Geothermal Prospects of Co-produced Water in Utah

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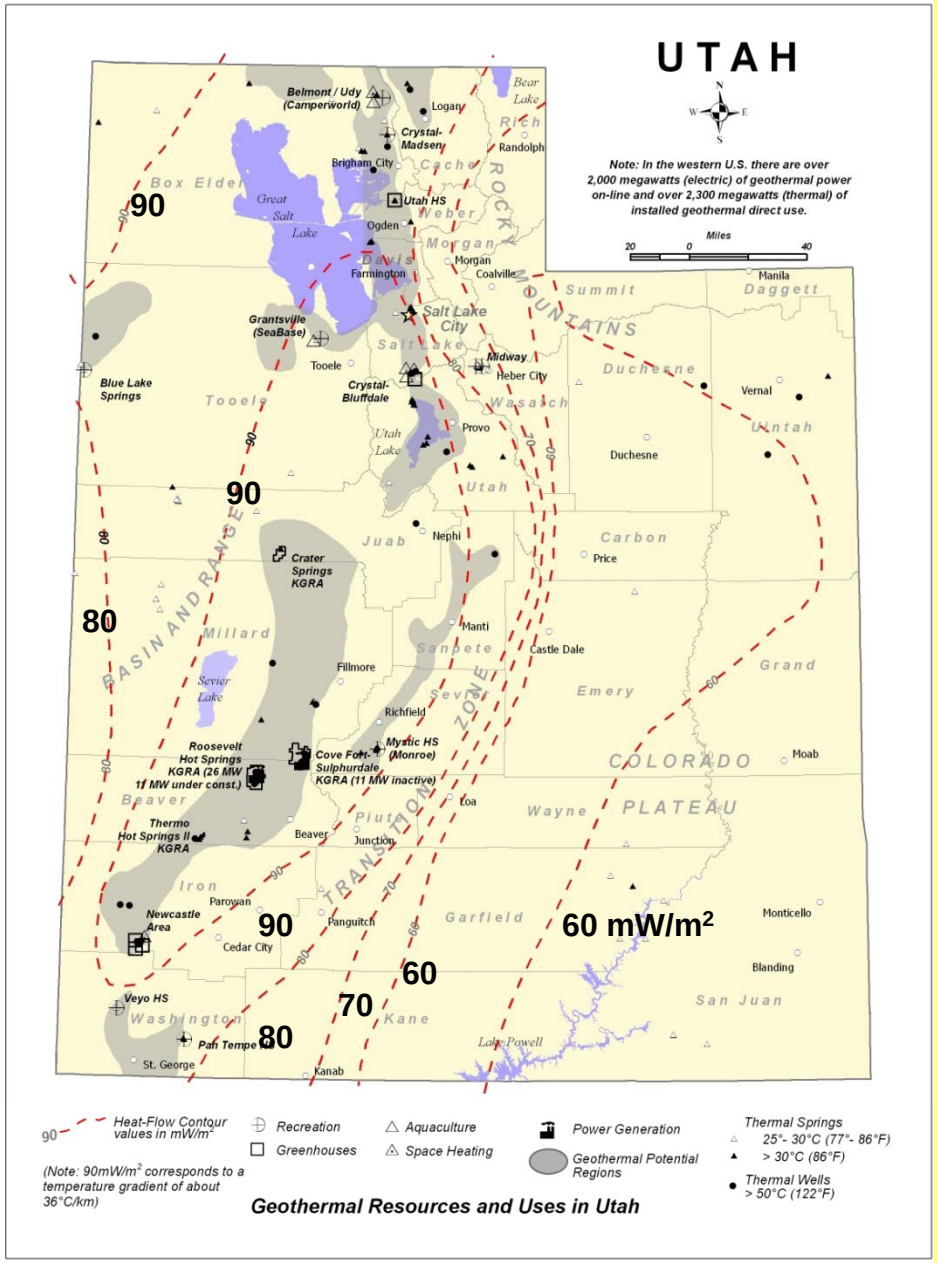
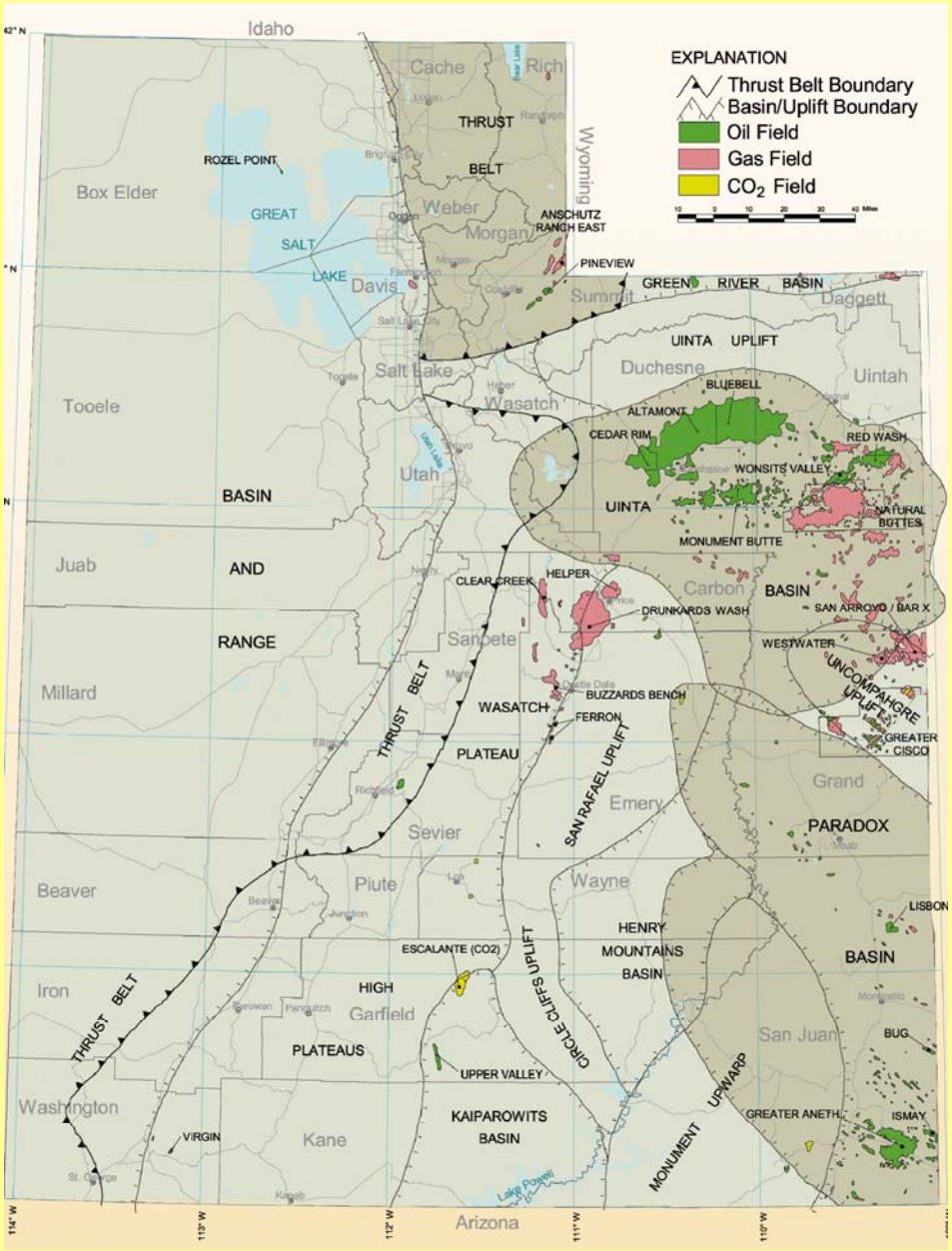
Comparison of Utah's basins and thermal regime





Utah Geothermal Power Plants

Area	*Temp (°F)*	*Plant Type*	*Operating (MW)*	*Under Const., Planned (MW)*	*TOTAL (MW)*
Roosevelt HS	464 - 514	1-Flash	26	?	26
Roosevelt HS	464 - 514	Binary (OEC)	11	-	11
Thermo HS	280 - 320	Binary (UTC)	10	?	10
Cove Fort	315 - 350	Binary	-	26	26
Cove Fort	315 - 350	Steam	-	7	7
Shoshone Renaissance	286	Binary	-	32	32
TOTAL	-	-	47	65	112

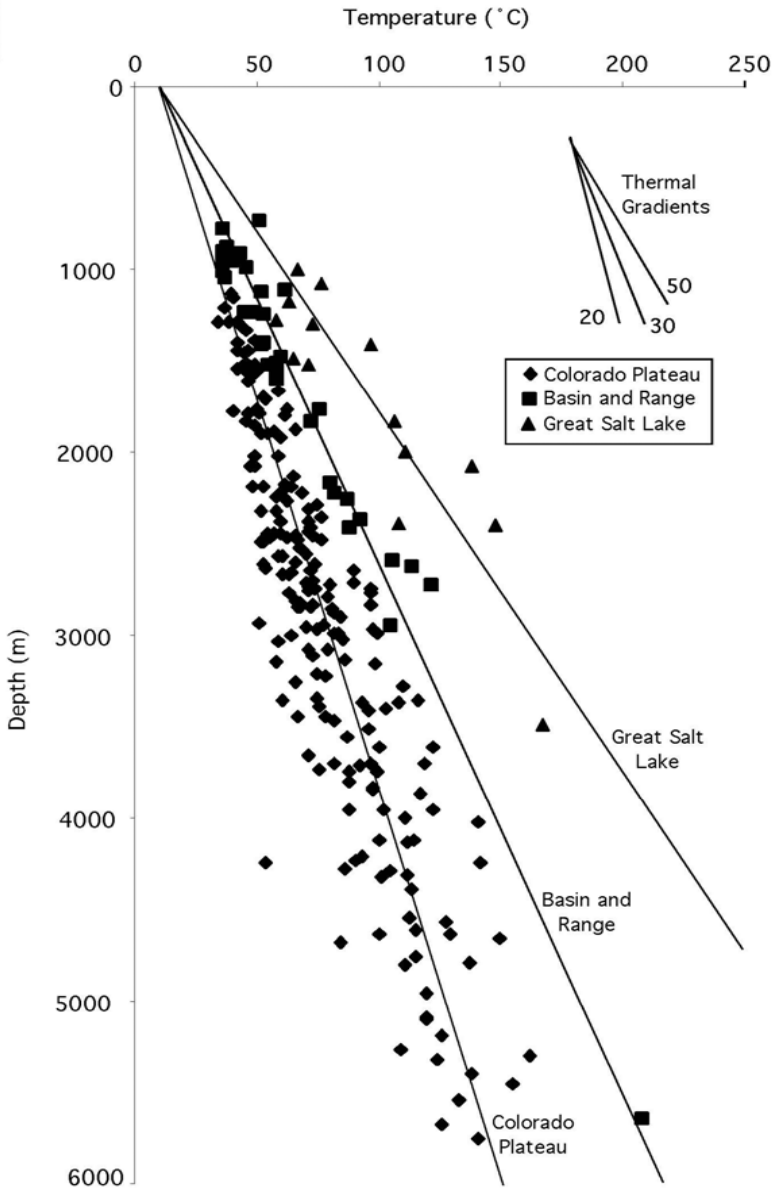


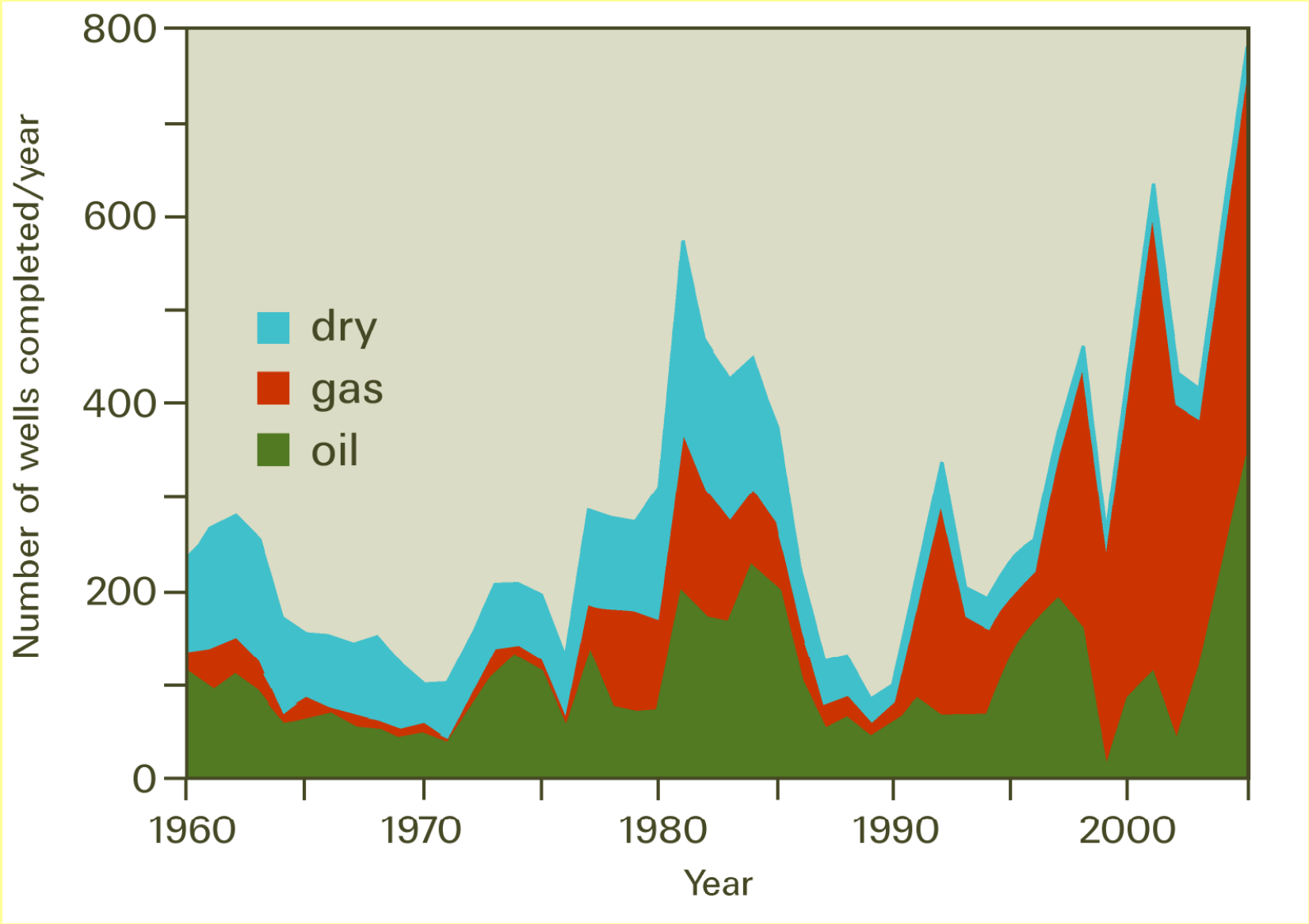
Figure 5. Temperature versus depth for all of the data collected in this study. Average thermal gradients projected on the figure are for the Great Salt Lake (60°C km^{-1}), Basin and Range (35°C km^{-1}) and Colorado Plateau (26°C km^{-1}). The Basin and Range and Colorado Plateau are separated according to the geomorphic transition.

Summary of Utah BHT information from oil exploration wells (Hendriksen and Chapman, 2002)

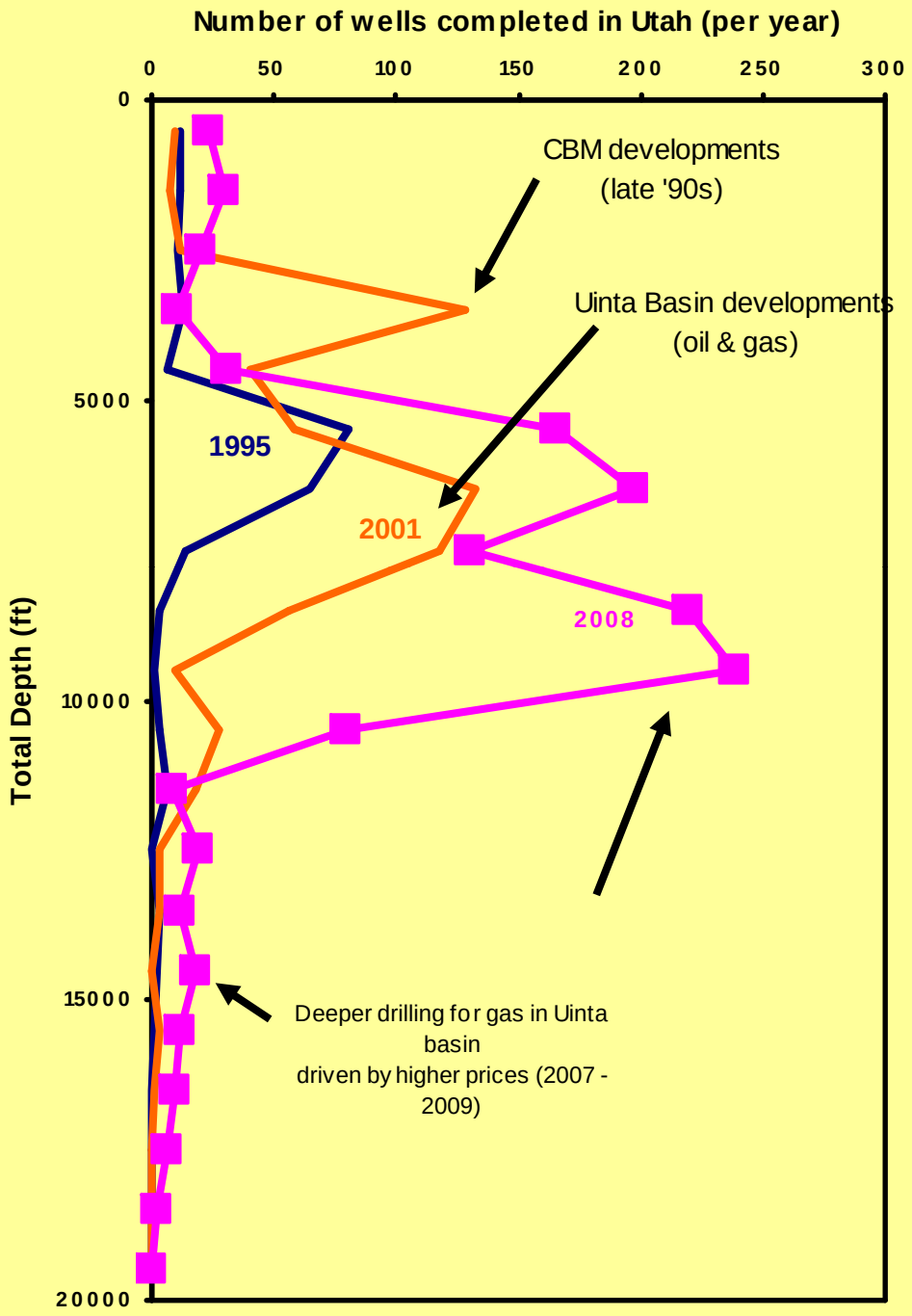
BHTs have been corrected for time since circulation stopped, but the data set is still very noisy.

The Colorado Plateau gradient is about two thirds of that in the Basin and Range

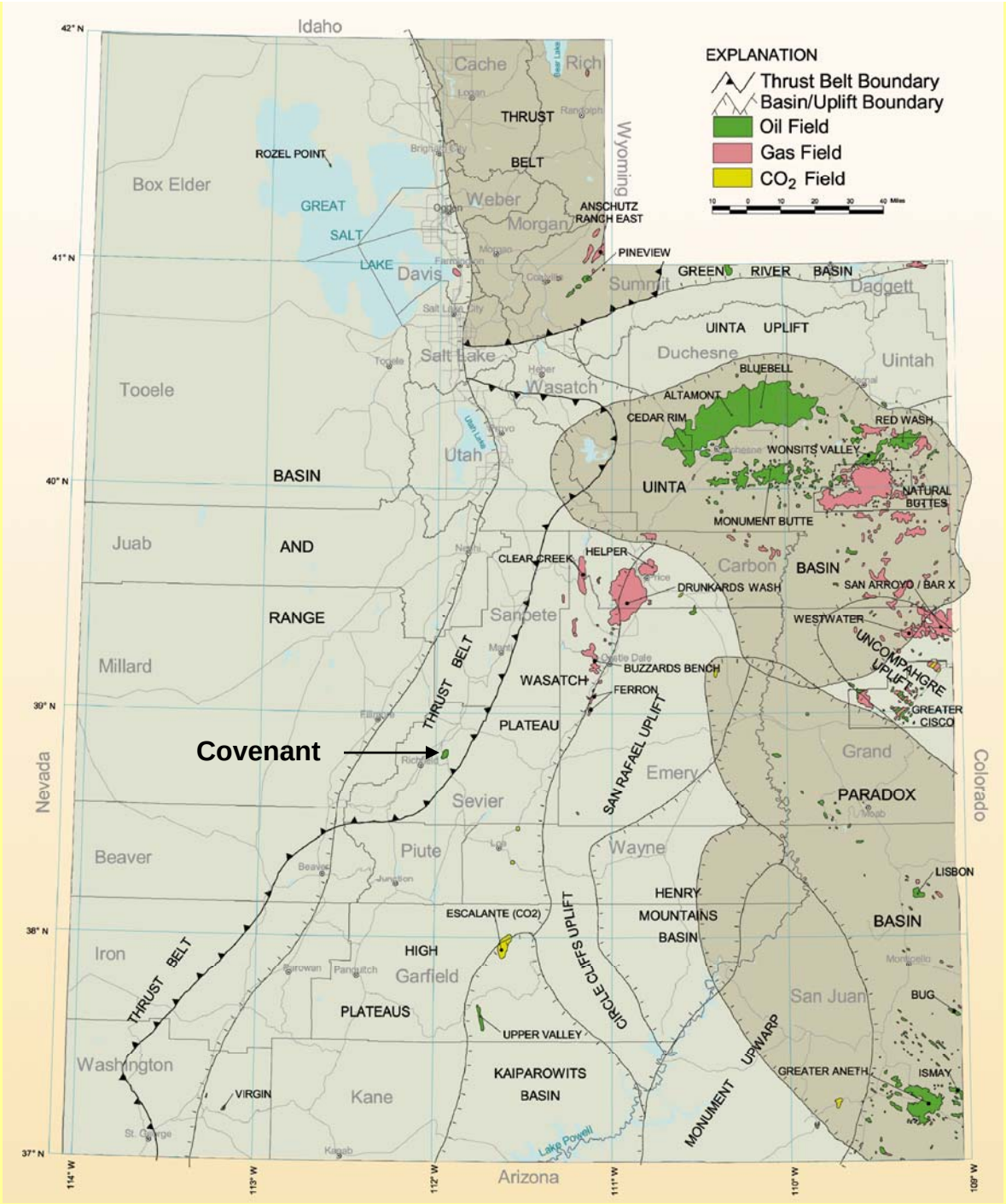
Utah's Drilling History



Source: Division of Utah Oil, Gas and Mining

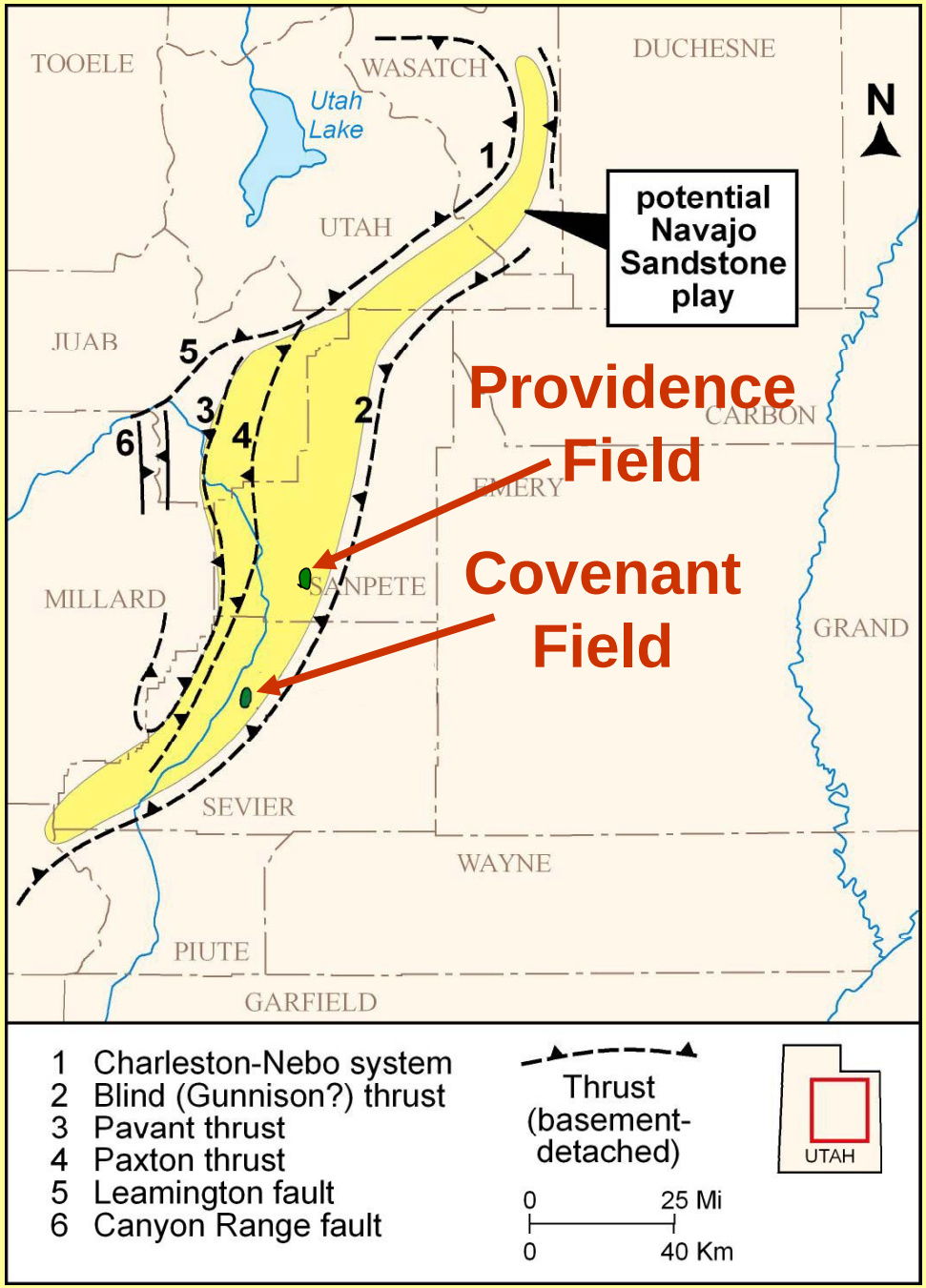


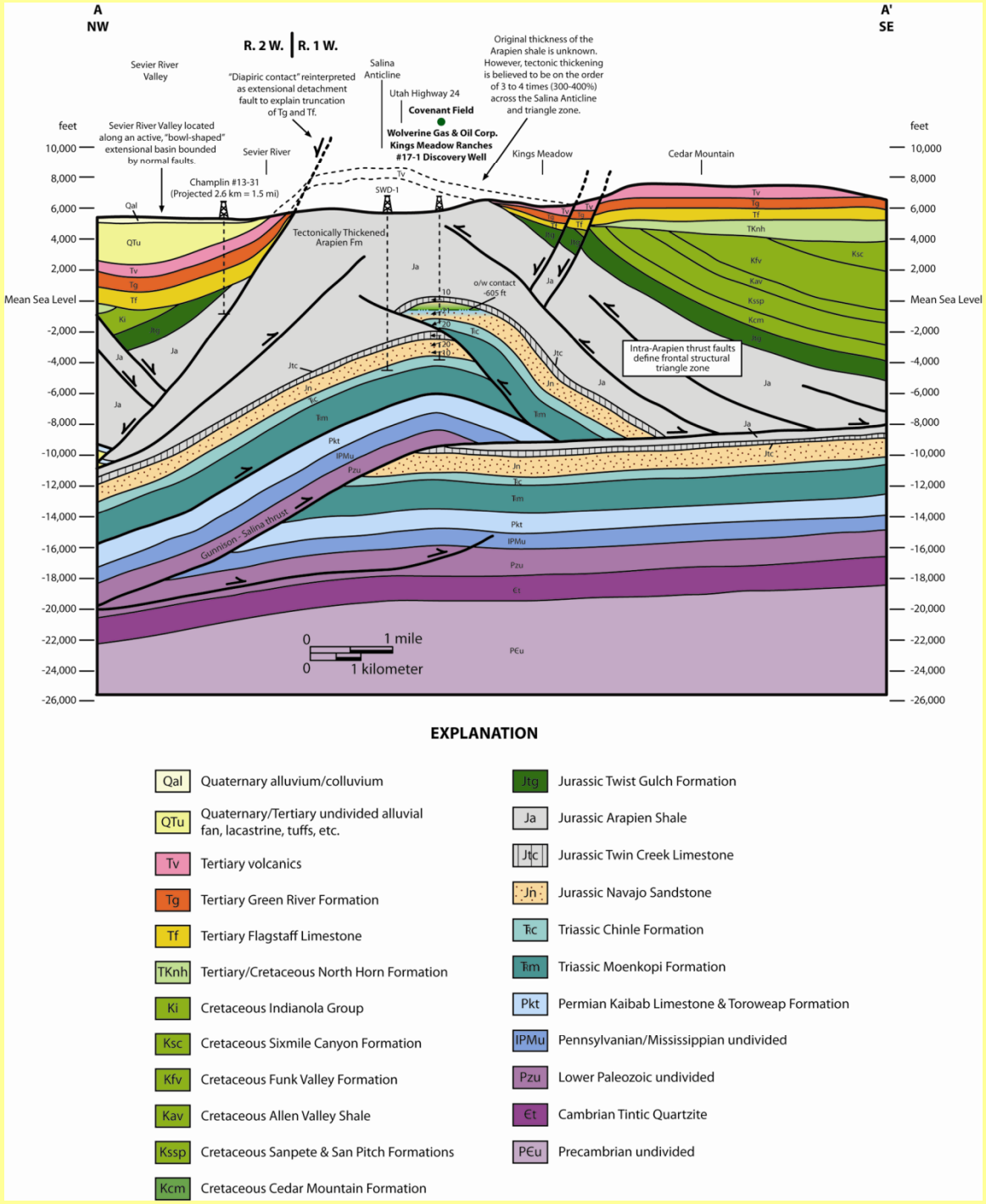
The trend towards deeper wells in recent years also means increased thermal energy in the co-produced water



Utah's oil and gas fields

Central Utah Thrust Belt Play Area





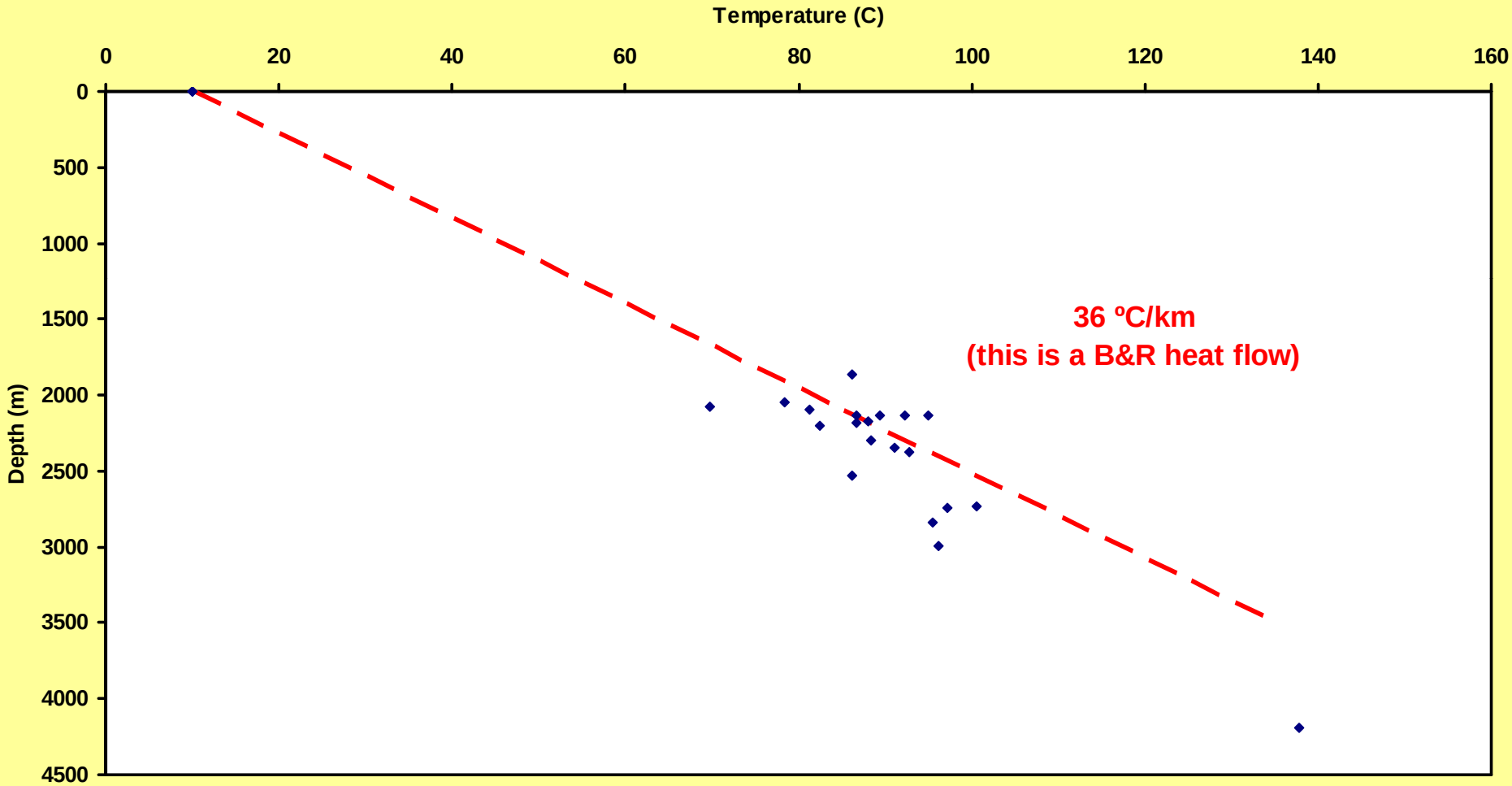
EXPLANATION

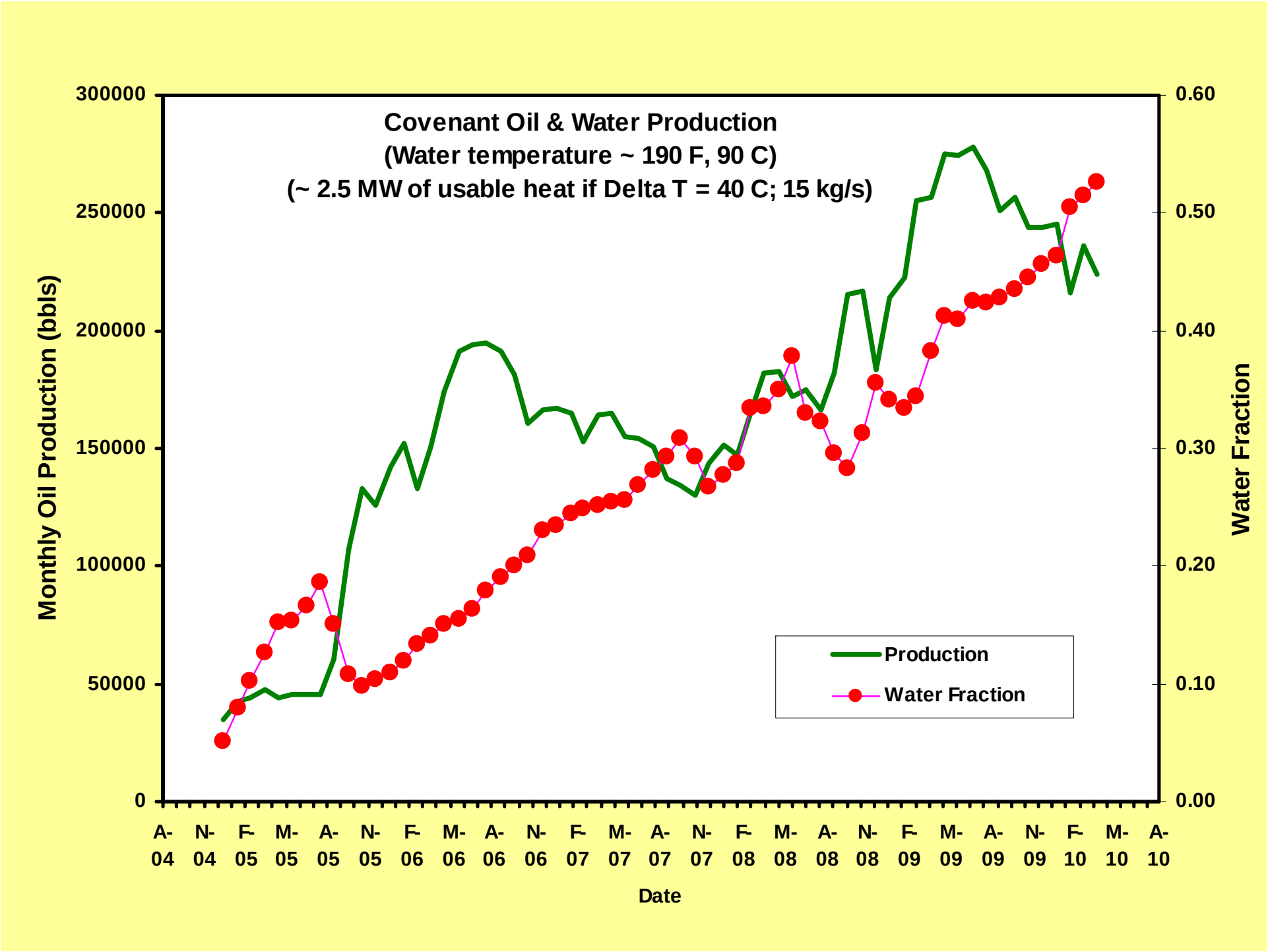
Qal	Quaternary alluvium/colluvium	Jtg	Jurassic Twist Gulch Formation
QTu	Quaternary/Tertiary undivided alluvial fan, lacastrine, tuffs, etc.	Ja	Jurassic Arapien Shale
Tv	Tertiary volcanics	Jtc	Jurassic Twin Creek Limestone
Tg	Tertiary Green River Formation	Jn	Jurassic Navajo Sandstone
Tf	Tertiary Flagstaff Limestone	Trc	Triassic Chinle Formation
TKnh	Tertiary/Cretaceous North Horn Formation	Trm	Triassic Moenkopi Formation
Ki	Cretaceous Indianola Group	Pkt	Permian Kaibab Limestone & Toroweap Formation
Ksc	Cretaceous Sixmile Canyon Formation	IPMu	Pennsylvanian/Mississippian undivided
Kfv	Cretaceous Funk Valley Formation	Pzu	Lower Paleozoic undivided
Kav	Cretaceous Allen Valley Shale	Ct	Cambrian Tintic Quartzite
Kssp	Cretaceous Sanpete & San Pitch Formations	PCu	Precambrian undivided
Kcm	Cretaceous Cedar Mountain Formation		

East – West Cross Section, Covenant Field

One well has now been drilled to 13,000’ depth, with TD in Kaibab Lst.

Covenant Oil field (BHTs)




Covenant Oil & Water Production
(Water temperature ~ 190 F, 90 C)
(~ 2.5 MW of usable heat if Delta T = 40 C; 15 kg/s)
Monthly Oil Production (bbls)
Water Fraction
Date
Production
Water Fraction
300000
250000
200000
150000
100000
50000
0
0.60
0.50
0.40
0.30
0.20
0.10
0.00
A-04
N-04
F-05
M-05
A-05
N-05
F-06
M-06
A-06
N-06
F-07
M-07
A-07
N-07
F-08
M-08
A-08
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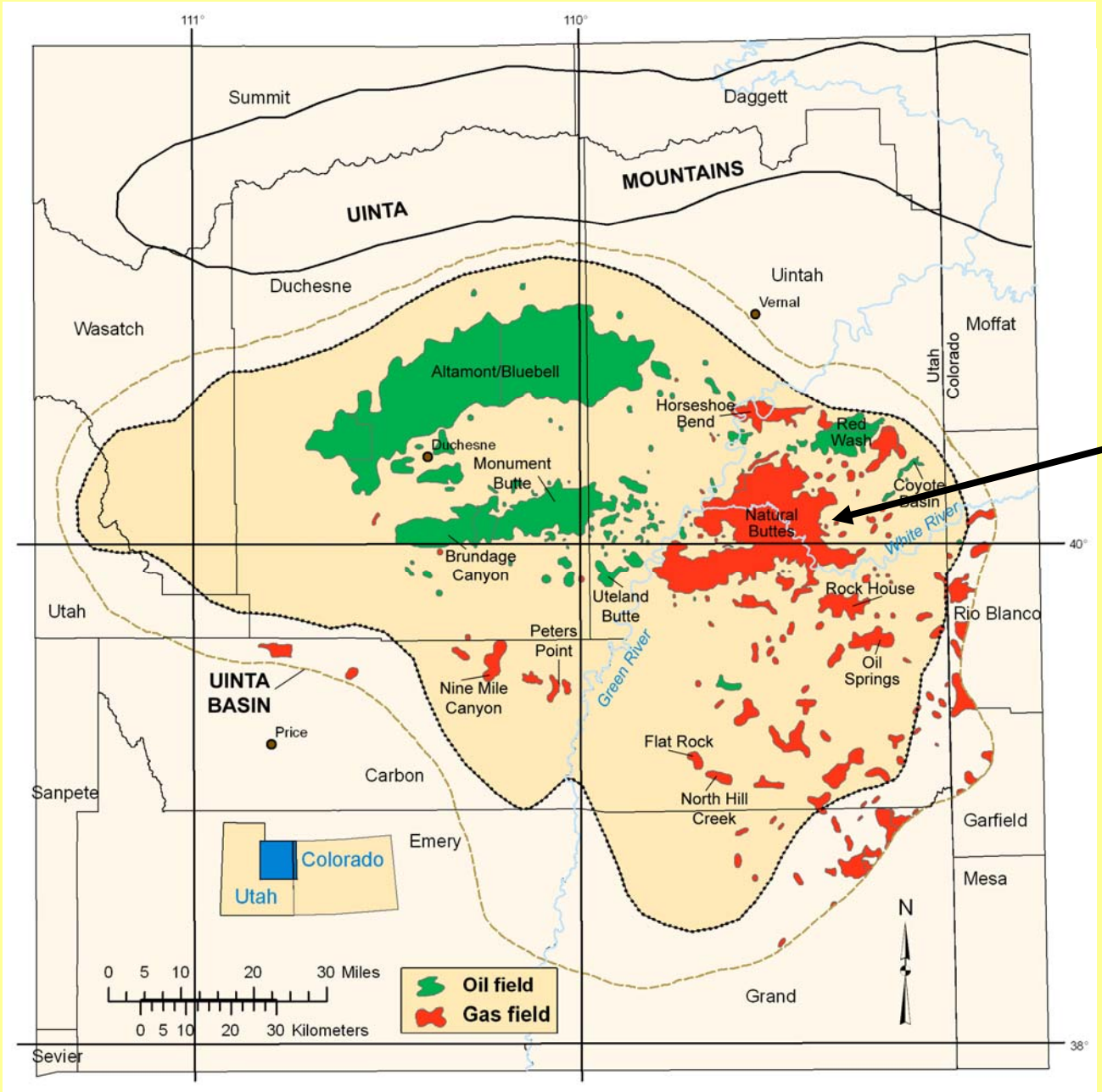
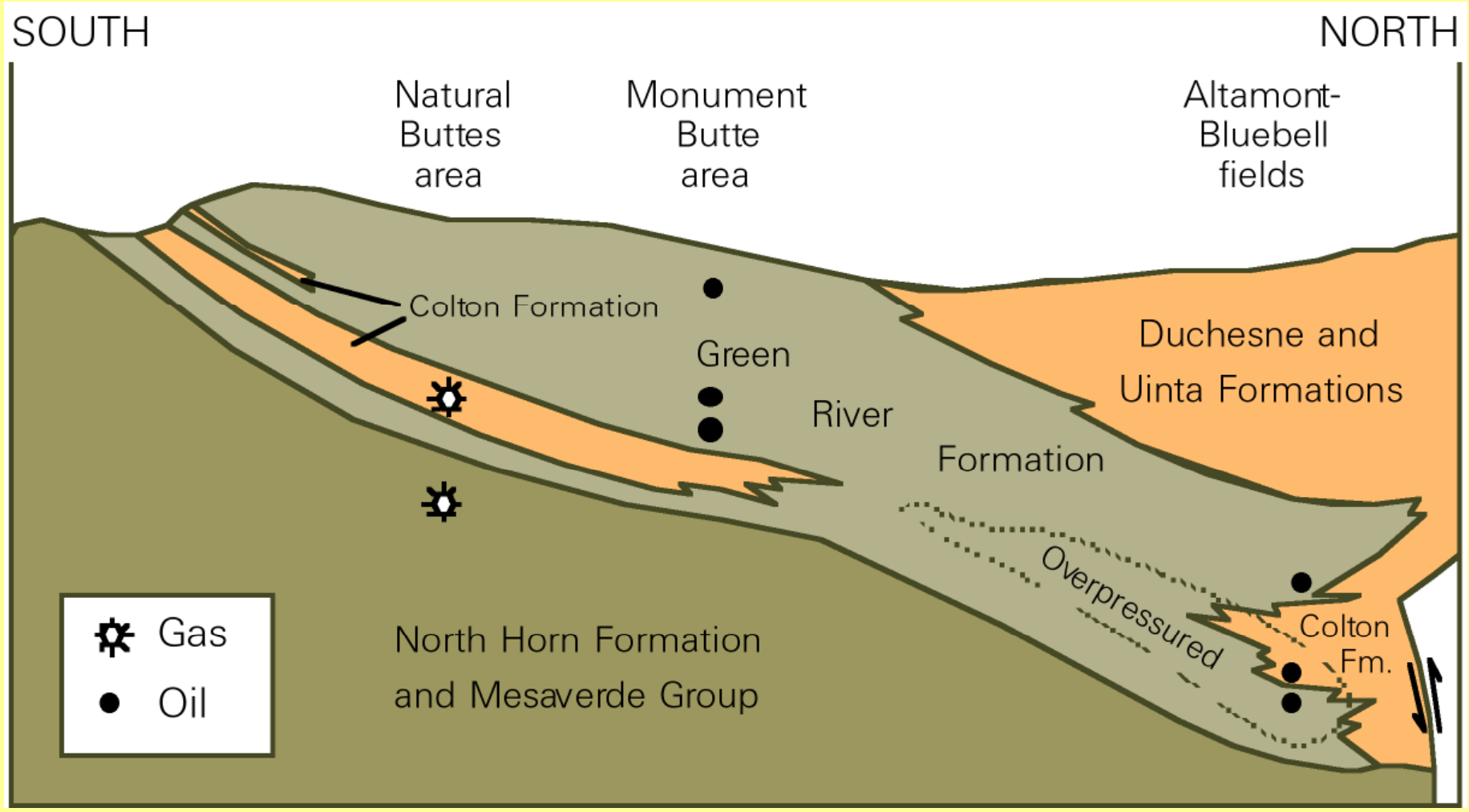
F-10
M-10
A-10

Oil & Gas Fields of the Uinta Basin

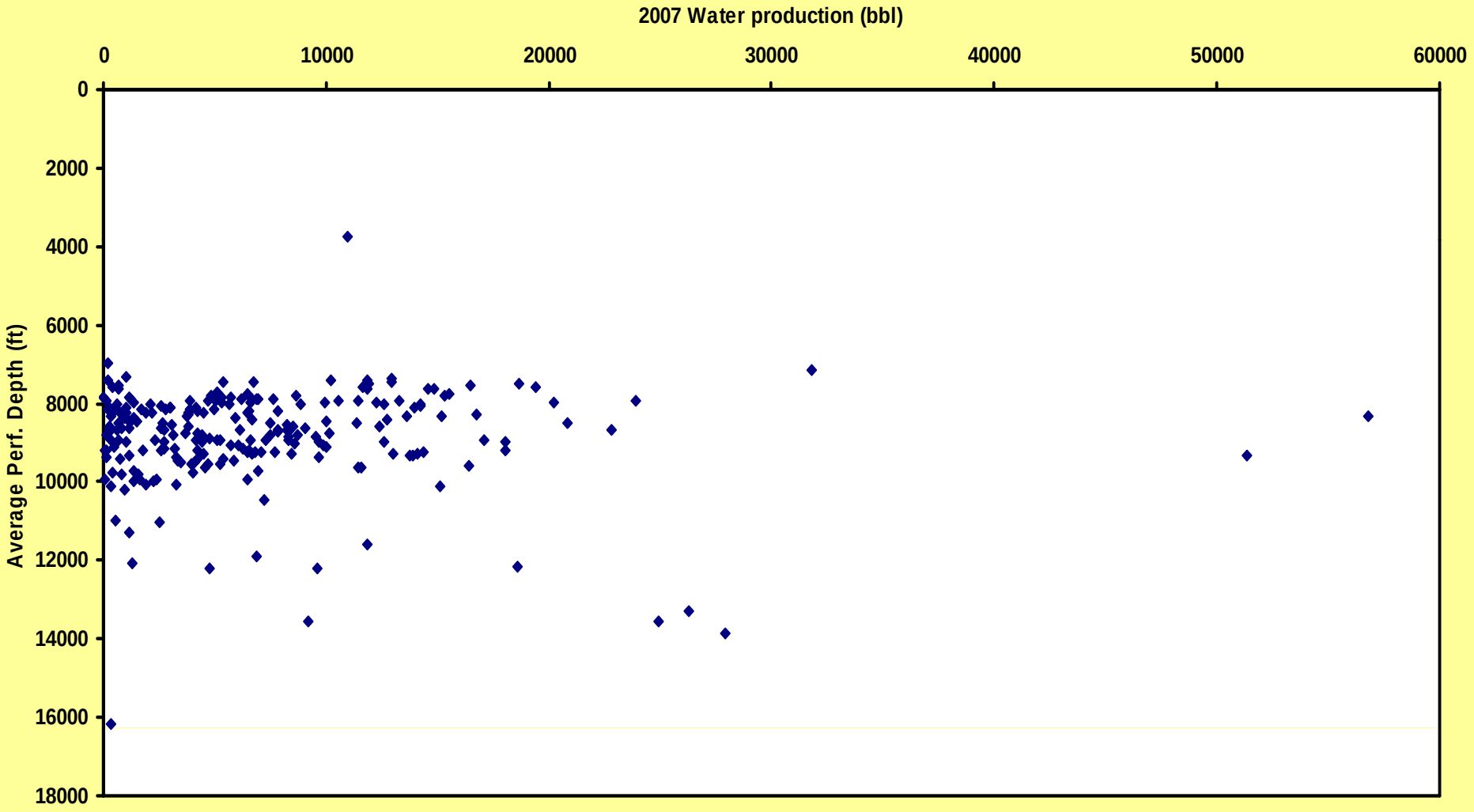


Natural Buttes: 2 TCF

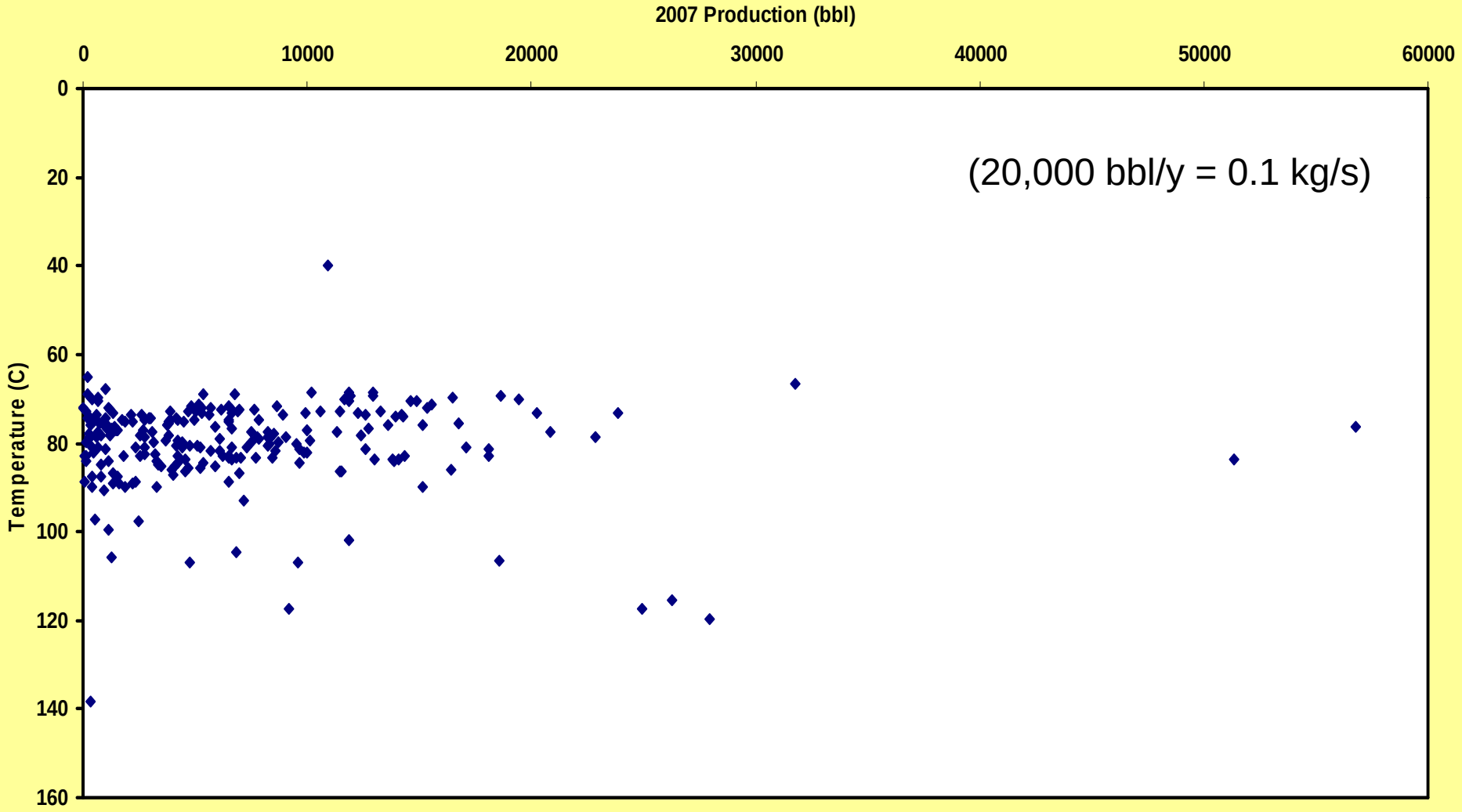
Trapping Mechanisms



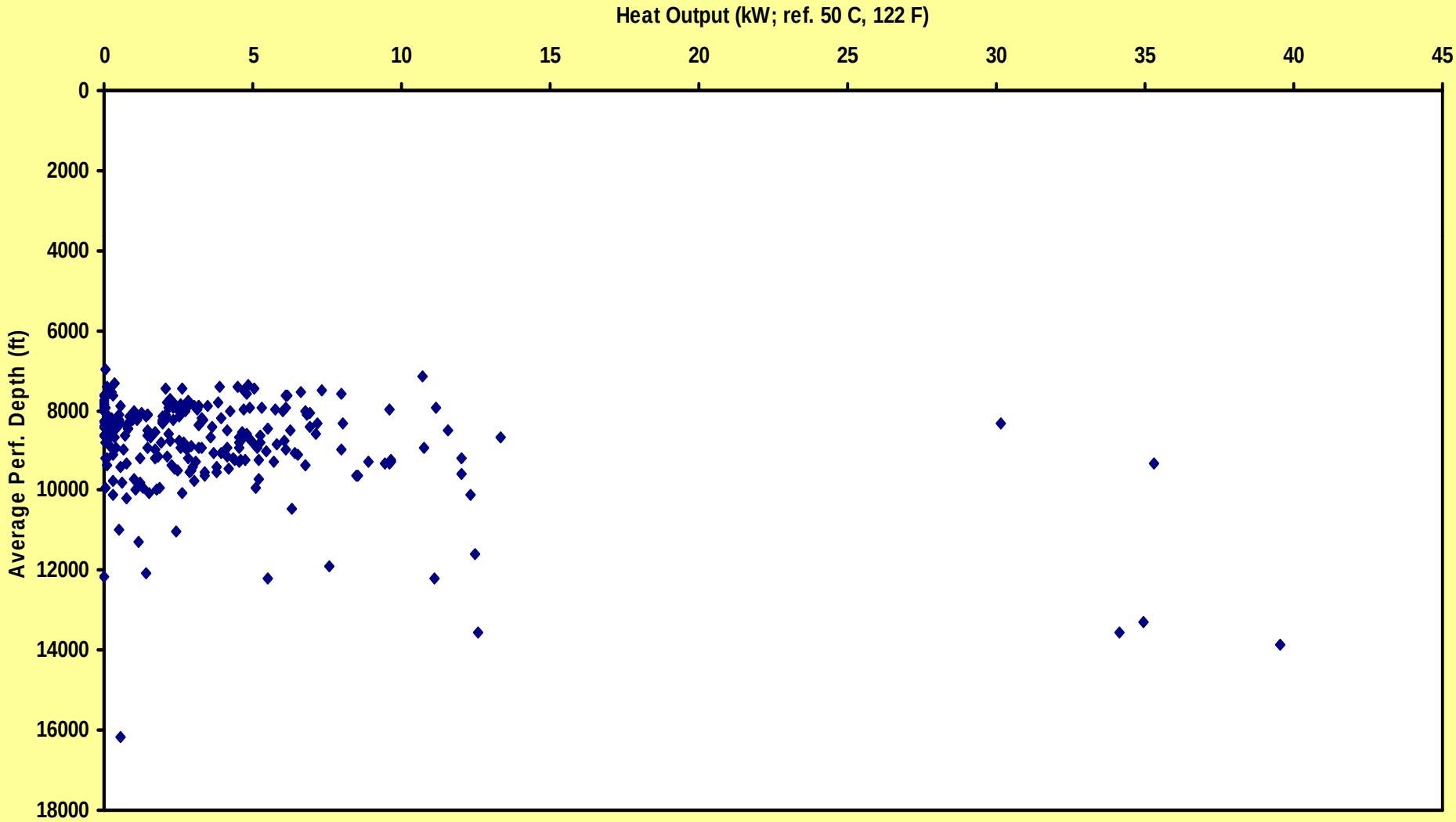
Natural Buttes, Uinta Basin



Natural Buttes



Natural Buttes, Uinta Basin



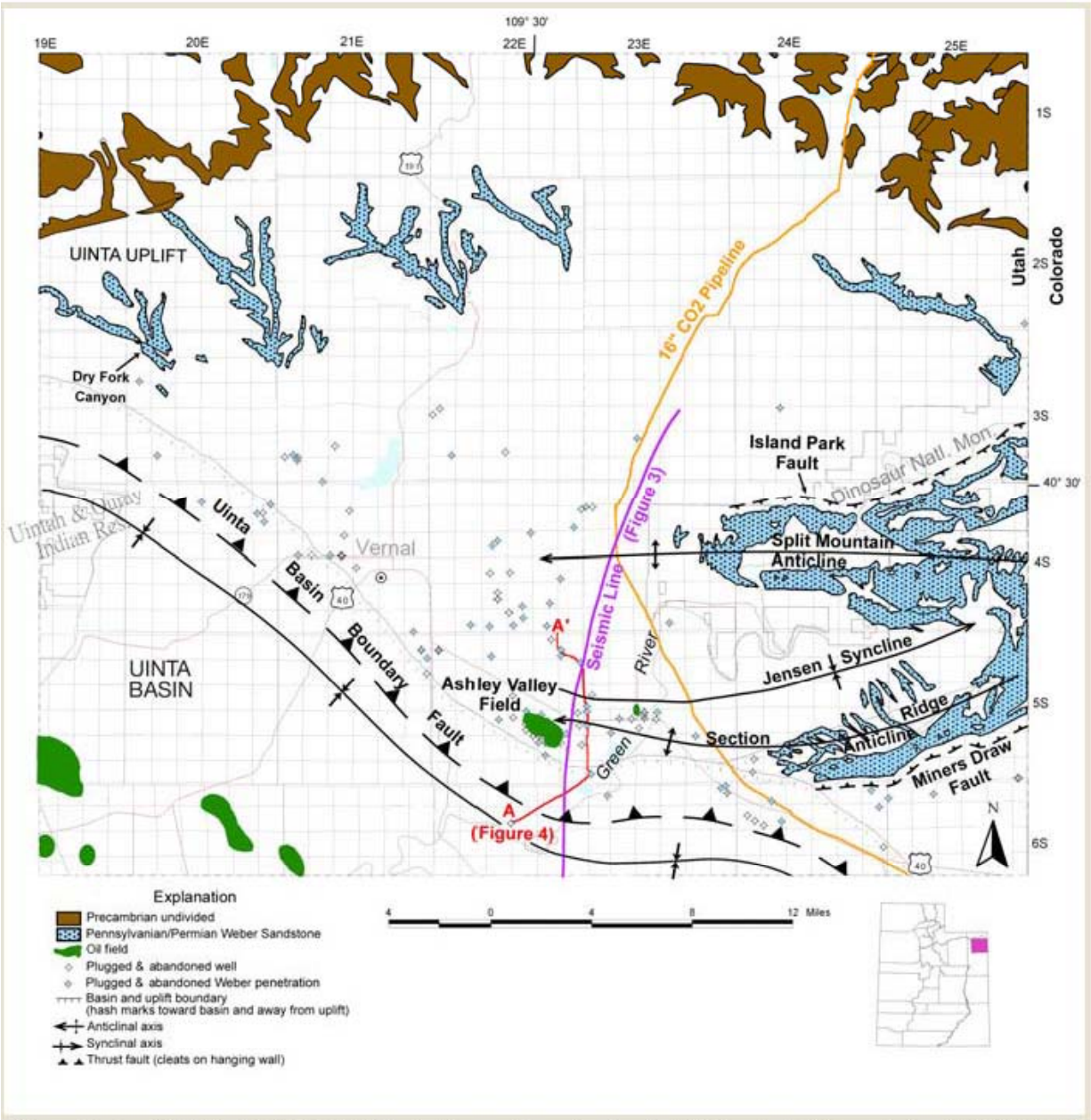
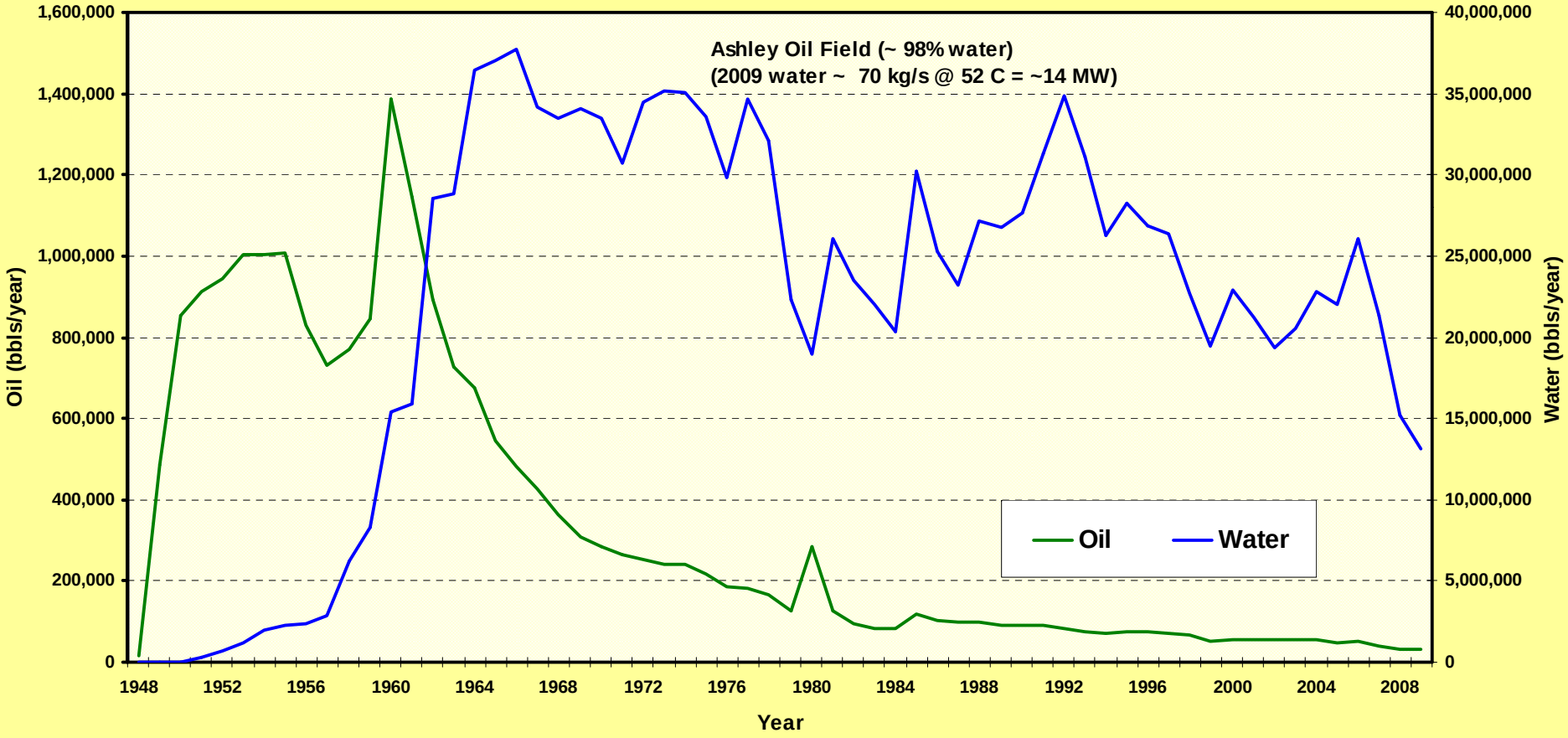


Figure 1. *Location of Ashley Valley field, exploratory wells, major structural features, and Precambrian (undivided) and Weber Sandstone outcrops, Uintah County, Utah. Seismic profile shown on figure 3; cross section A-A' shown on figure 4. Uinta Basin Boundary fault after Osmond (1986); outcrop geology from Hintze and others (2000).*

Ashley Valley Oil Field has produced over 20 million bbl oil over the last 60 years:

It also produces a lot of water (98% of flow) from the Permian Weber sst at about 4200' depth (at ~ 52ºC)

Ashley Oil Field, Uinta Basin



Concluding Comments

- The most attractive area for geothermal resources in Utah is the Basin and Range Province (western half of state).
- Although some geothermal power developments exist here, there is only one producing oil field (so far). This is in the transitional province of Colorado Plateau, but has B&R heat flow (~35ºC/km)
- Co-produced water from Covenant oil field is at 90ºC (190ºF), and total flow is such that about 2.5 MW of heat could theoretically be available using a waste temperature of 50ºC. Given these temperatures a direct-heat application may be the best use of the available heat
- Utah's main oil and gas basins are in lower heat flow regions, and with a few exceptions maximum temperatures are too low for electricity generation. One or two wells at Natural Buttes gas field may be able to generate electricity at the 10 -100 kW level.
- Co-produced water in Utah is not likely to make a significant contribution to future electricity generation.