Gale, M., Ruksznis, A., and Becker, L., 2013: Geochemical and Thermal Conductivity Data of Selected Vermont Bedrock Formations: Vermont Geological Survey Technical Report Report TR13-2

Results of thermal conductivity analyses and geochemistry of 44 rock samples from Vermont are presented.

The data was contributed to the Geothermal Data project, funded through the US Dept. of Energy and the Association of American State Geologists. Data is also distributed through the National Geothermal Data System portal at http://geothermaldata.org/

Methods

3" to 8" thick rock samples were collected from outcrops and rock quarries during 2012-2013. Samples were located with a GPS.

Cores were cut at New England Research, Inc in White River Junction, VT. Cores were 1" thick and 1.5" in diameter with ends parallel to within 0.1 mm, specifications required by Southern Methodist University (SMU).

Samples were sent to the Geothermal Laboratory at SMU and thermal conductivity values obtained at elevated pressure following protocols of Blackwell and Spafford, 1982. Most samples were run perpendicular to bedding or foliation although several were also run parallel to the foliation for comparative purposes.

40 samples were sent to AcmeLabs in Vancouver, Canada for complete geochemical analyses. Samples were analyzed using ICP – ES (emission spectroscopy) and ICP-MS (mass spectrometry). 11 major elements and several minor elements were analyzed by ICP-ES following a lithium borate fusion and dilute acid digestion. Analyses include Loss on ignition (LOI) and Leco analysis for total carbon and sulphur. A 45 element suite of trace elements was analyzed using ICP-MS (mass spec). Rare earth elements and refractory elements report from a lithium borate decomposition to give total abundances. Metals were generated from an aqua regia digestion.

Results

Tables:

1) Table 1 lists sample locations in WGS 84, Formation name based on Ratcliffe et al, 2011, Bedrock Geologic Map of Vermont: USGS SIR 3181, and rock type.
2) Table 2 are the results from the rock geochemical analyses given in weight percent (%), parts per million (ppm), and parts per billion (ppb).
3) Table 3 are the results of the thermal conductivity analyses.

Map: The map shows the sample locations on the 2011 Bedrock Geologic Map of Vermont.

Table 1:

Sample locations in WGS 84

Formation name based on Ratcliffe et al, 2011, Bedrock Geologic Map of Vermont: USGS SIR 3181,

Rock type

Sample Number	Lat WGS1984	Long WGS1984	Formation Name	Rock Type	Thermal Conductivity	Geochemistry	Site Name
101720121	44.9080060	-73.113589	Iberville shale	shale	Y	Y	Swanton Quarry|Swanton
1018121	44.211292	-72.580314	Waits River Fm	sandy marble	Y	Y	Crosstown Rd|Berlin
1018121C	44.126958	-72.513681	Waits River Fm	phyllite	Y	Y	Crosstown Rd|Berlin
1018122	44.126958	-72.513681	Gile Mountain Fm	micaceous quartzite	Y	Y	Graniteville Rd|Williamstown
1018123	44.142589	-72.480653	New Hampshire Plutonic Suite	granodiorite	Y	Y	Barre Granite Quarry, Graniteville
1018124	43.865089	-72.613450	New Hampshire Plutonic Suite	quartz monzonite	Y	Y	Bethel Quarry, Bethel
1019121	43.591742	-73.225303	Mettawee Slate	gray slate	Y	Y	Camara Slate Co, Rice Willis Rd, Fair Haven
1019122	43.591742	-73.225303	Mettawee Slate	green slate	Y	Y	Camara Slate Co, Rice Willis Rd, Fair Haven
1019123	43.584478	-73.242411	Mettawee Slate	mottled slate	Y	Y	Tatro Bros, Evergreen Rd, Fair Haven
VT621122	44.649333	-73.329031	Glens Falls Fm	limestone	Y	Y	Lessors Quarry, South Hero
VT76122	43.967300	-73.030672	Mt Holly Complex	gneiss	Y	Y	Middlebury River, Middlebury
VT76123	43.666919	-72.808036	Chittenden Intrusive Suite	granitic gneiss	Y	Y	Rte 4 and 100, Killington
VT76124	43.545856	-72.711200	Pinney Hollow Fm	schist	Y	Y	Rte 100A, Plymouth
VT802122	44.423142	-73.018681	Pinnacle Fm	metawacke	Y	Y	Kenyon Rd, Richmond
VT802123	44.344175	-72.748931	Ottauquechee Fm	phyllite and schist	Y	Y	Rte 100, Waterbury
VT802124	44.383961	-72.717781	Stowe Fm	greenstone	Y	Y	Suss Rd, Waterbury
VT81121	44.277192	-73.213778	Monkton Fm	quartzite	Y	Y	Mt Philo, Charlotte
VT81122	44.352147	-73.194136	Shelburne Fm	limestone	Y	Y	Lime Kiln Rd, Charlotte
VT81124	44.391572	-73.221878	Winooski Fm	dolostone	Y	Y	Rte 7, Shelburne
VTP4420131 Parallel	44.269652	-72.6295278	Moretown Fm	schist	Y	Y	Rte 2, Middlesex
VT4420131	44.269652	-72.6295278	Moretown Fm	schist	Y	Y	Rte 2, Middlesex
VT4420132	44.598364	-73.1984311	Dunham Fm	dolostone	Y	Y	Rte 2, Colchester
VT4420133	44.282451	-73.2694111	Bascom Fm	dolostone	Y	Y	Thompson Point Rd, Charlotte

VT4420134	44.282951	-73.2673291	Bridport Fm	dolostone	Y	Y	Thompson Point Rd, Charlotte
VT4420135	44.292067	-73.2706584	Chazy Group	limestone	Y	Y	Lake Rd, Charlotte
VT4520131	44.601884	-73.1578484	Clarendon Springs Fm	dolostone	Y	Y	Milton
VT4520132	44.081091	-73.0709502	Cheshire Fm	quartzite	Y	Y	Bristol Notch Rd, Bristol
VT49131	43.469691	-72.5332221	Felchville Gneiss	trondjemitic gneiss	Y	N	Rte 44 and 106, Felchville
VT49132	43.394550	-72.5682784	Washington Gneiss	gneiss|garnet schist	Y	Y	Rte 131, Cavendish
VT49133	43.408810	-72.7157755	Tyson Fm	schist	Y	Y	Okemo Mtn, Ludlow
VT49134	43.418030	-72.7274846	Okemo Quartzite	quartzite	Y	Y	Okemo Mtn, Ludlow
VT49135	43.385959	-72.6506836	ultramafic rocks	serpentinite	Y	Y	Rte 103, Ludlow
VT49136	43.333039	-72.6153755	Gassetts member | Cavendish Fm	biotite gneiss	Y	Y	Rte 103, Chester
VTP49136 Parallel	43.333039	-72.6153755	Gassetts member | Cavendish Fm	biotite gneiss	Y	Y	Rte 103, Chester
VT49137	43.325067	-72.6118025	South Londonderry Igneous Suite	biotite gneiss	Y	Y	Rte 103, Chester
VT429133	42.766985	-72.5175044	Oliverian Plutonic Suite	granitic gneiss	Y	Y	Rte 142, Vernon
VT429134	42.746648	-73.0896499	Stamford granite | Cardinal Brook Intrusive Suite	granite	Y	Y	Lesure Rd, Stamford
VTBMA	44.773820	-72.5515030	Belvidere Mtn Complex	amphibolite	Y	Y	Belvidere Mtn, Lowell
VT621121F	44.764072	-73.2735766	Stony Point Fm	shale|limestone	Y	N	Ladd's Marina, Grand Isle
VT621121S	44.764072	-73.2735766	Stony Point Fm	shale|limestone	Y	N	Ladd's Marina, Grand Isle
VT429131	43.435398	-72.4190780	White Mtn Igneous Suite | Ascutney Stock	granite	N	Y	White Mtn Igneous Suite, Ascutney Stock
VT429132	42.925301	-72.6105498	NH Plutonic Suite | Black Mtn Granite	two-mica granite	N	Y	NH Plutonic Suite, Black Mtn Granite
VT621121	44.764072	-73.2735766	Stony Point Formation	shale|limestone	N	Y	Ladd's Marina, Grand Isle
VT5270816	44.319478	-73.1909378	Danby Formation	sandy dolomite	N	Y	Danby Formation, Charlotte
101720121b	44.908060	-73.113589	Iberville Formation	dark gray shale	N	Y	Iberville Formation

Table 2:

Results from the rock geochemical analyses in weight percent (%), parts per million (ppm), and parts per billion (ppb)

			Method	WGHT	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B
			Analyte	Wgt	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	Cr2O3	Ni	Sc	LOI	Sum
			Unit	KG	%	%	%	%	%	%	%	%	%	%	%	PPM	PPM	%	%
			MDL	0.01	0.01	0.01	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.002	20	1	-5.1	0.01
Sample	Rock Type	Formation	Type																
101720121	dark gray shale	Iberville Shale	Drill Core	0.09	50.47	13.05	5.26	2.24	10.78	1.36	2.72	0.58	0.17	0.09	0.011	45	12	13.1	99.79
1018121	sandy marble	Waits River Fm	Drill Core	0.08	38.16	1.4	1.31	1.88	29.58	0.2	0.31	0.09	0.07	0.07	0.002	<20	2	26.7	99.76
1018121c	gray phyllite	Waits River Fm	Drill Core	0.07	55.31	22.84	6.44	2.35	0.22	0.91	5.41	1.04	0.11	0.04	0.019	23	21	5.1	99.75
1018122	garnet granofels, micaceous quartzite	Gile Mountain Fm	Drill Core	0.07	77.71	11.19	2.87	0.78	0.46	3.56	1.35	0.45	0.12	0.04	0.016	22	11	1.3	99.81
101812-3	granodiorite	New Hampshire Plutonic Suite	Drill Core	0.08	70.88	14.33	1.91	0.62	1.34	3.96	4.8	0.26	0.09	0.03	0.005	<20	3	1.6	99.82
1018124	quartz monzonite	New Hampshire Plutonic Suite	Drill Core	0.08	72.83	16.24	0.5	0.11	2.7	5.78	0.98	0.03	0.05	<0.01	0.015	<20	<1	0.6	99.82
1019121	gray slate	Mettawee Slate	Drill Core	0.14	54.97	10.39	4.62	3.45	9.02	1.55	2.5	0.53	0.1	0.04	0.006	35	8	12.6	99.76
1019122	green slate	Mettawee Slate	Drill Core	0.08	60.63	15.87	7.87	3.24	0.97	3.15	2.63	0.79	0.15	0.12	0.011	42	15	4.4	99.81
1019123	mottled slate	Mettawee Slate	Drill Core	0.08	59.91	18.4	7.98	2.24	0.27	1.51	4.37	0.94	0.11	0.11	0.011	34	16	4	99.82
VT76122	gneiss	Mt Holly Complex	Drill Core	0.09	62.82	15.55	5.15	2.17	2.1	3.45	3.2	0.71	0.15	0.06	0.013	25	17	4.4	99.8
VT76123	granitic gneiss	Chittenden Intrusive Suite	Drill Core	0.08	73.6	13.02	2.35	0.45	0.48	3.84	4.37	0.25	0.08	0.04	<0.002	<20	4	1.4	99.83
VT76124	chlorite schist	Pinney Hollow Fm	Drill Core	0.09	45.55	25.74	13.07	2.68	0.41	1.98	3.7	1.47	0.11	0.12	0.018	54	28	4.9	99.71
VT621122	limestone	Glens Falls Fm	Drill Core	0.08	10.75	2.06	0.87	2.09	44.01	0.16	0.47	0.08	0.17	0.03	0.009	<20	2	39.1	99.77
VT81121	quartzite	Monkton Fm	Drill Core	0.08	54.85	13.96	2.82	3.24	4.71	1.33	10.13	0.79	0.25	0.06	0.008	<20	6	7.5	99.68
VT81122	limestone	Shelburne Fm	Drill Core	0.08	1.39	0.46	0.14	1.09	53.3	<0.01	0.23	0.02	0.01	<0.01	0.067	<20	<1	43.2	99.96
VT81124	dolostone	Winooski Fm	Drill Core	0.08	6.08	1.37	0.55	18.74	28.53	0.06	0.87	0.08	0.01	0.03	0.009	<20	1	43.6	99.96
VT802122	metawacke	Pinnacle Fm	Drill Core	0.09	63.55	14.11	8.1	2.23	1.12	4.47	2.28	1.34	0.23	0.09	0.01	<20	10	2.2	99.71
VT802123	phyllite and schist	Ottauquechee Fm	Drill Core	0.08	63.87	18.34	4.44	2.57	0.09	0.91	4.44	0.76	0.06	0.04	0.012	<20	16	4.3	99.82
VT802124	greenstone	Stowe Fm	Drill Core	0.09	44.08	12.61	13.39	5.21	12.52	3.42	0.56	3.57	0.37	0.17	0.011	38	25	3.8	99.76
VT4420131	schist	Moretown Fm	Drill Core	0.08	73.66	11.4	4.49	1.57	1.59	2.23	1.83	0.71	0.13	0.06	0.01	30	12	2.1	99.81
VT4420132	dolostone	Dunham Fm	Drill Core	0.08	32.13	4.78	1.23	12.31	17.82	0.41	2.99	0.33	0.05	0.06	0.038	<20	3	27.7	99.87
VT4420133	dolostone	Bascom Fm	Drill Core	0.08	11.33	2.04	1.06	15.87	27.92	0.1	1.58	0.07	0.03	0.03	0.005	<20	1	39.9	99.94
VT4420134	dolostone	Bridport Fm	Drill Core	0.08	12.81	1.96	0.41	16.59	26.88	0.04	1.64	0.07	0.02	0.01	0.003	<20	1	39.5	99.92
VT4420135	limestone	Chazy Group	Drill Core	0.08	7.63	1.37	0.71	3.04	46.39	0.06	0.7	0.07	<0.01	0.01	<0.002	<20	2	39.9	99.89
VT4520131	dolostone	Clarendon Springs Fm	Drill Core	0.08	0.69	0.08	0.43	20.49	31.07	0.02	0.05	<0.01	0.02	0.05	<0.002	<20	<1	47.1	99.99
VT4520132	quartzite	Cheshire Fm	Drill Core	0.07	79.34	8.84	1.17	0.22	0.28	0.58	7.19	0.8	0.07	0.03	0.046	<20	4	1.1	99.7
VT49132	gneiss, muscovite-garnet-	Washington gneiss and Wilcox Fm	Drill Core	0.09	59.06	24.13	7.66	1.26	0.49	1.29	2.18	0.9	0.28	0.05	0.026	44	10	2.4	99.79

	staurolite schist																		
VT49133	quartz-albite schist	Tyson Fm	Drill Core	0.09	55.89	19.64	8.06	2.03	0.79	3.09	6.37	0.98	0.13	0.04	0.01	<20	13	2.7	99.7
VT49134	quartzite	Okemo Mtn quartzite, Mt Holly Fm	Drill Core	0.08	96.59	1.04	0.98	0.07	0.05	0.02	0.44	0.1	0.05	<0.01	0.003	<20	1	0.6	99.93
VT49135	serpentinite	Ultramafic Rocks	Drill Core	0.08	40.44	0.38	9.03	40.99	0.08	<0.01	<0.01	<0.01	<0.01	0.13	0.387	2181	7	8.2	99.92
VTP49136	biotite gneiss	Cavendish Fm, Gassetts Member	Drill Core	0.08	70.69	14.11	3.5	1.34	2.1	4.45	1.92	0.44	0.08	0.05	0.021	<20	7	1.2	99.85
VT49137	biotite gneiss, tonalite gneiss	S Londonderry Igneous Suite	Drill Core	0.08	70.82	15.67	2.39	0.7	2.98	4.39	1.52	0.25	0.11	0.03	0.006	<20	1	0.9	99.75
VT429131	granite	White Mtn Igneous Suite, Ascutney Stock	Drill Core	0.08	70	16.4	1.62	0.73	2.83	6.3	0.93	0.13	0.04	0.04	0.009	<20	3	0.8	99.85
VT429132	two-mica granite	NH Plutonic Suite, Black Mtn Granite	Rock	0.17	73.73	14.79	1.02	0.18	1.29	4	4.43	0.1	0.06	0.02	<0.002	<20	1	0.2	99.83
VT429133	granitic gneiss	Oliverian Plutonic Suite	Rock	0.22	71.61	14.21	2	0.26	0.78	4.37	5.34	0.24	0.09	0.05	0.011	<20	1	0.9	99.81
VT429134	granite gneiss	Cardinal Brook Intrusive Suite, Stamford granite	Drill Core	0.08	63.67	18.77	2.86	0.1	1.06	4.23	8.05	0.24	0.06	0.04	<0.002	<20	3	0.5	99.57
VTBMA	coarse-grained garnet amphibolite	Belvidere Mountain Complex	Drill Core	0.09	45.23	13.14	14.17	11.11	9.86	2.41	0.15	0.95	0.12	0.35	0.035	112	46	2.2	99.76
VT621121	interbedded shale and limestone	Stony Point Fm	Drill Core	0.09	25.81	5.36	1.49	1.68	33.08	0.45	1.16	0.26	0.15	0.03	0.021	96	5	30.2	99.65
VT5270816	sandy dolomite	Danby Fm	Rock	0.13	55.94	6.16	1.3	6.42	9.18	0.18	4.93	0.36	0.12	0.04	0.01	<20	4	15.2	99.83
101720121b	dark gray shale	Iberville Fm	Drill Core	0.19	21.73	4.2	1.61	1.66	35.96	0.77	0.93	0.18	0.18	0.04	0.004	<20	4	32.5	99.74

	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B
	Ba	Be	Co	Cs	Ga	Hf	Nb	Rb	Sn	Sr	Ta	Th	U	V	W	Zr	Y
	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
	1	1	0.2	0.1	0.5	0.1	0.1	0.1	1	0.5	0.1	0.2	0.1	8	0.5	0.1	0.1
Sample																	
101720121	398	<1	15.6	3.8	19	3.2	11.1	114.2	3	484.7	0.8	10.1	3.8	124	1.5	113.8	24.2
1018121	55	<1	1.5	0.8	3.2	1.4	2.5	15	<1	1565.5	0.2	1.8	0.5	19	<0.5	66.4	10.6
1018121c	853	<1	8.5	11.3	33.3	4.8	19.6	239	5	261.9	1.3	17.2	3	200	1.8	174.9	24.3
1018122	226	<1	6.7	4	15.1	8	12.3	74.5	3	283.7	0.9	12.2	2.1	49	0.7	258.2	32.5
1018123	544	3	3.4	5	22.1	2.7	3.7	151.6	2	441.5	0.3	4.3	2	28	<0.5	82.4	5
1018124	263	2	0.7	0.5	19.1	2.6	1	13.6	<1	858	<0.1	0.8	0.2	<8	<0.5	88.3	2.8
1019121	807	4	9.8	3.5	15.8	4.2	8.9	91.4	2	211.3	0.5	7.4	8.5	156	1.3	155.6	29.7
1019122	547	2	18.4	4.9	23.8	4.5	15.8	110.9	5	50.8	1.1	14.8	2.6	109	2.1	169.6	33.6
1019123	376	3	21.4	6.5	28.2	6	18.7	172.2	4	35.9	1.3	14.9	2.9	108	2	204.5	42
VT76122	489	<1	12	4.9	24.2	6	9.2	132.3	4	213.4	0.5	10	4	123	0.9	217.9	36.2
VT76123	399	<1	2.5	0.2	21	7.9	13.9	138.7	3	52.2	0.9	12.9	1.8	14	<0.5	253.8	47.6
VT76124	589	2	31.8	3.8	39.1	7	29.8	134.7	4	227	2.1	18.7	2.8	173	1	264.1	52.1
VT621122	63	<1	2	1.1	3.2	0.7	1.7	23.5	<1	1621.6	<0.1	1.9	0.6	13	<0.5	23	6.1
VT81121	1060	1	6.1	1	18.9	15.5	15.4	151.7	2	183.3	0.9	7.3	2.9	37	0.5	678.2	64.1
VT81122	14	<1	0.7	<0.1	0.9	0.3	0.4	5.4	<1	249.7	<0.1	0.2	0.2	<8	<0.5	15.3	1.1
VT81124	92	<1	2.4	0.4	2.5	0.9	1.5	17.3	<1	124.8	<0.1	0.9	0.4	15	3.2	37	4.7
VT802122	653	<1	14.2	9.1	23.1	20.2	23.1	125.6	4	113.8	1.3	11.9	2.7	102	0.5	825.8	39.3
VT802123	626	9	3.2	6.1	28.2	3.3	13.3	166.7	3	117.5	1	11.6	2.3	122	1.3	130.5	17.2
VT802124	110	2	43.7	0.2	22.9	4	21.2	7.7	2	556	1.4	1.3	0.4	397	<0.5	166.3	24.5
VT4420131	323	2	13.3	3.5	15	7.2	11.3	85.1	1	160	0.9	11.6	1.9	91	1.4	278.6	28.8
VT4420132	412	2	4.4	0.5	7.1	6	5.4	52.2	<1	149.1	0.3	2.7	1.1	21	<0.5	226.4	13.9
VT4420133	132	<1	1	0.3	2.4	1	1.2	19.7	<1	149.3	<0.1	1.8	0.5	9	<0.5	47.8	5.1
VT4420134	141	<1	1	0.2	2.3	1.5	1.2	19.3	<1	131.2	0.1	1.1	0.5	<8	<0.5	71.4	4
VT4420135	86	<1	1	0.3	2.9	1.8	1.1	15.7	<1	344.1	<0.1	1.3	0.8	27	1.1	59.4	6.3
VT4520131	9	<1	0.3	<0.1	<0.5	<0.1	<0.1	0.8	<1	82.1	<0.1	<0.2	0.5	<8	<0.5	3.9	1
VT4520132	818	<1	4	0.3	9.1	21.4	13.1	82.8	<1	68.9	0.7	8.8	1.9	28	<0.5	961.8	23.1
VT49132	422	5	26.5	2.3	39.2	3.7	14.8	95.9	4	156.7	1.1	14.3	2.8	92	1	130.7	27.4
VT49133	887	<1	16.7	5	28	10.4	19.1	186.6	2	297.2	1	12.3	2	113	0.7	442.1	44.4
VT49134	68	<1	1.3	0.6	2.2	2.3	1.9	17.2	<1	4.6	<0.1	2.3	0.4	<8	0.7	105.7	8.2
VT49135	3	<1	117.4	<0.1	1.2	<0.1	<0.1	0.3	<1	1.3	<0.1	<0.2	<0.1	24	2.7	0.7	0.2
VTP49136	310	2	9.5	3.3	19.6	3.9	7.9	103.1	2	289.3	0.6	6	3.2	48	<0.5	139.1	26.8
VT49137	570	<1	3.5	0.3	17.7	6	0.5	36.1	<1	801.3	<0.1	24.5	1.6	21	<0.5	205.9	2.8
VT429131	323	3	3.3	0.7	16.8	2.3	1.9	22.6	<1	481.1	0.1	2.2	1.3	21	<0.5	90.3	6.3
VT429132	668	4	0.9	6	22	2.6	3.7	161.8	2	202.1	0.4	9.1	1.8	22	<0.5	65.6	6
VT429133	303	4	2.1	2.6	23.5	7.5	128.7	232.7	5	176	9.8	28.5	6.1	22	1.2	237.5	25.8
VT429134	2466	<1	1.2	0.1	32.5	10.5	9.4	104.8	<1	329.5	0.4	0.7	0.3	<8	<0.5	479	13.2
VTBMA	20	1	58	0.5	13.8	1.4	2.9	1.9	<1	24	0.2	<0.2	<0.1	363	<0.5	32.8	24.3
VT621121	214	<1	7.4	2.4	8.1	1.5	5.2	50.7	<1	1769.4	0.3	4.2	3.1	74	0.8	65.1	16.4
VT5270816	520	1	3.3	0.7	6.6	10.4	5	51.5	<1	97.6	0.3	3.4	0.9	29	<0.5	382.8	16.4
101720121b	205	1	5.3	3	5.4	1.3	2.9	38.8	<1	1629.8	0.2	3.3	1.5	36	<0.5	36.7	11.7

	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	4A-4B	2A Leco	2A Leco
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	TOT/C	TOT/S
	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	%	%
	0.1	0.1	0.02	0.3	0.05	0.02	0.05	0.01	0.05	0.02	0.03	0.01	0.05	0.01	0.02	0.02
Sample																
101720121	35.9	69.9	8.28	33.4	6.88	1.2	5.45	0.8	4.36	0.81	2.19	0.37	2.29	0.34	7.69	<0.02
1018121	8.4	13.4	1.78	6.5	1.32	0.49	1.48	0.22	1.39	0.26	0.78	0.12	0.65	0.1	3.92	1.13
1018121c	15.7	34.7	3.76	14	2.56	0.52	2.34	0.45	3.1	0.75	2.63	0.38	2.55	0.43	0.5	0.16
1018122	33.5	79.9	9.05	36.5	7.27	1.03	6.41	1.04	5.96	1.28	3.41	0.6	3.66	0.57	0.09	<0.02
1018123	7.9	16.8	2.01	6.6	1.66	0.49	1.29	0.17	0.65	0.15	0.45	0.06	0.33	0.06	0.13	<0.02
1018124	4.4	8.2	0.95	3.7	0.71	0.24	0.63	0.09	0.49	0.09	0.24	0.04	0.29	0.05	<0.02	<0.02
1019121	39.1	73.6	9.06	36.4	6.67	1.32	5.62	0.87	5.1	0.96	2.91	0.45	2.62	0.41	4.47	1.81
1019122	50.3	103	11.18	42.6	7.86	1.44	6.69	1.02	5.88	1.18	3.51	0.52	3.4	0.54	0.29	<0.02
1019123	59.2	121.3	14.06	53.7	10.05	1.8	8.04	1.28	7.1	1.48	4.06	0.62	4.17	0.61	0.08	<0.02
VT76122	39.3	77.9	9.4	37.8	7.93	1.67	7.18	1.16	6.23	1.29	3.66	0.51	3.23	0.48	0.87	0.14
VT76123	49	105.6	12.23	46.7	9.21	0.76	8.22	1.33	8.54	1.69	5.03	0.74	4.93	0.76	0.11	0.2
VT76124	98	198.9	22.92	84.6	16.32	2.96	12.89	1.99	10.29	1.85	5.12	0.74	4.63	0.67	0.05	<0.02
VT621122	8.9	15.5	1.88	6.6	1.09	0.26	1.04	0.15	0.92	0.2	0.44	0.07	0.45	0.06	11	0.15
VT81121	43.9	102.6	12.21	51.2	10.76	2.58	10.21	1.71	10.74	2.17	6.62	0.98	6.25	0.95	1.86	<0.02
VT81122	1.8	2.8	0.32	1.1	0.25	0.07	0.22	0.04	0.23	0.04	0.12	0.02	0.09	0.02	12.2	<0.02
VT81124	4.9	9.9	1.17	4.8	1.02	0.2	0.87	0.14	0.81	0.15	0.45	0.07	0.43	0.07	12.4	<0.02
VT802122	32.4	73.9	8.5	36.4	7.14	1.44	6.73	1.14	7.25	1.47	4.08	0.61	4.36	0.66	0.12	<0.02
VT8021-3	18.3	33.4	3.72	13.6	2.11	0.5	1.98	0.38	2.94	0.64	1.76	0.26	1.76	0.31	0.64	<0.02
VT802124	19.6	44.9	6.01	27.2	6.62	2.33	6.54	0.97	5.39	0.91	2.16	0.31	1.75	0.25	0.61	0.15
VT4420131	38.3	75.6	8.54	32.9	6.02	1.31	5.86	0.84	5.12	0.98	3.06	0.44	2.96	0.39	0.08	<0.02
VT4420132	13.3	31.1	3.47	14	2.7	0.64	2.64	0.41	2.57	0.46	1.53	0.22	1.56	0.21	7.64	<0.02
VT4420133	6.9	15	1.5	5.6	1.2	0.26	0.96	0.15	0.87	0.15	0.48	0.07	0.39	0.07	11.2	<0.02
VT4420134	4.8	9.1	1.09	4.3	0.83	0.22	0.67	0.1	0.7	0.12	0.32	0.06	0.31	0.06	11	<0.02
VT4420135	7.2	13.7	1.64	7.1	1.2	0.26	1.16	0.16	1	0.19	0.51	0.07	0.51	0.1	11.4	0.22
VT4520131	1.1	1.6	0.17	0.6	0.1	0.04	0.16	0.02	0.15	0.03	0.04	<0.01	0.09	<0.01	13.2	<0.02
VT4520132	23	55.1	5.73	22.4	4.44	0.99	4.07	0.61	3.51	0.76	2.32	0.39	2.73	0.43	0.07	<0.02
VT49132	45.5	93.3	11.32	41.9	8.15	1.62	7.42	1	5.34	1.04	2.86	0.42	2.32	0.34	0.03	0.37
VT49133	56.5	120.6	14.18	56.1	10.47	2.34	9.36	1.36	7.84	1.67	4.28	0.64	4.18	0.63	0.15	<0.02
VT49134	11.2	25	2.79	9.7	1.96	0.35	1.65	0.25	1.58	0.28	1.01	0.13	0.81	0.11	<0.02	<0.02
VT49135	0.3	0.5	0.06	<0.3	<0.05	<0.02	0.05	<0.01	0.06	<0.02	<0.03	<0.01	<0.05	<0.01	0.07	<0.02
VTP49136	20.4	42.3	5.03	18.8	3.83	0.85	3.89	0.6	4.16	0.88	2.32	0.36	2.24	0.36	0.04	<0.02
VT49137	69.5	133.2	13.41	44.5	5.52	1.07	2.84	0.19	0.7	0.08	0.24	0.03	0.16	0.03	<0.02	<0.02
VT429131	13.3	24.4	2.7	10.5	1.68	0.49	1.46	0.2	1.14	0.2	0.63	0.09	0.54	0.08	0.04	<0.02
VT429132	16.3	34.3	3.19	12.9	2.4	0.57	1.77	0.2	1.05	0.17	0.46	0.06	0.44	0.06	<0.02	<0.02
VT429133	57.7	98.3	8.99	26.7	5.02	0.72	4.77	0.74	4.95	0.91	2.49	0.37	2.31	0.34	0.05	<0.02
VT429134	19.6	35.9	4.4	18.2	4.04	4.96	3.97	0.51	3.08	0.53	1.33	0.19	1.19	0.19	<0.02	<0.02
VTBMA	2.6	6.5	0.97	5.5	1.97	0.85	3.5	0.6	4.35	0.97	2.96	0.43	2.64	0.42	<0.02	0.37
VT621121	19.5	32.4	3.75	13.8	2.76	0.53	2.57	0.36	2.3	0.5	1.33	0.19	1.05	0.16	9.32	0.34
VT5270816	17.6	42.4	4.34	17.2	3.69	0.91	3.48	0.5	3.05	0.63	1.9	0.27	1.95	0.31	3.96	0.02
101720121b	15.1	27.2	3.05	10.7	1.97	0.49	1.86	0.27	1.54	0.41	0.95	0.13	0.86	0.13	9.88	0.61

	1DX	1DX	1DX	1DX	1DX	1DX	1DX	1DX	1DX	1DX	1DX	1DX	1DX	1DX
	Mo	Cu	Pb	Zn	Ni	As	Cd	Sb	Bi	Ag	Au	Hg	Tl	Se
	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPB	PPM	PPM	PPM
	0.1	0.1	0.1	1	0.1	0.5	0.1	0.1	0.1	0.1	0.5	0.01	0.1	0.5
Sample														
101720121	1.3	26.1	20.9	54	35	8.3	<0.1	0.4	0.2	<0.1	<0.5	0.05	<0.1	0.5
1018121	0.6	2.6	12.2	19	4	3	<0.1	<0.1	<0.1	<0.1	0.5	<0.01	<0.1	<0.5
1018121c	1	19.9	8.8	95	17.5	0.8	<0.1	0.1	0.6	0.2	<0.5	<0.01	<0.1	<0.5
1018122	0.9	19.8	20.1	77	24.4	1.7	0.1	<0.1	0.4	<0.1	0.7	<0.01	0.3	<0.5
1018123	0.6	3.9	23.4	52	2.2	0.6	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	0.3	<0.5
101814	0.6	4.8	3.7	15	1.4	<0.5	<0.1	<0.1	<0.1	<0.1	1.2	<0.01	<0.1	<0.5
1019121	19	35.9	12.8	66	35.4	24.6	0.5	1.4	0.1	<0.1	0.7	0.12	0.2	1.8
1019122	0.4	17.8	15.9	87	48.5	0.7	<0.1	<0.1	0.4	<0.1	0.7	<0.01	<0.1	<0.5
1019123	0.2	31.9	7.7	121	40.2	<0.5	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
VT76122	0.6	9.6	3.3	56	18.6	<0.5	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	0.4	<0.5
VT76123	1.4	3.5	9.8	29	1.1	1.1	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
VT76124	0.2	37.5	6.1	161	52.7	<0.5	<0.1	<0.1	0.1	<0.1	2.1	<0.01	<0.1	<0.5
VT621122	0.2	2.1	2.4	7	2.4	0.6	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
VT81121	0.3	3.8	3.4	18	5.9	<0.5	<0.1	<0.1	<0.1	<0.1	0.5	<0.01	<0.1	<0.5
VT81122	0.1	2.1	4.2	6	0.8	0.6	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
VT81124	0.1	2.4	2.3	4	3	0.7	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
VT802122	0.5	3.3	2	92	17.4	<0.5	<0.1	<0.1	<0.1	<0.1	0.5	<0.01	0.8	<0.5
VT802123	1.6	20	3.2	65	3.8	0.6	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	0.7
VT802124	0.4	62.9	0.9	60	31.2	1.1	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
VT4420131	0.6	16.6	2.5	53	24.1	1.1	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
VT4420132	0.3	1.4	3.2	27	3.4	<0.5	0.1	<0.1	<0.1	<0.1	0.6	<0.01	<0.1	<0.5
VT4420133	0.4	2.1	2.8	5	1.6	<0.5	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
VT4420134	0.3	1.4	2.5	2	1.7	<0.5	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
VT4420135	0.7	1.8	2.6	5	2.8	1	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
VT4520131	<0.1	1.1	1.3	<1	0.3	0.7	<0.1	<0.1	<0.1	<0.1	0.5	<0.01	<0.1	<0.5
VT4520132	0.7	7.5	5	11	3.3	1.8	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
VT49132	2.1	52.5	2.9	9	33.7	0.6	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	0.1	<0.5
VT49133	0.6	2.7	3.3	76	21.7	<0.5	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	0.7	<0.5
VT49134	1.9	2.1	1.6	6	1.3	<0.5	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	<0.1	<0.5
VT49135	0.2	1.9	1.4	15	1769.3	15.3	<0.1	0.1	<0.1	<0.1	0.7	<0.01	<0.1	<0.5
VTP49136	0.7	1.7	3	58	19	<0.5	<0.1	<0.1	<0.1	<0.1	<0.5	<0.01	0.4	<0.5
VT49137	1	13	1.7	33	3	0.6	<0.1	<0.1	<0.1	<0.1	0.7	<0.01	0.1	<0.5
VT429131	0.6	27	3.1	34	4.1	0.6	<0.1	<0.1	<0.1	0.1	1.7	<0.01	0.1	<0.5
VT429132	0.6	4.2	5.9	30	0.5	<0.5	<0.1	<0.1	0.3	<0.1	4.5	<0.01	0.2	<0.5
VT429133	2.3	2.5	2.8	27	3.3	1	<0.1	<0.1	0.1	<0.1	3.9	<0.01	<0.1	<0.5
VT429134	0.7	2.1	4	36	0.5	<0.5	<0.1	<0.1	<0.1	<0.1	1.1	<0.01	0.2	<0.5
VTBMA	0.6	783.1	2	120	46.1	4.3	0.6	<0.1	<0.1	0.2	4.1	0.03	<0.1	0.7
VT621121	1.2	21	6.7	24	12.3	3.6	0.3	0.2	<0.1	<0.1	1.3	0.04	<0.1	0.8
VT5270816	0.4	6.5	4.8	12	5.9	1.4	<0.1	<0.1	<0.1	<0.1	0.7	<0.01	<0.1	<0.5
101720121b	0.9	15.9	5.3	20	14.9	3.5	0.1	0.2	<0.1	<0.1	<0.5	0.03	<0.1	0.6

Table 3:

Thermal conductivity data

Label	Location	Lat WGS84	Long WGS84	Sample Height, cm	Sample Width, cm	Sample Density	Uncertainty Density	Density Units	Measurement Pressure, PSI	Sample Temp, C	Measurement Duration	Measurement Run	Saturated Conductivity	Dry Conductivity	Average Conductivity	Uncertainty TC	Units TC	Formation	Rock Type	Porosity – values in red are suspect
101720121	Swanton Quarry, Swanton	44.9080060	-73.113589	2.54	3.81	2.03	0.01	g/cc	1350	20	30	3	2.37	2.01	2.35	0.03	W/m/K	Iberville shale	shale	4.59
1018121	Crosstown Rd, Berlin	44.211292	-72.580314	2.54	3.81	2.69	0.01	g/cc	1350	20	30	1	3.79	3.04		0.03	W/m/K	Waits River Fm	sandy marble	0.31
1018121C	Crosstown Rd, Berlin	44.126958	-72.513681	2.42	3.81	2.58	0.01	g/cc	1350	20	30	2	1.65	1.15	1.65	0.03	W/m/K	Waits River Fm	phyllite	2.36
1018122	Graniteville Rd, Williamstown	44.126958	-72.513681	2.50	3.81	2.5	0.01	g/cc	1350	20	30	4	3.25	1.67	3.25	0.03	W/m/K	Gile Mountain Fm	garnet granofels, micaceous quartzite	2.9
1018123	Barre Granite Quarry, Graniteville	44.142589	-72.480653	2.54	3.81	2.58	0.01	g/cc	1350	20	30	2	3.18	2.89		0.03	W/m/K	New Hampshire Plutonic Suite	granodiorite	0.31
1018124	Bethel Quarry, Bethel	43.865089	-72.613450	2.54	3.81	2.61	0.01	g/cc	1350	20	30	2	2.99	2.62		0.03	W/m/K	New Hampshire Plutonic Suite	quartz monzonite	0.55
1019121	Rice Willis Rd, Fair Haven	43.591742	-73.225303	2.54	3.81	1.97	0.01	g/cc	1350	20	30	3	1.78	1.42	1.78	0.03	W/m/K	Mettawee Slate	gray slate	2.55
1019122	Rice Willis Rd, Fair Haven	43.591742	-73.225303	2.54	3.81	2.69	0.01	g/cc	1350	20	30	3	1.9	1.86	1.88	0.03	W/m/K	Mettawee Slate	green slate	0.28
VT621122	Lessors Quarry, South Hero	44.649333	-73.329031	2.54	3.81	2.71	0.01	g/cc	1350	20	30	2	2.61	2.52		0.03	W/m/K	Glens Falls Fm	limestone	0.03
VT76122	Middlebury River, Middlebury	43.967300	-73.030672	2.54	3.81	2.74	0.01	g/cc	1350	20	30	2	3.08	2.71		0.03	W/m/K	Mt Holly Complex	gneiss	0.14
VT76123	Rte 4 and 100, Killington	43.666919	-72.808036	2.52	3.81	2.62	0.01	g/cc	1350	20	30	2	3.68	3.03		0.03	W/m/K	Chittenden Intrusive Suite	granitic gneiss	0.56
VT76124	Rte 100A, Plymouth	43.545856	-72.711200	2.54	3.81	2.87	0.01	g/cc	1350	20	30	3	1.8	1.35	1.82	0.03	W/m/K	Pinney Hollow Fm	schist	1.17
VT802122	Kenyon Rd, Richmond	44.423142	-73.018681	2.54	3.81	2.73	0.01	g/cc	1350	20	30	3	2.67	2.26	2.67	0.03	W/m/K	Pinnacle Fm	wacke	0.31
VT802123	Rte 100, Waterbury	44.344175	-72.748931	2.54	3.81	2.58	0.01	g/cc	1350	20	30	1	1.75	1.54		0.03	W/m/K	Ottauquechee Fm	phyllite and schist	0.62
VT802124	Suss Rd, Waterbury	44.383961	-72.717781	2.54	3.81	3.02	0.01	g/cc	1350	20	30	3	2.57	1.98	2.57	0.03	W/m/K	Stowe Fm	greenstone	0.45
VT81121	Mt Philo, Charlotte	44.277192	-73.213778	2.54	3.81	2.65	0.01	g/cc	1350	20	30	3	2.59	2.45	2.59	0.03	W/m/K	Monkton Fm	quartzite	0.52
VT81122	Lime Kiln Rd, Charlotte	44.352147	-73.194136	2.54	3.81	2.69	0.01	g/cc	1350	20	30	2	3.18	3.09		0.03	W/m/K	Shelburne Fm	limestone	0.41
VT81124	Rte 7, Shelburne	44.391572	-73.221878	2.54	3.81	2.82	0.01	g/cc	1350	20	30	2	4.89	4.72		0.03	W/m/K	Winooski Fm	dolostone	0.07
VTP4420131 Parallel	Rte 2, Middlesex	44.269652	-72.6295278	2.5	3.8	2.7	0.01	g/cc	1350	20	30	2	5.10	4.98	5.04	0.07	W/m/K	Moretown Fm	schist	0.011
VT4420131	Rte 2, Middlesex	44.269652	-72.6295278	2.6	3.8	2.76	0.01	g/cc	1350	20	30	2	3.10	3.09	3.09	0.03	W/m/K	Moretown Fm	schist	0.045
VT4420132	Rte 2, Colchester	44.598364	-73.1984311	2.5	3.8	2.74	0.01	g/cc	1350	20	30	5	4.33	4.06	4.18	0.11	W/m/K	Dunham Fm	dolostone	0.007
VT4420133	Thompson Point Rd, Charlotte	44.282451	-73.2694111	2.5	3.8	2.75	0.01	g/cc	1350	20	30	2	3.98	3.96	3.97	0.03	W/m/K	Bascom Fm	dolostone	0.024
VT4420134	Thompson Point Rd, Charlotte	44.282951	-73.2673291	2.6	3.8	2.77	0.01	g/cc	1350	20	30	2	4.33	4.27	4.30	0.03	W/m/K	Bridport Fm	dolostone	0.015

VT4420135	Lake Rd, Charlotte	44.292067	-73.2706584	2.6	3.8	2.75	0.01	g/cc	1350	20	30	5	3.22	2.97	3.10	0.09	W/m/K	Chazy Group	limestone	0.01
VT4520131	Milton	44.601884	-73.1578484	2.5	3.8	2.82	0.01	g/cc	1350	20	30	2	5.26	5.17	5.21	0.04	W/m/K	Clarendon Springs Fm	dolostone	0.008
VT4520132	Bristol Notch Rd, Bristol	44.081091	-73.0709502	2.6	3.8	2.56	0.01	g/cc	1350	20	30	2	4.40	4.38	4.39	0.03	W/m/K	Cheshire Fm	quartzite	0.027
VT49131	Rte 44 and 106, Felchville	43.469691	-72.5332221	2.5	3.8	2.66	0.01	g/cc	1350	20	30	2	2.80	2.74	2.77	0.03	W/m/K	Felchville Gneiss	trondjemitic gneiss	0.007
VT49132	Rte 131, Cavendish	43.394550	-72.5682784	2.5	3.8	2.95	0.01	g/cc	1350	20	30	2	3.68	3.61	3.65	0.03	W/m/K	Washington Gneiss	gneiss|garnet schist	0.009
VT49133	Okemo Mtn, Ludlow	43.408810	-72.7157755	2.5	3.8	2.79	0.01	g/cc	1350	20	30	2	1.68	1.62	1.65	0.03	W/m/K	Tyson Fm	schist	0.012
VT49134	Okemo Mtn, Ludlow	43.418030	-72.7274846	2.6	3.8	2.68	0.01	g/cc	1350	20	30	1	6.40	6.40	6.40	0.03	W/m/K	Okemo Quartzite	quartzite	0.004
VT49135	Rte 103, Ludlow	43.385959	-72.6506836	2.5	3.8	2.82	0.01	g/cc	1350	20	30	2	3.05	3.01	3.03	0.03	W/m/K	ultramafic rocks	serpentinite	0.008
VT49136	Rte 103, Chester	43.333039	-72.6153755	2.6	3.8	2.7	0.01	g/cc	1350	20	30	2	3.70	3.64	3.67	0.03	W/m/K	Gassetts member, Cavendish Fm	biotite gneiss	0.011
VTP49136 Parallel	Rte 103, Chester	43.333039	-72.6153755	2.6	3.8	2.71	0.01	g/cc	1350	20	30	2	3.85	3.80	3.83	0.03	W/m/K	Gassetts member, Cavendish Fm	biotite gneiss	0.006
VT49137	Rte 103, Chester	43.325067	-72.6118025	2.6	3.8	2.71	0.01	g/cc	1350	20	30	2	2.40	2.32	2.36	0.04	W/m/K	South Londonderry Igneous Suite	biotite gneiss	0.013
VT429133	Rte 142, Vernon	42.766985	-72.5175044	2.5	3.8	2.74	0.01	g/cc	1350	20	30	1	3.74	3.74	3.74	0.03	W/m/K	Oliverian Plutonic Suite	granitic gneiss	0.009
VT429134	Lesure Rd, Stamford	42.746648	-73.0896499	2.5	3.8	2.6	0.01	g/cc	1350	20	30	2	2.48	2.42	2.45	0.03	W/m/K	Stamford granite, Cardinal Brook Intrusive Suite	granite	0.012
VTBMA	Belvidere Mtn, Lowell	44.773820	-72.5515030	2.5	3.8	3.21	0.01	g/cc	1350	20	30	2	3.27	3.17	3.22	0.05	W/m/K	Belvidere Mtn Complex	amphibolite	0.005
VT621121F	Ladd's Marina, Grand Isle	44.764072	-73.2735766	1.1	3.8	2.51	0.01	g/cc	1350	20	90	1	1.65	1.64	1.59	0.6	W/m/K	Stony Point Fm	shale, limestone	0.038
VT621121S	Ladd's Marina, Grand Isle	44.764072	-73.2735766	1.05	3.8	2.51	0.01	g/cc	1350	20	90	2	1.53	1.53	1.59	0.6	W/m/K	Stony Point Fm	shale, limestone	0.035

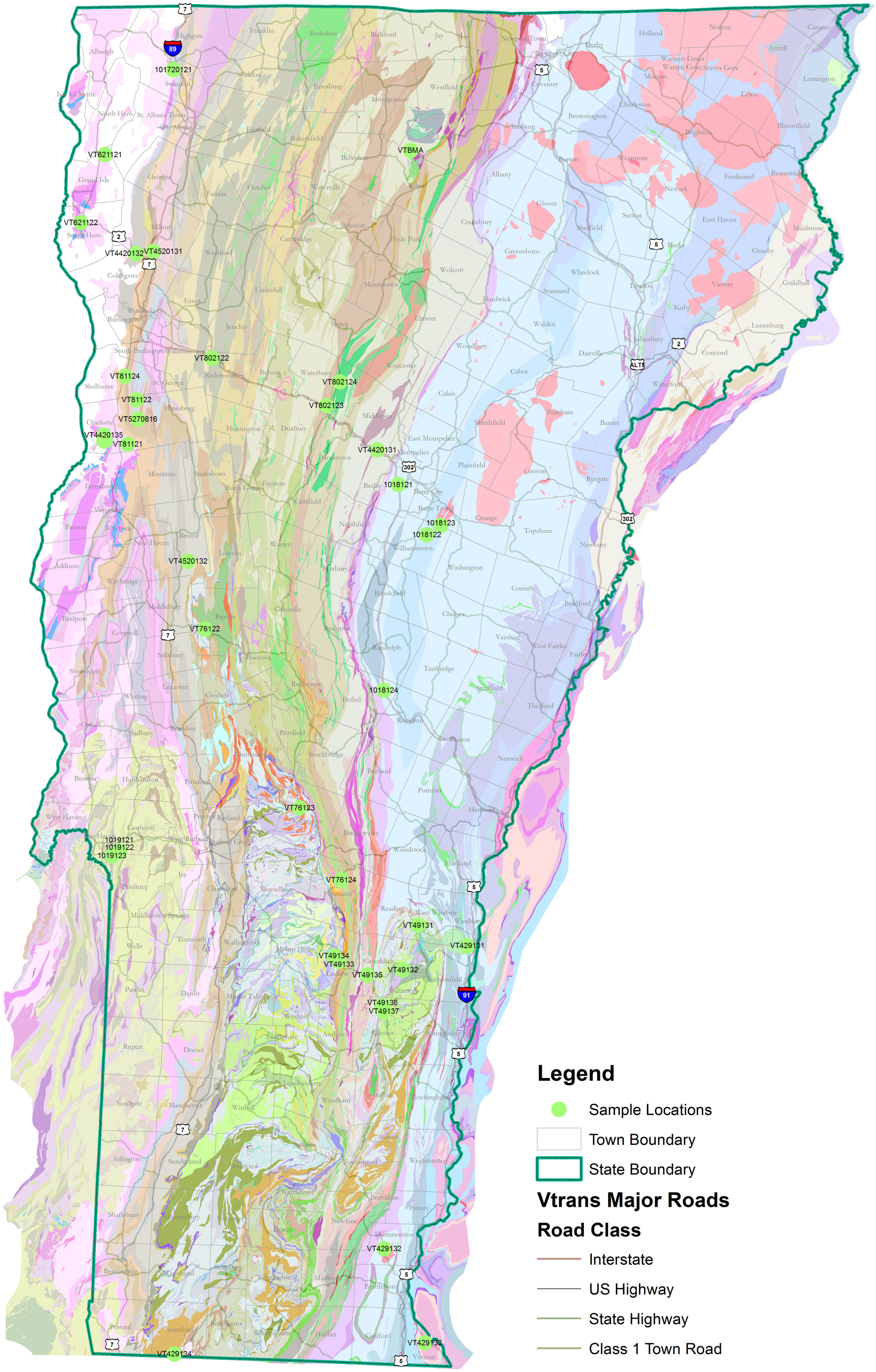

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Plate 1: Vermont Geothermal and Geochemical Sample Base Map

Marjorie Gale

VGS Open File Report VG13-5

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