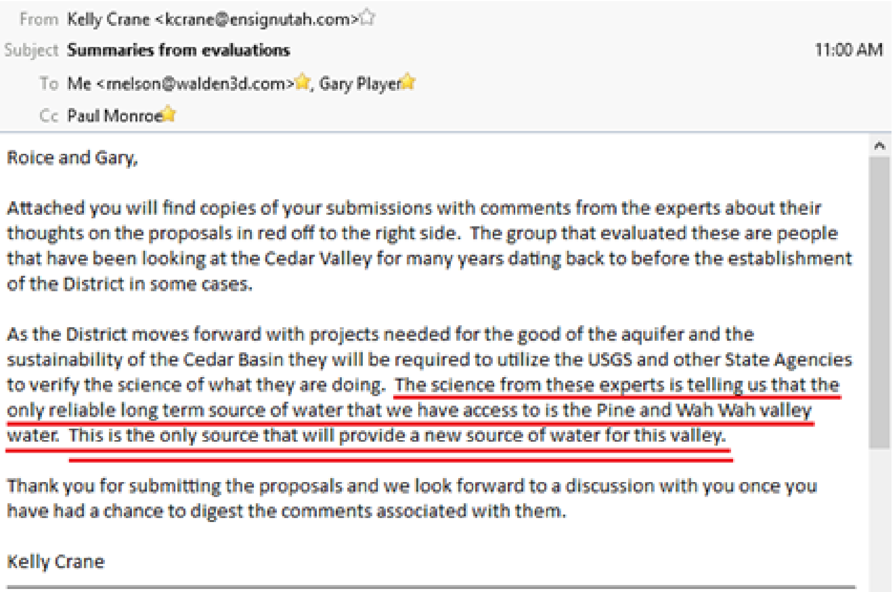
Untapped Aquifers
Cedar Valley Drainage Basin

H. Roice Nelson, Jr. & Gary Farnsworth Player - Iron County Commissioners Field Trip

08 March 2019

Previous Presentation to Iron County Commissioners on 11 July 2016: “The Cedar Valley Aquifer and The Cedar Valley Drainage Basin”
http://www.walden3d.com/IronCounty/CedarValleyWater/pdf/160711_Cedar_Valley_Water.pdf

This presentation, with links, can be downloaded from: http://www.walden3d.com/IronCounty/CedarValleyWater/pdf/190308_Untapped_Aquifers.pdf



From Kelly Crane <kcrane@ensignutah.com>
Subject **Summaries from evaluations** 11:00 AM
To Me <rnelson@walden3d.com>, Gary Player
Cc Paul Monroe

Roice and Gary,

Attached you will find copies of your submissions with comments from the experts about their thoughts on the proposals in red off to the right side. The group that evaluated these are people that have been looking at the Cedar Valley for many years dating back to before the establishment of the District in some cases.

As the District moves forward with projects needed for the good of the aquifer and the sustainability of the Cedar Basin they will be required to utilize the USGS and other State Agencies to verify the science of what they are doing. The science from these experts is telling us that the only reliable long term source of water that we have access to is the Pine and Wah Wah valley water. This is the only source that will provide a new source of water for this valley.

Thank you for submitting the proposals and we look forward to a discussion with you once you have had a chance to digest the comments associated with them.

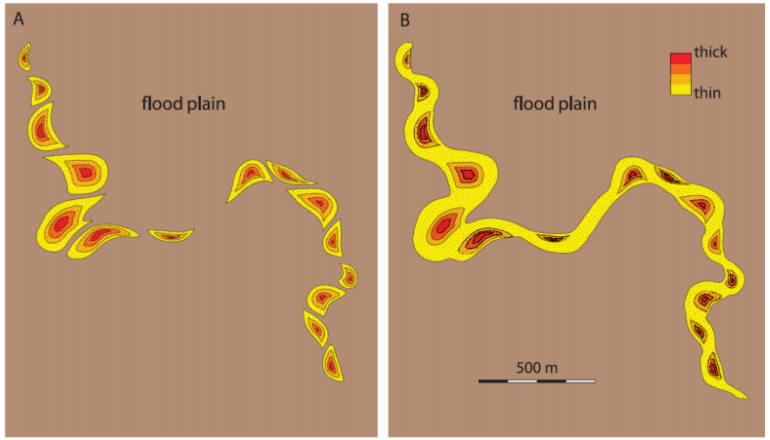
Kelly Crane

Discussing Water Rights, A Western Pastime

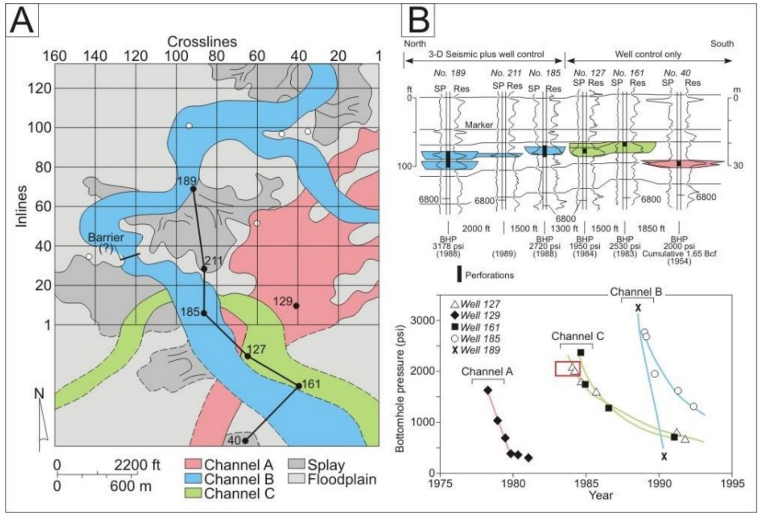
Fluvial Systems and Aquifers,

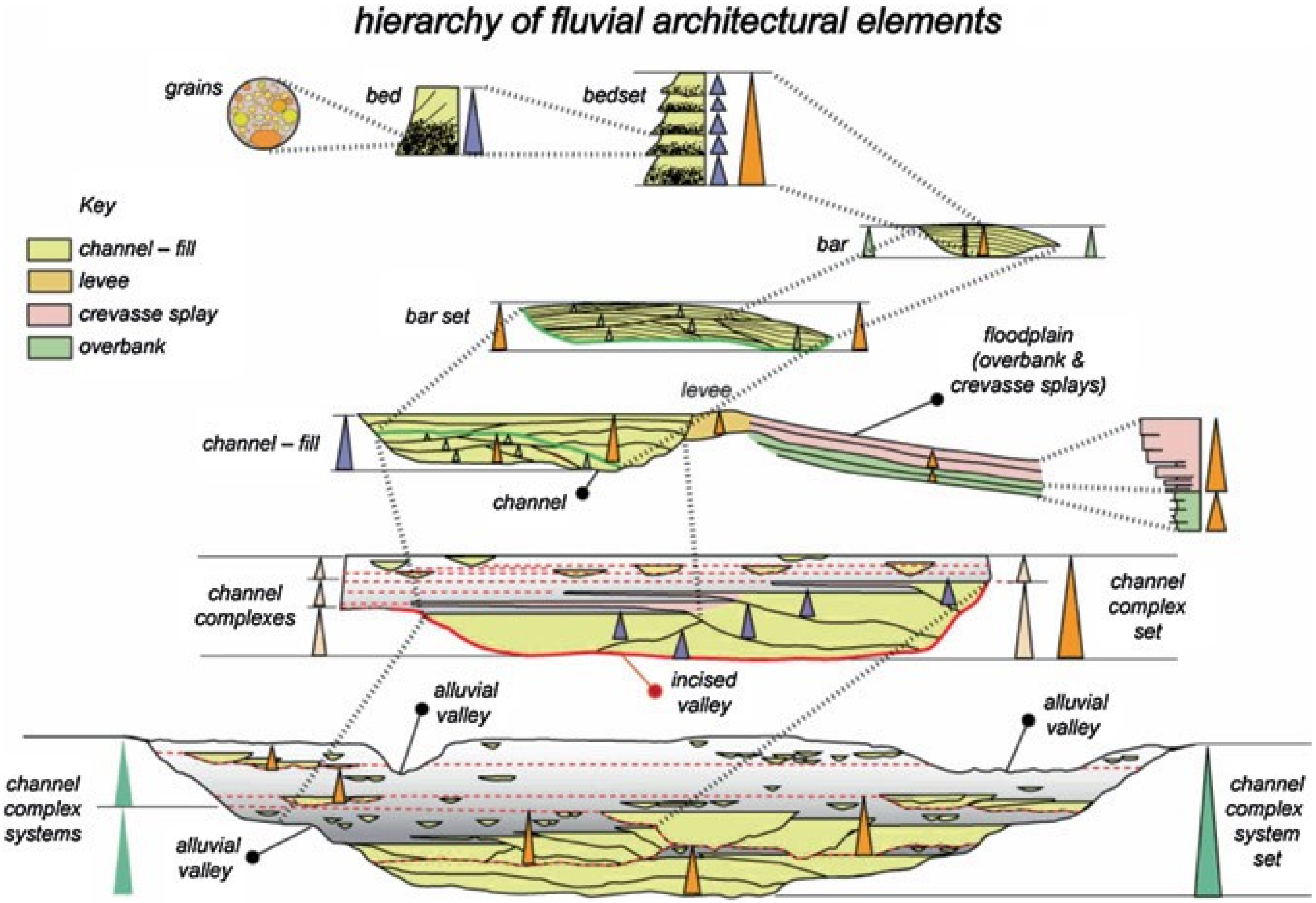
like the Cedar Valley Aquifer, have complex geometries

Walden 3–D, Inc.
Continuing to make a positive difference!



Flow Processes and Sedimentation in a Low-Sinuosity High Net-Sand Content Fluvial Channel Belt: 3D Outcrop Study of the Cedar Mountain Formation, Utah, Bradley Nuse, http://inside.mines.edu/UserFiles/File/CoRE/Thesis_Dissertation/Nuse_Bradley.pdf



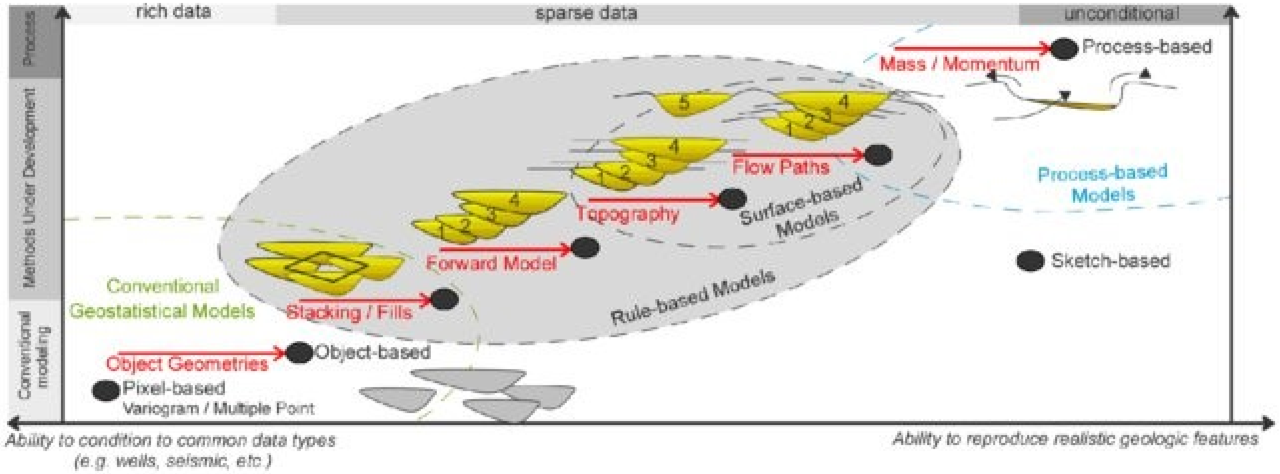


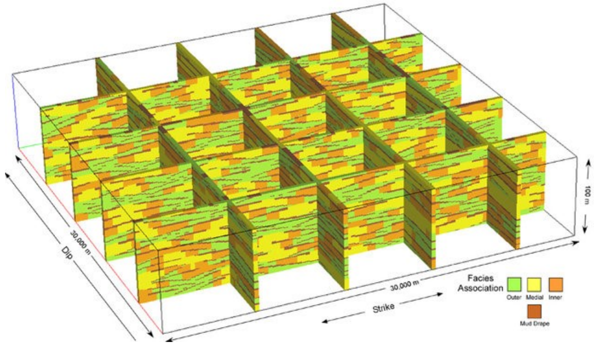
Chapter 2, The Facies and Architecture of Fluvial Systems, Figure 2.2, page 11.

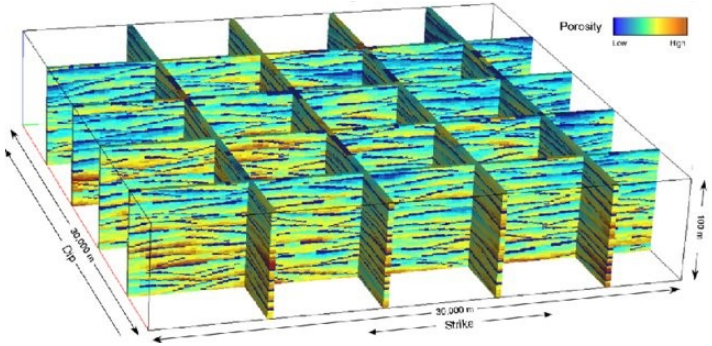
A 3-D seismic case history evaluating fluvially deposited thin-bed reservoirs in a gas-producing property, Bob A. Hardage, et. al., Geophysics, Nov. 1994.

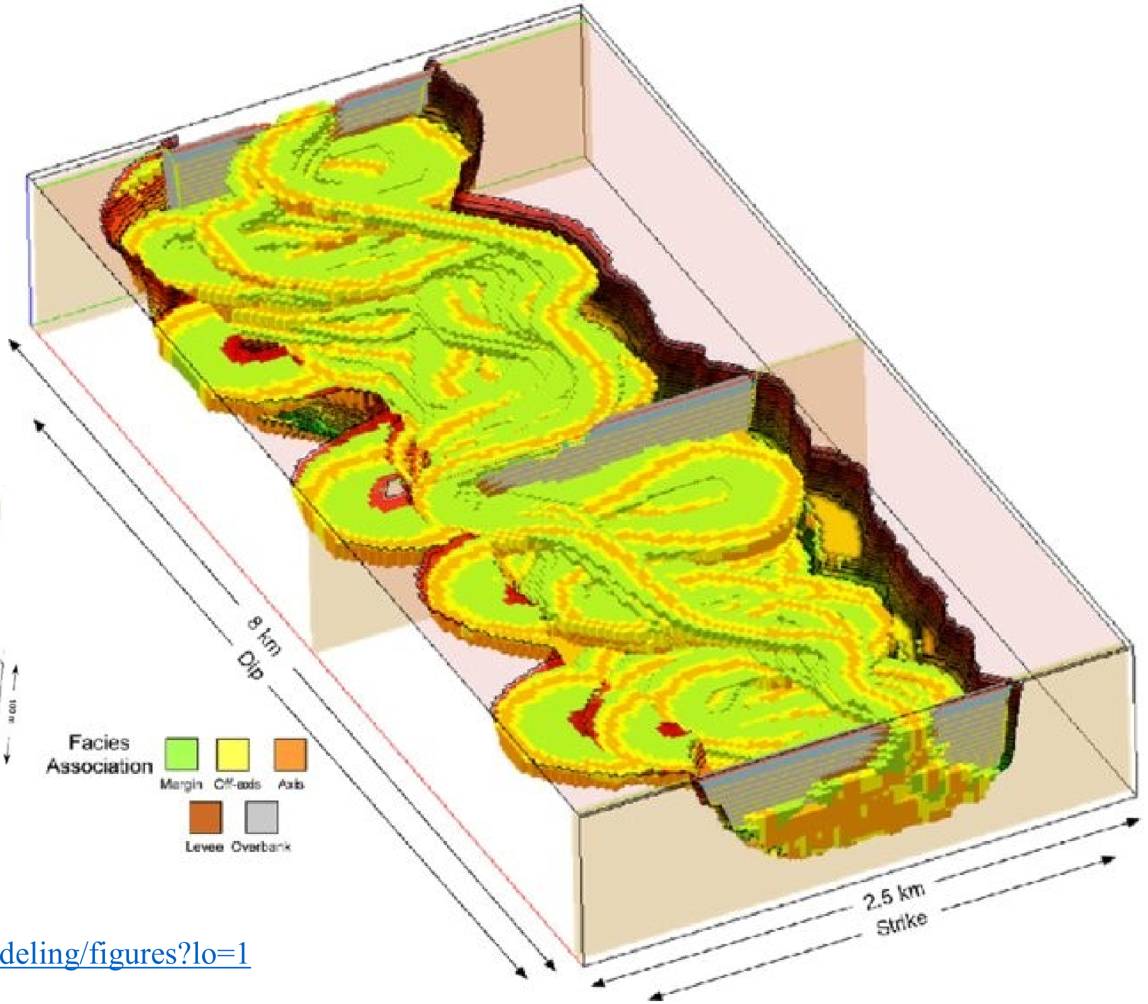
Aquifers in the first 600-800 feet of the Cedar Valley Aquifer are Complex

Walden 3-D, Inc.
Continuing to make a positive difference!







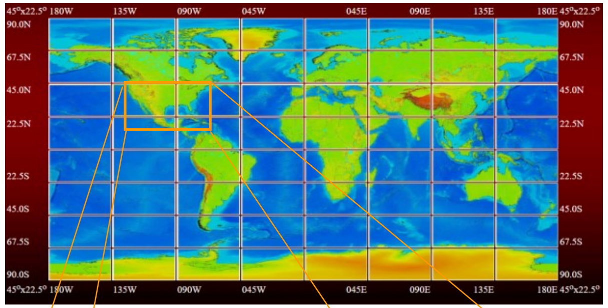


https://www.researchgate.net/publication/303960851_Stratigraphic_rule-based_reservoir_modeling/figures?lo=1

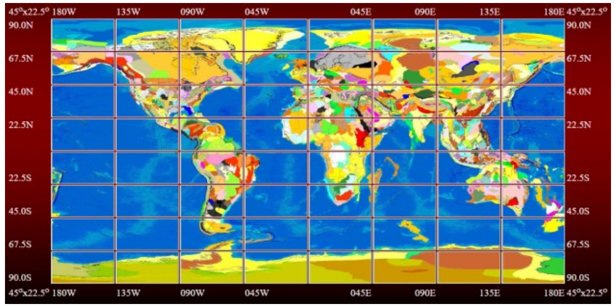
Infinite Grid^{sm} Spatial Index

Walden 3-D, Inc.
Continuing to make a positive difference!

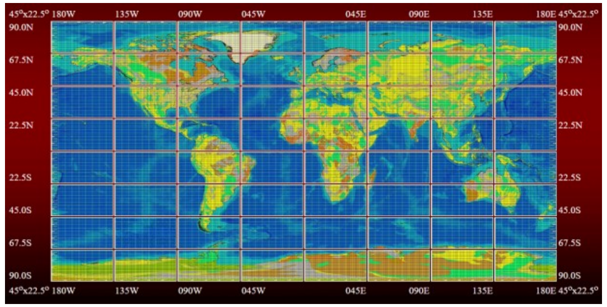
In order to know what is available there needs to be context, and regarding water, this context is provided by a spatial index.



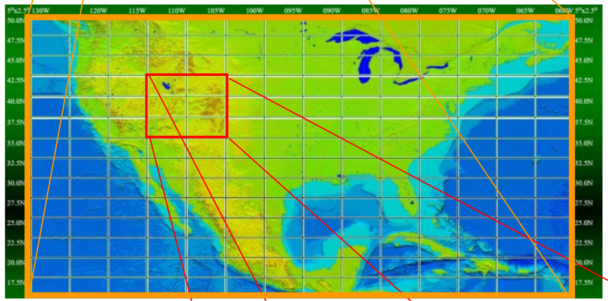
IG1, 45°x22.5°: Topography



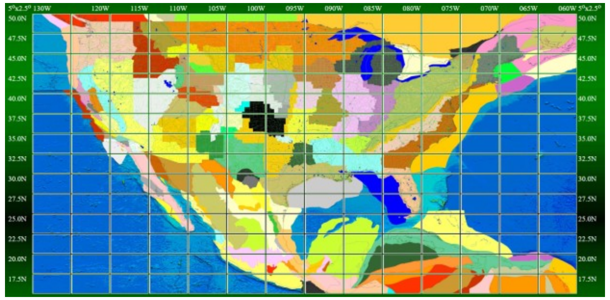
IG1: Basins



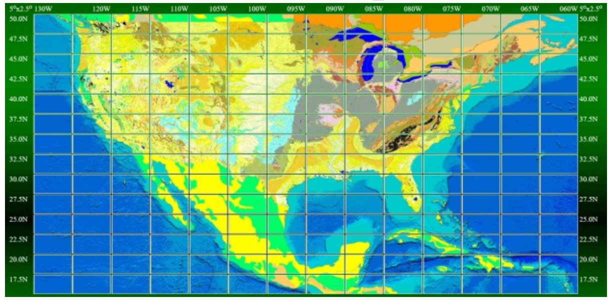
IG1: Outcrops



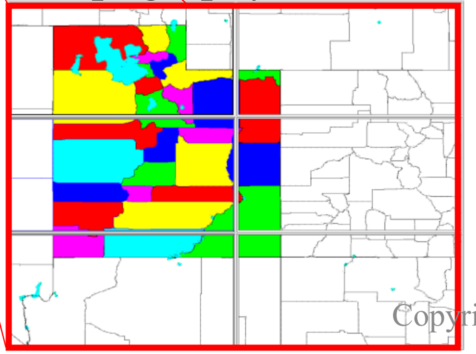
IG2, 5°x2.5°: Topography



IG2: Basins

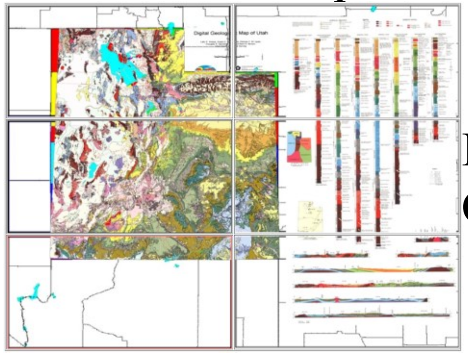


IG2: Outcrops



IG2, 5°x2.5°: Utah Counties

http://www.walden3d.com/IronCounty/ig/index.html

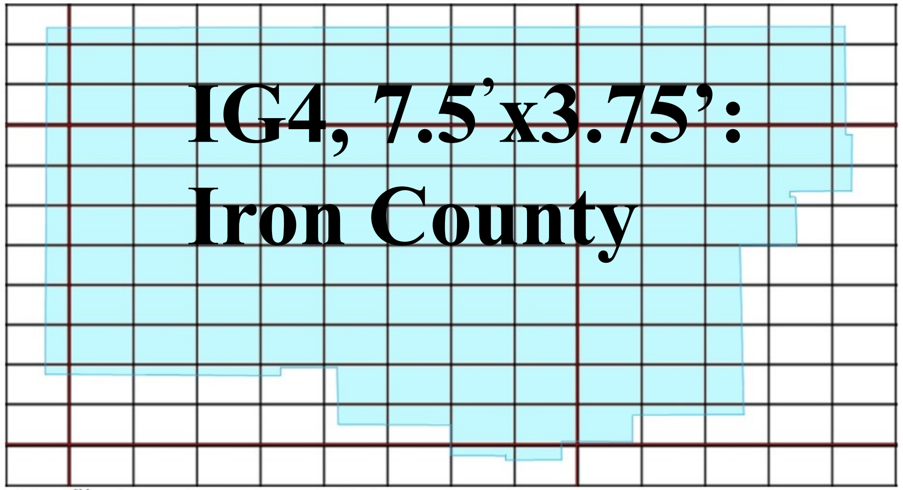


IG2: Utah Outcrop Geology

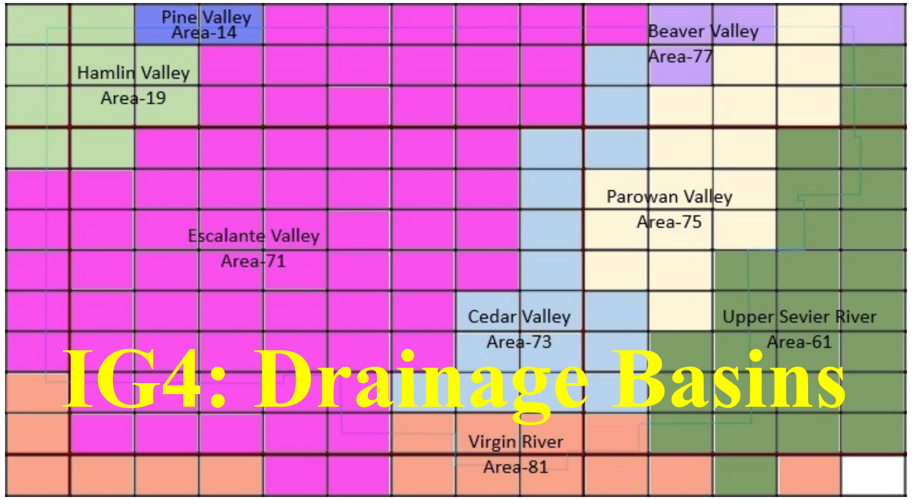
Iron County Indexed with IG4

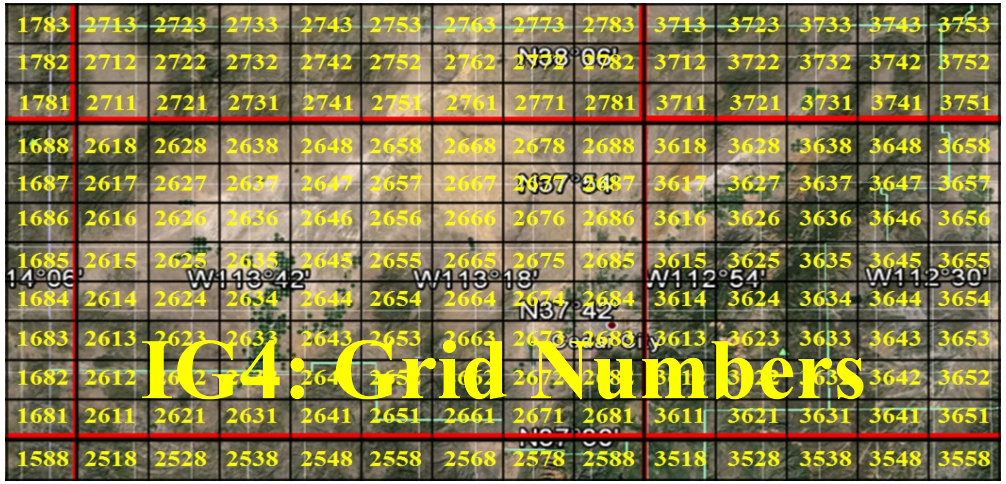
Walden 3-D, Inc.
Continuing to make a positive difference!

The Infinite Grid^{sm} provides a way to keep track of spatial relationships down to the size of an i-PAD.



Infinite Grid[SM] Level 4, or IG-4, based on 8x8 7'30" x 3'45" grid cells.





http://www.walden3d.com/IronCounty/ig/IronCounty/index.html

Walden 3-D, Inc.
Continuing to make a positive difference!

Cedar Aquifer (white) is a subset of the Cedar Valley Drainage Basin (black)

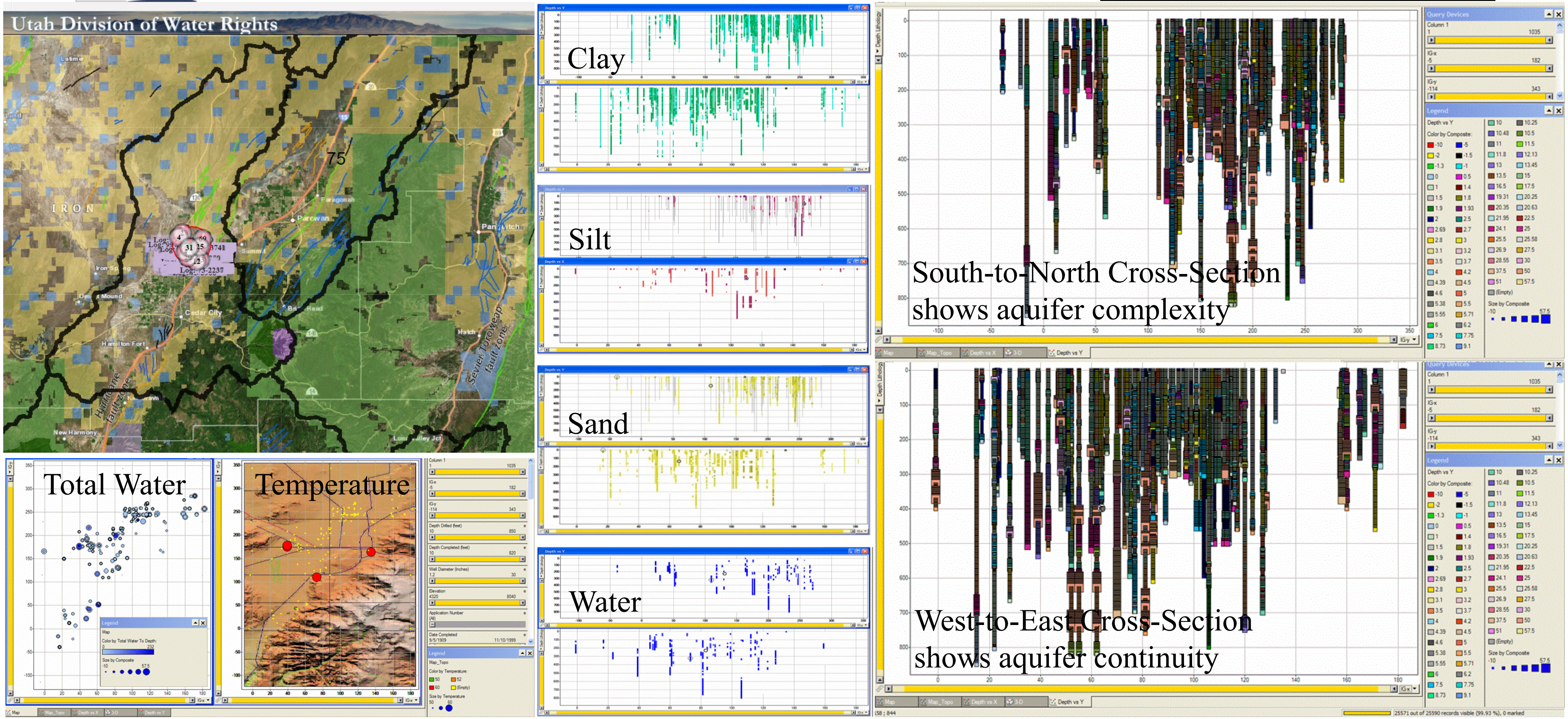
The Cedar Valley Aquifer is a subset of the Cedar Valley Drainage Basin, and is the white area on map to the left.

Black areas are referred to as “Bedrock” areas.

http://www.walden3d.com/IronCounty/ig/IronCounty/IC_CVA.html

2006 Study: 145 wells, deepest 820 feet deep

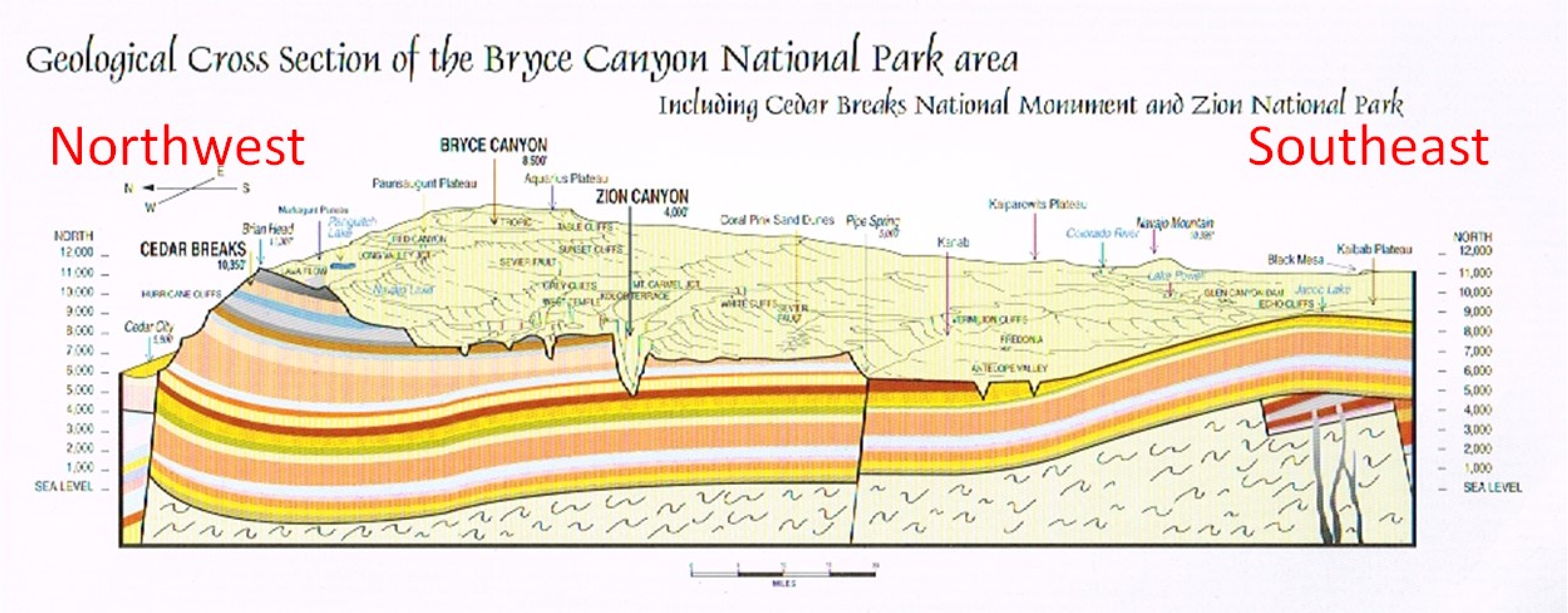
Walden 3-D, Inc.
Continuing to make a positive difference!



http://www.walden3d.com/IronCounty/CedarValleyWater/060423/index.html

Cross-Sections Show Trends

Walden 3-D, Inc.
Continuing to make a positive difference!



In Cedar we can drive up the Cedar Canyon to study geology faulted down underneath the valley by the Hurricane Fault.

http://www.walden3d.com/IronCounty/ig/IronCounty/IC_Geologic_Map.html

Seismic & Geologic Cross-Sections in Cedar Valley

Walden 3-D, Inc.
Continuing to make a positive difference!

Geology of Cedar Valley, Iron County, Utah 7

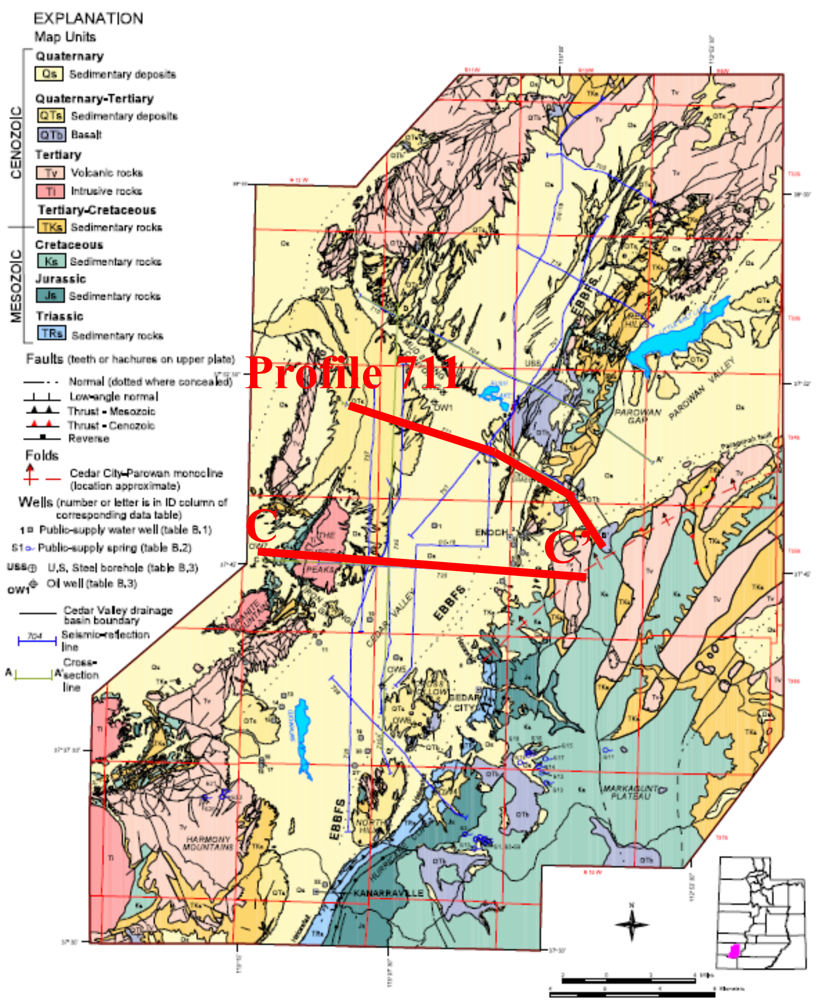
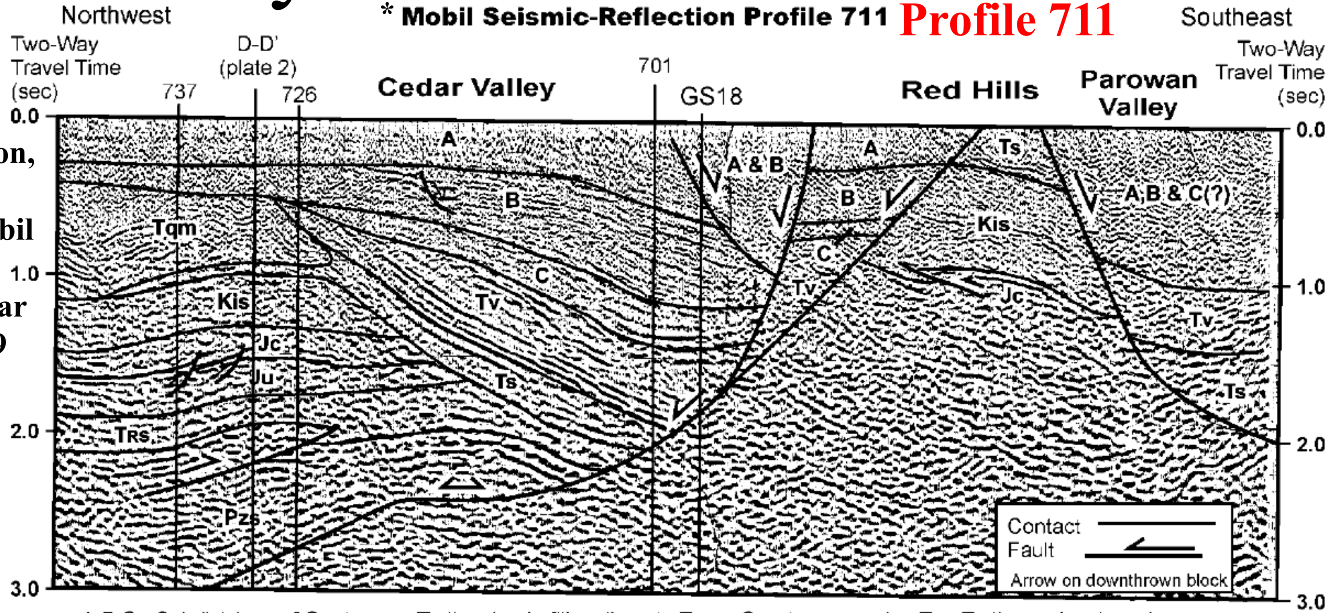
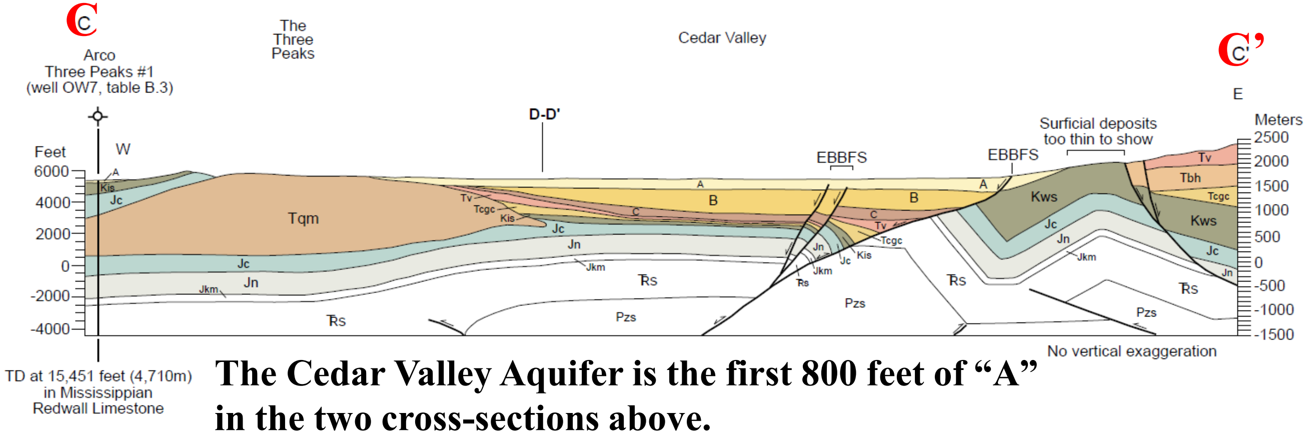


Figure 6. Simplified geologic map of Cedar Valley drainage basin and adjacent areas. EBBFS is eastern basin-bounding fault system. See figure 5 for stratigraphic column, and appendix A for correlation of map units with those on plates 1 and 2.

***Roice Nelson, geophysicist running Mobil Oil seismic crew in Cedar in 1978-1979**



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; TRs - Triassic sedimentary rocks; Pzs - Paleozoic sedimentary rocks.



The Cedar Valley Aquifer is the first 800 feet of "A" in the two cross-sections above.

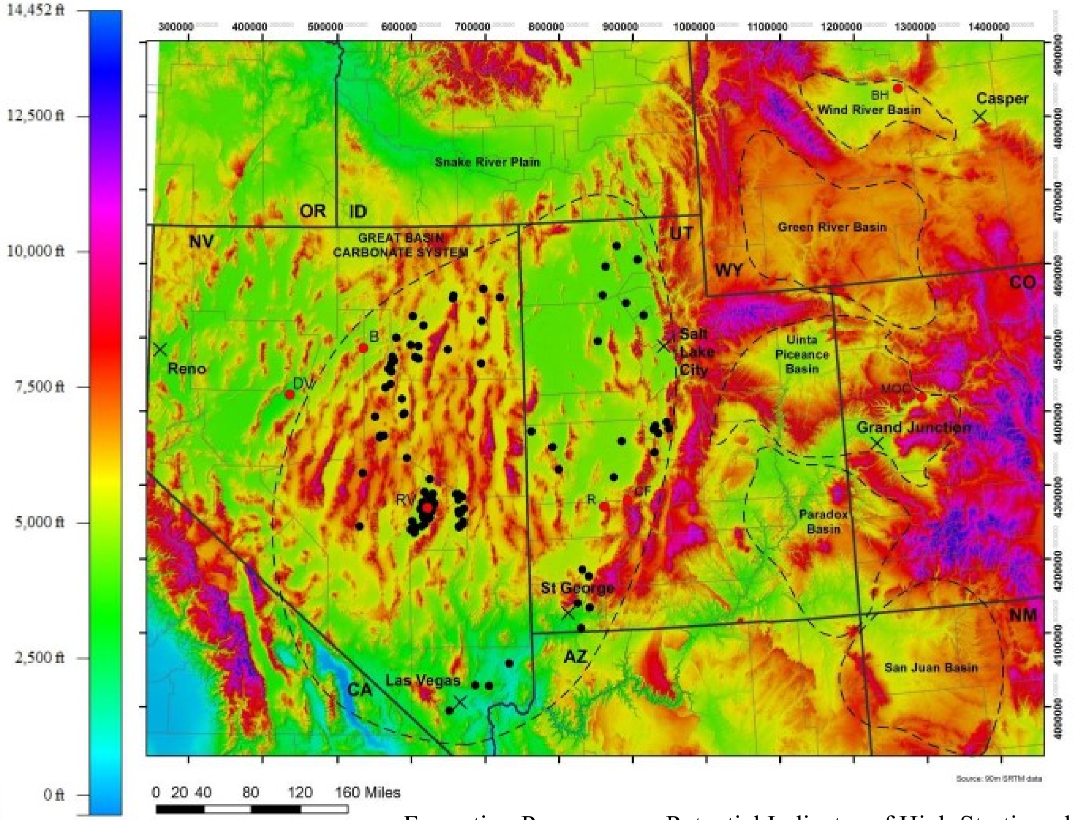
The Geology of Cedar Valley, Iron County, Utah, and its relation to ground-water conditions, https://ugspub.nr.utah.gov/publications/special_studies/ss-103.pdf

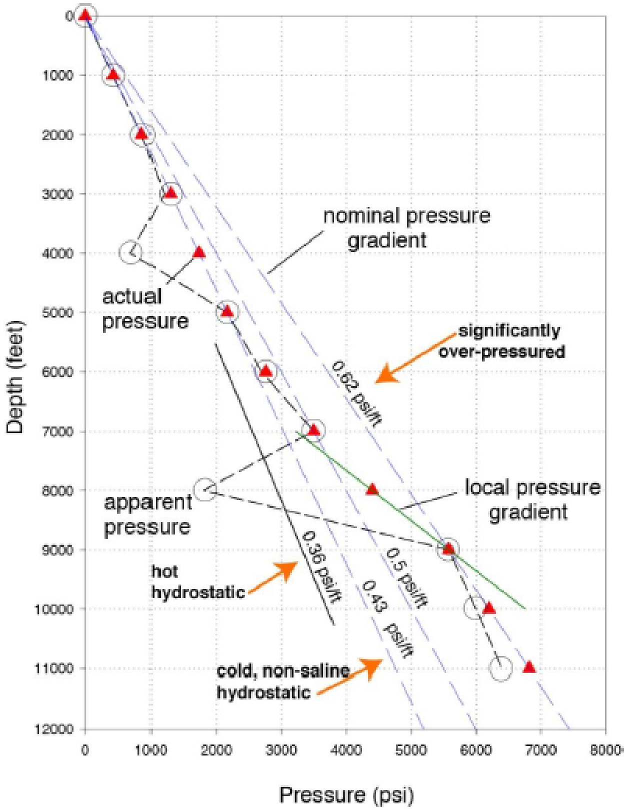
Lower Hydrostatic Pressure

Walden 3-D, Inc.
Continuing to make a positive difference!

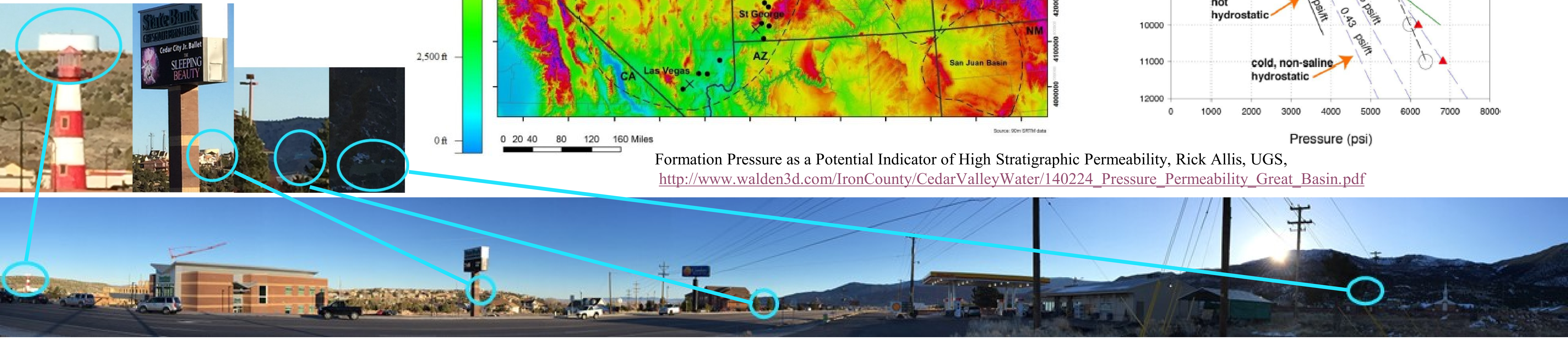
The Southern Great Basin has lower than normal hydrostatic pressure, which like when there is low hydrostatic pressure in a city water system, means there is a leak in the system.

The leak is Grand Canyon.



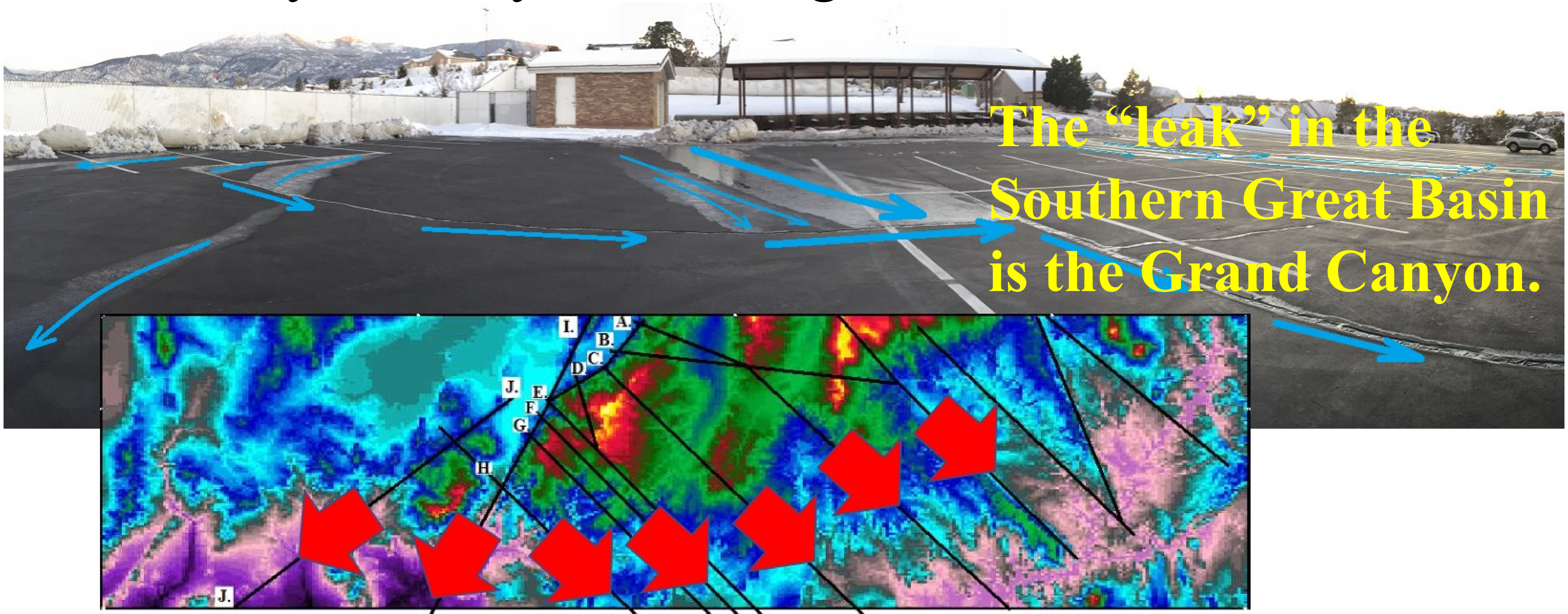


Formation Pressure as a Potential Indicator of High Stratigraphic Permeability, Rick Allis, UGS,
http://www.walden3d.com/IronCounty/CedarValleyWater/140224_Pressure_Permeability_Great_Basin.pdf



Water Flows
By Gravity and Along Cracks

Walden 3-D, Inc.
Continuing to make a positive difference!



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

I.

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

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

See http://www.walden3d.com/IronCounty/CedarValleyWater/ #8. at bottom of page.

Water & the Potentiometric Surface

Walden 3-D, Inc.
Continuing to make a positive difference!

Cedar Mountain water flows east, away from Cedar Valley, as shown by the ice flows just past the landslide area up Cedar Canyon

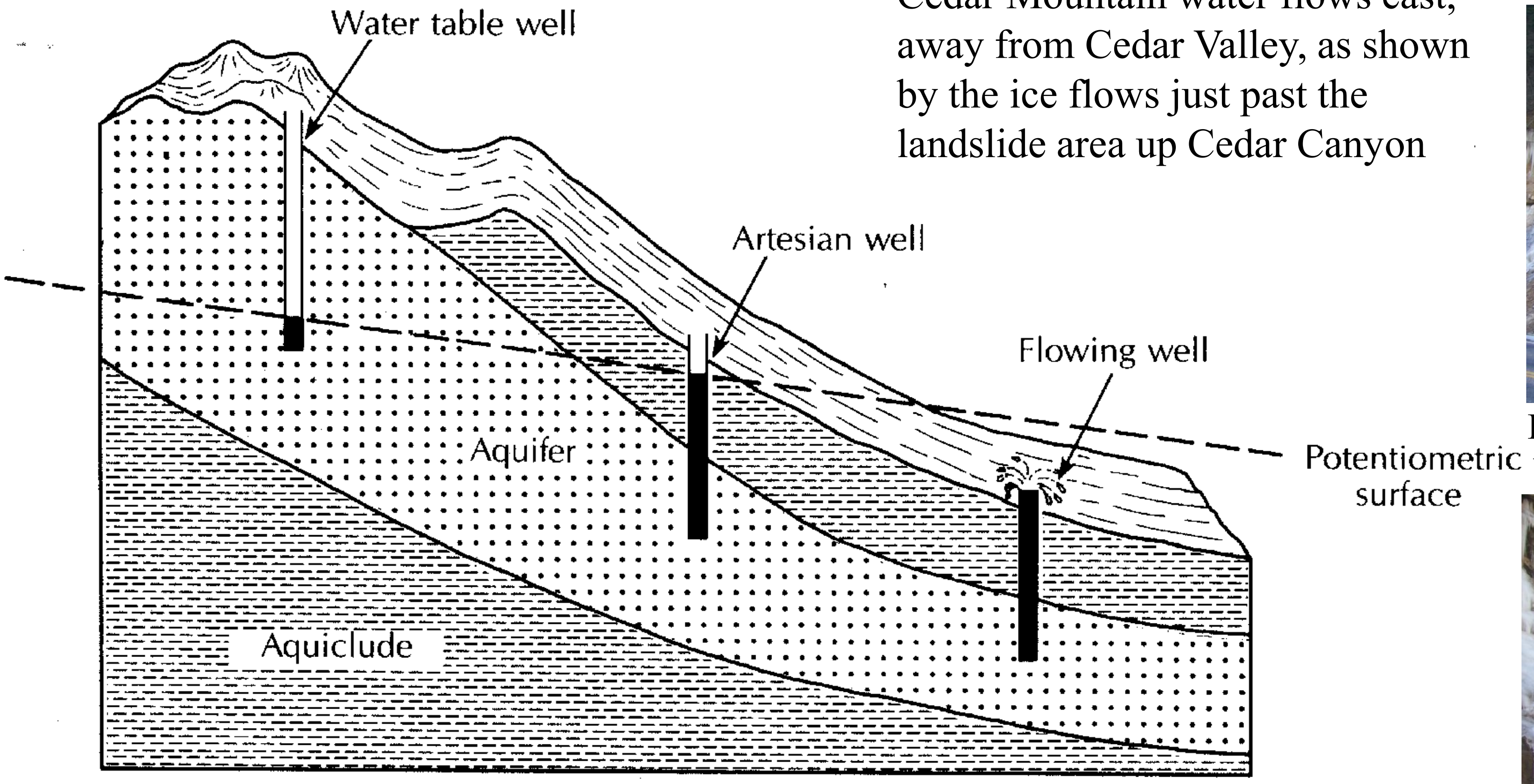


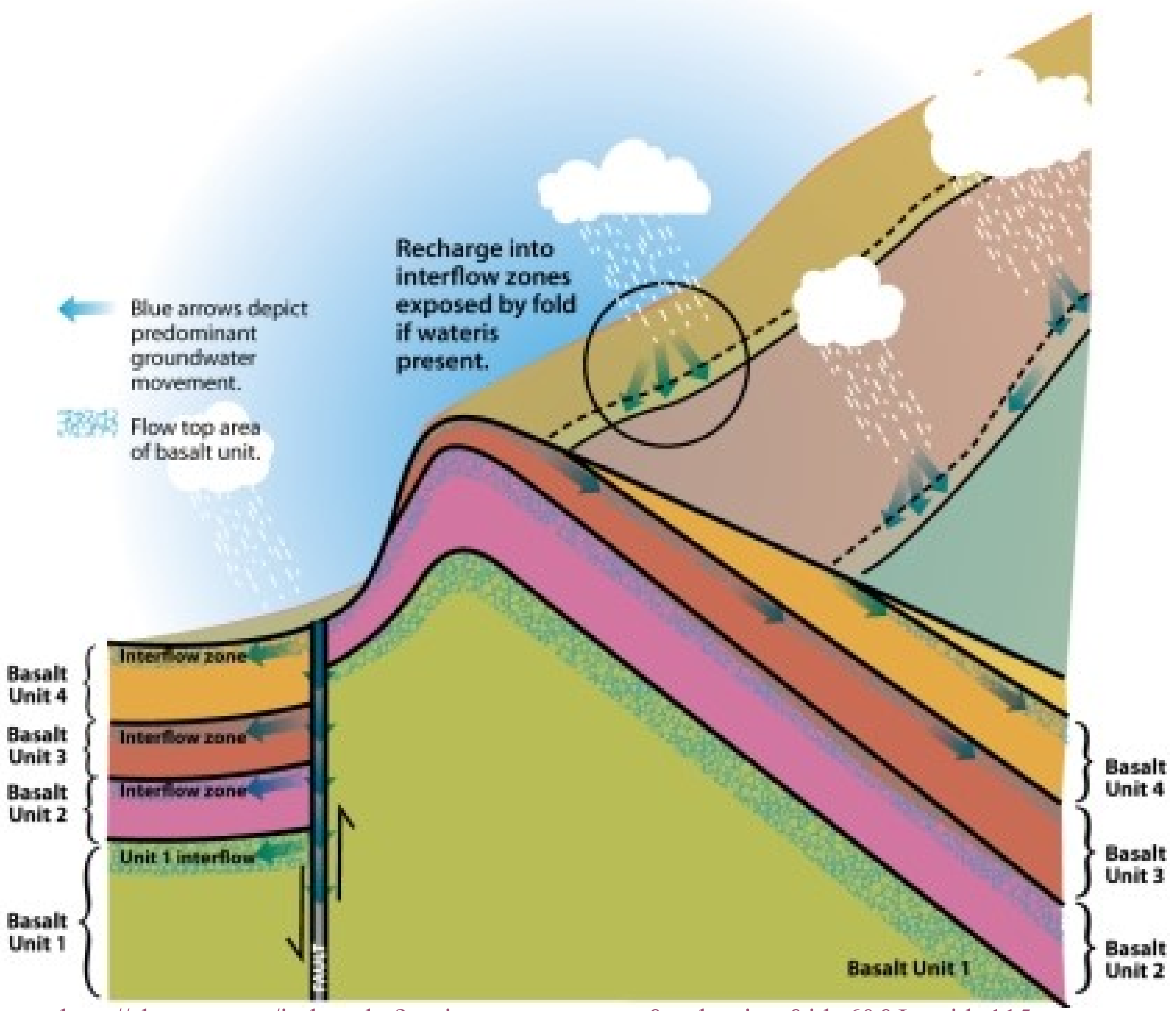
FIGURE 4.21 Artesian and flowing well in confined aquifer.

https://www.slideshare.net/VISHNUBARUPAL/types-of-aquifer-by-bablu-bishnoi-65855846, slide 16 of 24.

Both photos west side of Highway 14
No ice flows on east, due to east dip.

Photos by Gary F. Player

Faults & Dip Force Water Flows from Cedar Mountain East & South

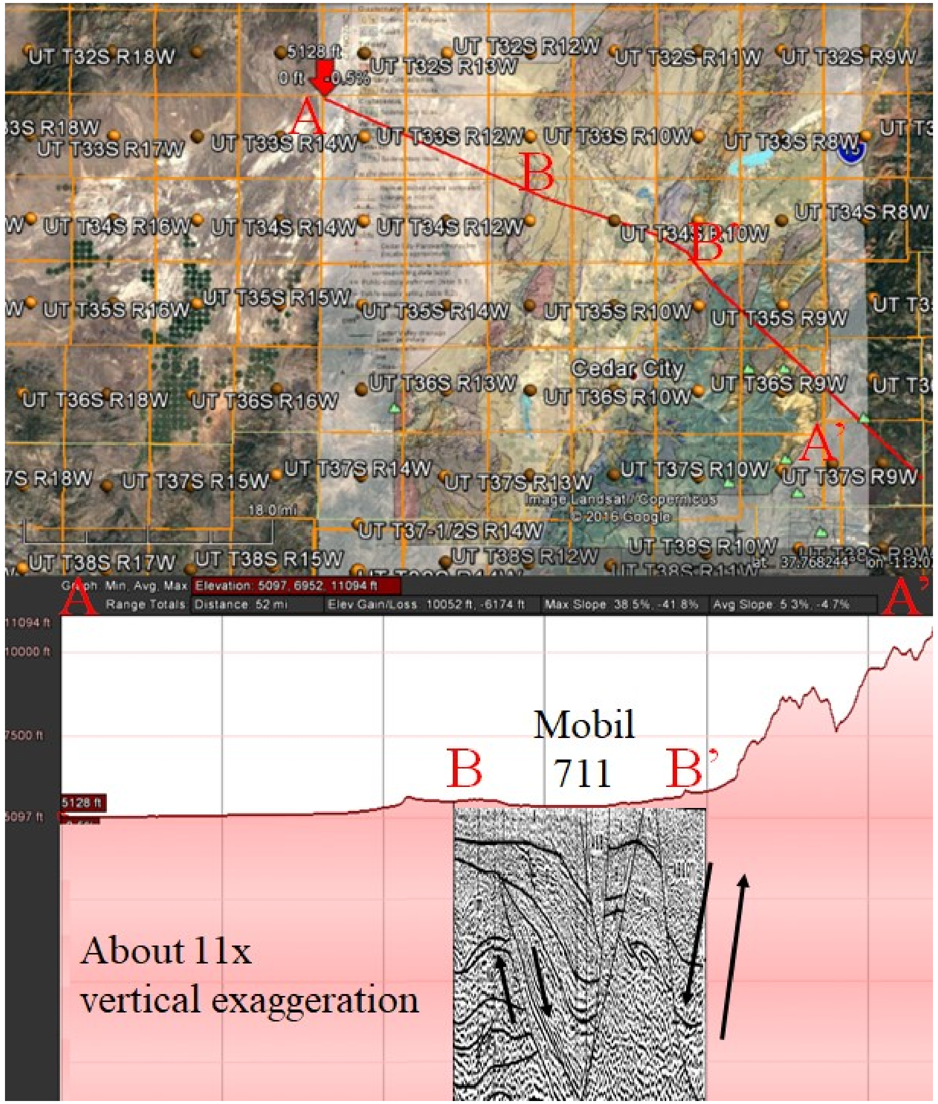


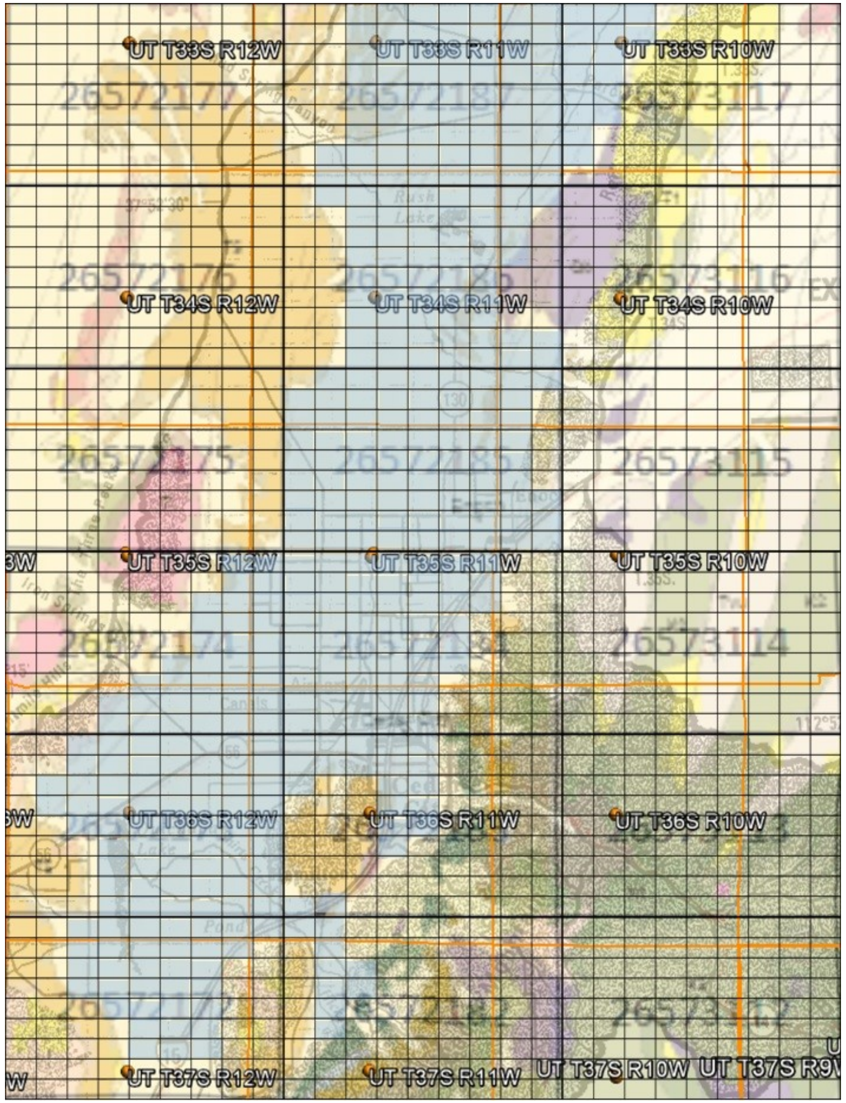
http://cbgwma.org/index.php?option=com_content&task=view&id=60&Itemid=115

- Bedrock dips to the east about 10 degrees;

- Faults bounding the valley disrupt baseflow, especially into the Cedar Valley basin fill aquifer.
- Aquifer overproduction is very shallow (less than 800 feet depth) and except for water flowing down Coal Creek and Fiddler's Canyon these shallow layers are isolated from mountain recharge by layers of clay and the potentiometric surface dip.

The Overproduced Cedar Valley Aquifer





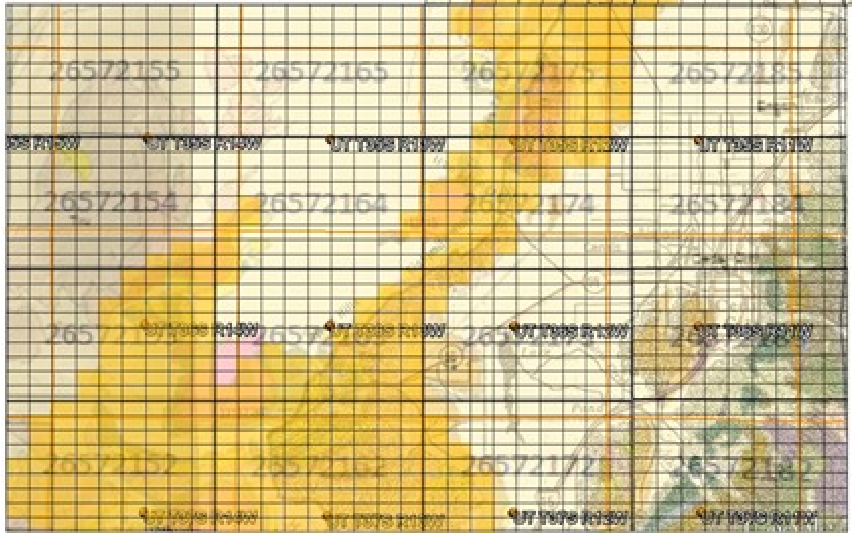
- Map and cross-section to the far left, show configuration under the Cedar Valley aquifer.
- Almost all water wells are less than 800 feet deep.
- With over a mile of sediment, only the first 800 feet have been tested with water wells and produced.
- The Cedar Valley Aquifer is shown by the blue colored squares on map just to left.
- Each colored square is about ~0.36 square miles in size. There are 421 cells covering the Cedar Valley Aquifer, or 152 sq. miles.

http://www.walden3d.com/IronCounty/ig/IronCounty/IC_CVA.html

The Untapped Quartz Monzonite & Cretaceous Aquifers

Walden 3-D, Inc.
Continuing to make a positive difference!

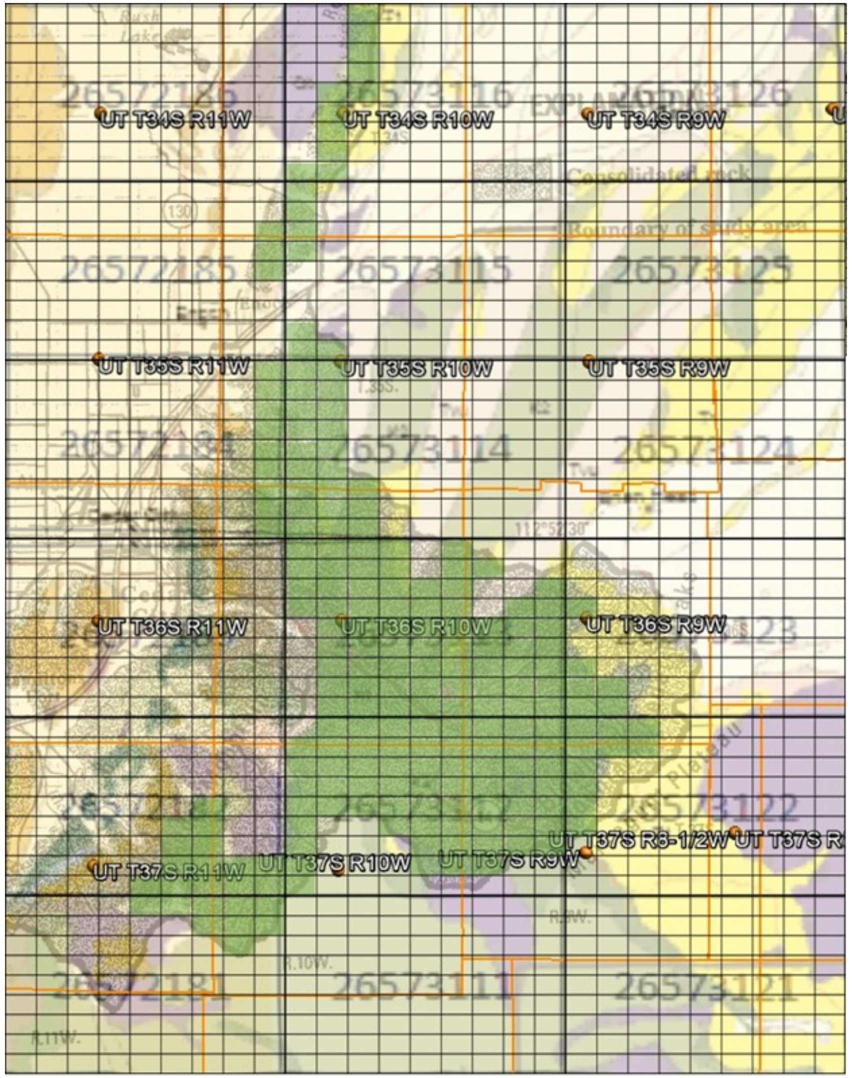
The Fractured Quartz Monzonite Aquifer is shown by the orange colored squares on the map to the right and below.



Each gold colored square is about ~0.36 square miles in size. There are 681 cells, or 245 square miles of untapped quartz monzonite aquifer.

To the right, Cretaceous Aquifer is shown by the green colored map squares.

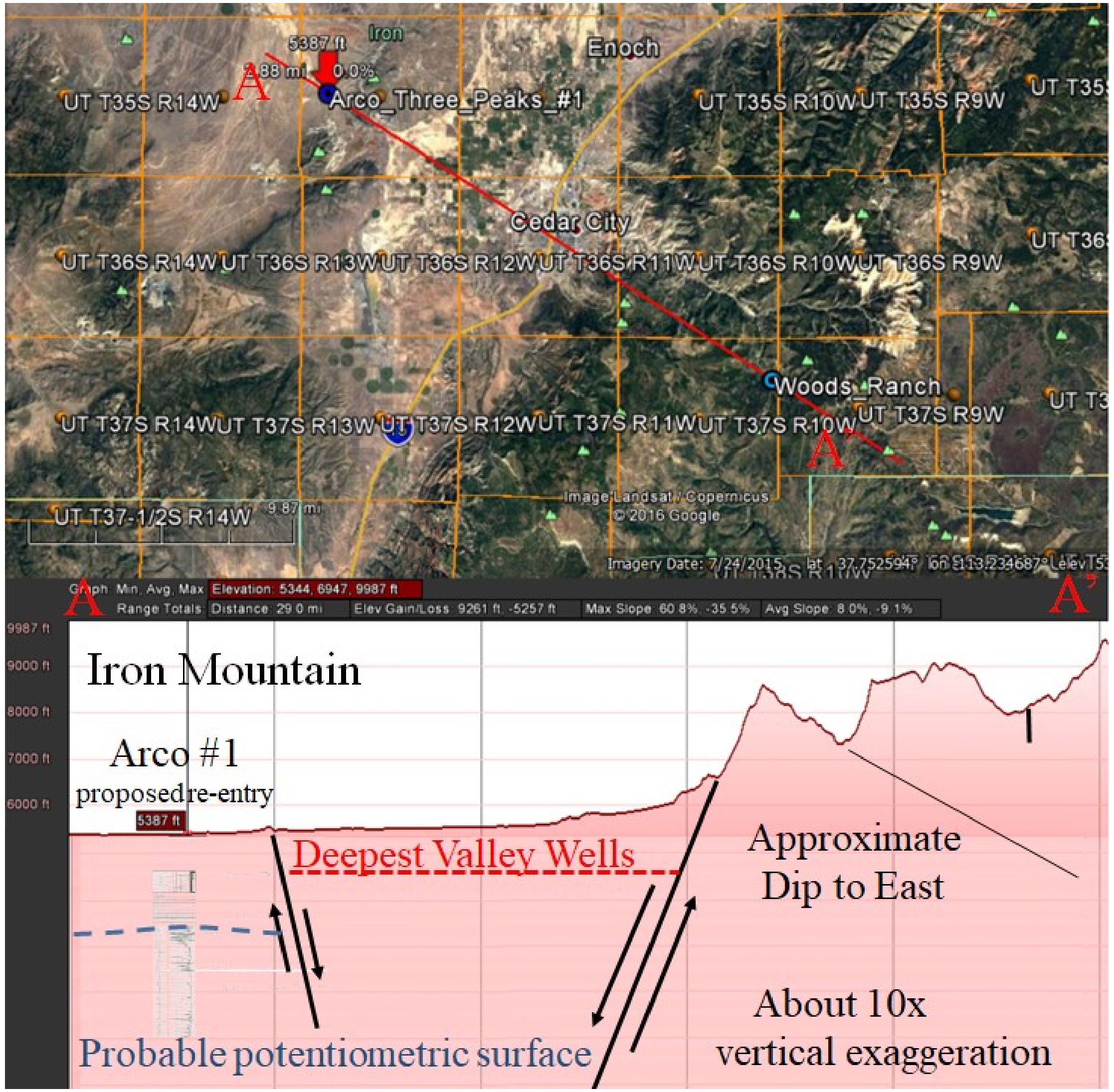
Each colored square is about ~0.36 square miles in size. There are 213 cells covering the Cretaceous Aquifer, or 77 square miles.

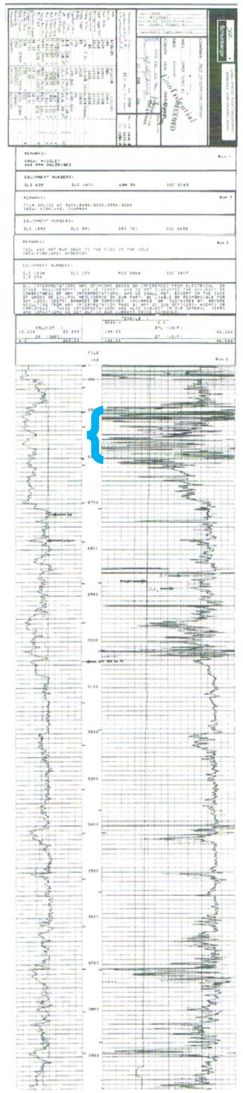


http://www.walden3d.com/IronCounty/ig/IronCounty/IC_3_Aquifers.html

The Quartz Monzonite Aquifer

Walden 3-D, Inc.
Continuing to make a positive difference!





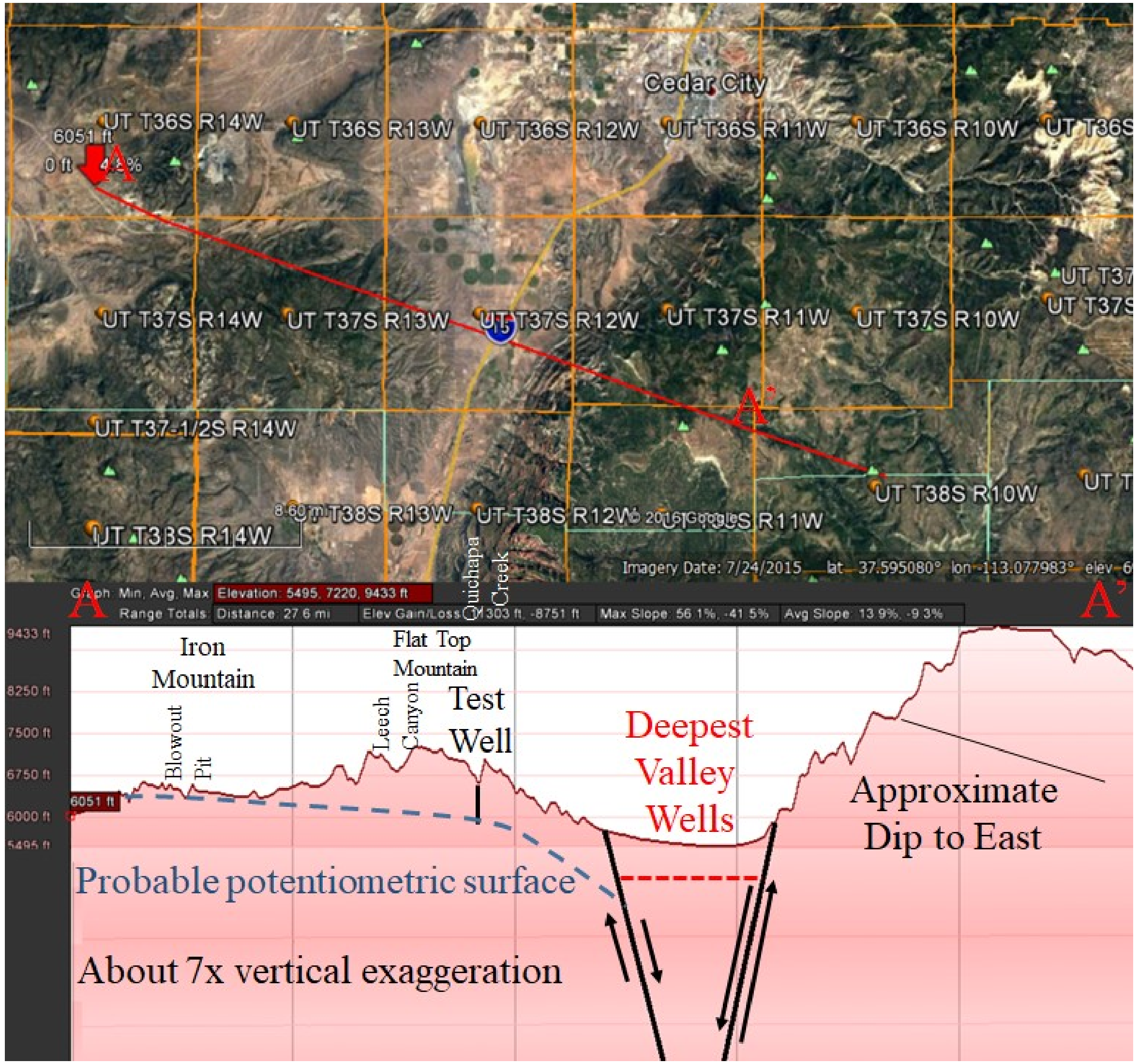
Untapped quartz monzonite aquifer at Blowout Pit, Iron Mountain.

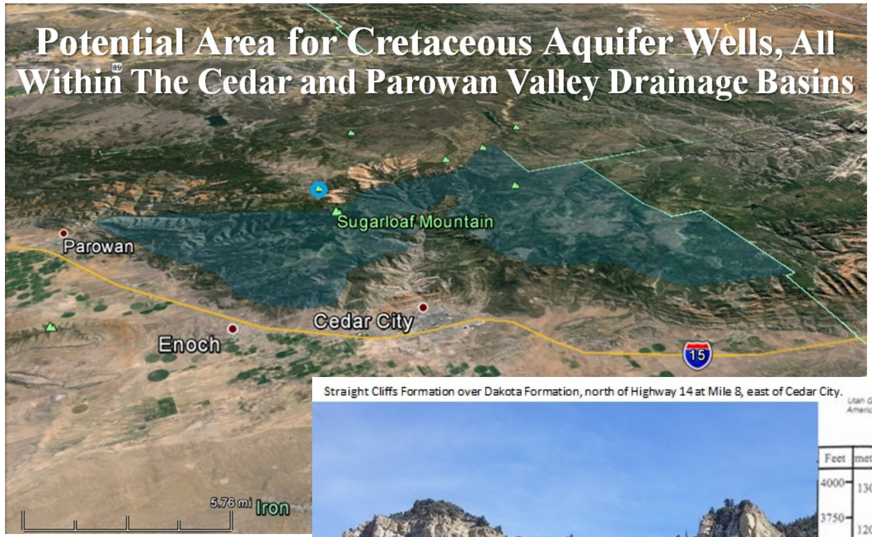
To the left are Schlumberger well log results dated 30 Jun 1984, 20 Sep 1984, and 17 Jan 1985 from a well Arco drilled at Iron Springs. The high porosity, highlighted with { in blue, is from fresh water in the fractured quartz monzonite. This fractured quartz monzonite is the same geology as the successful well drilled in Enoch against the dipping Cretaceous beds.

http://www.walden3d.com/IronCounty/ig/IronCounty/IC_QMA.html

The Cretaceous Aquifer

Walden 3-D, Inc.
Continuing to make a positive difference!





The Cretaceous Aquifer was successfully tapped at Brian Head in the city well.

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

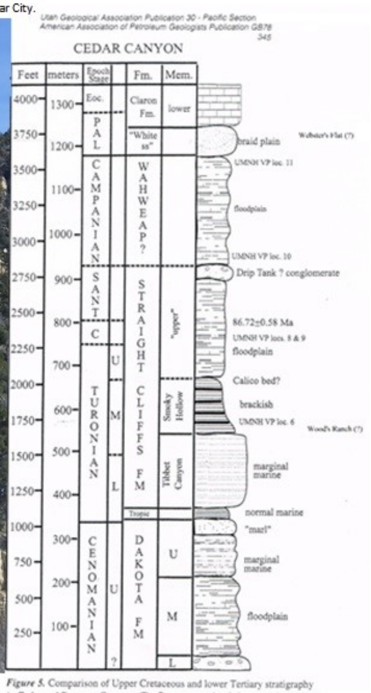
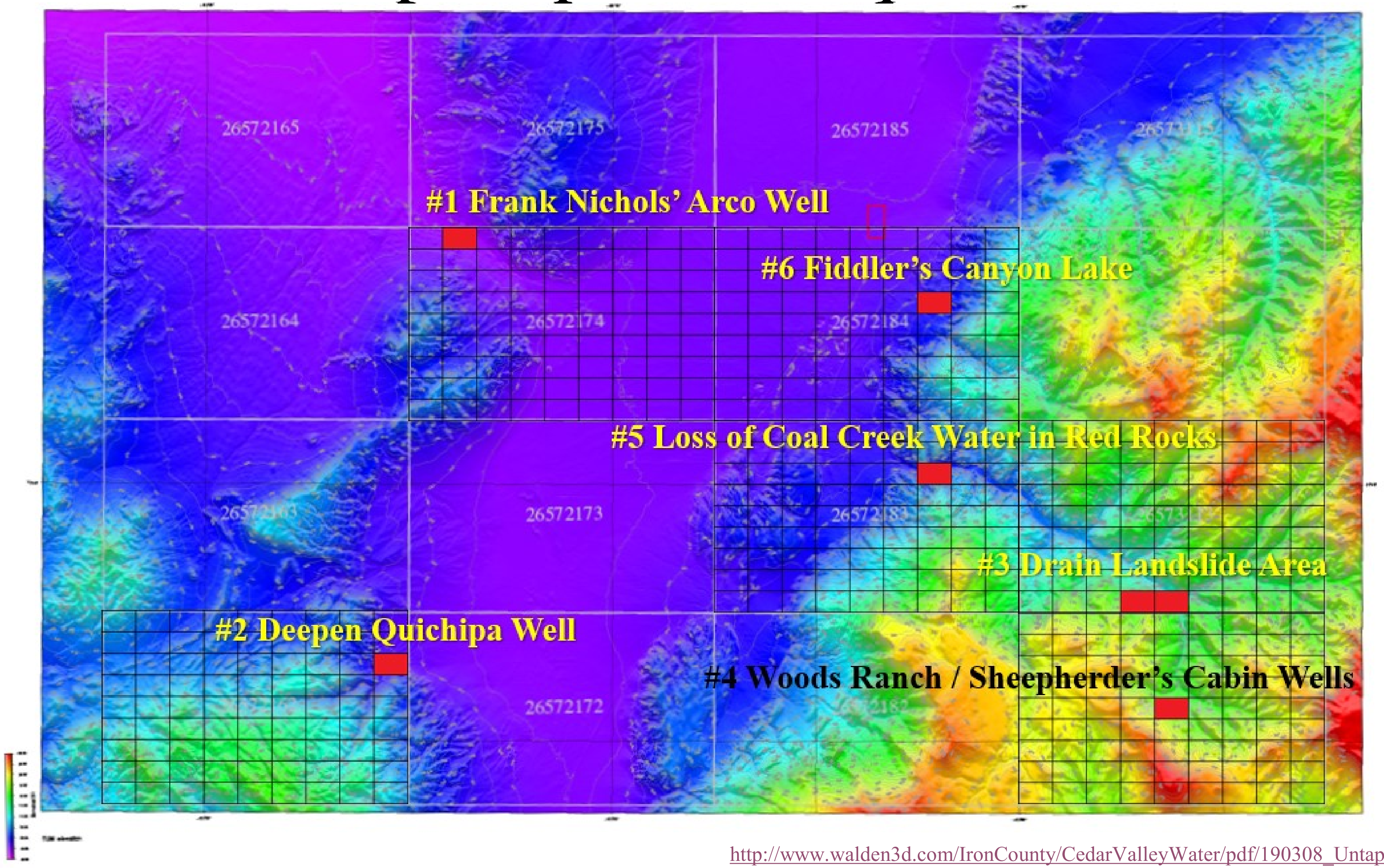


Figure 5. Comparison of Upper Cretaceous and lower Tertiary stratigraphy in Cedar and Parowan Canyons.

The landslides are not a result of the coal mine having been here, they are a result of the coal mine not draining water off of the cliffs.

http://www.walden3d.com/IronCounty/ig/IronCounty/IC_KA.html

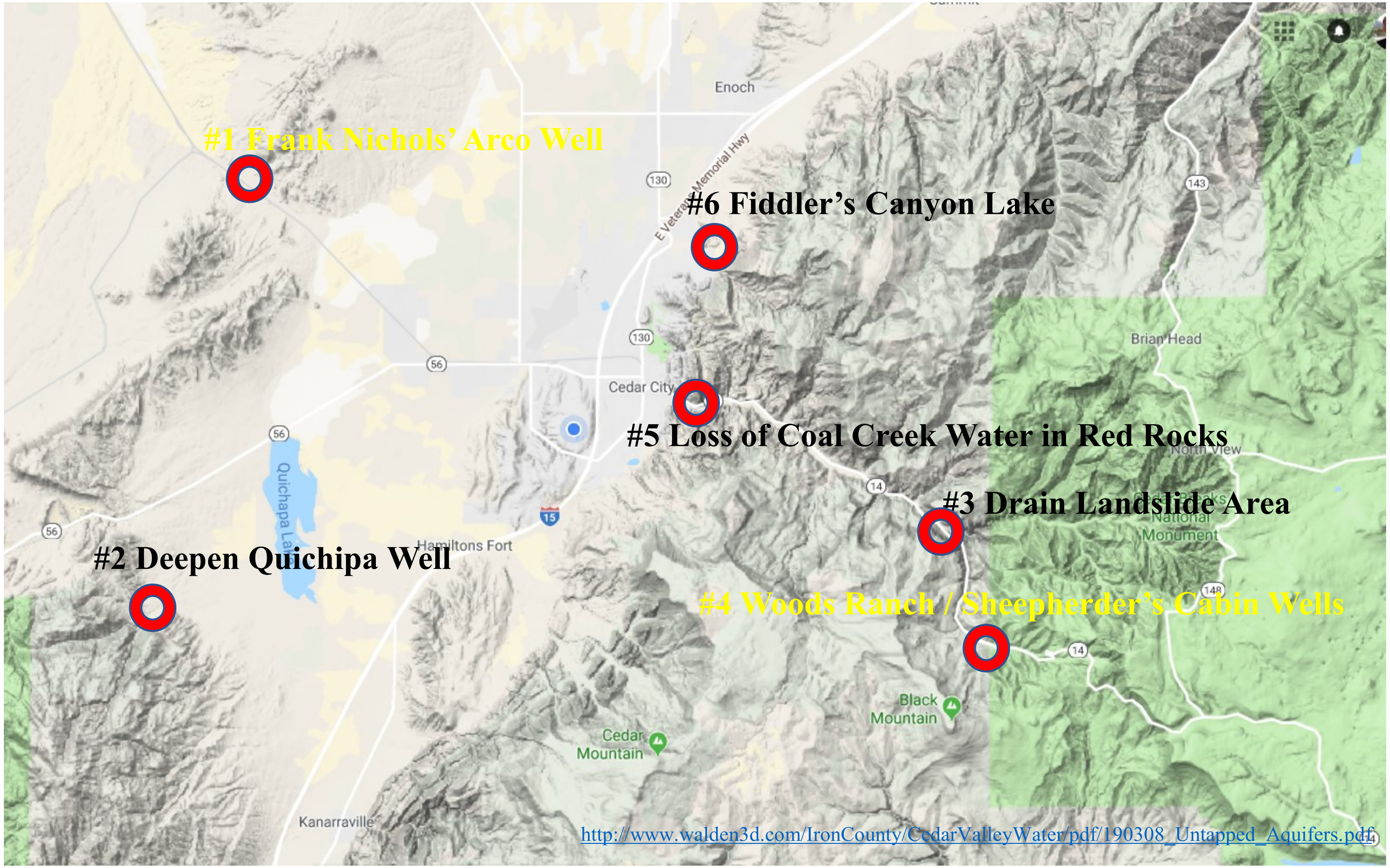
Iron County Commissioners Field Trip Stops IG5 Map



http://www.walden3d.com/IronCounty/CedarValleyWater/pdf/190308_Untapped_Aquifers.pdf

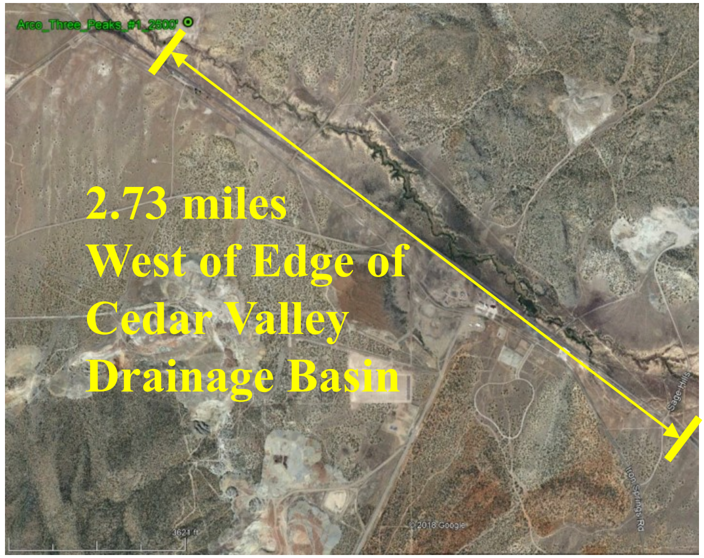
Iron County Commissioners Field Trip Stops Terrain Map

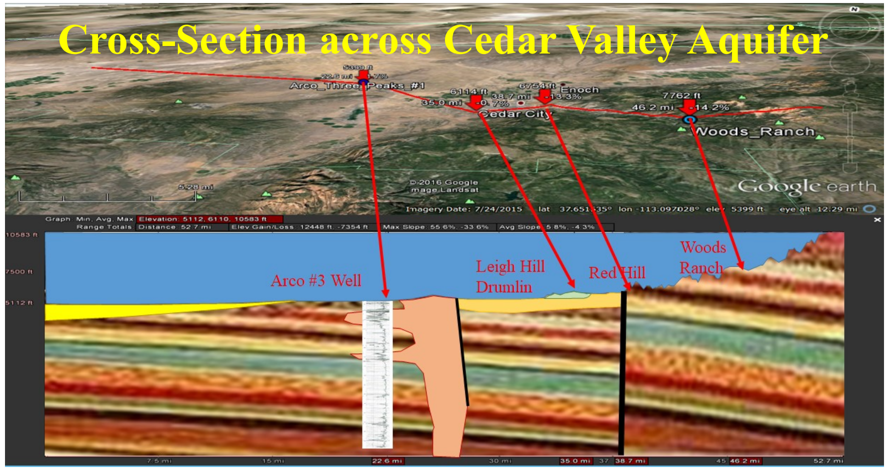
Walden 3-D, Inc.
Continuing to make a positive difference!



12,358 foot Arco-3 Dry Oil Well

Walden 3-D, Inc.
Continuing to make a positive difference!





To: Frank Nichols
From: Gary F. Player
Subject: Possible Water Resources Surrounding ARCo Three Peaks No. 1
Date: November 10, 2017

Happy day before Veterans' Day! I just about completed the new casing diagram showing the locations of cement plugs in the subject well, and I couldn't stop myself from doing a little conjecturing about possible water resources.

I have drilled and reviewed dozens of wells completed in fractured granite aquifers in Utah and California, so I feel confident about assigning a very conservative likely porosity of three (3) percent. Given the known thickness of the granitic rocks at Three Peaks (3,964 feet) we can calculate the volume of potential water present in one square mile (640 acres). Here goes:

Area = 640 acres
Thickness = 3,964 feet
Porosity = .03
Water volume = (640)*(3,964)*(.03) = 76,108.8 acre-feet.

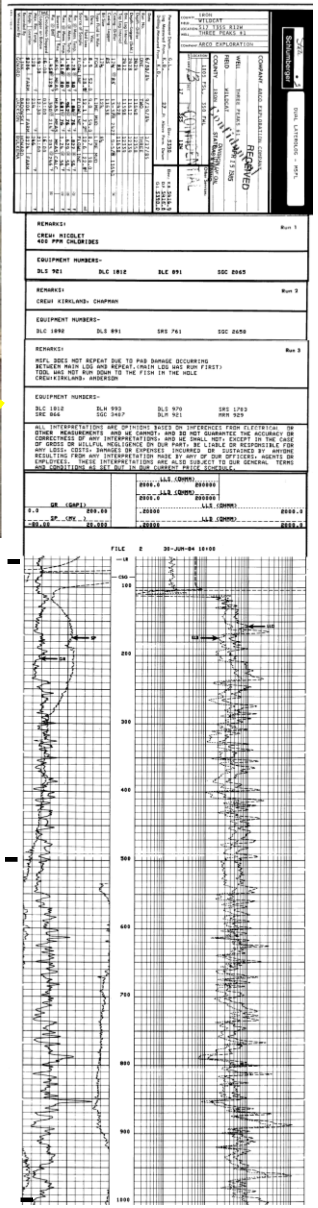
The Iron Mountain granite intrusive extends over an area of about 200 square miles in Iron County, allowing an estimated water resource of (200)*(76,108.8) = **15,221,760 acre-feet**. I believe that possibility is worth an inexpensive test in an existing well: The ARCo Three Peaks No. 1, now owned exclusively by you.

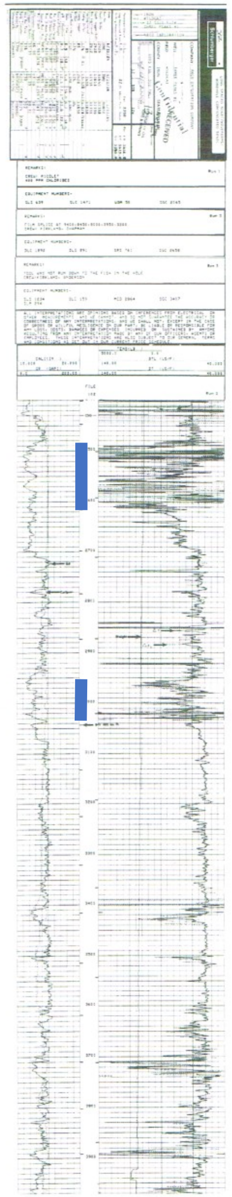
Sincerely,

Gary F. Player

Gary F. Player
Utah Professional Geologist No. 5280804-2250

Potential Quartz Monzonite Water:
15,221,760 acre-feet
Probable Annual Recharge:
21,333 acre-feet per year



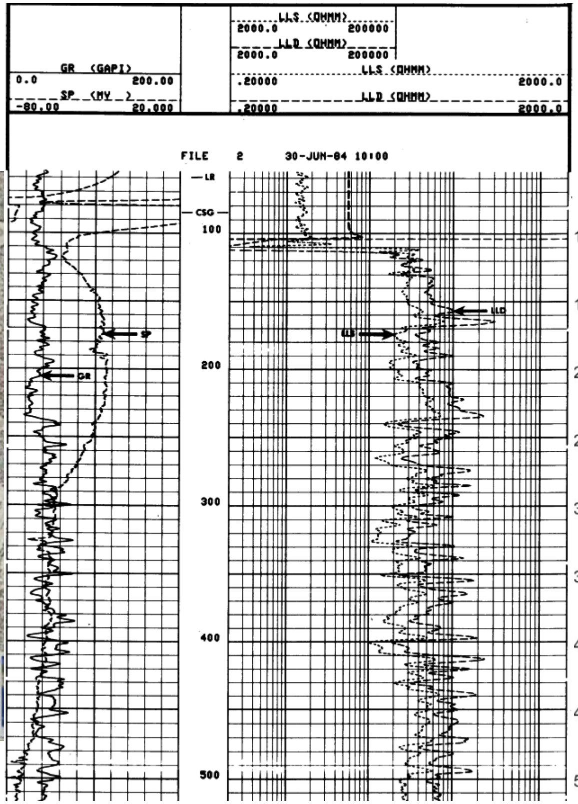


33 Traces using Mark Burr's "Passive Seismic" – 01 Mar 2019

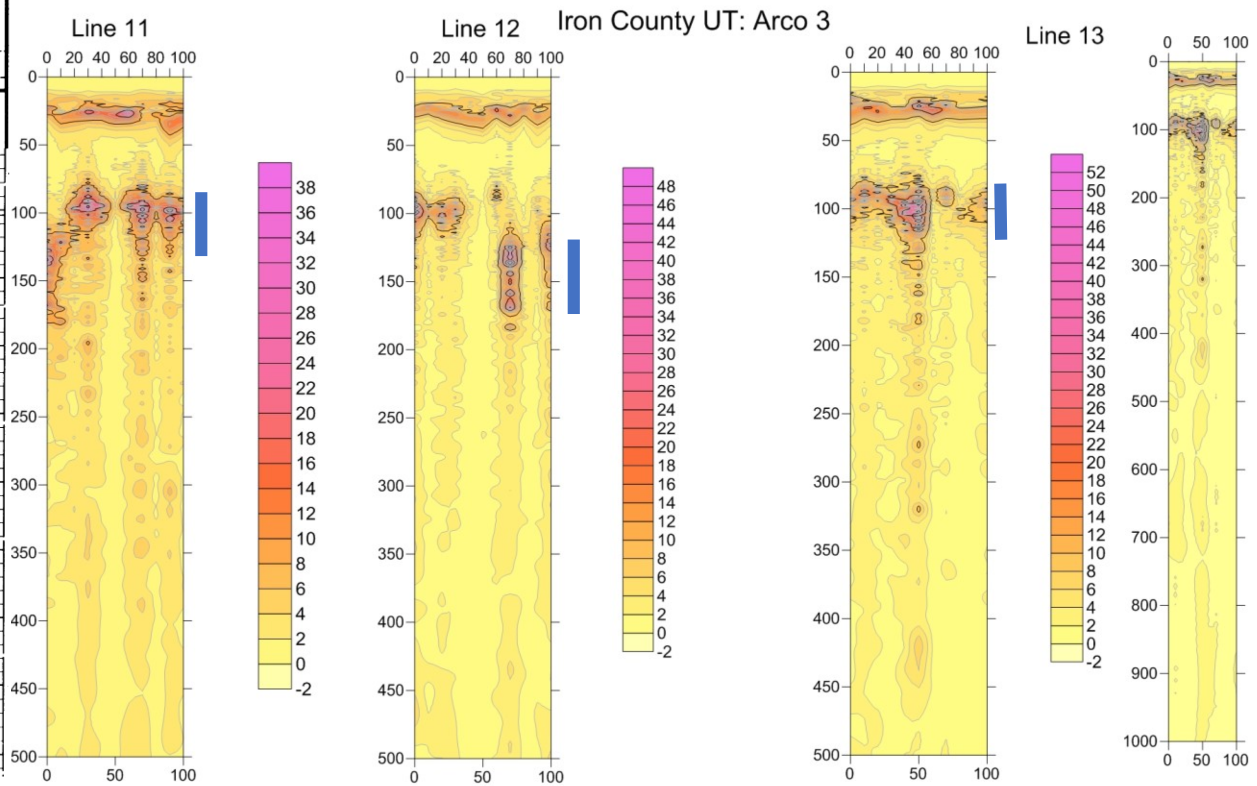
Walden 3-D, Inc.
Continuing to make a positive difference!

Locations of 33 "Passive Seismic" Measurements by the Arco-1 Well

Schlumberger Resistivity Log



PrimaryWaterTechnologies.com

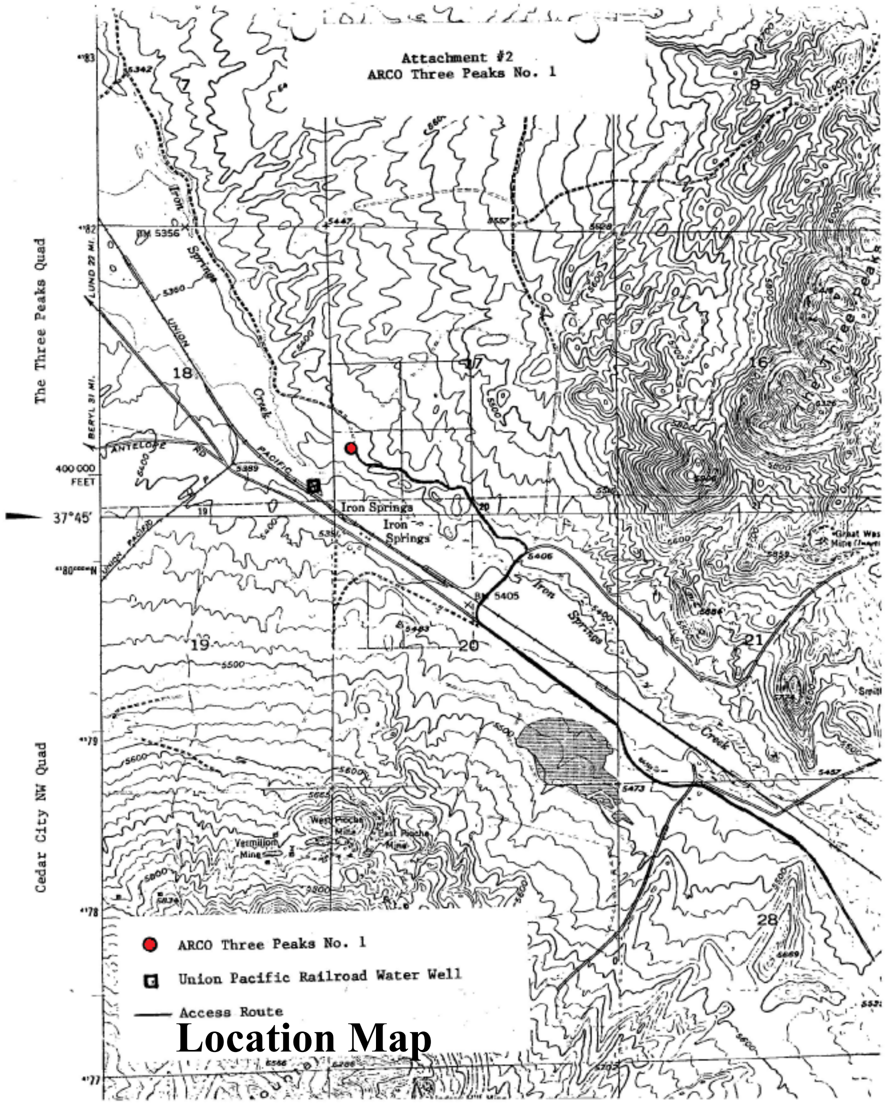


Note these are not primary acoustic signals (seismic), rather they are the calculated spectrum of acoustic signals

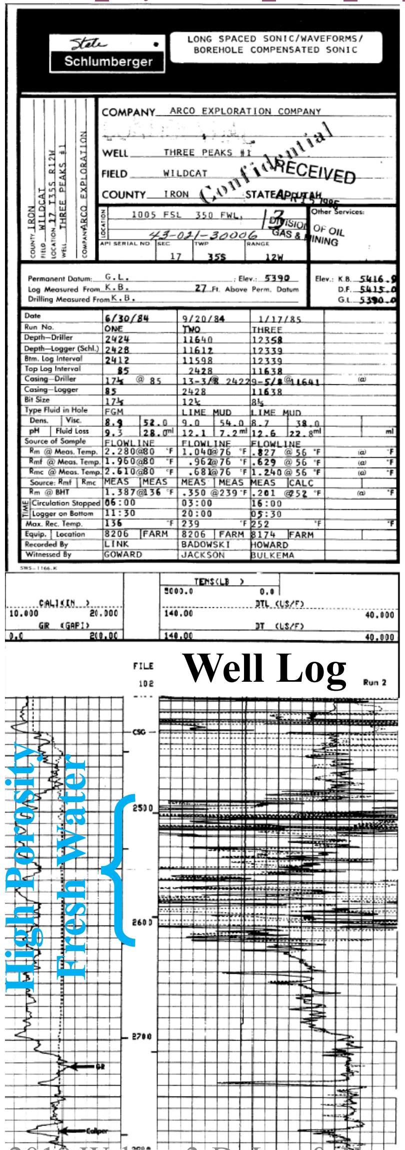
#1 Frank Nichols Arco Well

http://www.walden3d.com/IronCounty/CedarValleyWater/pdf/150821_Player-Nelson_ARCo_well_Three_Peaks_w_comments.pdf

Walden 3-D, Inc.
Continuing to make a positive difference!



Location Map

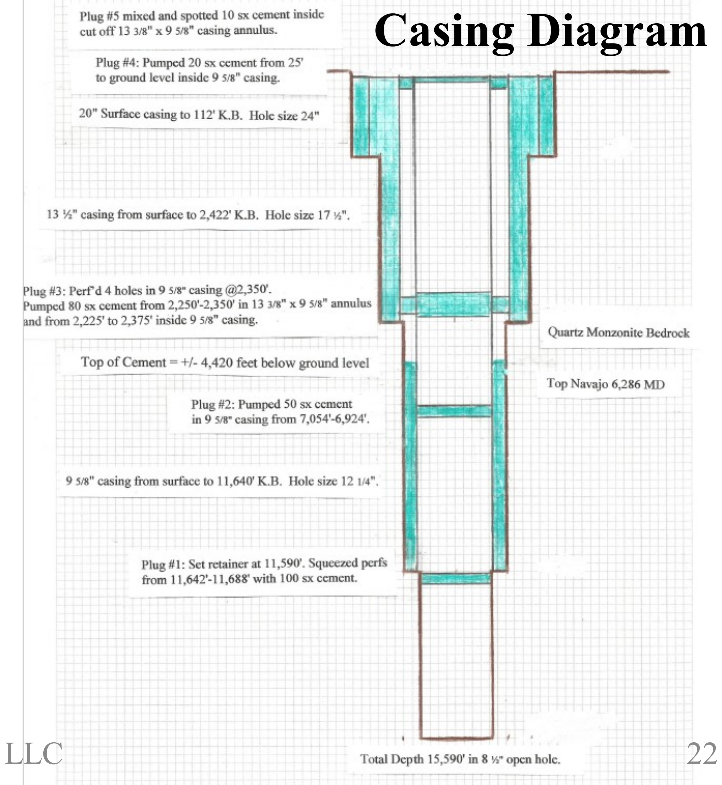


Well Log

Guesstimating cement in ARCo Three Peaks NO. 1:

- Annulus between 17 ½" hole and 13 ½" casing:
  - Open hole volume is area of 17.5 less area of 13.5, times 2422 feet area of 17.5 = pi*r2 = 240.53 square inches area of 13.5 = 143.14 square inches with a difference = 97.39 square inches, or 0.676 sq. ft.
  - Volume of annulus = 1,638 cubic feet (2,422*.676)
  - Amount of cement = 2,750 sacks, where each sack = 1.68 cubic feet
- Annulus between 12 1/4" hole and 9 5/8" casing:
  - Open hole volume is are of 12.25 less 9.625, times 11,640 feet area of 12.25 = pi*r2 =117.86 square inches area of 9.625 = 72.76 square inches with a difference = 45.1 square inches, or 0.313 square feet.
  - Volume of annulus = 3,545 cubic feet.
  - Amount of cement = 1,400 sacks, or 2,352 cubic feet
- Ratio of amount of cement to volume of annulus = 2,352/3,545 = .66. Therefore, cement came up 2/3 of the length of the casing (11,640)*(.66) = 7,223 feet.
- The top of the cement would be at 11,640 - 7,223, or 4,417 feet below ground level.

Casing Diagram



Frank Nichols Water Opportunity

Walden 3-D, Inc.
Continuing to make a positive difference!

See submission response at 21.2. at http://www.walden3d.com/IronCounty/CedarValleyWater/

ARCo Three Peaks oil well drilled in SWq of the SWq of S17, T35S, R12W in 1984-1985:

- Location: Iron Springs Gap
- Potential Aquifer(s): Fractured Quartz Monzonite (Qm)
- Likely Annual Recharge: Greater than 10,000 acre-feet
- Existing Well:
    - Aquifer(s) penetrated: Qm from 2,322' - 6,286' BGL (Below Ground Level)
    - Well Log(s): Dual Induction Laterolog and Sonic Log
    - Casing Diagram completed by ARCo is shown on the previous page
- The well reached a total depth of 15,590 feet without detecting any showings of oil or gas.
- The well was plugged with cement plugs and abandoned by ARCo on March 15, 1985.
- Several cement plugs were placed in the 9 and 5/8" casing: below 11, 590 feet BGL; from 7,050 feet to 6,920 feet BGL; and from 2,350 feet to 2,225 feet BGL. One last plug was set from the surface to 25 feet BGL.
- The 9 and 5/8" casing is open for potential future aquifer testing below 2,350 feet BGL.
- Frank Nichols has committed to test the quartz monzonite (Qm) aquifer with a workover rig; probably using Grimshaw Drilling in Enoch; they will set up over the hole and drill out the surface plug and the next shallow plug present from 2,225 feet to 2,350 feet BGL.
- The "sonic" log run in open hole (before casing was set) disclosed a very porous interval at the depths proposed for perforating, from 2,480 feet to 2,610 feet BGL. The porous zone is a highly fractured portion of the quartz monzonite aquifer. Water present in the Qm could enter the perforations from any other fractures present from the top of the cement in the annulus between the 9 and 5/8" casing and the bedrock (4,420') to the base of the shallow cement plug (2,350').

- Gary Player has drilled and reviewed dozens of wells completed in fractured granite aquifers in Utah and California, so feels confident about assigning a conservative and likely porosity of three (3) percent.
- Given the known thickness of the granitic rocks at Three Peaks (3,964 feet) we can calculate the volume of potential water present in one square mile (640 acres):

    Area = 640 acres
    Thickness = 3,964 feet
    Porosity = .03
    Water volume = (640)*(3,964)*(.03) = 76,108.8 acre-feet.
- The Iron Mountain granite intrusive extends over an area of about 200 square miles in Iron County, allowing an estimated water resource of (200)*(76,108.8) = **15,221,760 acre-feet**.

Wells drilled into the same Qm zone at Quichapa Creek and at the base of the Pine Valley Mountains southwest of New Harmony are very productive with high quality water. The closest well (Quichapa, Stop #2 on this Field Trip) penetrated only the first two hundred feet of the Qm, and was producing at a rate of about 150 gallons per minute by air lift while the well was being drilled. Wells at New Harmony have been pump tested at rates on the order of 2,500 gallons per minute with little drawdown. If the initial flow of water from the perforated intervals appears to be indicative of high porosity and permeability in the zone tested, then it would be appropriate to fire additional shots, and then set a 5" diameter, gravel packed slotted liner inside of the 9 5/8" casing in order to control possible entry of loose silt and sand during long term production. Exact details of the completion should be settled upon by consulting with the drilling company chosen to test and then complete the well. Grimshaw Drilling has provided Frank with a estimate of $70,000 to reenter and hopefully complete the well. Frank has agreed to do this test, when cash flow allows. Note, this untapped aquifer goes from Pine Valley Mountain to Minersville, as shown on page 13.

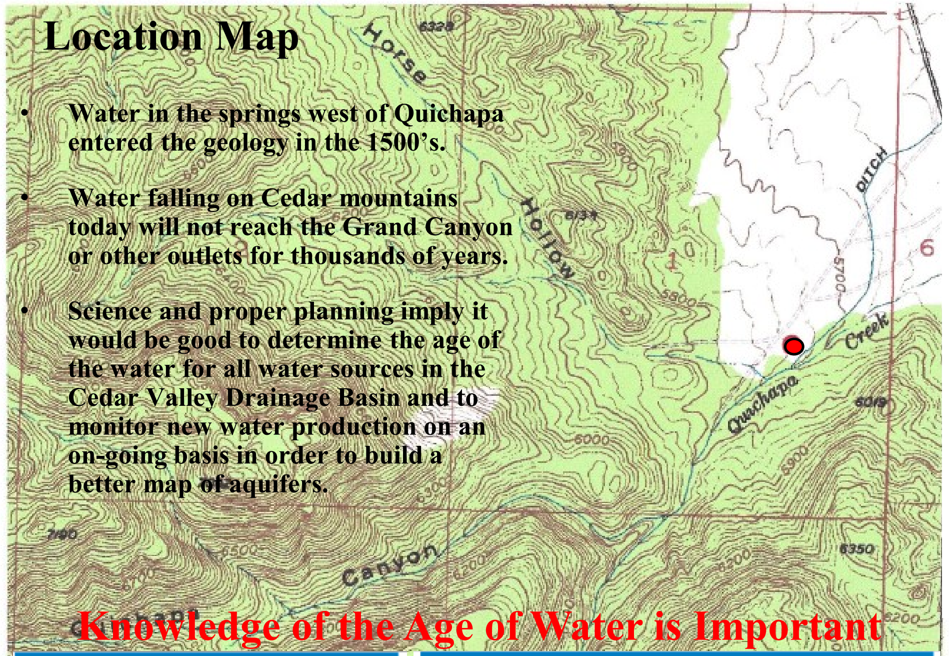
Notes on Arco Well Proposal from CICWCD Geology Advisors (Player/Nelson comments):

- The fracturing within this is only on the very surface of these formations (outcrops disagree) and the likelihood of large water volumes within them is very slim (**incorrect?**) and if a large volume of water was found it would most likely be finite in nature (12" annual recharge) and would deplete quickly as the wells proved for the Iron Mines just south west of the proposed well.
- The individual laccoliths are formed individually and are not equally fractured. The same conclusion cannot be drawn between the granite structures in the Cedar Valley and the well that the Church drilled in the New Harmony area within the ash creek drainage. That well is located at the confluence of multiple fracture systems and has the drainage from the north end of the Pine Valley mountains (there are also multiple fracture zones in the Iron Springs Gap).
- This project as proposed would not be a new source of water and would be quite expensive to develop since the water would be pumped from depths approximately 2,500 feet deep (hydrostatic level expected to be only a few hundred feet deep). In addition to having challenges of pumping from such depths the well casing is small and you would not be able to pump more than 500 gpm from this size of well (13.5" at pump 9.5" where perforated, rates determined by testing).
- From a water rights perspective this water would come from existing water rights within the Beryl Enterprise basin. This would not be considered as a new appropriation of water since the basin is closed and has been for some time. (still new water for Beryl, well is on the boundary of the two basins, the water could be diverted either way, as CIWCD is currently pumping water further to the west. The key is to test for a new source of water which has a different age and a different hydrostatic pressure than any water in the Cedar Valley fill aquifer or the Beryl Valley aquifer).

#2 Deepen Quichipa Well

Location Map

- Water in the springs west of Quichapa entered the geology in the 1500's.
- Water falling on Cedar mountains today will not reach the Grand Canyon or other outlets for thousands of years.
- Science and proper planning imply it would be good to determine the age of the water for all water sources in the Cedar Valley Drainage Basin and to monitor new water production on an on-going basis in order to build a better map of aquifers.



Knowledge of the Age of Water is Important

BETA ANALYTIC INC.
DR. M.A. TAMERS and MR. D.G. HOOD
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305-667-5167 FAX:305-663-0964
beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Mr. Jonathan Stathis — Report Date: 6/11/2012
Cedar City Corporation — Material Received: 6/5/2012

Sample Data	Apparent C14 Age (fraction modern)	C13/C12 Ratio
Beta - 323271	510 +/- 30 BP (Fmdn 0.9385 +/- 0.0034)	-15.0 o/oo
Beta - 323272	1660 +/- 30 BP (Fmdn 0.8133 +/- 0.0030)	-15.7 o/oo

Beta - 323271: SAMPLE : quichapatest; ANALYSIS : AMS-Standard delivery; MATERIAL/PRETREATMENT : (water DIC): acidify-gas strip
Beta - 323272: SAMPLE : springstest1; ANALYSIS : AMS-Standard delivery; MATERIAL/PRETREATMENT : (water DIC): acidify-gas strip

BETA ANALYTIC INC.
DR. M.A. TAMERS and MR. D.G. HOOD
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305-667-5167 FAX:305-663-0964
beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Mr. Jonathan Stathis — Report Date: 6/25/2012
Cedar City Corporation — Material Received: 6/6/2012

Sample Data	Apparent C14 Age (fraction modern)	C13/C12 Ratio
Beta - 323310	16650 +/- 70 BP (Fmdn 0.1258 +/- 0.0011)	-11.7 o/oo

SAMPLE : well#8sample
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (water DIC): acidify-gas strip

LOCATION MAP:
PROPOSED CEDAR CITY QUICHAPA CREEK NO. 1 WELL RE-ENTRY, Iron County
Basemap from Stoddard Mountain USGS 1:24,000 Topographic Map

Submitted by H. Roice Nelson, Jr. and Gary F. Player

Well Log

QUICHAPA CREEK TEST WELL NUMBER 1

LOGGED BY WATSON ENGINEERING FROM SURFACE TO 450 FEET.
LOGGED BY GARY F. PLAYER BELOW 450 FEET.

DATE	FROM	TO	THICK	RATE FT/HOUR	WATER GPM	LITHOLOGY
05/08/12	450	460	10	30	30 GPM	QUICHAPA VOLCANICS--REDDISH BROWN ASH FLOW TUFFS. WATER ENTRY FROM ABOVE ONLY.
	460	470	10	60	30 GPM	SAME
	470	475	5	40	30 GPM	SAME
	475	485	10	20	30 GPM	CUTTINGS SIZE INCREASING TO GRANULES AND FINE PEBBLE SIZE, FRACTURED
	485	490	5	20	30+ GPM	BASALT INTERBBEDED WITH ASH FLOW TUFF. DRILL BIT BOUNCING, WATER INCREASING SLIGHTLY
	490	495	5	20	30+ GPM	AS ABOVE
	495	500	5	20	30+ GPM	**DEEPLY WEATHERED QUARTZ MONZONITE, WHITE, CLAYEY, WITH TRACES OF RED-BROWN ANDESITE** LAST FOOT OF CUTTINGS ARE FULL OF WHITE CLAY, DRILLED SLOWLY BUT SMOOTHLY. WATER INCREASING. TOP OF GRANITE MAY BE WEATHERED EROSION SURFACE COVERED BY BASALT EXTRUSION AT BASE OF QUICHAPA GROUP. STOPPED TO REAM OUT HOLE TO 8" AND GET PERMISSION TO CONTINUE TO 700 FEET.
05/11/12	501	507	6	60	50+ GPM	CIRCULATED OUT FILL. COARSE FRACTURED MATERIALS--MIX OF VOLCANICS AND QUARTZ MONZONITE. WHITE CLAY
	507	512	5	60		GRANITIC QUARTZ MONZONITE CUTTINGS INCREASED TO 50%.
	512	517	5	48		GRANITIC CUTTINGS TO 75%
	517	522	5	25		GRANITIC CUTTINGS TO 80%. NO INDICATIONS OF ANY ROUNDING--ANGULAR CHUNKS
	522	527	5	37	60+	SLIGHT PINK TINGE TO QUARTZ MONZONITE. QUARTZ XTALS TO 4 MM. WATER INCREASING GRADUALLY
	527	532	5	37		PLAGIOCLASE PHENOCRYSTS TO 4 MM IN PINKISH GROUND MASS
	532	537	5	33		AS ABOVE
	537	542	5	33	75+	AS ABOVE, SLIGHTLY MORE FRACTURES; 20% DARK MINERALS IN PINKISH TO WHITE QM. BIOTITE AND PYROXENES
	542	547	5	30		QM FRESH AND HARD, A FEW WHITE, MOSTLY PINKISH GRAINS OF QM, AS AT PINE VALLEY MTNS.
	547	552	5	30	80+	AS ABOVE, FRACTURED AT 549. DRILLING AIR PRESSURE UP TO 130 PSI--STARTED TODAY AT 120 PSI.
	552	557	5	37		AS ABOVE
	557	562	5	30		FRACTURES 561-562
	562	567	5	60		FRACTURES 562-567+ IN QM
	567	572	5	30		FRACTURES CONTINUING IN QM. WATER INCREASING. MICROCRYSTALLINE WHITE QUARTZ LINES FRACTURES.
	572	577	5	30	90+	FRACTURES CONTINUING IN QM. WATER INCREASING. PINKISH QM MICROCRYSTALLINE WHITE QUARTZ LINES FRACTURES.
	577	582	5	35		FRACTURES CONTINUING IN QM. WATER INCREASING. MICROCRYSTALLINE WHITE QUARTZ LINES FRACTURES.
	582	702	120	10-60	120+GPM	QUARTZ MONZONITE, AS ABOVE, VARYING FROM LIGHT GRAY TO REDDISH BROWN (WHERE WEATHERED) TO PINK LOCALLY FRACTURED. WATER BEARING.

NOTE: WELL REMAINED IN FRACTURED QUARTZ MONZONITE TO 702 FEET BELOW GROUND. MEASURED AIR PRESURE INCREASED TO OVER 200 PSI WATER PRODUCTION RATE MEASURED (ESTIMATED WITH A 5 GALLON BUCKET DIPPED INTO STREAM) AT ABOUT 120 GALLONS PER MINUTE BELOW 650 FEET. SCANNED FIELD NOTES INTO A .PDF FILE.

Florida based Beta Analytics age dated the water with Carbon-14, have done 500,000 dates, and have 20,000 clients. $595 per sample with 14 day delivery. 305.667.5167.

Water in Harmony Hills

	A	B	C	D	E	F	G	H
1								
2		WATER STORED IN HARMONY MOUNTAINS, SOUTHWEST OF CEDAR CITY						
3		WITHIN CEDAR VALLEY DRAINAGE BASIN OF UTAH DEPARTMENT OF WATER RIGHTS						
4								
5		GARY F. PLAYER	27-Jan-18					
6								
7		AREA	0.627	TOWNSHIPS				
8		AREA	22.572	SQ. MILES				
9		AREA	14446.08	ACRES				
10		AREA	629,271,245	SQ. FEET				
11								
12		GROSS THICK.	500	FEET	MINIMUM			
13		GROSS THICK.	1000	FEET	LIKELY			
14		GROSS THICK.	2000	FEET	MAXIMUM			
15								
16		IGNEOUS	1	VOL/VOL	MINIMUM			
17		IGNEOUS	1	VOL/VOL	LIKELY			
18		IGNEOUS	1	VOL/VOL	MAXIMUM			
19								
20		POROSITY	0.02	VOL/VOL	MINIMUM			
21		POROSITY	0.03	VOL/VOL	LIKELY			
22		POROSITY	0.05	VOL/VOL	MAXIMUM			
23								
24		VOLUME OF WATER = AREA * THICKNESS * % IGNEOUS * POROSITY						
25		MINIMUM	144,461	ACRE-FEET				
26		LIKELY	433,382	ACRE-FEET				
27		MAXIMUM	1,444,608	ACRE-FEET				
28								
29		LIKELY VOLUME OF GROUND WATER IN PLACE UNDER 23 SECTIONS:						
30			433,382	ACRE-FEET				
31								
32		ANNUAL INFILTRATION						
33		PRECIP.	17	INCHES PER YEAR	MINIMUM	1.42	FEET	
34		PRECIP.	19	INCHES PER YEAR	LIKELY	1.58	FEET	
35		PRECIP.	21	INCHES PER YEAR	MAXIMUM	1.75	FEET	
36								
37		AREA	0.63	TOWNSHIPS				
38		AREA	22.57	SQ. MILES				
39		AREA	14,446	ACRES				
40		AREA	629,271,245	SQ. FEET				
41								
42		INFILTRATION	0.05	VOL/VOL	MINIMUM			
43		INFILTRATION	0.10	VOL/VOL	LIKELY			
44		INFILTRATION	0.15	VOL/VOL	MAXIMUM			
45								
46								
47		ANNUAL INFILTRATION = AREA * PRECIPITATION * INFILTRATION						
48		MINIMUM	1,023	ACRE-FEET				
49		AVERAGE	2,287	ACRE-FEET				
50		MAXIMUM	3,792	ACRE-FEET				
51								
52		LIKELY VOLUME OF ANNUAL INFILTRATION UNDER 23 SECTIONS:						
53			2,287	ACRE-FEET				
54								

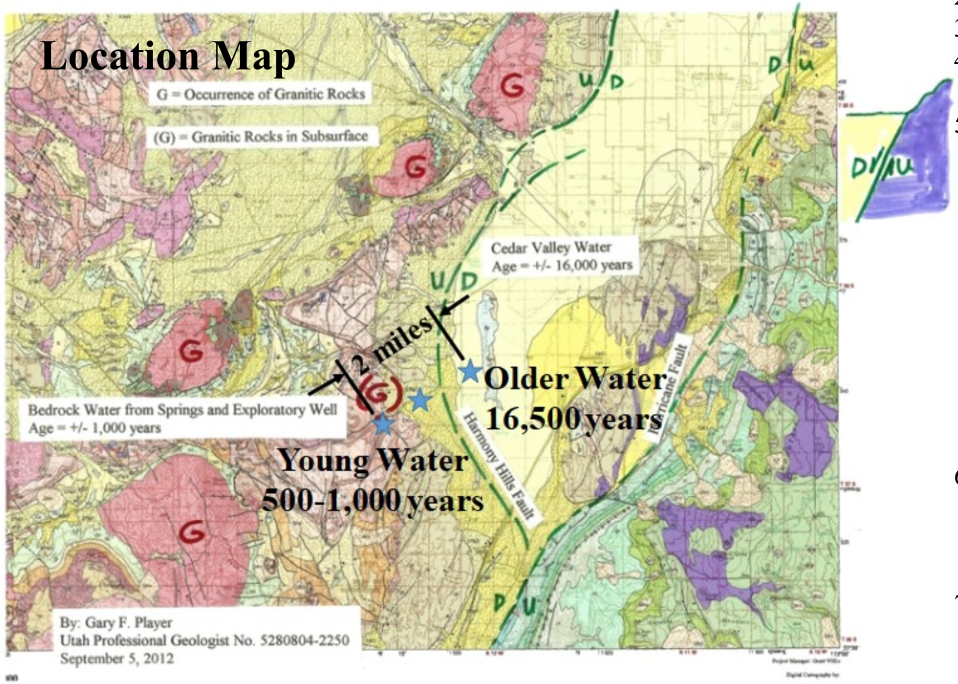
http://www.walden3d.com/IronCounty/CedarValleyWater/pdf/150824_Player-Nelson_Quichapa_Creek_Well_Re-Entry_w_comments.pdf

Gary Player on-site.

Age of Water and Harmony Hills

See submission response at 21.4. at http://www.walden3d.com/IronCounty/CedarValleyWater/

Walden 3-D, Inc.
Continuing to make a positive difference!



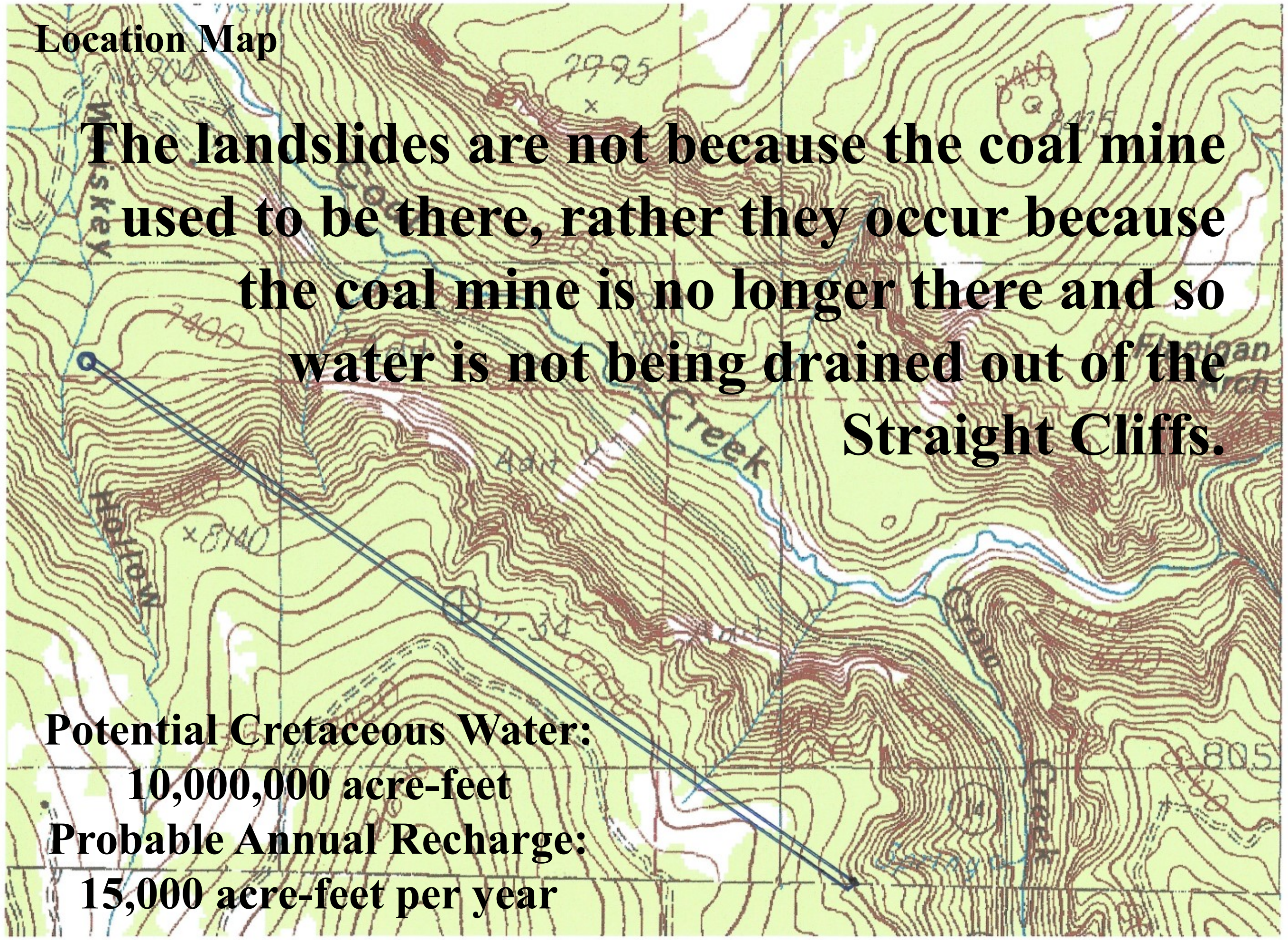
1. Harmony Hills
2. Location: Southwest of Quichapa Lake. Test well drilled just east of the intersection of two tributaries of Quichapa Creek.
3. Potential Aquifer(s): Fractured Quartz Monzonite (Qm)
4. Likely Annual Recharge: on the order of 2,500 acre-feet within Cedar City aquifer boundary; much greater (10,000 acre-feet or more) within entire mountain range.
5. Existing Well
   a. Materials penetrated : Quichapa volcanics (Tq) and fractured Qm.
   b. Well Log: Tq from 0 - 495', Qm from 495' - 702' (total depth).
   c. Casing History:
      i. Cedar City was able to install casing to 275 feet in the well in order to seal off the shallow aquifer. However, the well bore below the casing collapsed before water could be sampled from the granitic aquifer.
      ii. Now that casing is in place, the well should be deepened to at least 1,000 feet, "under reamed" out to no less than 6" diameter, cased with a slotted liner from 500 feet to total depth, and tested with a multi-stage, slim hole, submersible or top drive pump.
      iii. Once these additional steps are completed, the County will have a better knowledge of the potential water supply that could be obtained from the fractured quartz monzonite aquifer.
6. Water Quality: Visual observations during drilling showed increasing amounts of available water with depth, with the greatest quantity (about 125 - 150 gallons per minute) estimated at 702 feet (total depth). However, the specific yield of the fractured granitic aquifer discovered in the well was not determined with a brief, shallow test. Similarly, the true chemical nature of water from the granitic aquifer was not disclosed by sampling only the shallower "cascading" water source.
7. Water sampled from the shallower "cascading" water source (a thin sandstone layer within the Quichapa Volcanics) was virtually identical in age and water quality to the water now being produced from fractured Quichapa Volcanics at Spilsbury Springs.

Notes on Quichapa Creek ell Re-Entry from CICWCD Geology Advisors (Player/Nelson comments):

- This project will affect the overall system much the same as the Arco well re entry project. (It is proposed to test the Quartz Monzonite, and not in the Beryl Valley Aquifer Water Rights Area).
- The supposition that additional water is existent at these lower depths is incorrect. (Based on what? Science or conjecture?) The water from these lower depths would be connected to the existing aquifer that we currently draw water from (Check the age of the water). The infiltration rates discussed in the Fractured Quartz Monzonite Aquifer are not realistic and are an over simplified method of determining recharge. (Nelson has worked several oil & gas fields tied to natural fracture permeability. The issue is the water moves a long distance, the oil and gas cones out, the water comes and comes and comes.).
- The Quartz Monzonite is formed from the laccoliths that are essentially big bulges of granite that have surfaced in a bulge in different areas where the soils above allowed. (As cool fracture, the untapped water reservoir.).
- The fracturing within this is only on the very surface of these formations (**check outcrops**) and the likelihood of large water volumes within them is very slim (check outcrops) and if a large volume of water was found it would most likely be finite in nature (review Ghawar, Ciudad del Carmen, Maui, and other fractured reservoirs) and would deplete quickly as the wells proved for the Iron Mines just south west of the proposed well (needs test).
- The individual laccoliths are formed individually and are not equally fractured. The same conclusion cannot be drawn between the granite structures in the Cedar Valley and the well that the Church drilled in the New Harmony area within the ash creek drainage. That well is located at the confluence of multiple fracture systems and has the drainage from the north end of the Pine Valley mountains. In addition to having challenges of pumping from such depths the well casing is small and you would not be able to pump more than 500 gpm from this size of well. (since comments are repeated, see comments above).
- From a water rights perspective this water would come from existing water rights within the Cedar basin. This would not be considered as a new appropriation of water since the basin is closed and has been for some time. (If it is demonstrated to be a different age and to have a different hydrostatic water pressure, it can be proven to be a new source of water.).

#3 Drain Landslide Area

Walden 3-D, Inc.
Continuing to make a positive difference!



Well to drain Cretaceous sandstones. Surface location to right of Whiskey Hollow. Scale: 5.5" = 1 mile.
Horizontal Well Length = 5,665'. Surface Elevation = 7,380'. Well direction = S 60^0 E. G.F. Player 2/8/2018

The map to the left shows a horizontal well draining into Whiskey Hollow, then flowing into Coal Creek. Jay Grimshaw suggested a horizonal well from the east base of the landslide to the west to drain the rubble beds at the base of the landslide.

The plan is to eliminate future landslides caused by water buildup in the old mine adits and natural fractures southwest of and above the right of way. UDOT expressed some interest in these ideas. Additional benefits could be the addition of water to Coal Creek in the dry times of the year.

Player & Nelson took Jay Grimshaw on a field trip, where we learned Grimshaw Drilling can drill horizontally in bedrock. Jay did not like the idea of drilling from above the landslide and deviating the well underneath the highway to empty water into Coal Creek. All of the fractures in the Straight Cliff Formation create a significant risk of water escaping from of the drill hole, and coming out of the cliff above the landslide area and creating problems for the road.

http://www.walden3d.com/IronCounty/CedarValleyWater/pdf/170817_How_to_Test_Proposed_New_Aquifers.pdf

Outcrop Photo and Stratigraphy

See submission response at 21.3. at http://www.walden3d.com/IronCounty/CedarValleyWater/

Walden 3-D, Inc.
Continuing to make a positive difference!

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

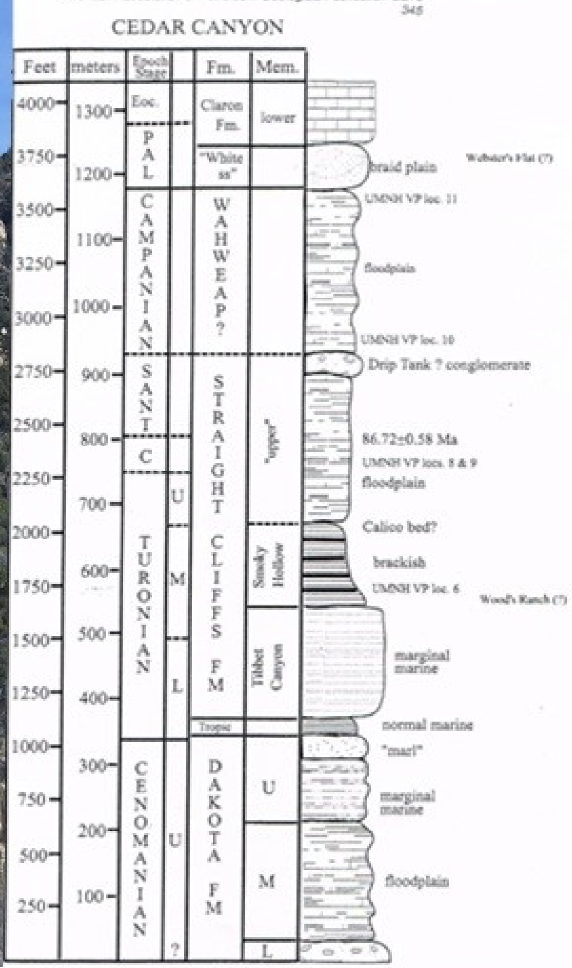


Figure 5. Comparison of Upper Cretaceous and lower Tertiary stratigraphy in Cedar and Parowan Canyons. The Parowan section is hung on the contact between the Claron and Grand Castle Formations. UGA Pub. 30

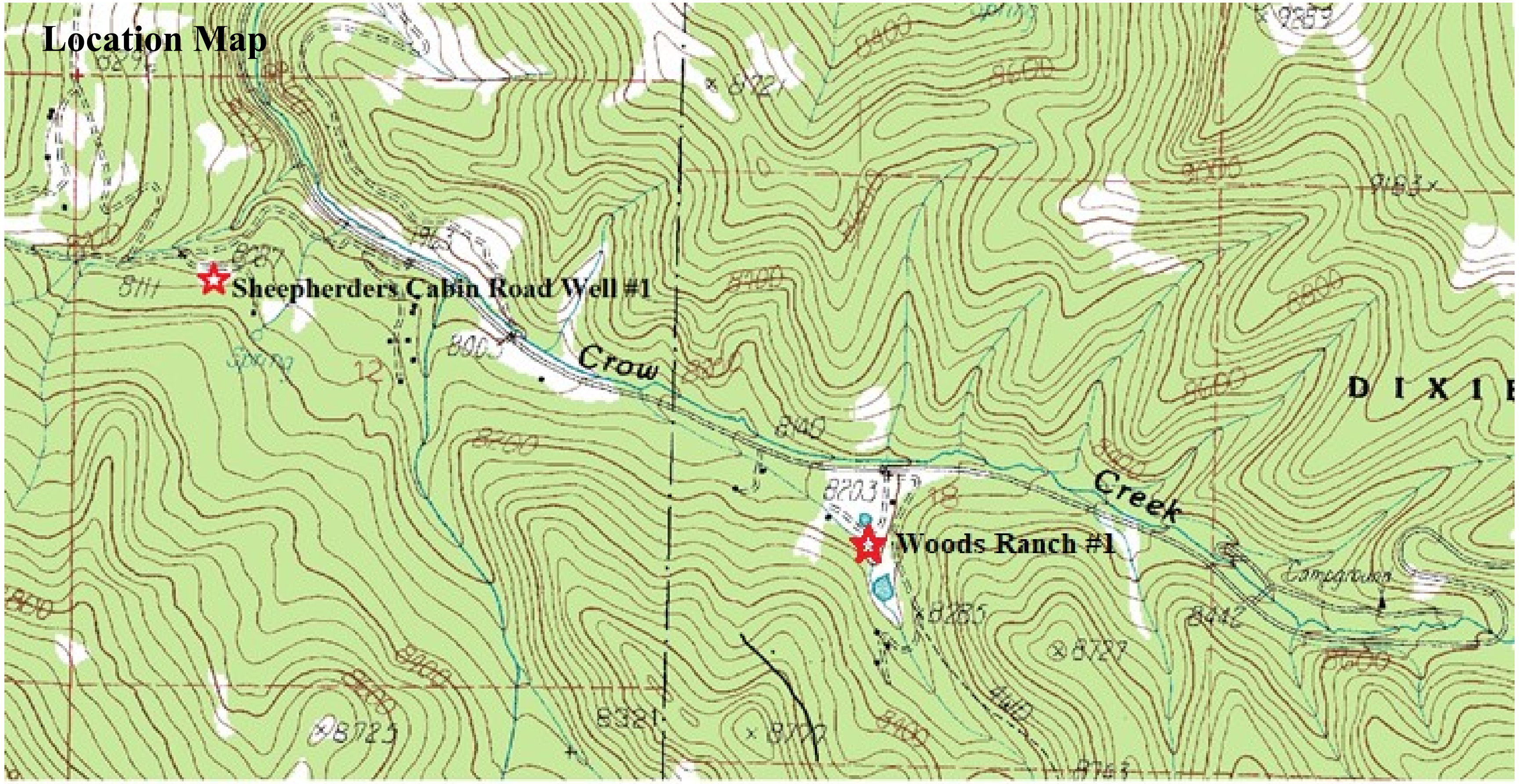
Notes on Cretaceous Well at Sheepherder's Cabin from CICWCD Geology Advisors (Player/Nelson comments):

- This was an interesting discussion with the UGS and USGS and water resources hydro geologists (Too bad Player & Nelson were not invited).
- The water that would be withdrawn from this location would most likely be connected to springs in the area and would have a direct effect (Thick shales between springs at 9,000 feet and Woods Ranch (8,200 feet). The 20-40% porosity of these rocks implies water is moving down and out of the system and needs to be captured. Wells and springs must be measured and monitored to answer this question.).
- The geologic formation at this location is not in the same formation as the Brian Head well. This geologic zone is below Brian Head and a conclusion cannot be made that the formations would yield the same volumes of water (The Brian Head well is the top of the Cretaceous base of the Paleocene, and the proposed well is in mid-Cretaceous. This is a similar related package of rocks. Measured porosity and permeability are similar.).
- The only way that water rights could be changed to this location as a point of diversion would be to acquire the most senior rights in Coal Creek and dry up agriculture and transfer them up to the location (Is there or is not an overallocation of water in Cedar Valley? Would those who face losing water rights transfer them, as was done for Brian Head?).
- After pumping to the surface placing the water into coal creek as a conveyance method would be a poor use of water (Cheaper than a pipeline).
- Utilizing this water for the district would require a pipeline which would be an expensive way to convey water (See proposed Fiddler's Canyon Lake, #6). In the event that there is excess runoff water it would then be passed by and hopefully recharged into the aquifer.
- The cost of infrastructure and pumping does not equate to virtually free water (Is a $250 million dollar pipeline is free? Once the Cretaceous water is proven, and producing it does not dry up springs, Player & Nelson propose wells be drilled to drain the landslide area, emptying into Coal Creek).
- This example well is not at all in the same formation as the proposed well would be in (The Brian Head well produces from Upper Cretaceous sandstones).

#4 Woods Ranch / Sheepherder's Cabin Wells

Walden 3-D, Inc.

Continuing to make a positive difference!



LOCATION MAP:

PROPOSED SHEEPHERDERS CABIN ROAD EXPLORATORY WELL #1 & WOODS RANCH #1

Basemap is Webster's Flat Topographic Map

Submitted by G.F. Player and H. Roice Nelson, Jr.

http://www.walden3d.com/IronCounty/CedarValleyWater/pdf/150824_Player-Nelson_Cretaceous_Well_at_Sheepherders_w_comments.pdf

Online Services | Agency List | Business | Search

Utah Division of Water Rights

SUU Well Log

WELLPRT Well Log Information Listing

Version: 2003.09.18.00   Rundate: 10/13/2003 04:04 AM

Utah Division of Water Rights

Water Well Log

```
LOCATION:
         N   113 ft W  1423 ft from E4 CORNER of SECTION 12 T 37S R 10W BASE SL    Elevation:          feet
DRILLER ACTIVITIES:
         ACTIVITY # 1 NEW WELL
         DRILLER: GRIMSHAW DRILLING                                      LICENSE #: 240
         START DATE: 11/12/2002    COMPLETION DATE: 12/03/2002
BOREHOLE INFORMATION:
            Depth(ft)  Diameter(in) Drilling Method      Drilling Fluid
           From    To
              0   109  12.2         AIR ROTARY           AIR, FOAM
            109   400  9.88         AIR ROTARY           AIR, FOAM
LITHOLOGY:
   Depth(ft)  Lithologic Description                                                    Color      Rock Type
  From    To
     0     1  OTHER                                                                     BROWN      TOP SOIL
     2    30  CLAY                                                                      GRAY
    30    32  CLAY                                                                      BROWN
    32    37  CLAY                                                                      GRAY
    37    43  CLAY,GRAVEL,COBBLES,BOULDERS                                              GRAY       LIMESTONE
    43    47  CLAY,BOULDERS                                                             GRAY       LIMESTONE
    47    60  CLAY                                                                      GRAY
    60    65  CLAY,BOULDERS                                                             GRAY       LIMESTONE
    65    77  CLAY                                                                      GRAY
    77    85  CLAY,BOULDERS                                                             GRAY
    85    92  CLAY                                                                      GRAY
    92    98  CLAY,COBBLES                                                              GRAY
    98   102  BOULDERS
   102   108  CLAY                                                                      GRAY
   108   109  CLAY,COBBLES                                                              GRAY
   109   112  CLAY                                                                      GRAY
   112   158  OTHER                                                                     GRAY       LIMESTONE
              BED ROCK
   158   223  OTHER                                                                     GRAY       LIMESTONE
              FRACTURED
   223   260  OTHER                                                                     GRAY       LIMESTONE
   260   265  OTHER                                                                     GRAY       LIMESTONE
              FRACTURED
   265   288  OTHER                                                                     GRAY       LIMESTONE
   288   300  WATER-BEARING,LOW-PERMEABILITY,OTHER                                      GRAY       LIMESTONE
              FRACTURED
   300   400  WATER-BEARING,LOW-PERMEABILITY,OTHER                                      GRAY       LIMESTONE
              FRACTURED
WATER LEVEL DATA:
         Date         Time    Water Level (feet)   Status
                              (-)above ground
         12/03/2002           170.00               STATIC
CONSTRUCTION - CASING:
            Depth(ft)  Material              Gage(in)  Diameter(in)
           From    To
             +2   109  A 53 GRADE B          .250      8.62
             95   400  A 53 GRADE B          .250      6.62
CONSTRUCTION - SCREENS/PERFORATIONS:
            Depth(ft)  Screen(S) or Perforation(P)  Slot/Perf. siz  Screen Diam/Length Perf(in)  Screen Type/# Perf.
           From    To
            340   400       PERFORATION             .125            2.50                         6 PER ROUND
CONSTRUCTION - FILTER PACK/ANNULAR SEALS
            Depth(ft)  Material                Amount    Density(pcf)
           From    To
              0    30  BENTONITE HOLE PLUG     23-50#BG
             30   100  50-50 SAND CEMENT       2.50 YRD
             95   400  DBL WASHED PEA GRAVEL   3.3 YARD
            100   107  BENTONITE HOLE PLUG     8-50# BG
WELL TESTS:
         Date        Test Method       Yield (CFS)  Drawdown (ft)  Time Pumped (hrs)
         12/02/2002  AIR LIFT            .007          174            5
GENERAL COMMENTS:
          CONSTRUCTION INFORMATION:
          Well head configuration: Steel plate
          Casing type: Butt weld
          Perforator: Milled, 6 per round 12 per foot
          Surface seal: Yes, 105 ft.
          Drive Shoe: No
          Surface seal placement method: Place 5# hole plug, Tremie 50/50
          cement 100 ft., pump back to surface.
          GROUT DENSITIES:
          0-30,3/8" hole plug, 2 gal. water per sack
          30-100,5.5 gal. water per cu.ft.
          100-107,3/8" hole plug, 2 gal. water per sack
          95-400, 3/8" washed pea gravel 100%
          NO PUMP
          SUU Mountain Center
          Additional data not available
```

Woods Ranch & Sheepherder's Cabin

Walden 3-D, Inc.
Continuing to make a positive difference!

See submission response at 21.3. at http://www.walden3d.com/IronCounty/CedarValleyWater/

WOODS RANCH & SHEEPHERDER'S CABIN WATER OPPORTUNITIES

1. Name: Woods Ranch Exploratory Well
2. Location: Woods Ranch County Park, Highway 14
3. Potential Aquifer(s): Cretaceous Straight Cliffs Sandstone (Ksc)
4. Likely Annual Recharge: Greater than 10,000 acre-feet
5. Closest Existing Well: SUU Mountain Cabin
    a. Aquifer(s) penetrated: upper Ksc from 112' to 400' Below Ground Level (BGL)
    b. Well Log(s): Drillers Log
    c. Casing:

Depth(ft) Material Gage(in) Diameter(in)
From To
+2 109 A 53 GRADE B .250 8.62
95 400 A 53 GRADE B .250 6.62

Perforations were milled in the casing from 340' to 400' below ground level. Bedrock (Ksc) was sandstone, tightly cemented with calcite (calcium carbonate), and the driller logged it as "limestone." Porosity and permeability were very low (not measured), as indicated by slow water test production of 0.007 cubic feet per second, or just 3.14 gallons per minute.

Woods Ranch "Kid's Pond" reservoir was constructed in a spring-fed fracture system. The fractures continue down slope to the parking lot, where a well could be expected to penetrate fractured and leached sandstone with much higher porosity and permeability than occur in the SUU Mountain Cabin well. This well would be a good test of whether a new well will dry up springs above it, or if the water is coming from separate aquifers.

PROOF OF WATER AVAILABILITY IN BEDROCK WITHIN DRAINAGE BASIN

1. A Brian Head City well producing about 1,000 gallons per minute from Cretaceous sandstone.
2. An Enoch City well that produces about 800 gallons per minute from 424 feet of fractured quartz monzonite (granite) east of the Hurricane Fault System.
3. Cedar City exploratory well that produces about 150 gallons per minute from 250 feet of fractured granite underlying Quichapa Volcanics at Quichapa Creek (see pages 24-25); and
4. A private well 2 miles east of Three Peaks that produced 1,400 gallons per minute from 250 feet of fractured ("decomposed") granite with just 102 feet of drawdown during a 5-day test. The water level in the well stabilized at 10 feet below ground level immediately after the test.

#5 Loss of Coal Creek Water in Red Rocks

Walden 3-D, Inc.
Continuing to make a positive difference!

Water migrates down bedding planes. Bedding planes continue underneath the valley fill soils. Joe Armstrong contends there is 50% water loss from Coal Creek as the creek passes over the high porosity Navajo Sandstone formation.

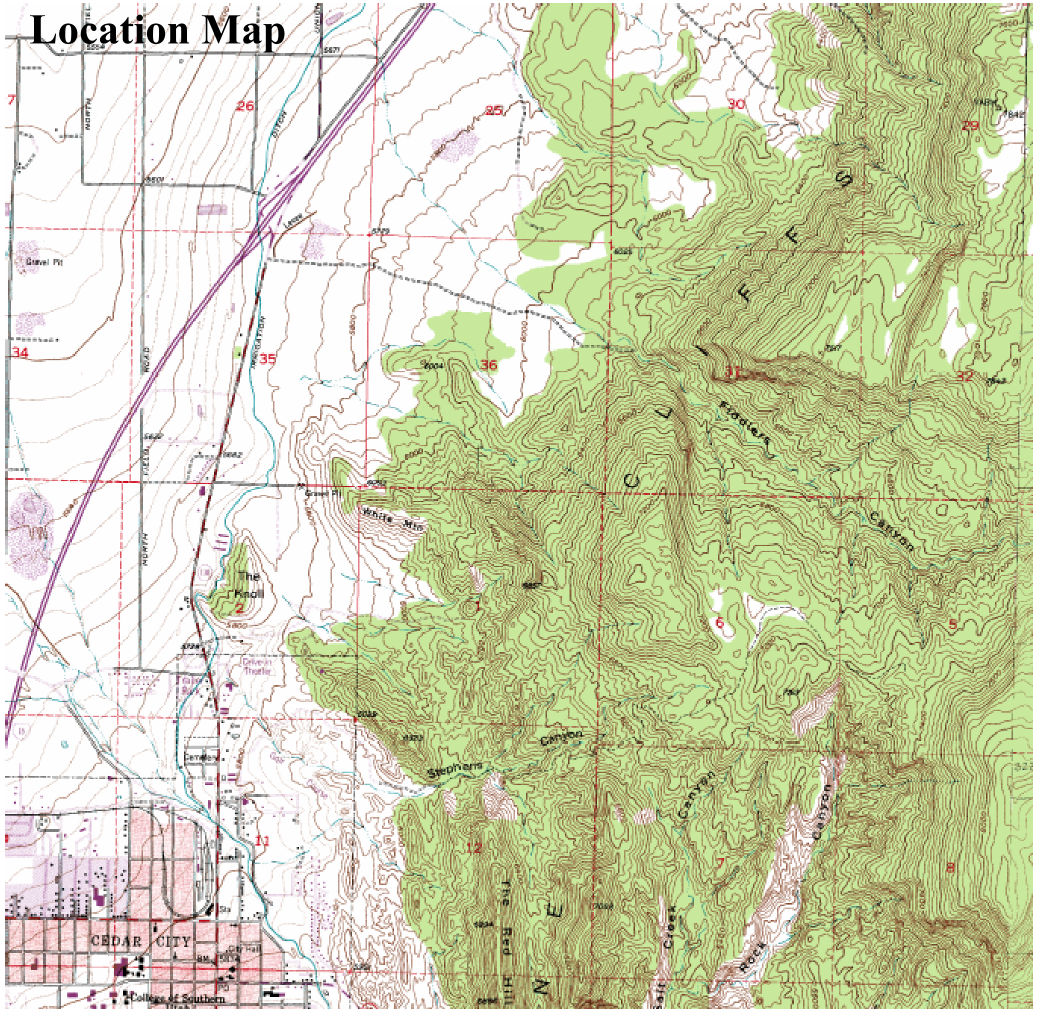
Easy to Quantify Water Loss by Seepage into the Navajo Sandstones

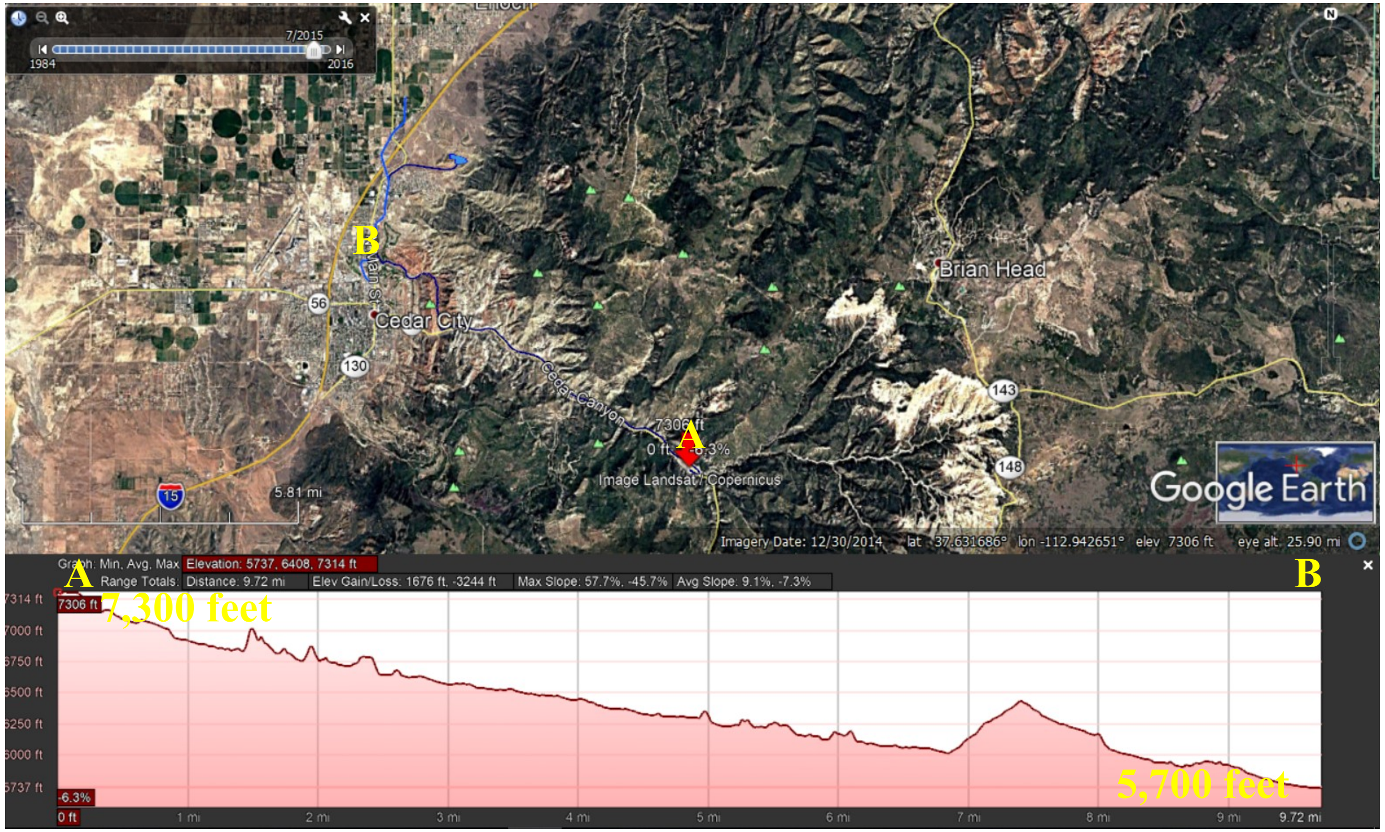
Walden 3-D, Inc.
Continuing to make a positive difference!

The USGS already measured water flow in Coal Creek. Measuring water flow above the Jurassic Sandstone is an easy way to determine how much, if any, water loss there is as Coal Creek crosses the bedding planes and high porosity sandstones.

#6 Fiddler's Canyon Lake

Walden 3-D, Inc.
Continuing to make a positive difference!

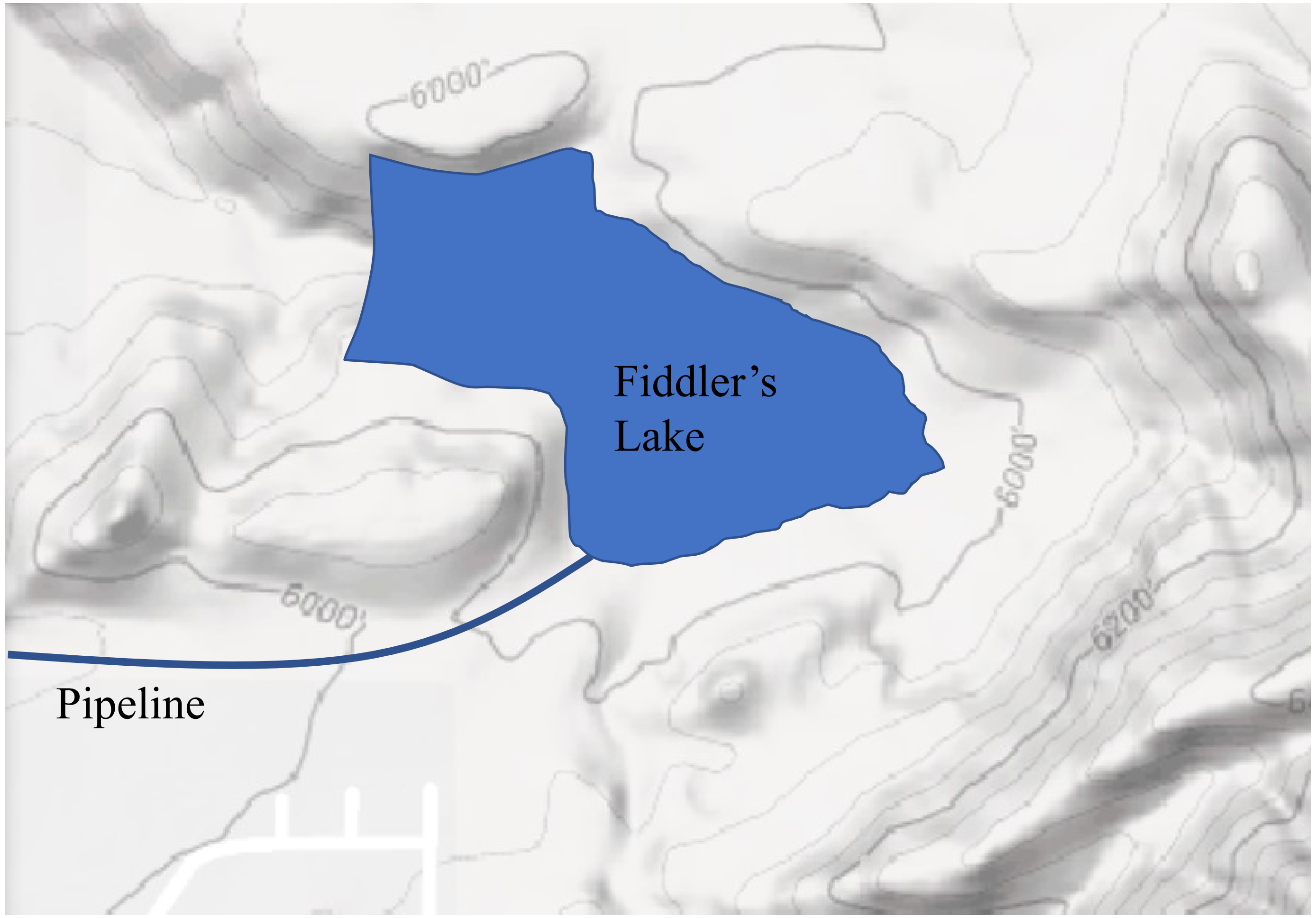


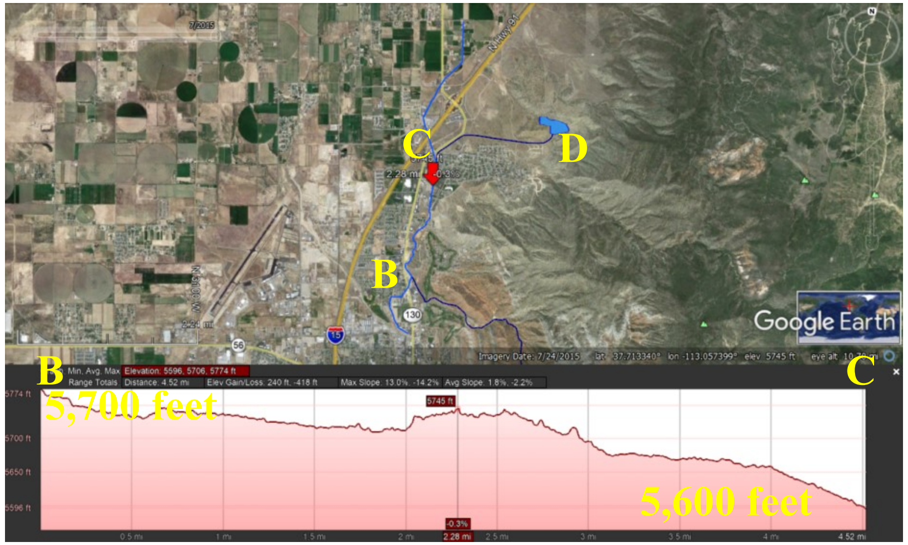


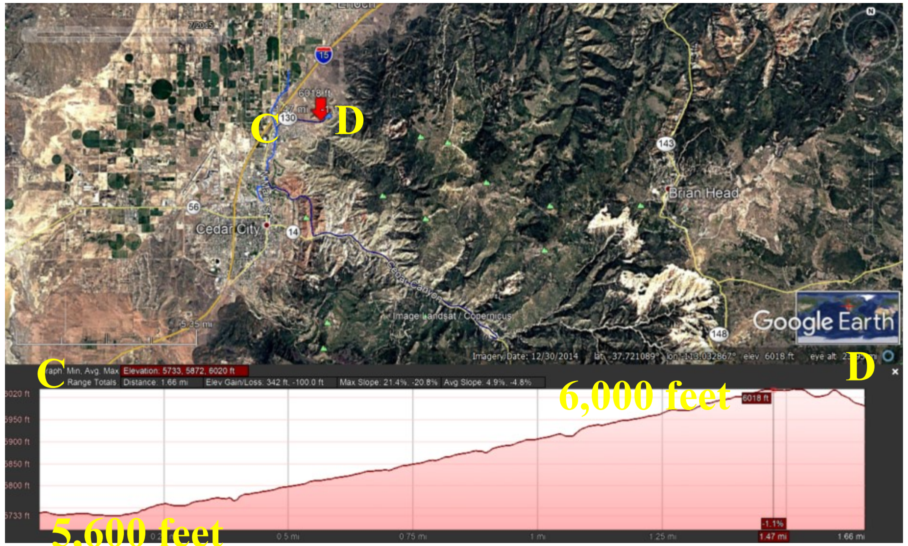
Potential Reservoir site north of Fiddler's Canyon in SW 1/4 of section 30, below the 6,000 foot elevation contour.

Proposed Lake North of Fiddlers

Walden 3-D, Inc.
Continuing to make a positive difference!







Gary Farnsworth Player Vita

Walden 3-D, Inc.
Continuing to make a positive difference!

GENERAL STATEMENT
Gary F. Player is a geologist and manager with fifty years of experience in the application of the earth sciences to problems in exploration, engineering, and the environment. Married to Corrie Lynne Player, he is the father of nine grown children and forty grandchildren. Mr. Player speaks Spanish.

EDUCATION
B.S. Geology, Stanford University, 1964; M.A. Geology, UCLA, 1966

EXPLORATION SUCCESS
He has explored successfully for mineral fuels: Player has helped find more than five billion tons of coal in central Alaska, one trillion cubic feet of natural gas in Cook Inlet Basin, Alaska, and 20 billion barrels of heavy oil on the North Slope of Alaska. He recently discovered oil and gas in a frontier basin in northern California. Player has discovered significant quantities of excellent quality ground water in Utah, California, and Arizona.

GEOLOGICAL EXPLORATION SKILLS
Mr. Player has mastered the following techniques: geophysical well log analysis on mainframe and personal computers, surface and subsurface mapping, sedimentary petrology and petrography, sample and core description, reflection and refraction seismology, sandstone geometry, basin analysis, structural geology, aquifer and reservoir hydrology, drilling supervision, photo geology, computerized data bases, porosity and permeability evaluation from geophysical logs, field, and laboratory measurements, stratigraphy and regional correlation, plate tectonics, petroleum geochemistry, etc..

ENGINEERING GEOLOGY SKILLS
Player has practical experience in project management, resolution of conflicts between agencies and individuals, pipeline route surveys, municipal and industrial waste disposal, subdivision design, groundwater hydrology, active fault studies, field mapping, nuclear power plant safety analysis, drilling, hydraulic fracturing, reflection and refraction seismology, seismicity, environmental impact reports, dam site investigations, foundation engineering, slope stability, soils classification, permafrost description, glaciology, marine geology and open-pit mining.

ENVIRONMENTAL GEOLOGY SKILLS
Gary F. Player supervised multi-company teams of biologists, engineers and geologists monitoring construction of the Trans-Alaska Pipeline System as a consultant to the U.S. Department of the Interior. He later provided environmental inspection services for the 36" diameter Kern River Gas Transportation System in southwestern Utah. As Research Analyst at the University of Alaska's Arctic Environmental Information Data Center he joined interdisciplinary teams of scientists studying northwestern and Arctic Alaska for State and Local government agencies. As a project manager he has written and edited environmental assessments and reports for offshore oil platforms, industrial plant sites, power plants, municipal water systems, arid design landfills, power lines, and proposed pipelines.

GEOGRAPHICAL DIVERSITY OF EXPERIENCE
Gary F. Player has worked throughout the continental United States and Alaska as an explorationist and engineering geologist. He has conducted field investigations in Alaska, Arizona, California, Nevada, Oregon, Utah, Idaho, Wyoming, Texas, Oklahoma, Alabama, Florida, Pennsylvania, Arkansas, Minnesota, Wisconsin, New Jersey, Delaware, Maryland, and Illinois. He also supervised a soils investigation in Puerto Ordaz, Venezuela. Mr. Player has studied the geology of dry lake desert basins, pull-apart basins, rifted continental margins, fore-arc basins, cratonic depressions and glaciated terrains. He identified surface and groundwater resources developed by the Municipality of Anchorage. Player has studied the geology and hydrology of Utah, Idaho, Wyoming and eastern Nevada to aid in the design and permitting of new sanitary landfills. He has discovered large resources of high quality ground water in desert basins and mountains of southern Utah. In California he has studied Los Angeles, San Joaquin, Sacramento, Ventura, Antelope Valley, Owens Valley, Surprise Valley and Honey Lake basins.

Since 1983 Gary F. Player has operated independent consulting firms offering services in engineering geology, water resources, waste management, public education, conflict resolution, seismology, oil and gas exploration, and mining geology. He directs all phases of projects, including client contacts, proposal preparation, cost analysis, technical work and billing.

PUBLICATIONS
Most of Gary F. Player's written and oral presentations have been to proprietary audiences of employers and clients. Significant contributions have been made in the fields of surface and groundwater exploration and development, regional and local fault patterns, alternative landfill designs for arid climates, energy minerals exploration, and methane dissolved in ground water.

Published papers include the following:
Tryck, Nyman and Hayes; Dames and Moore (G. F. Player, Project Geologist); and Leeds, Hill, Jewett, 1973, Anchorage Water Resources, for Anchorage Water Utility and Central Alaska Utilities, 307 p., 258 references. Selkregg, L., Whiteman, K., Wilson, W.J., Aho, M., and Player, G. F., 1976. Northwest Alaska Community Profiles: A Background for Planning. University of Alaska Arctic Environmental Information Data Center, Anchorage, 8 maps with descriptive folios. Wilson, W. J., Buck, Eugene H., Player, G. F., and Dreyer, L. D., 1977, Winter Water Availability and Use Conflicts as Related to Fish and Wildlife in Arctic Alaska: A Synthesis of Information. University of Alaska Arctic Environmental Information Data Center, Anchorage, 252 p. Player, G. F., 1983, Petrology of the Munson Creek Phosphorite Deposit, Ventura Basin, California. Geological Society of America, Cordilleran Section Meeting, (Abstract). Player, G. F., 2007, Economic Production of Sand Bed Methane from Ground Water, American Association of Petroleum Geologists, 2007 Annual Meeting, Long Beach, California Player, G. F., and McDonald, Blair, 2010, Indications of Glaciation in Southwestern Utah and Adjacent States, Pacific Section GSA, Anaheim, California, Poster Session.

PROFESSIONAL REGISTRATIONS
American Association of Petroleum Geologists Number 31523-5
Professional Geologist in Utah, Arizona, Idaho, and California (not active).

CONTACT INFORMATION:
1671 West 546 South, Cedar City, UT 84720 T. (435) 590-8705
Gary Player <dirtdoctor43@gmail.com>

H. Roice Nelson, Jr. Vita

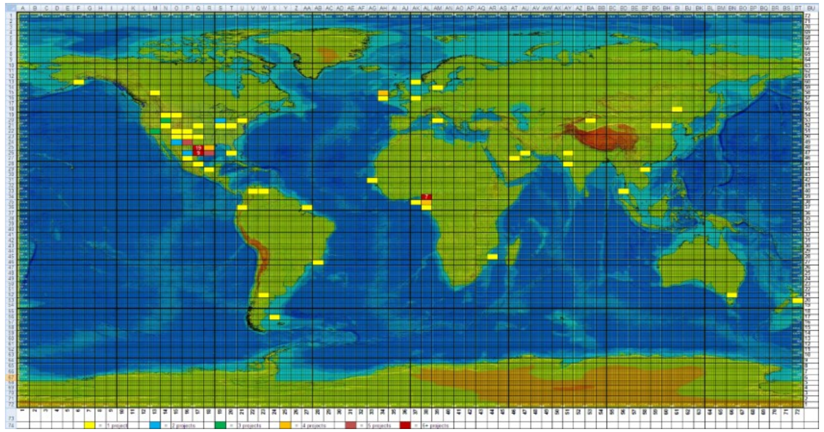
Walden 3-D, Inc.
Continuing to make a positive difference!

GENERAL STATEMENT

Roice is an experienced interpretation geoscientist who has spent his career working in the international petroleum industry. As a seismic interpreter he has worked over 100 interpretation projects worldwide. Roice has proven success in using, creating, and building new tools and processes for the hydrocarbon exploration industry. In 2008 Roice selected 6 professionals to join with him as co-founders of Dynamic Measurement, LLC (DML), and they have spent the last 10 years laying the groundwork for a new branch in the geophysical service industry: lightning analysis.

As the initial founder of Landmark Graphics, Roice designed the interpretation software, and created a university program which placed advanced interactive interpretation systems in many universities worldwide to support research and teaching. He taught courses on interactive interpretation and new technologies for Landmark and for IHRDC all over the world. He also has a consulting company (W3D) and an exploration company (DRC) to utilize industry and proprietary tools and processes to explore for, develop, and produce natural resources: hydrocarbons, geothermal energy, minerals, etc.

The map below shows locations of many of the exploration projects Roice has worked on since 1970.



W3D Infinite Grid^{SM} Spatial Resume showing Roice's interpretation project locations.

ROICE NELSON CHRONOLOGY

Dynamic Measurement LLC, Co-Founder / Manager, Oct 2008-Present
DML established to exploit using lightning data as an on-shore and shelf NSEM (Natural Sourced Electromagnetic Method) exploration tool and to create a new branch in the geophysical services industry.

Dynamic Resources Corporation, Finder / President, Jan 2001-Present
Generate and drill or mine prospects and commercialize new technologies.

Walden 3-D, Inc., Finder / President, May 1990-Present
W3D established as a new company incubator, doing geotechnical consulting and mini-urban design. Primary companies started include DML, DRC, Walden Visualization Systems, vPatch, Advanced Structures Incorporated, HyperMedia Corporation. Completed major seismic interpretation projects on 5 continents, and developed several unique information technologies including The Infinite Grid^{SM}, The Knowledge Backbone^{SM}, and the Abbott Atlas.

Geophysical Development Corporation (GDC), Vice-President Interpretation Business Development, April 2004- Sep 2007
Opened GDC China market, and helped build an integrated interpretation business. Interpretation for Ji Dong (3700 B/D, largest find in China in 10 years), Tarim (130 BCM, 3rd largest gas field in Xinjiang), Da Qing, Xing Jiang, and Tuha Chinese Oilfields. Created GDC's Tiles^{TM} Studies.

Continuum Resources Intern'l Corp., Co-Founder, Sep 1997-Aug 2000
Demonstrated real-time simultaneous virtual reality collaboration with terabyte databases in London England, Perth Australia, and Houston.

HyperMedia Corporation, Jan 1991-2007, Co-Founder
Designed, built, and produced a UNIX, X-Windows, Motif, Client-Server hypertext engine, sold, and installed site-license to Saudi Aramco.

Landmark Graphics Corporation, Nov 1982-Sep 1992, Co-Founder
Designed user interface of first stand-alone seismic interpretation workstation software, only exploration geophysicist, worked with customers all over the world, established and ran Landmark's University Program.

University of Houston's Allied Geophysical Labs (AGL) & Seismic Acoustics Lab (SAL), Jan 1980-Nov 1982, Founder, General Manager
Managed physical modeling facility at SAL, created 4 new labs.

Mobil Oil Corporation, Jul 1974-Jan 1980, Geophysicist
Seismic interpretation, processing, and acquisition geophysicist.

Amoco Corporation/Pan American Corporation, Summers 1973 & 1970
Summer Intern and Assistant Geophysicist in Denver

EDUCATION

1981, MBA (Master's Business Administration) Southern Methodist Univ.
1974, B.S. Geophysics, University of Utah

OTHER

- Published 220+ technical papers since 1973, including the book New Technologies in Exploration Geophysics in English and Chinese. Details available on request, lightning papers can be reviewed at http://www.dynamicmeasurement.com/TAMU.
- Co-Organized 9 SEG Research Workshops, including Remote Sensing Workshop at the Anaheim, California Convention, Friday, 19 Oct 2018.
- Honorary Membership GSH (Geophysical Society of Houston).
- Enterprise Award SEG (Society of Exploration Geophysicists).
- Key Professional Societies: AAPG, EAGE, GSH, HGS, and SEG.

PROFESSIONAL REGISTRATIONS

American Association of Petroleum Geologists Number 476651
Texas Professional Geoscientist #5120
Louisiana Professional Geoscientist #879 (not active).

CONTACT INFORMATION:

2155 West 700 South #31, Cedar City, UT 84720 T. (713) 5420-2207
Roice Nelson <rnelson@walden3d.com>