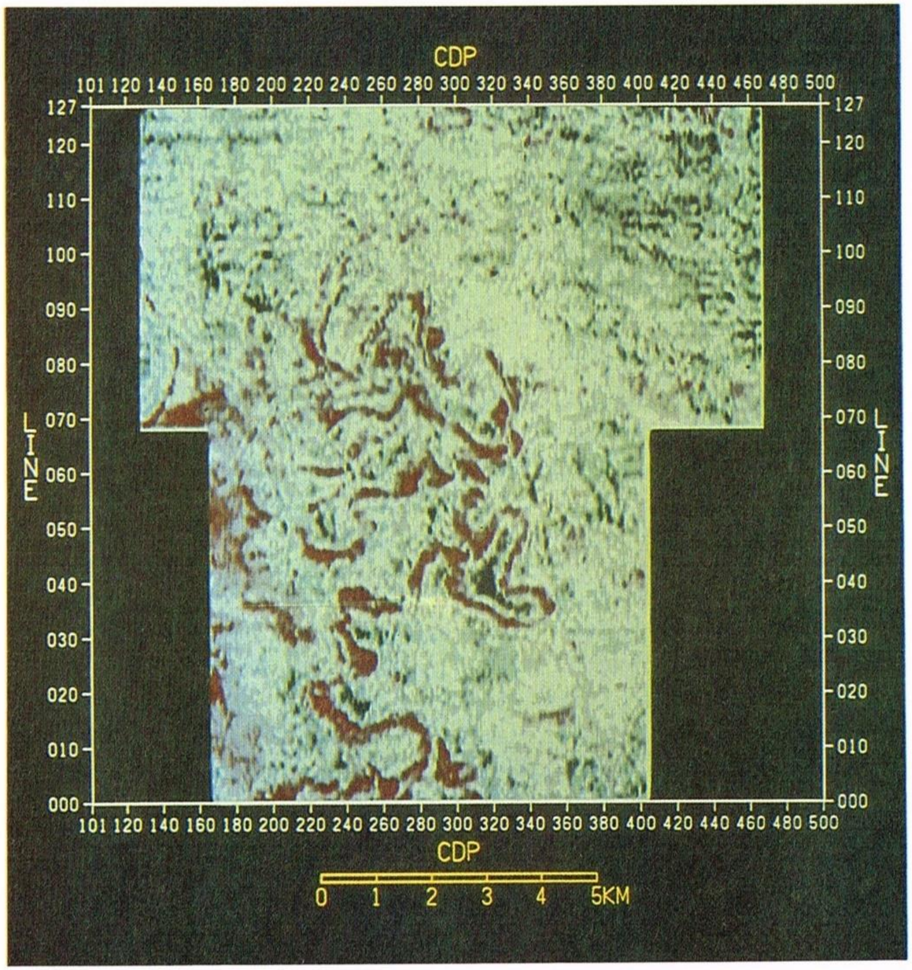


Figure 4-7. The unique capabilities to interpret a subsurface geologic sequence with 3D data volumes is shown by this horizontal (SEISCROP) seismic section slicing a meandering stream channel in the Gulf of Thailand. (Courtesy Geophysical Service, Inc.)

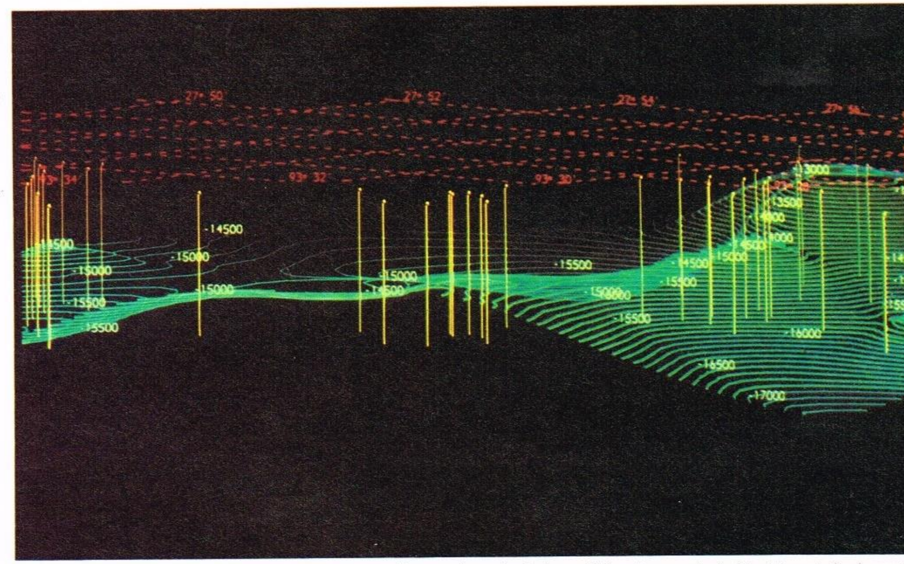
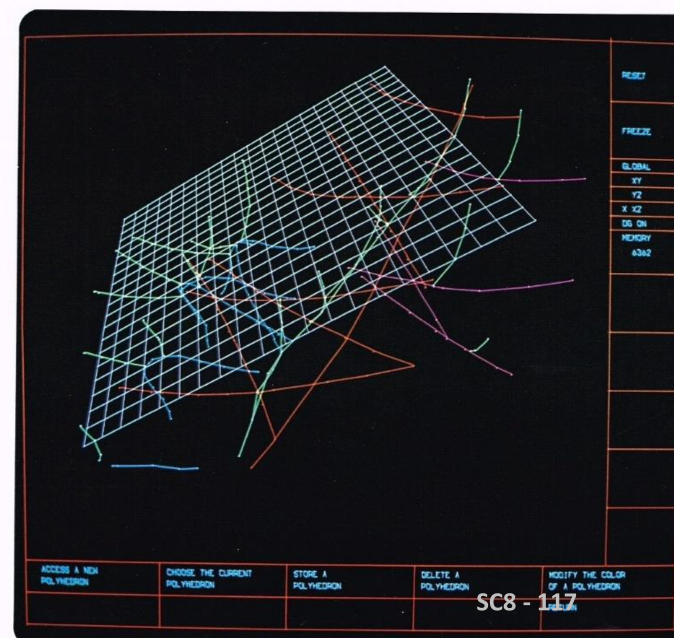
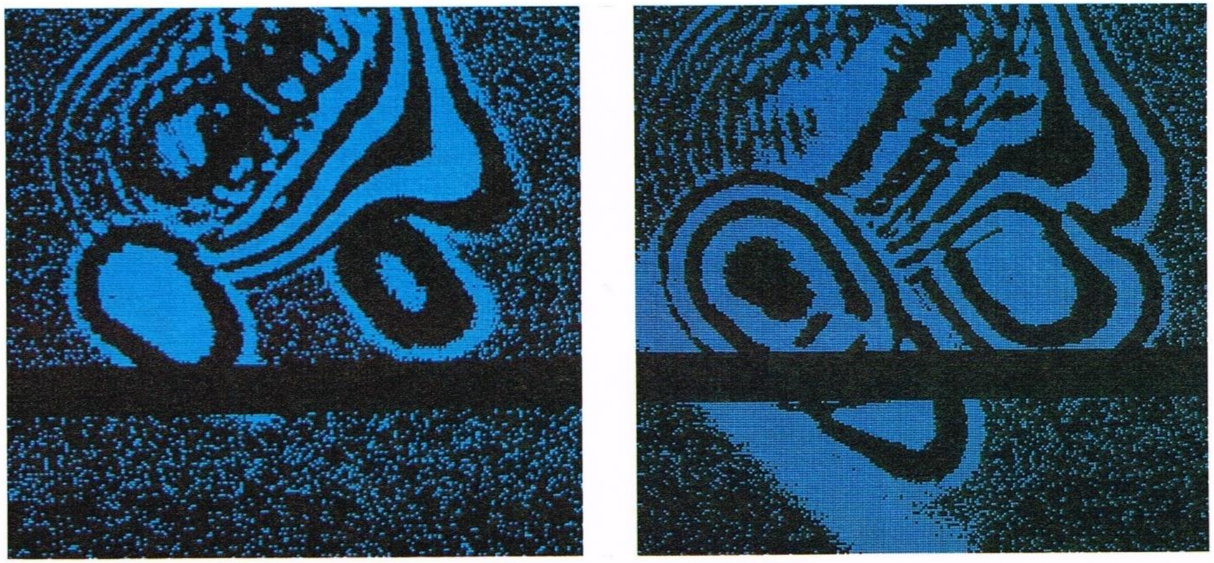


Figure 2-2. Example of a full-color, 3D display that is rotatable around an axis. Such capability enhances seismic data interpretation in a world with 3D relationships. (Courtesy Evans and Sutherland.)

EVANS & SUTHERLAND

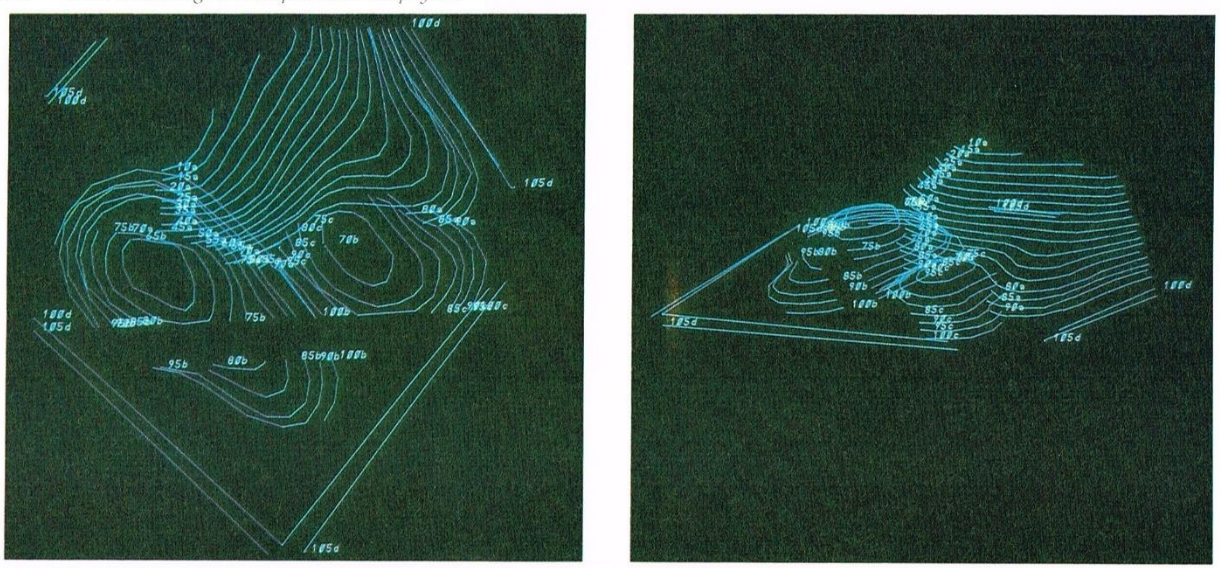


Seismic Data Analysis—The Picture System can be a powerful tool for interpreting seismic data. Here fault lines are displayed beneath a grid representative of the earth's surface. Color is used to identify lines belonging to a common fault plane.



A B

Figure 4-8. Interactive 3D interpretation techniques are becoming much more common. Here two horizontal sections across the SALGLF model are shown (A and B). There is no data in the black strip because of a data collection error.



C D

Figure 4-8 (continued). As horizontal sections are stepped through, they can be interactively interpreted as a 3D contour map that can be rotated in 3D space in real time (C and D).

First Interactive 3-D Displays

on the Adage Raster Segment Generator and Vector Display

Complex Seismic Traces
3-D Rotating Phase at NASA on E&S

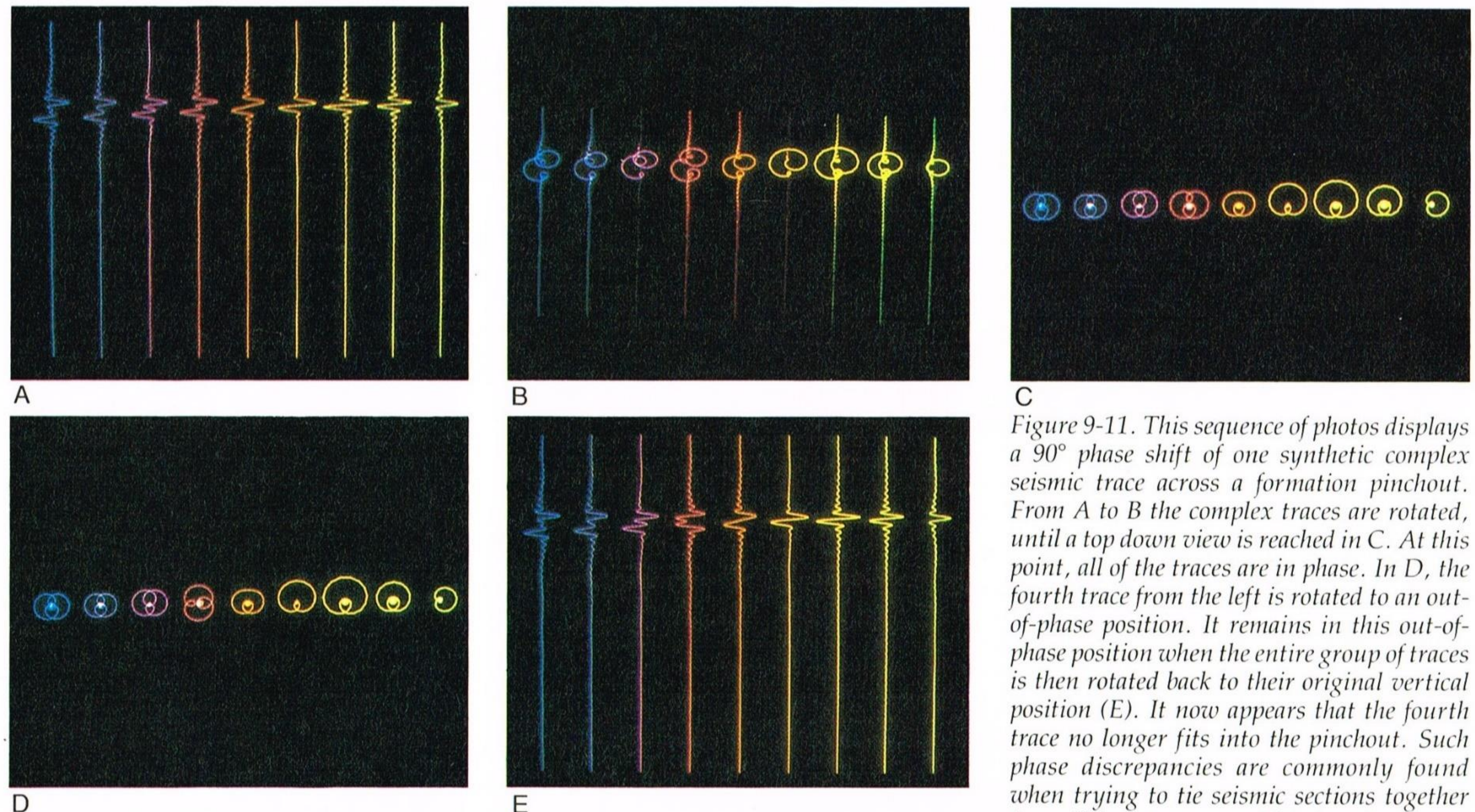


Figure 9-11. This sequence of photos displays a 90° phase shift of one synthetic complex seismic trace across a formation pinchout. From A to B the complex traces are rotated, until a top down view is reached in C. At this point, all of the traces are in phase. In D, the fourth trace from the left is rotated to an out-of-phase position. It remains in this out-of-phase position when the entire group of traces is then rotated back to their original vertical position (E). It now appears that the fourth trace no longer fits into the pinchout. Such phase discrepancies are commonly found when trying to tie seismic sections together from different surveys. This is only one example of the subtle characteristics of and problems with seismic data interpretation. (Courtesy Geosource, Petty-Ray Geophysical Division.)

Vibrating Mirrors & Holograms

True 3D Display Types **201**

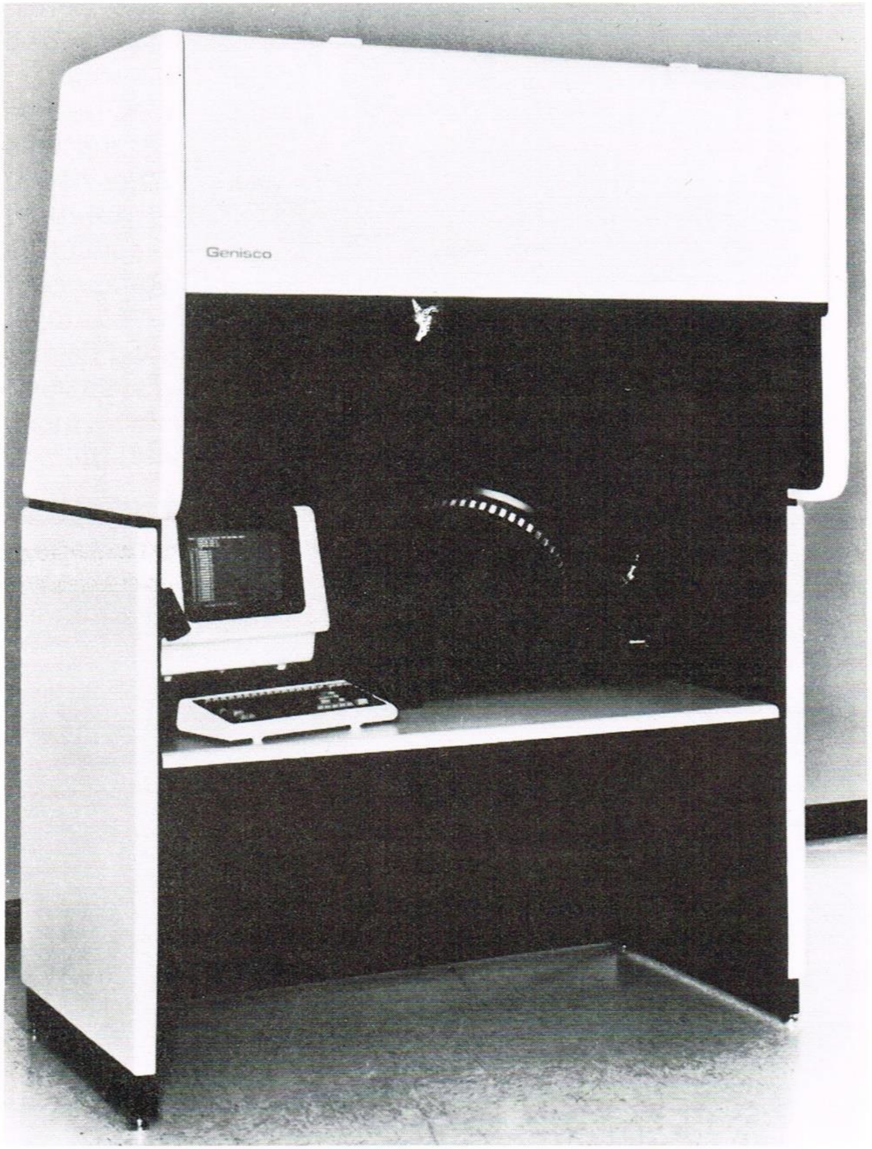
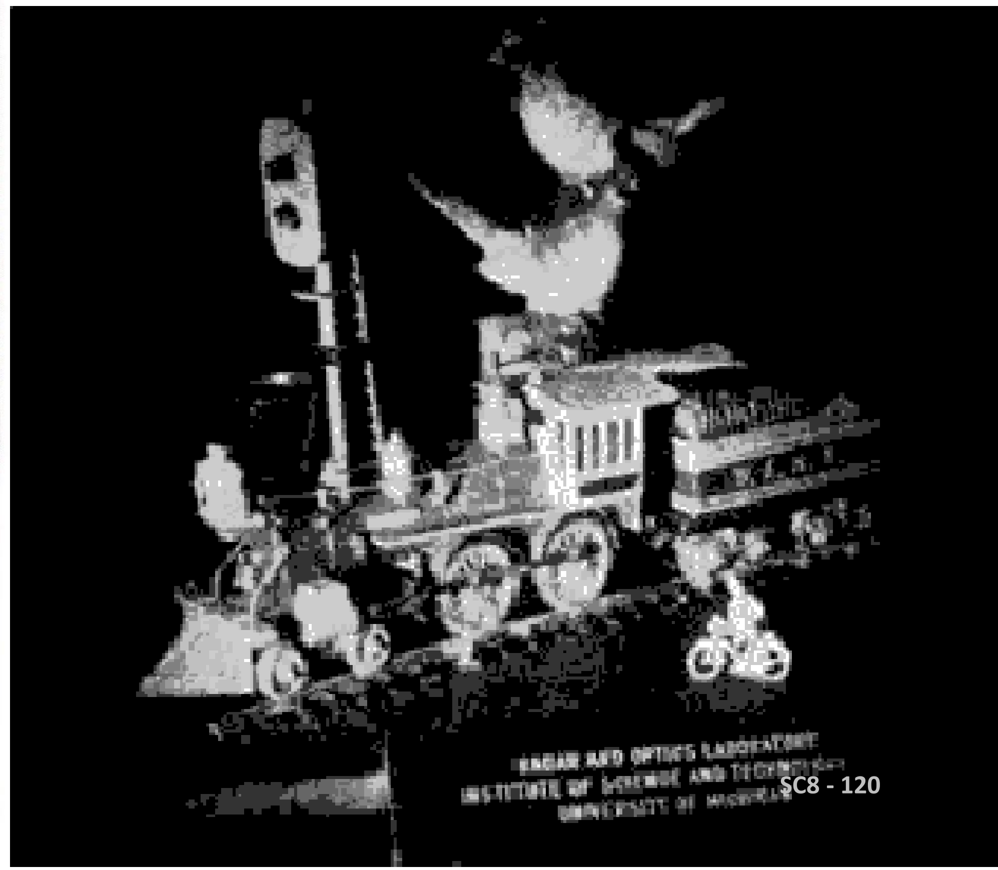
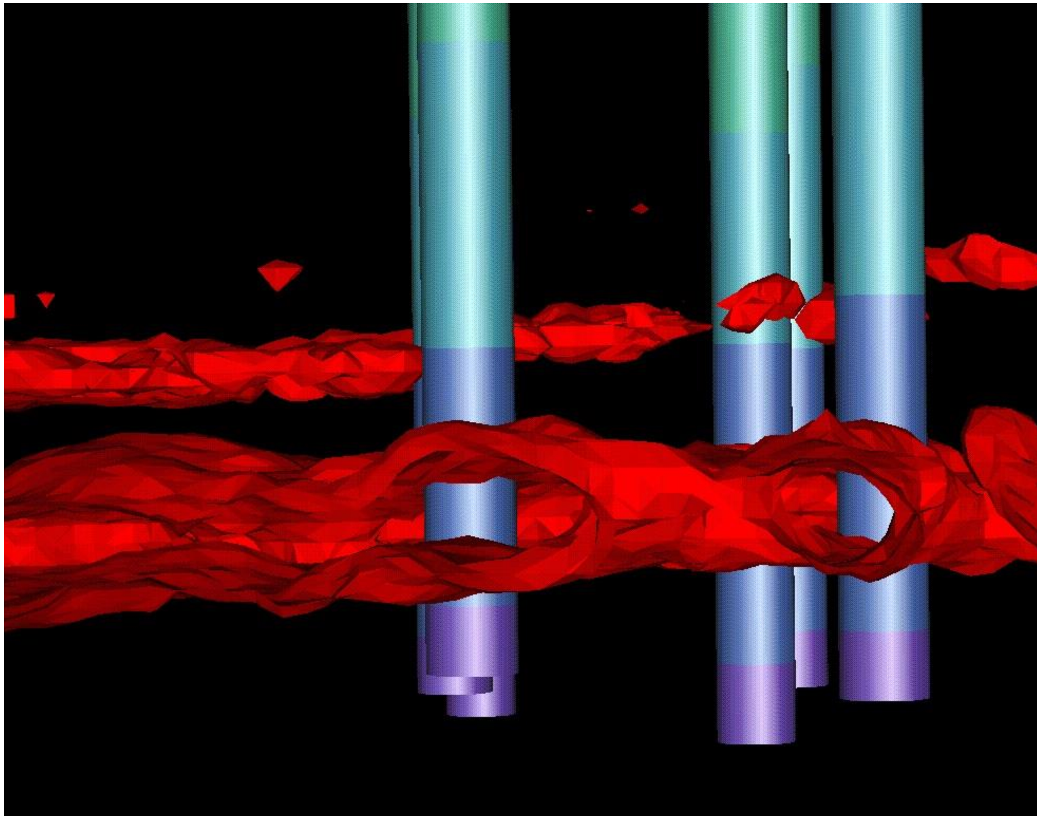


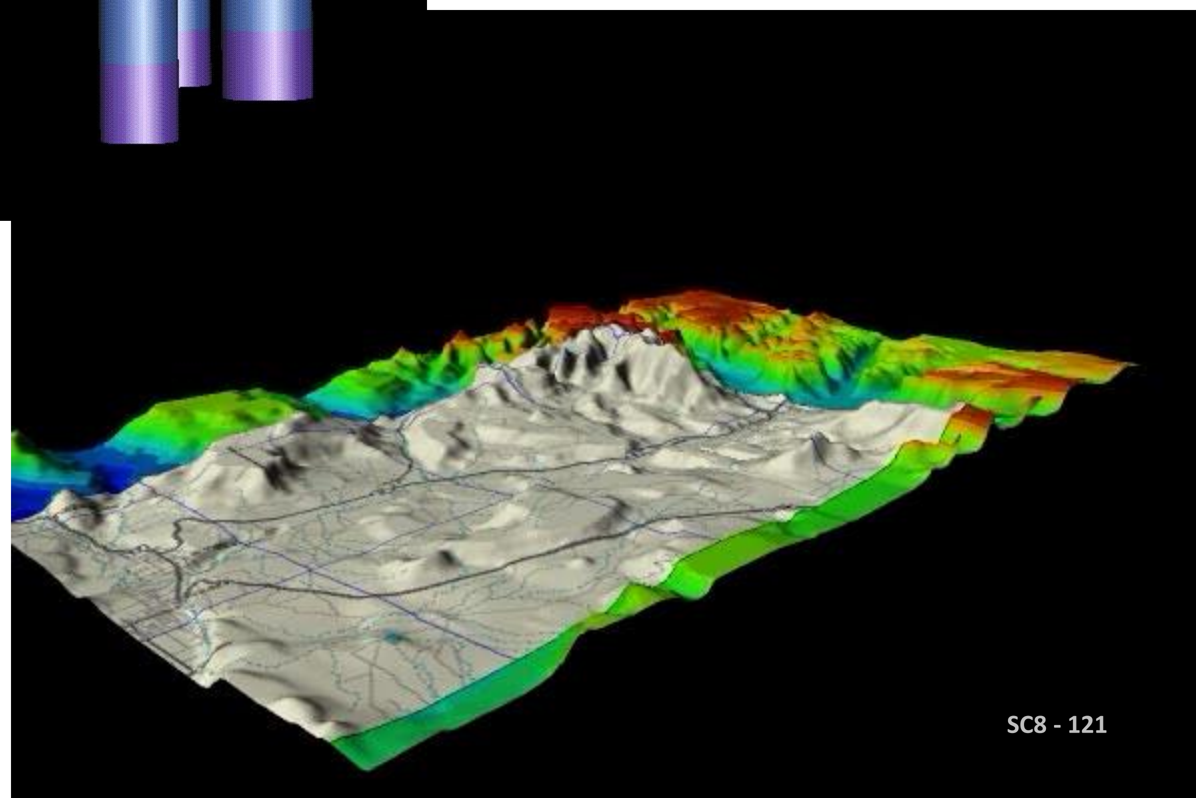
Figure 8-10. The Genisco SpaceGraph vibrating mirror 3D display device. A 40-cm vibrating mirror is partially shown at the center of the display. A high-resolution CRT is housed within the overhead casing. (Courtesy Hand Stover, Genisco Computer Corp.)

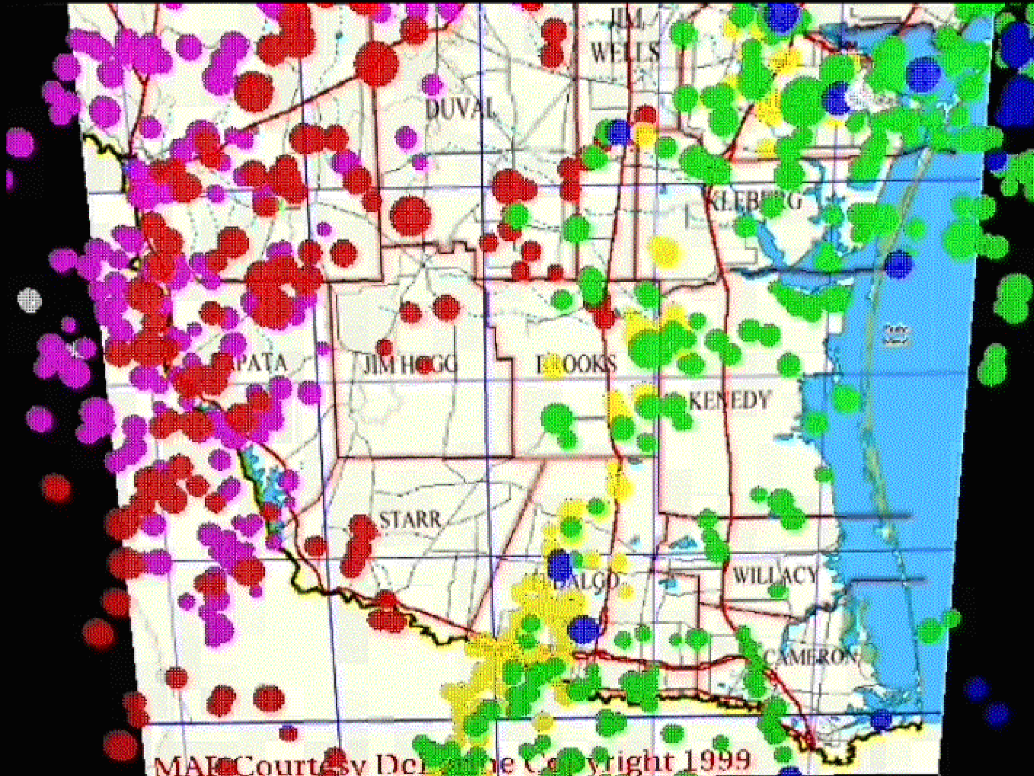




U of U 3D & Continuum Resources

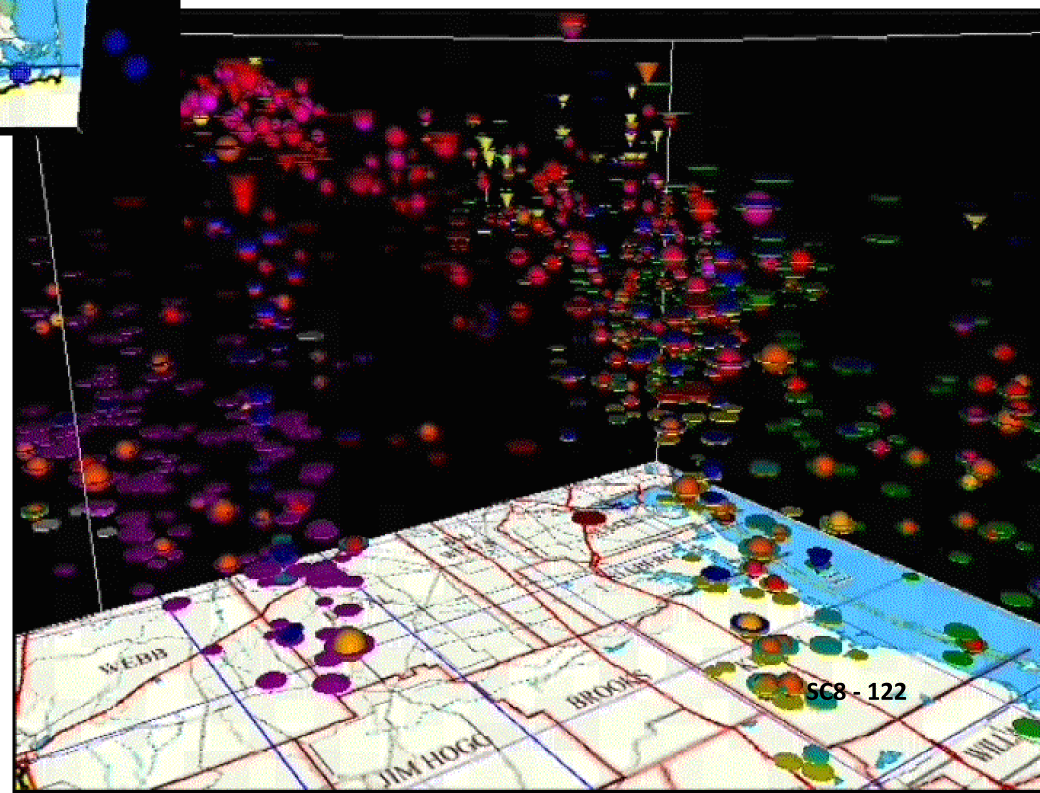
Zion and the Road to Hurricane



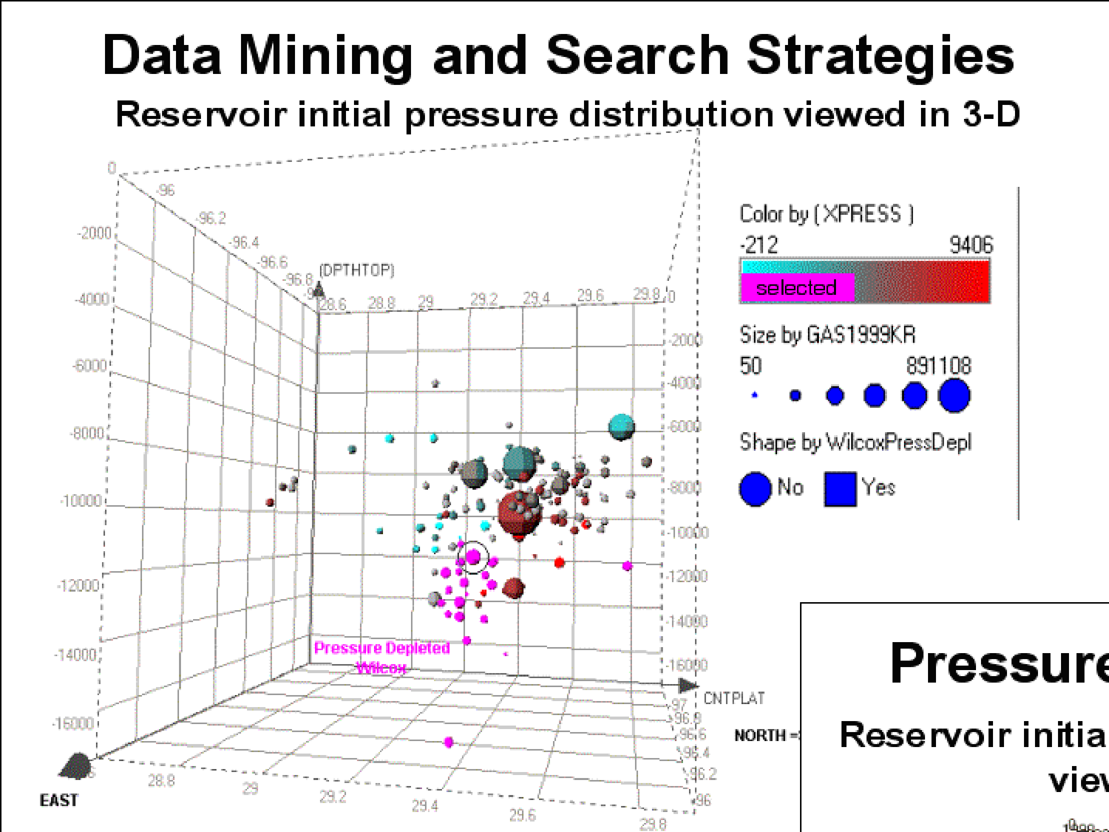


South Texas Horizon Tops in 3-D at Continuum

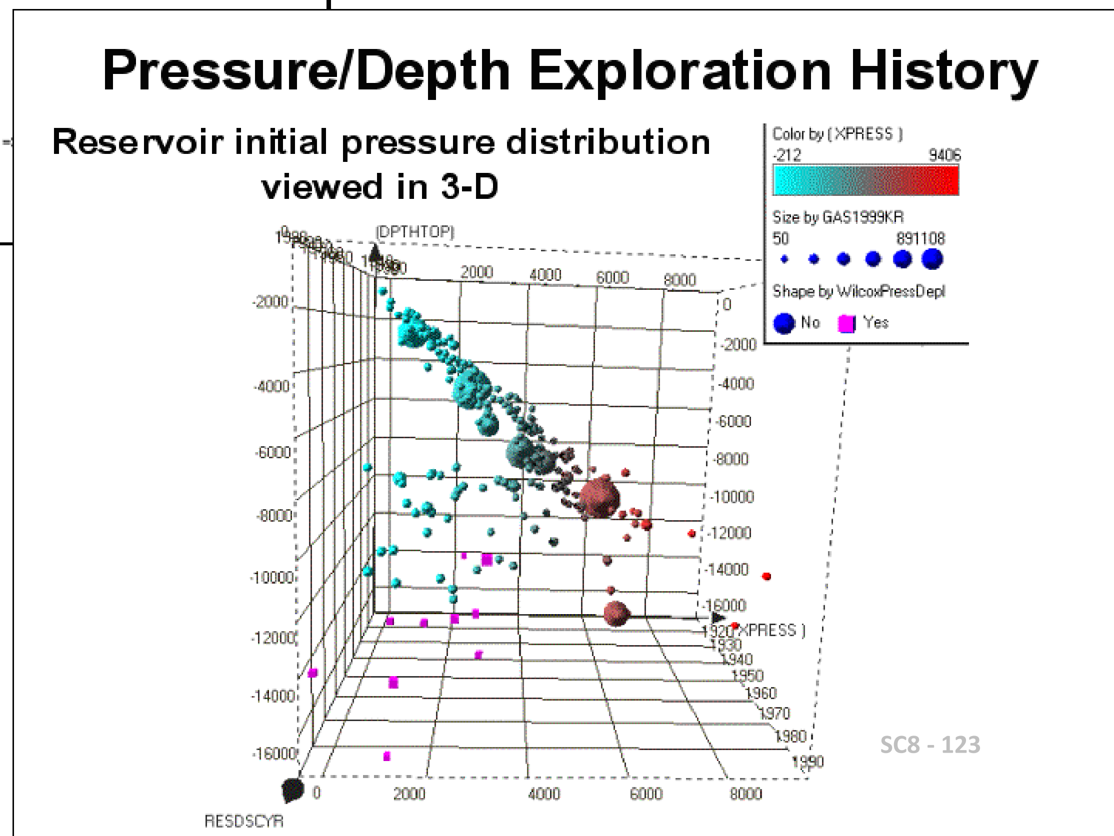
South Texas Example of Visualizing an Entirely New Exploration Play: Wilcox Turbidite Channels



Depth of Gas & Geopressure



Colorado County Gas Wells and New Trends



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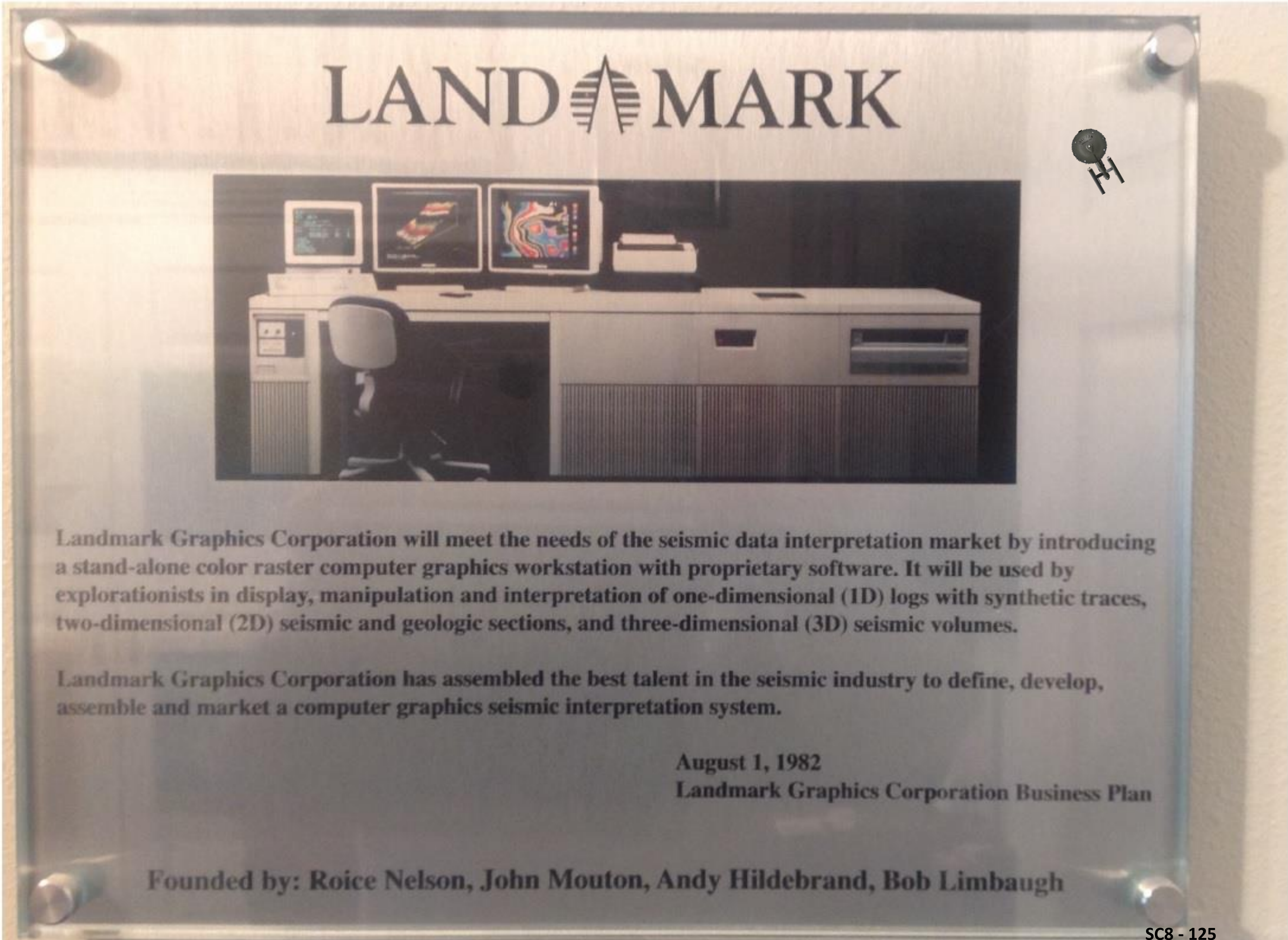


LANDMARK

Landmark Graphics Corporation will meet the needs of the seismic data interpretation market by introducing a stand-alone color raster computer graphics workstation with proprietary software. It will be used by explorationists in display, manipulation and interpretation of one-dimensional (1D) logs with synthetic traces, two-dimensional (2D) seismic and geologic sections, and three-dimensional (3D) seismic volumes.

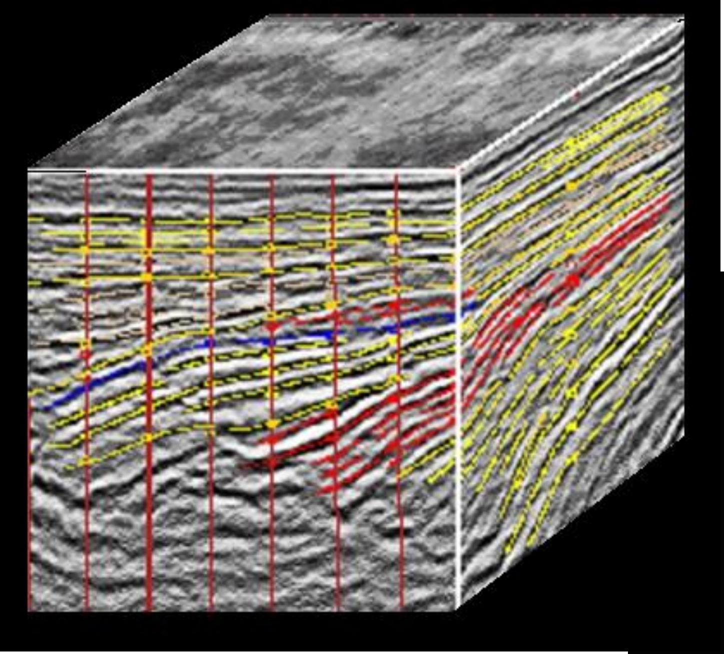
Landmark Graphics Corporation has assembled the best talent in the seismic industry to define, develop, assemble and market a computer graphics seismic interpretation system.

August 1, 1982
Landmark Graphics Corporation Business Plan

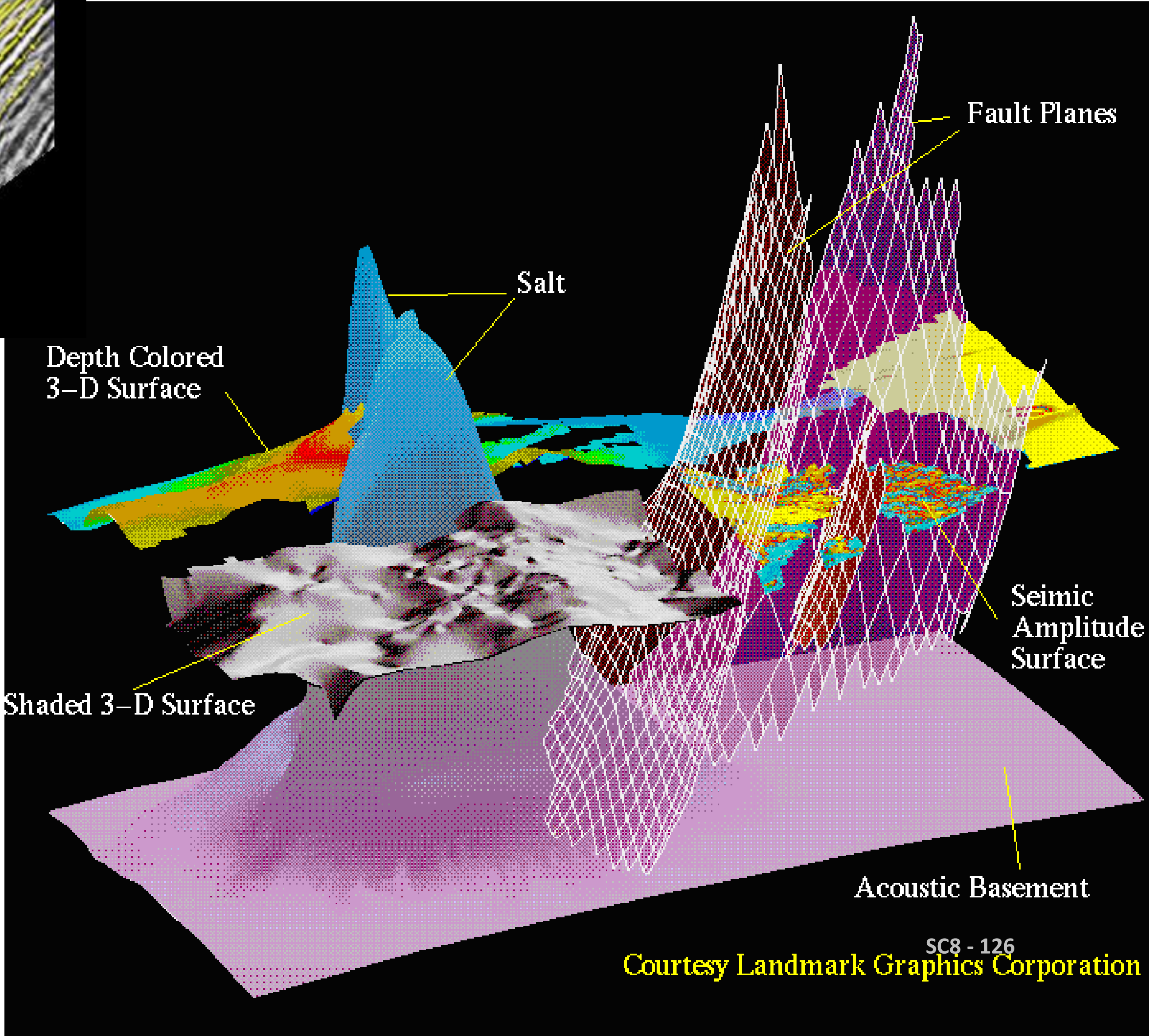
Founded by: Roice Nelson, John Mouton, Andy Hildebrand, Bob Limbaugh

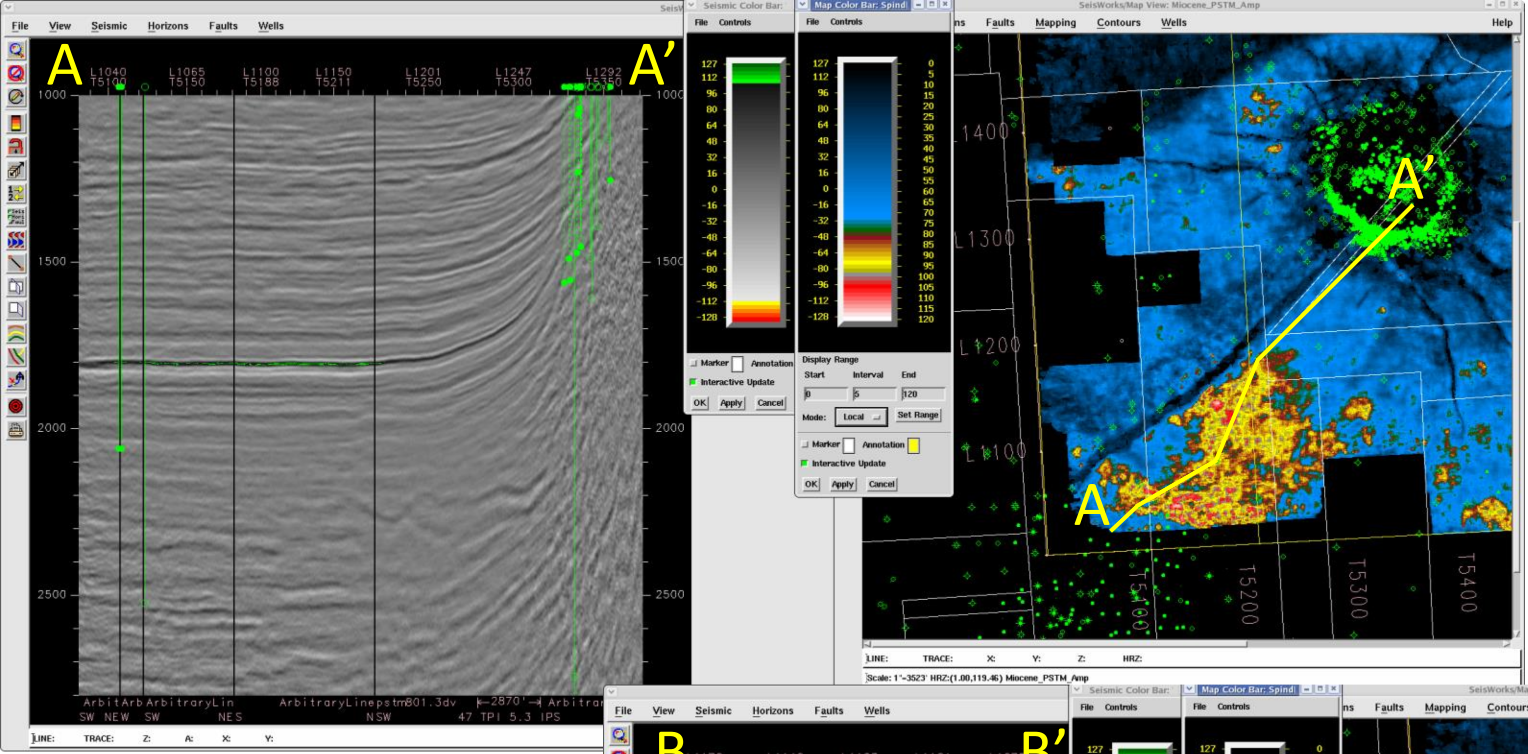
http://www.walden3d.com/photos/Grandkids_Science_Camps/170802-04_Science_Camp/7_Landmark_Graphics.pdf

3-D Landmark Displays



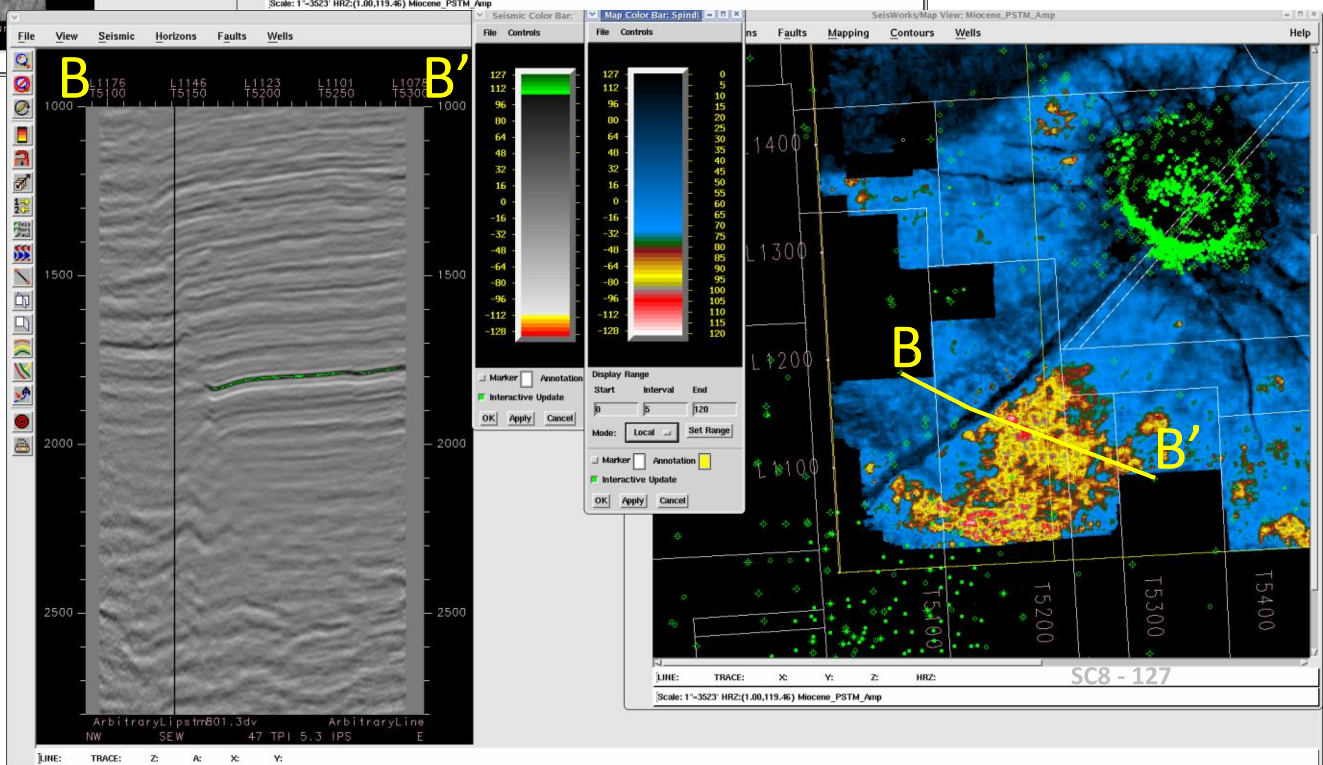
1994, Still Doing
Jimmy-Rig
3-D Displays
(Stratton Above)



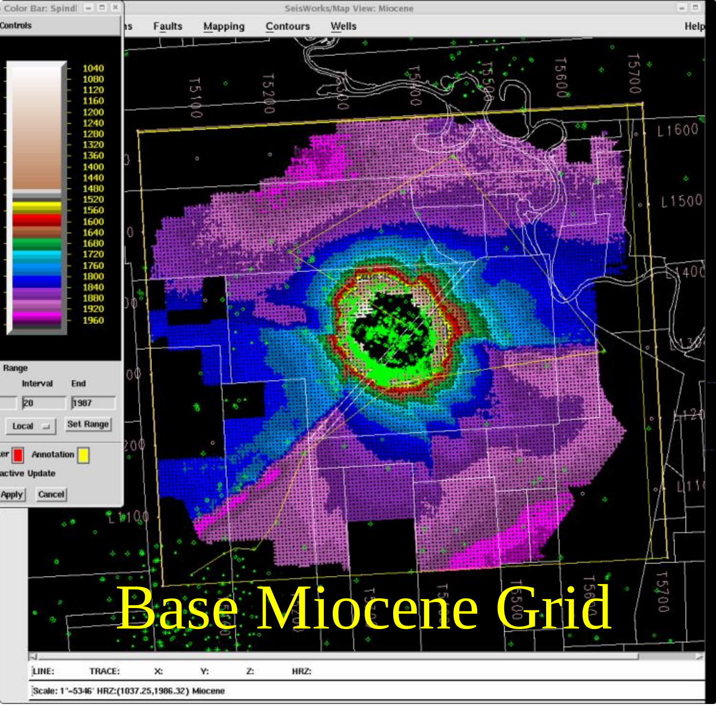


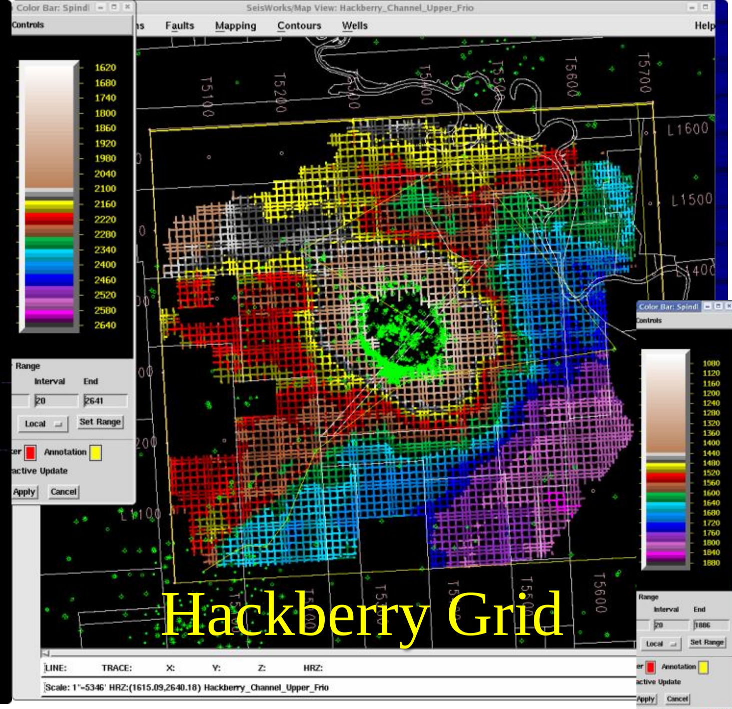
Spindletop

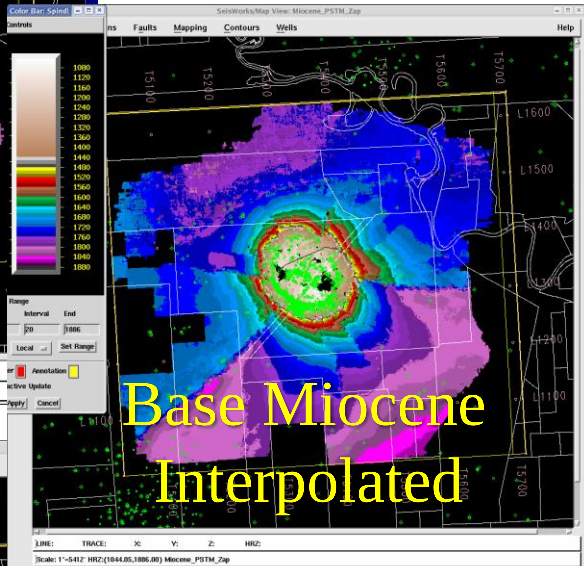
3-D Seismic Interpretation

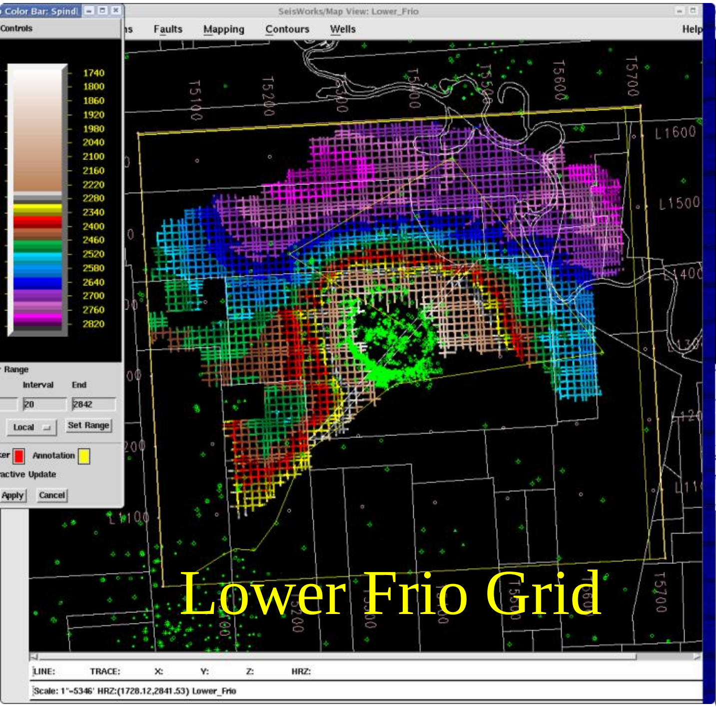


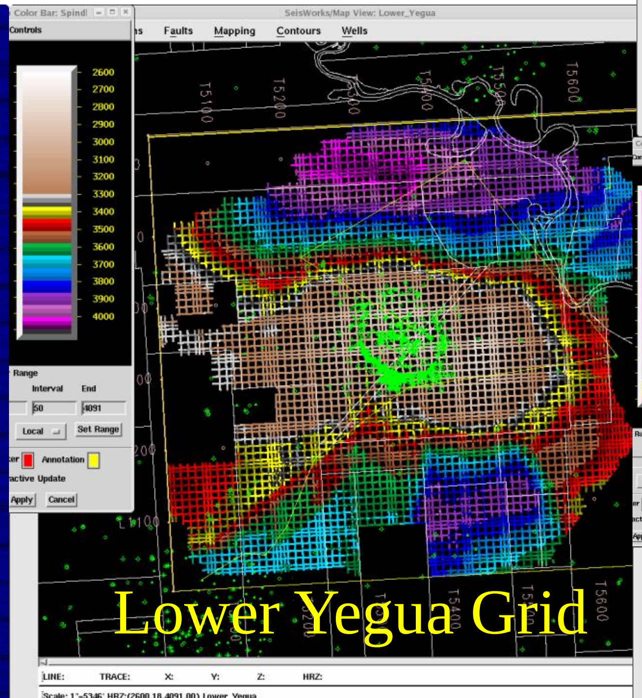
3-D Interpretation

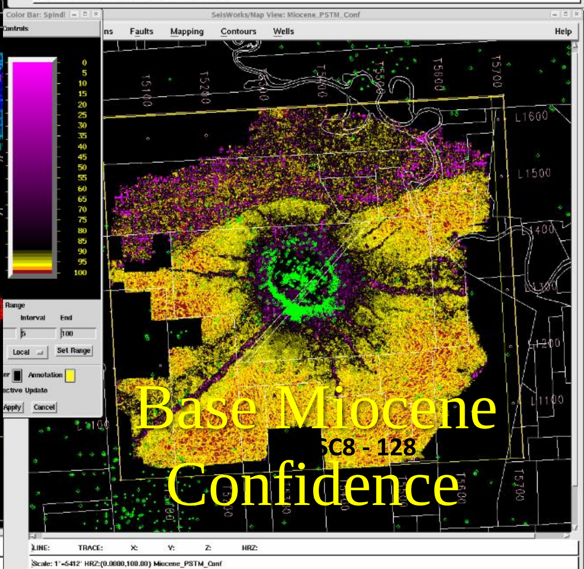


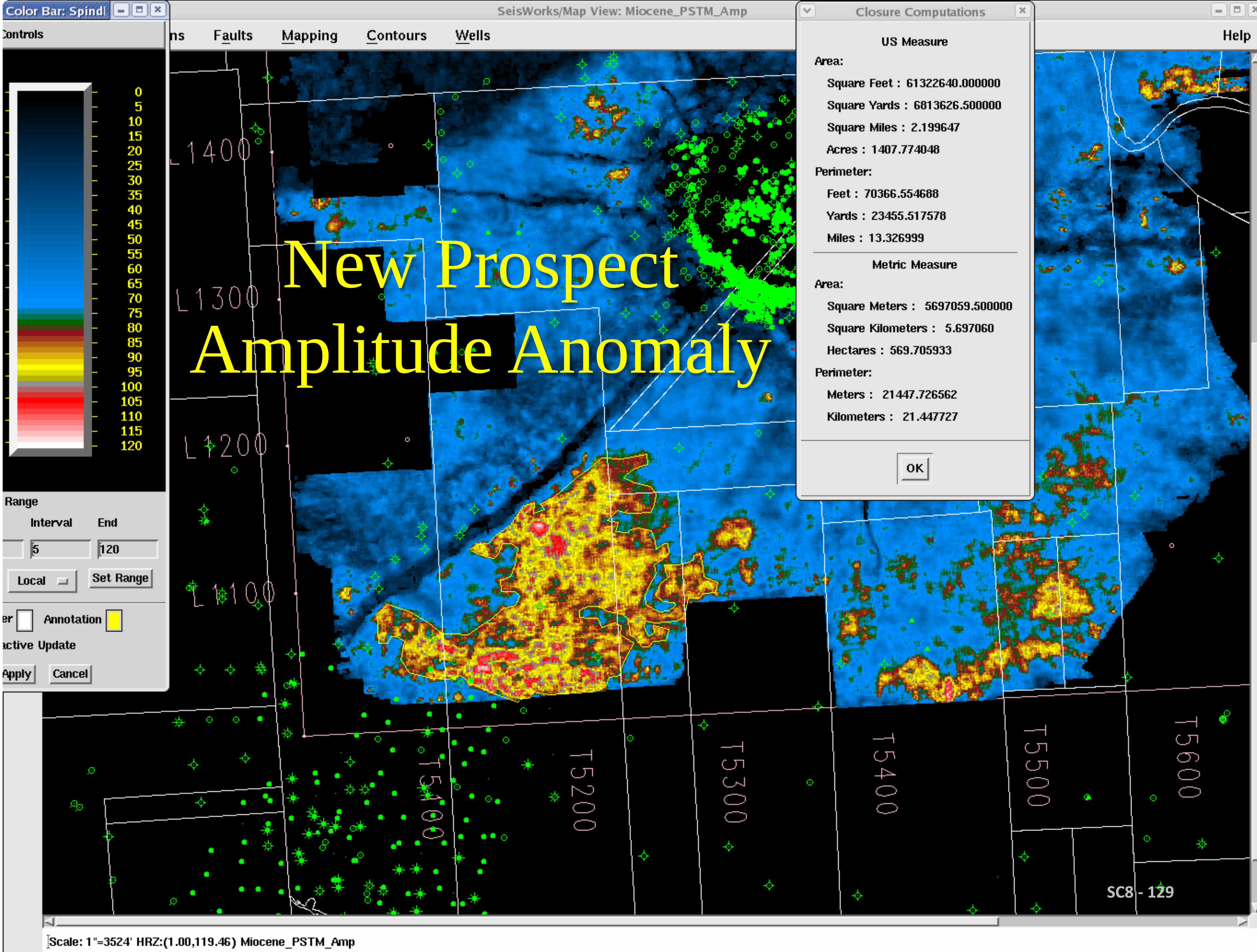











Color Bar: Spindl
Controls
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End
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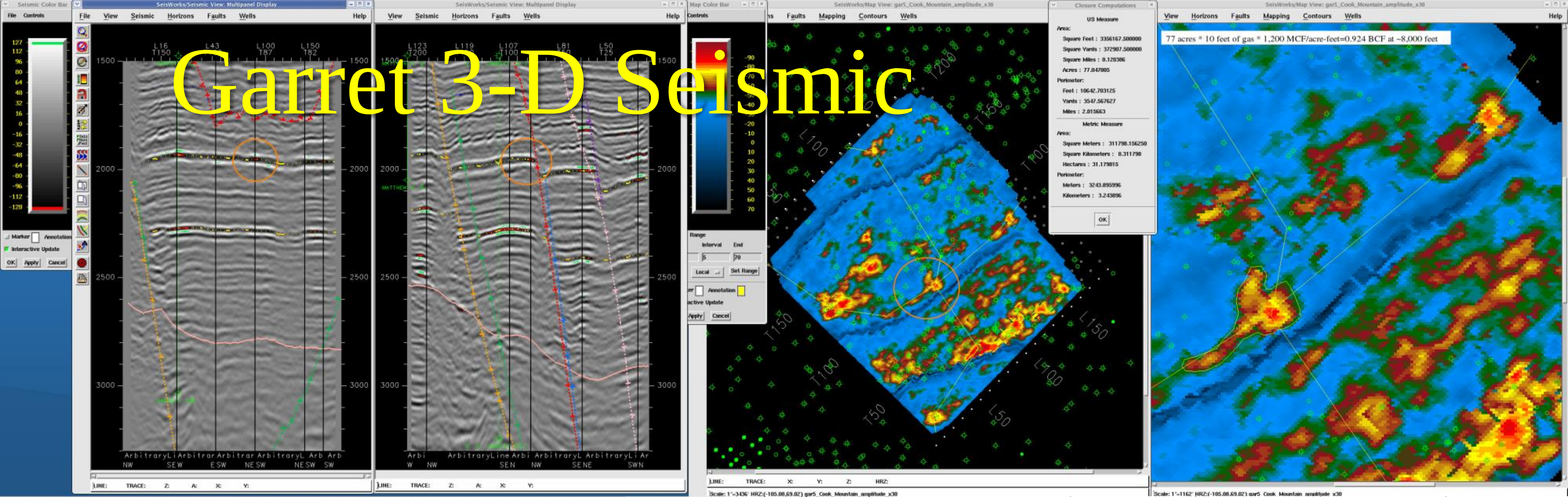
120
Local
Set Range
Annotation
active Update
Apply
Cancel
SeisWorks/Map View: Miocene_PSTM_Amp
Faults
Mapping
Contours
Wells
Help
New Prospect
Amplitude Anomaly
L1400
L1300
L1200
L1100
T5100
T5200
T5300
T5400
T5500
T5600
Closure Computations
US Measure
Area:
Square Feet : 61322640.000000
Square Yards : 6813626.500000
Square Miles : 2.199647
Acres : 1407.774048
Perimeter:
Feet : 70366.554688
Yards : 23455.517578
Miles : 13.326999
Metric Measure
Area:
Square Meters : 5697059.500000
Square Kilometers : 5.697060
Hectares : 569.705933
Perimeter:
Meters : 21447.726562
Kilometers : 21.447727
OK
Scale: 1"=3524' HRZ:(1.00,119.46) Miocene_PSTM_Amp

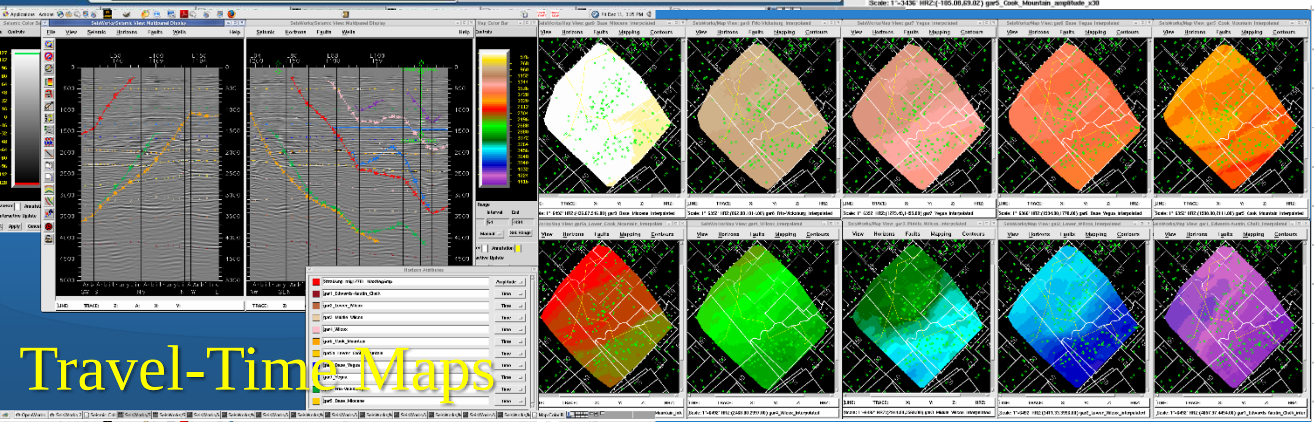
Potential Value Undrilled Anomalies

Depth	Formation	Acreage	Formation Acreage	Reserves in BCF (acres*20 ft gas * 1.2 MCF/acre ft / 1000 MCF/BCF)			
1	100-500ms Miocene	5		0.12	20	1.2	$3
2	500-1s Miocene	39		0.936			
3	1s-Base Miocene	32.7		0.7848			
3	1s-Base Miocene	140		3.36			
3	1s-Base Miocene	152		3.648			
3	1s-Base Miocene	158		3.792			
3	1s-Base Miocene	177		4.248			
3	1s-Base Miocene	229		5.496			
3	1s-Base Miocene	235		5.64			
3	1s-Base Miocene	342		8.208			
3	1s-Base Miocene	375		9			
3	1s-Base Miocene	479	2363.7	11.496	56.7288	$170,186,400	
4	Base Miocene +-20	46		1.104			
4	Base Miocene +-20	79.8		1.9152			
4	Base Miocene +-20	94		2.256			
4	Base Miocene +-20	207		4.968			
4	Base Miocene +-20	1663	2089.8	39.912	50.1552	$150,465,600	$119,736,000
5	Middle Frio +-100	27		0.648			
6	Middle Frio-Lower Frio	29	56	0.696	1.344	$4,032,000	
7	Lower Frio	59	59	1.416	1.416	$4,248,000	
8	Hackberry+-100	5	5	0.12	0.12	$360,000	
9	Hackberry-Lower Yegua	24.9		0.5976			
9	Hackberry-Lower Yegua	25		0.6			
9	Hackberry-Lower Yegua	25.2		0.6048			
9	Hackberry-Lower Yegua	28		0.672			
9	Hackberry-Lower Yegua	28.2		0.6768			
9	Hackberry-Lower Yegua	31		0.744			
9	Hackberry-Lower Yegua	50	212.3	1.2	5.0952	$15,285,600	
10	Lower Yegua +-100	39		0.936			
10	Lower Yegua +-100	43	82	1.032	1.968	$5,904,000	
11	Lower Yegua-5000	24.2		0.5808			
11	Lower Yegua-5000	34	58.2	0.816	1.3968	$4,190,400	
		4926	4926	118.224	118.224	$354,672,000	

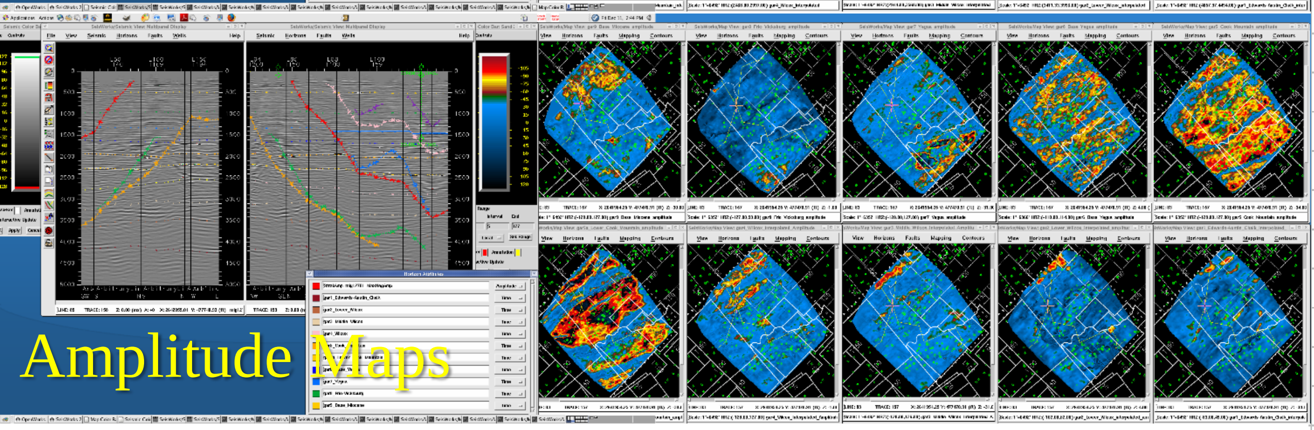
Spindletop Acreage | **Spindletop Formations** | Sheet3

Garret 3-D Seismic





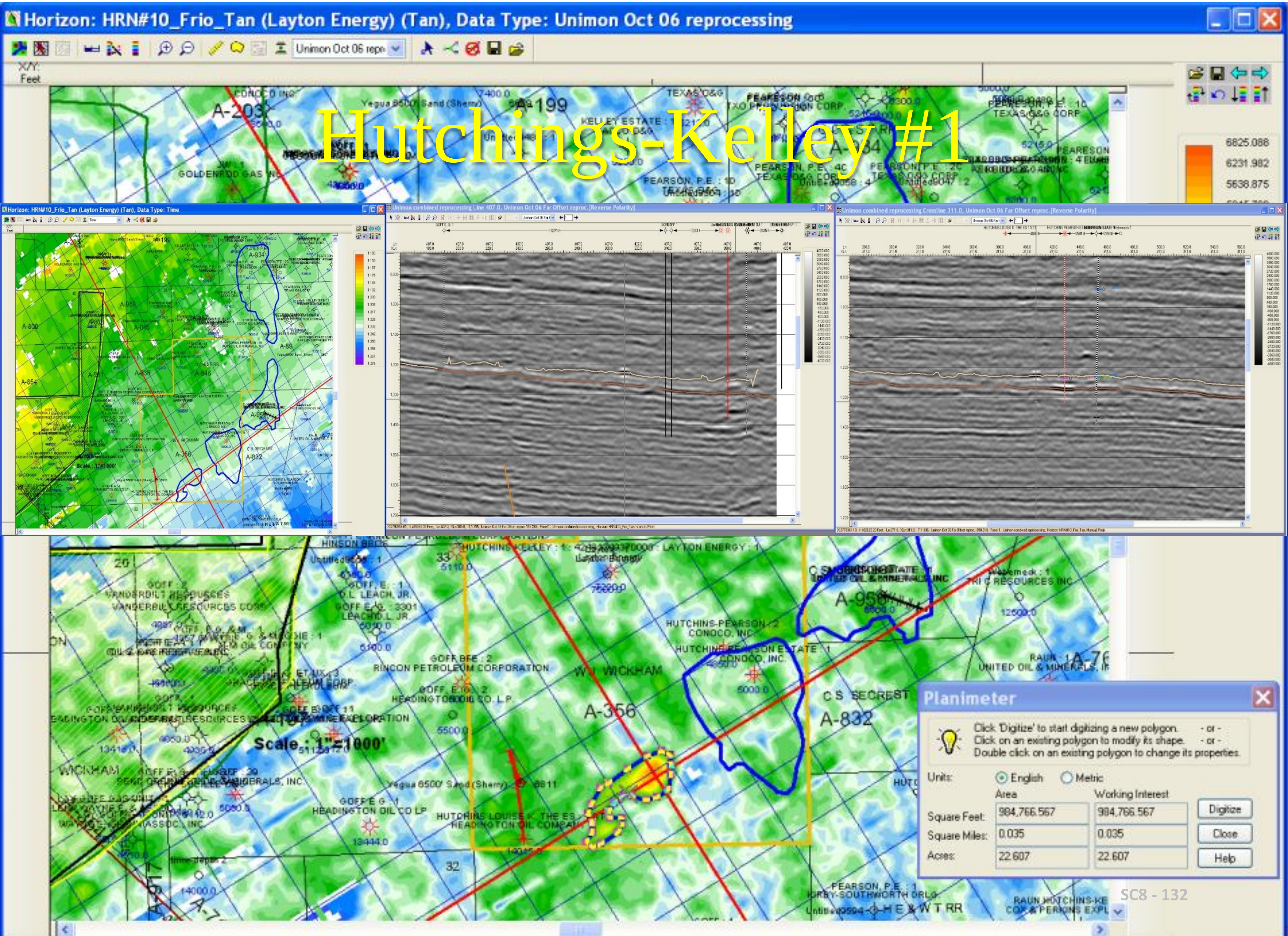
Travel-Time Maps



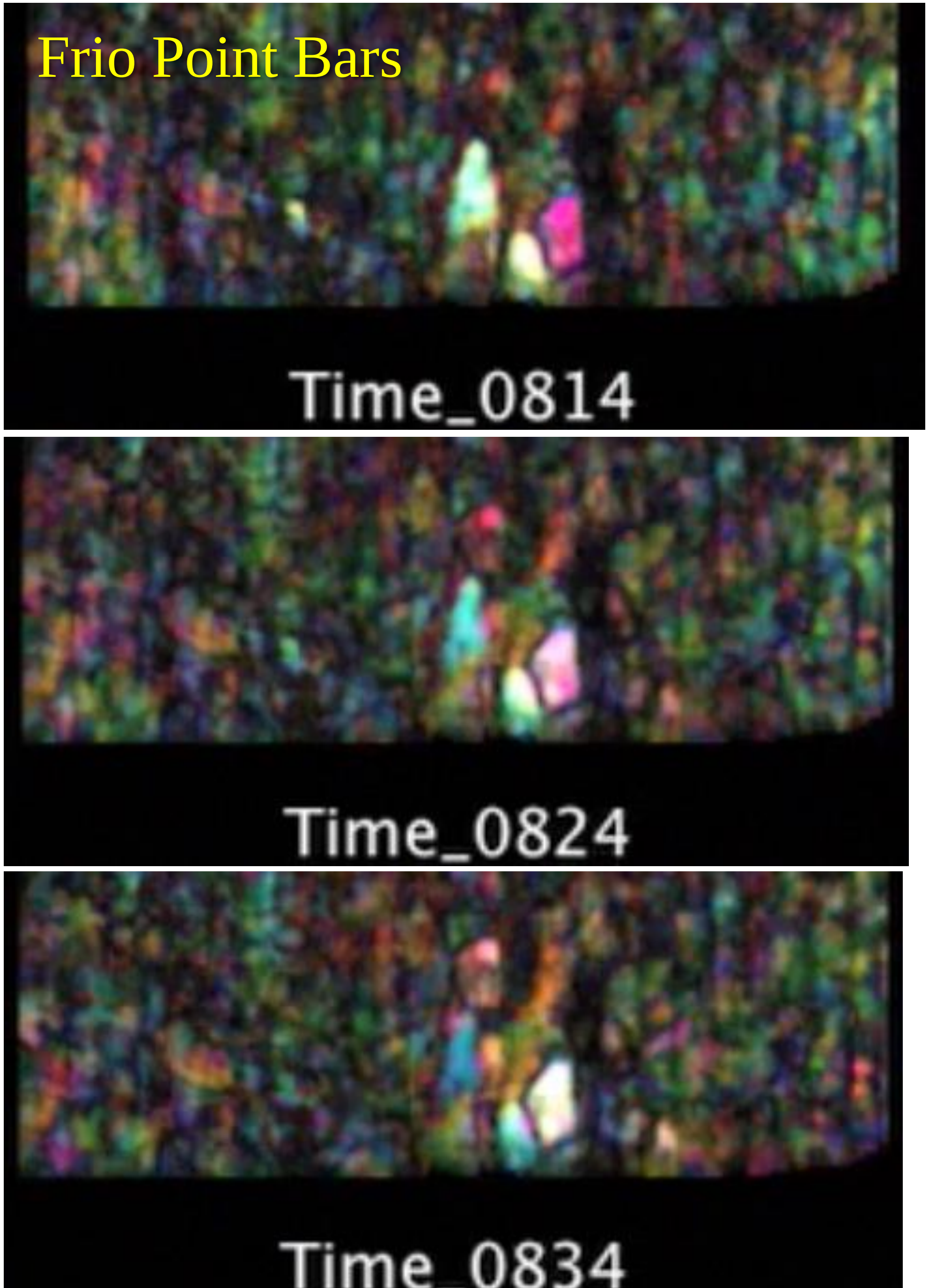
Amplitude Maps

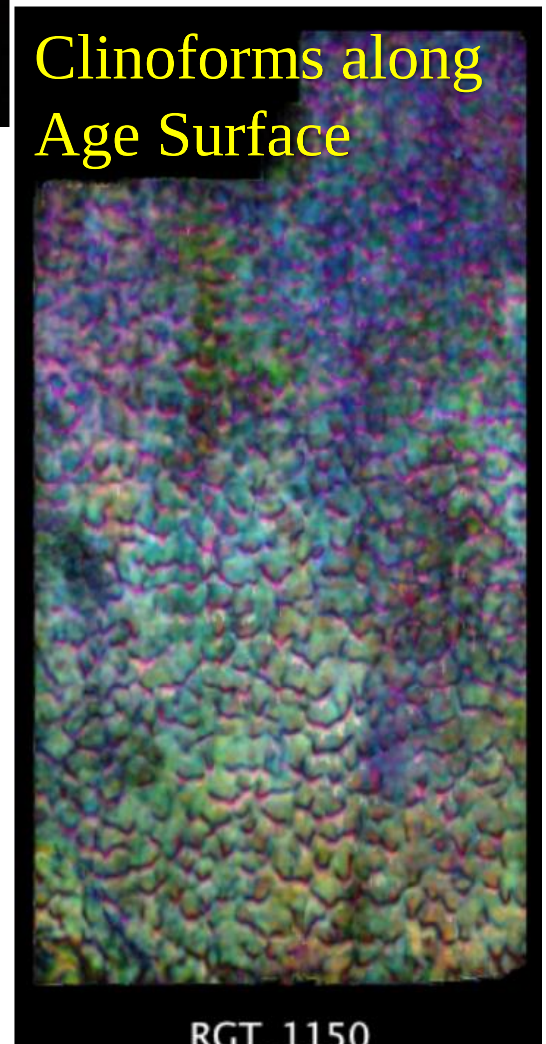
Prospect	Time	Depth	CFGE
gar-m98	488	1850	1176000
gar-m66	498	1900	792000
gar-fv46	941	3450	552000
gar-fv163	989	3650	1956000
gar-y26	1406	5350	312000
gar-y16	1406	5350	192000
gar-y90	1440	5500	1080000
gar-y161	1454	5550	1932000
gar-y245	1437	5500	2940000
gar-by133	1634	7100	1596000
gar-cm77		8000	924000
gar-cm54		7800	660000
gar-cm61		8200	732000
gar-cm35		7800	420000
gar-cm307		7800	3684000
gar-lcm279		9750	3348000
gar-lcm138		10200	1656000
gar-lcm40		10900	480000
gar-lcm30		10900	360000
			24792000

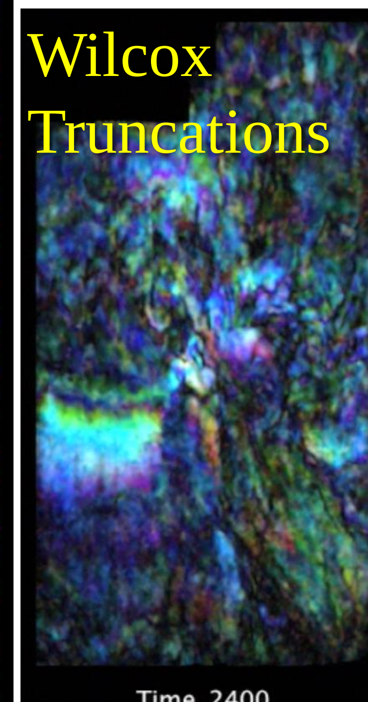
Hutchings-Kelley #1



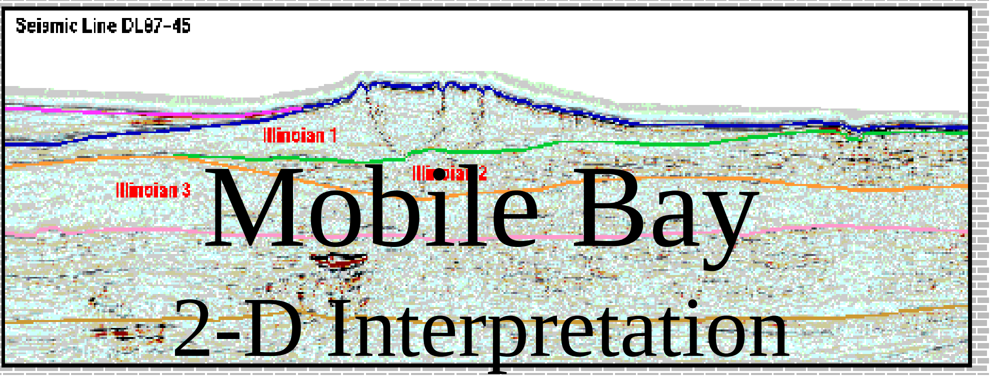
Tracy Stark Processing



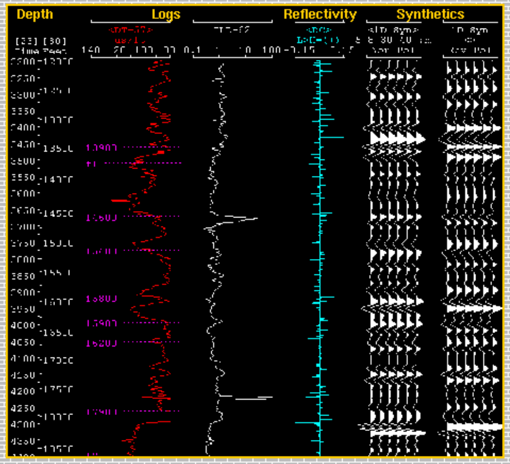




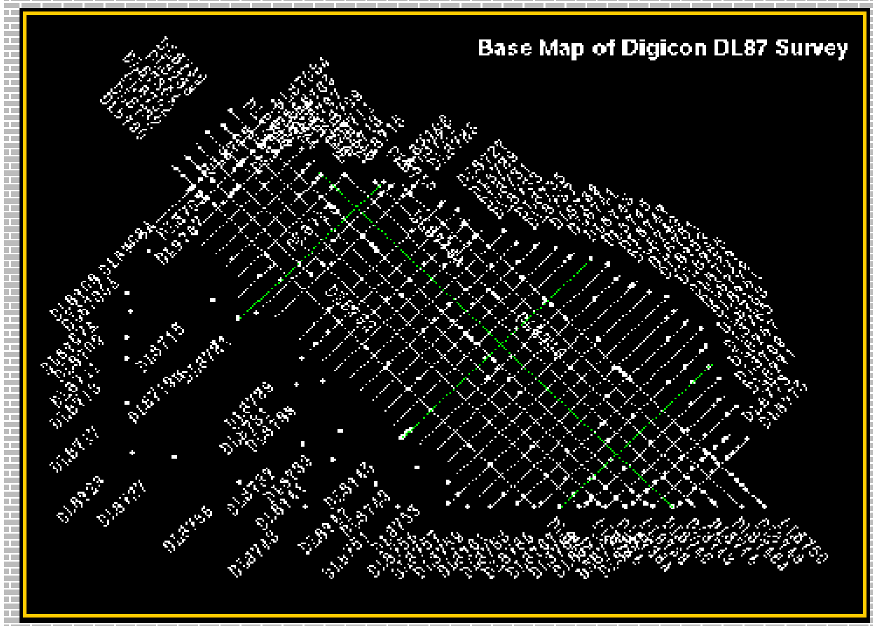
Data are instances of specific meanings occurring in the real–world.



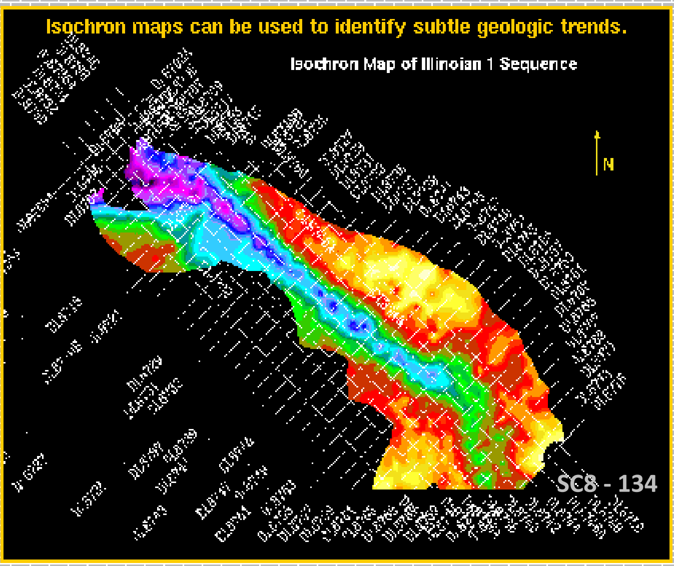
Knowledge is the progressive gathering of bits of experience, along with the links which associate these disparate parts into a unified whole.



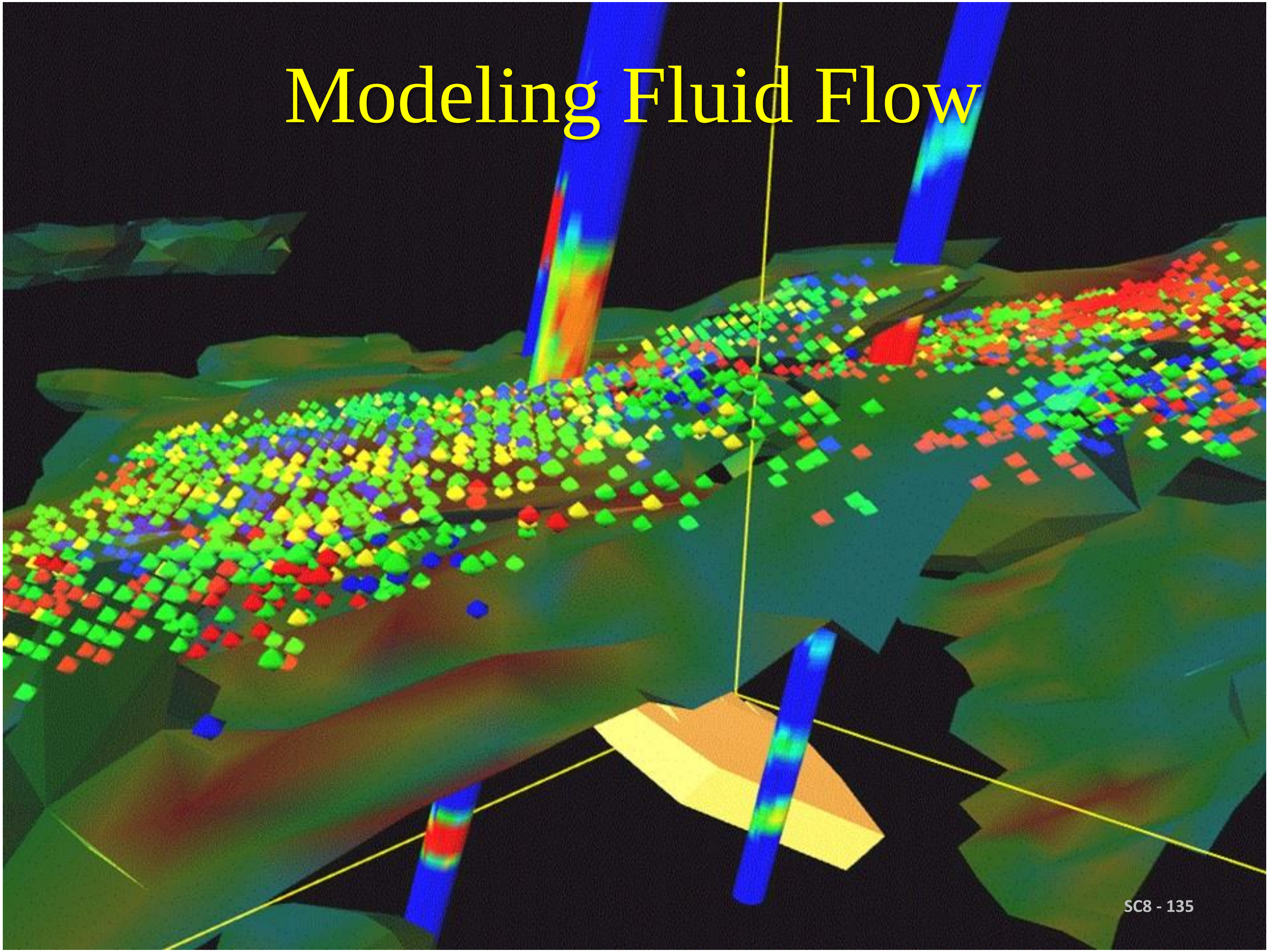
Information is data in context, related to a specific purpose.



Wisdom is knowledge of what is true or right coupled with good judgement, and is embodied in those who remember the recipe and can tell the stories.



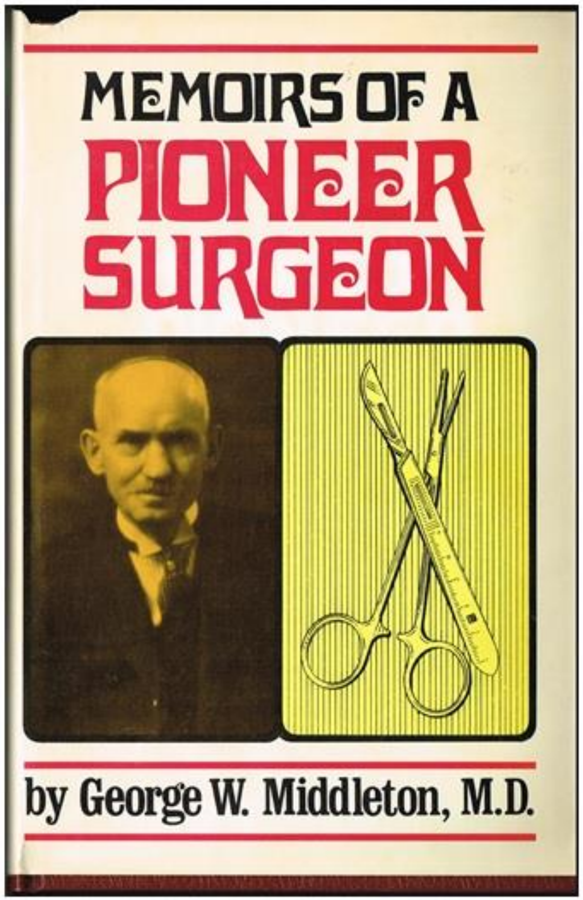
Modeling Fluid Flow

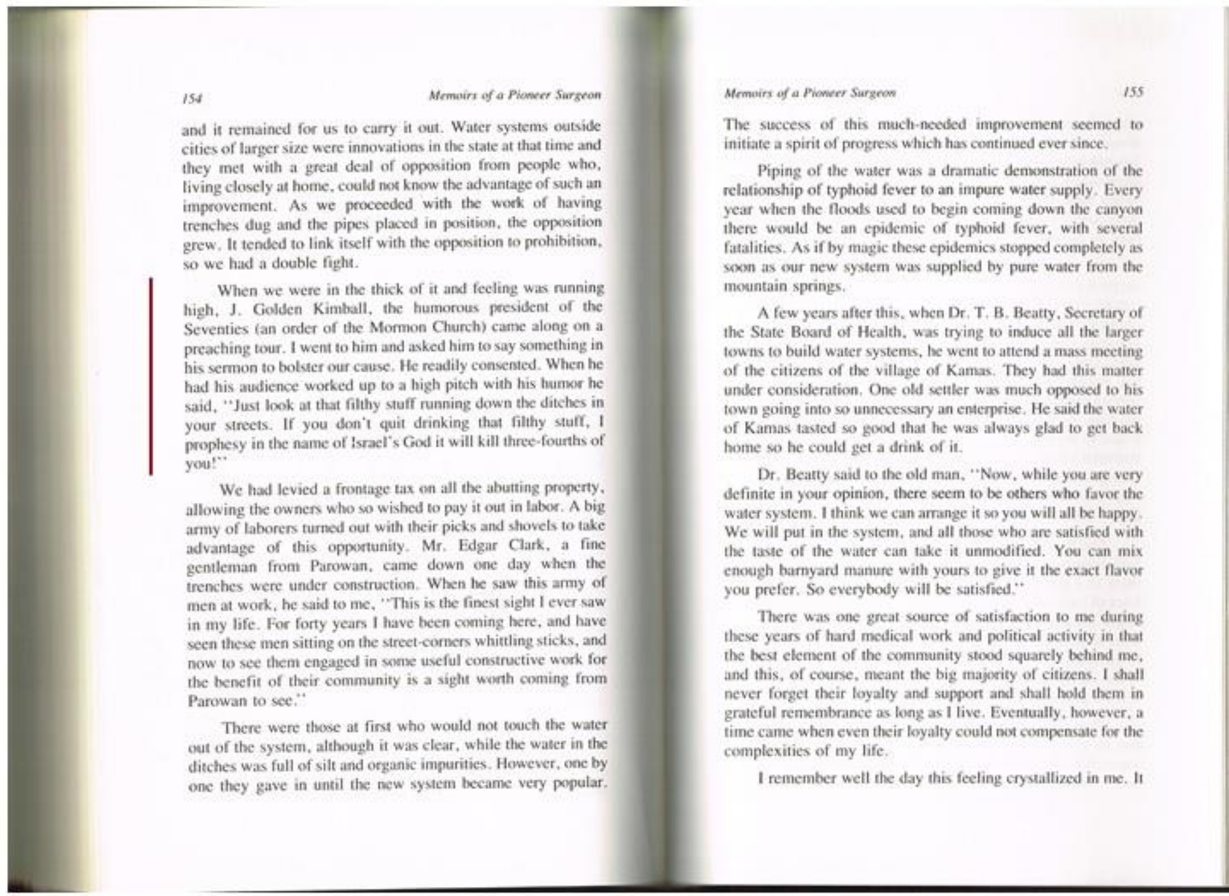


Notes

Water is a Critical Natural Resource

Historical Water Issue in Cedar City





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and it remained for us to carry it out. Water systems outside cities of larger size were innovations in the state at that time and they met with a great deal of opposition from people who, living closely at home, could not know the advantage of such an improvement. As we proceeded with the work of having trenches dug and the pipes placed in position, the opposition grew. It tended to link itself with the opposition to prohibition, so we had a double fight.

When we were in the thick of it and feeling was running high, J. Golden Kimball, the humorous president of the Seventies (an order of the Mormon Church) came along on a preaching tour. I went to him and asked him to say something in his sermon to bolster our cause. He readily consented. When he had his audience worked up to a high pitch with his humor he said, "Just look at that filthy stuff running down the ditches in your streets. If you don't quit drinking that filthy stuff, I prophesy in the name of Israel's God it will kill three-fourths of you!"

We had levied a frontage tax on all the abutting property, allowing the owners who so wished to pay it out in labor. A big army of laborers turned out with their picks and shovels to take advantage of this opportunity. Mr. Edgar Clark, a fine gentleman from Parowan, came down one day when the trenches were under construction. When he saw this army of men at work, he said to me, "This is the finest sight I ever saw in my life. For forty years I have been coming here, and have seen these men sitting on the street-corners whittling sticks, and now to see them engaged in some useful constructive work for the benefit of their community is a sight worth coming from Parowan to see."

There were those at first who would not touch the water out of the system, although it was clear, while the water in the ditches was full of silt and organic impurities. However, one by one they gave in until the new system became very popular.

Memoirs of a Pioneer Surgeon 155

The success of this much-needed improvement seemed to initiate a spirit of progress which has continued ever since.

Piping of the water was a dramatic demonstration of the relationship of typhoid fever to an impure water supply. Every year when the floods used to begin coming down the canyon there would be an epidemic of typhoid fever, with several fatalities. As if by magic these epidemics stopped completely as soon as our new system was supplied by pure water from the mountain springs.

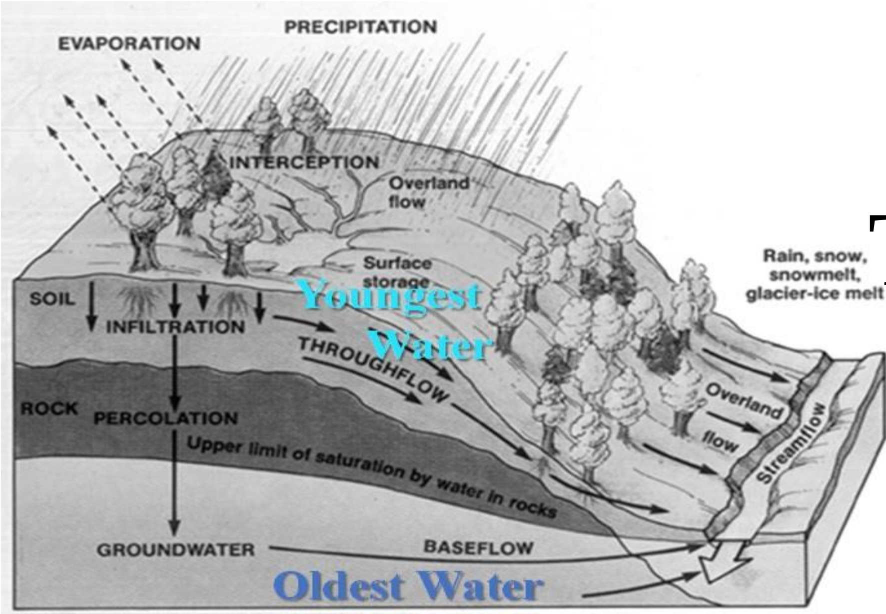
A few years after this, when Dr. T. B. Beatty, Secretary of the State Board of Health, was trying to induce all the larger towns to build water systems, he went to attend a mass meeting of the citizens of the village of Kamas. They had this matter under consideration. One old settler was much opposed to his town going into so unnecessary an enterprise. He said the water of Kamas tasted so good that he was always glad to get back home so he could get a drink of it.

Dr. Beatty said to the old man, "Now, while you are very definite in your opinion, there seem to be others who favor the water system. I think we can arrange it so you will all be happy. We will put in the system, and all those who are satisfied with the taste of the water can take it unmodified. You can mix enough barnyard manure with yours to give it the exact flavor you prefer. So everybody will be satisfied."

There was one great source of satisfaction to me during these years of hard medical work and political activity in that the best element of the community stood squarely behind me, and this, of course, meant the big majority of citizens. I shall never forget their loyalty and support and shall hold them in grateful remembrance as long as I live. Eventually, however, a time came when even their loyalty could not compensate for the complexities of my life.

I remember well the day this feeling crystallized in me. It

http://www.walden3d.com/photos/Grandkids_Science_Camps/170802-04_Science_Camp/7_Geophysics-Water.pdf

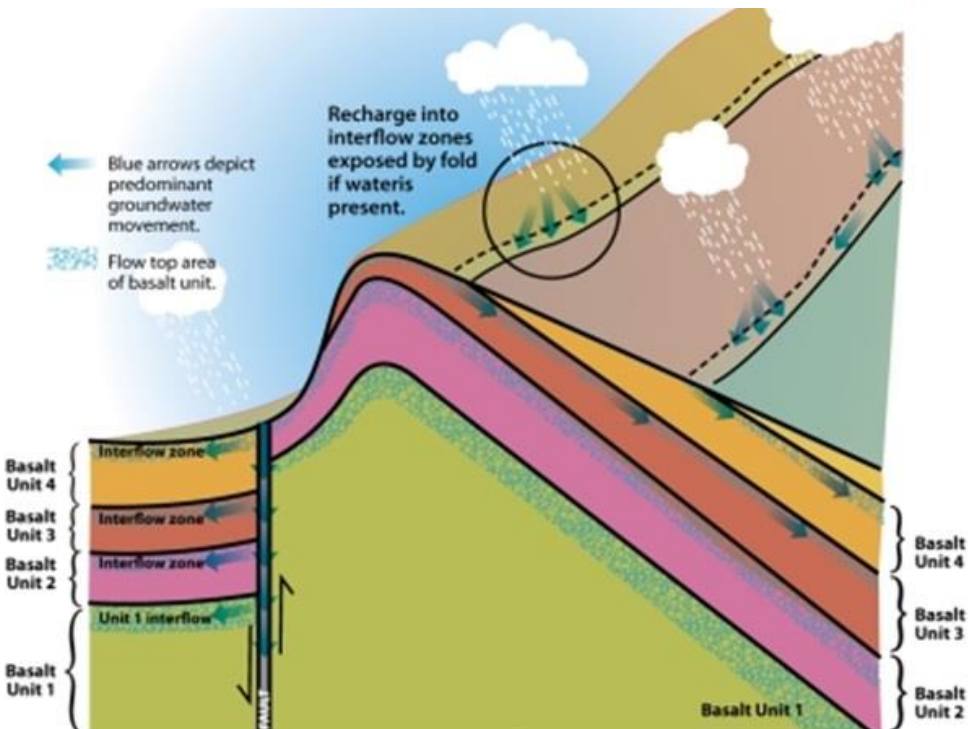


http://snobear.colorado.edu/Markw/geog5321_webpage_04.html

Applying Experience Today to Cedar Valley Water Problems

- Bedrock dips to the east;

- Faults bounding the valley disrupt baseflow, especially into the Cedar Valley basin fill aquifer, which is isolated by clays and is very shallow.



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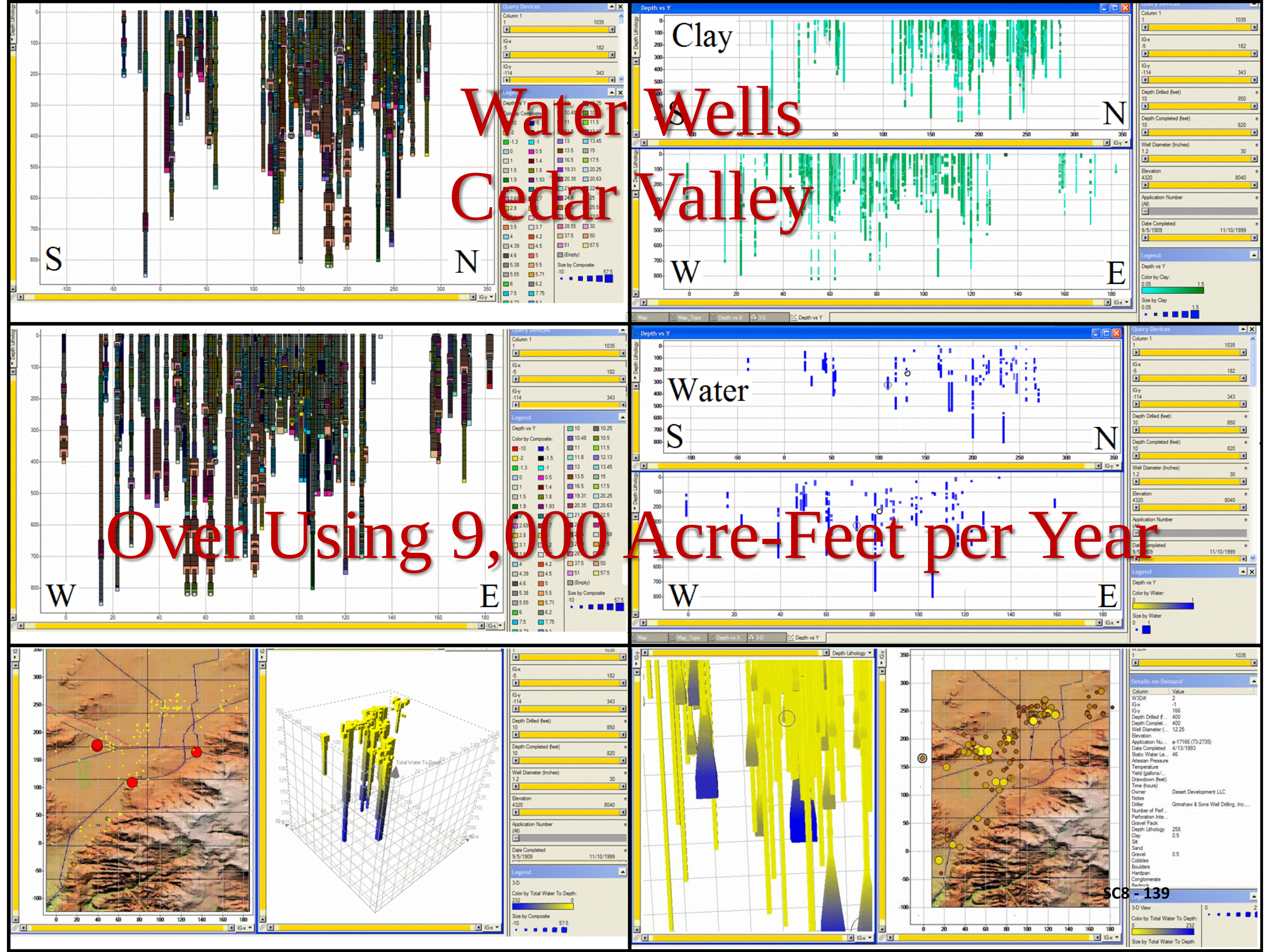

Water Wells
Cedar Valley
Over Using 9,000 Acre-Feet per Year
Clay
Water
S
N
W
E

Geology & Geophysics Are Key

How do Geoscientists see under the ground?

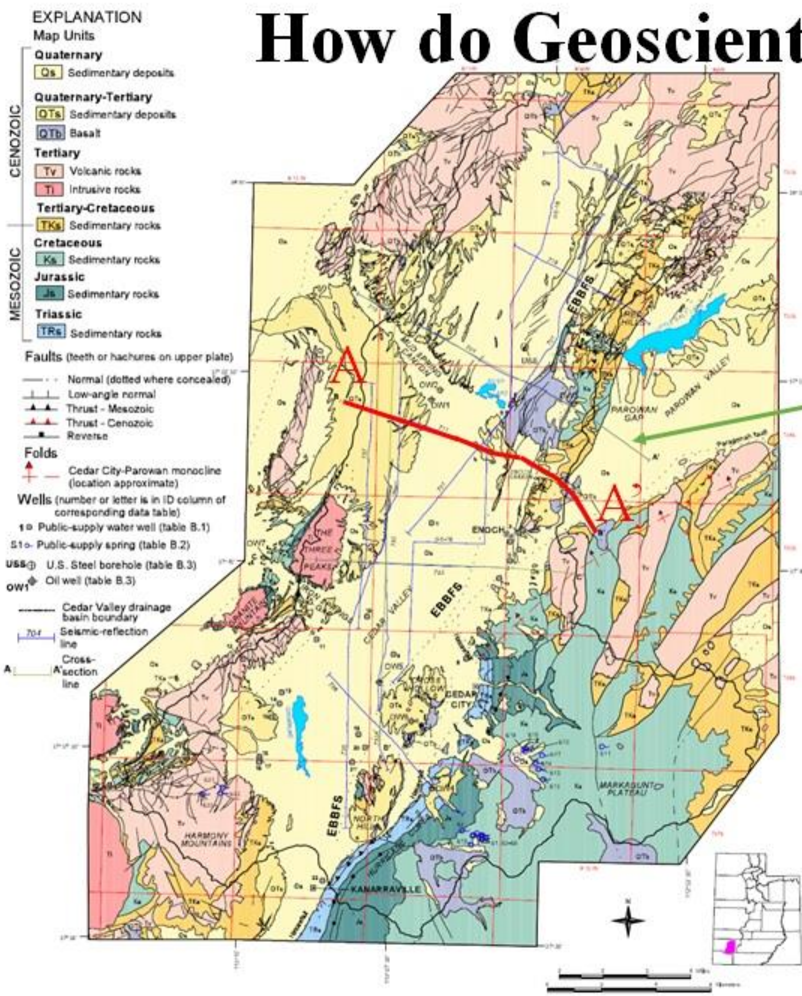
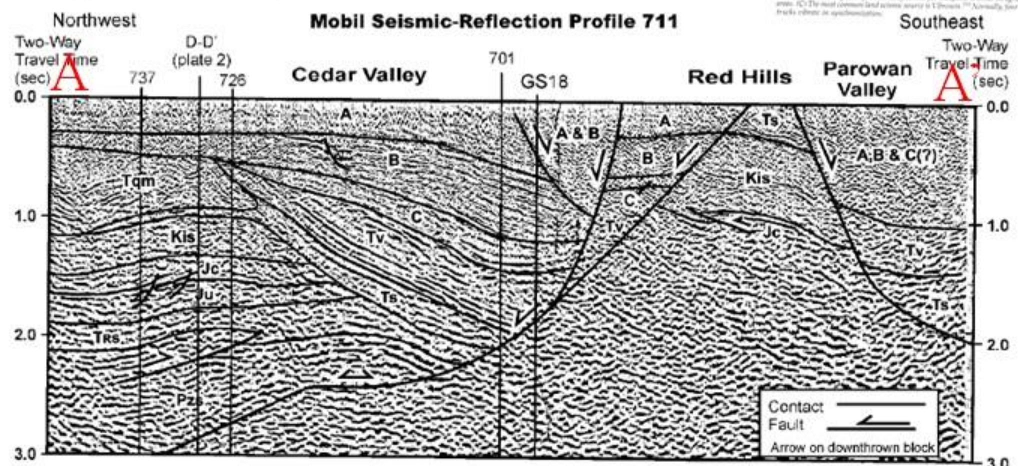


Figure 6. Simplified geologic map of Cedar Valley drainage basin and adjacent areas. EBBFS is eastern basin-bounding fault system. See figure 5 for stratigraphic column, and appendix A for correlation of map units with those on plates 1 and 2.

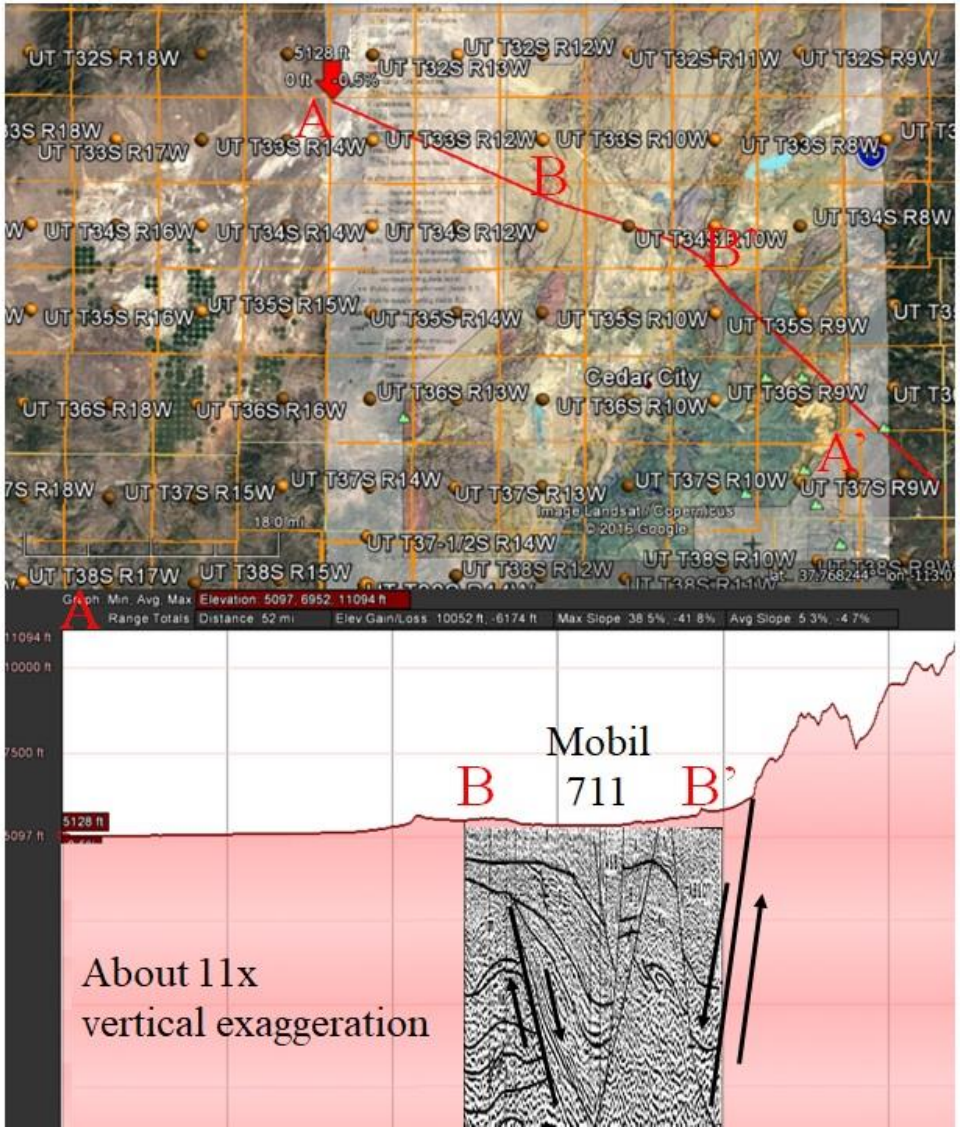
- Line 711 was my first assignment in Mobil Field Operations in February 1978 (it was cold, saw bear tracks).
- When I learned of Bengt Nelson's first winter (1856-1857) at Iron Springs.
- Figures to right from Line 704.

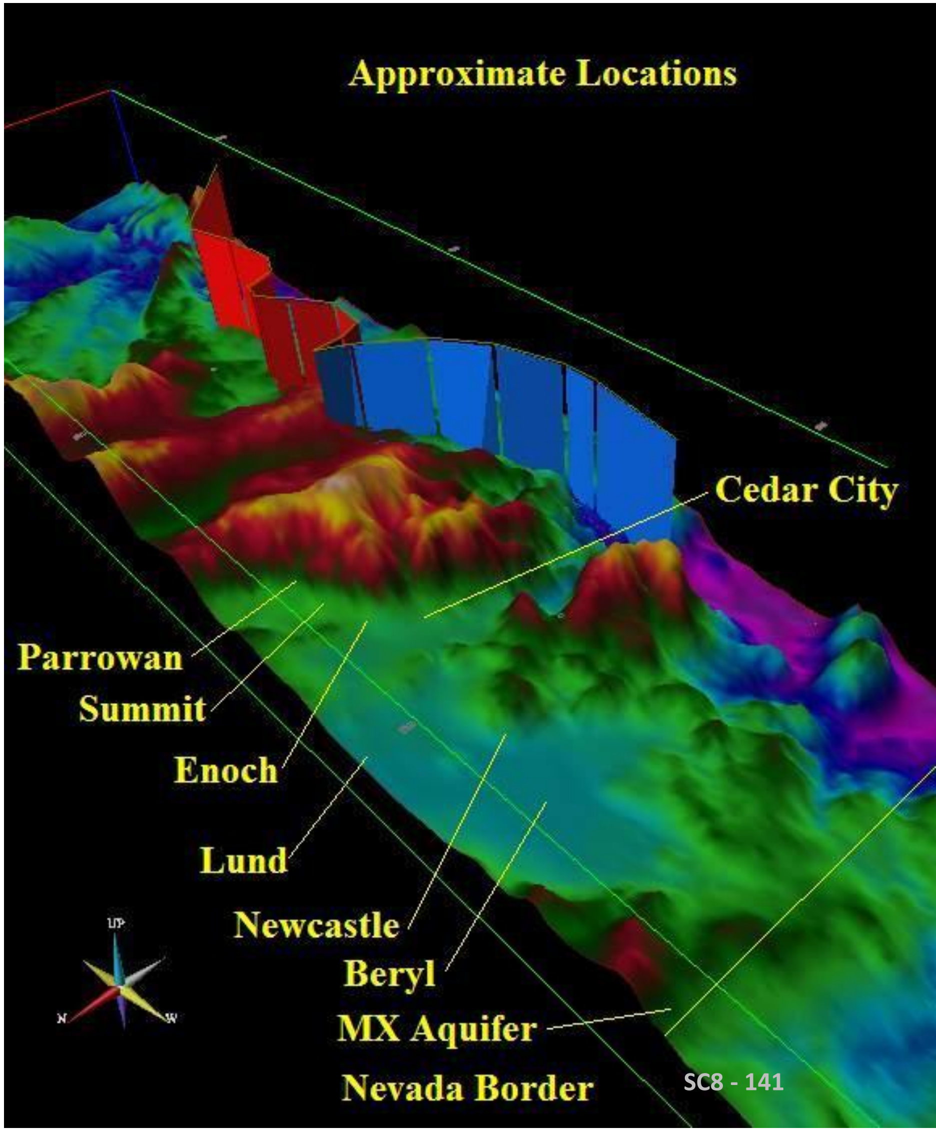


A,B,C - Subdivisions of Quaternary-Tertiary basin-fill sediment; Tqm - Quartz monzonite; Tv - Tertiary volcanic rocks; Ts - Tertiary sedimentary rocks; Kis - Iron Springs Formation; Jc - Carmel Formation; Ju - Navajo Sandstone, Kayenta, and Moenave Formations, undifferentiated; Ŧs - Triassic sedimentary rocks; Pzs - Paleozoic sedimentary rocks.

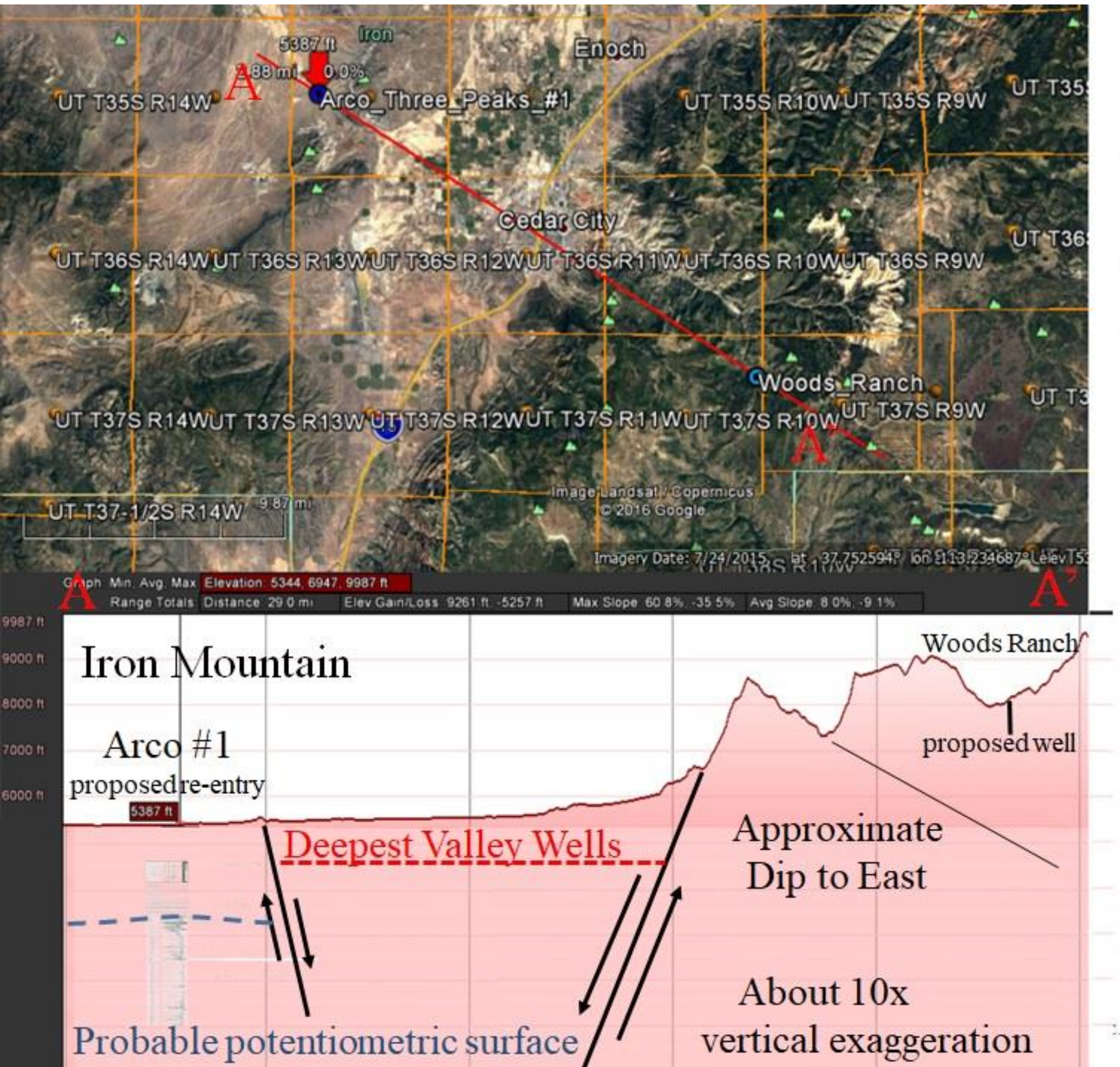
Lake Powell Pipeline

Mobil Line 711 cross-section

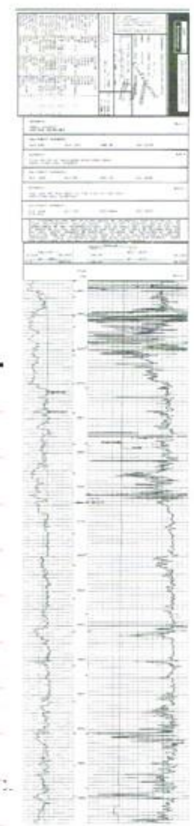




Water at Iron Springs
Where Bengt & Ellen Nelson Lived



Arco #1 – Woods Ranch cross-section



- An opportunity to test the Fractured Quartz Monzonite Aquifer is to reopen this well.

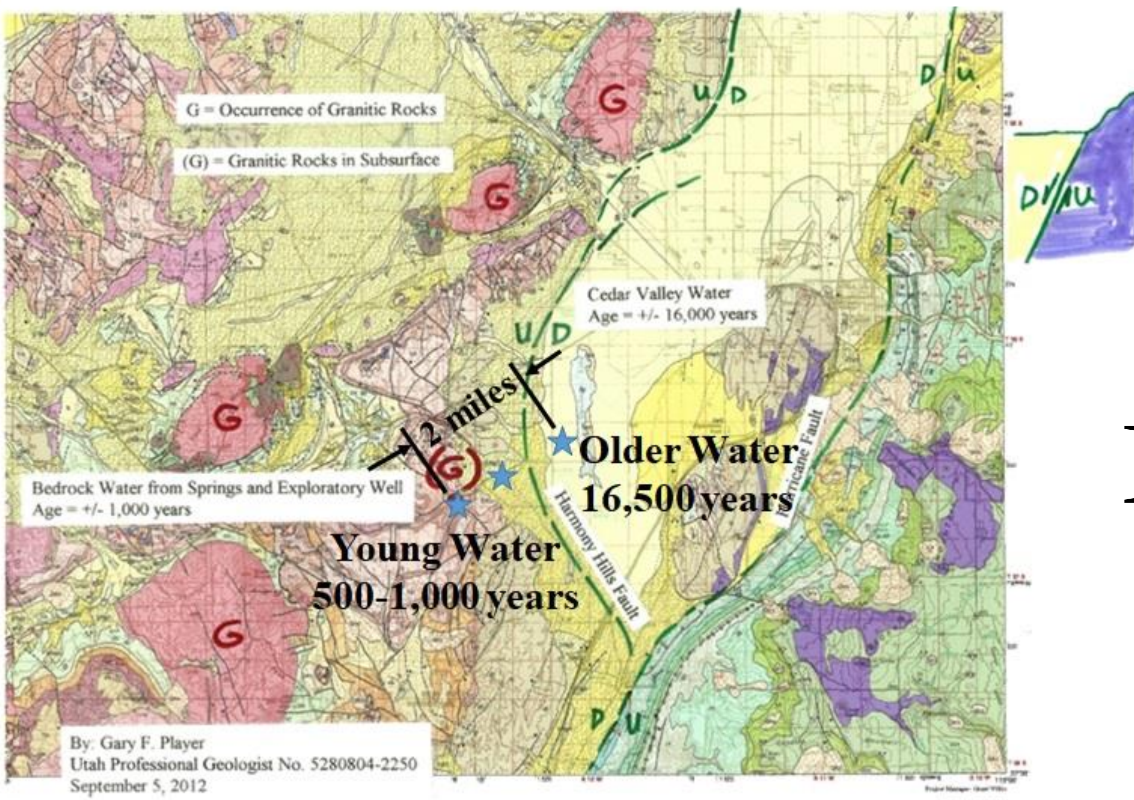
Top Qm = 2,322'
Fractured: 2,500'-2,615'

Fractured: 2,960'-3,050'

- The proposed test in the Cretaceous rocks is at Woods Ranch or Sheepherder's Cabin.

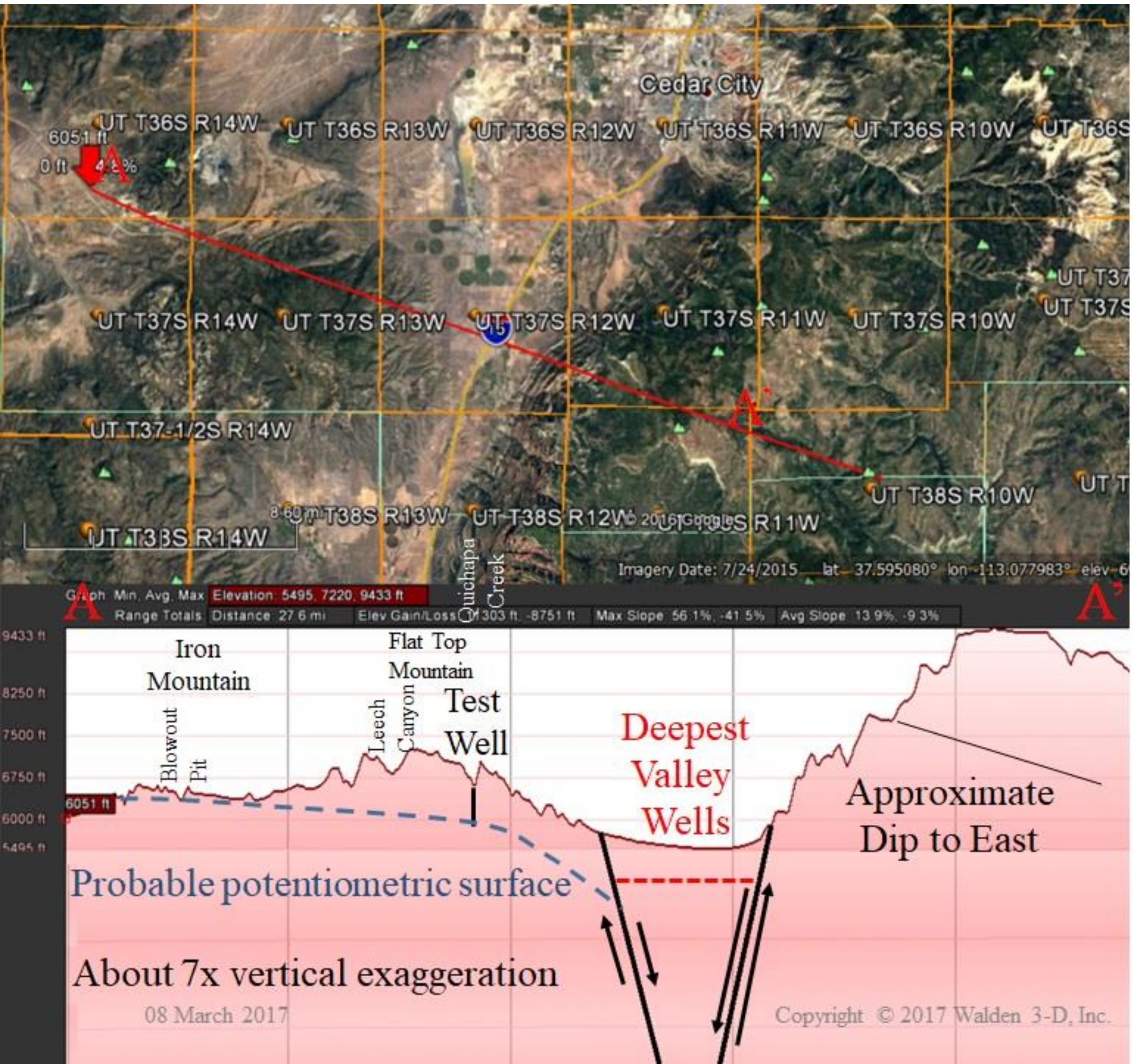
Untapped Fractured Quartz Monzonite Aquifer
Photograph of water in Blowout Pit at Iron Mountain

Photograph by Gary Player



Water from Fractured Quartz Monzonite Fills Blowout Pit and Other Iron Mine Pits

Fractured Quartz Monzonite Wells Will Hopefully Be "New Water"

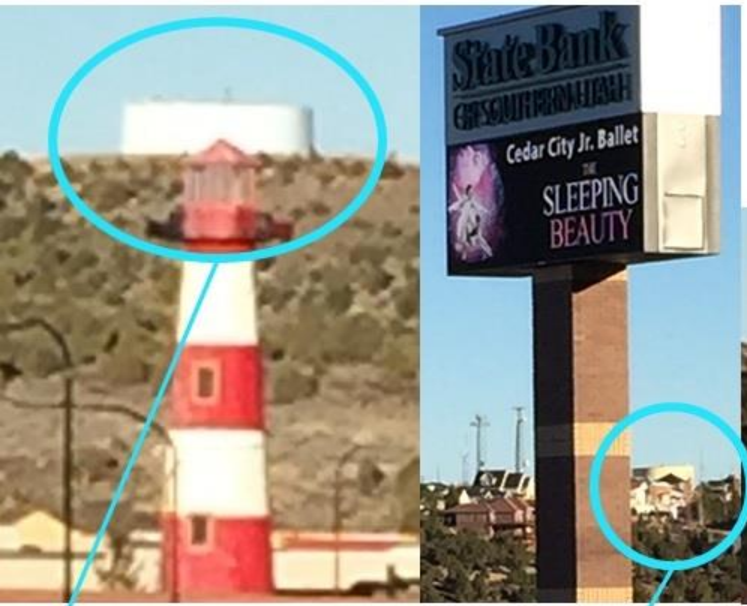


Blowout Pit Cross-Section

- Dip on bedrock to east drives water falling on Cedar Mountain east.
- Throw of Hurricane Fault allows water to drop down 5,000 feet to the porous Jurassic Sandstone.
- Water filling Blowout Pit tested in Quichapa Creek test well.

Hydrostatic Pressure Is Key

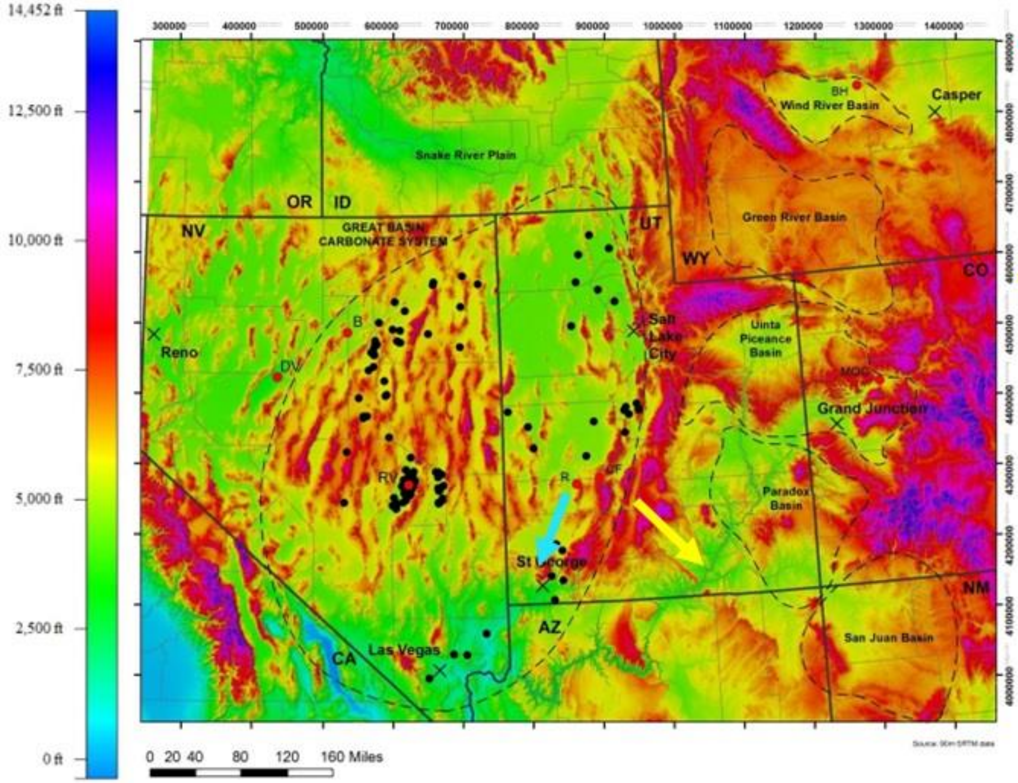
Water Tanks in Cedar City demonstrate hydrostatic pressure



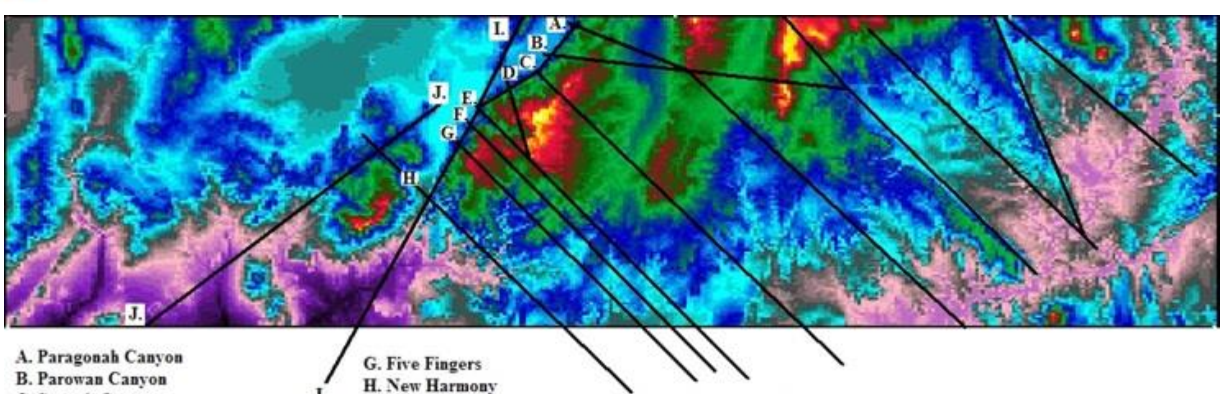
- Stacking water increases density 1 pound per square inch every 2.31 feet, by the equation p=density (water 1 g/cm^2)*gravity (9.7 m/s^2)*depth (or height).

- The pressure in our water faucet is tied to the height the water tank is above us.
- Less than normal hydrostatic pressure means there is a leak in the water system.

Looking at the Bigger Picture



- There is significant baseflow discharge from The Great Basin (e.g. Cedar City at 5,000 feet) to the south (e.g. St. George at 3,000 feet).
- There is equal or larger baseflow discharge from The Great Basin (e.g. Cedar Valley) to the southeast (e.g. The Grand Canyon).
- This discharge is much deeper than 800 feet, with water running below the isolated Cedar Valley Fill Aquifer.



A. Paragonah Canyon
B. Parowan Canyon
C. Summit Canyon
D. Fiddlers Canyon
E. Cedar Canyon
F. Kararaville Canyon

G. Five Fingers
H. New Harmony
I. Hurricane Fault
J. Pinevalley

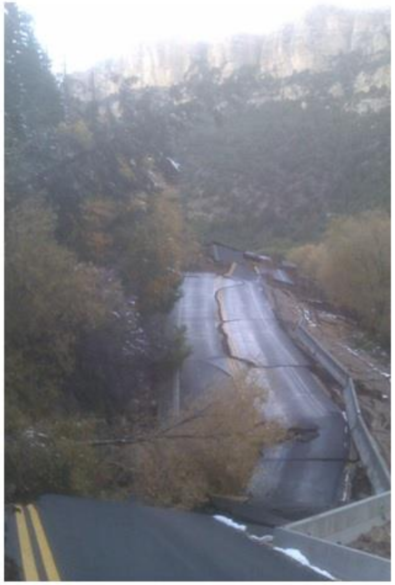
Possible Fault Geopressure Leak Pathways from Cedar Valley to the Colorado River

Less Than Normal Hydrostatic Pressure

Untapped Cretaceous Aquifer
above the repeated road repairs in Cedar Canyon
(note most significant flow is on east facing outcrops, because beds dip east)

Water Flowing East Is Within Drainage Basin

What is the cost to repair the road?
Compared to the cost of drilling a deviated hole
and draining the water out of the cliffs to prevent landslides?



Deviated Hole Requires No Pumps and Turbines in the Well Generate Power

Cretaceous Aquifer east of Cedar City

Straight Cliffs Formation over Dakota Formation, north of Highway 14 at Mile 8, east of Cedar City.

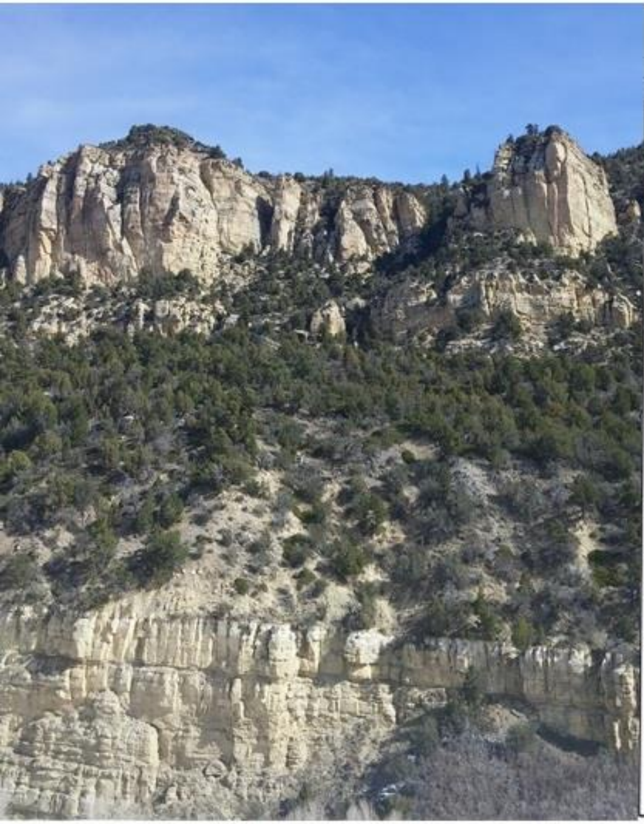


Photo by Gary F. Player, Utah Professional Geologist 5280804-2250, March 14, 2015

Utah Geological Association Publication 30 - Pacific Section
American Association of Petroleum Geologists Publication GB78
345

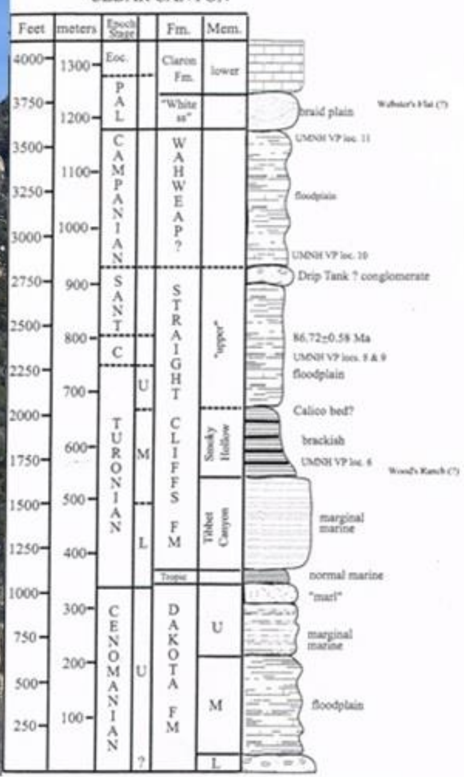
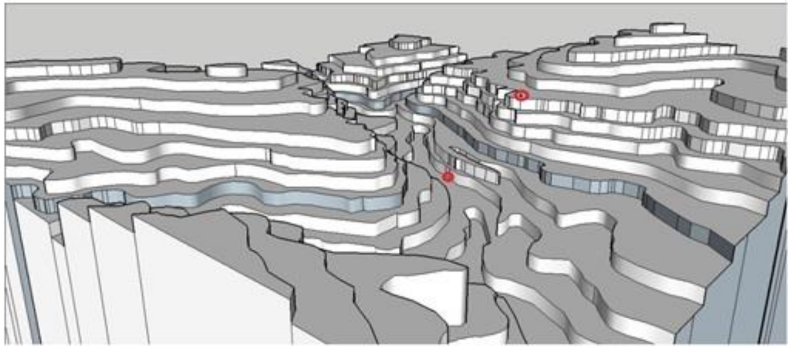
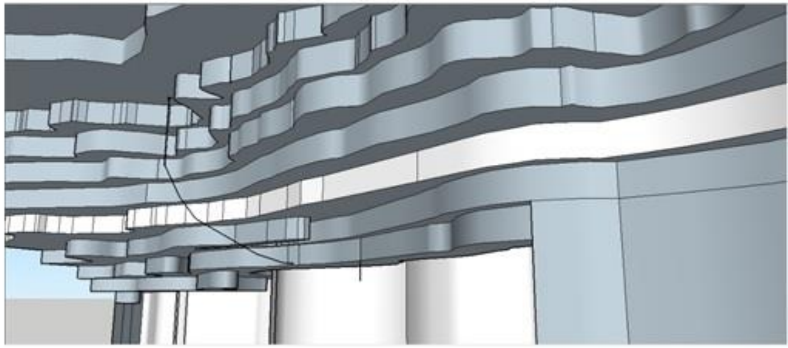
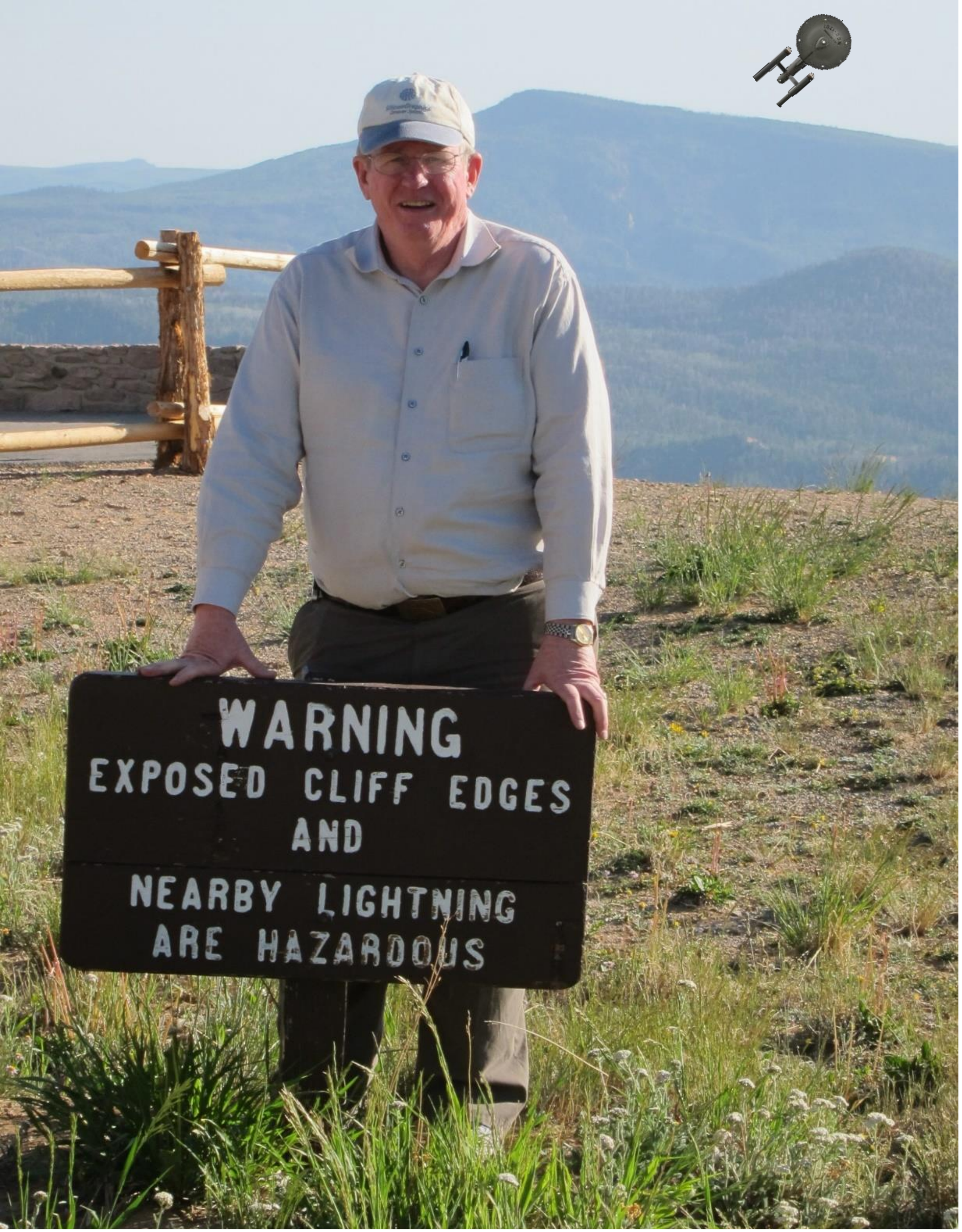


Figure 5. Comparison of Upper Cretaceous and lower Tertiary stratigraphy in Cedar and Parowan Canyons. The Parowan section is hung on the contact between the Claron and Grand Castle Formations. UGA Pub. 30





Notes

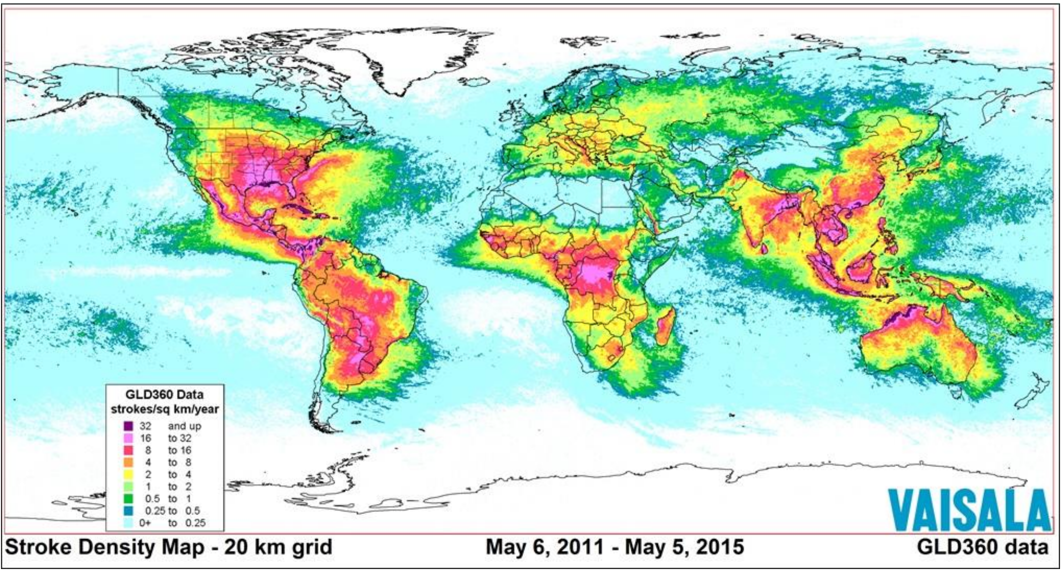


How can we find and optimize natural resources?

http://www.walden3d.com/photos/Grandkids_Science_Camps/170802-04_Science_Camp/7_Geophysics-Lightning.pdf

Lightning Occurs Everywhere

5+ Years of Data in GLD-360 Data Base

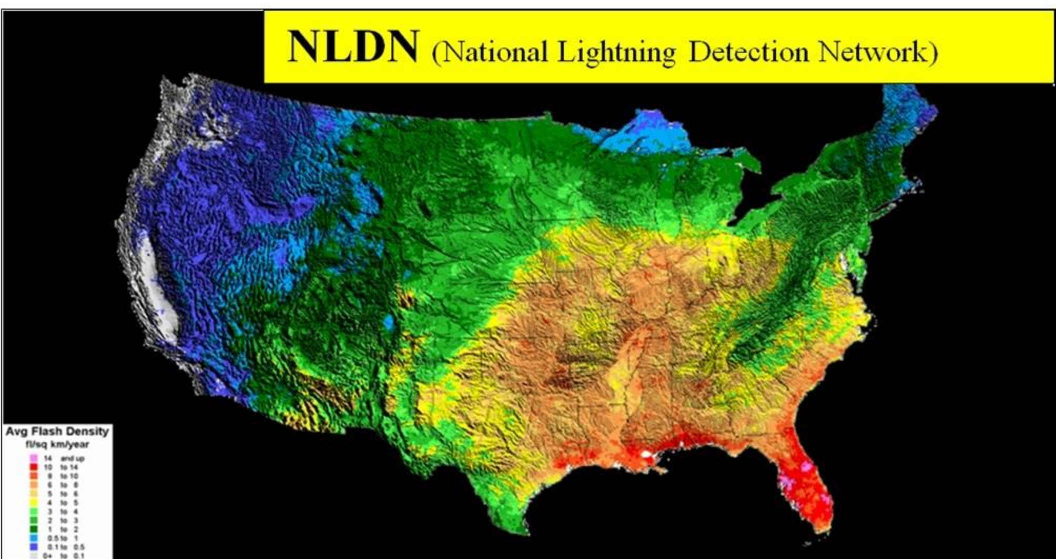


Lightning Data

Was Only Used For Insurance, Safety, & Meteorological Purposes

The U.S. has the most complete database

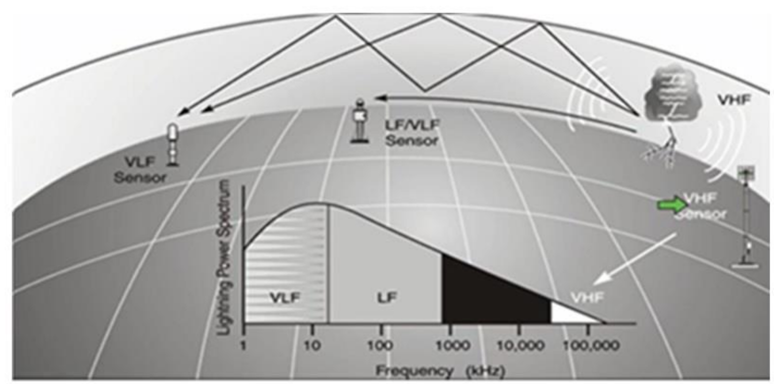
18+ Years of Data in the NLDN Data Base



Originally Collected for Insurance, Meteorology, and Safety Reasons

Sensors measure Direction to strike & Lightning Attributes

Strike Triangulated & Measurements Reconciled



Vaisala: Martin Murphy
2016 Webinar used with permission

We Discovered Strike Locations Are Controlled by Telluric Currents

DYNAMIC MEASUREMENT

US009523785B2

(12) **United States Patent**
Denham et al.

(10) **Patent No.: US 9,523,785 B2**
(45) **Date of Patent: Dec. 20, 2016**

(54) **METHOD FOR DETERMINING GEOLOGICAL SURFACE AND SUBSURFACE RESISTIVITY**

(71) Applicant: **Dynamic Measurement, LLC**, Cedar City, UT (US)

(72) Inventors: **L. R. Denham**, Houston, TX (US); **H. Roice Nelson, Jr.**, Cedar City, UT (US); **D. James Siebert**, Katy, TX (US)

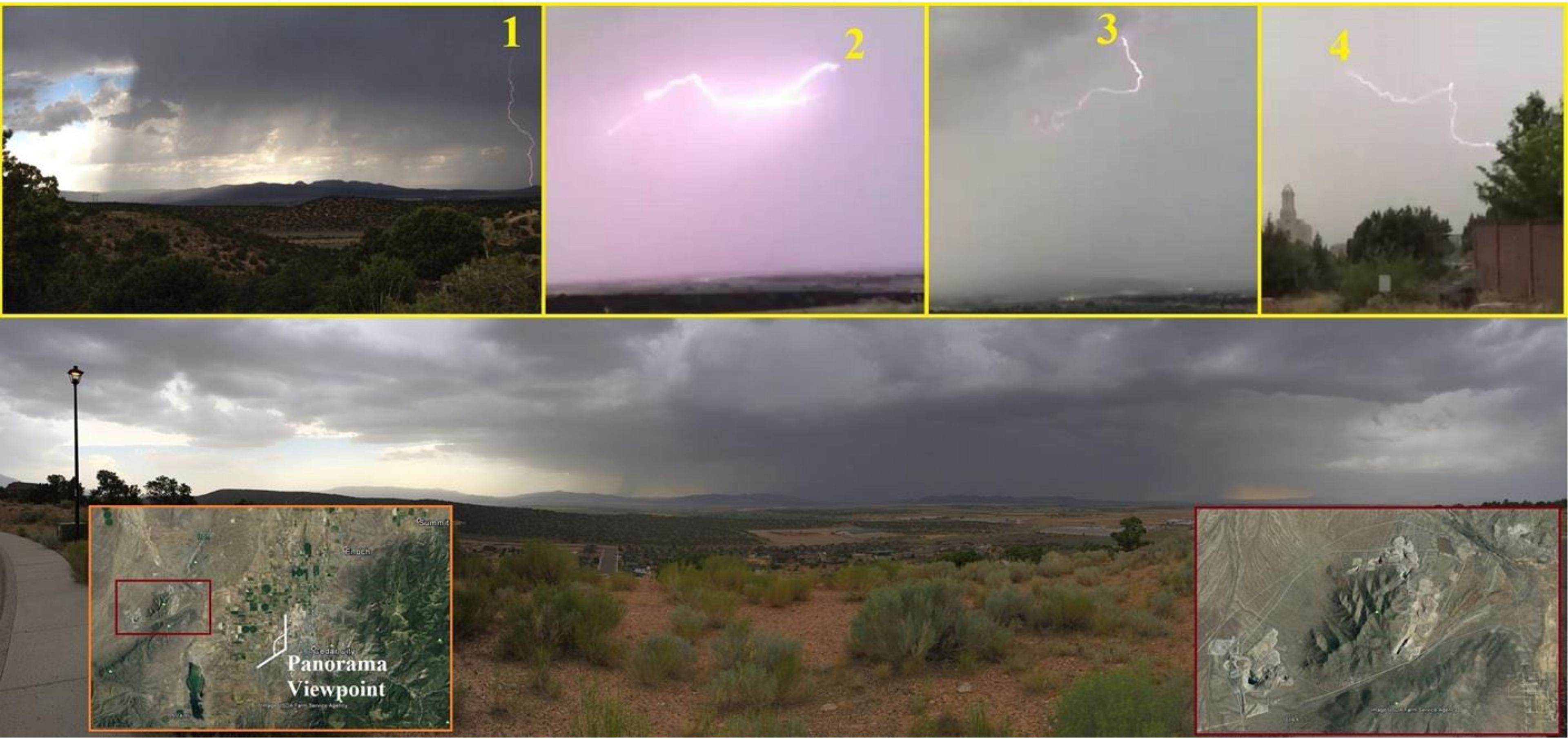
(73) Assignee: **Dynamic Measurement, LLC**

(57) **ABSTRACT**

A method for determining geological subsurface resistivity. The method includes obtaining a set of lightning parameters associated with a lighting strike received by a geological volume of material, the set of lightning parameters including an indicium of the current of the lightning strike at a first initial time and an indicium of the current of the lightning strike at a first decay time subsequent to the first initial time, and inferring the resistance of the volume of geological material, at least in part, from the set of lightning parameters.

6 Claims, 2 Drawing Sheets

The Magnetite at Iron Mountain Attracts Lightning Strikes



Lightning Strikes Encourage Rock Hounding

What is a Lodestone?

Lodestones are rocks that are magnetized. They are made of Magnetite , a type of iron ore. Magnetite itself is not necessarily magnetic. A piece of magnetite that is magnetic qualifies as a lodestone.

What makes a Lodestone magnetic?

For a piece of magnetite to become magnetized it must be exposed to a magnetic field. The weak magnetic field of the earth is not strong enough so another source must be looked to. One way it may occur is by lighting strikes on magnetite causing the magnetite particles to align in the right way to produce a magnetic field.

The first compasses were made over 2000 years ago using lodestones. If a long piece of lodestone is freely suspended it will rotate until it ligns up with the Earth's poles. Early navigators were able to use lodestones to help them find their way.

Lodestone Examples

Utah is a major source of iron ore and in particular, natural magnetic ore called lodestone or magnetite. These particular specimens both very rich in iron, making them magnetic.

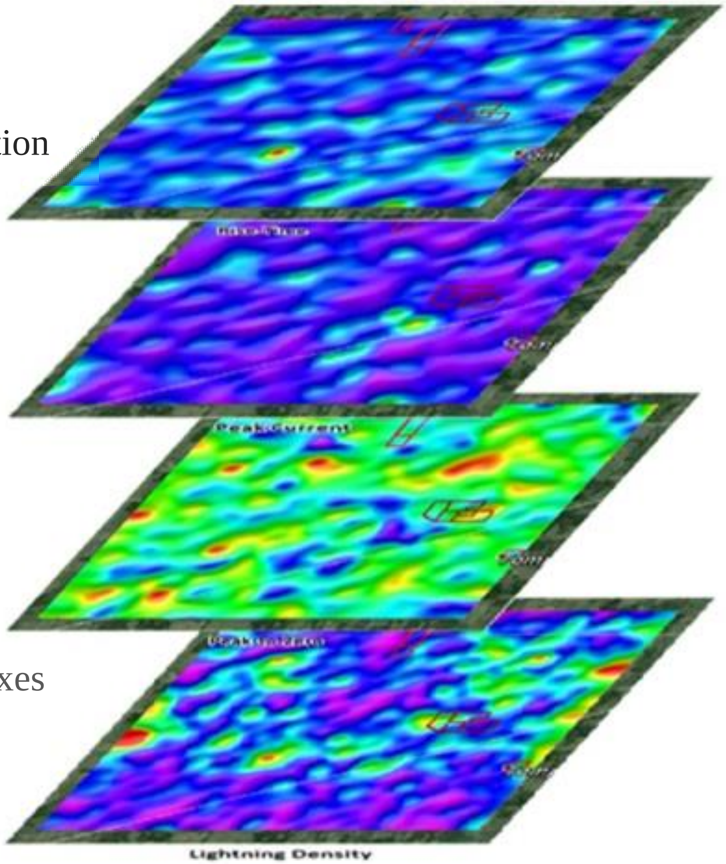
Fulgurites are fused sand from lightning strikes

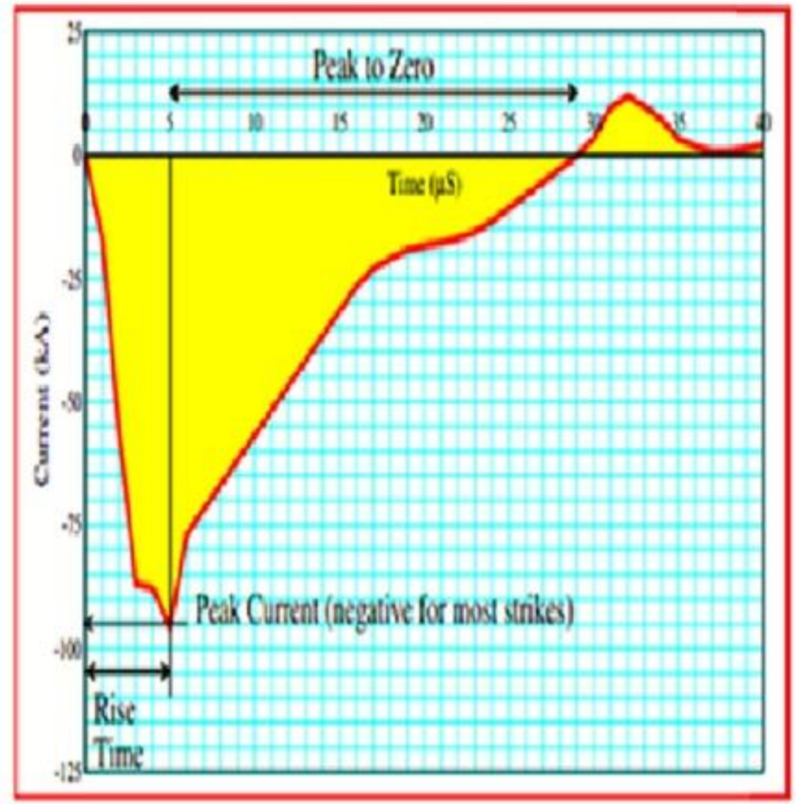
Sand fulgurites found on the top of Mount Raymond. U.S. quarter for scale. 1 / 2

Rock fulgurite (circled in white) found on quartzite at the summit of Mount Raymond in the Wasatch Range, Salt Lake County, Utah. Hammer for scale. 2 / 2

Lightning Measurements

- Location
- Time and Duration
- Rise Time
- Peak Current
- Polarity
- Peak-to-Zero
- Density
- Major/Minor Axes
- Chi-Squared

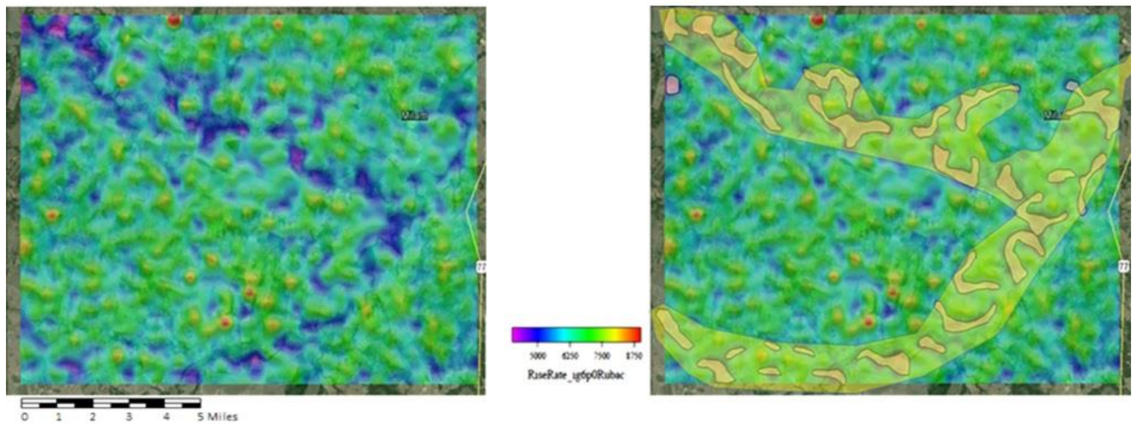




- Other attributes calculated from these measurements.
- The time of the lightning strike is correlated with solar and lunar tides.
- Measurements separated by time.

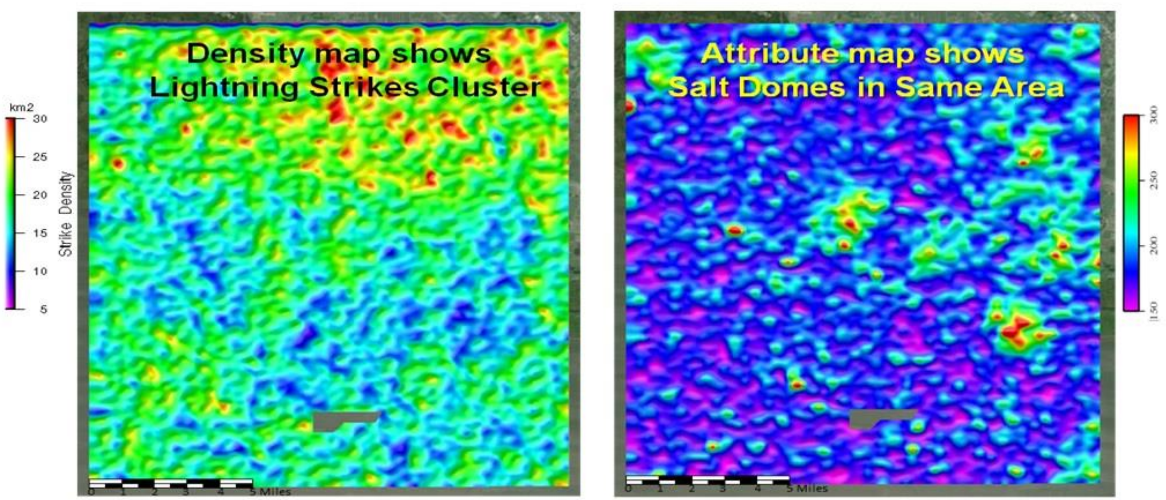
Lightning Analysis & Attributes

1. **Analysis area selected.**
2. **Patented and Patent-Pending Processes produce maps and volumes of derived rock properties and lightning attributes.**
3. **Existing geology and geophysics integrated with new data.**



Lightning Attribute: Rate of Rise-Time – Milam County, Texas

Louisiana Example

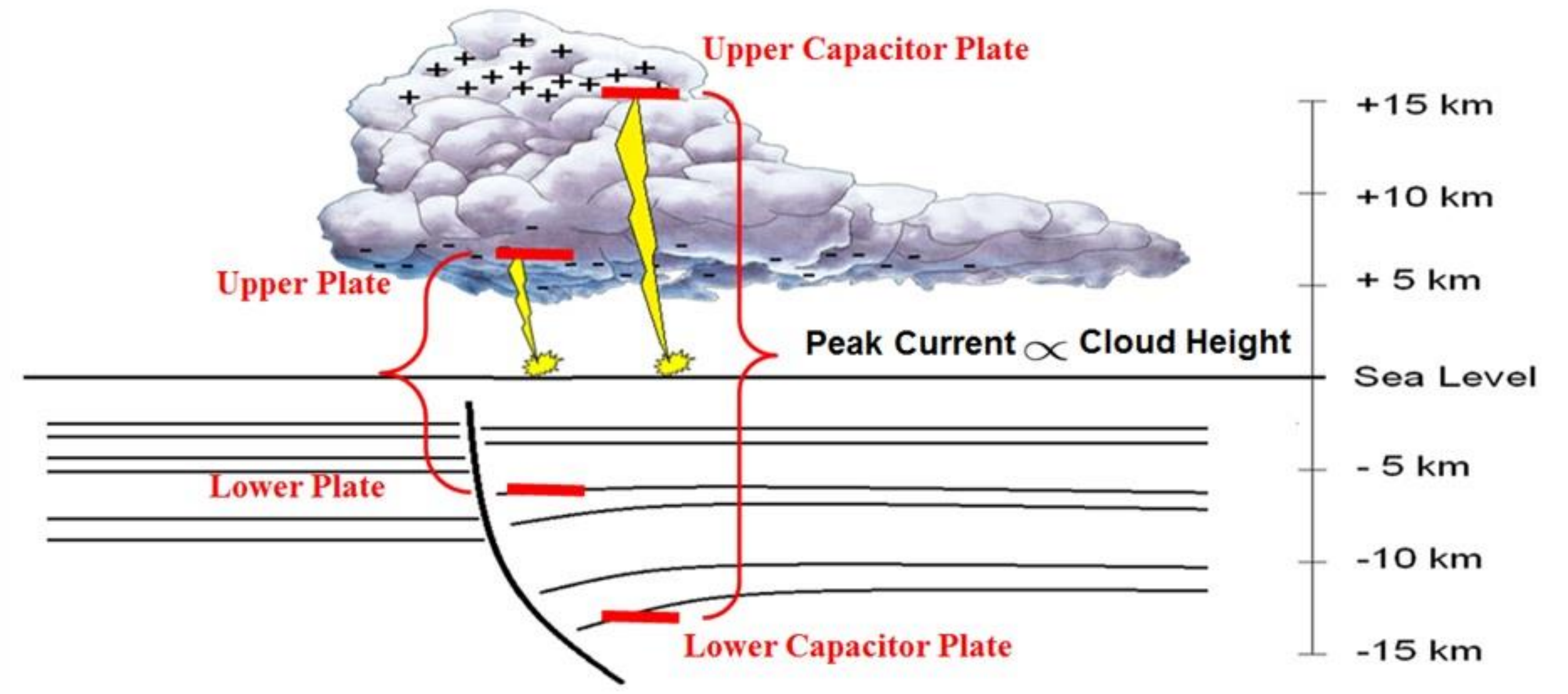


Density Map & Rate-of-Rise-Time Map

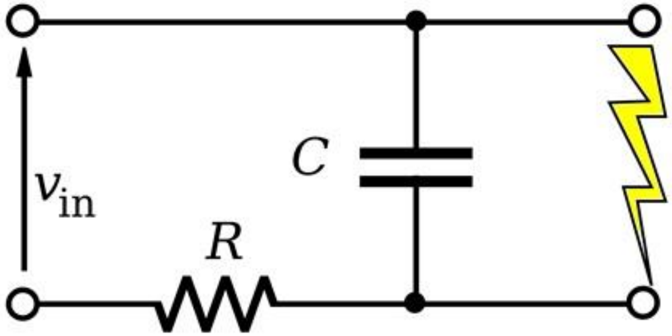
Rock Property & Attribute Maps & Volumes

Key Assumptions:

1. Lightning occurs when there is sufficient charge to bridge the capacitor.
2. Lightning is affected by geology to a depth proportional to cloud height, as derived from Peak Current

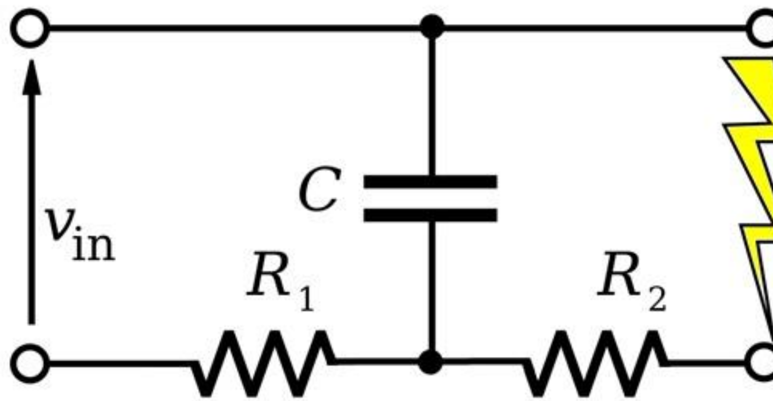


Relaxation Oscillator Physics and Lightning (a giant neon tube)

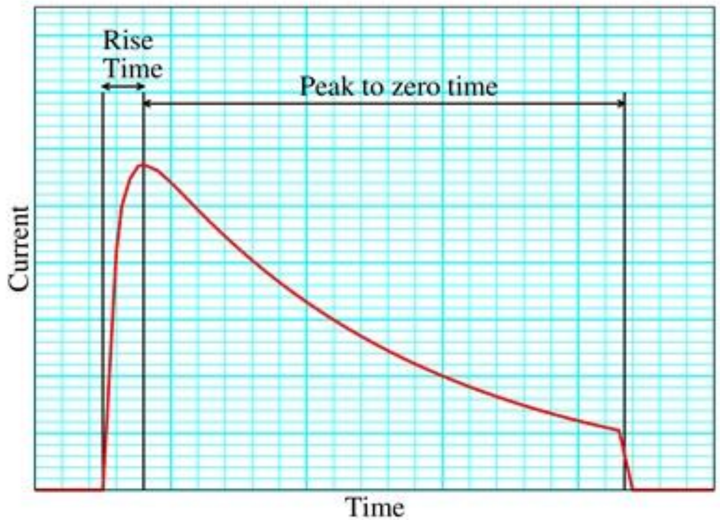


- The atmospheric capacitor is like a relaxation oscillator
- Just an additional resistance (R_2) limiting the current

- R_2 is the resistance between the lightning strike point and the bottom plate of the capacitor

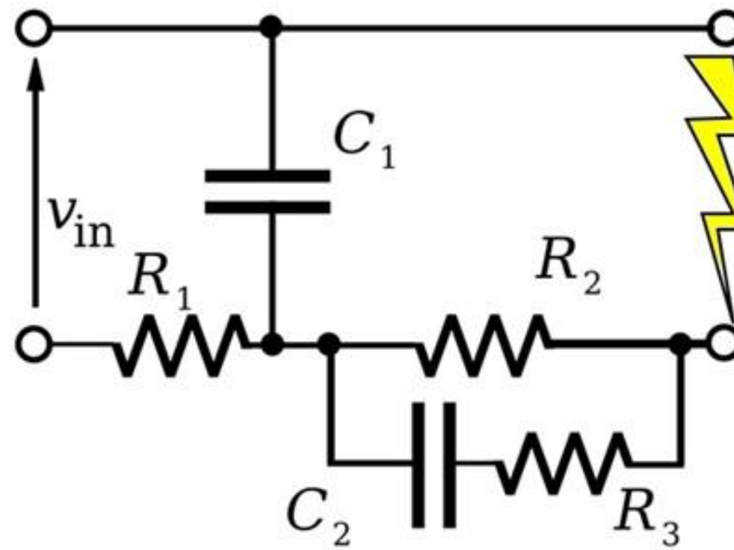


Lightning and the Induced Polarization Effect



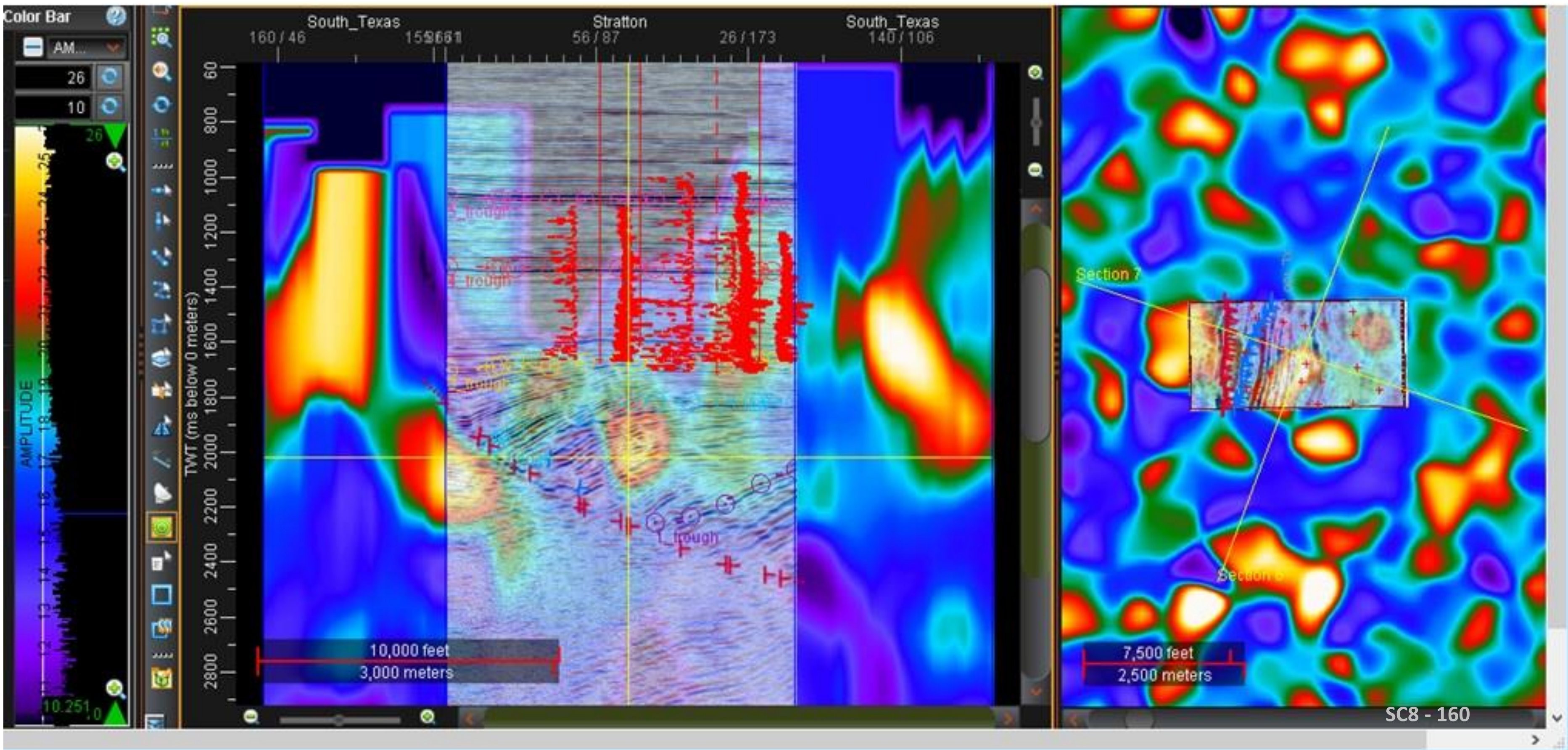
- Lightning does not have a square waveform
- But it does have a very steep onset
- Variations in the onset as measured (rise-time) show the IP Effect

- By treating this steep onset as charging a capacitor (C2) through a resistor (R3), an apparent capacitance can be calculated.
- From the apparent capacitance a value for average permittivity can be calculated

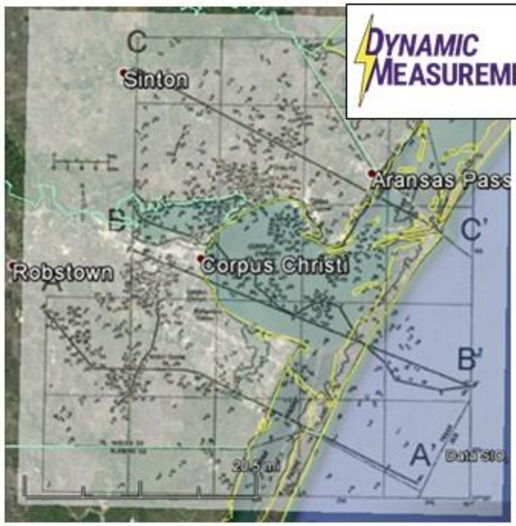


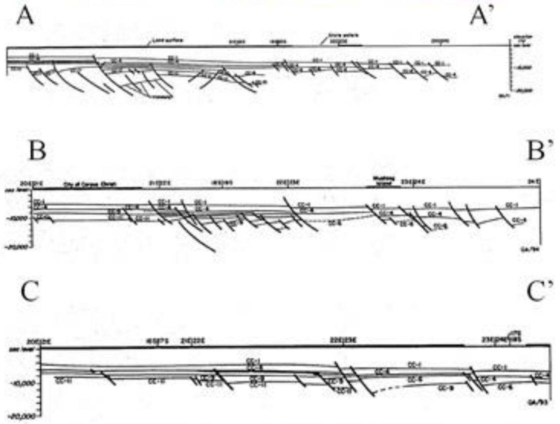
Dynamic Uses Seismic Techniques

Stratton Apparent Resistivity Sections



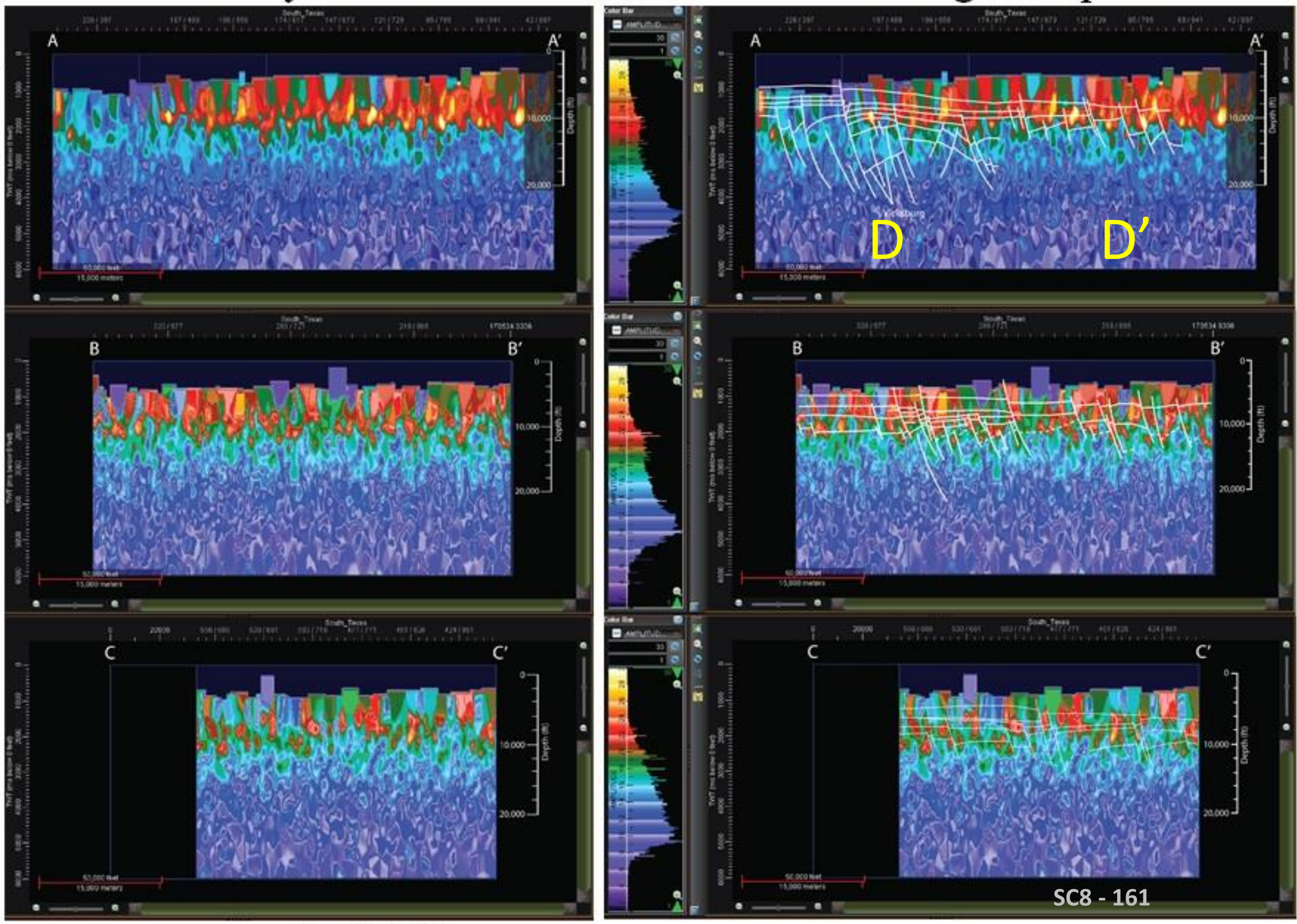
South Texas Example





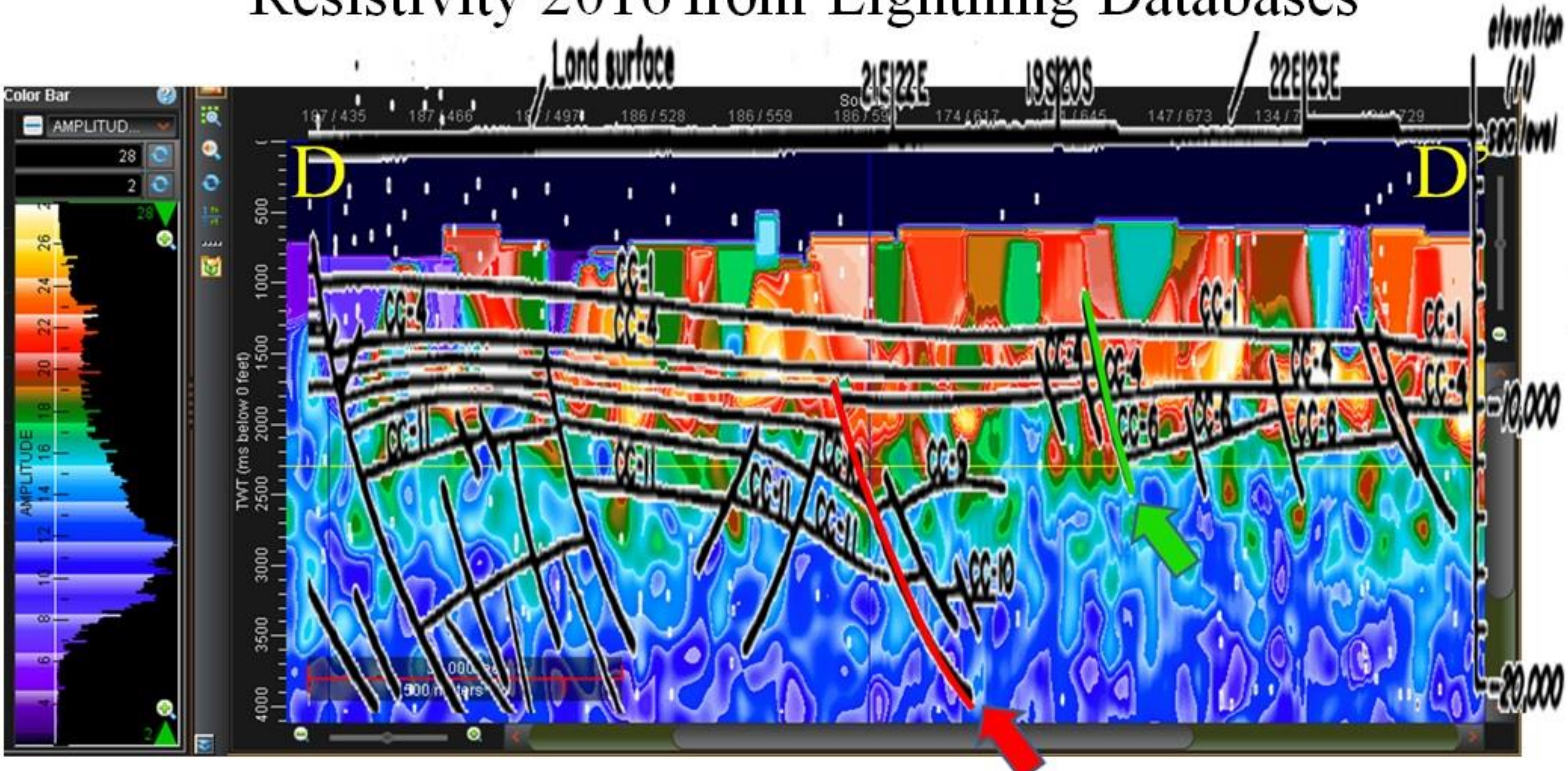
Ewing, T.E., 1986, Structural Styles of the Wilcox and Frio Growth-Fault Trends in Texas: Constraints on Geopressured Reservoirs: BEG, Report of Investigations, 154, 27-56.

Resistivity Sections with Ewing interpretation



D-D' Close-Up on Graben to the west

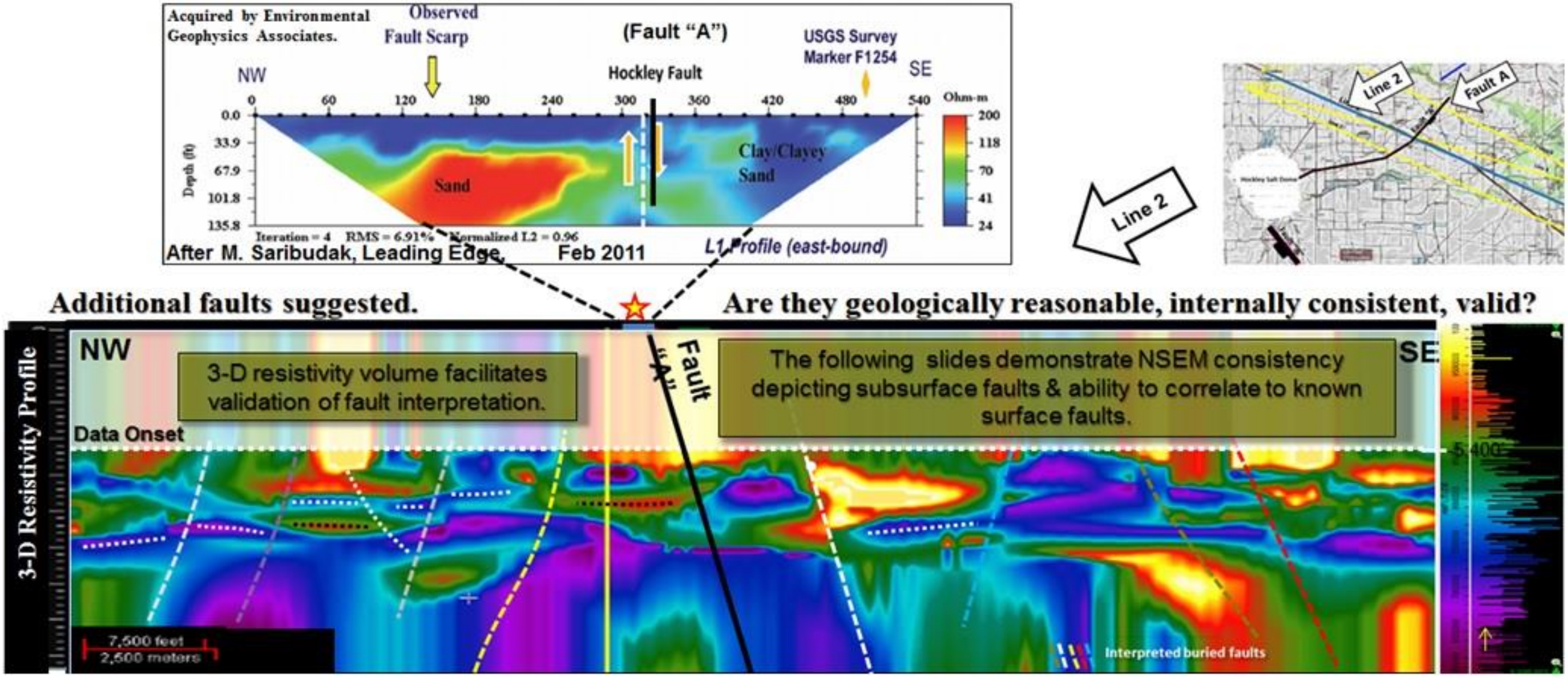
Interpretation 1986 by Tom Ewing, Apparent Resistivity 2016 from Lightning Databases



Note: interpretation by Tom Ewing in 1986. The resistivity section calculated from lightning in 2016. Co-located sections show breaks where faults were interpreted. There are resistivity plumes tied to faults.

Hockley, Texas
(where it all started)

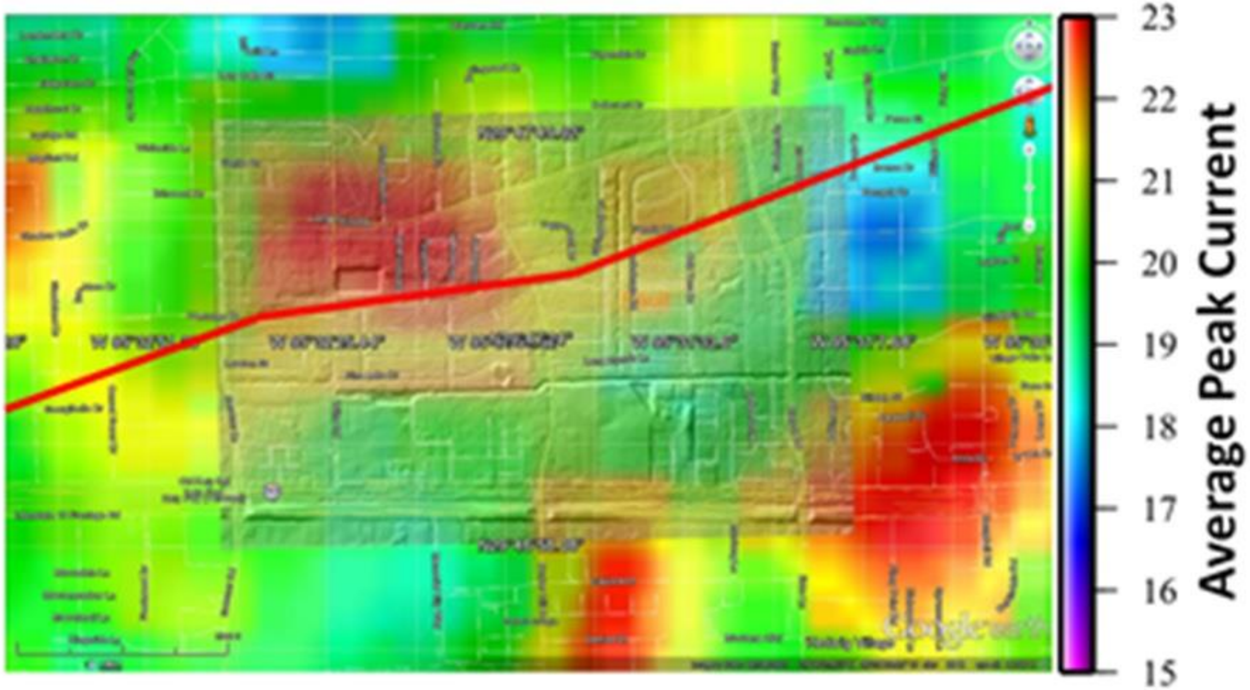
Texas Example

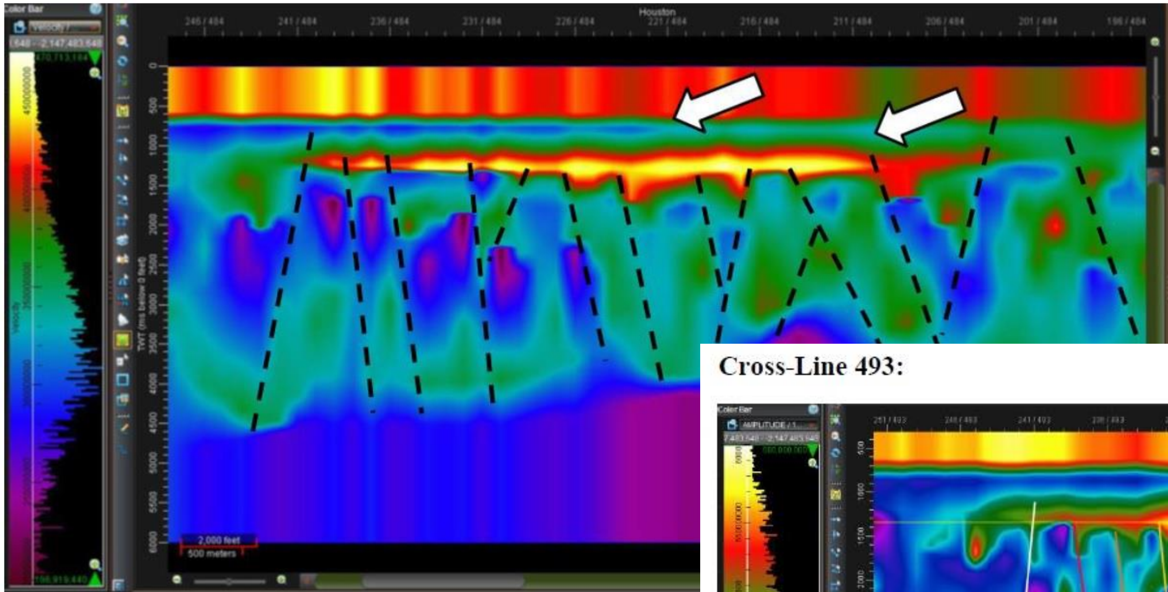


2-D Resistivity Survey ties Lightning Derived Resistivity Cross-Section

Average Negative Peak Current vs. Density

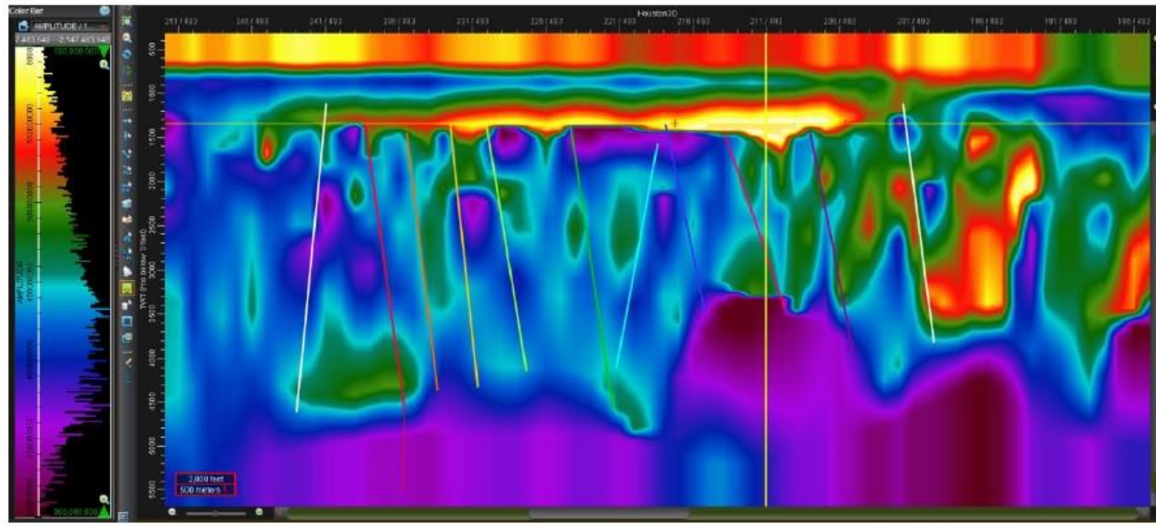
Peak Current Zoom with LIDAR & Long Point Fault



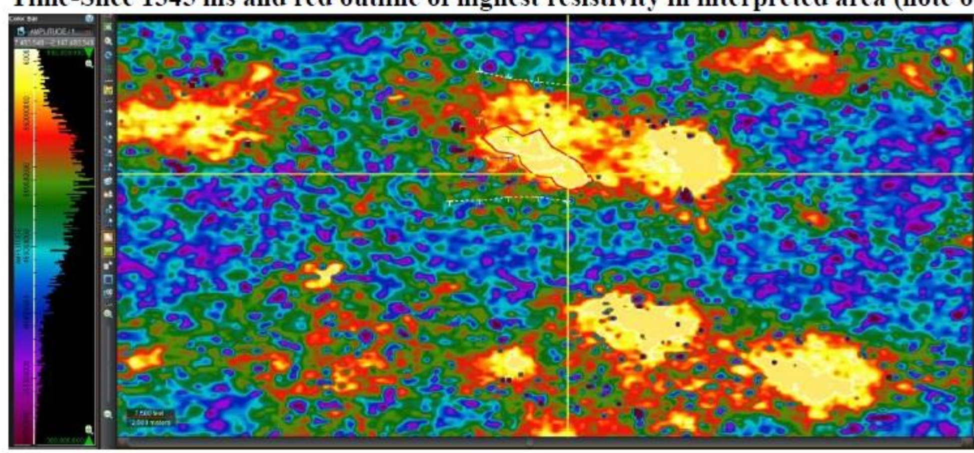


Possible Gas Field in Northwest Houston

Cross-Line 493:

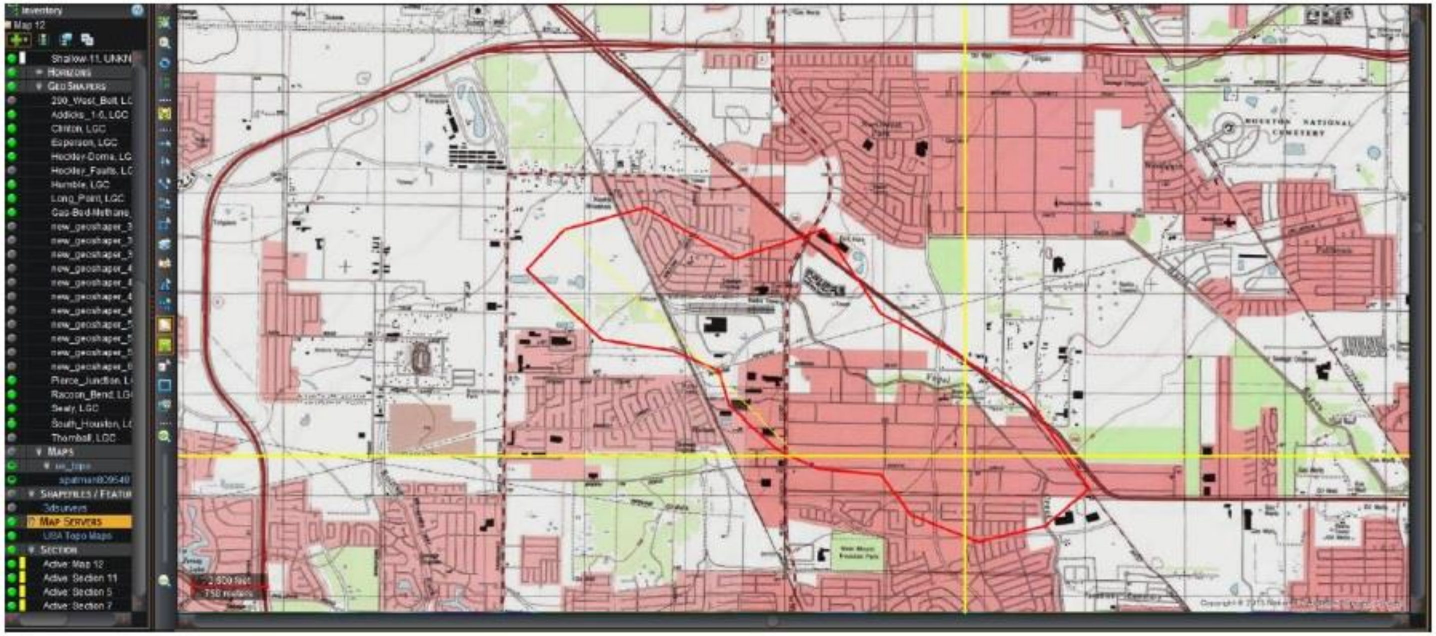


Time-Slice 1345 ms and red outline of highest resistivity in interpreted area (note other anomalies):



Location & Economics

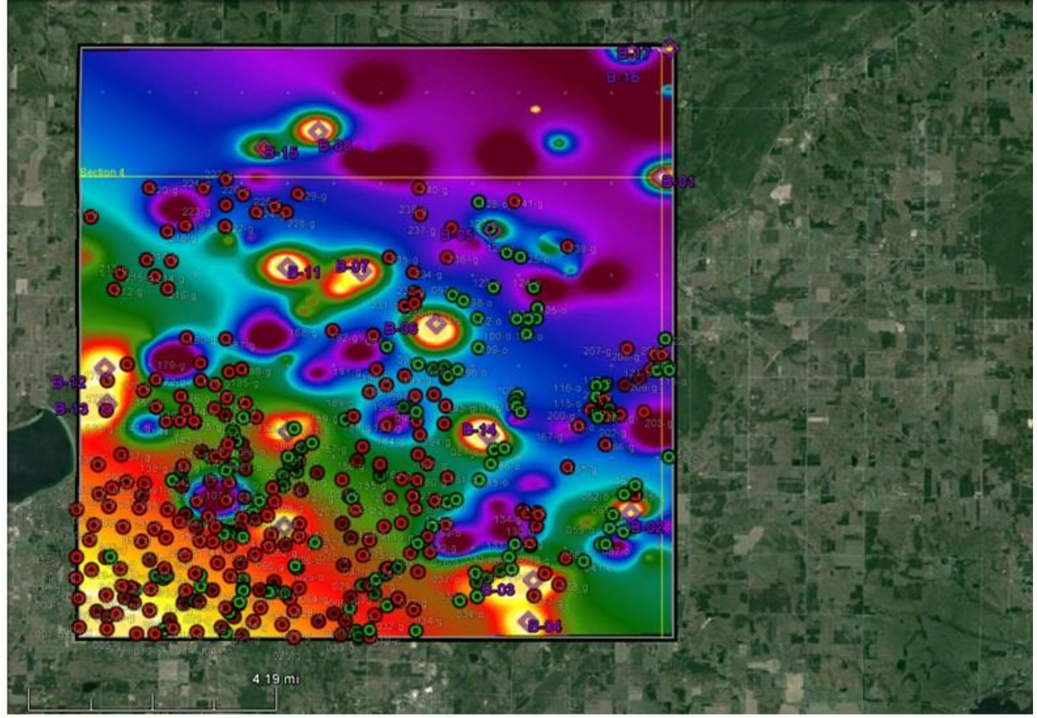
Zoom on Houston Infrastructure for this area:

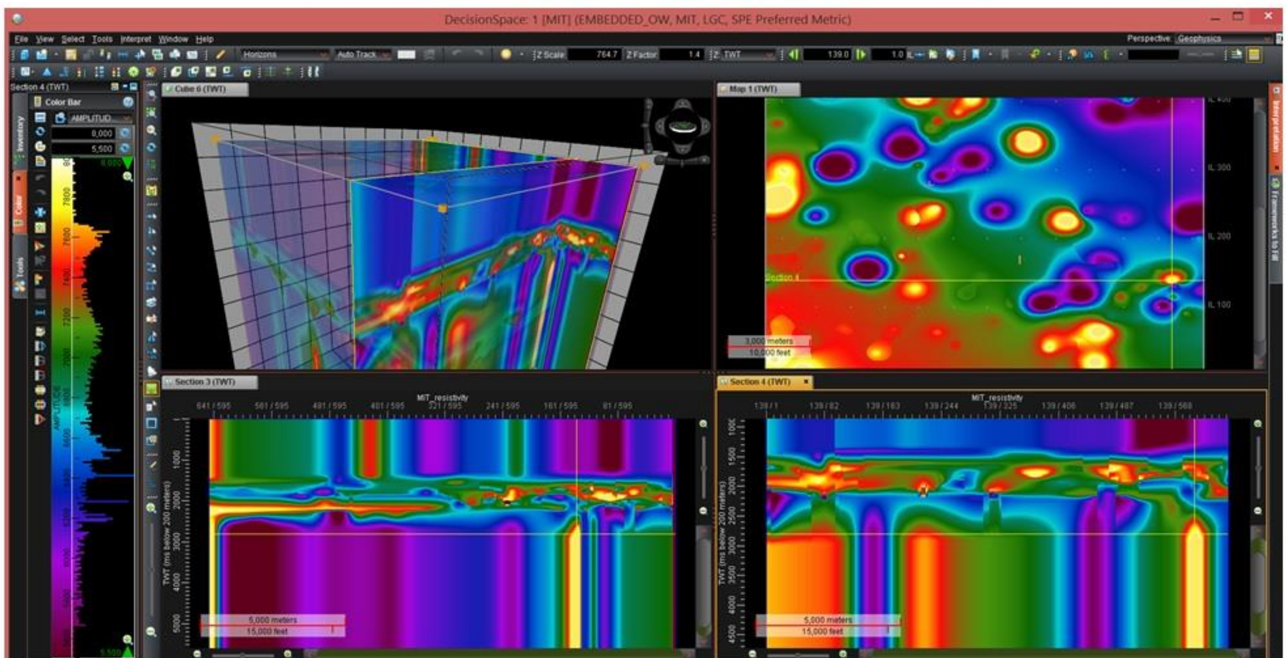


Quick Overview Economics for a 3 square mile area:

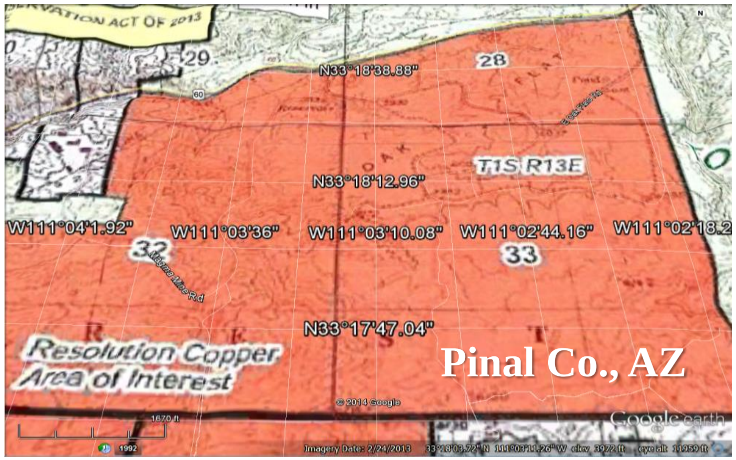
	Area	acre-feet	barrels	MCF @ 15 cf/b	MCF @ 23 cf/b	MCF @ 100 cf/b
Square Miles	3					
Acres	1920					
10 foot sand		19200	148,960,655	2,234,410	3,426,095	14,896,066
50 foot sand		96000	744,803,273	11,172,049	17,130,475	74,480,327
100 foot sand		192000	1,489,606,546	22,344,098	34,260,951	148,960,655
Value 10 foot sand at $2/MCF				$ 4,468,820	$ 6,852,190	$ 29,792,131
Value 50 foot sand at $2/MCF				$ 22,344,098	$ 34,260,951	$ 148,960,655
Value 100 foot sand at $2/MCF				$ 44,688,196	$ 68,521,901	$ 297,921,309

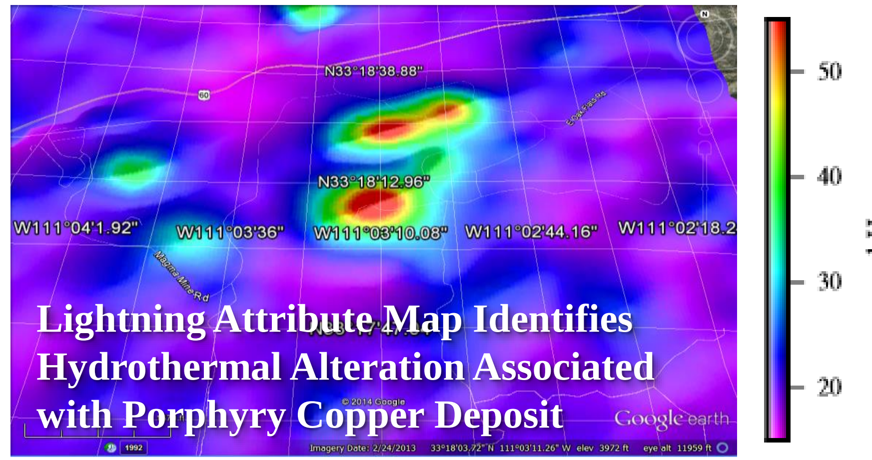
Reefs in Michigan

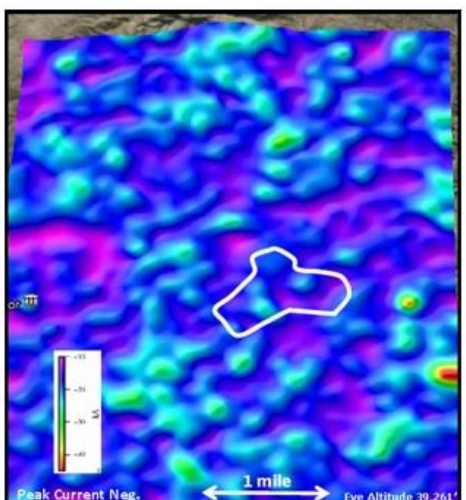




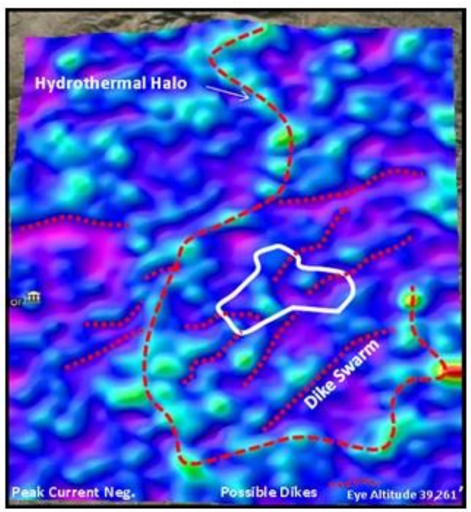
$6 Billion Resolution Copper Mine
Superior, Arizona



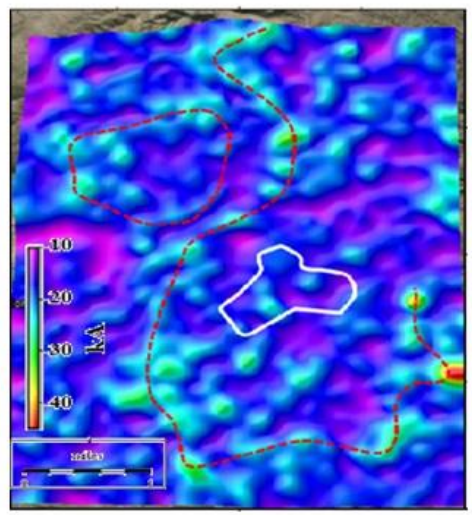




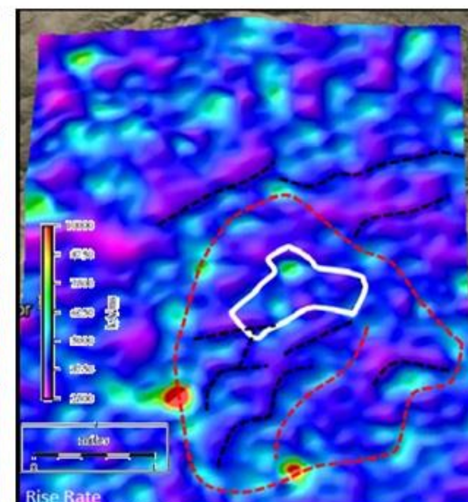
Negative Peak Current



Negative Peak Current



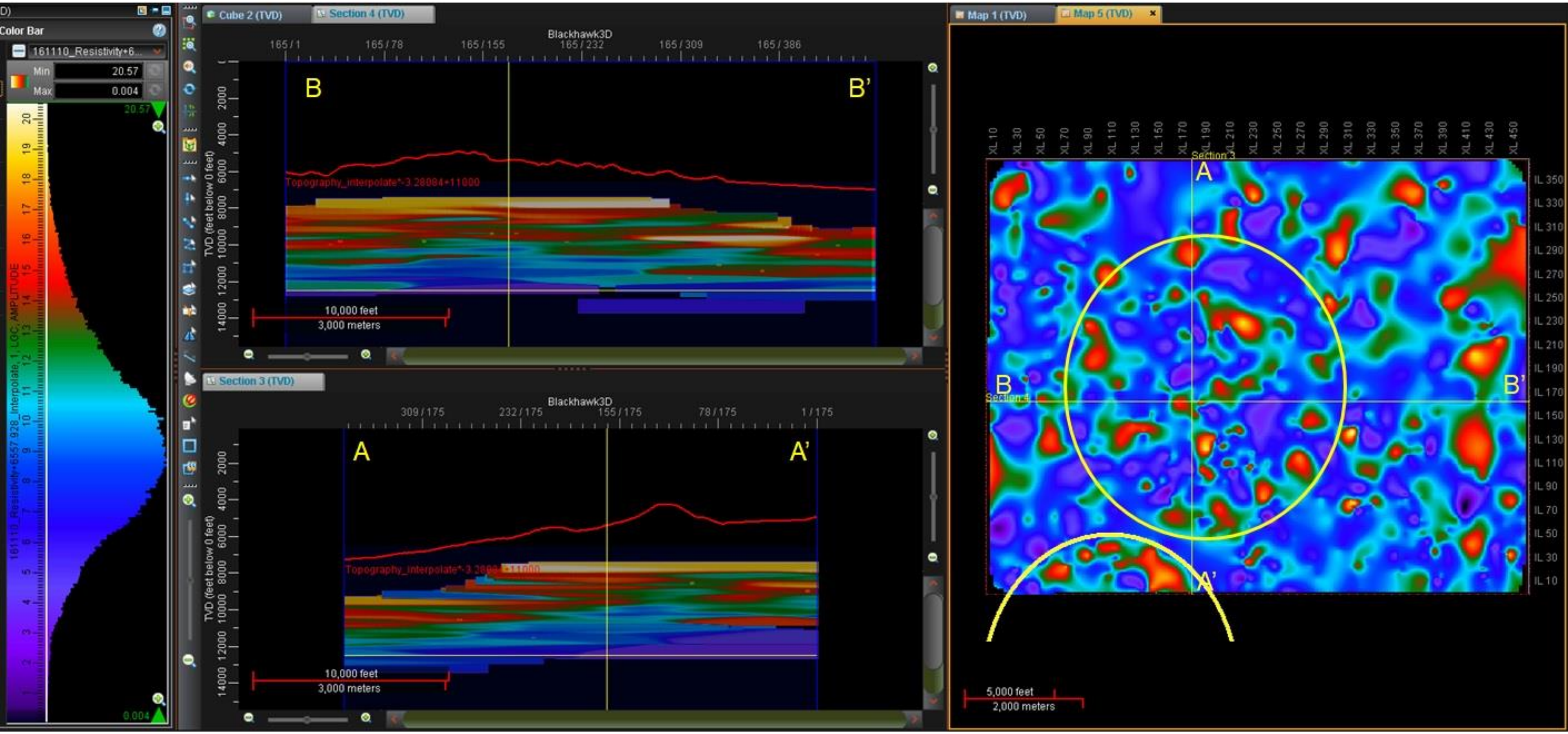
Peak Current



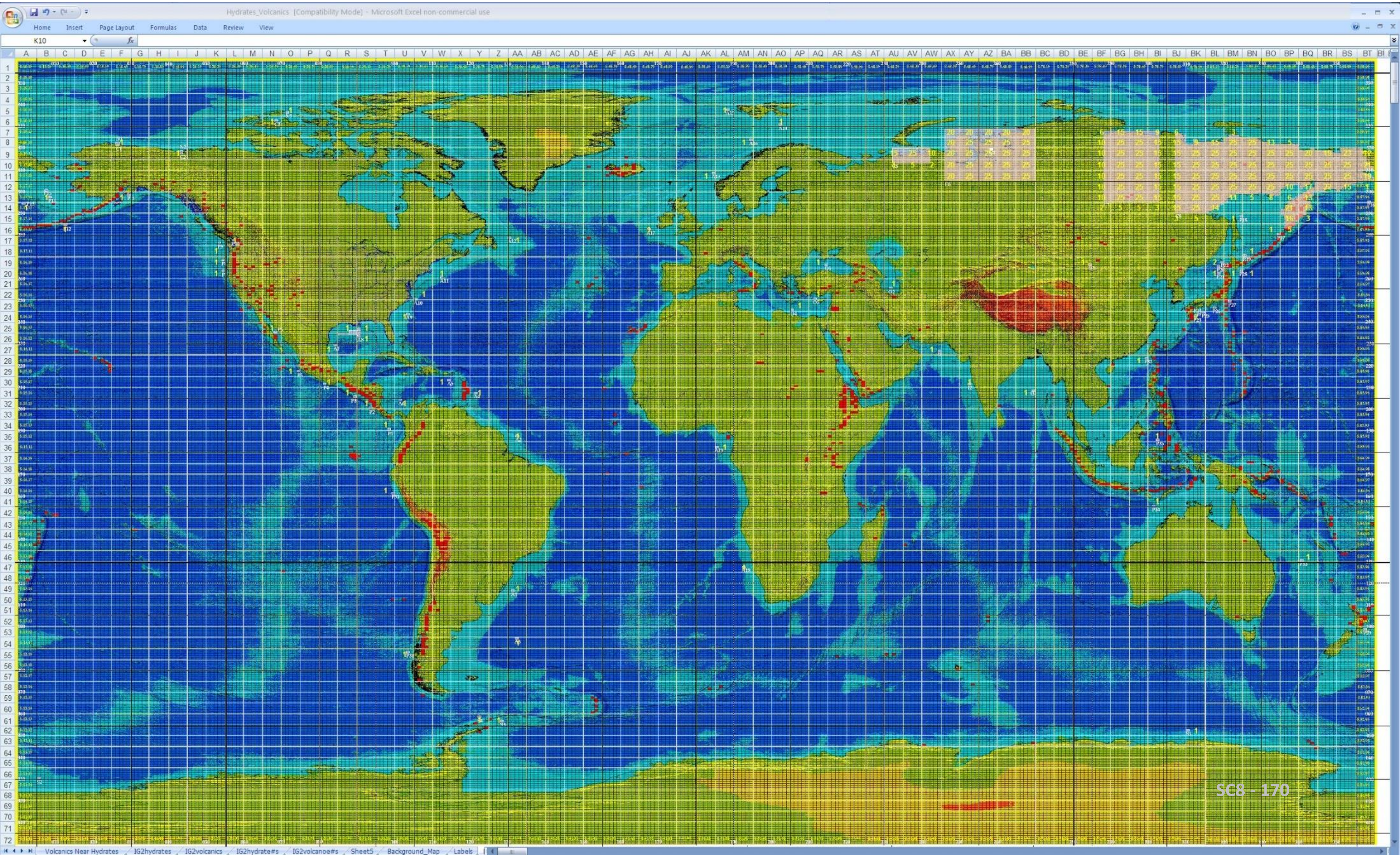
Rise-Rate

Gold Mine, San Bernardino County, CA

Interpretation of Anomaly on Surface Resistivity Map



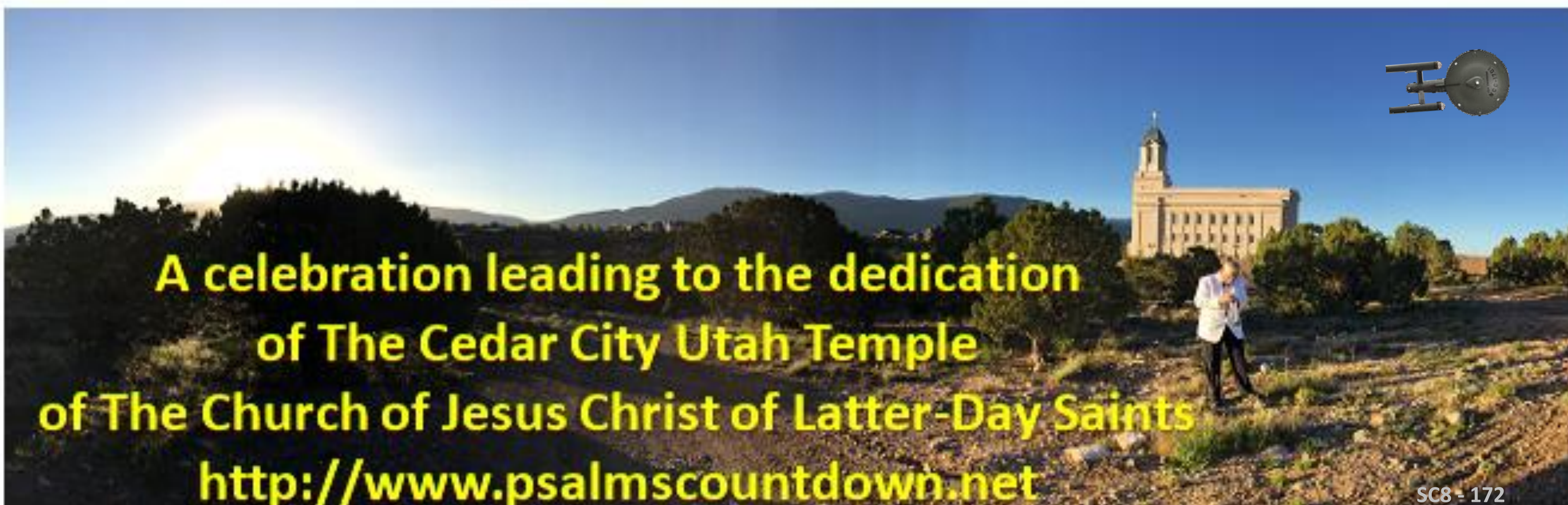
A Future Project: Gas Hydrates



Notes

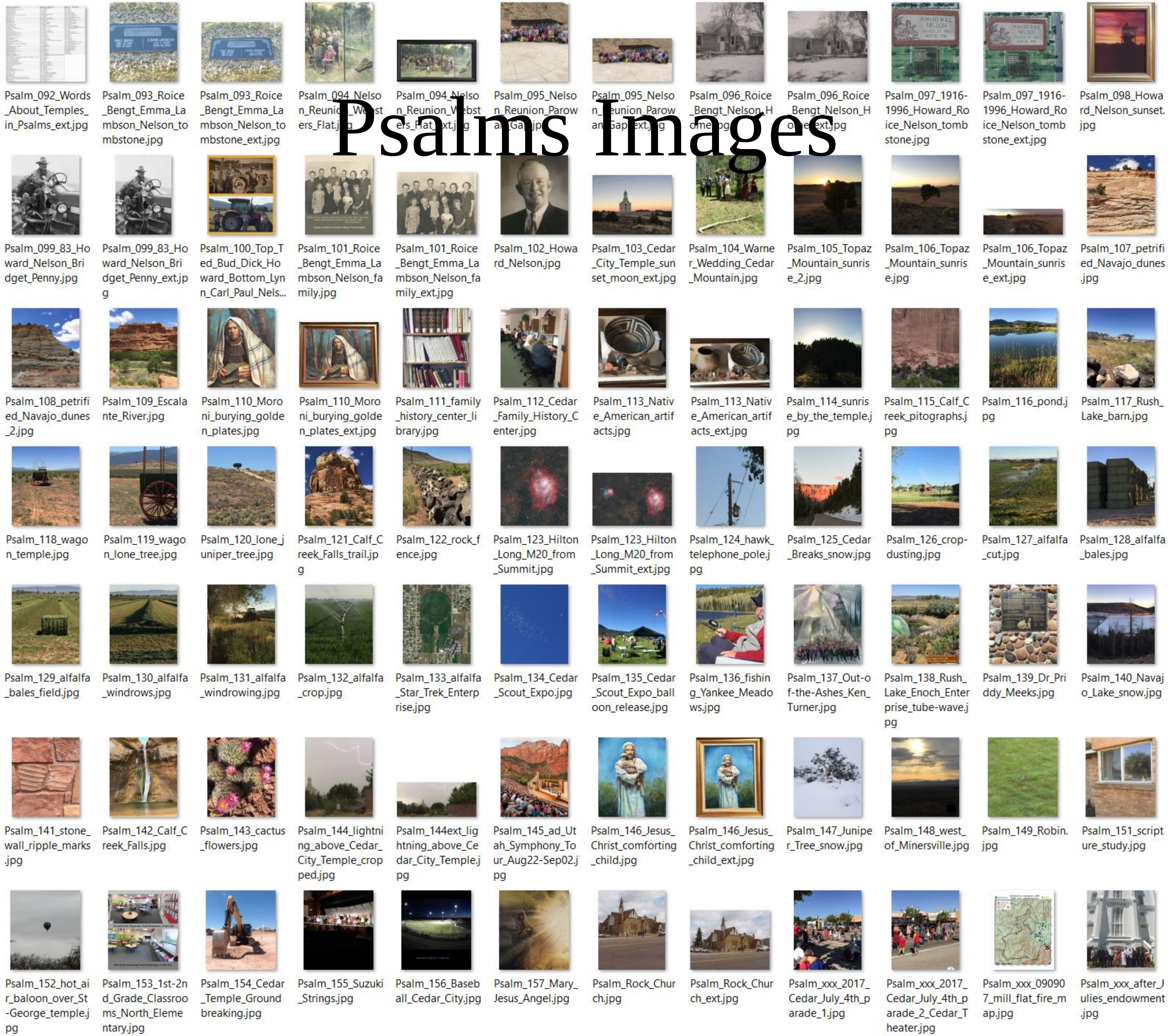
8. Guitar

A musical instrument with usually six strings plucked with a pick or with the fingers.



http://www.walden3d.com/photos/Grandkids_Science_Camps/170802-04_Science_Camp/8_Guitar.pdf

Psalms Images



2017 Science Camp

- What was best about 2017 Science Camp?
  - ____________________________________
  - ____________________________________
  - ____________________________________

- What would be your ideal 2018 Science Camp Theme?
  - ____________________________________
  - ____________________________________
  - ____________________________________