3-Dimensional Geologic Model of the Flathead River Valley at Kalispell Montana

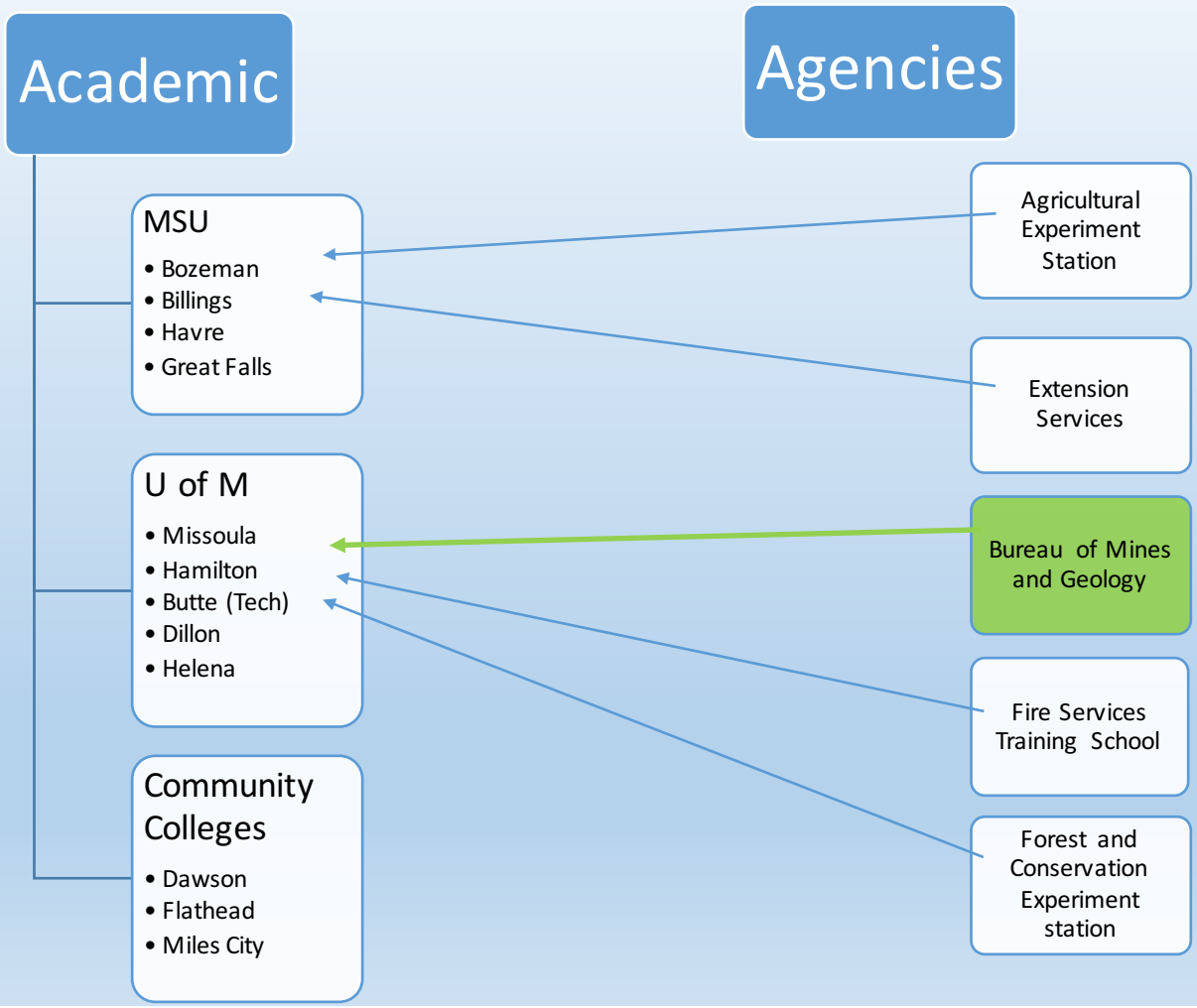
April 6, 2016
Kalispell Montana

James Rose and John Wheaton

MBMG
Montana Bureau of Mines and Geology

GWIP
Answering complex, locally identified hydrologic questions across Montana

Montana University System



http://www.mbmg.mtech.edu/datacenter/datacenter.asp

MBMG

Ground Water Programs

GWAP- Ground Water Assessment Program: Regional, multi-county characterization

GWIP- Ground Water Investigation Program: local, focused groundwater concerns

GWIC- Ground Water Information Center:

State Water Wells Database http://mbmggwic.mtech.edu/

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The Flathead Valley, Deep Aquifer Project- GWIP

Tonight's discussion ---

Setting the stage:

- Why this project happened
  - Geologic History of the Kalispell Valley
  - Current Geologic setting
    - Hydrogeology of the Deep Aquifer

James Rose- Associate Hydrogeologist
John Wheaton- Senior Hydrogeologist

GWIP
Answering complex, locally identified hydrologic questions across Montana

Ali Gebril

Andy Bobst

The Flathead Valley, Deep Aquifer Project
Ground Water Investigations Program – MBMG

Research Questions --- What do we need to know?

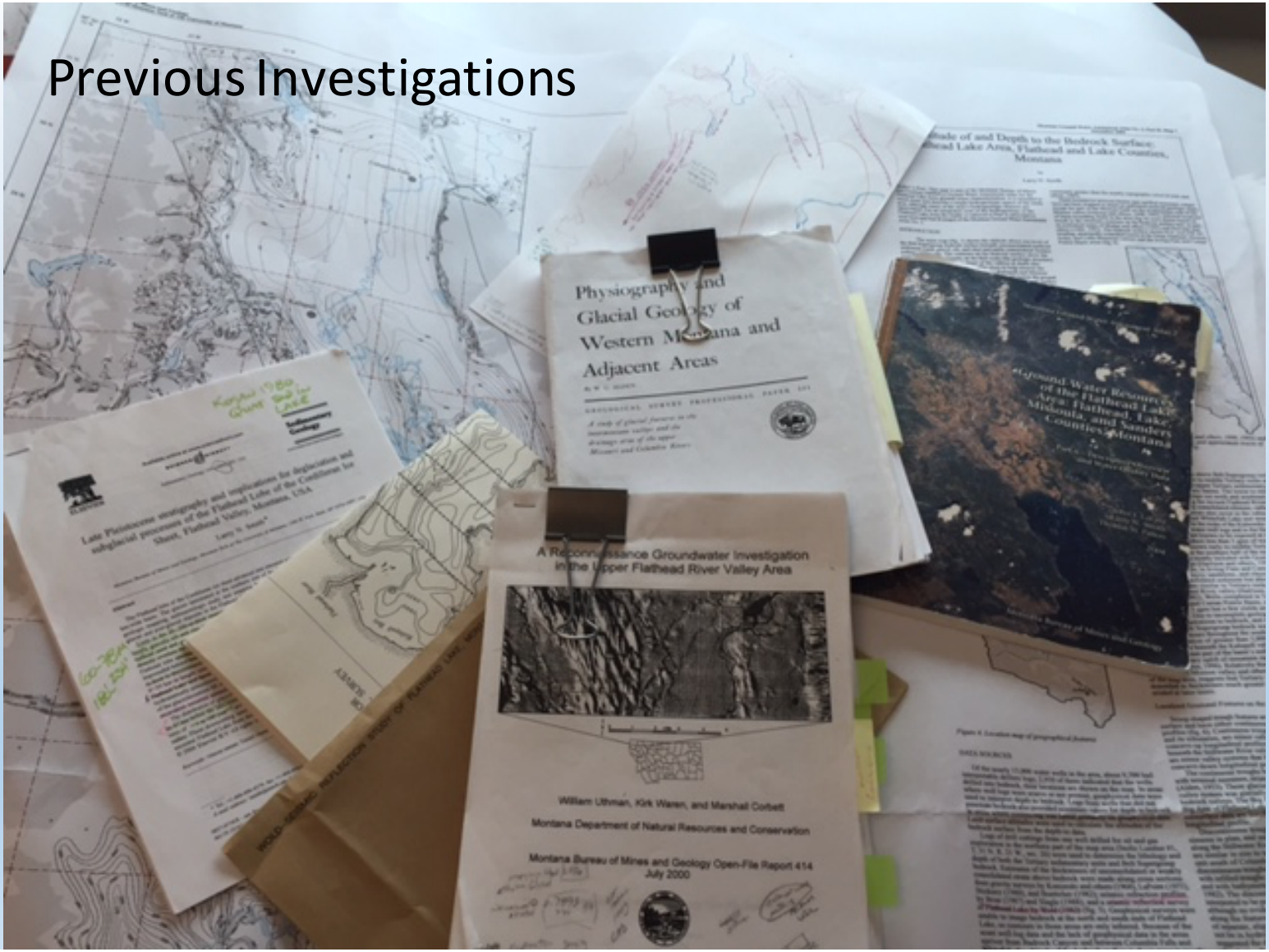
- **Confining Unit**
- **Water storage capacity**
- **Is Deep Aquifer Connected to Flathead Lake**
- **Provide scientific information to assist with local planning**

Why Geology ?–
Geology influences groundwater

Geology defines-

- groundwater flow paths
- aquifer size (boundaries)
- depth to the aquifer
- surface water/groundwater connections
- aquifer hydraulic properties

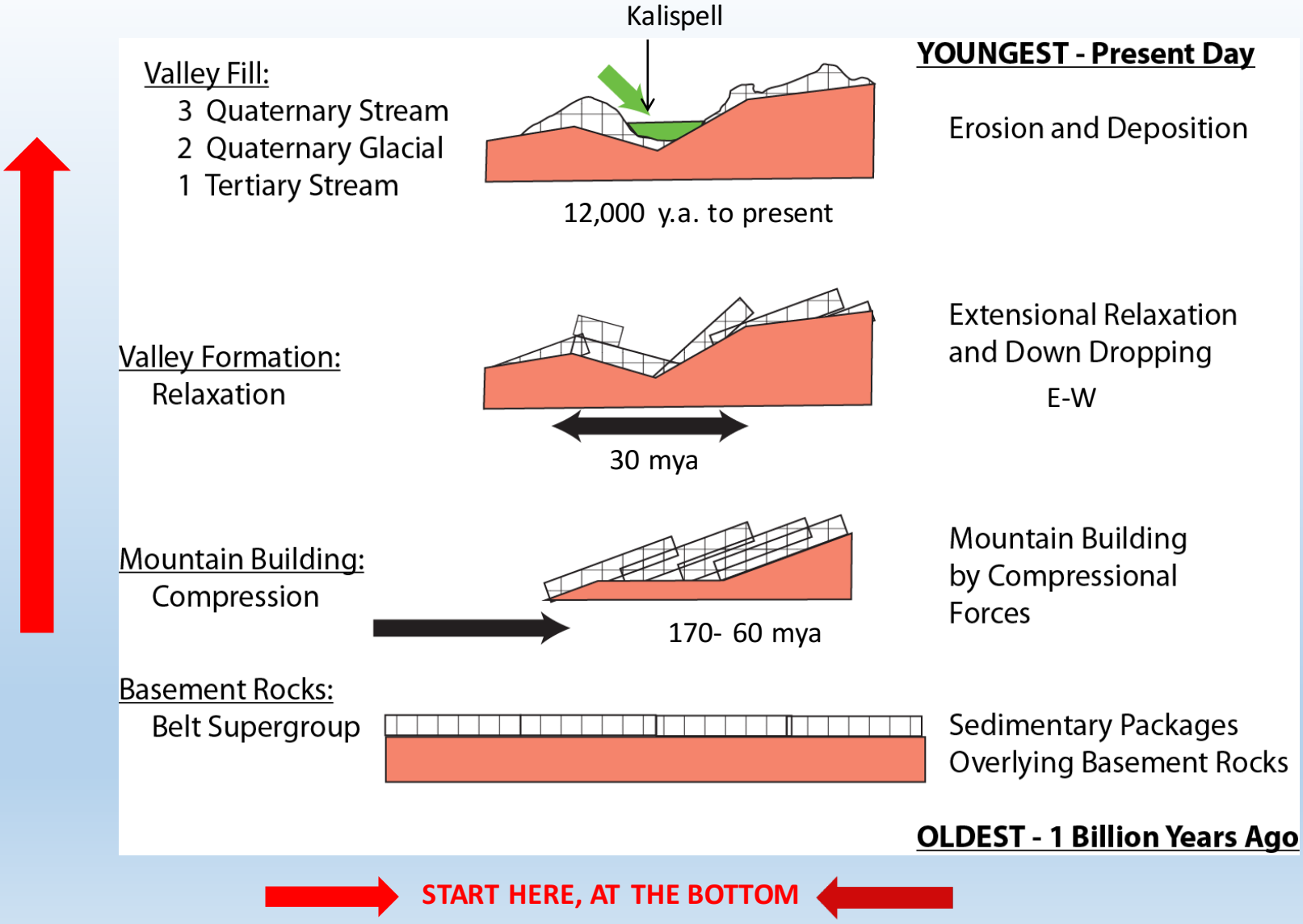
Previous Investigations



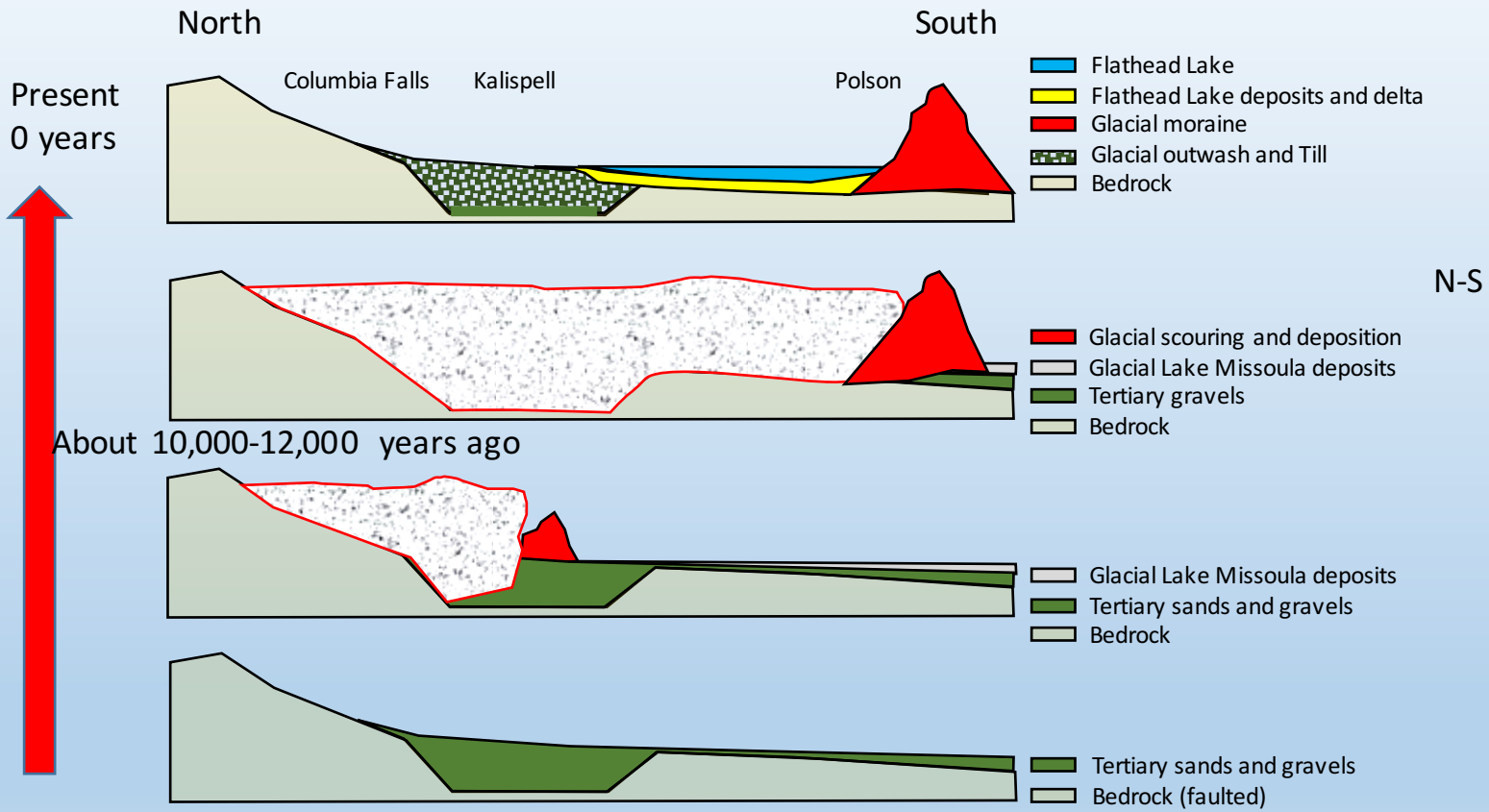
How do we form these rows of mountains and deep valleys?

Mountain building forces occurred west to east.

setting

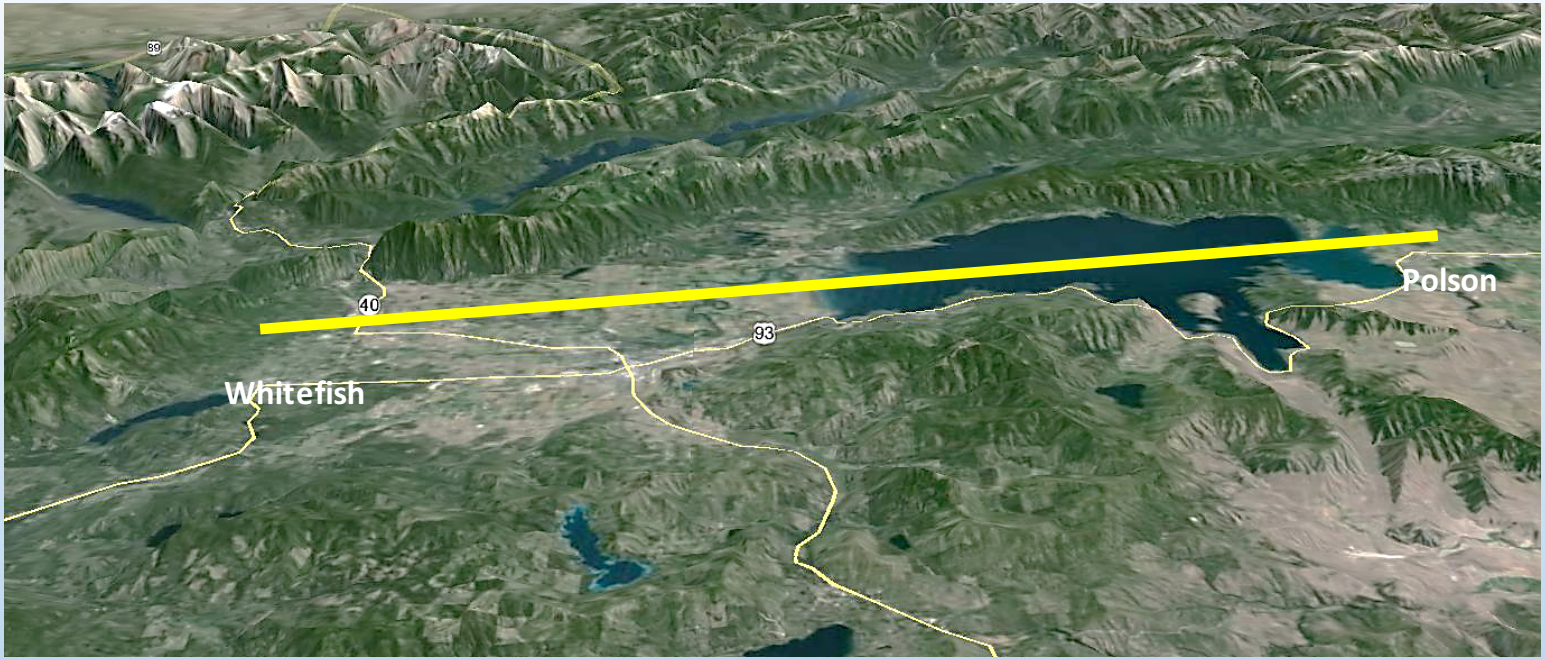

Kalispell
Valley Fill:
3 Quaternary Stream
2 Quaternary Glacial
1 Tertiary Stream
12,000 y.a. to present
YOUNGEST - Present Day
Erosion and Deposition
Valley Formation:
Relaxation
30 mya
Extensional Relaxation
and Down Dropping
E-W
Mountain Building:
Compression
170- 60 mya
Mountain Building
by Compressional
Forces
Basement Rocks:
Belt Supergroup
Sedimentary Packages
Overlying Basement Rocks
OLDEST - 1 Billion Years Ago
START HERE, AT THE BOTTOM

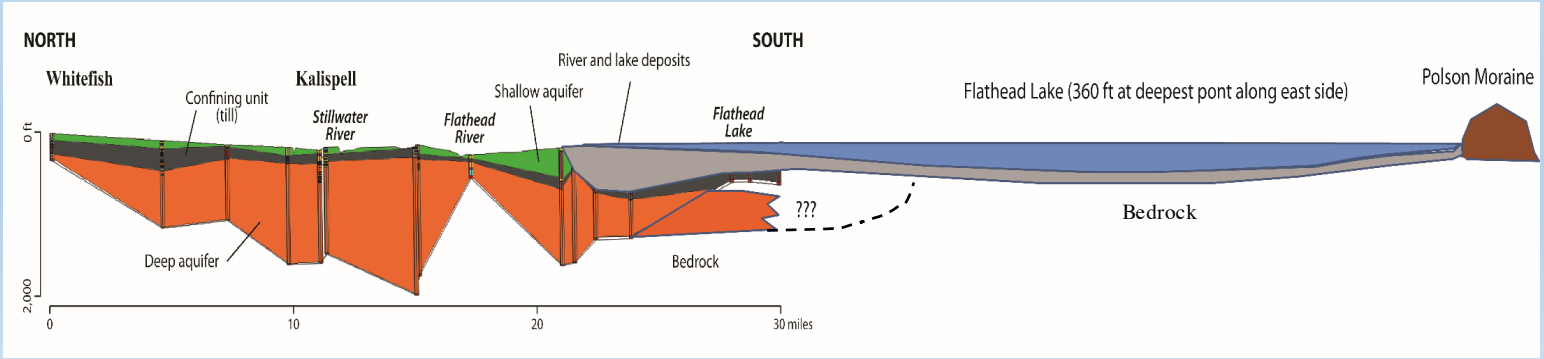
A possible geomorphological history of the Flathead Valley glaciation.



Animate to reveal next image

Here we are, but how did we get here?





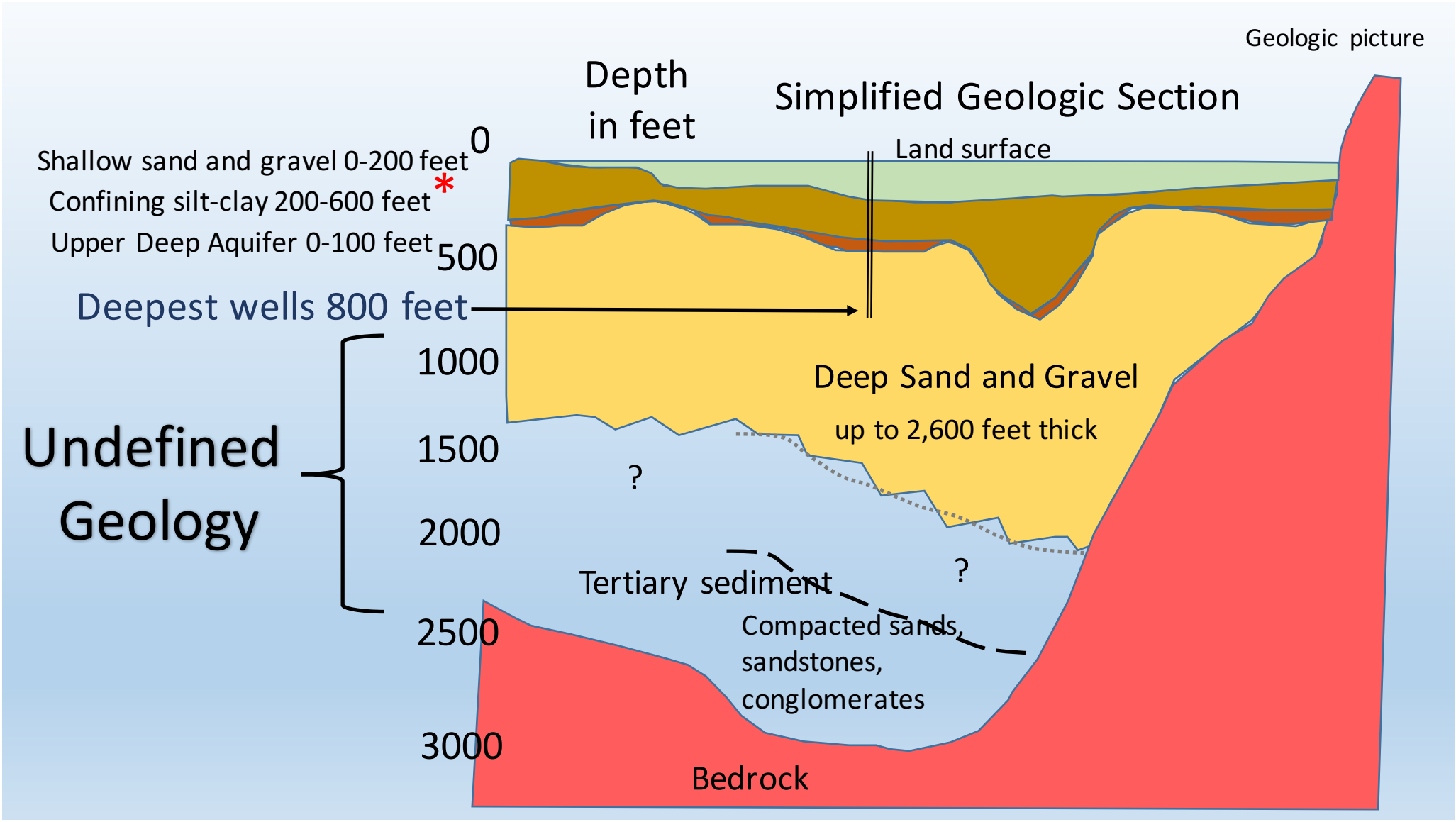
Geologic Section

Thickness of unit	Hydrogeologic Unit	Age	Material Description
0-200’	Shallow sand and gravel	Holocene-present	sand and gravel with silt and clay
<50’-400’	Confining Unit	Pleistocene - Holocene	Silt and silty-clay lacustrine sediments and till (gravel embedded in clay)
0’-100’	Upper Deep Aquifer	Quaternary	coarse sand and gravel with abundant silt or clay
~1,500’- ?	Deep Aquifer	Quaternary	Clean coarse sands and gravels with occasional silty or clay-rich intervals
+/- 1000’?	Tertiary Sediments	Tertiary	semi-consolidated sands and gravels and conglomerate
	Belt bedrock	Pre-Cambrian	argillite,quartzite, siltite, mudstone, marble, dolomite

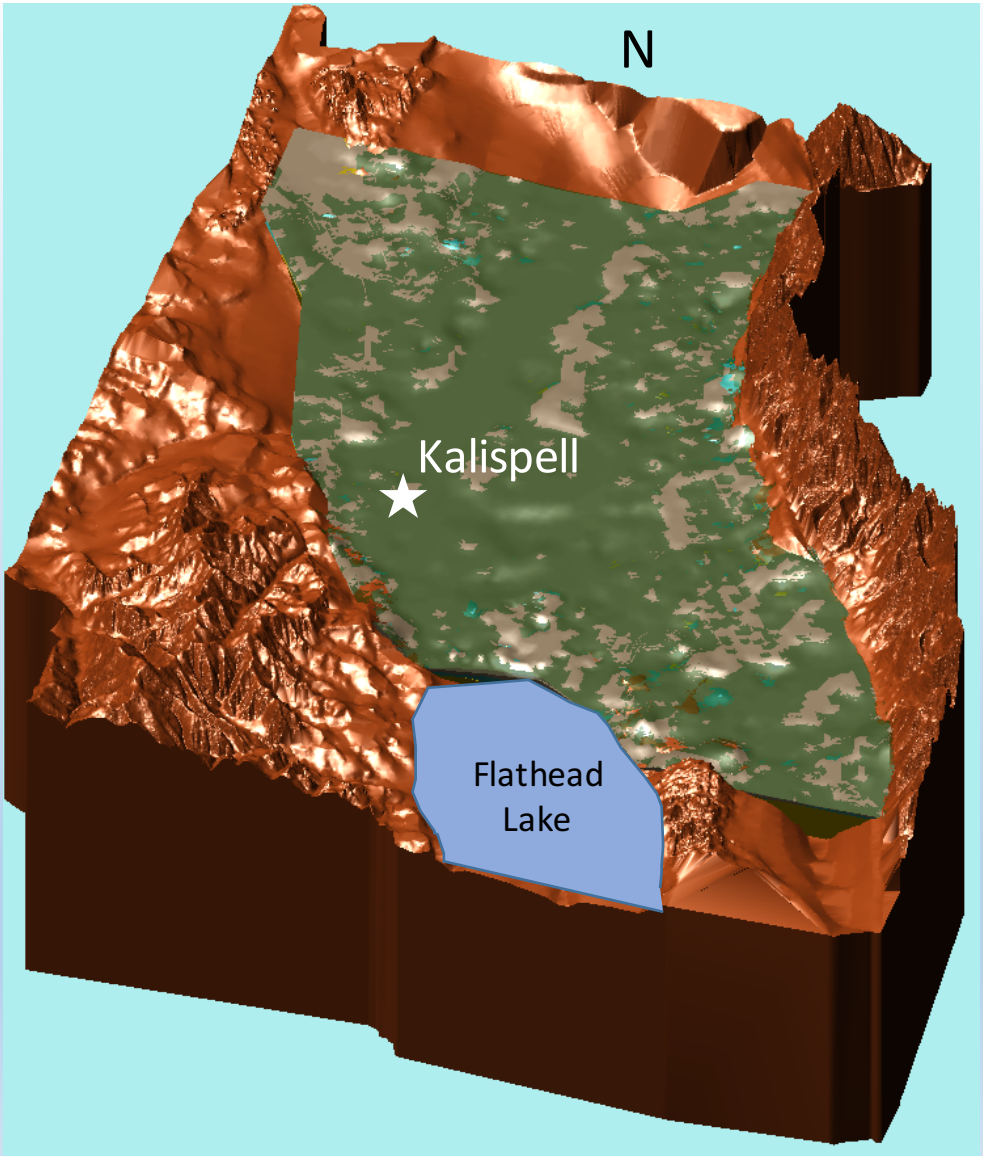
Wells data

Good clean water source

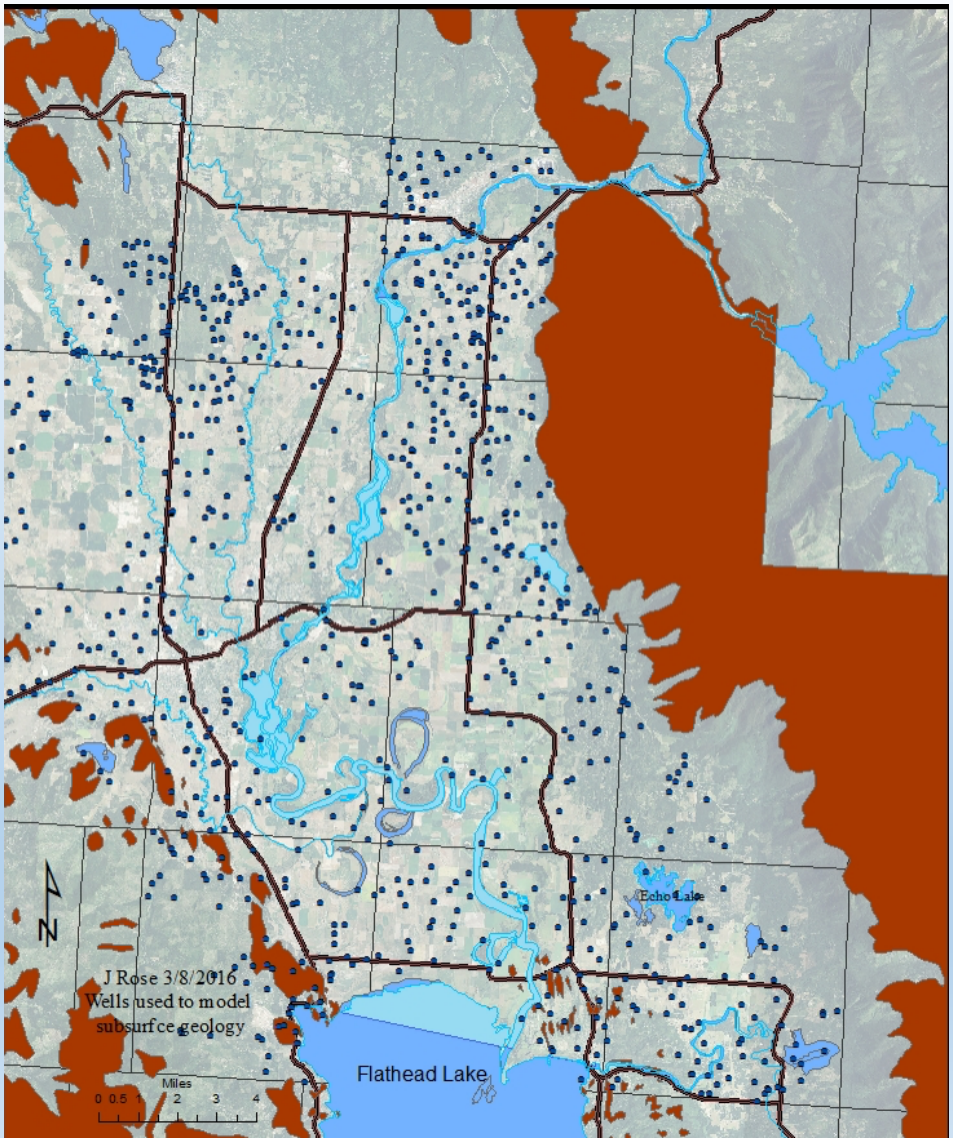
Great water filter


Geologic picture
Depth in feet
Simplified Geologic Section
0
Land surface
Shallow sand and gravel 0-200 feet
Confining silt-clay 200-600 feet *
Upper Deep Aquifer 0-100 feet
500
Deepest wells 800 feet
1000
Deep Sand and Gravel
up to 2,600 feet thick
Undefined Geology
1500
?
2000
Tertiary sediment
?
2500
Compacted sands, sandstones, conglomerates
3000
Bedrock

3-Dimensional computer generated Geologic Model



Consolidate existing information



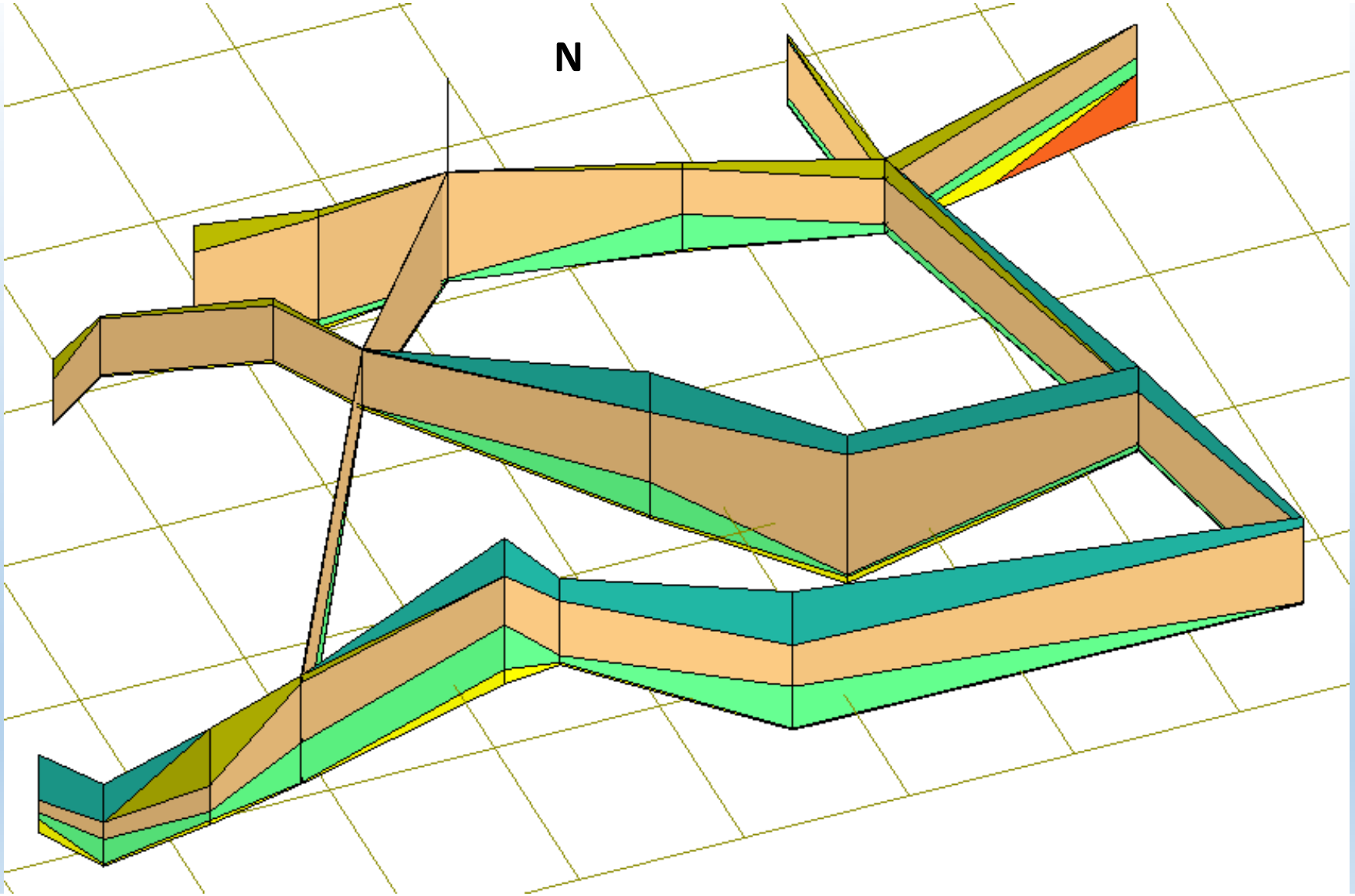
Geologic Model

980 selected wells

Drillers detailed log

From	To	Welll Drillers Description	Geologic interpretation	From	To	Simplified Hydrogeologic Unit Grouping
0	1	TOPSOIL	Top Soil	0	1	Land Surface
1	8	SANDY TAN CLAY	Sandy Clay	1	8	Clay
8	34	WET BROWN SAND	Brown Sand	8	34	Shallow Aquifer
34	63	TAN CLAY	Tan Clay	34	189	Confining Unit
63	189	SAND GRAVEL AND COBBLESTONES EMBEDDED IN TAN SILTY CLAY	Till			
189	241	CEMENTED SAND GRAVEL AND COBBLESTONES SOME WATER	Cemented Gravel	189	442	Upper Deep Aquifer
241	243	BOULDER	Boulder			
243	278	CEMENTED SAND GRAVEL AND COBBLESTONES SOME WATER	Cemented Gravel			
278	293	HARD PACKED SAND GRAVEL AND COBBLESTONES IN TAN SILT MATRIX SOME WATER	Silt with sand and gravel			
293	304	LOOSER LARGE GRAVEL MIXED IN SILTY SAND. SOME SILTY SANDY WATER	Sand with gravel and silt			
304	326	CEMENTED SAND GRAVEL AND COBBLESTONES	Cemented Gravel			
326	334	GRAVEL MIXED IN TAN SILTY SAND SOME SANDY WATER	Sand with gravel and silt			
334	340	CEMENTED SAND AND GRAVEL SOME WATER	Cemented Gravel			
340	341	HEAVING GRAVEL MIXED IN COARSE SAND SOME SANDY WATER	Sand with gravel			
341	345	CEMENTED SAND GRAVEL AND COBBLESTONES SOME WATER	Cemented Gravel			
345	348	HEAVING GRAVEL MIXED IN SAND. APPROX 200 GPM SANDY WATER	Sand with gravel			
348	359	CEMENTED SAND AND GRAVEL SOME WATER	Cemented Gravel			
359	360	HEAVING GRAVEL MIXED IN SAND	Sand with Gravel			
360	379	CEMENTED SAND AND GRAVEL. SOME WATER	Cemented Gravel			
379	401	GRAVEL MIXED IN SAND SOME SANDY WATER	Sand with gravel			
401	408	HARD PACKED SAND AND GRAVEL IN SILT MATRIX	Silt with sand and gravel			
408	412	GRAVEL AND COBBLESTONES MIXED IN SAND. SOME SANDY WATER	Sand with Gravel			
412	419	CEMENTED SAND AND GRAVEL SOME SANDY WATER	Cemented Gravel			
419	432	GRAVEL MIXED IN SAND SOME SANDY WATER	Sand with Gravel			
432	434	CEMENTED SAND AND GRAVEL SOME SANDY WATER	Cemented Gravel			
434	442	GRAVEL MIXED IN SAND SOME SANDY WATER	Sand with Gravel			
442	444	CLEAN COARSE SAND AND GRAVEL	Sand and Gravel	442	510	Deep Aquifer
444	453	CEMENTED SAND AND GRAVEL SOME SANDY WATER	Cemented Gravel			
453	465	CLEAN COARSE SAND GRAVEL COBBLESTONES 300-400 GPM	Sand and Gravel			
465	488	CLEAN COARSE SAND AND GRAVEL WITH STRINGERS OF CEMENTED SAND AND GRAVEL 300-400 GPM	Sand and Gravel			
488	510	CEMENTED SAND GRAVEL AND COBBLESTONES 1300+ GPM	Sand and Gravel			

Modeled Hydrologic Layers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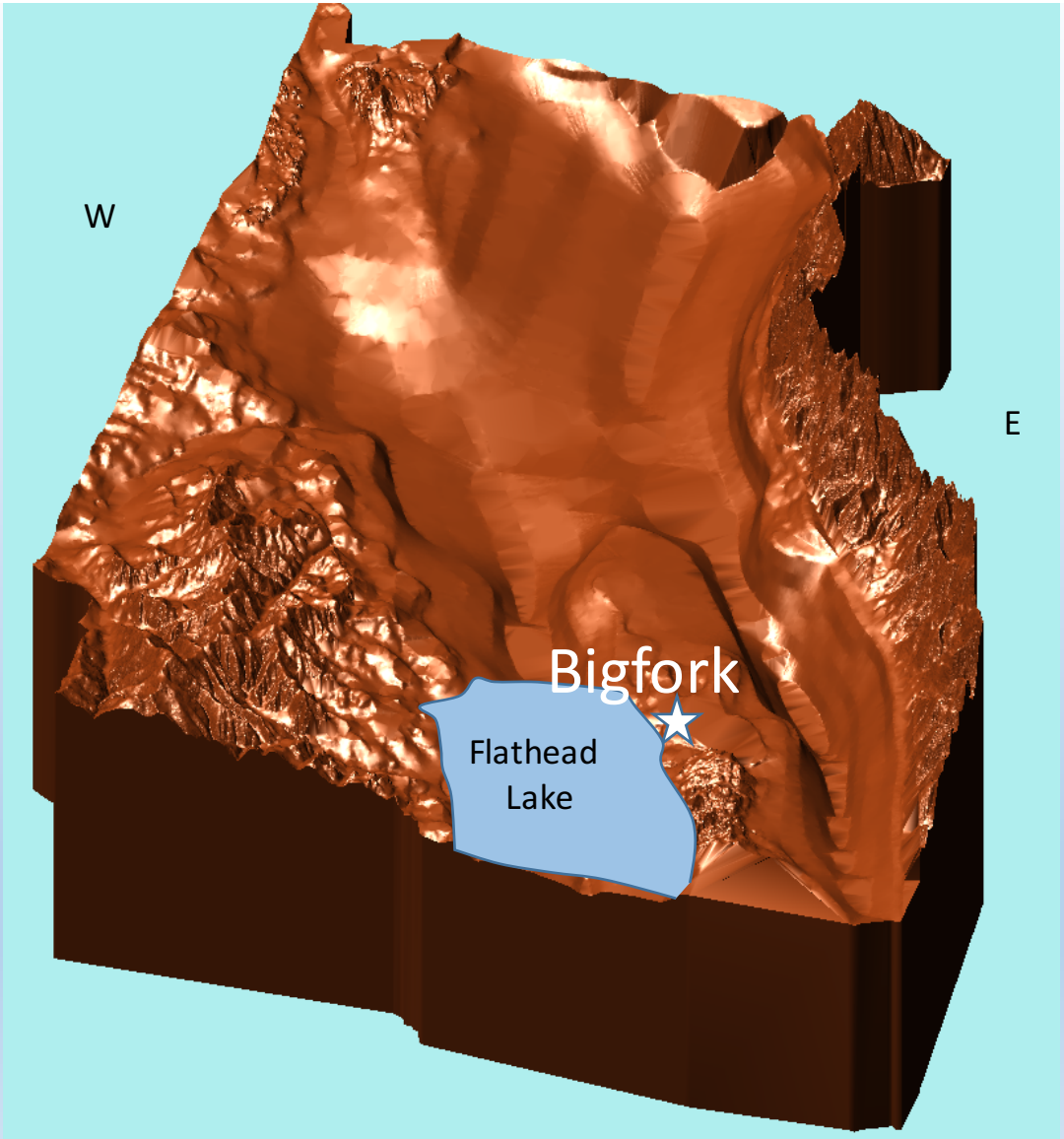
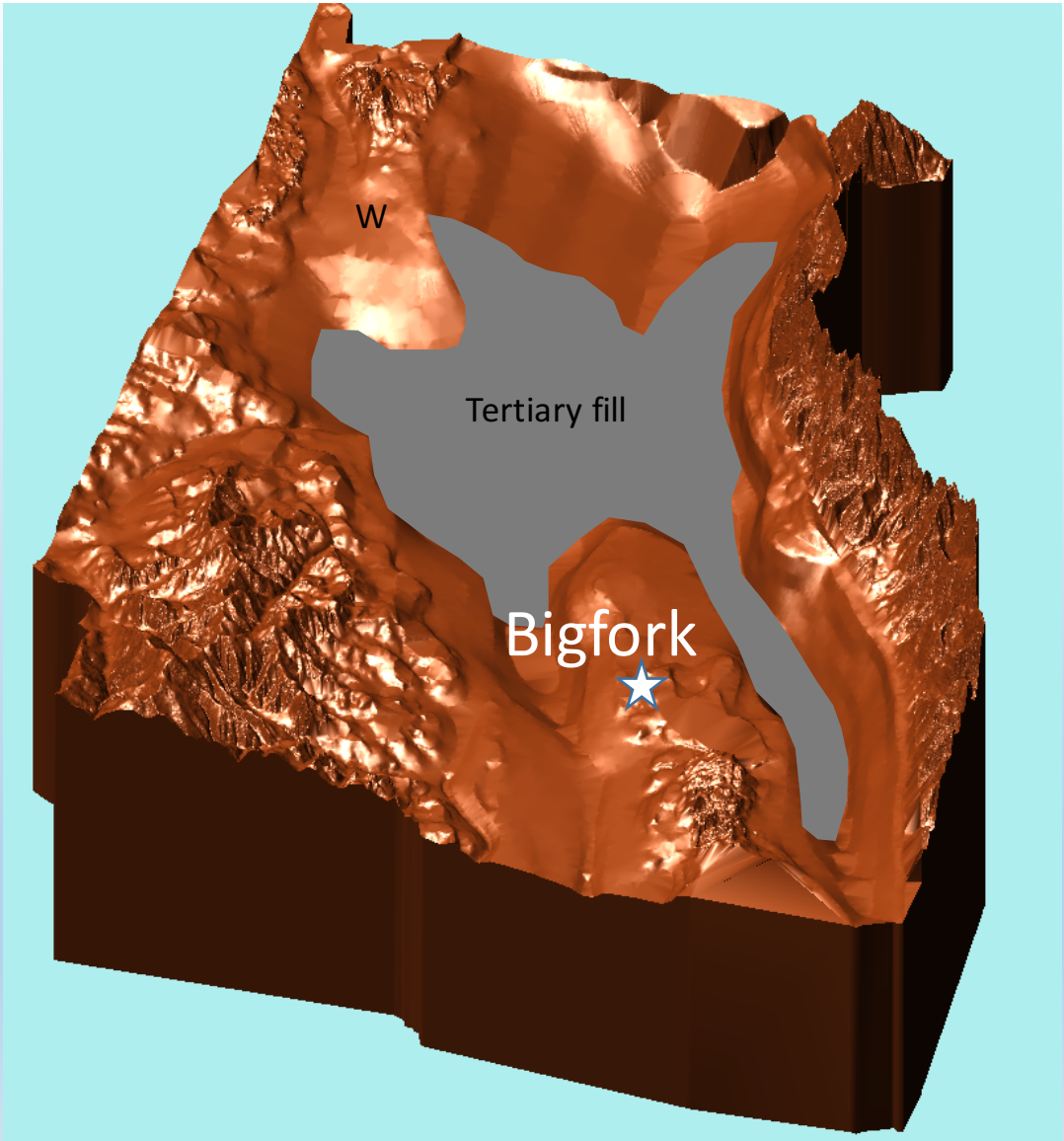


Bedrock surface troughs

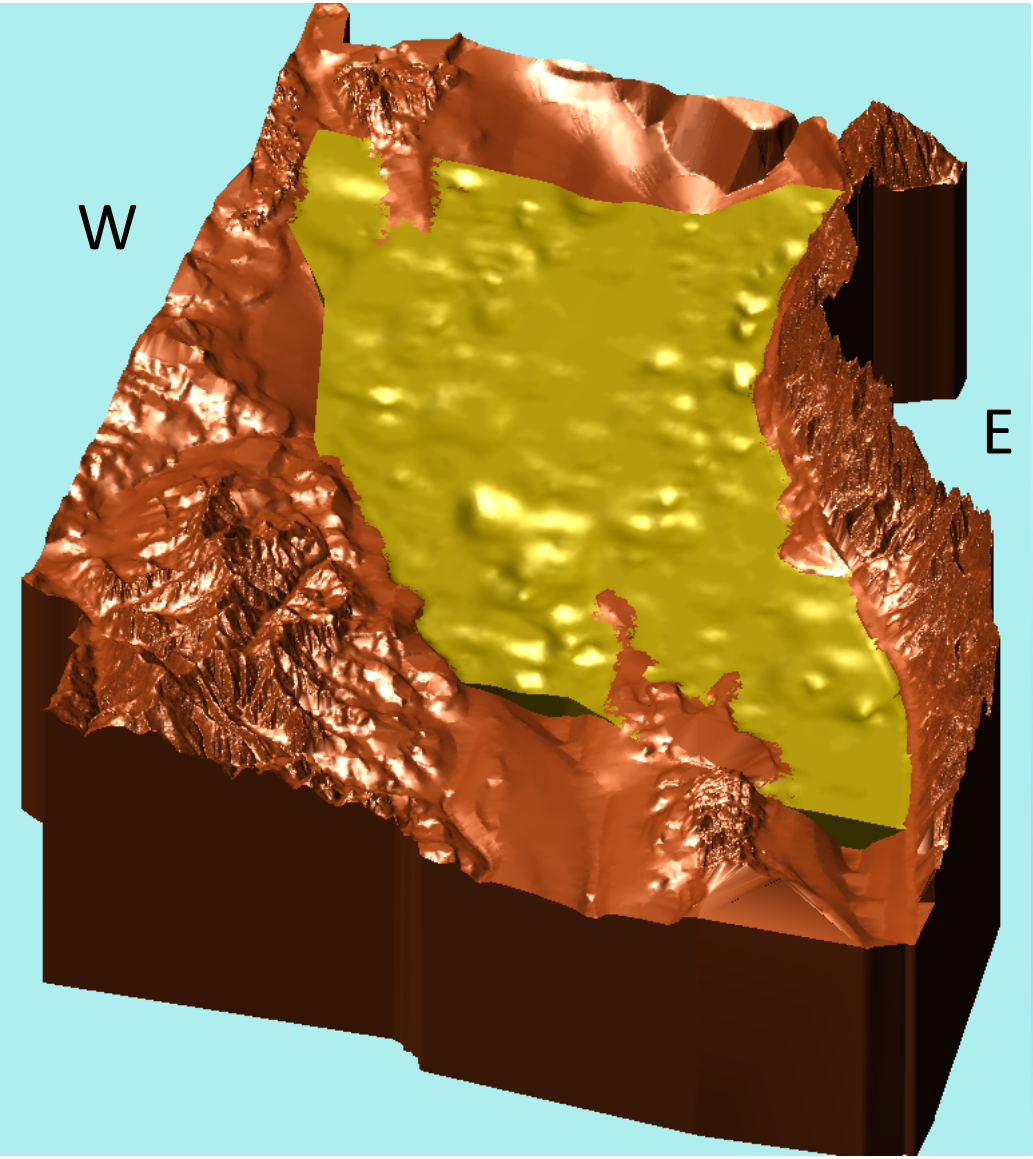
ridge



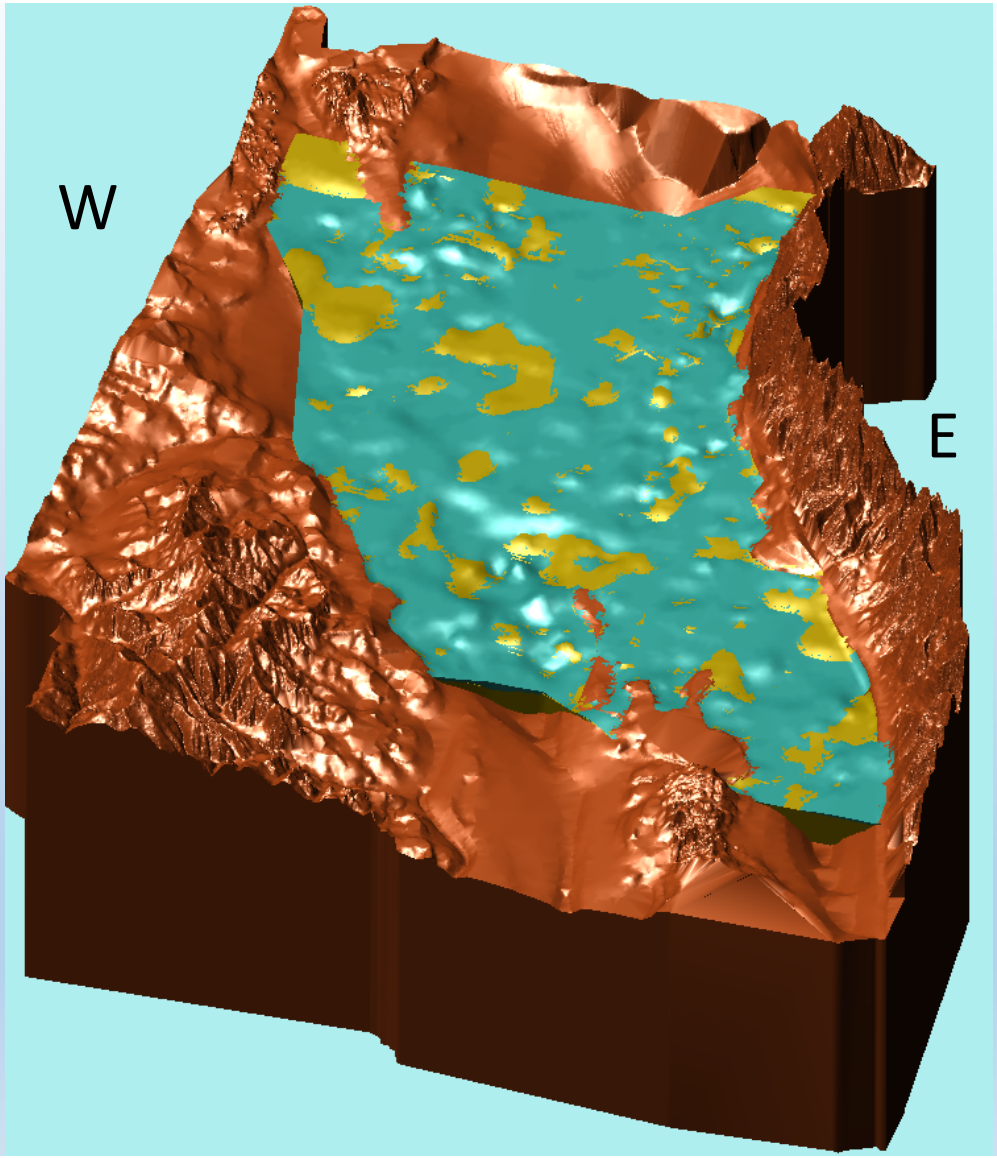
Estimated Tertiary sediment fill thickness

Estimated thickness, not drilled

Sandstone and conglomerate

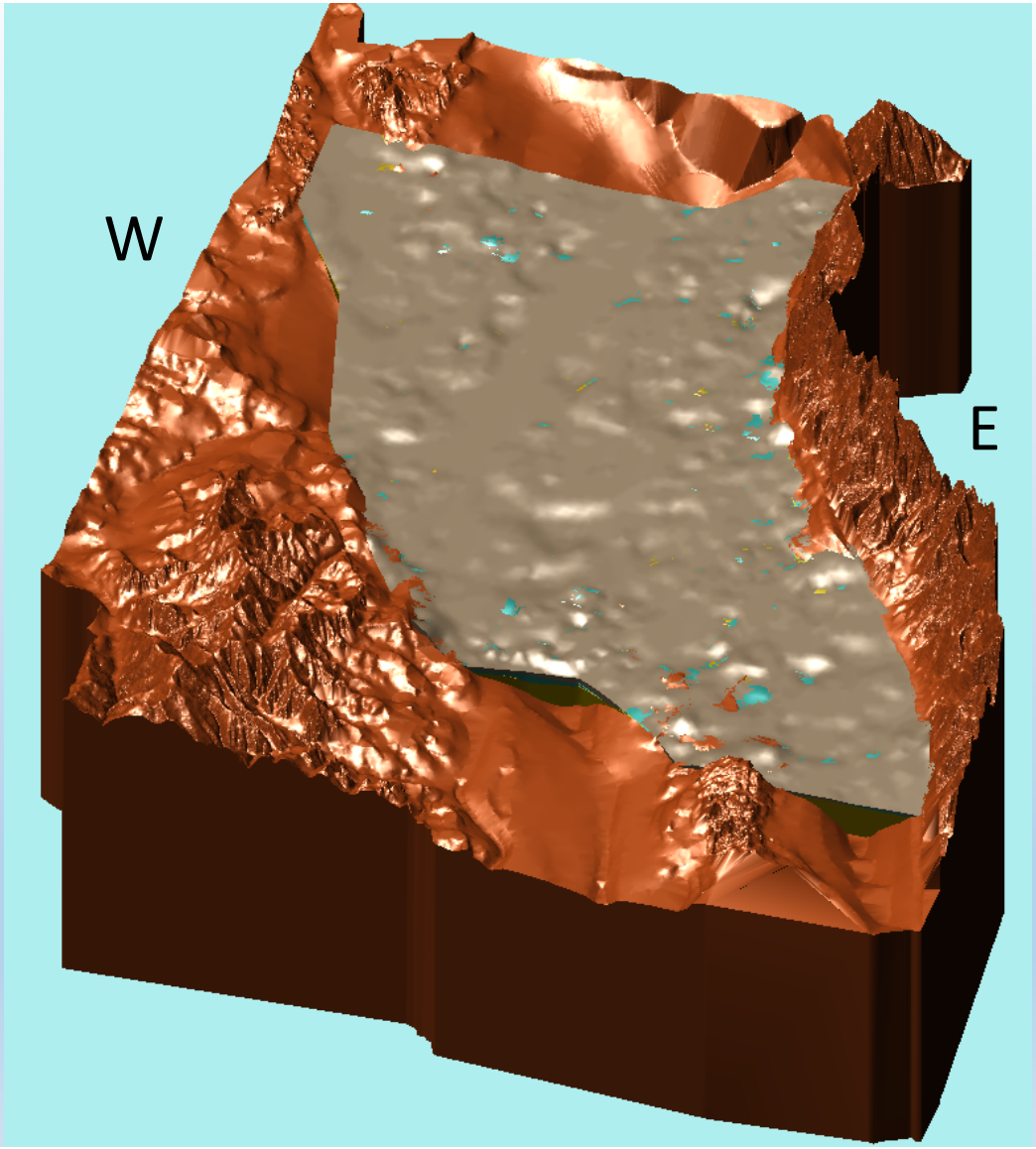


Deep sand and gravel aquifer



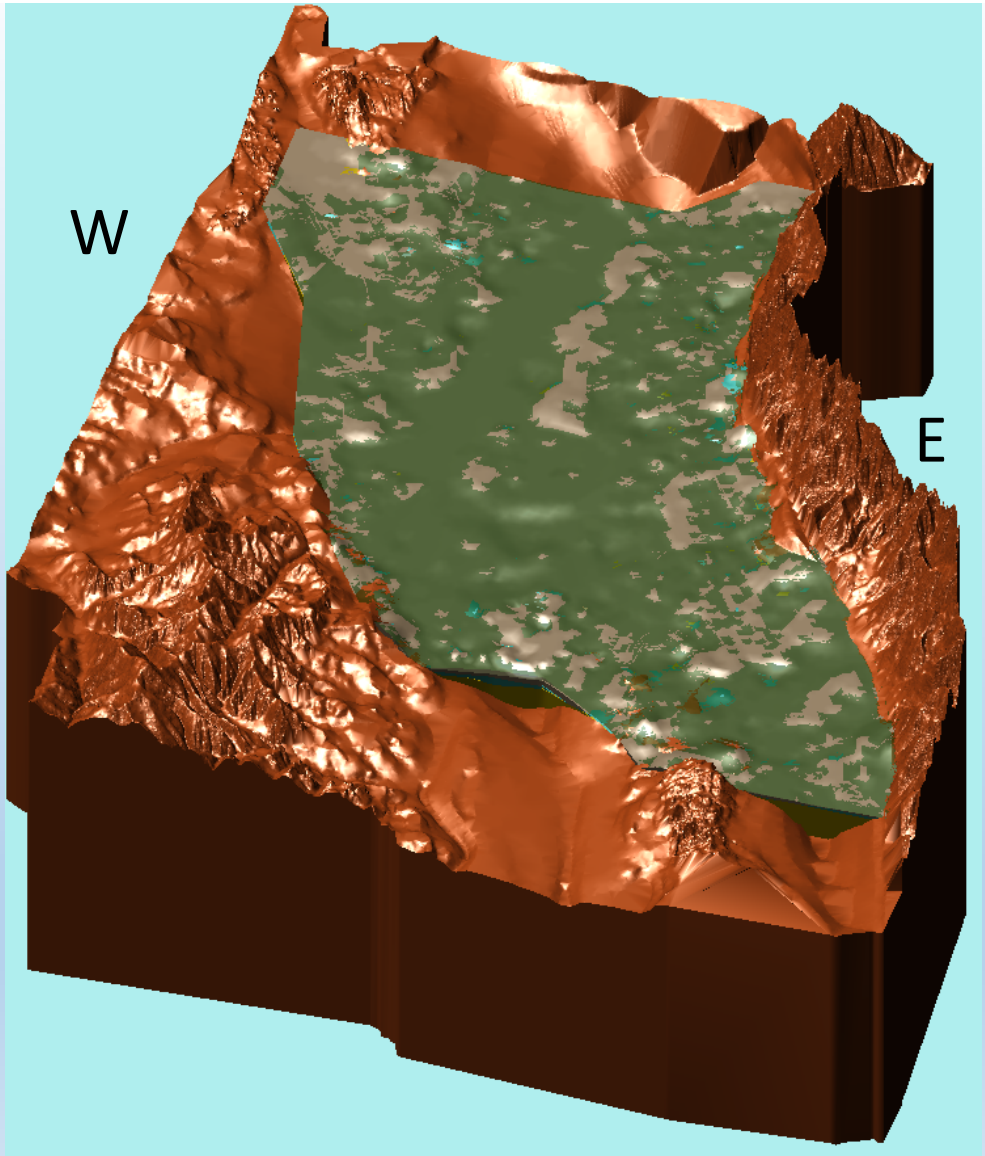
Top of Deep Aquifer

Very silty sand and gravel



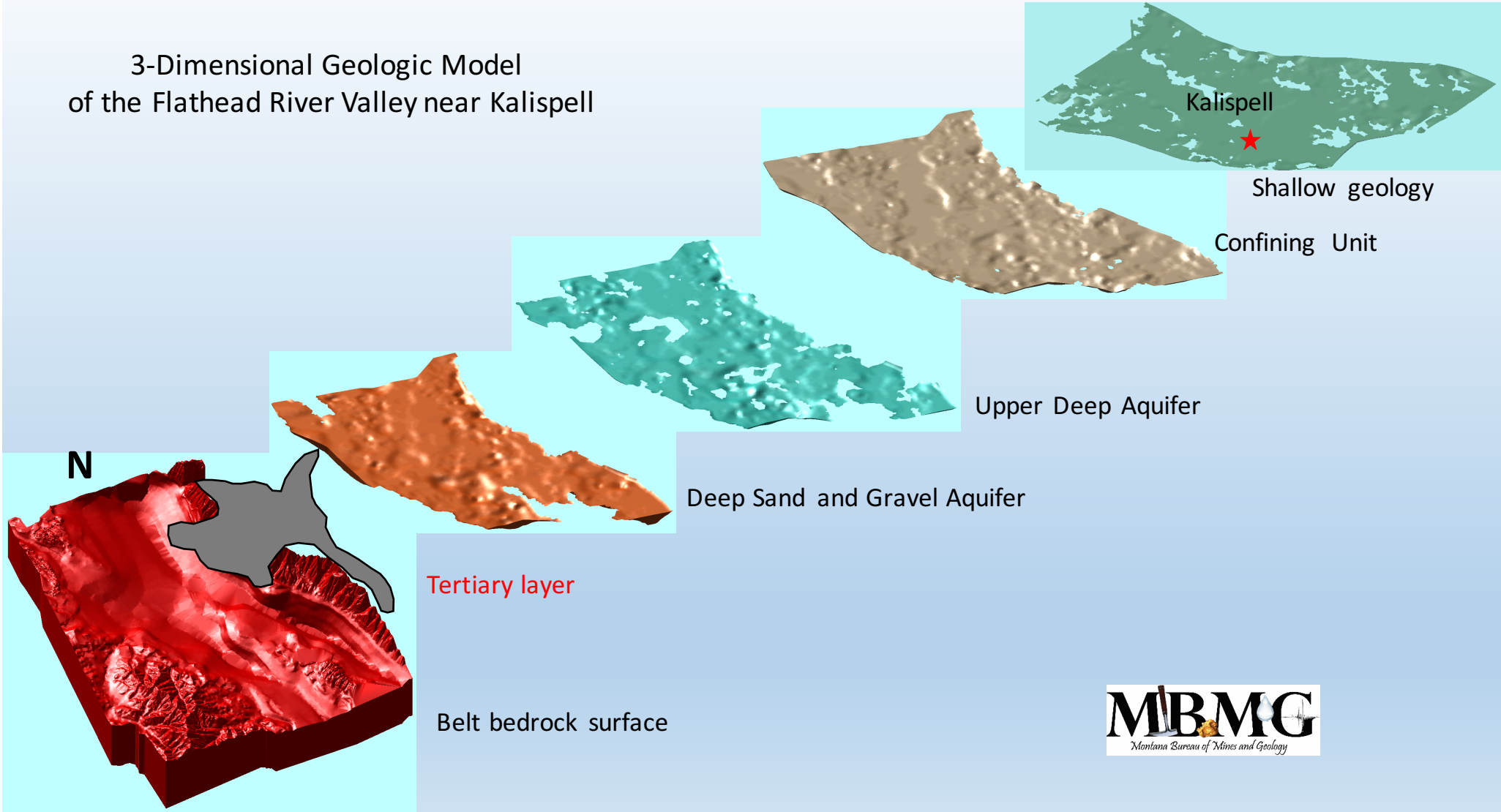
Confining Unit

Silt-clay



Land surface/
Modern sand, gravel, silt, and clay

3-Dimensional Geologic Model of the Flathead River Valley near Kalispell



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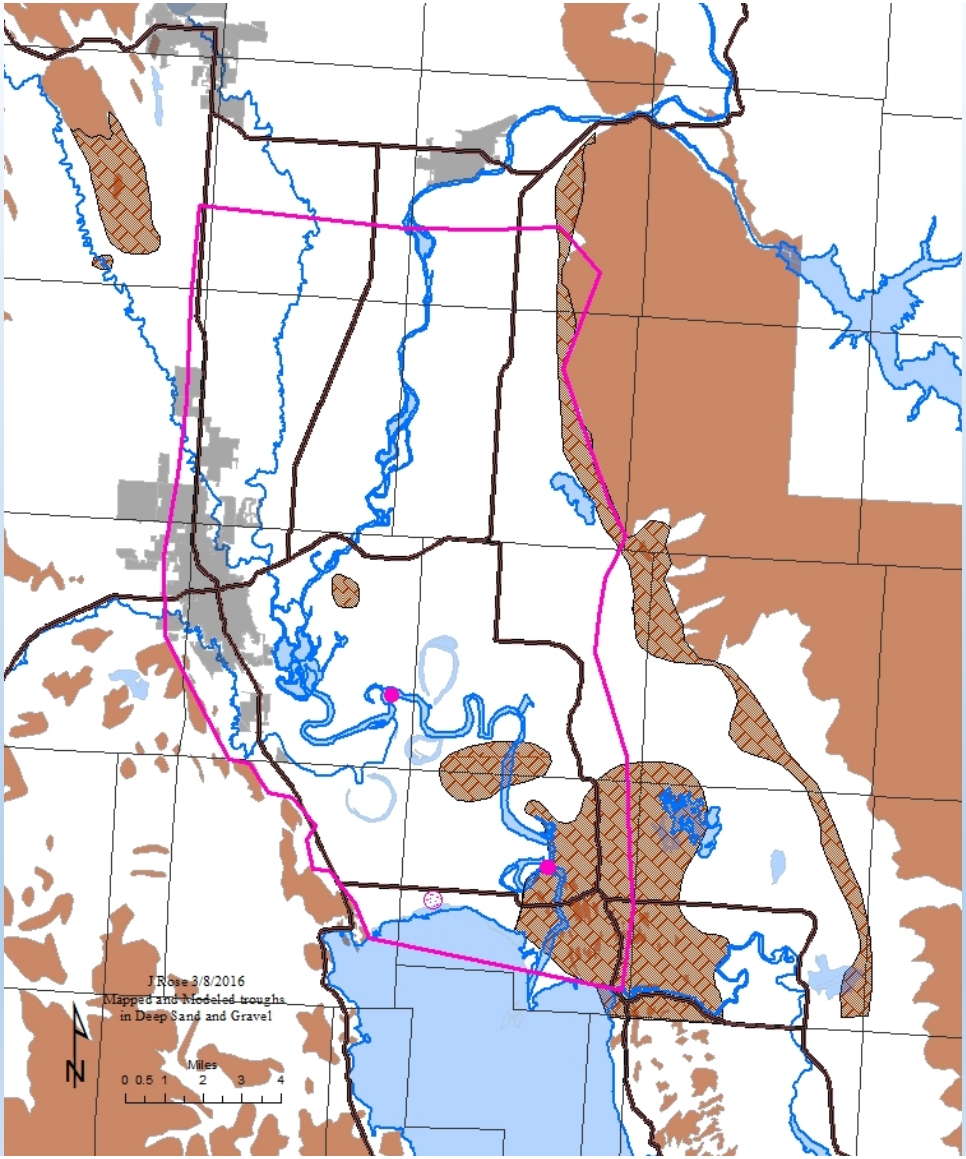
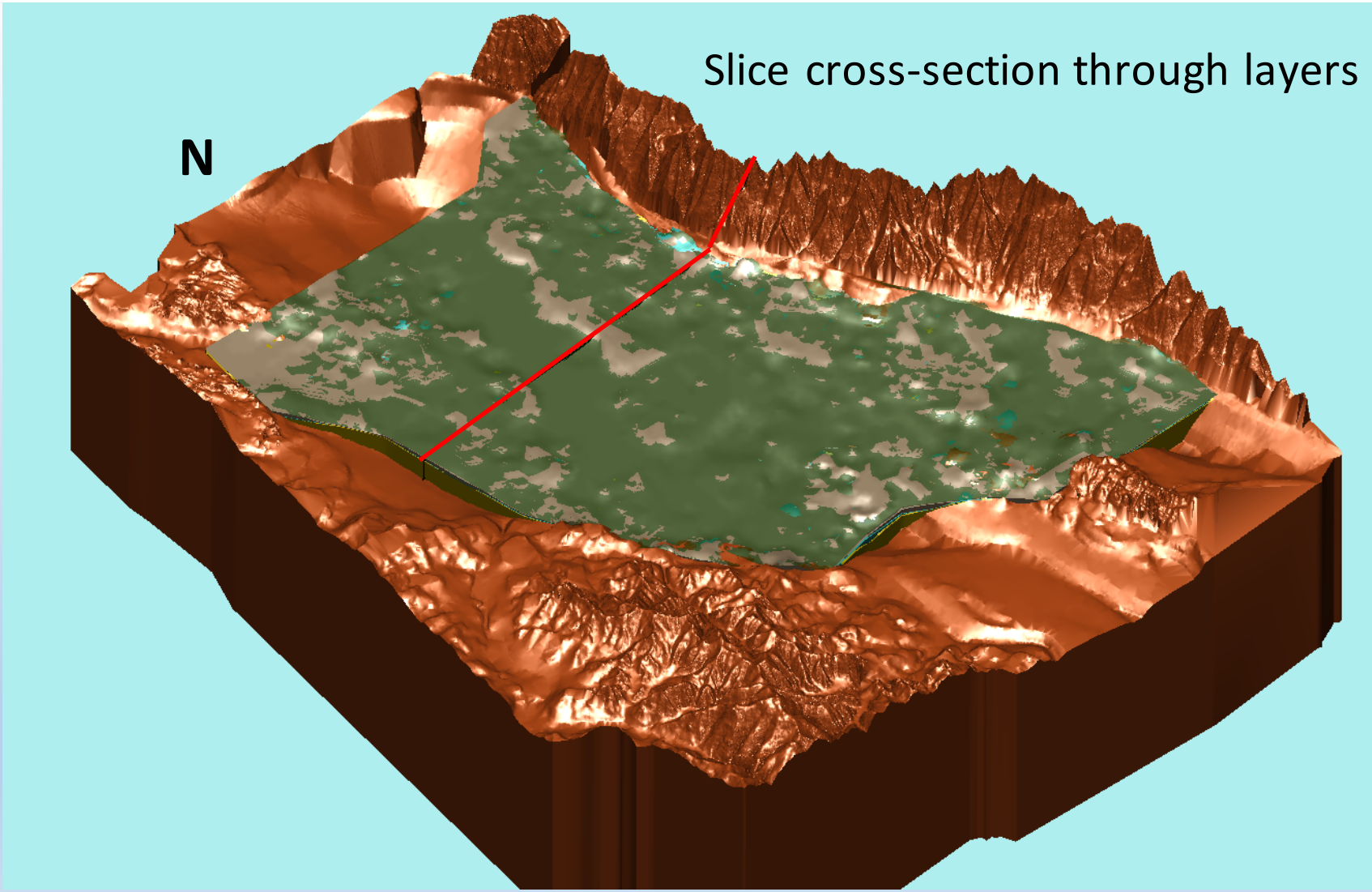
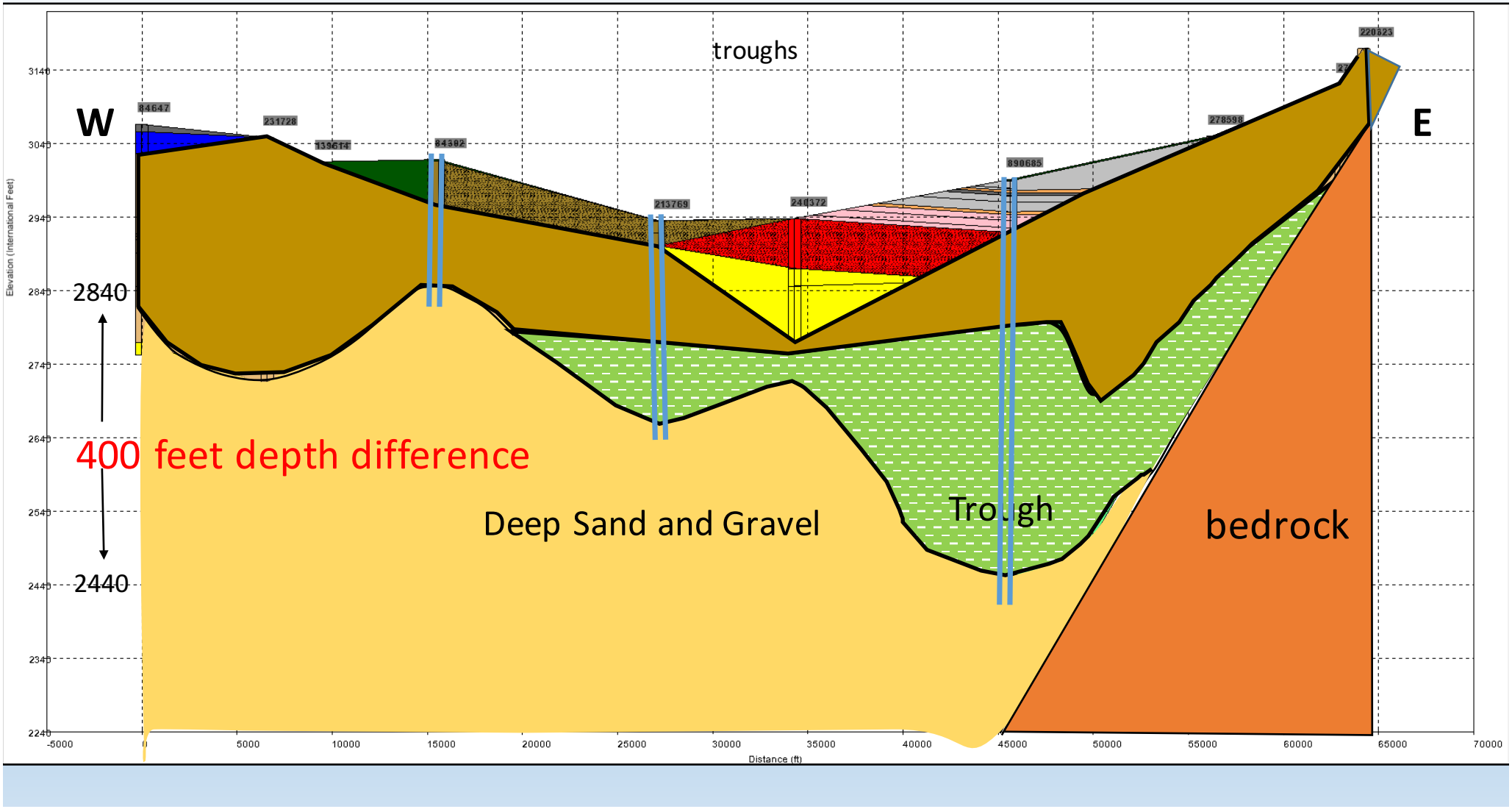
That's nice, but what did we learn

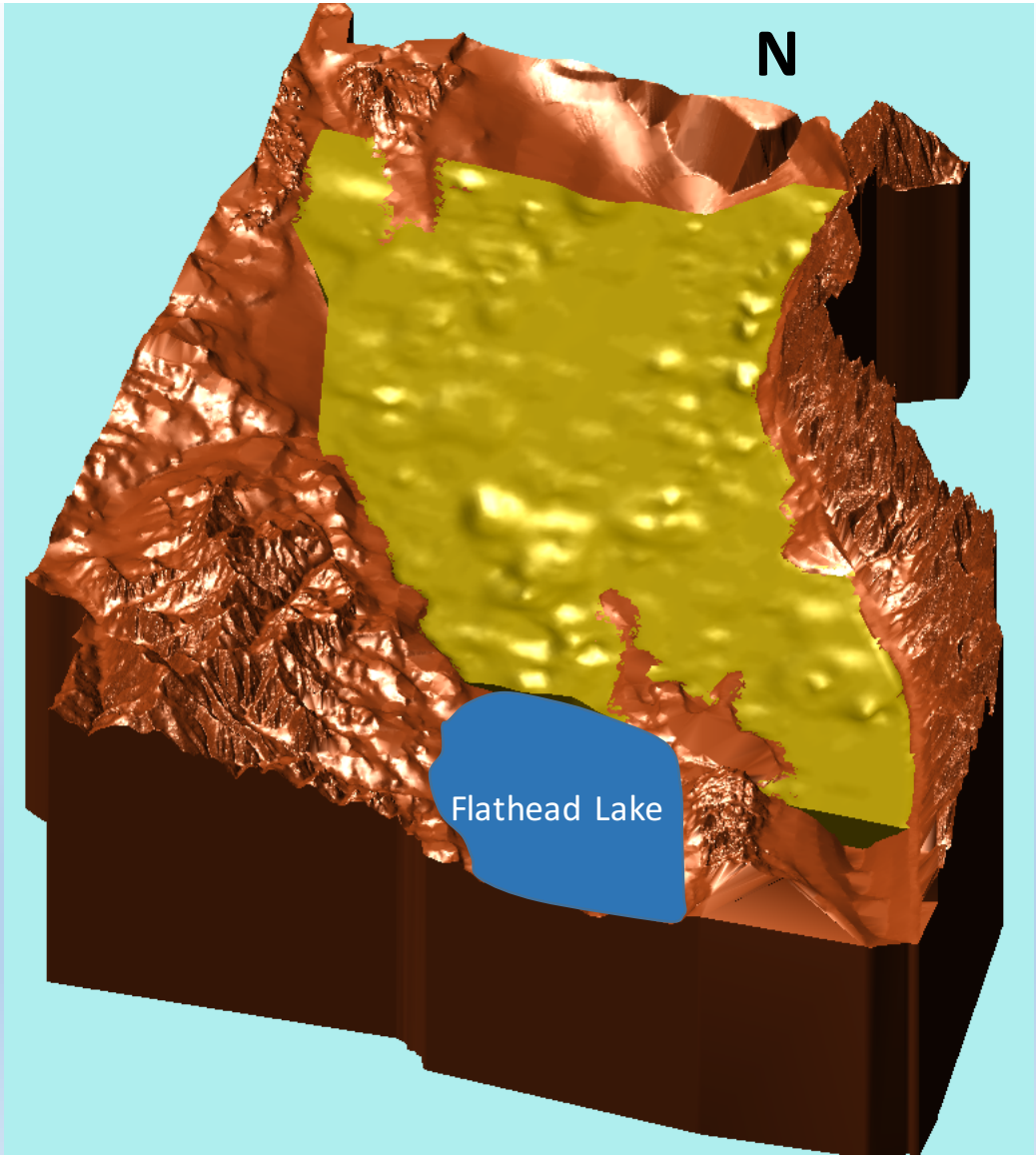
- **Plunging bedrock** Bigfork, and **Shallow bedrock** east of Kalispell
- **Trough channels** into the Deep Aquifer
- **Deep Aquifer surface**
- **Confining Unit** thickness
- Geologic volumes



Drilled wells data


Slice cross-section through layers
N

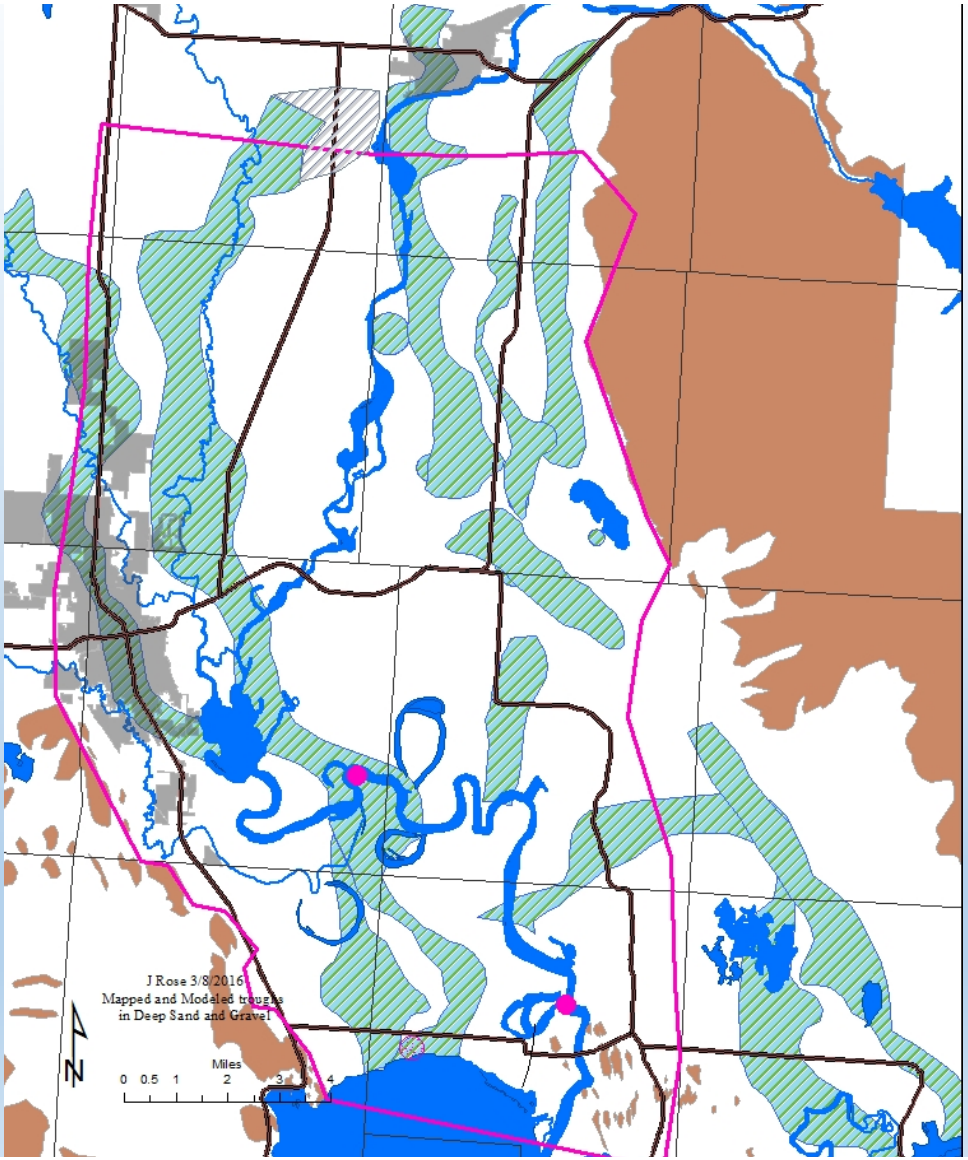

troughs
W
E
84647
231728
1396144
84382
213769
240372
890685
278598
220323
2840
2440
400 feet depth difference
Deep Sand and Gravel
Trough
bedrock
Elevation (International Feet)
Distance (ft)
3140
3040
2940
2840
2740
2640
2540
2440
2340
2240
-5000
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
55000
60000
65000
70000



Deep Sand and Gravel Aquifer

Potholed and gouged surface

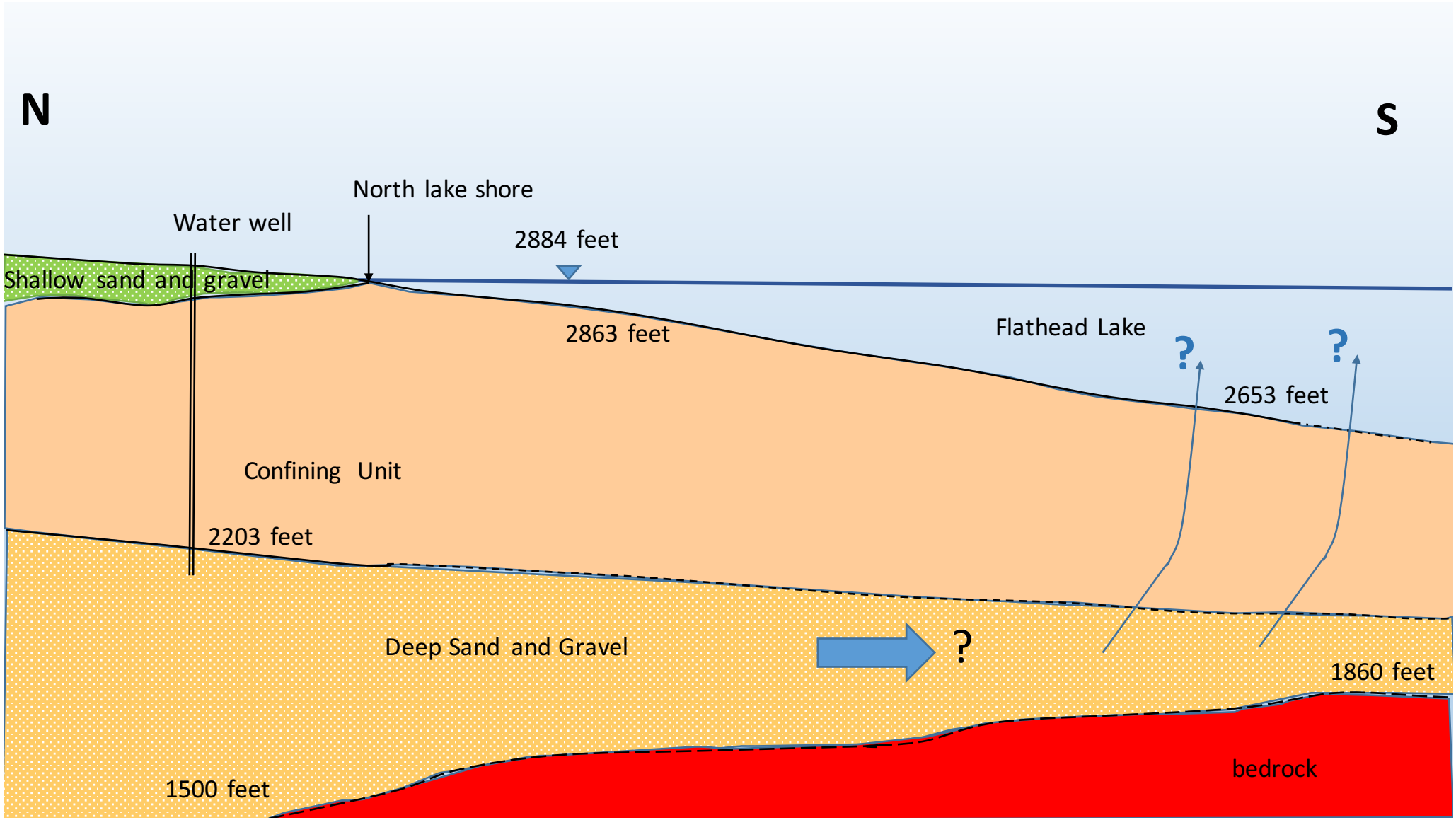
Groundwater modeling layer

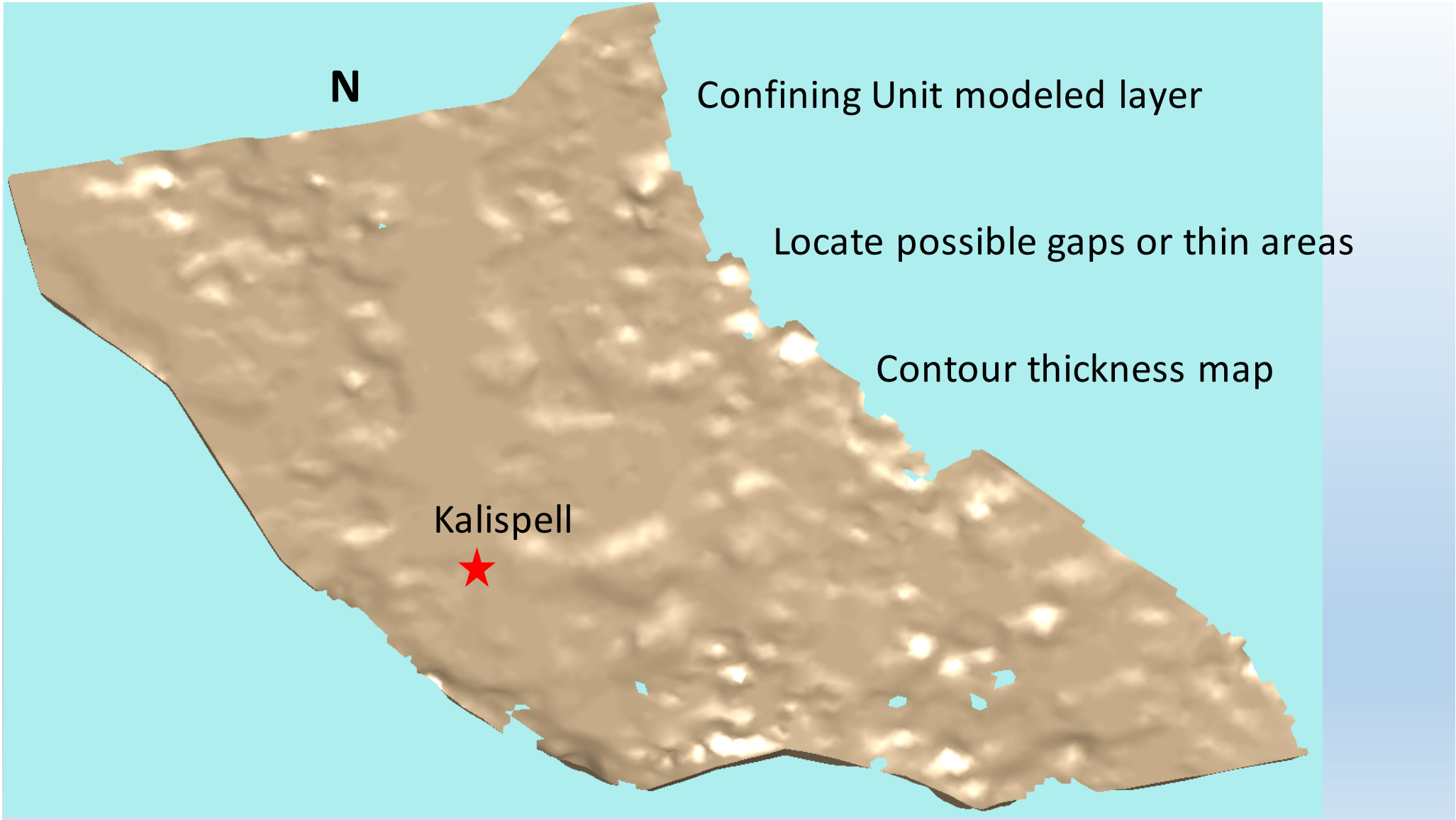


Troughs cut into
Deep Aquifer sand and gravel

Troughs in surface of
Deep Sand and Gravel

Follow trace of:
bedrock depressions
and modern rivers in similar pattern


N
S
North lake shore
Water well
2884 feet
Shallow sand and gravel
2863 feet
Flathead Lake
?
?
2653 feet
Confining Unit
2203 feet
Deep Sand and Gravel
?
1860 feet
bedrock
1500 feet


N
Confining Unit modeled layer
Locate possible gaps or thin areas
Contour thickness map
Kalispell