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L [illegible] V [illegible] w [illegible], A, [illegible] w [illegible], [illegible] w [illegible] 18

Alpine Circle Project Summary

Alpine Circle LLC (Alpine) is the Town of Mammoth Lakes (Figure 1). Alpine is the potential direct use of geothermal fluids in a planned Alpine Minaret Summit Board well reached a target depth of 1505 ft. (459 temperatures of 139°F approximately while the range of temperature gradients in the drilled in the western The Mammoth Lakes area. The flow rate is 77 gpm (4.85 a maximum flowing temperature of 143°F. The production well is comparable to the adjacent water supply wells completed in similar aquifers and those rates during peak demand periods.

1 Project Purpose

Alpine Circle LLC (Alpine) is evaluating the results of Alpine Well 1 a plan Alpine Well 2 is a well to be completed. The EGS project background geologic and geochemical information for the area surrounding the of the project area publicly available information on surrounding water Mammoth Community Water District (MCWD). to direct use of geothermal summary report for Well 1 archive data from USGS. The drilled by the Town of Mammoth Lakes compiling and evaluating well data that are publically available through the California Division Resource (DOGGR; http://geosteam.conservation.ca.gov/WellSearch/GeoWellSearch.aspx). published temperature data from the western caldera rim. There, heat regime of the Alpine Circle project will include well and inject into the planned injection well in a closed loc exposed at the surface.

2 Geology

The Alpine Circle project is located in the southwestern part of volcanic collapse feature formed by a massive eruption of ash approximately 760,000 years ago. from volcanic centers have continue to modify and fill the caldera. A geologically recent sequence of western part of Long Valley (Figure 2) illustrates the sequence of rock units penetr water supply wells and temperature gradients. volcanic units a commonly stage (<200,000 year old) moat basalt eruptions and the two glacial events that have last occurred 250,000 years. the

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Rock types penetrated by the Alpine Well are similar to those penetrated by completed Alpine production wells (Figure 3) and wells drilled in the southwestern caldera including the Mammoth Groundwater Basin (Wildermuth, 2009). The Alpine well penetrates a thick 530 ft. (162 m) obsidian indicating the hole is close to the 10,000 feet level of the Mammoth Knolls rhyolites immediately north but, unlike the older basalts and intrusive siliceous obsidian is usually little or no permeability. The deeper stratigraphic sequence from glacial till and Wasatch Formation to MCWD well #17 drilled approximately ½ mile southwest of the Alpine well (Figure 1). The Alpine well produces from a deeper basalt interval than the wells at produce from either basalts or rhyolites. The basalt map of the Alpine area (Figure 4) illustrates that the thickness and the extent of considerably because existing topography and the discontinuous nature of units within The basalt aquifer Alpine Well 1 feet thick source Group, However, in the most recent flows the upper part of the total thickness bearing units could approach the 430 deepest Alpine Well 1 correlate with 600,000 Layer Rhyolite penetrated at similar elevations in water wells and the temperature gradient holes regional to extensive West Marker horizons do not occur in discontinuous volcanic environments like Long of individual beds or eruptive units is very difficult. The gen illustrated in South Mono Craters through the rare Figure 5

Natural gamma logs were run in the Alpine Well and Urban, 1999; Figure 6) part of the characterization of the potential Mammoth Lakes area. Geophysical logs collected in any of the wells near the The logs distinguish unaltered basalt flows from altered basalt flows comparable to the fractured basalt aquifer penetrated by the Alpine Well in the western caldera is at least 350 feet poorly consolidated lithic ash and tuff sections as pervasively altered and fractured geothermal system that developed collapse of the caldera. Rhyolite units rarely sustain fractures and discontinuous stony rhyolite flows or intraflow erosional breaks rather network. The MCWD generally regards the deep dated Early Rhyolite units as a incapable of producing significant quantities of water. Rhyolite units separ cold groundwater from the high temperature geothermal system is currently under production approximately 2 km to the Southeast of Service Mammoth Ranger and Shady Rest Campground.

3 Reservoir□□□Characteristics□□□

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Wildermuth꿮□η(2009)꿮□η□□□

3.3 Temperature

Compiled temperature data for the western part of the Long Valley area (Figure 8) show a relatively low of heat flow typical of areas outside the hydrothermal system (Figure 9). Linear temperature gradients below ~500 feet (~150 m) indicate a conductive isothermal section from 1100 to 1300 feet (335 to 396 m) in basalt production zone identified during drilling and probably reflects the temperature of fluids in deeper basalt units. 월/100 feet (330 °C/km) gradients in the upper portion of the hole are less than gradients at greater depths. The hole approximately 0.2 mi (0.3 km) west of the hole. 월/100 feet (33 °C/km) gradients in the lower portion of the hole. The 59.139 °C bottom hole static temperature was less than the 74.5 °C (166°F bottom hole temperature recorded during lateral distance from the geothermal reservoir in the north. Linear extrapolation of temperatures has questionable in a caldera setting like Long Valley and comparable water hydrologic gradients in Alpine Circle have significant effects on heat flow 1987). Deeper temperature gradient data suggest temperatures greater than wells are not the upward flow of the water but instead the likely heat flow in the periphery of the geothermal system in the western

3.4 Geochemistry

Bailed water samples from wells are neutral pH HCO_3 type with TDS (280 mg/L) since western caldera groundwater rather than geothermal fluids. Chloride, sulfate and bicarbonate (and SO_4) CO_2 contents in Alpine Circle have cold chloride groundwater compositions in the Weight ratios of conservative elements Cl and in many geothermal systems including Long Valley to identify the determine a common origin between hotter geothermal fluids and sur consistent geochemical evidence for substantial thermal water input into the groundwater beneath the western portion of Long Valley. Chloride for wells 11 and 11.8 suggesting the possibility of some geothermal fluids in from geothermal Long Valley with 2/3 ratio elevated temperatures in the western caldera around Alpine Circle are likely heating within the background geo the elevated heat flow at the Long Valley geothermal reservoir.

4 Well Plan

Well drilling plan attached as Appendix A well drilling plan outlining the geology, temperatures and potential zones and a detailed drilling plan fluids, casing(s), cementing and casing plan are described through as noted in Section *Geology*, volcanic units are laterally discontinuous and complicated in

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Diment,꿯□ηW.H.꿯□ηand꿯□ηUrban,꿯□ηT.C.,꿯□η1990,꿯□ηTemperature logs obtained during drilling of the MLGRAP#1꿯□ηand꿯□η#2,꿯□ηMammoth꿯□ηLakes,꿯□ηCalifornia: Preliminary data, USGS Open File Rpt 90-460.꿯□η

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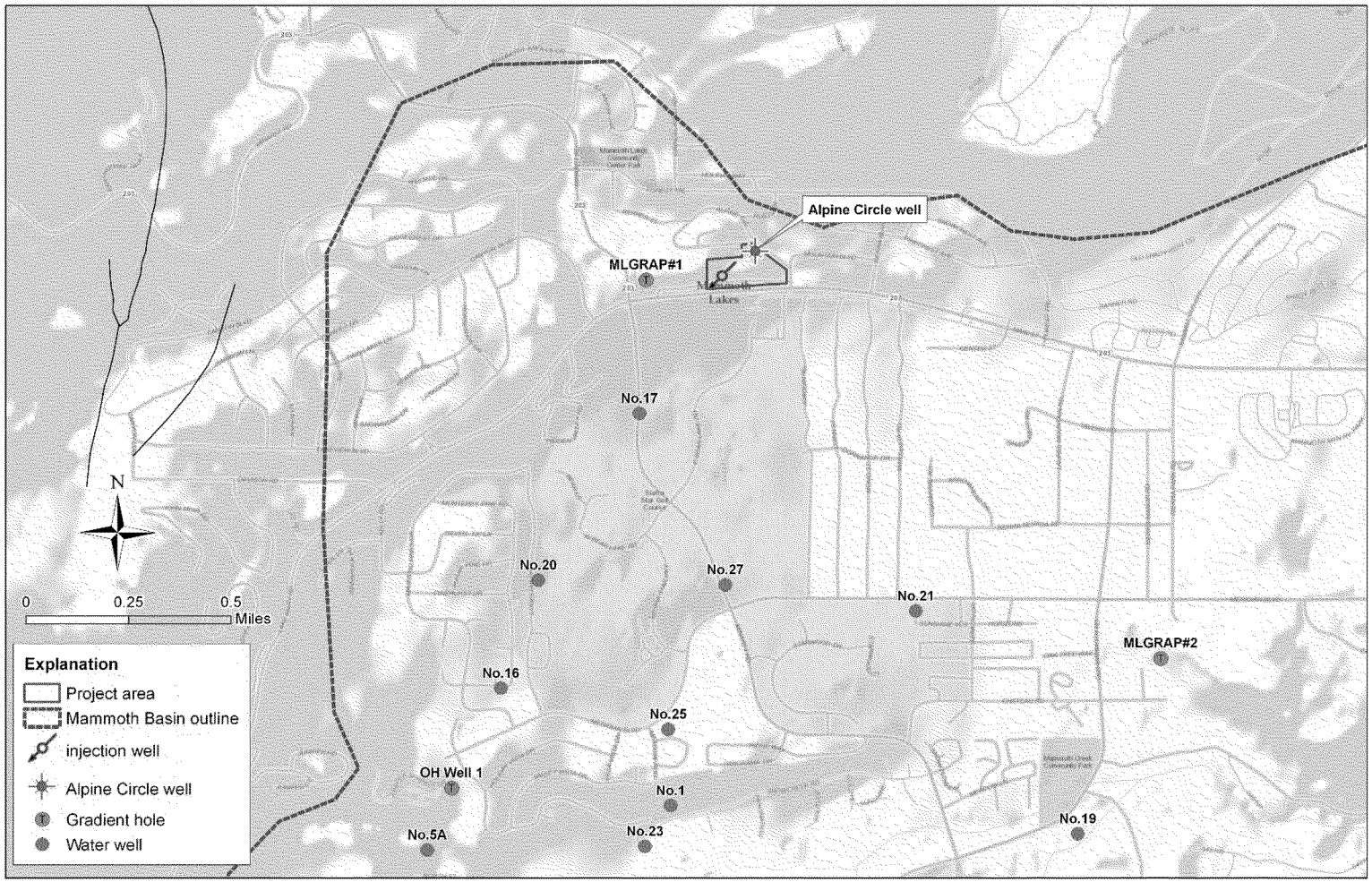

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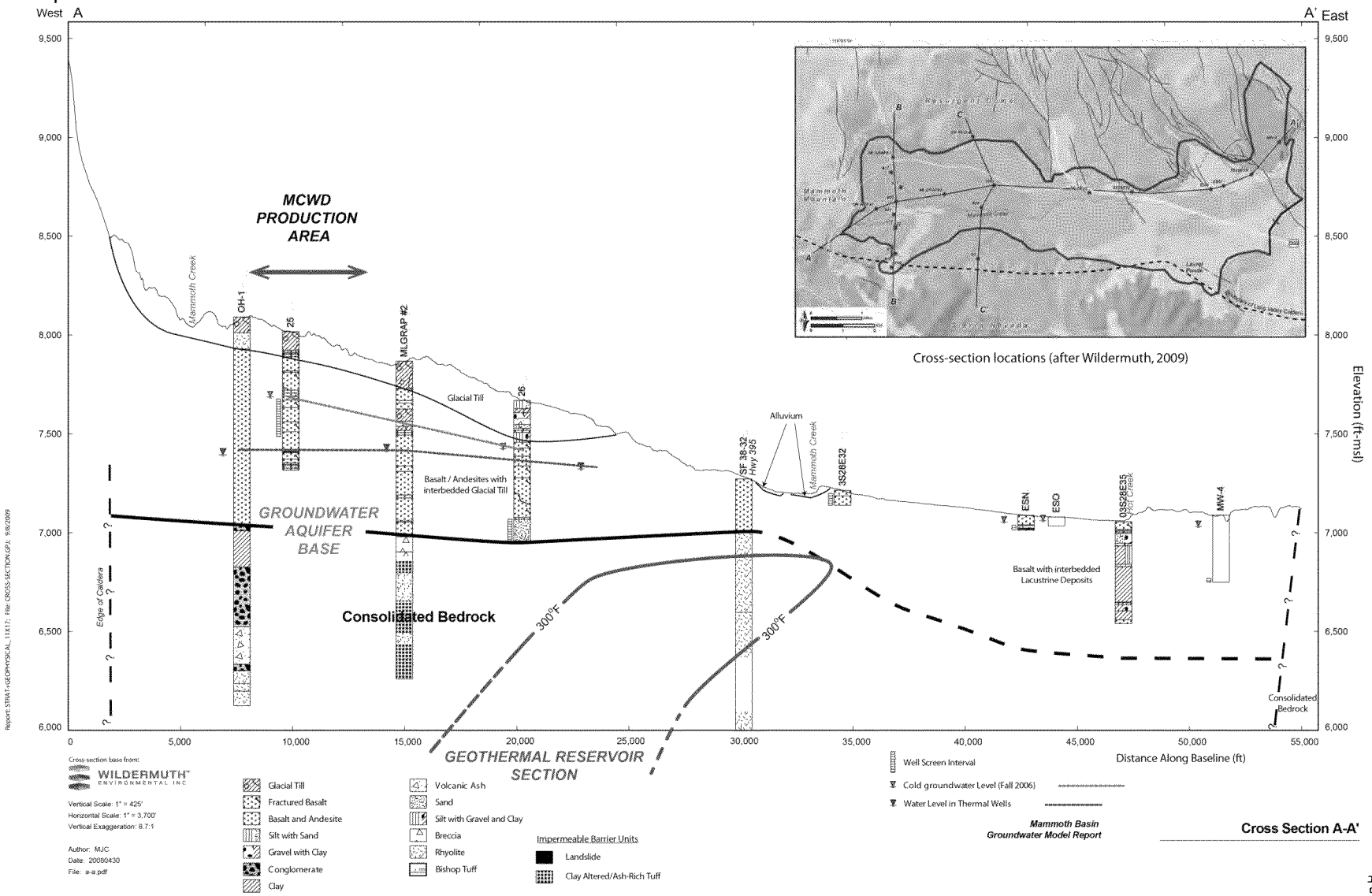

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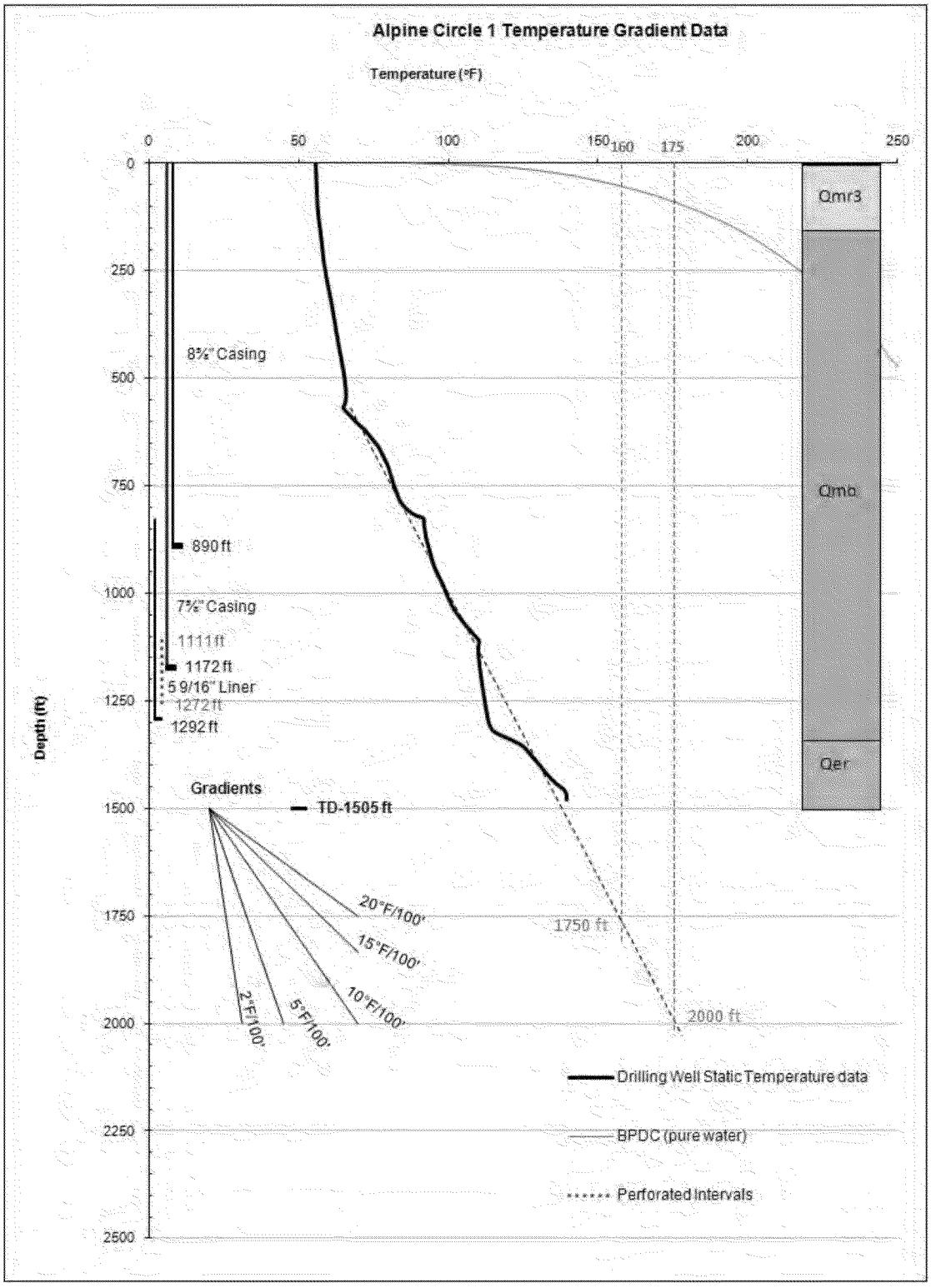

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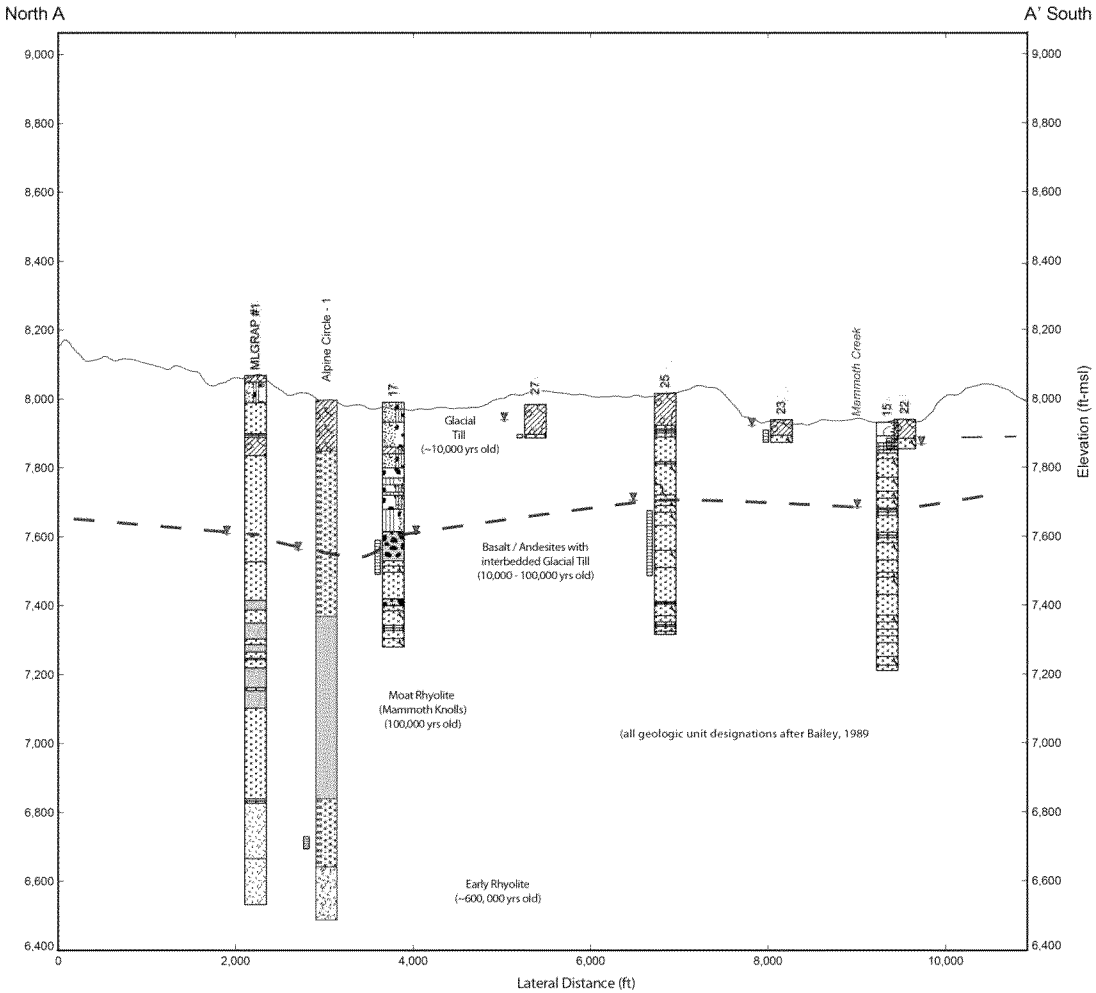

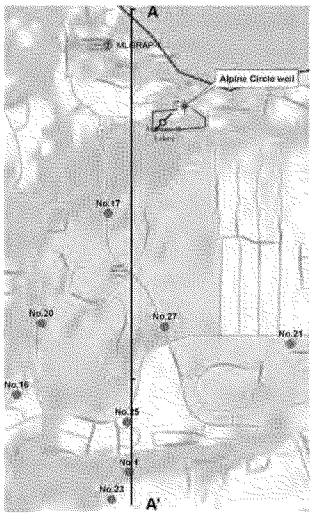

North - South
Cross Section A - A'
(Well locations projected on section line)

EGS INC

Vertical Scale: 1" = 315'
Horizontal Scale: 1" = 1220'
Vertical Exaggeration: 3.9:1

Adapted from Wildermuth, 2009

- Boulders/Cobbles with Sand
- Basalt / Andesite
- Fractured Basalt
- Silt with Sand
- Clay with Sand and Silt
- Sand with Silt
- Clay
- Sand with Silt and Clay
- Volcanic Ash
- Glacial Till
- Sand with Gravel
- Sand with Clay
- Sand
- Sand with Gravel and Silt
- Gravel
- Moat Rhyolite
- Early Rhyolite
- Well Screen Interval
- Static Water Levels
- Static Water Level - Mammoth Basin Deep Aquifer

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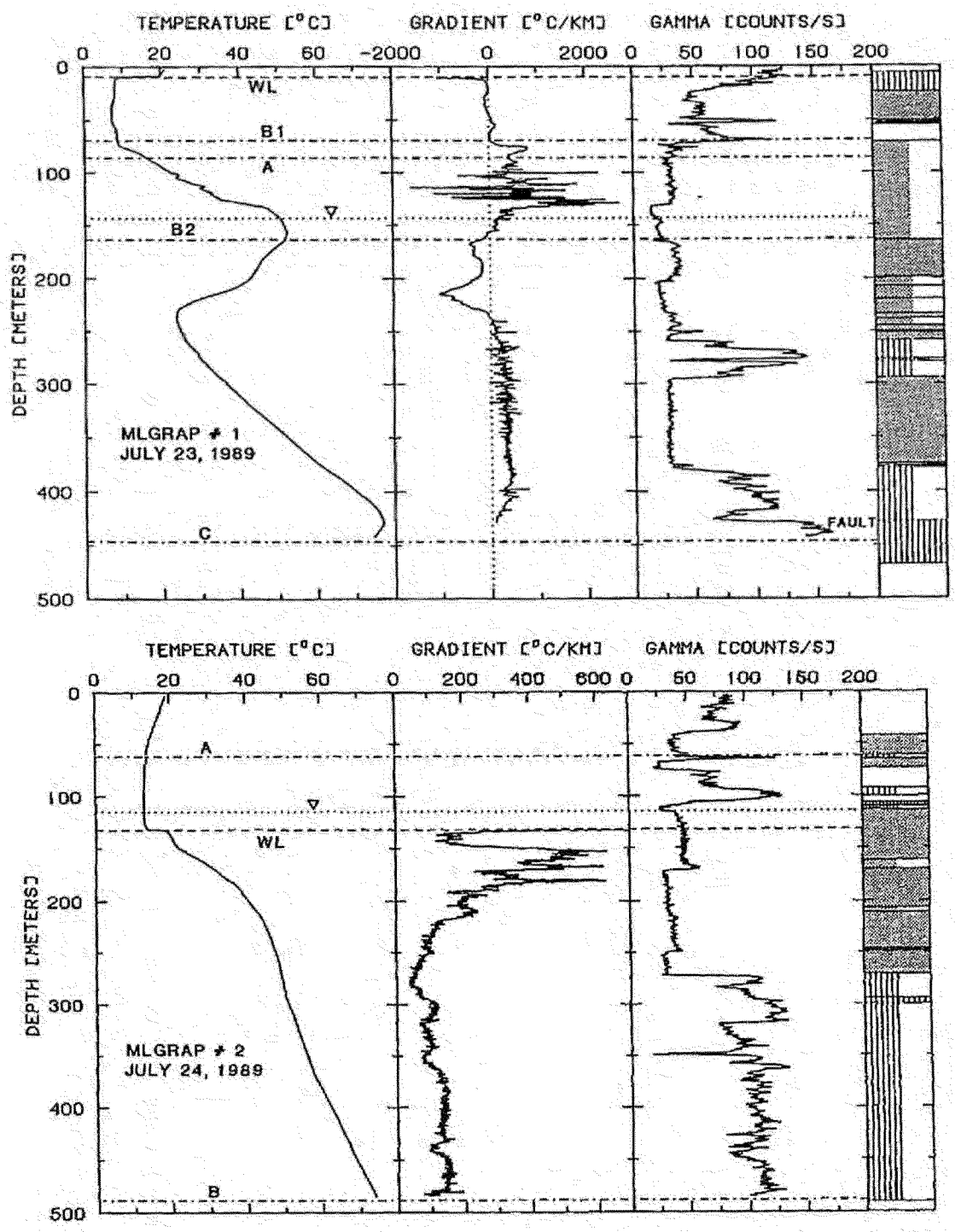

Lithology generalized from Goodwin (1988) White - glacial till, Dots-basalt, Vertical-rhyolite.
WT-waer table, WL-waer levle in tubing, A...B- bottom of casing strings. TD is bottom of lith log.꿹□η

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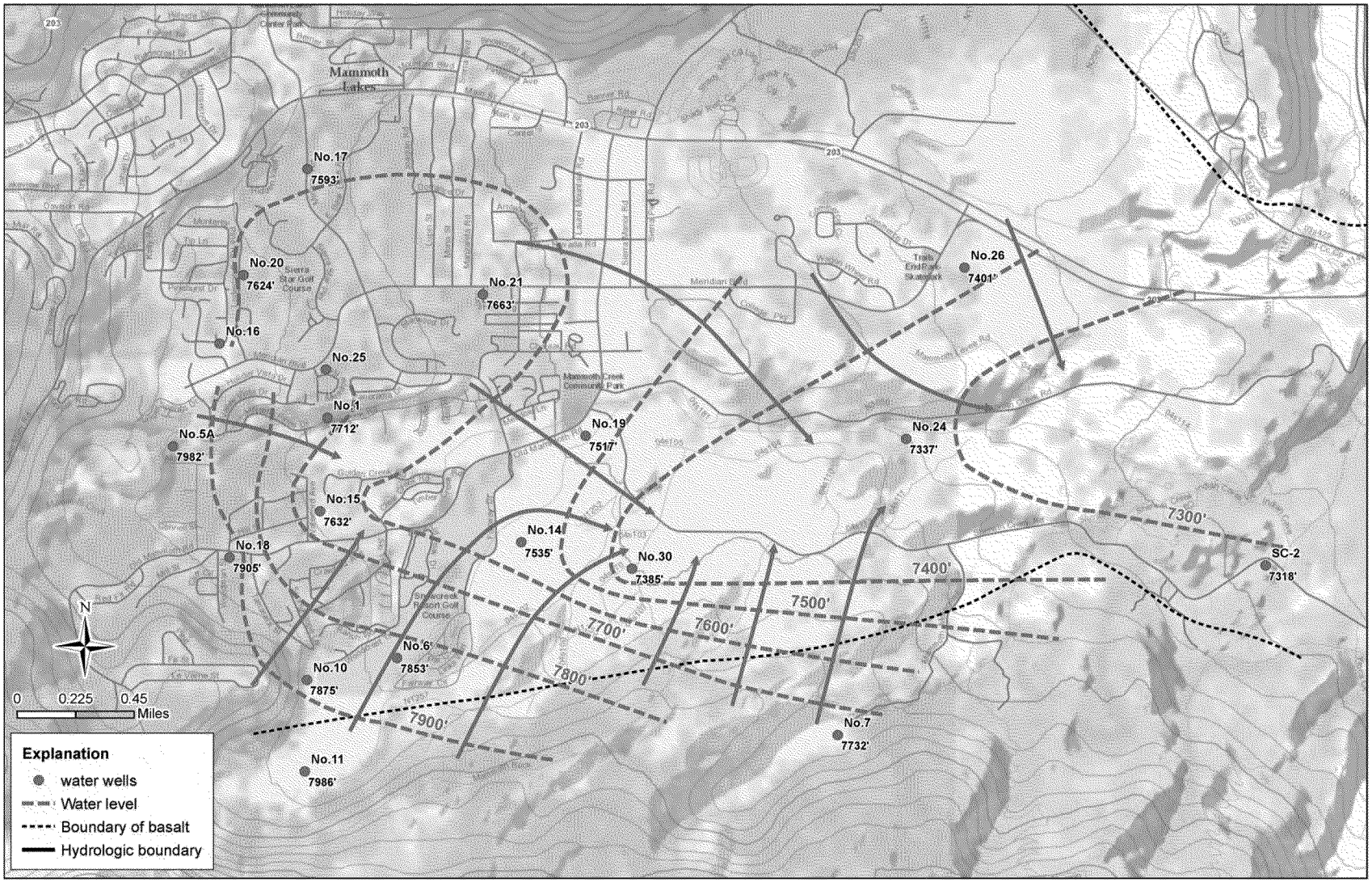

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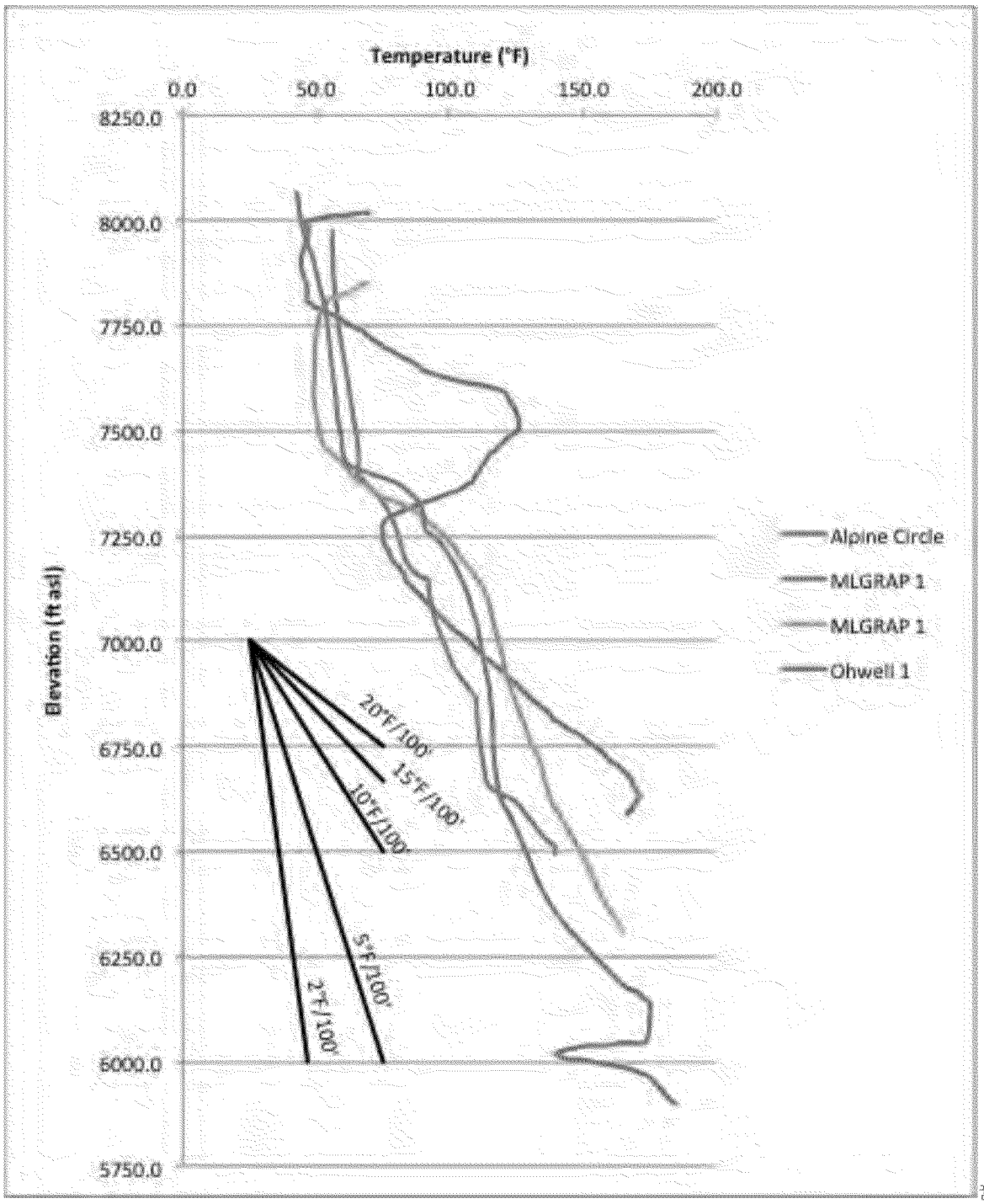

Figure 3: Temperature gradient summary for Alpine Circle and surrounding wells.

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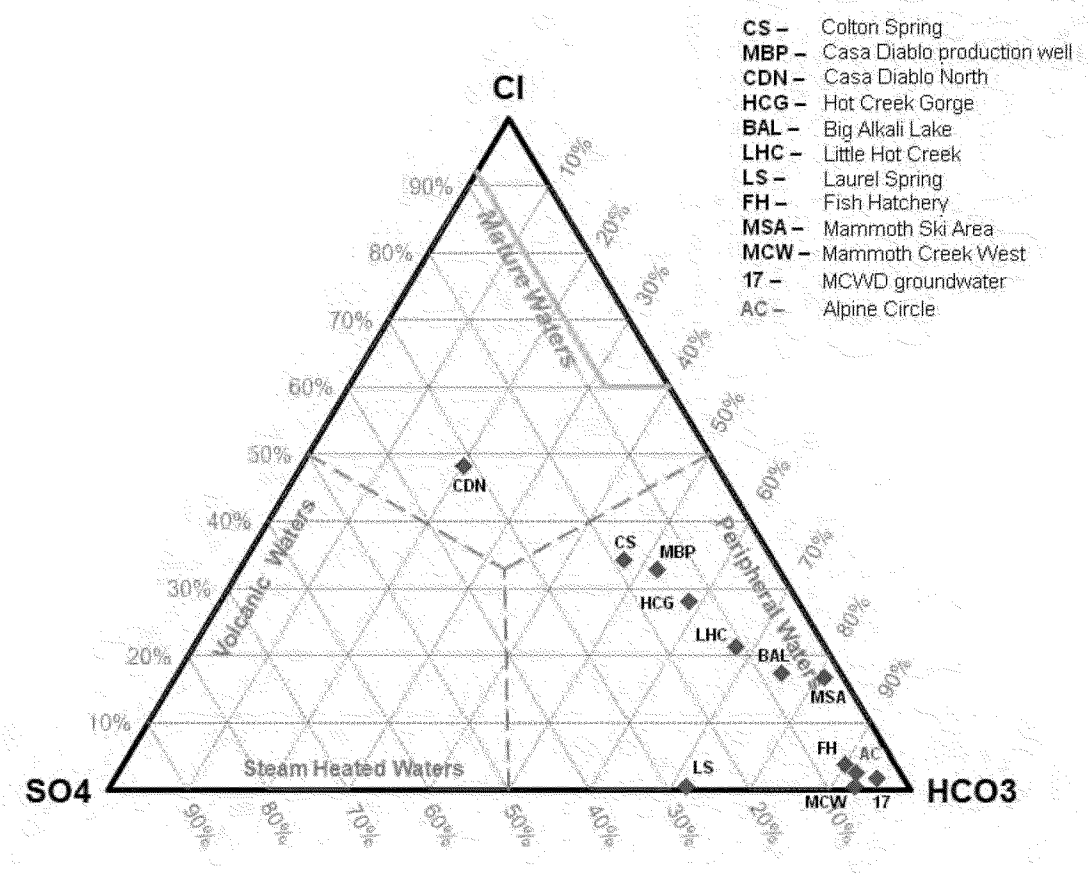

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Sample Name	Date	Sample Label	Temp °C	pH	Li	Na	K	Ca	Mg	SiO2	B	Cl	F	SO4	HCO3
Colton Spring	4/17/91	CS	92.7	8.7		370	29	1.2	0.02	260	12	260	11	140	357
MBP brine	7/10/90	MBP	161	6.3		330	31	7.4	-0.02	210	10	240	8	110	377
Casa Diablo North	4/9/86	CDN	81	6.7		260	23	16	2.4	220	11	230	8.5	150	96
Hot Creek Gorge	4/16/92	HCG	81	7.6		370	12	3.2	0.07	160	10	230	12	110	475
Big Alkali Lake	1/10/90	BAL	57.1	7		370	38	24	0.66	190	6.4	150	4.4	64	645
Little Hot Creek	7/15/93	LHC	82.7	7.8		390	24	23	0.62	86	9.7	190	8.7	100	602
Laurel Spring	7/28/95	LS	11.5	8.7		5.7	1.2	16	0.57	21	0.01	0.3	0.1	15	39
Fish Hatchery	7/7/99	FH	15.6	7.1		22.7	5.1	13.8	10.7	55.9	0.29	5.1	0.2	8.4	120
Mammoth Ski Area (water well)	11/3/95	MSA	4.5	5.7		17	8.5	15	11	43	0.02	19	-0.1	2.6	91
Mammoth Creek Well	7/28/95	MCW	11	7.6		23	4.5	4.9	18	56	0.09	0.8	0.5	8.9	123
MCWD Well 17	5/11/12	17	20.5	7.5		42		17				3.6	0.5	8.6	
Alpine Circle-1	8/8/11	Alpine Circle	46.6	6.47		52	13	17	13	54	0.6	7.1		15	250

Table 1. Comparative chemistry and geothermometer estimates for Alpine Well 1and Long Valley thermal wells, springs and groundwater supply wells.

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APPENDIX꿹□꿹꿹꿹