Geothermal Resources for the Eastern United States

Wendy Kelly, DGMR

April 11th 2013

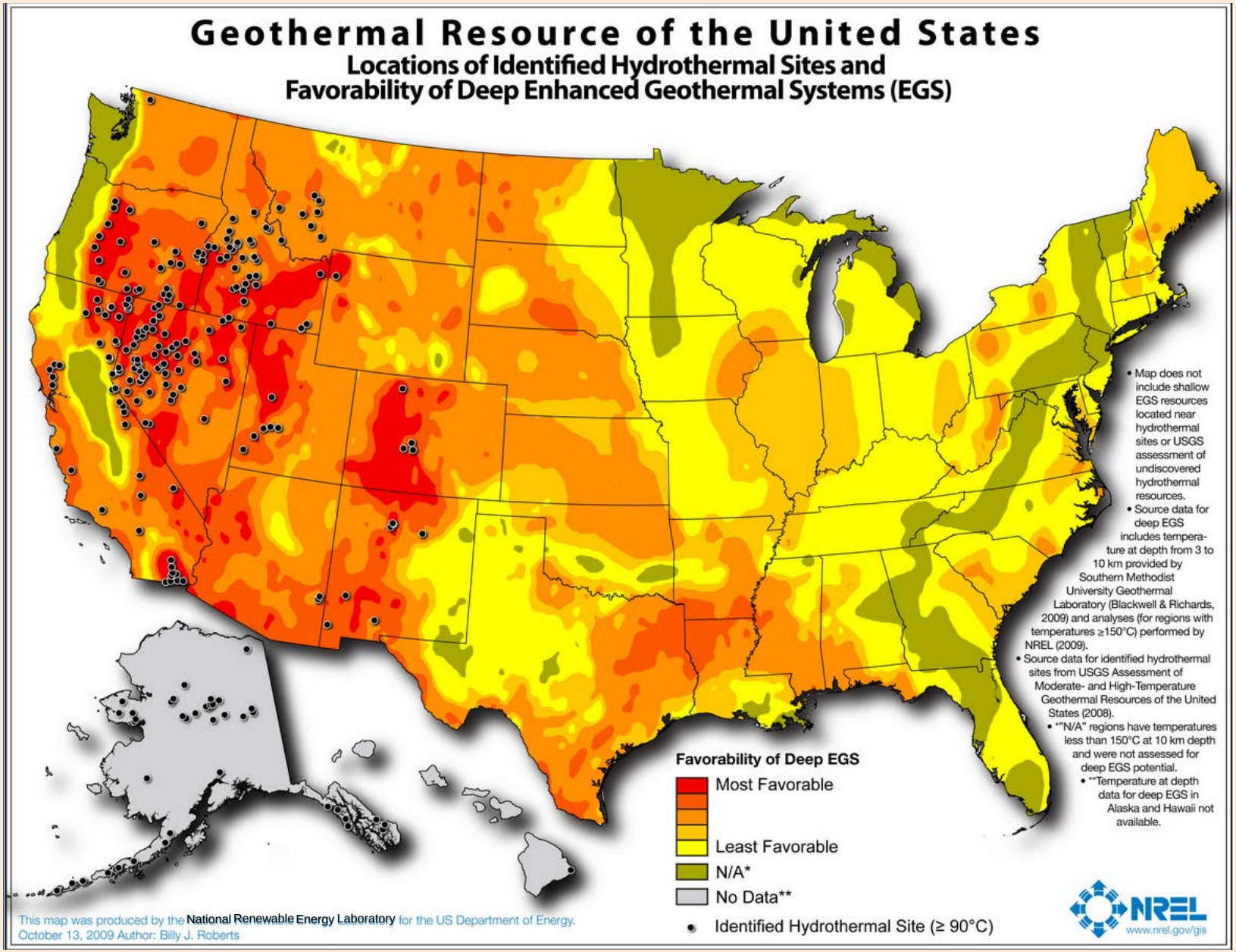
Virginia Department of Mines, Minerals and Energy

U.S. DEPARTMENT OF ENERGY

Outline

1. The National Geothermal Data System
2. Contributors and the Contributed
3. What are we doing with the Data?

Geothermal Energy Potential



NGDS National Geothermal Data System

geothermaldata.org

State Agencies

Federal Agencies

Private Industry

Research Universities

U.S. DEPARTMENT OF ENERGY

USGS science for a changing world

AASG Association of American State Geologists

SMU

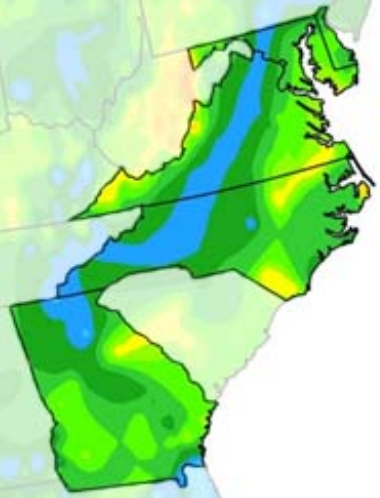
NREL

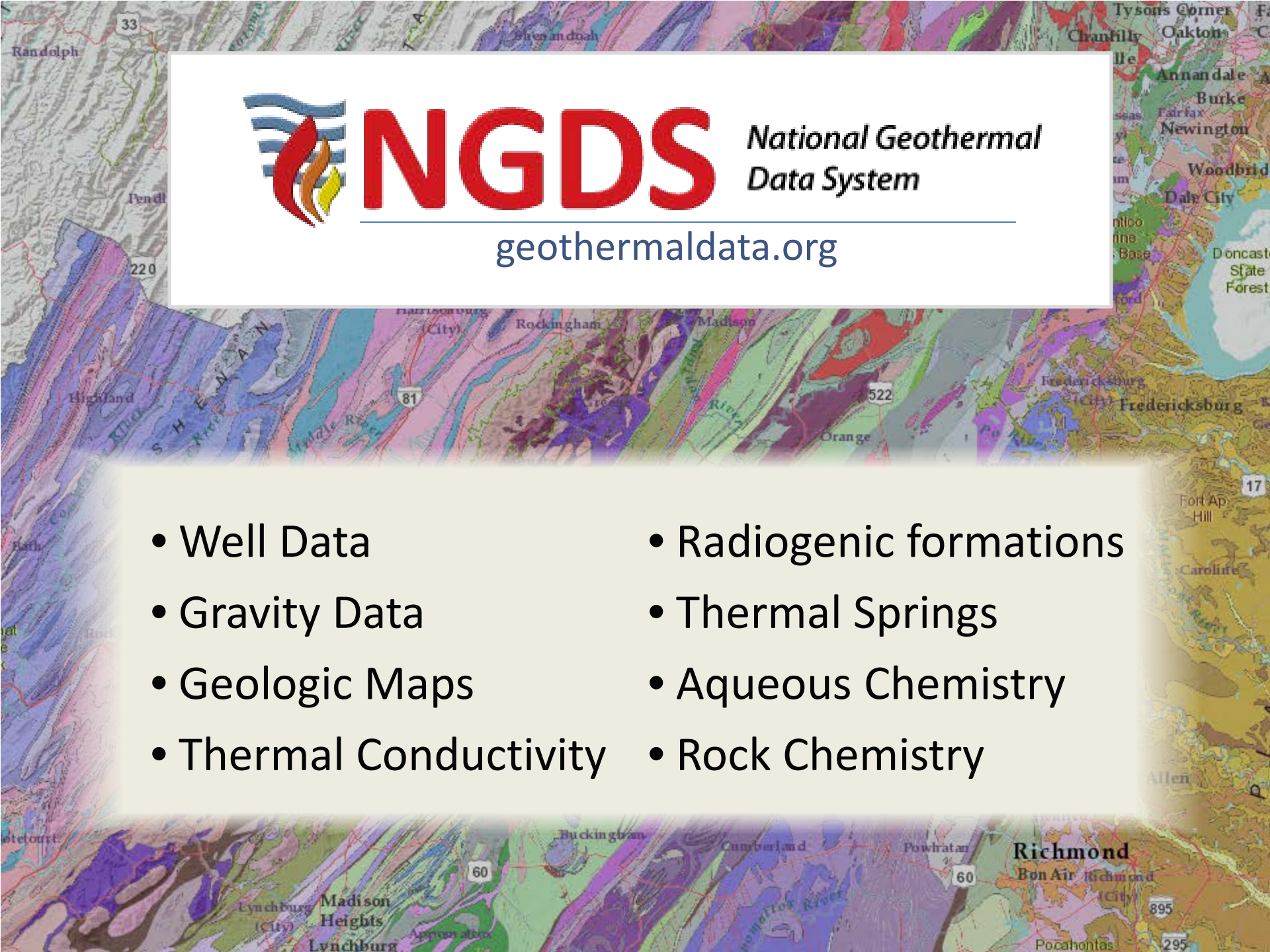
BOISE STATE UNIVERSITY

NGDS National Geothermal Data System

geothermaldata.org

Virginia Division of Geology and Mineral Resources





- Well Data
- Gravity Data
- Geologic Maps
- Thermal Conductivity
- Radiogenic formations
- Thermal Springs
- Aqueous Chemistry
- Rock Chemistry

ACCOMACK COUNTY

WWCR	OWNER	DRILLER	LOCATION (nearest town)	TD	SWL	Yld (gpm)	D'd	PT (hrs.)	HOLE SIZE (dia. x length)	CASING SIZE (dia. x length)	SCREEN SIZE (dia. and depths)	AQUIFERS (depths)	Bed-rock	PUMP GPM	PUMP D.I.	Com-pleted	RIG	Source of info.	USE	Topo. Exp.	REMARKS*
51	Thornton, Richard	Scott, John	Atlantic	65	12	17				2" x			-			1950	J	usgs	Dom	Flat	Soft water, El. 27
52	Thornton, Richard	Scott, John	Atlantic	64	8	17				2" x			-			5/49	J	usgs	Dom.	Flat	El. 25', Soft water, A
53	Long, Pat	Scott, John	Temperanceville	200	30	18	3-4'	3		2" x			-			4/50	J	usgs	Dom.	Flat	El. 27', Soft water, A-
54	Lecato Conquest		Chincoteague	180						2" x			-				J	usgs	Dom.	Flat	El. 5', Soft water, El
55	Hall, Frederick	Scott, John	Hallwood	265	30	14	3-4			2" x			-	450		4/49	J	usgs	Dom	Flat	El. 30', A-55, soft wa
56	Gladden, Kai	Scott, John	Hallwood	248	1½	25	3-4'			2" x 84'			-	350		4/48	J	usgs	Dom	Flat	El. 25',
57	Roberts, Anna	Scott, John	Hallwood	232	1½	25				2" x	60 mesh		-	350		5/48	J	usgs	Dom	Flat	El. 25', A-57
58	Dewey Marshall	Scott, John	Hallwood	240	1½	16⅔	4'	3-4		2" x			-	350		1950	J	usgs	Dom	Flat	El. 25', A-58
59	Davis, Henry	Scott, John	Hallwood	237	1½	16⅔	8'	2		2" x			-	16⅔		7/51	J	usgs	Dom	Flat	El. 30', A-59
60	Hall, James A.	Clark, T. B.	Hallwood	186						1½" x		10'-30', 110'-150'	-			1903		usgs			El. 10', D. 60
61	Tappin, Melvin	Scott, John	Hallwood	231	1½	25				2" x	60 mesh		-			3/48	J	usgs	Ind.	Flat	El. 25', A-61
62	Nock, Haddy	Scott, John	Hallwood	240	12	16	4	3		2" x	60 mesh		-			1950	J	usgs	Dom.		El. 25'
63	Seaside Fish Co.		Assateague Is.	412						6" x			-			1935		usgs		Flat	F, Ab., well under w
64	Gordy, John B.		Mappsville	130									-				J?	usgs	Dom.		El. 40', A-64
65	Adkins, May		Meaxville	190	1½	2				1½" x			-			1936	J	usgs	Dom.	Flat	A-65, El. 9', F
66	Taylor, George E.	Scott, John	Means	256	1½					2" x , 1½" x			-			1936	J	usgs	Dom.	Flat	El. 28', A-66
67	Groton, Samuel B.		Hallwood	199						2" x			-			1946	J	usgs	Dom	Flat	El. 25', A-67
68	Bloxom Auto	Scott, John	Mappsville	255	30		4-5'	3		2" x			-	16⅔		11/51	J	usgs	Dom	Flat	El. 25', A-68
69	Flemings Brothers	Ewell, W.	Means	21	4			6		2" x			-			7/48	Dug	usgs	Dom	Flat	El. 25', A-69
70	Natl. Adv. Comm. Aeronau		Wallops Island	147	2½	30				6" x 133'	4½" (132'-147') 16 slot	134'-147'	-	100				usgs	Dom.		El. 9', A-20
71	Linwood, D. Lewis	Scott, John	Mappsville	225	32					2" x			-	16⅔		11/50	J	usgs	DOM.	FLAT	El. 25', A-71, Soft
72	Jenkins, A. M.	Jenkins, A. M.	Bloxom	23						1½" x			-	1½		7/45	Dug	usgs	DOM.	FLAT	El. 16', A-72
73	Gillespie, H. W.	Scott, John	Bloxom	220	14					2" x			-			1945	J	usgs	DOM.		A-73
74	Custis, John	Millburn, F.	Bloxom	18½	8½					2" x			-				Dug	usgs	DOM.	Willy	El. 19', A-74, Soft wa
75	Langford, Preston	Scott, John	Bloxom	265	24		4'	2		2" x			-	16⅔		1/51	J	usgs	DOM.	FLAT	El. 25', A-75, Soft wa
76	West, Jack	Scott, John	Nelsonia	240	31					2" x			-	800		9/50	J	usgs	DOM.	FLAT	El. 25', A-76, Soft w
77	Bloxom, L. N.	Scott, John.	Nelsonia	230	30	15	6'	8		2" x			-	900		11/48		usgs	DOM.	FLAT	El. 25', A-77, Hard wa
78	Bloxom, Alva	Scott, J.	Nelsonia	255	30					2" x			-	16⅔		9/52	J	usgs	DOM.	FLAT	El. 25' Soft wa
79	Mason, Shoat	Scott, J.	Madestown	228	30	16⅔	9	4		2" x			-	75		11/48	J	usgs	DOM.	FLAT	El. 19', A-79, Hard w
80	Means, C.	Scott, J.	Nelsonia	230	29					2" x			-			1951	J	usgs	DOM.	FLAT	El. 25', A-80, Soft wa
81	Ewell, Abe	Scott, J.	Nelsonia	230	30					2" x			-	15		9/51		usgs	DOM.	FLAT	El. 25, A-81, Soft wa
82	Taylor, G. R.	Taylor, G. R.	Bloxom	34		50				1¼" x			-			11/48	Dug	usgs	DOM.	FLAT	El. 11½'
83	Annis, Forest	Taylor, Wm.	Hopeton	138	1½	1				1½" x	13" (138')		-			1935	D	usgs	DOM.	FLAT	El. ½', A-83
84	Pickens, Barnett	Scott, John	Mappsville	228	30	16⅔	6	3		2" x			-	16⅔		10/50	J	usgs	DOM.	FLAT	El. 25', Soft wate
85	Poulson, Milton R.		Hopeton	40		50				1¼" x			-			5/44	Dug	usgs	DOM.	FLAT	El. 31, Musty odo
86	Means, Wm. S.	Means, Wm. S.	Gargatha	18	4					1¼" x			-			9/36	Dug	usgs	DOM.	FLAT	El. 20', Soft wate
87	Costin, H. R.	Scott, John	Parksley	220	16	15	5'	2		2" x			-			11/52	J	usgs	DOM.	FLAT	El. 25'
88	Copper, J. L.		Hopkins	100	½	1½				1½" x			-			1914	Dug	usgs	DOM.	FLAT	El. 7', A-88
89	Watkinson, Brantley	Porter, W.	Hopkins	123		2				2" x			-				J	usgs	DOM.	FLAT	El. 3', A
90	Duncan, Linwood	Porter, W.	Chesconessex	123	2	30				2" x			-				J	usgs	DOM.	FLAT	El. 3', D-90
91	Dicks	Porter, W.	Parksley	165	17	100				2" x		20, 60-63, 163-165	-	350			J	usgs	DOM.	FLAT	El. 25', D-91
92	Town well #2	Sydnor	Parksley	65		150				8" x			-			9/47	D	usgs	P.S.		El. 30', D-92
93	Town well #1		Parksley	165		50				8" x			-					usgs	P.S.		
94	Richardson, Henry J.	Scott, John	Greenbush	220	1					2" x			-	300		7/43	J	usgs	DOM.	FLAT	ELEV. 3', A-94
95	Grosvenor, Walter	Scott, J.	Greenbush	50	10	33⅓	12	3		2" x			-			1951		usgs	DOM.	FLAT	ELEV. 25', A-95
96	Palley, W. F.		Franklin City	75	0	20				1¼" x 71'		20'-25'	-				D	usgs	DOM.	FLAT	ELEV. 3', A-96
97	Black	Porter	Chesconessex	160	8	20				2" x		18', 150'-160'	-			1951	J	usgs	DOM.	FLAT	ELEV. 7', D-97
98	Edwards, W.	Scott, J.	Chesconessex	150	6	15	4	4		2" x			-			7/49	J	usgs	DOM.	FLAT	ELEV. 4', A-98
99	Marsh, David W.	Watson, W.	Onancock	160	5					1¼" x			-			2/48	J	usgs	DOM.	FLAT	ELEV. 6', A-99
100	Russell, Milton	Scott, J.	Onancock	123	12	33⅓				2" x			-			10/48	J	usgs	DOM.	FLAT	ELEV. 25'

WWCR — Water Well Completion Report
TD — Total Depth
SWL — Static Water Level
Yld — Yield
D'd — Drawdown
PT — Pump Test
DI — Depth of Intake
*REMARKS: E — Electric and/or gamma ray logs available; W — Well sample collection available; A — Water analysis available; D — Driller's log available; G — Geologic log available; P — Pump test data available; F — Artesian flow (in gpm); Ab — Abandoned

1992.000 93.13085856

NGDS National Geothermal Data System

geothermaldata.org

Search site or data

Site

Data

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Welcome to NGDS, information for discovery, evaluation, and development of geothermal resources.

NGDS is your source for access to information resources on geothermal energy from a national network of data providers. Data are contributed by academic researchers, private sector participants, and state and federal agencies, primarily the Department of Energy. Access, view, and download data with this free and **easy online search tool**.

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OIT's GeoHeat Center submitted Document Metadata for the NGDS Design & Testing Project.

HELP

- Glossary
- USGIN Tutorials
- Using Apps

FAQ

FIRST VISIT

CONTACT US

SHARE DATA

Becoming a data provider to the NGDS is simple. To learn more about contributing your project's data to the DOE Geothermal Data Repository, data interchange formats, and data services follow the links below:

- Contribute to DOE Geothermal Data Repository
- Register Data

PARTICIPANTS

AASG Association of American State Geologists

BOISE STATE Boise State University

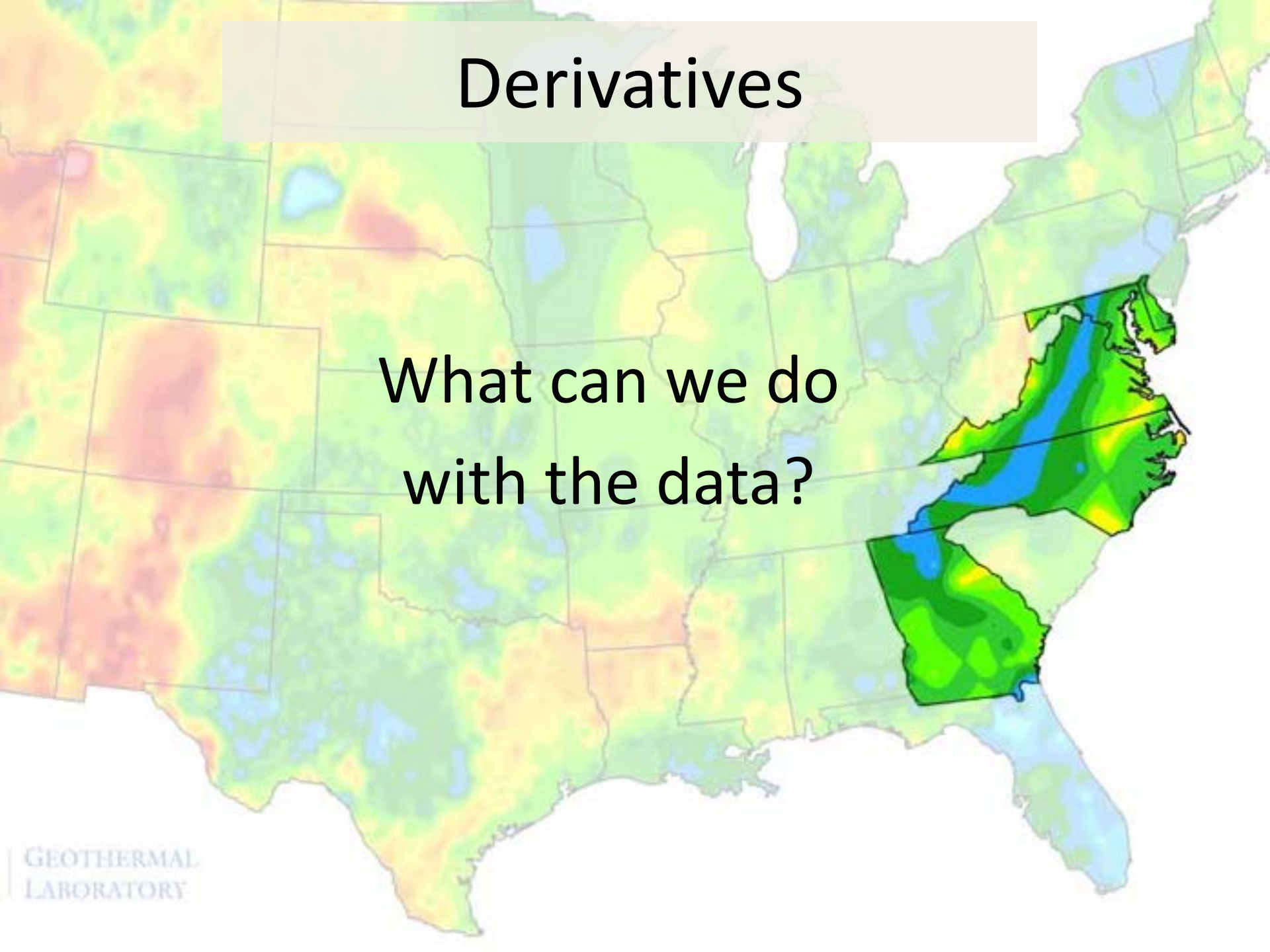
NREL National Renewable Energy Laboratory

SMU Southern Methodist University

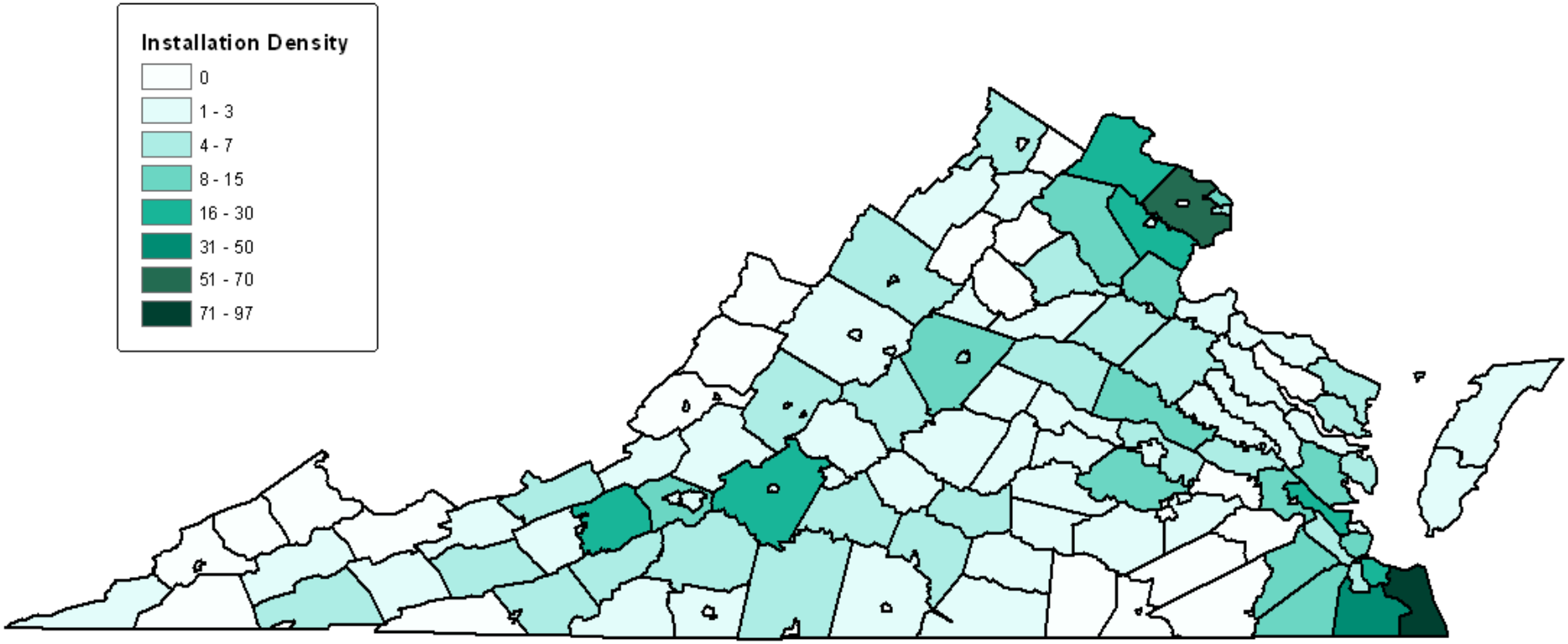
USGS U. S. Geological Survey

Full list of contributors

Derivatives

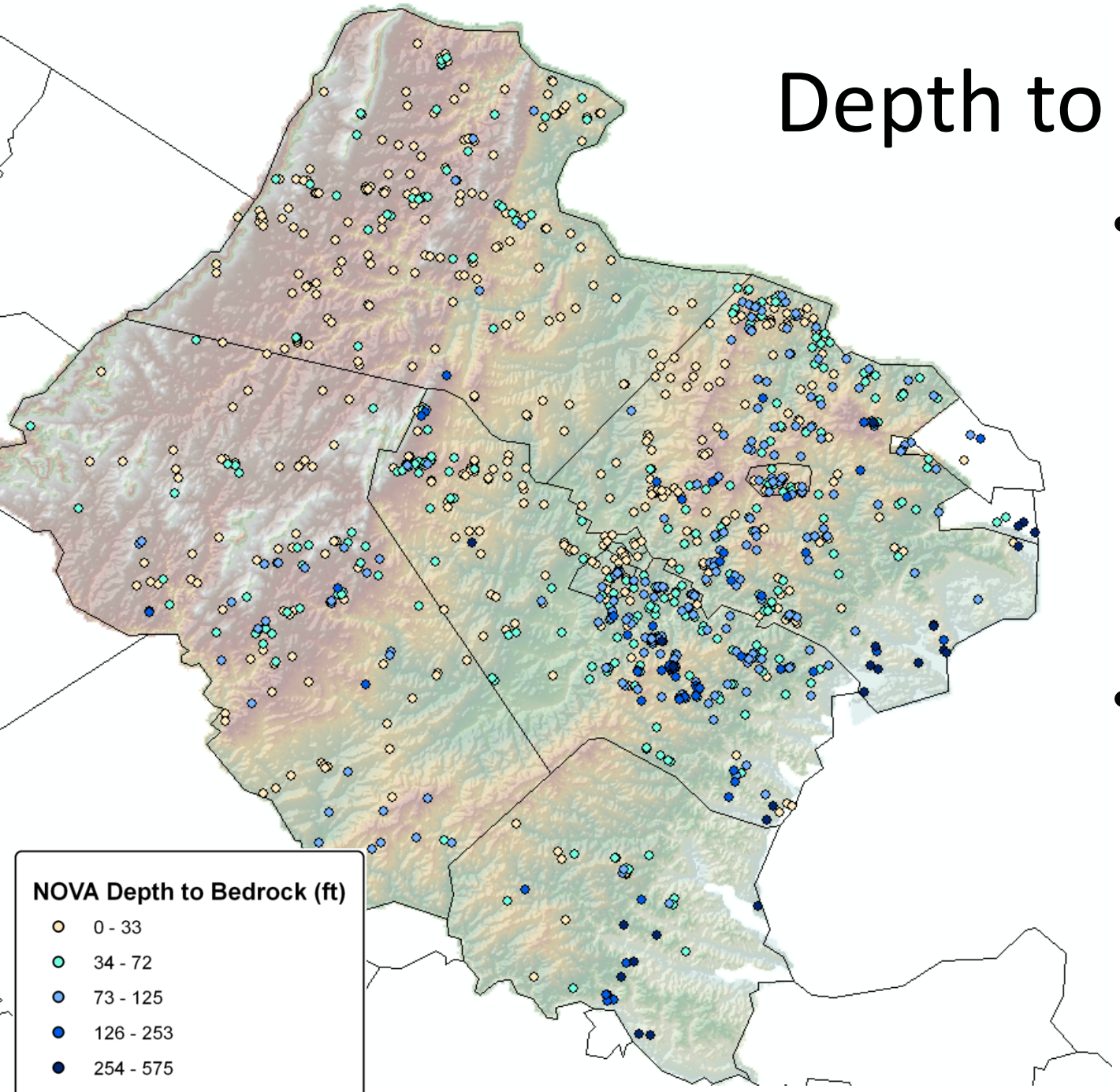


Geothermal Installations



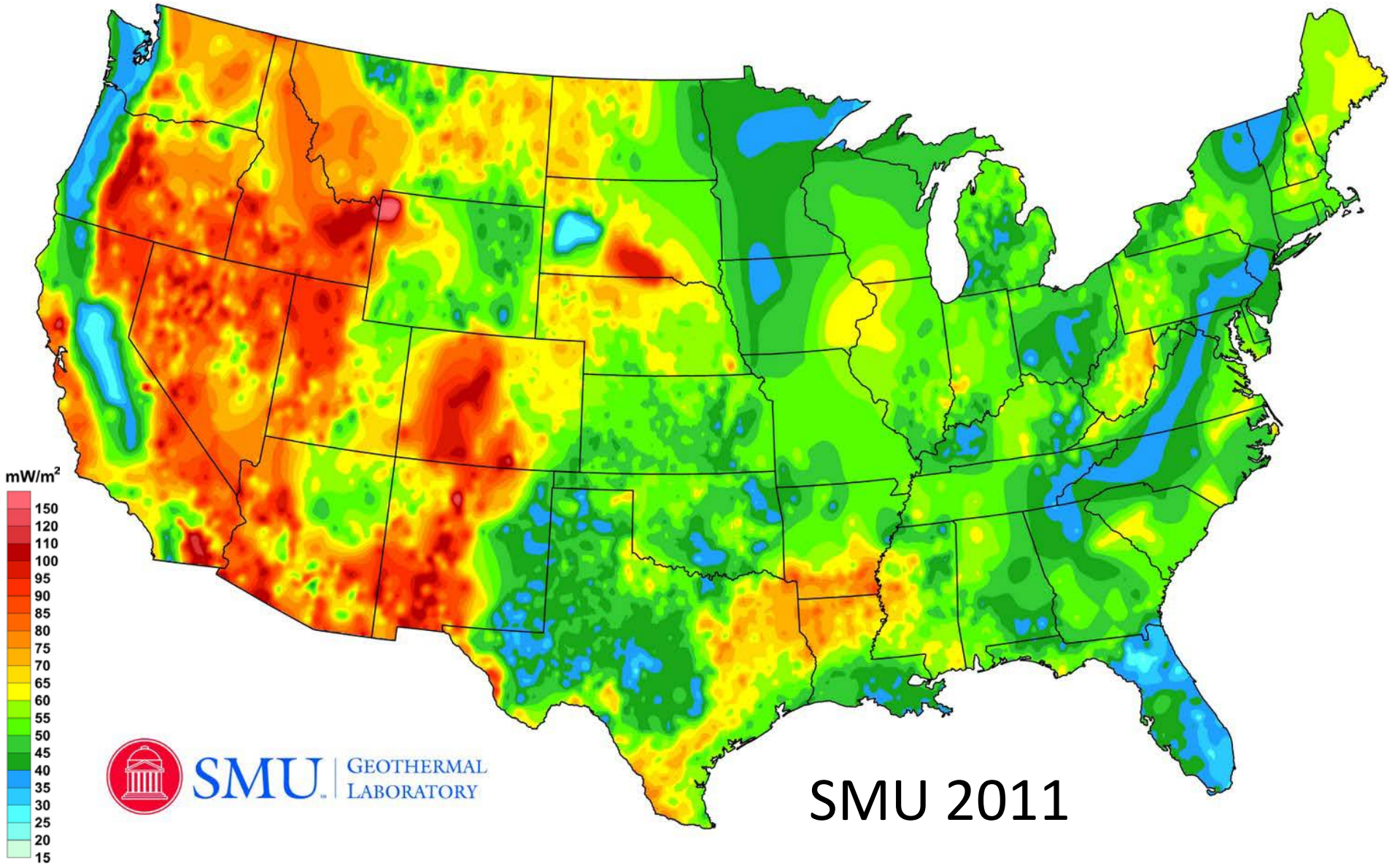
- Weighted county by county statewide
- Data source – rebates, school systems, installing companies

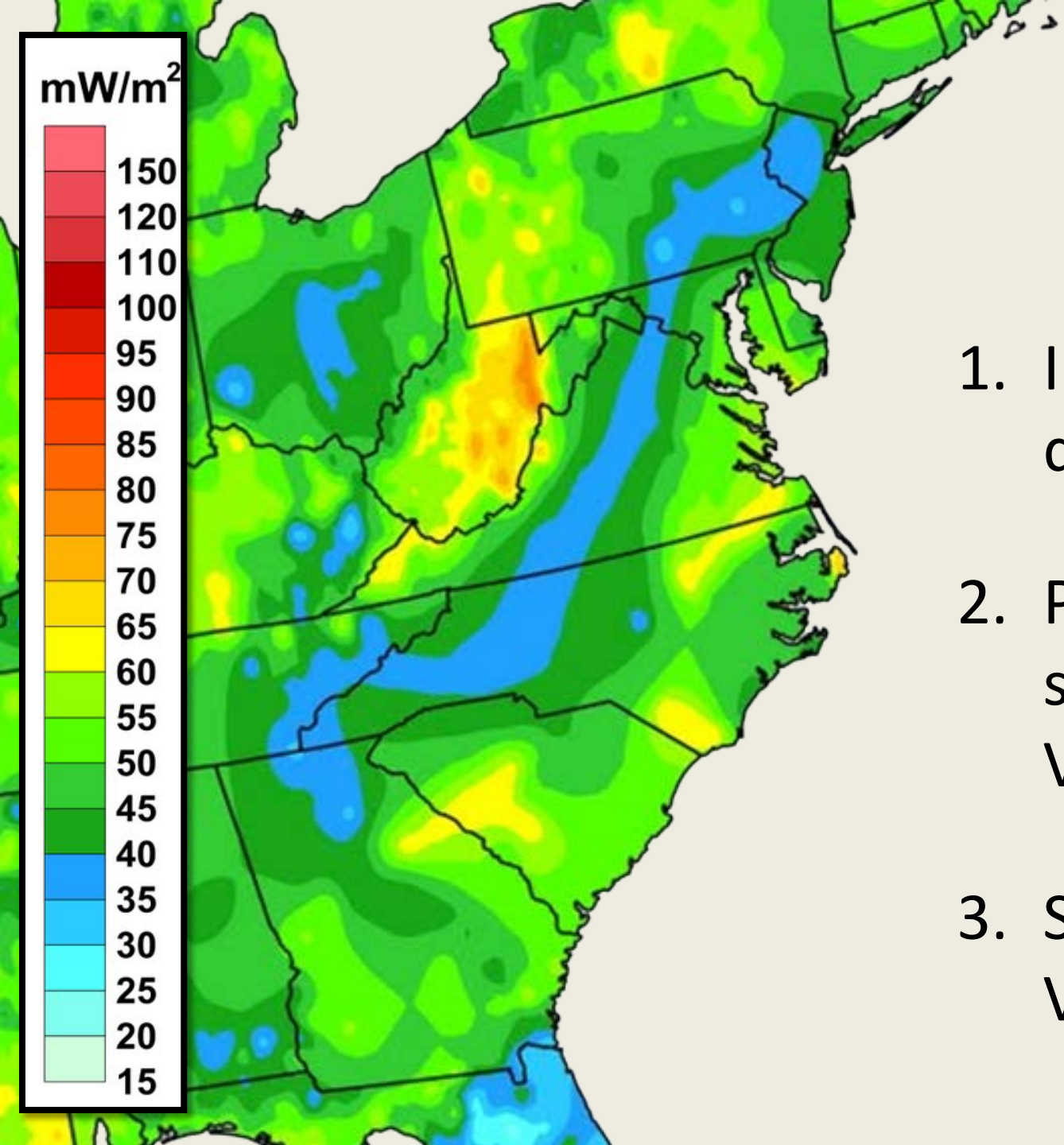
Depth to Bedrock



- Data from DGMR water well database (40,000+ wells statewide)
- Sub-maps target counties of high density installations

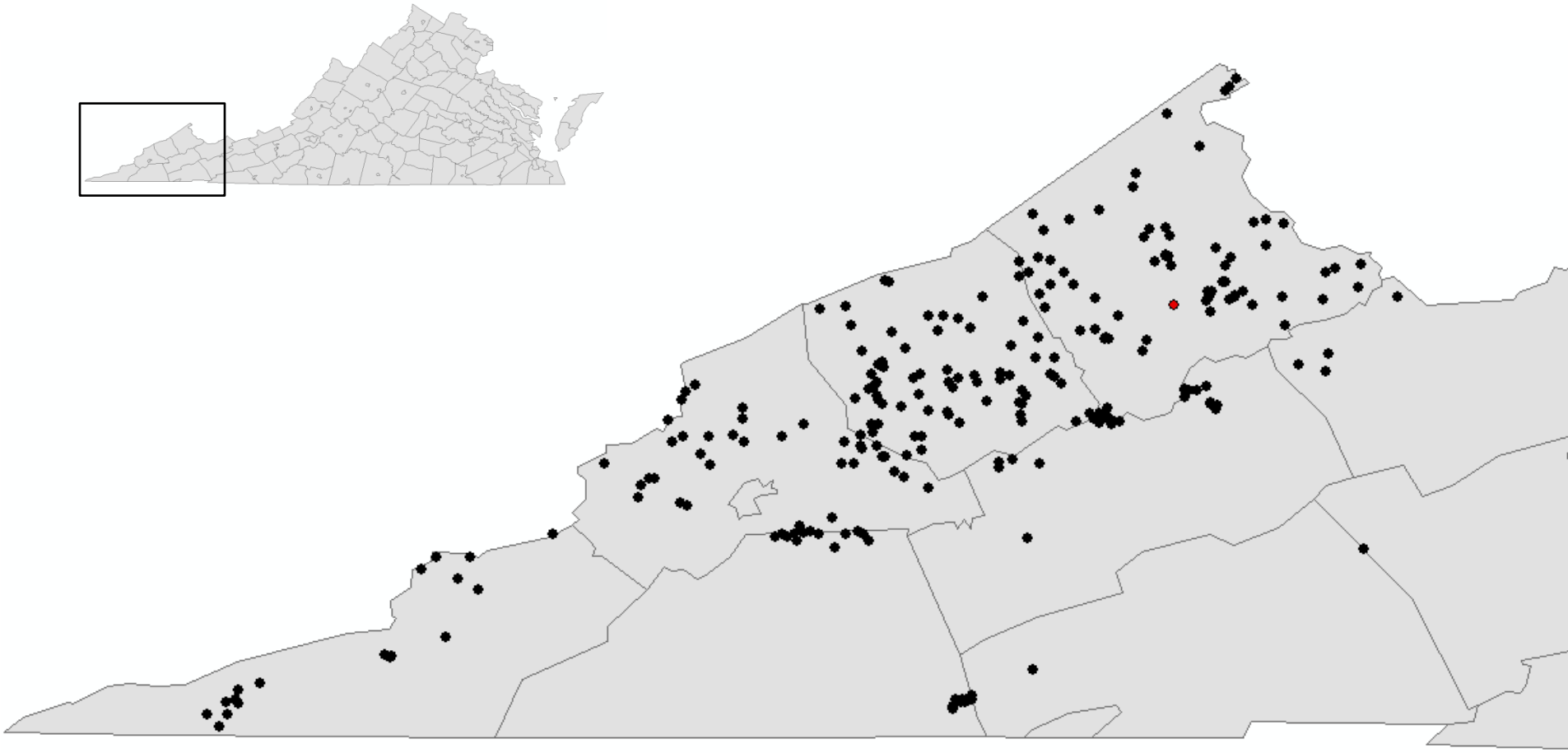
Temperature at Depth and Heat Flow

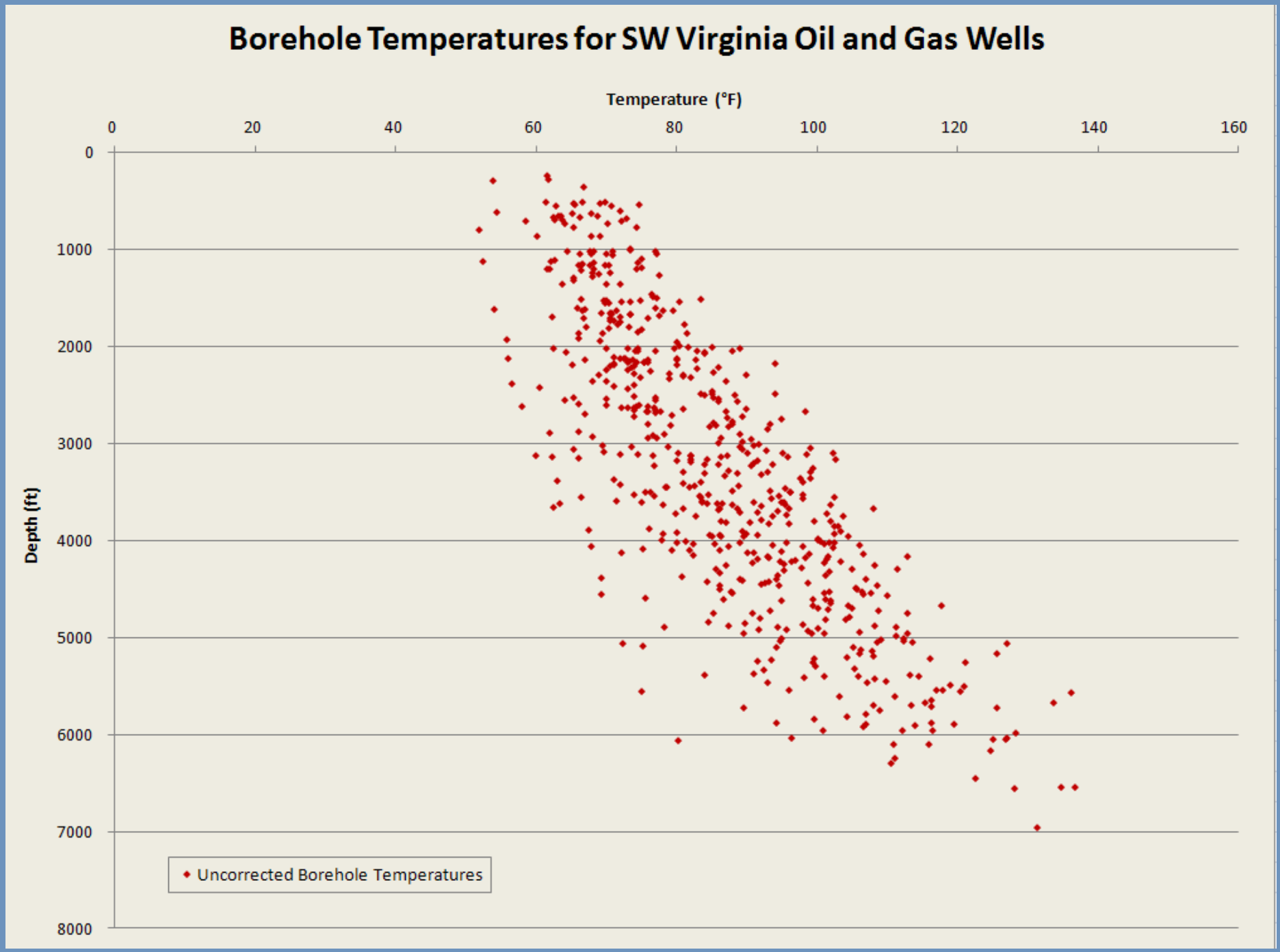


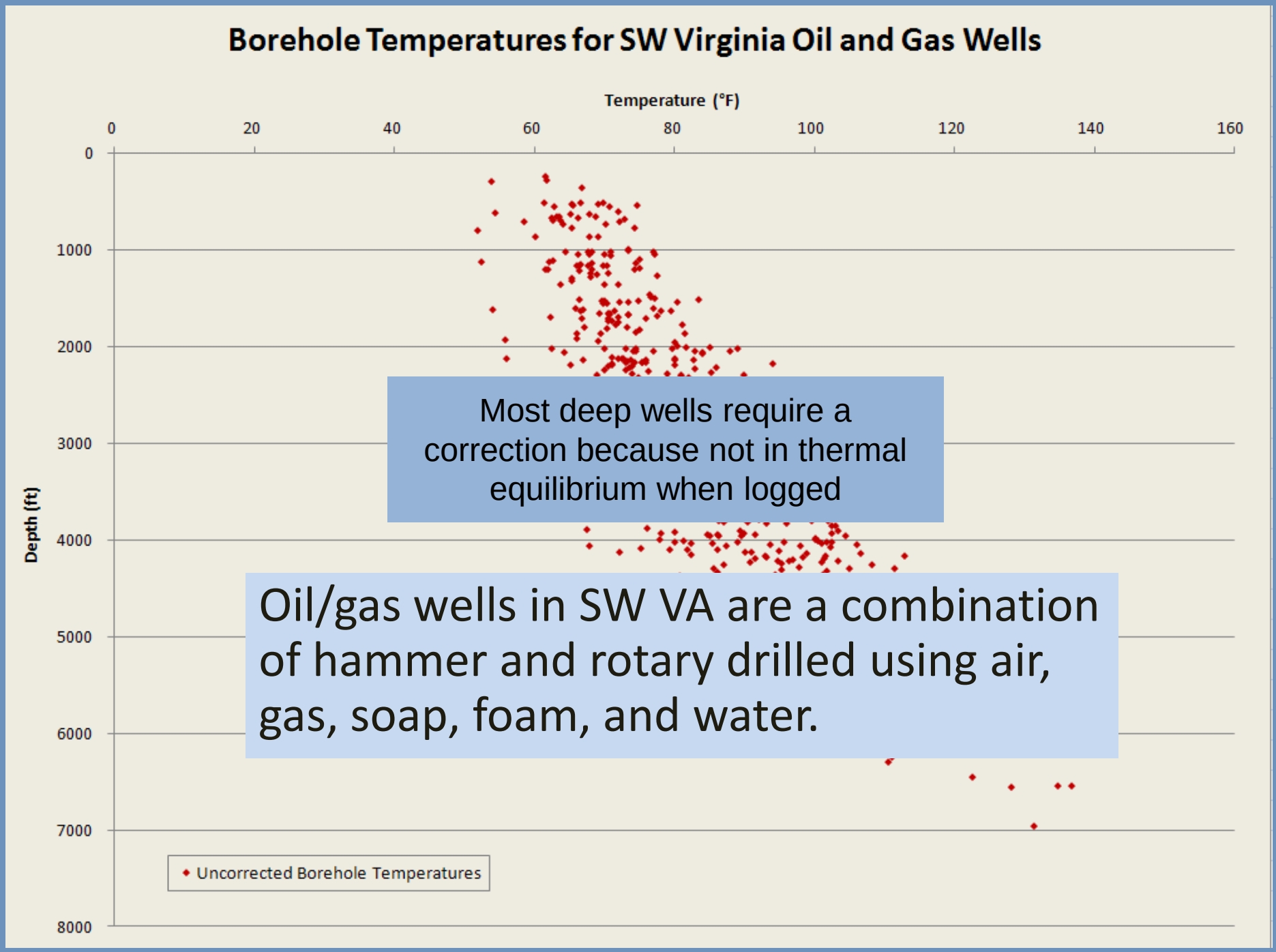


1. Increased data density
2. Primary focus southwestern Virginia
3. Statewide Virginia map?

Distribution of Deep Temperature Data




Borehole Temperatures for SW Virginia Oil and Gas Wells
Temperature (°F)
0
20
40
60
80
100
120
140
160
Depth (ft)
0
1000
2000
3000
4000
5000
6000
7000
8000
Uncorrected Borehole Temperatures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120
140
160
Depth (ft)
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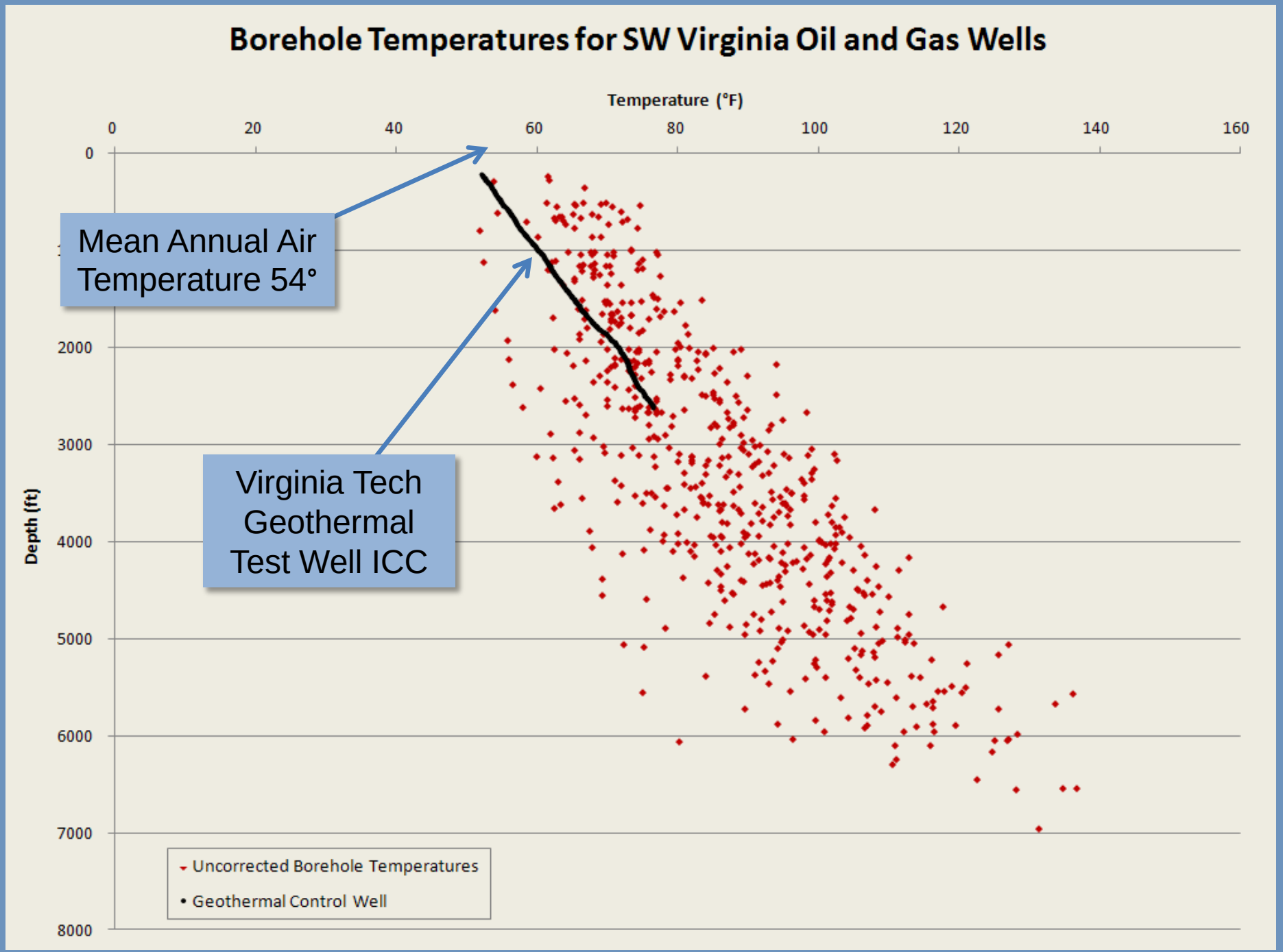
1000
2000
3000
4000
5000
6000
7000
8000
Most deep wells require a correction because not in thermal equilibrium when logged
Oil/gas wells in SW VA are a combination of hammer and rotary drilled using air, gas, soap, foam, and water.
Uncorrected Borehole Temperatures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80
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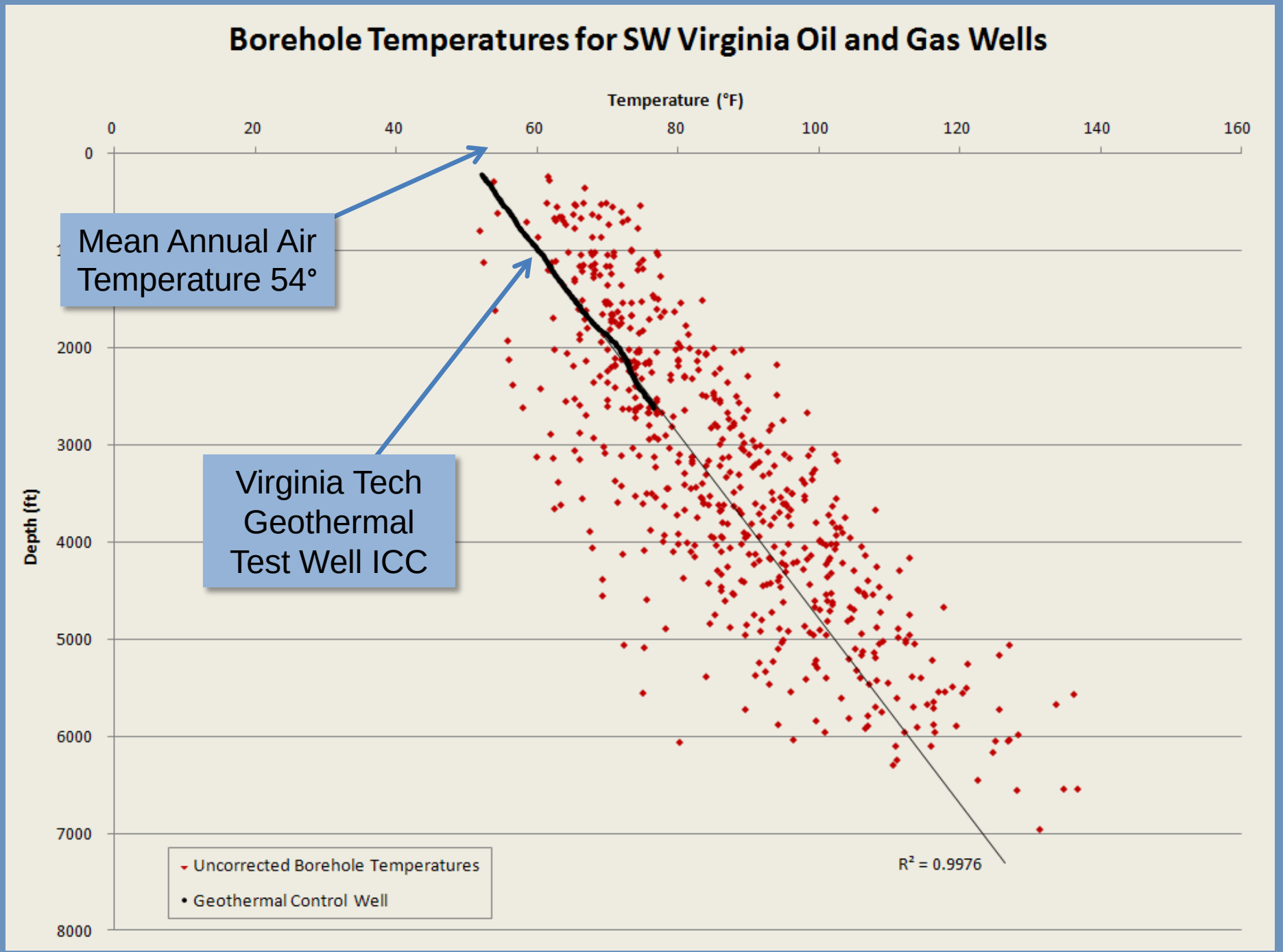
120
140
160
Depth (ft)
0
2000
3000
4000
5000
6000
7000
8000
Mean Annual Air Temperature 54°
Virginia Tech Geothermal Test Well ICC
Uncorrected Borehole Temperatures
Geothermal Control Well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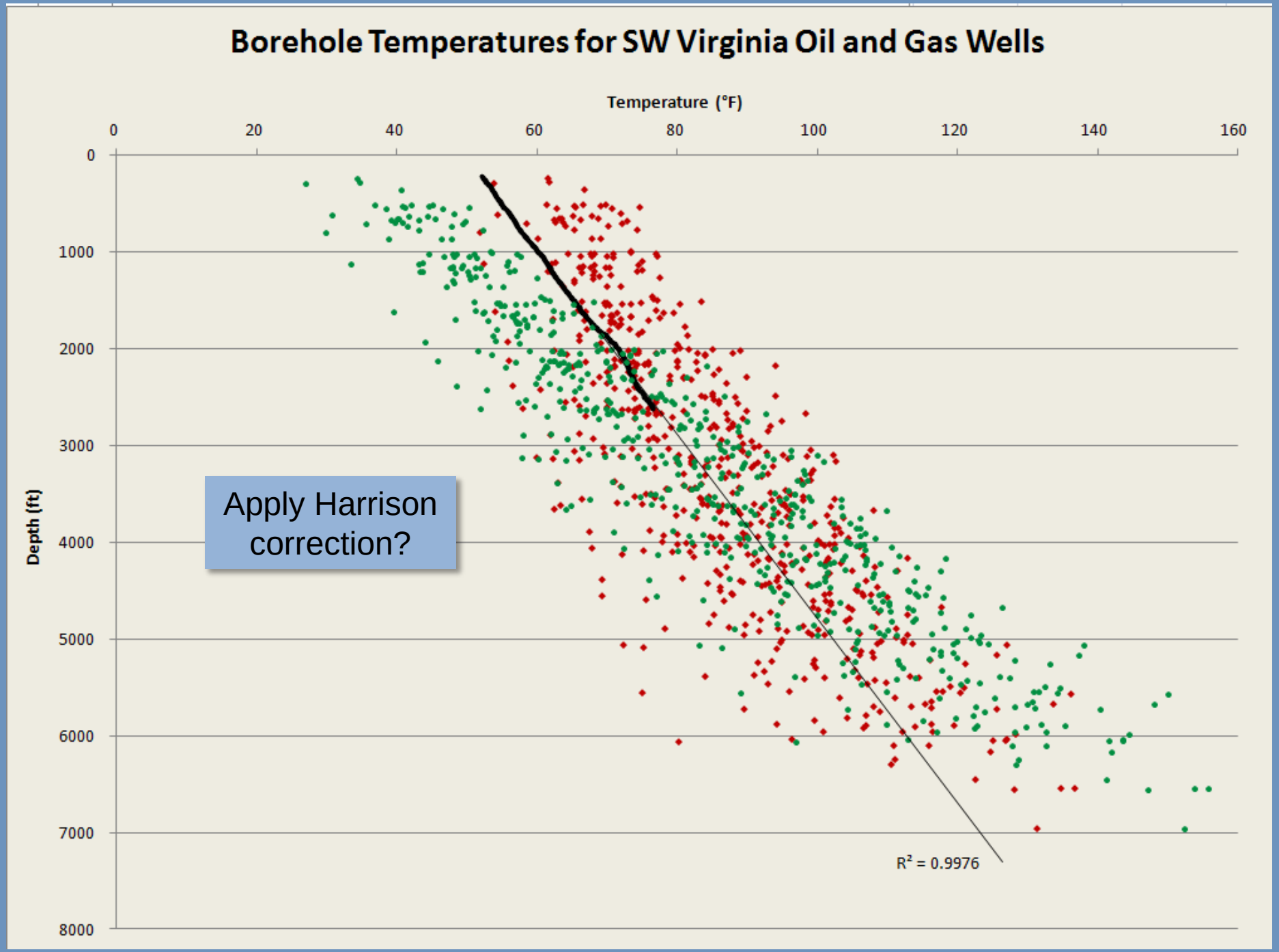
8000
Mean Annual Air Temperature 54°
Virginia Tech Geothermal Test Well ICC
Uncorrected Borehole Temperatures
Geothermal Control Well
R² = 0.9976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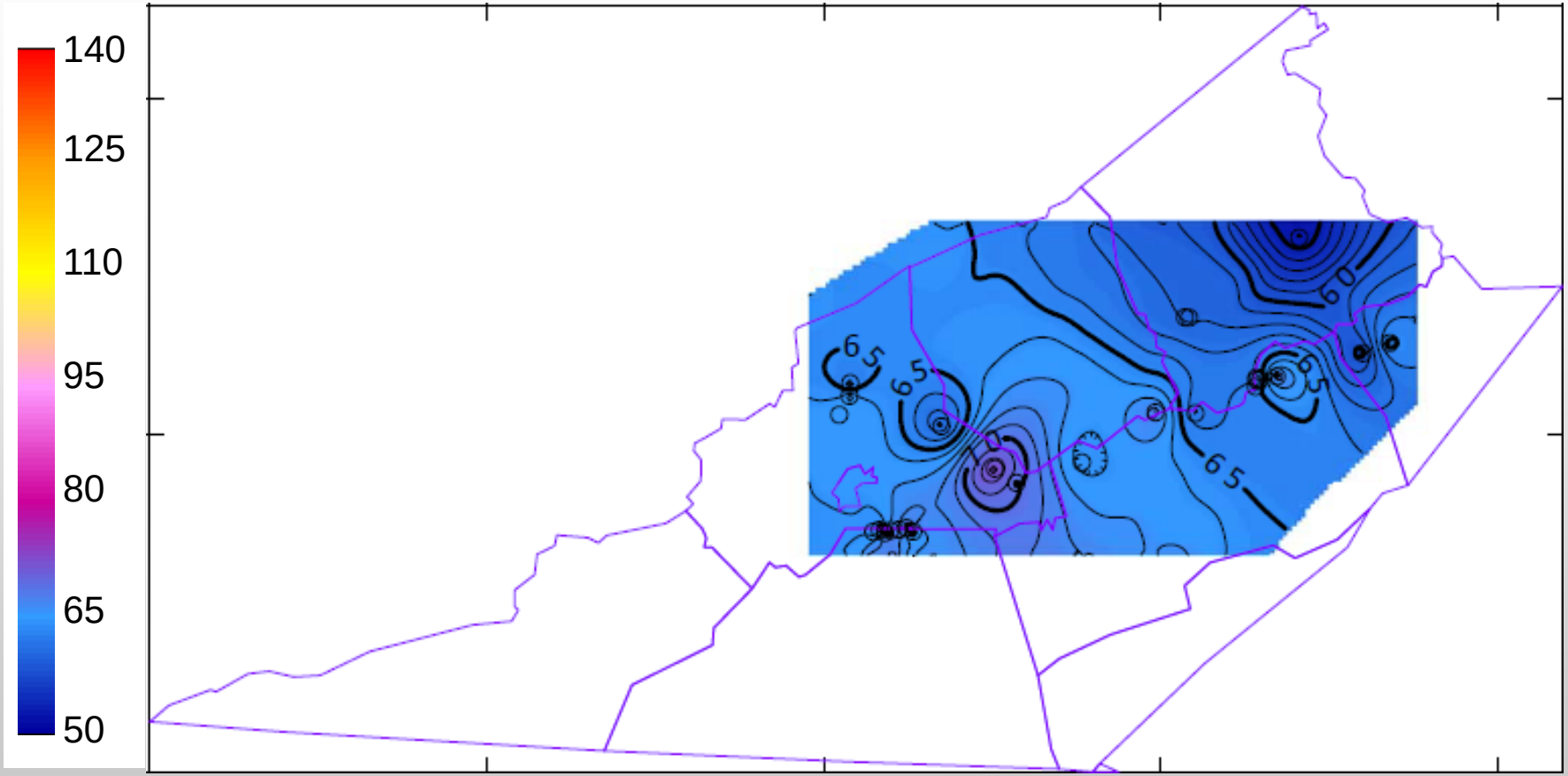
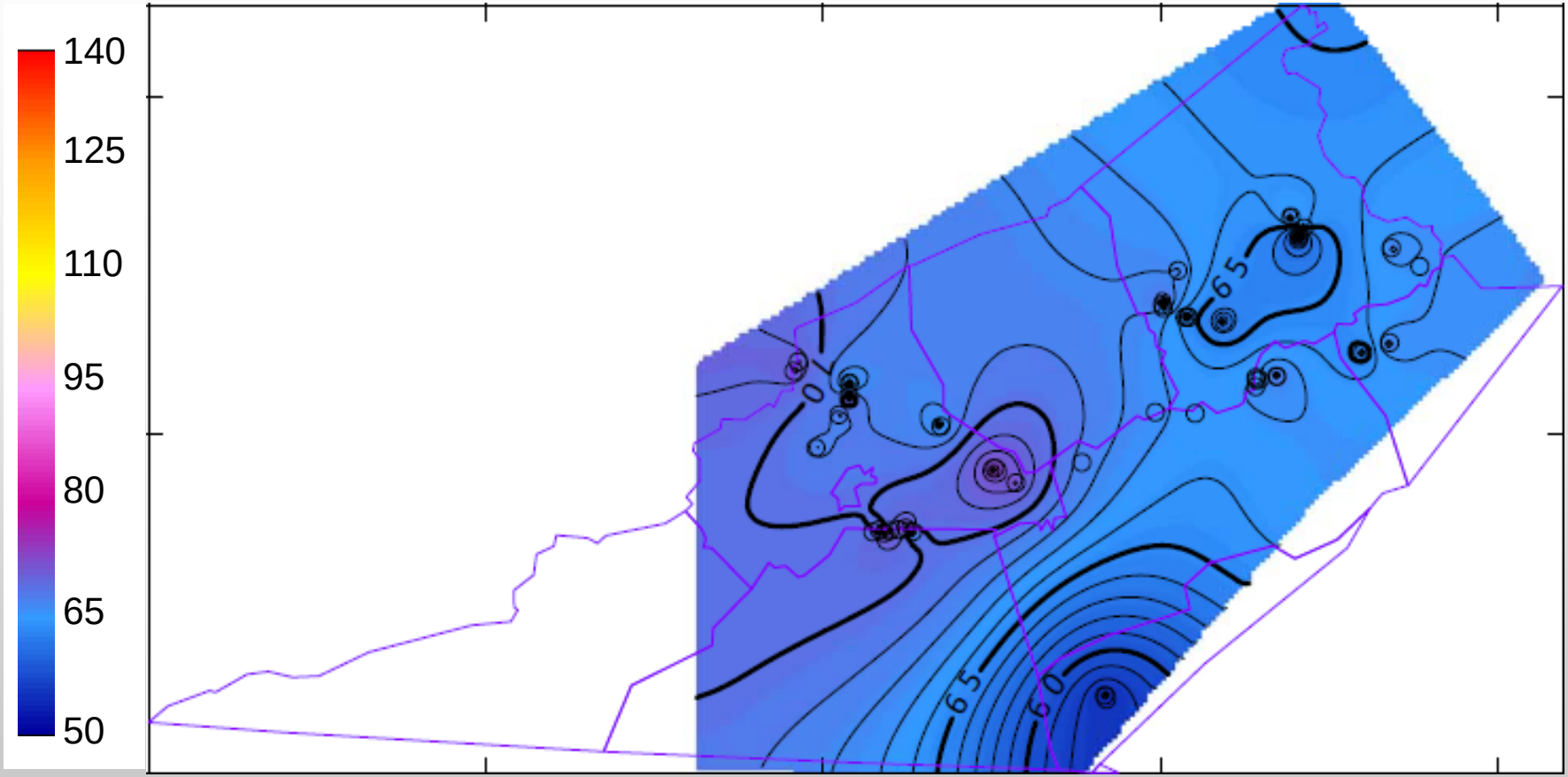
20
40
60
80
100
120
140
160
Depth (ft)
0
1000
2000
3000
4000
5000
6000
7000
8000
Apply Harrison correction?
R² = 0.9976

Temperature at Depth



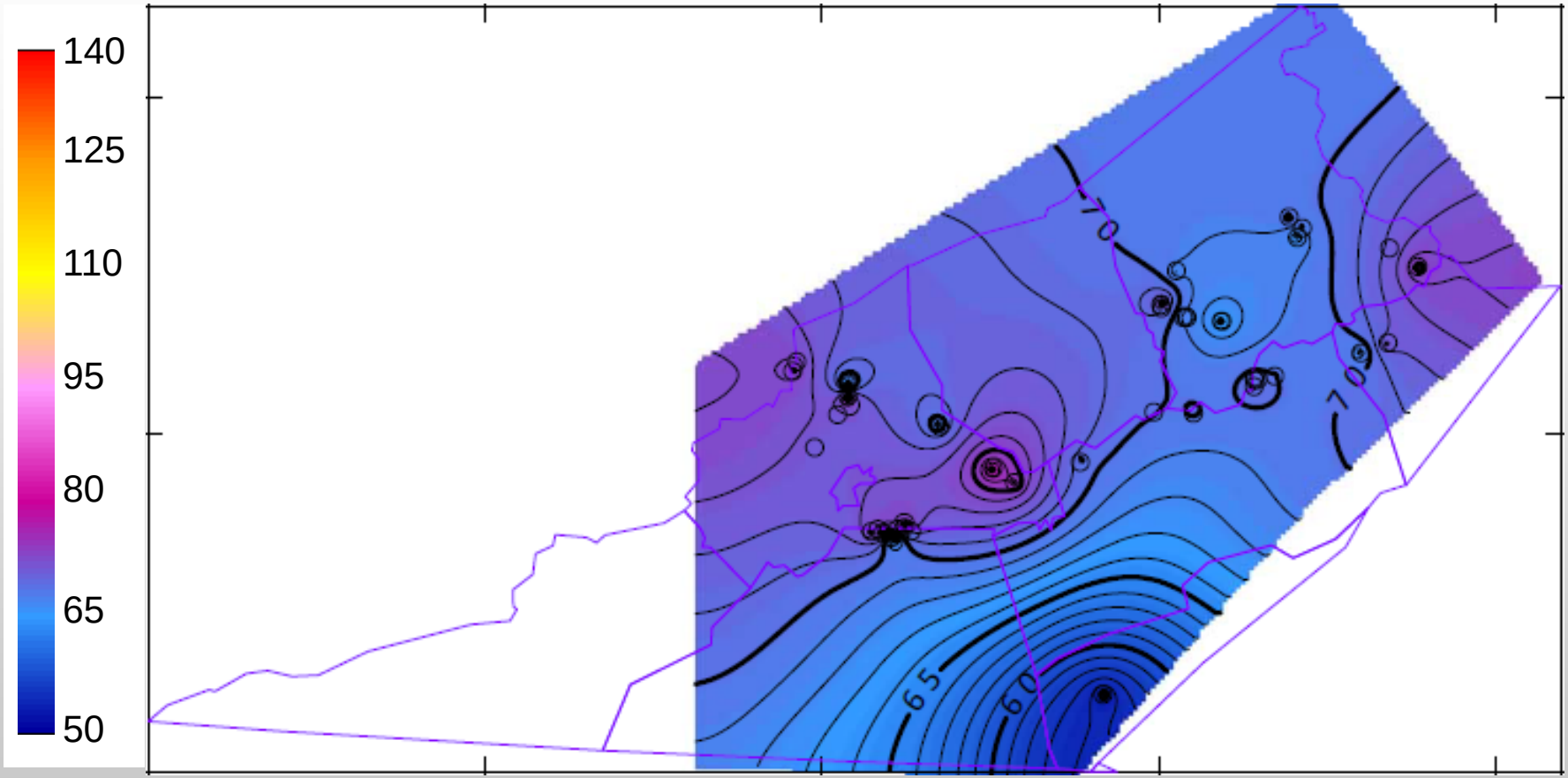
2000 feet above sea level

Temperature at Depth



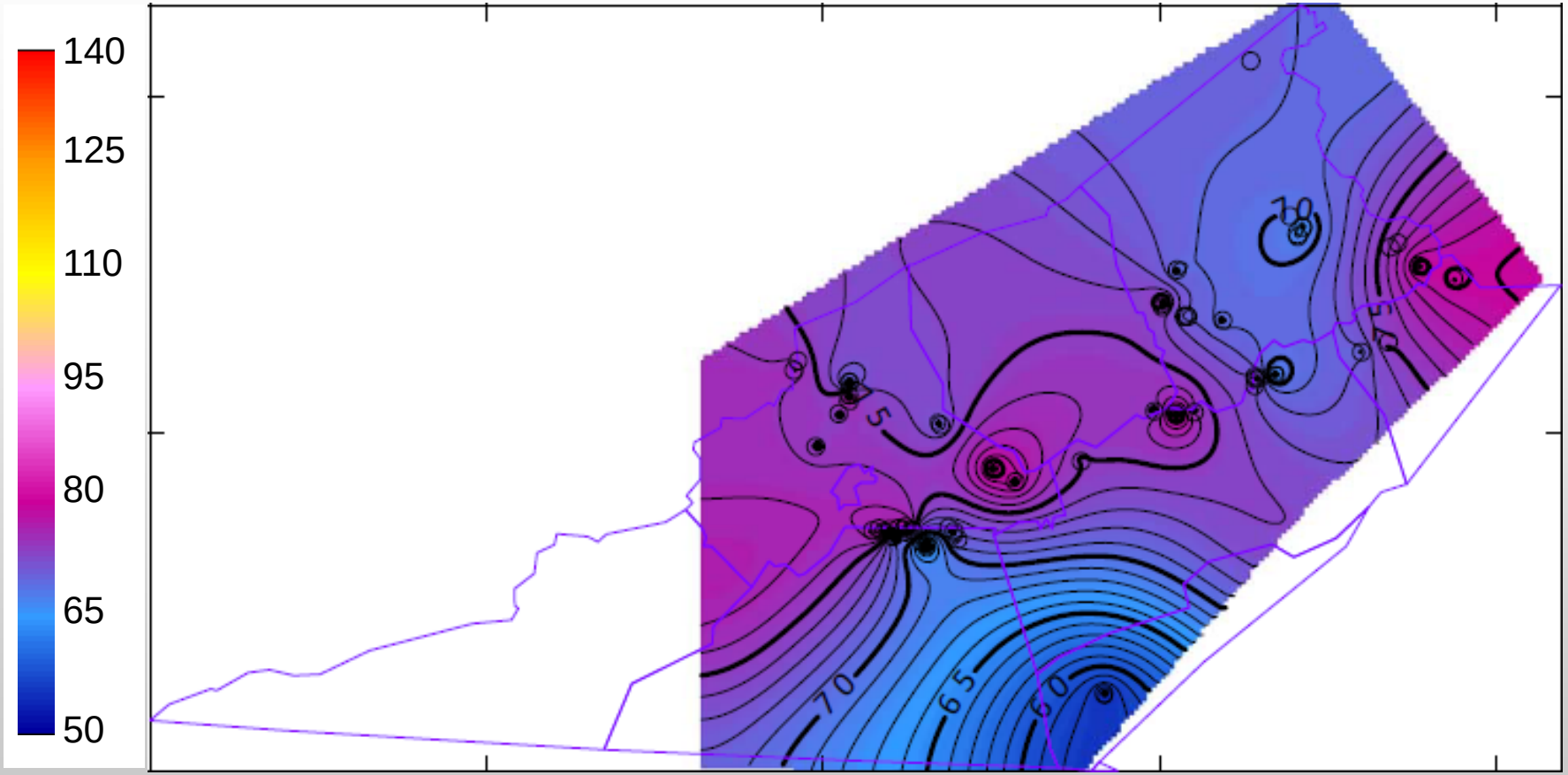
1500 feet above sea level

Temperature at Depth



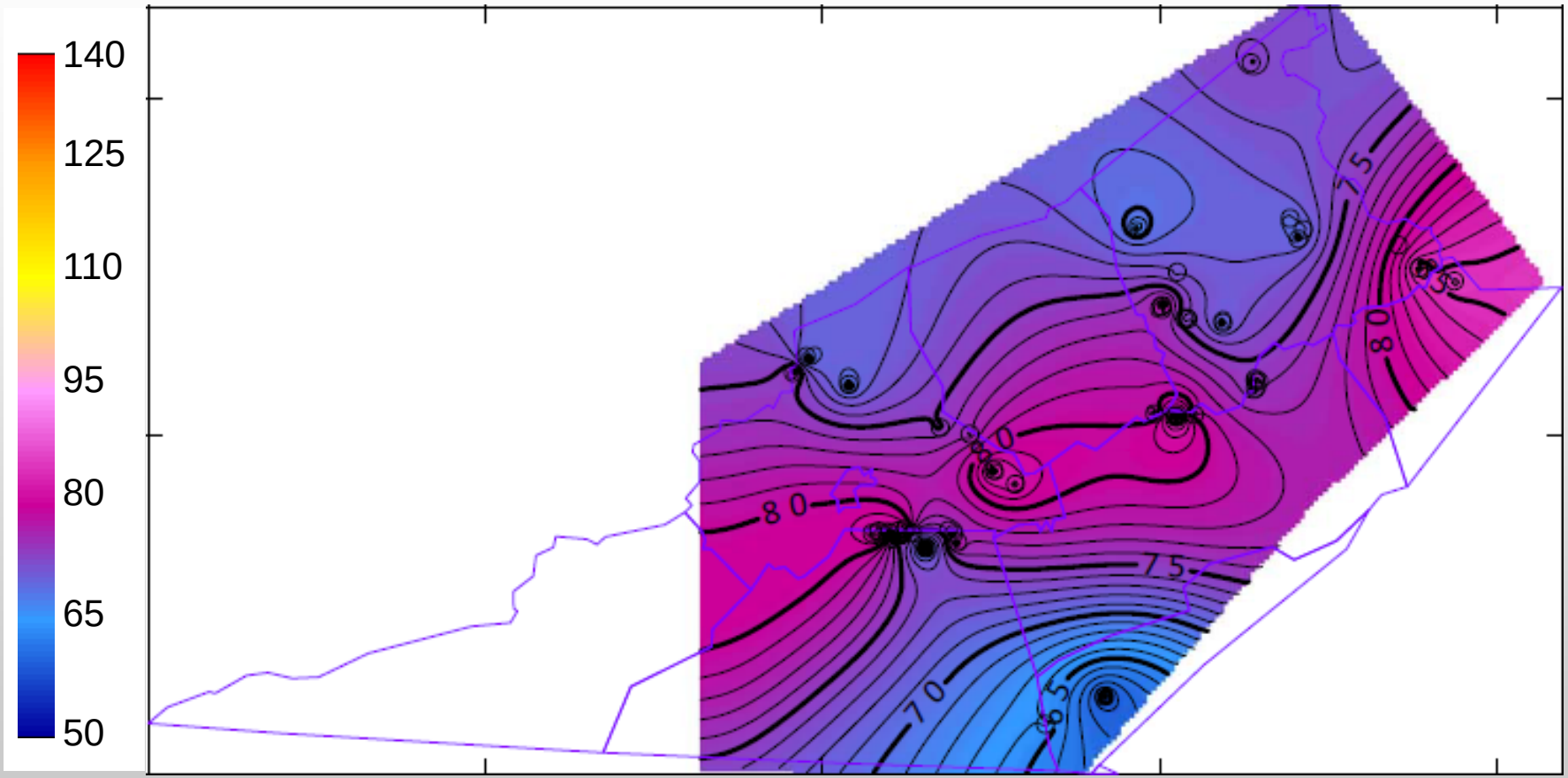
1000 feet above sea level

Temperature at Depth



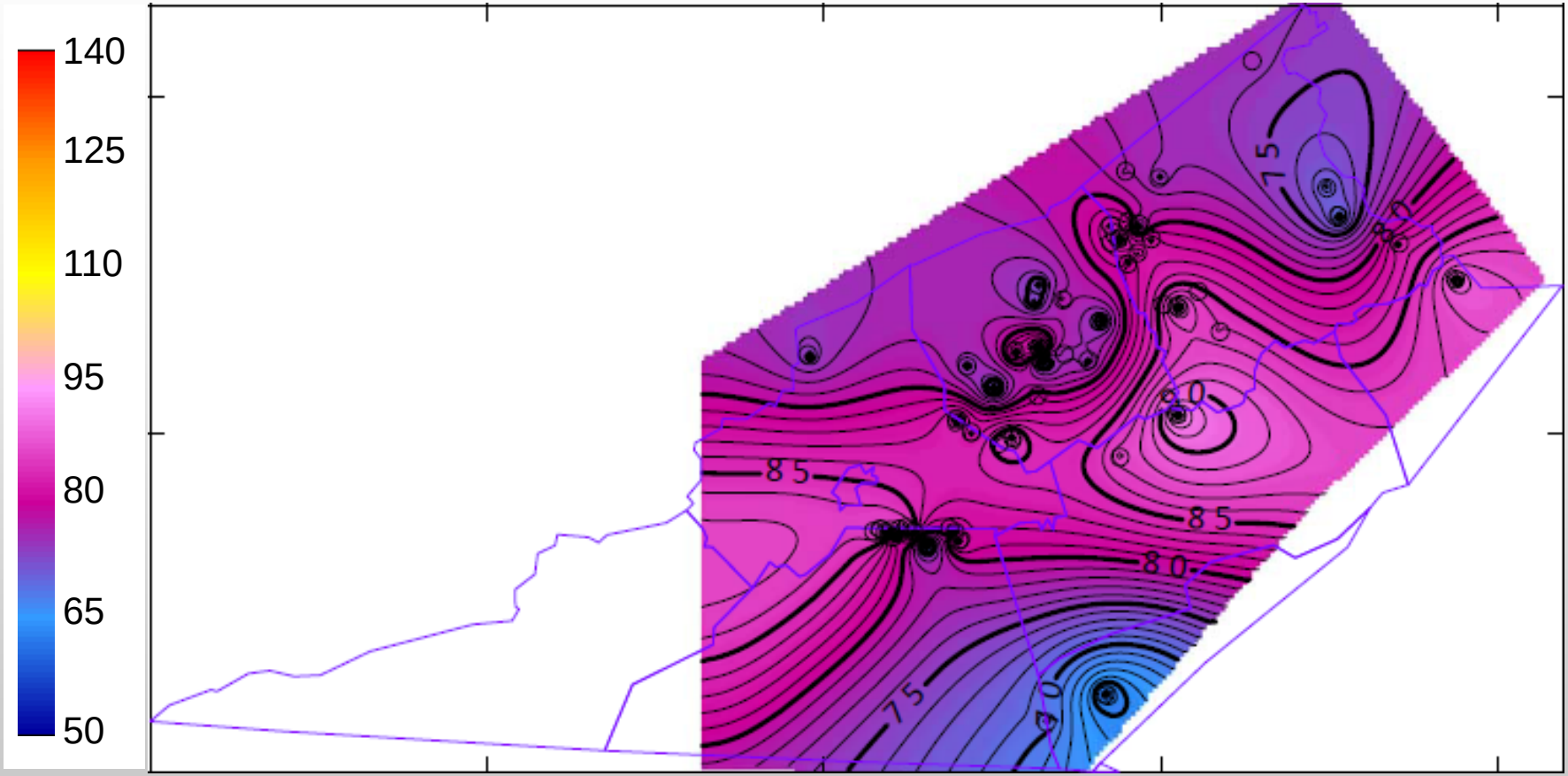
500 feet above sea level

Temperature at Depth



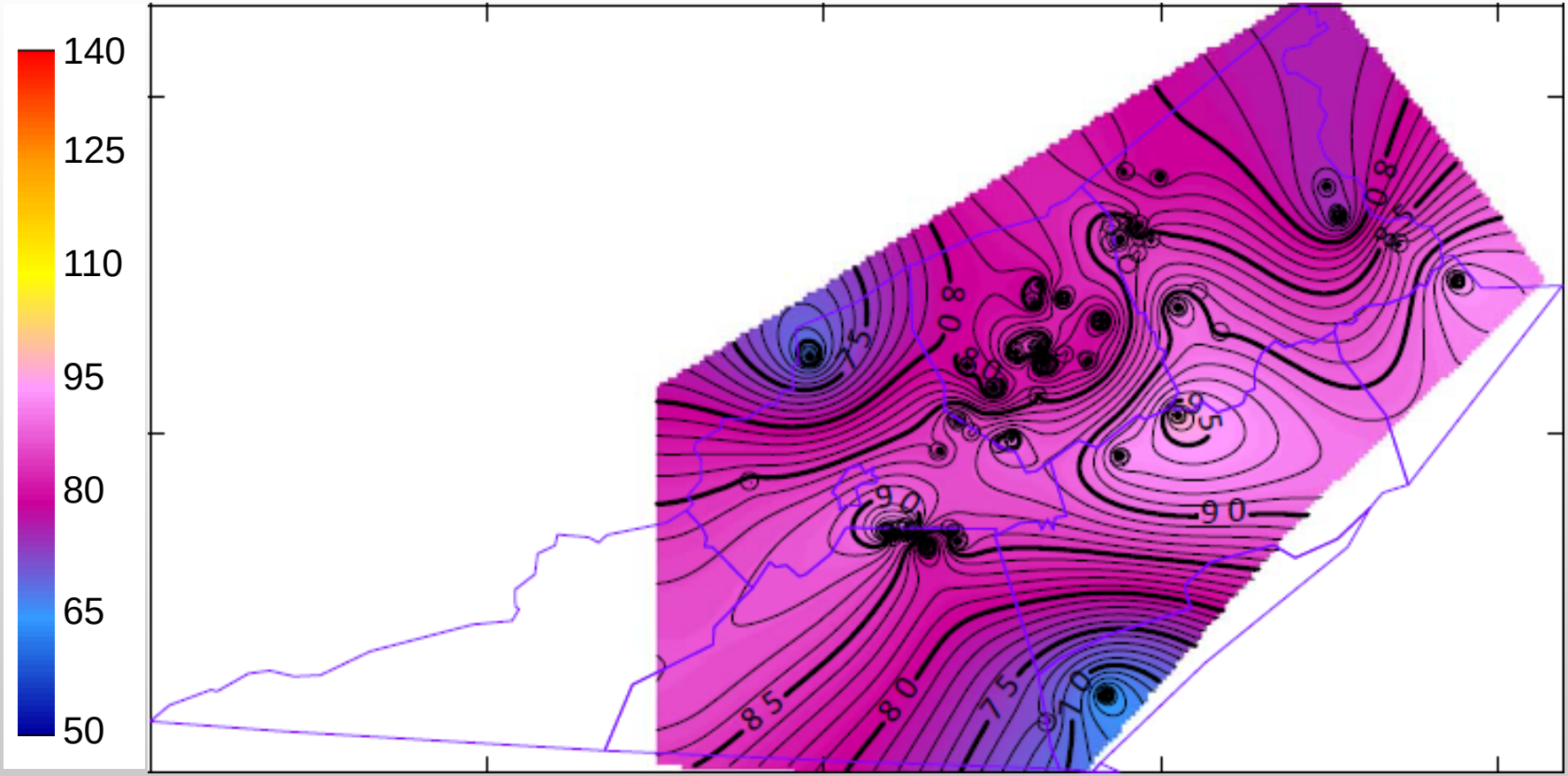
sea level

Temperature at Depth



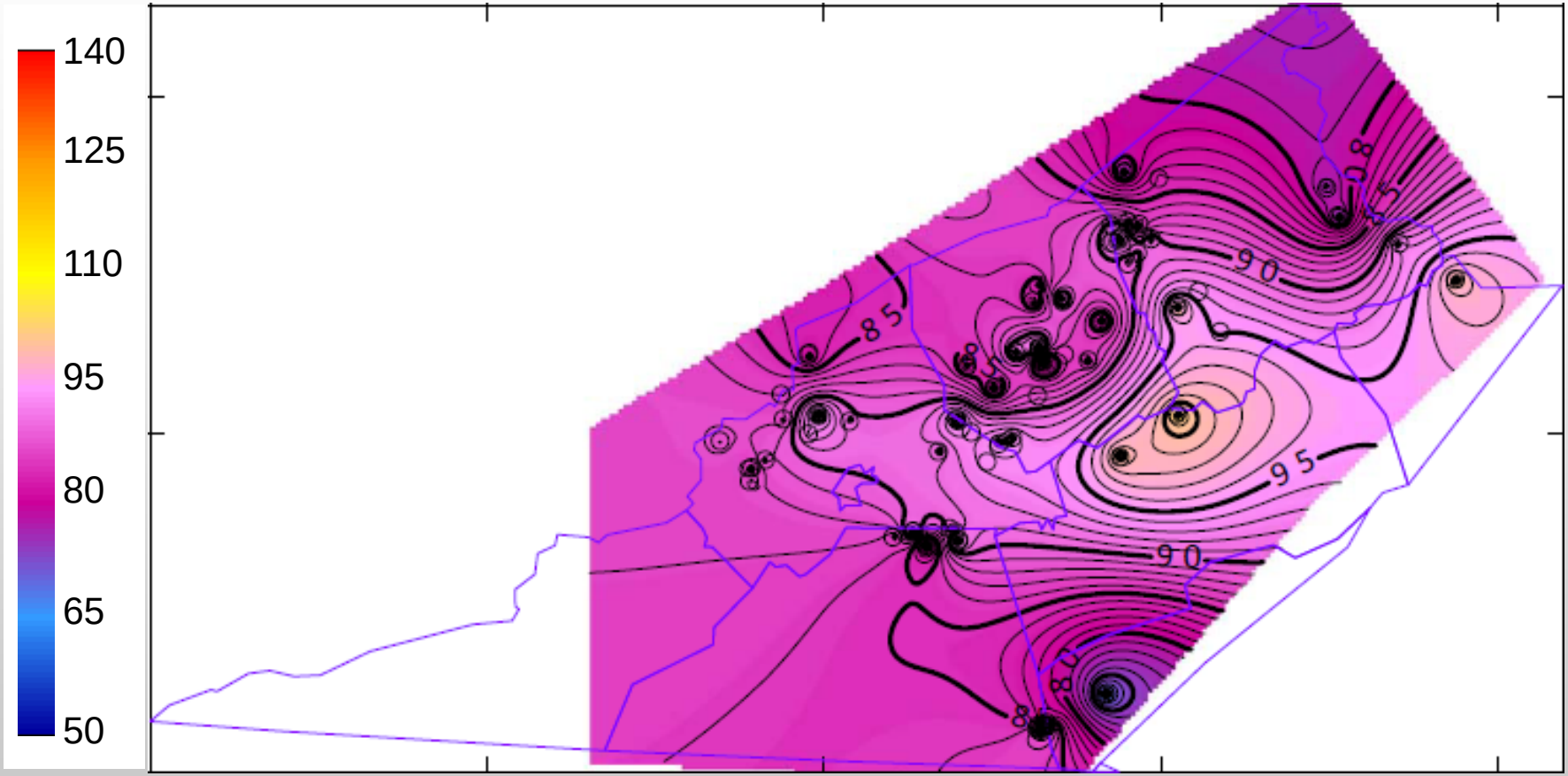
500 feet below sea level

Temperature at Depth



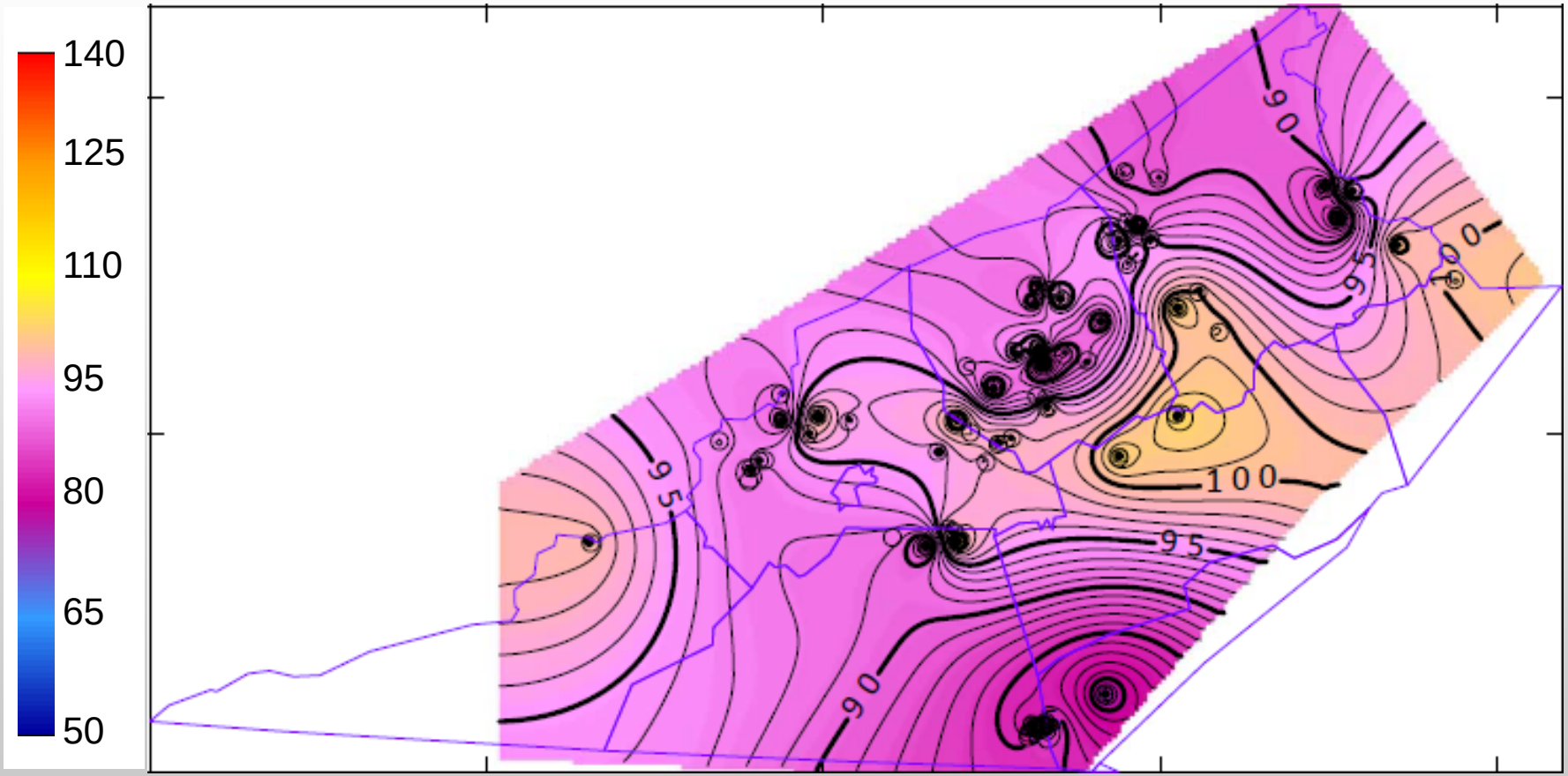
1000 feet below sea level

Temperature at Depth



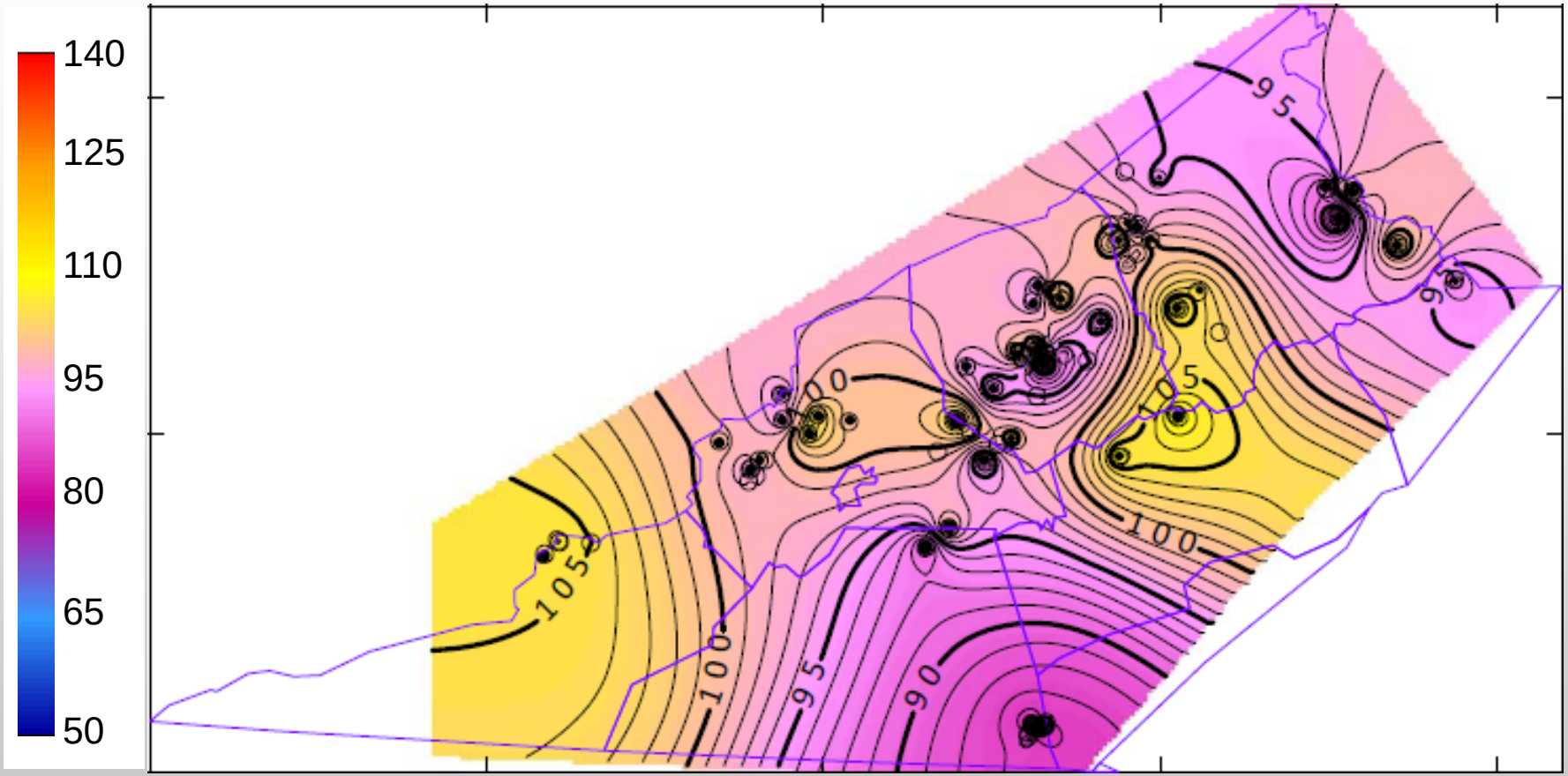
1500 feet below sea level

Temperature at Depth



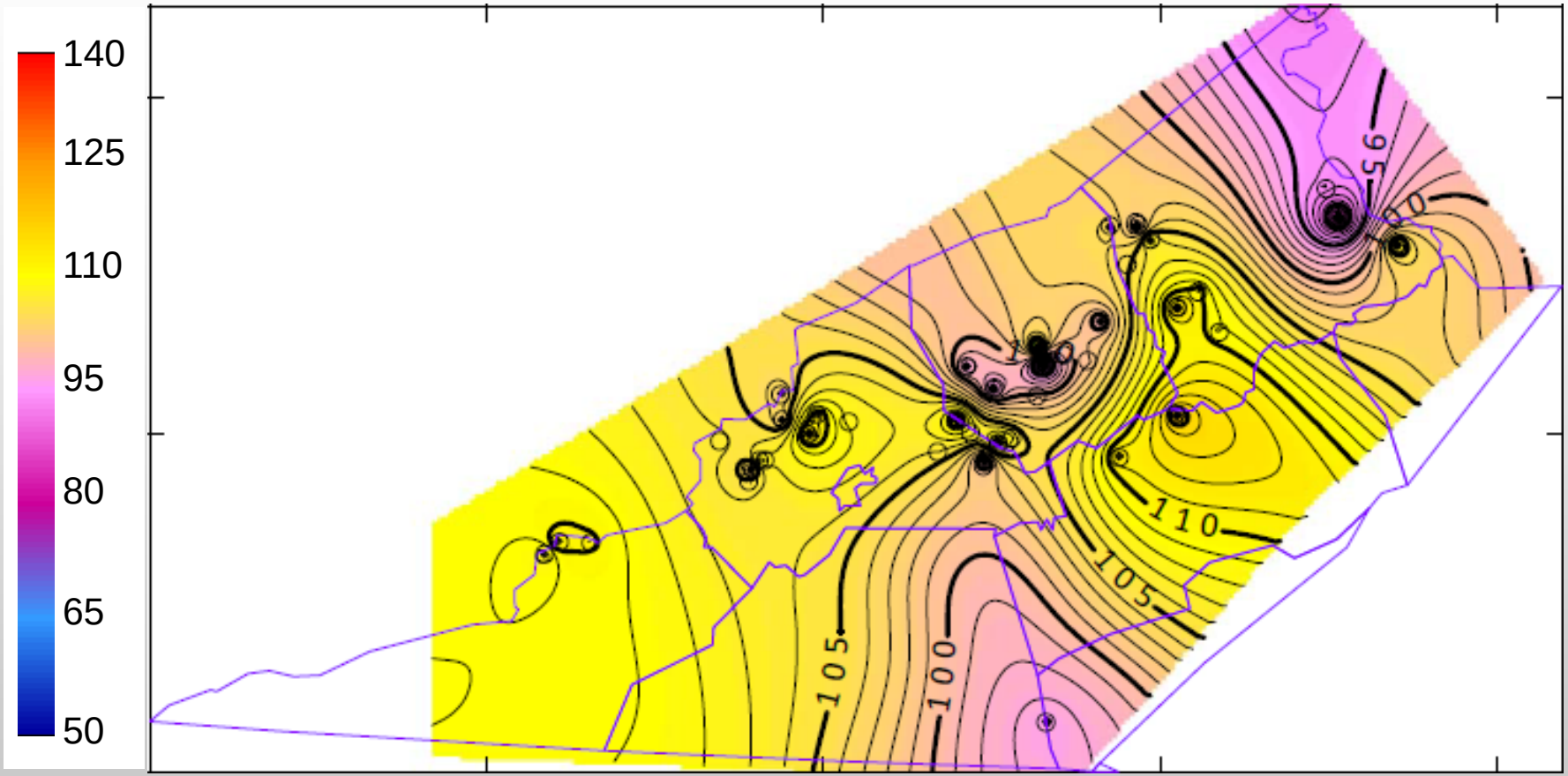
2000 feet below sea level

Temperature at Depth



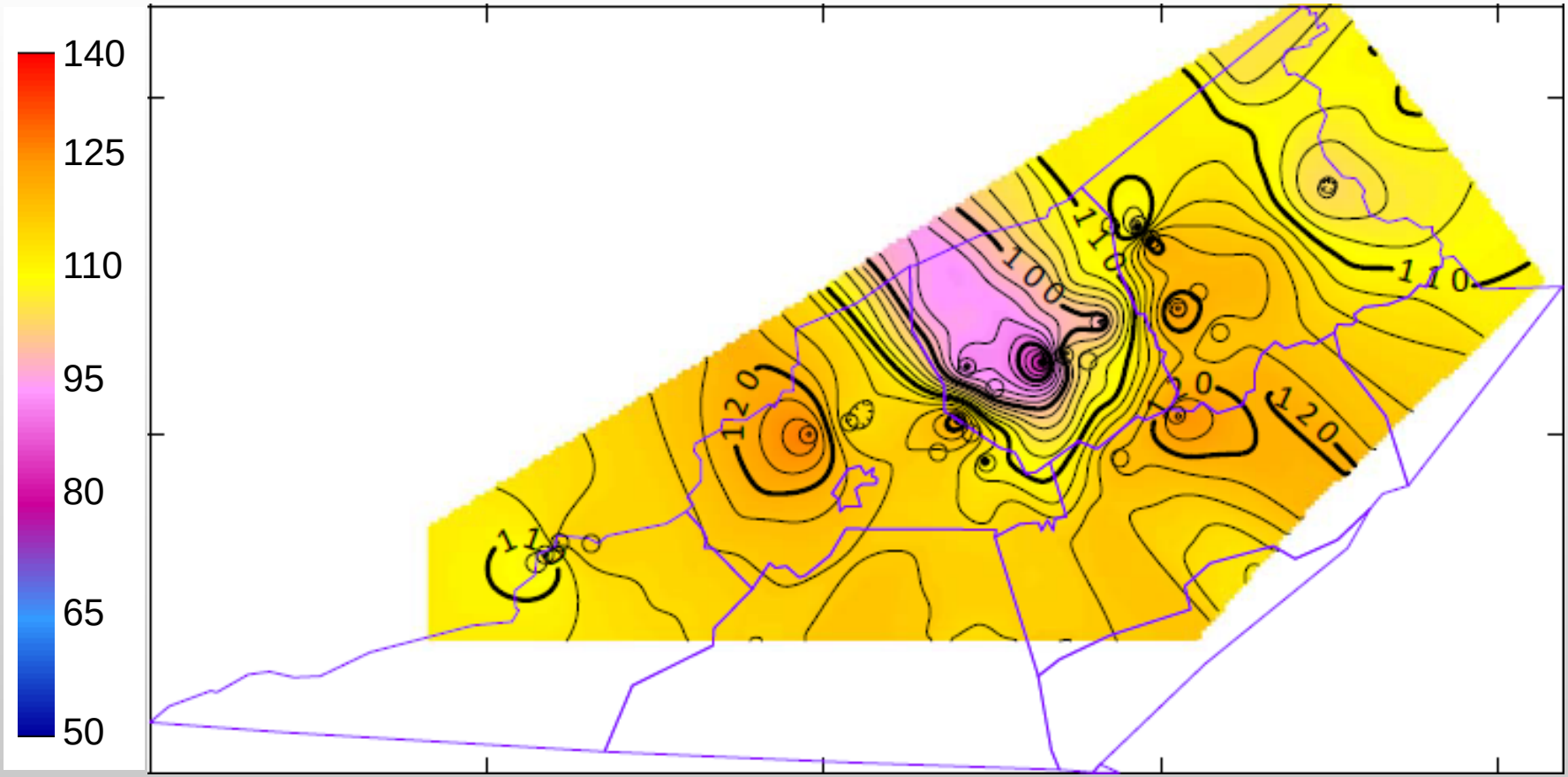
2500 feet below sea level

Temperature at Depth



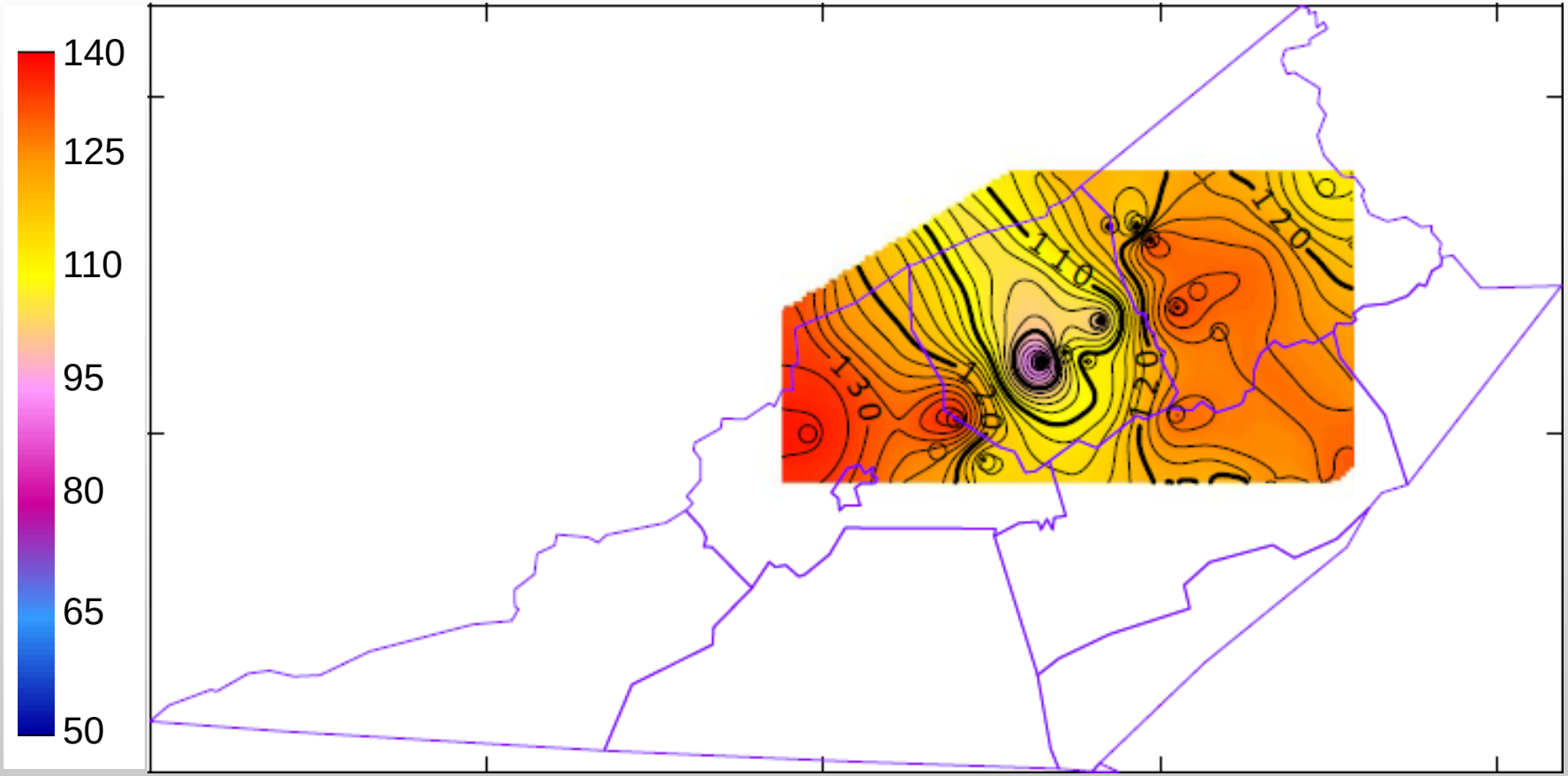
3000 feet below sea level

Temperature at Depth



3500 feet below sea level

Temperature at Depth

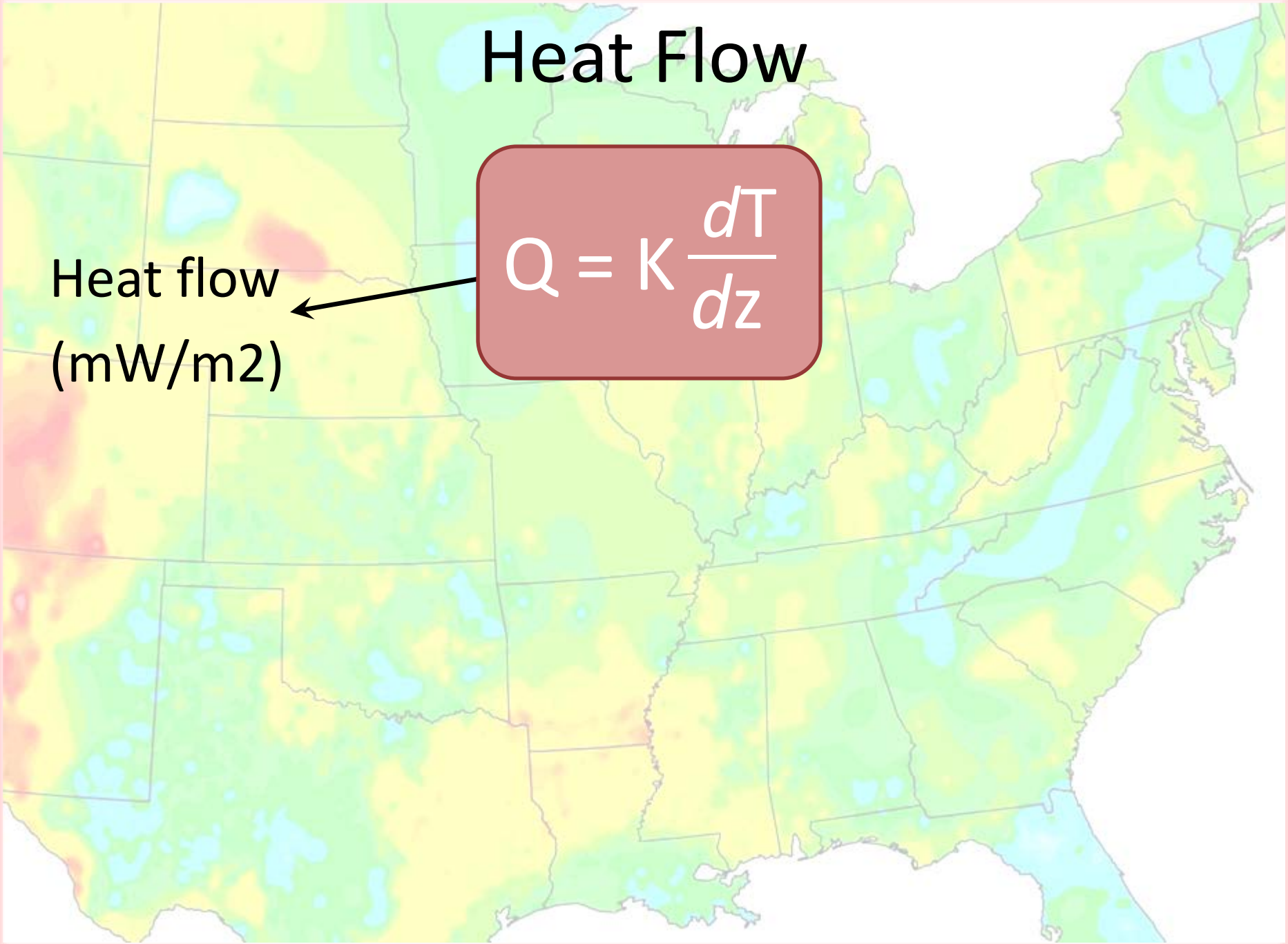


4000 feet below sea level

Heat Flow

$$Q = K \frac{dT}{dz}$$

Heat flow
(mW/m2)



Heat Flow

$$Q = K \frac{dT}{dz}$$

Thermal Conductivity

(ability of a material to conduct heat)

1. Identify down-hole stratigraphy
2. Assign generalized thermal conductivity per unit
3. Calculate weighted mean thermal conductivity per well

Heat Flow

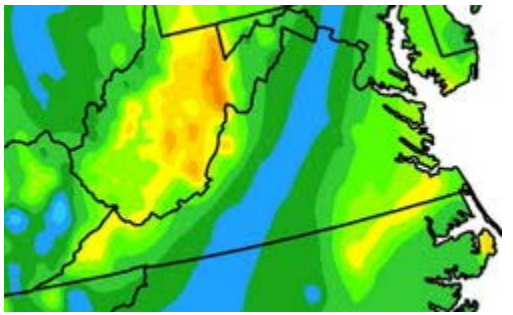
$$Q = K \frac{dT}{dz}$$

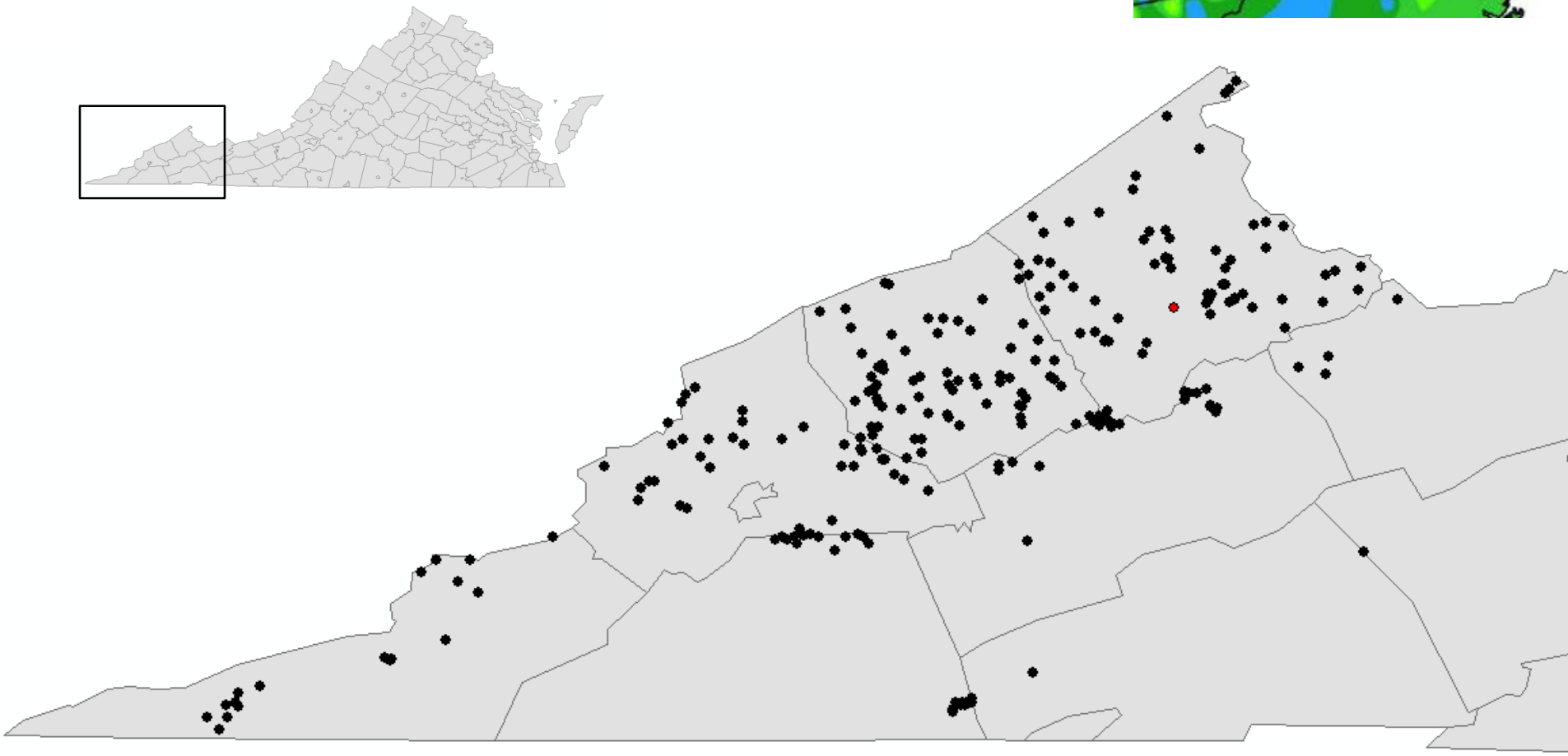
Thermal Gradient

(Δ°/Δdepth)

1. Calculate gradient per well
2. Use mean annual air temperature as an anchor

Heat Flow Data





1 2 3 4 5 6

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Division of Geology and Mineral Resources

The Division of Geology and Mineral Resources (DGMR) serves as Virginia's geological survey. DGMR performs investigations aimed at reducing risk from geologic hazards and encouraging sustainable development through the wise use of mineral, land, water, and energy resources. In addition to publishing maps and reports, DGMR maintains repositories of geological and geophysical data, as well as rock, fossil, and core samples. With our staff of experienced geoscientists, we are uniquely positioned to provide expert assistance in matters pertaining to the geology and mineral resources of the Commonwealth.

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