GeothermEx, Inc.
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AN ANALYSIS OF HYDROCHEMICAL DATA
FROM THE
COVE FORT, UTAH
GEOTHERMAL RESERVOIR

for

AMAX EXPLORATION, INC.

Denver, Colorado

by

GeothermEx, Inc.
Berkeley, California

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CONCLUSIONS

1. Analyses of drilling data and the chemistry of samples collected by Union Oil at their wells #42-7 and #31-33 at Cove Fort show that certain irregularities in the data can be explained as the results of (a) sample contamination by drilling and b) corrosion control additivies. Semi-quantitative subtraction of these effects shows that the Na-Cl reservoir fluids tapped by these wells are probably more homogeneous than previously thought. Ratios of Na/K and Na/Cl are the same in both wells.

2. The principal difference between fluids from wells #42-7 and #31-33 is that #31-33 is higher overall in salinity than #42-7.

3. The top of the reservoir tapped by #42-7 has anomalously high K which remains unresolved. Release of K by alteration of feldspars to clay minerals or a source of K in evaporite deposits seems the most likely explanation.

4. Dolomites penetrated below 4,800 feet in well #31-33 contain an anomalously dilute mixed cation-mixed anion recharge water which circulates beneath the thermal reservoir above. There is weak evidence that dilute waters also enter #42-7, below about 6,000 feet.

5. SiO_2 concentrations suggest that in well #42-7 either quartz or chalcedony is nearly in equilibrium with surrounding rocks. The SiO_2 data for well #31-33 are suspect because of a discrepancy between diluted and undiluted samples. Samples diluted at the time of collection indicate oversaturation with both quartz and chalcedony, which in turn implies that the fluid is mixed or that it has migrated from a hotter source area.

6. The cation geothermometer may not be applicable to these fluids due to scarcity of feldspars in the reservoir rocks. Cation temperatures are about 210-250°C without, and 175-235°C with Mg corrections. These could reflect rock-water interaction in parts of the deep system(s) not penetrated by the wells, where feldspars are more abundant and temperatures higher.

7. This is tentative, but the cation and silica results together encourage the possibility of finding temperatures above the maximum 180°C in #42-7.

8. Shallow well and spring waters from the Cove Fort area are all relatively dilute and lack distinctive signatures which might relate them to the deep system.

INTRODUCTION

In 1978 and 1979 Union Oil Company drilled three exploration wells at Cove Fort from which hydrochemical data were obtained. This paper presents conclusions from a review of those data and of Union's interpretations of their significance. The results of shallow groundwater geochemical surveys of the surrounding area have also been examined. The work has been done at the request of Dean Pilkington under a general consulting agreement between GeothermEx, Inc. and AMAX Exploration, Inc. for the provision of geochemical services.

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BACKGROUND

The only surface manifestations of thermal activity at Cove Fort are acid-sulfate springs at Sulphurdale, which almost certainly are heated by steam rising from depth. The warmest is 40°C.

Ash and others (1979) summarize the results of the Union drilling as follows. The wells in question are #42-7, #31-33, #14-29, and Forminco #1 (a dry hole).

> "The wells penetrated an underpressured, highly fractured, moderate to low temperature (178°C to 93°C), highly permeable geothermal reservoir consisting of contact metamoprhic and sedimentary carbonate rock in a geologically complex area. The lack of production was due to low temperature and low pressure which together with problems of toxic H_2S gas, lost circulation and fractured and unstable formations, lead to abandonment of the project.
>
> The geochemical data is complex. The wide variety of water, ranging from 1,320 ppm TDS to 10,000 ppm TDS was unexpected in the highly permeable reservoir that was thought to be well mixed and geochemically similar throughout the prospect.
>
> The four wells penetrated a variable thickness of surface volcanics of mid-Tertiary age (200 to over 2,000 feet) which lies with angular unconformity over highly faulted and folded Lower Mesozoic and Upper Paleozoic sedimentary rocks. Superimposed over a portion of this framework is an aureole of contact metamorphism and mineralization related to a Mid-Tertiary intrusive event.
>
> Static fluid levels in the wells are between 1,200 and 1,400 feet below the surface. Very high temperature gradients (13 to 16°F/100 feet) are present from the surface to the static water level in the resevoir. Below the top of the reservoir, the temperature profiles become nearly isothermal in the highly fractured and permeable reservoir. These isothermal sections are 300° to 310°F (150°-155°C) in the #42-7 well, 270°-275°F (130°-135°C) in the #31-33 well, and 190° to 195°F (85°-90°C) (not stable) in the #14-29 well.
>
> [Two month's post-completion the isothermal section in #42-17 had disappeared, and the well increased from 306°F (152°C) at 2,000 feet to 332°F (167°C) at about 6,000 to 6,900 feet.] The maximum temperature measured in the prospect was 354°F (179°C) at 7,320

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feet in the #42-7 well. The area around the #42-7 well appears to be near the source of the geothermal anomaly, as defined by the deep drilling. The rapid termination of the shallow-well temperature anomaly east, south and west of the #42-7 well leave little room for the presence of higher reservoir temperatures, considering the highly convective nature of the reservoir."

All four wells were very expensive to drill due to lost circulation and corrosion problems.

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RESULTS

All available hydrochemical data for major and minor dissolved species and most data for trace elements are shown uniformly tabulated and processed in tables 1-3. This includes approximately 20 shallow, cool ground water sources around Cove Fort and from the edge of the Belknap Caldera to the southeast. The acid-sulfate thermal springs at Sulphurdale are not listed. All data sources appear in the Bibliography.

Quality and Interpretation of Analytical Data

Most of the deep test samples show good ionic balances (table 2, column DIF), but three of the analyses do not. Samples 1.04 and 1.07 have large relative excesses of cations which appear to be due to failure to report carbonate. Errors in Na and SO_4 are also possible. The ionic imbalance of 1.15 is certainly due to incorrectly reported SO_4. Sample 1.08 has a reasonable balance, but a ratio of HCO_3 to CO_3 which is too low given its pH.

Most of the dilute, cool recharge samples are poorly balanced. The cause or causes of this have not been explored because the background information which they provide for contrast with thermal fluids is not adversely affected.

The SiO_2 data from well #31-33 are suspect. Analyses of samples treated by dilution at the time of collection (table 1, column Rd-SiO_2) indicate that the undiluted samples (Ru-SiO_2) should be at least saturated with amorphous SiO_2 at room temperature (a minimum of about 110 mg/l SiO_2). Reported values are greatly below saturation and place into doubt the quality of the SiO_2 data from both the undiluted and the diluted samples. SiO_2 analyses (molybdate technique) are also subject to interference by iron, which is high in some samples due to corrosion.

The thermal waters are all of Na-Cl composition, in spite of variable salinity. The shallow groundwaters are dilute mixed cation-bicarbonate types.

Wells #42-7 and #31-33 were sampled at the flow line repeatedly as water was made during drilling (figures 1 and 2). Resulting analyses show variations in composition which are initially difficult to interpret because: (a) the formation water composition may shift in response to boiling and degassing as it is aerated and as it mixes with injected drilling water; (b) sump water was pumped down-hole during aerated drilling, and occasionally injected in large slugs to clear the sump; (c) control of drill pipe and casing corrosion was practiced by injecting certain chemicals; (d) only occasional samples for determination of SiO_2 were diluted when collected; and (e) there is no evidence that any sample for cation determination was treated with acid, which should be done to prevent loss of calcium. The effects of these variables can, and to some extent tentatively, be subtracted from the initial results.

The Union Technical Report on well #42-7 indicates that flow-line samples were usually collected at the end of aerated drilling cycles, to minimize contamination by large injection slugs. There was corrosion control below 3,750 feet by injecting variable amounts of water soluble anime, NaOH, ammonia, organic phosphonate, Na_2SO_3 and $NaNO_2$. Data on corrosion control are sketchy, but rough data on the added NaOH suggest that 10% to 20% of the Na in the flow line samples may have been contributed by the injected NaOH. Na is much more variable from sample to sample than is K, either because there are real variations in the formation fluid, analytical errors, or variable contamination (figures 3, 4). There is a strong correlation between Na and total alkalinity, which includes hydroxide ion (OH^-) and it appears that some samples are either (a) mixtures of Na-Cl and Na-HCO_3 formation waters or (b) Na-Cl formation water mixed with injected NaOH (figure 1a, note samples 1.04 and 1.07). Contaminiation by injected NaOH seems more likely, particularly because the strong variations in Na and alkalinity are not accompanied by shifts in SO_4 and Cl.

SiO_2 measured in undiluted samples shows a strong correlation with pH (figure 5), either because injected sump water with high pH also had dissolved high SiO_2, because samples with higher pH tended to loose less SiO_2 during storage prior to analysis, or both.

Four flow line samples collected during aerated water drilling are available from well #31-33. It is reported that the samples were collected during cycles of drilling when there were substantial drilling returns with relatively high temperatures and low pH compared to the injected water. A fifth sample (2.05) was bailed from near TD after total salinity dropped suddenly and drastically near 4,800 feet from about 10,000 mg/l down to 1,300 mg/l. Permeable dolomite was entered at 4,800 feet beneath a sequence of sandstones and siltstones of low porosity.

Corrosion control was practiced below 2,019 feet, initially by injection of NH_4OH and phosphonate, and below 3,728 feet with substantial $NaNO_2$. It is concluded in the Union Oil Technical Report that the sample from 4,170 feet (2.04) is probably the most representative of the reservoir fluid above 4,800 feet, as it has the highest salinity and so is presumably

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less diluted by injected fluid than previous samples (2.01-2.03). However, a consideration of Na, Cl, pH and sketchy corrosion control data shows that this sample may have been the most heavily contaminated by NaOH. The Cl, Li and F in 2.04 show only a 10%-15% increase over shallower samples, whereas Na and TDS increase by 50% and 30%, respectively. Considering this, it seems that the 4,170-foot sample is possibly contaminated by NaOH (and $NaNO_2$?) and not necessarily more "representative" than the others.

Figures 6 and 7 have been developed from figures 1 and 2, to show concentrations of various species at the flowline versus depth, following elimination of the effects of suspected contamination discussed above, and slight smoothing of the curve for each specie. The curves are still approximations. There probably remains some effect of sample dilution by make-up water from the sump, but since most of the sump water was produced reservoir fluid this effect may have been small. The low salinity of sample 1.13 (7,607 feet) was due to one-day use of injection water with salinity of less than 1,000 mg/l prior to sample collection.

The curves show that the reservoir penetrated by well #42-7 is probably fairly homogeneous, except for anomalously high K at the very top. This K may have its source in evaporites or perhaps breakdown of the feldspars to form clay minerals. The decrease in salinity below about 5,560 feet is believed by Union to be caused by an increased flow of lower-salinity water into the borehole after porous wollastonite marble zones were drilled at 6,080 feet and 6,170 feet. The source and composition of this dilute water is uncertain, but it may be similar to the low salinity water found in dolomite penetrated by well #31-33 below 4,800 feet.

The reservoir penetrated by #31-33 above 4,800 feet is also fairly homogeneous, and differs from #42-7 principally in having a higher overall salinity of Na, K and Cl (note figures 3 and 4). If the reservoirs of the two wells are freely connected at depth, this may mean that #31-33 more closely represents the deep source.

Variations in SO_4 and alkalinity or HCO_3 are different in each well and contrast with the similar Na-K and Na-Cl ratios. Possible causes for variations are: (a) mixing of Na-SO_4 and Na-HCO_3 waters with Na-Cl waters; (b) shifts in equilibration of $CaSO_4$ and $CaCO_3$ with changes in temperature and P_{CO_2} in different parts of the reservoir(s); and (c) contamination by corrosion control additivies which include NaOH and $NaSO_3$. Oxidation of reservoir sulfide (H_2S) to H_2SO_4 in samples may also have occurred, but the amount of H_2S available is unlikely to fully explain the variations in SO_4. The flowline samples of #42-7 have much higher alkalinity than does the flow test sample (1.15) which was collected following completion of drilling. This suggests that alkalinity of the flow line, as represented on figure 6, may still include a large effect of contaminiation or some other alteration process.

Ca is not shown on figures 6 and 7 because of uncertainty about the reported data (see discussion of data quality). If its variability is due to loss of Ca from some samples prior to analysis, it may be assumed that Ca is about 40 to 70 mg/l in the reservoir of #42-7, and 60 to perhaps 200 mg/l in #31-33.

Geothermometry

Using the Na and K values of figure 6 and Ca ranging from 40 to 70 mg/l at each depth, the flowline chemistry of well #42-7 has the following cation temperatures:

Depth, feet	T°C, NaK-Ca	T°C, NaKCa-Mg*
3,000	260-270	230 ± 5
4,000	235-240	200 ± 5
5,000	230-235	200 ± 5
6,000	215-225	185 ± 5
7,000	210-215	175 ± 5
Flow Test (1.15)	237	195

*Calculated for flowline samples using Mg = 6.3, the average of samples 1.01-1.14 except 1.04, 1.07 and 1.08.

These compare with post-completion measurements in the reservoir of 150°-170°C, and a one-time maximum of 179°C at 7,320 feet.

Using the Na and K values of figure 7 and Ca ranging from 60 to 200 mg/l at each depth, the flow line chemistry of well #31-33 has the following cation temperatures:

Depth, feet	T°C, NaK-Ca	T°C, NaKCa-Mg*
2,500	245-260	230 ± 5
3,000	250-265	235 ± 5
4,000	240-255	235 ± 5

*Calculated for flowline samples using Mg = 7.0, the average of samples 2.01-2.04. With Mg = 14, the corrected temperatures drop by about 30°C.

These estimates compare with measured temperatures of 130-135°C in the isothermal section of the well.

Two qualifications to the Na-K-Ca geothermometer must be observed. First, when cation temperature estimates are compared with known reservoir temperatures (as from well logs) at about 200-250°C, the chemical temperature is rarely off by more than 20°C, but it may occasionally be as much as 50°C too high. This means that the estimates for well #42-7 are generally within the limit of maximum error of the geothermometer, but beyond the limit of most probable error. Second, the cation geothermometer is based upon water-rock systems which include feldspar minerals, which may be scarce in the sections penetrated by the Cove Fort wells, particularly #42-7. The applicability of the geothermometer in carbonate and quartz sandstone reservoirs is very questionable. This means that the cation temperatures may be meaningful only if they represent water-rock interaction in other, possibly deeper parts of the systems, not penetrated by drilling, where feldspars are present. If this is the case, temperatures as high as about 230°C can be expected. Hotter fluids may be cooling and migrating laterally to the top of the section penetrated by well #42-7, and then circulating downwards, possibly cooling very slightly or mixing with more dilute components. Evidence for lateral migration of somewhat cooler, more dilute waters into deeper parts of these systems has been cited above. Decreasing cation temperatures with depth in #42-7 may reflect this mixing, or an incomplete chemical re-equilibration process.

Data for SiO_2 are somewhat irregular and spotty, and the quality of measurements from well #31-33 is uncertain. Nevertheless, the maximum estimates of the quartz and chalcedony geothermometers applied to samples diluted at the time of collection are in fair agreement with the temperatures measured in well #42-7, whereas in #31-33 oversaturation is indicated:

Well	T°C, SiO_2 Quartz	T°C, SiO_2 Chalcedony	Measured in reservoir
#42-7			
2,000 feet-TD	175-190	165-170	150-170 (to 179°C)?
#31-33			
2,000-4,800 feet	185-195	165-175	130-135
below 4,800 feet	158	133	115 at TD

At temperatures below about 200°C, and in sedimentary rocks, silica may be controlled by either quartz or chalcedony. A decisive choice between the two geothermometers is not possible. In either case, it appears that silica has more closely equilibrated to reservoir temperatures at the depths tapped by the two wells than have the cations.

The single sample from well #14-29 (sample 3.01) has similar Cl to the #42-7 reservoir fluid, but much higher Ca and Mg and lower Na and K. This well was drilled to only 2,620 feet. The fluid sampled probably has migrated from a hotter part of the reservoir, reacting with rocks as it cools, and perhaps mixing with Ca-Mg-HCO_3 recharge. The chalcedony and cation temperatures agree roughly with a measured 85-90°C (not stable).

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start corrosion control

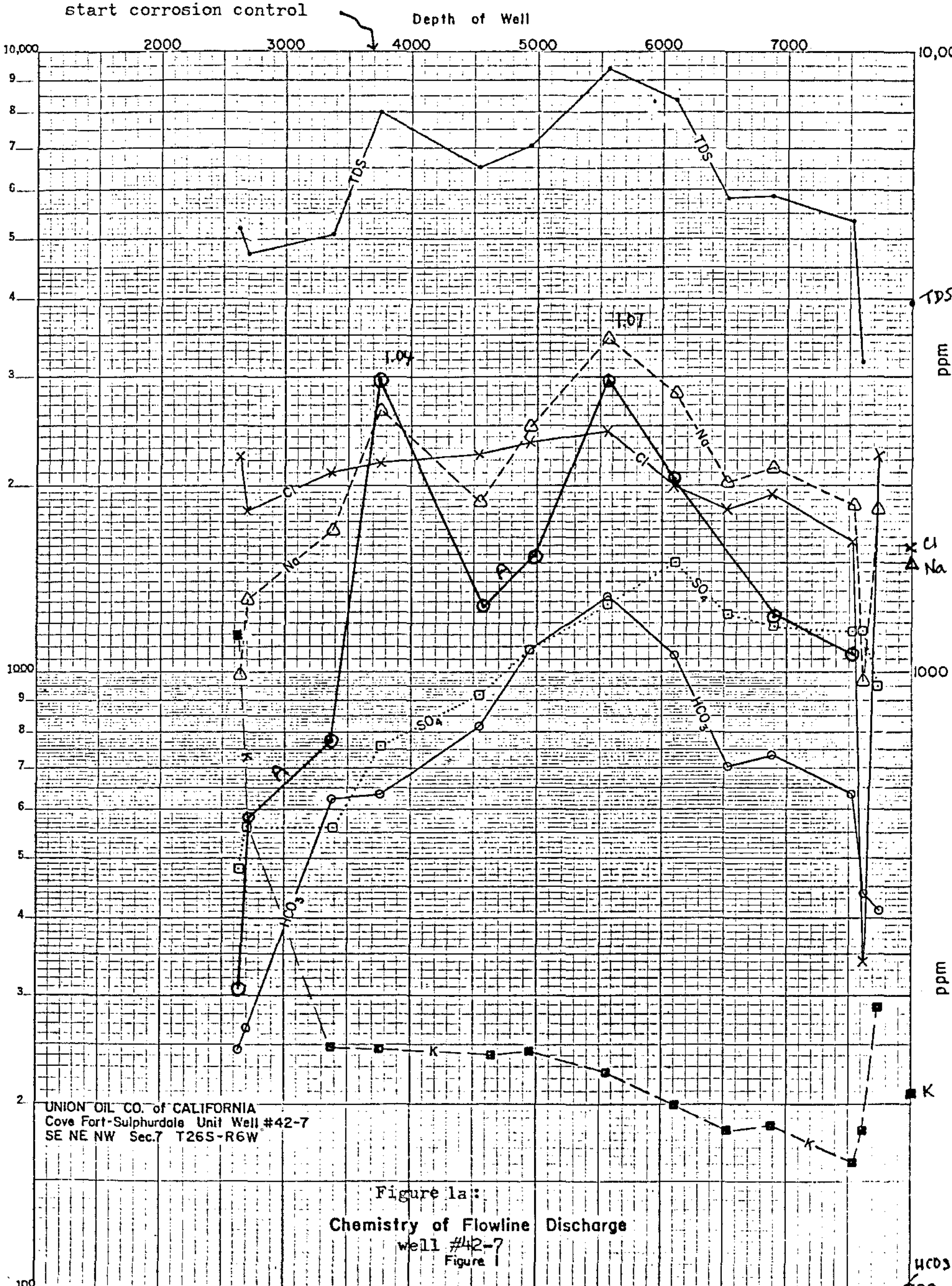


Figure 1a:

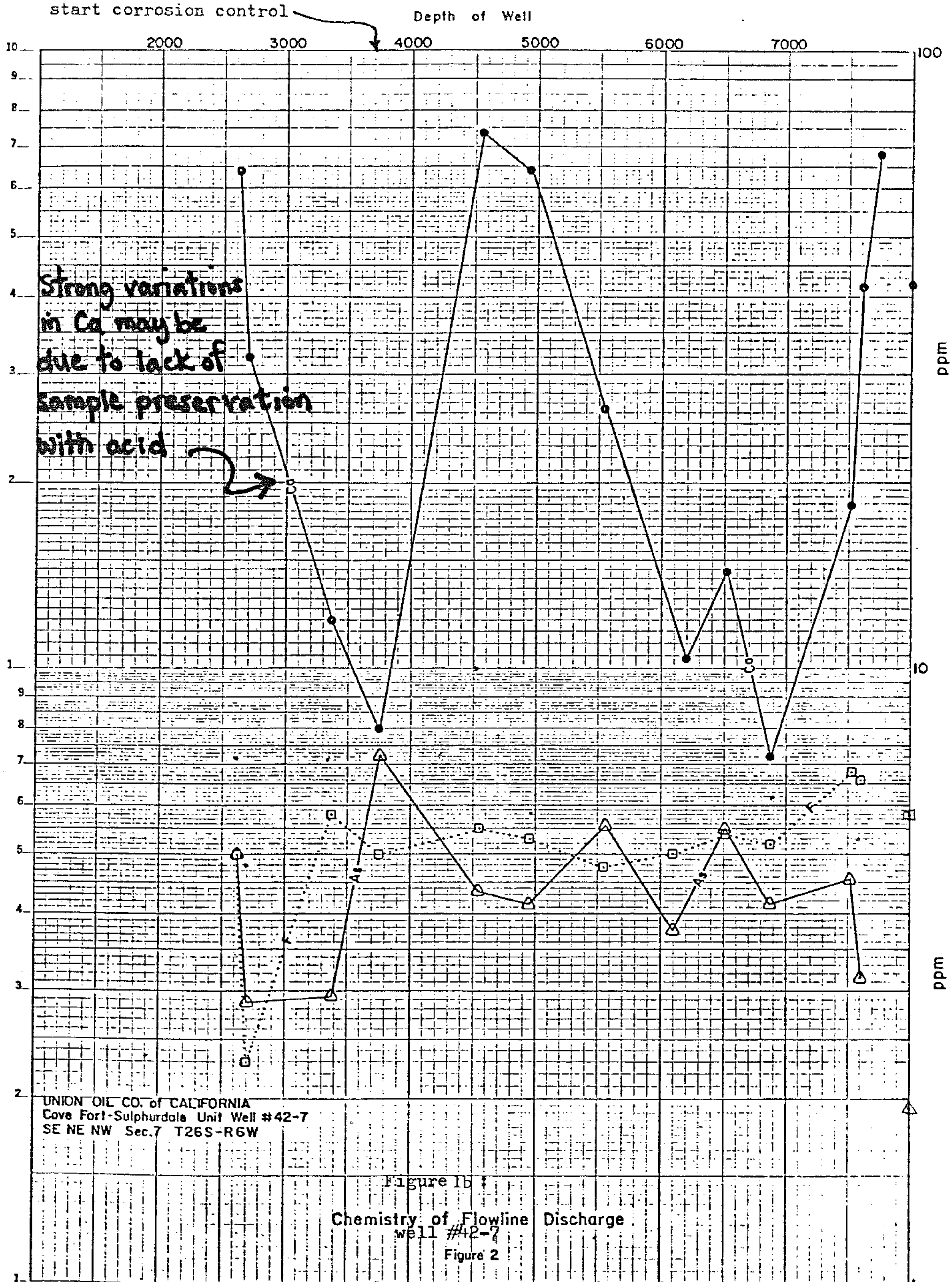
Chemistry of Flowline Discharge

well #42-7

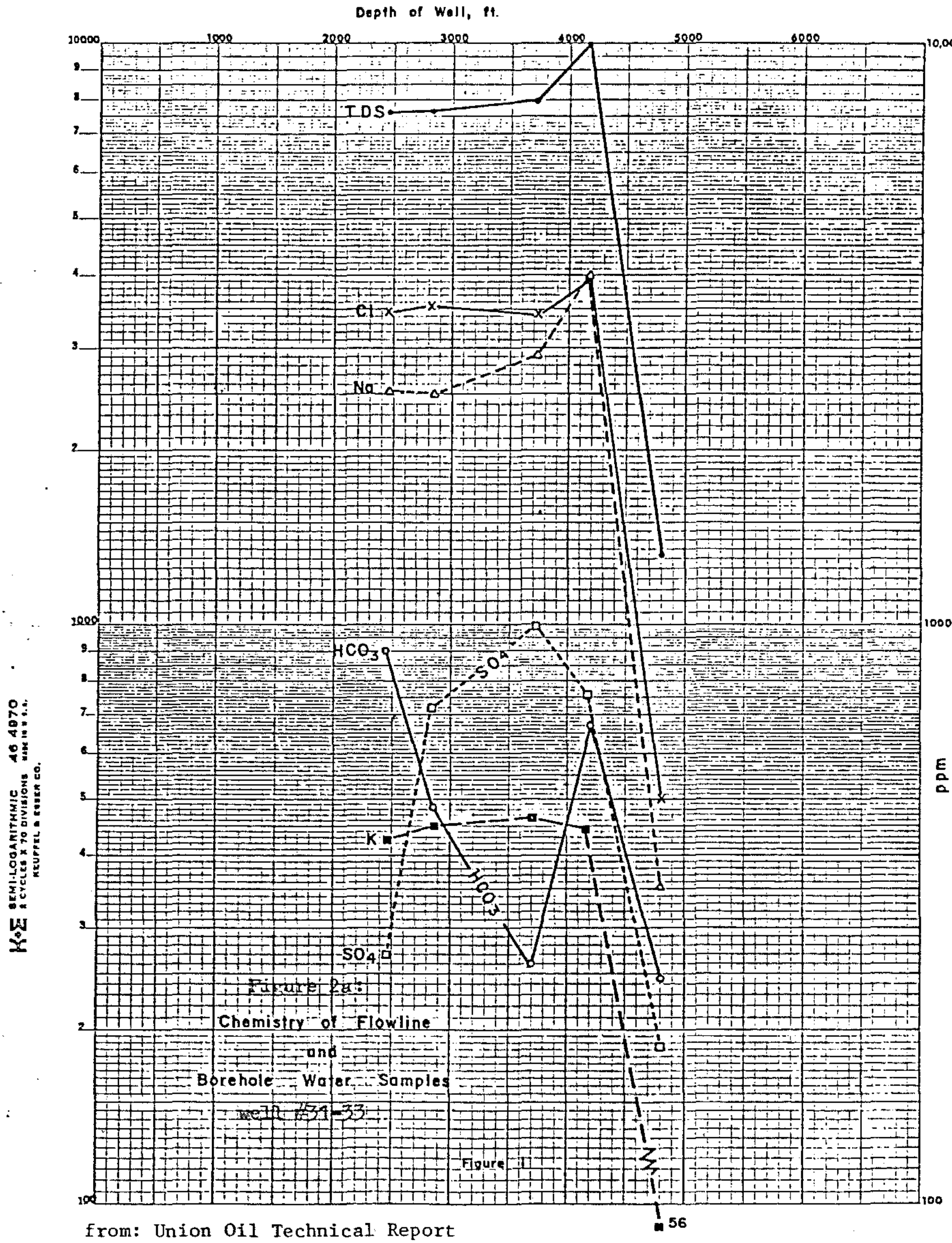
From: Union Oil Technical Report, with Alkalinity added.

A = total alkalinity as HCO3.

Sample 1.15



from: Union Oil Technical Report. Sample 1.15



from: Union Oil Technical Report

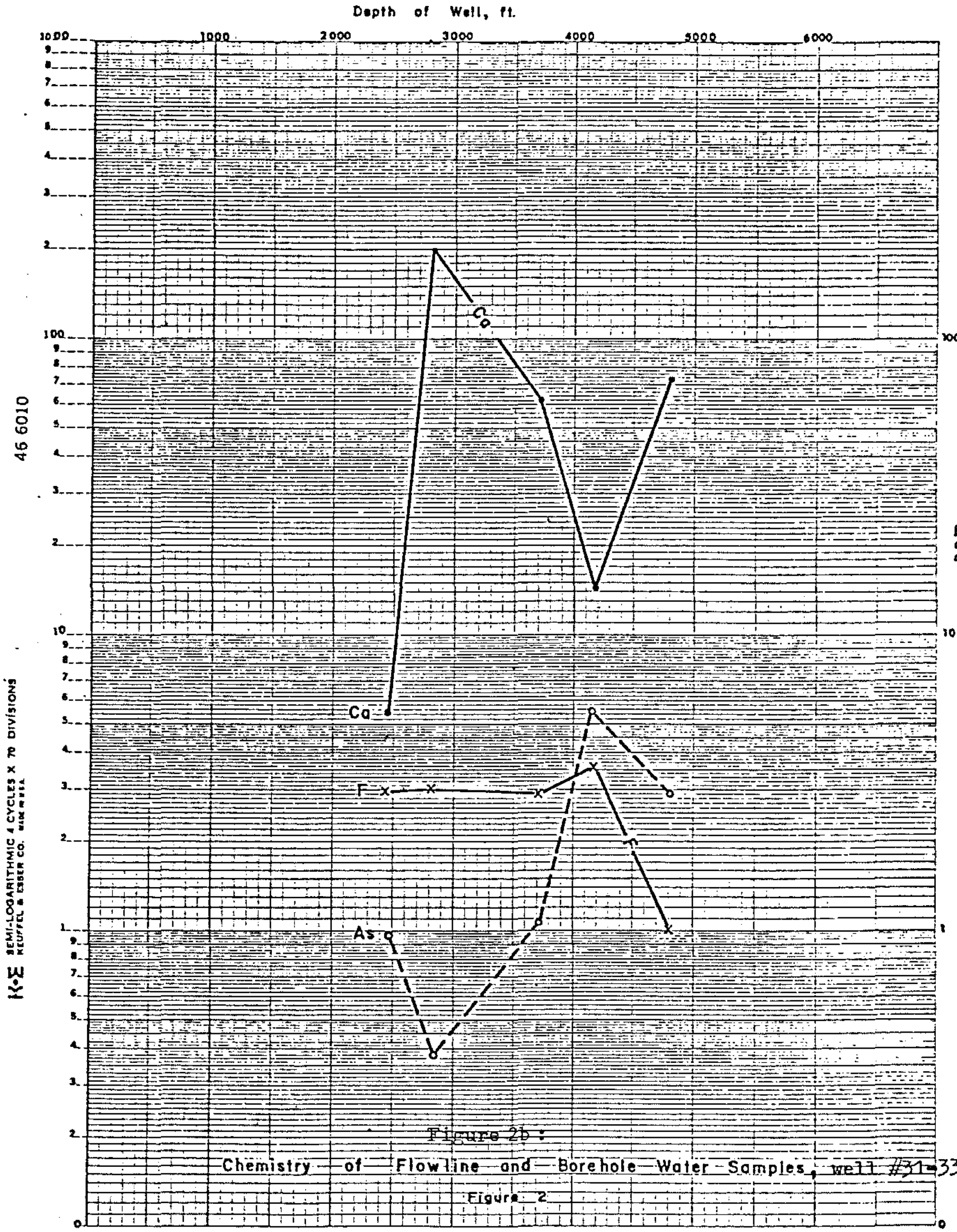


Figure 2b:

Chemistry of Flowline and Borehole Water Samples, well #31-33

from: Union Oil Technical Report

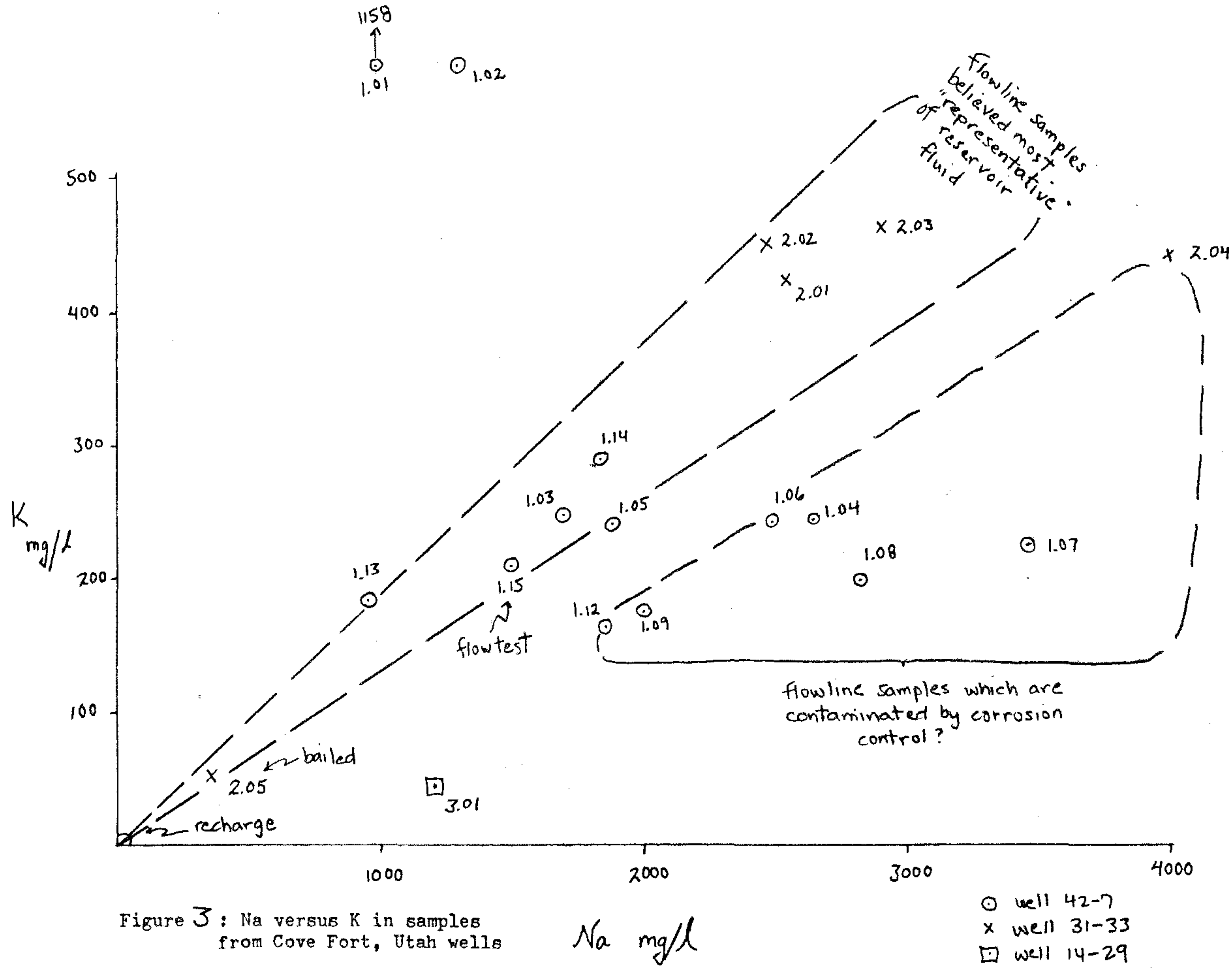


Figure 3 : Na versus K in samples from Cove Fort, Utah wells

Figure 4 : Na versus Cl in samples from Cove Fort, Utah wells.

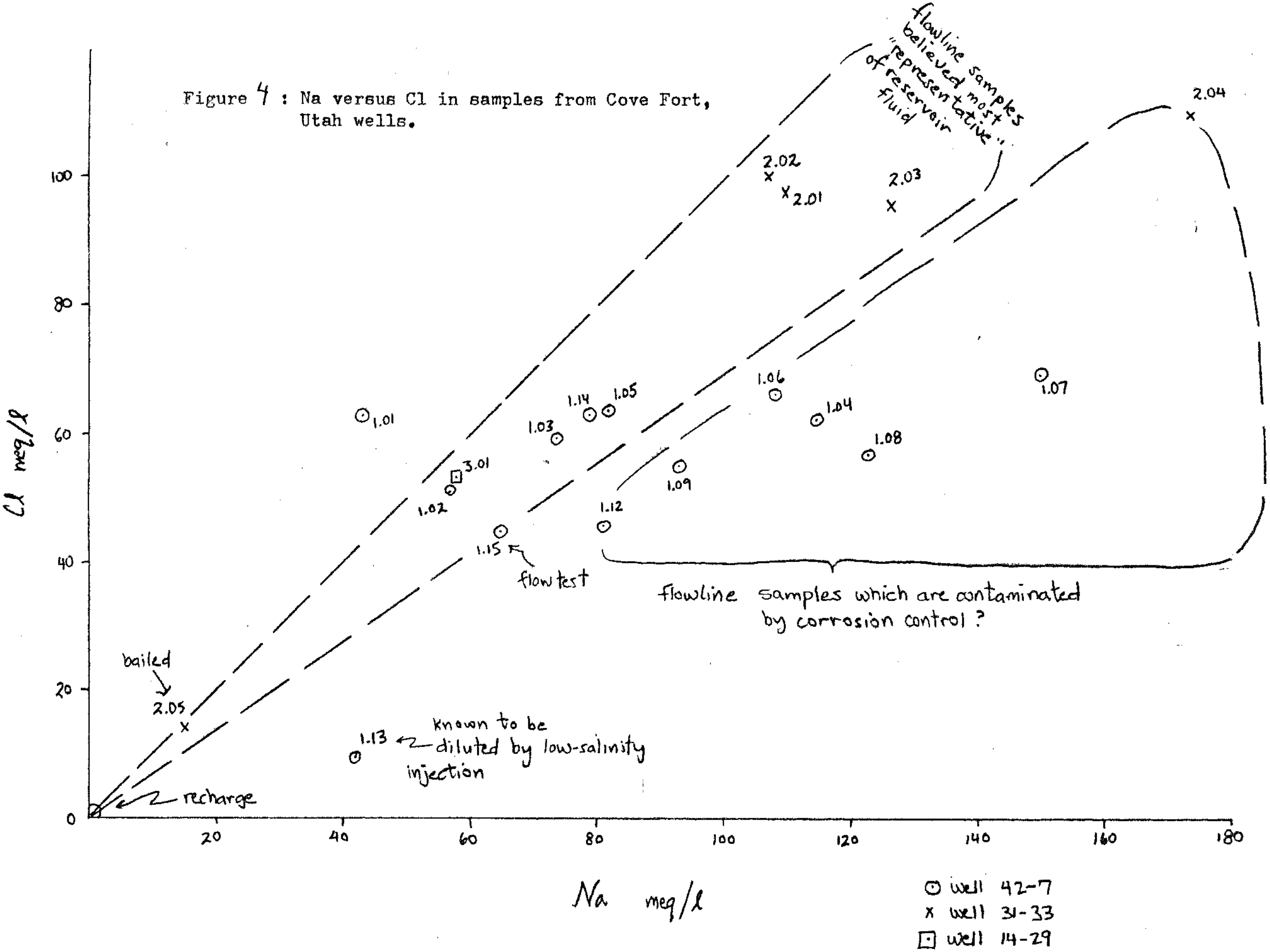


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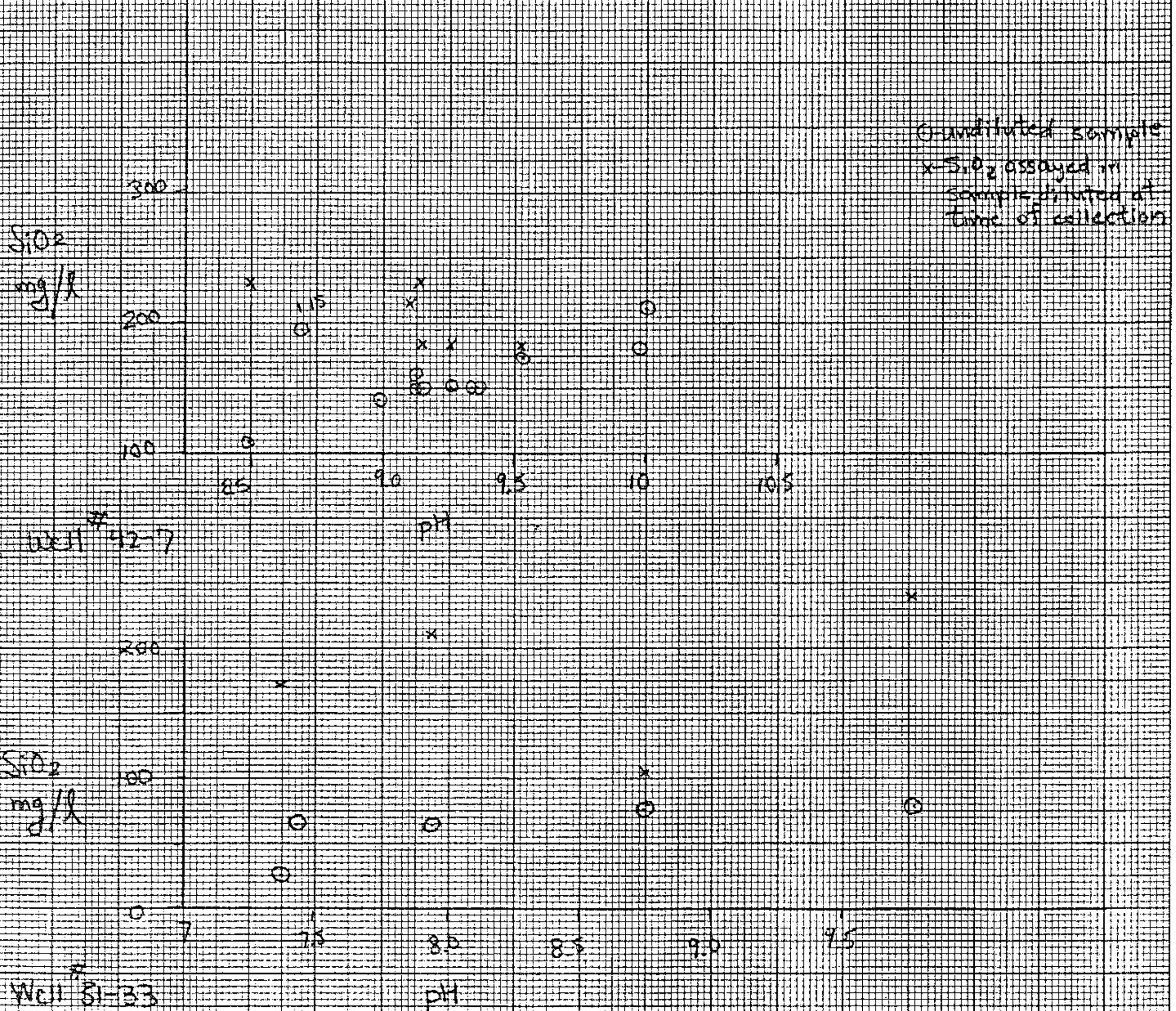
Figure 5 : pH versus SiO_2 in samples from wells #42-7 and #31-33, Cove Fort, Utah



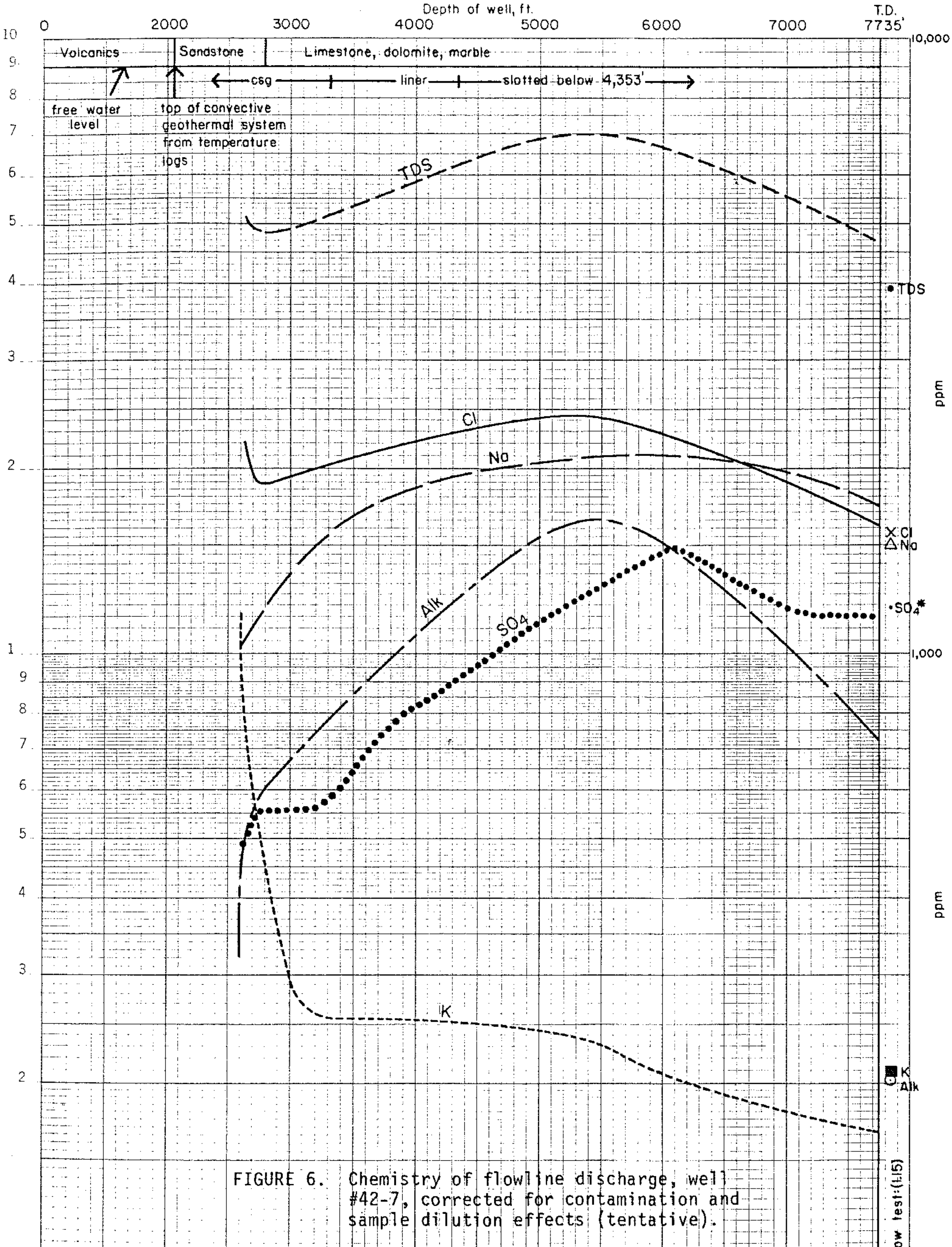


FIGURE 6. Chemistry of flowline discharge, well #42-7, corrected for contamination and sample dilution effects (tentative).

Alk = $HCO_3 + CO_3 + OH_4$

*SO_4 by difference between cations and Cl + HCO_3

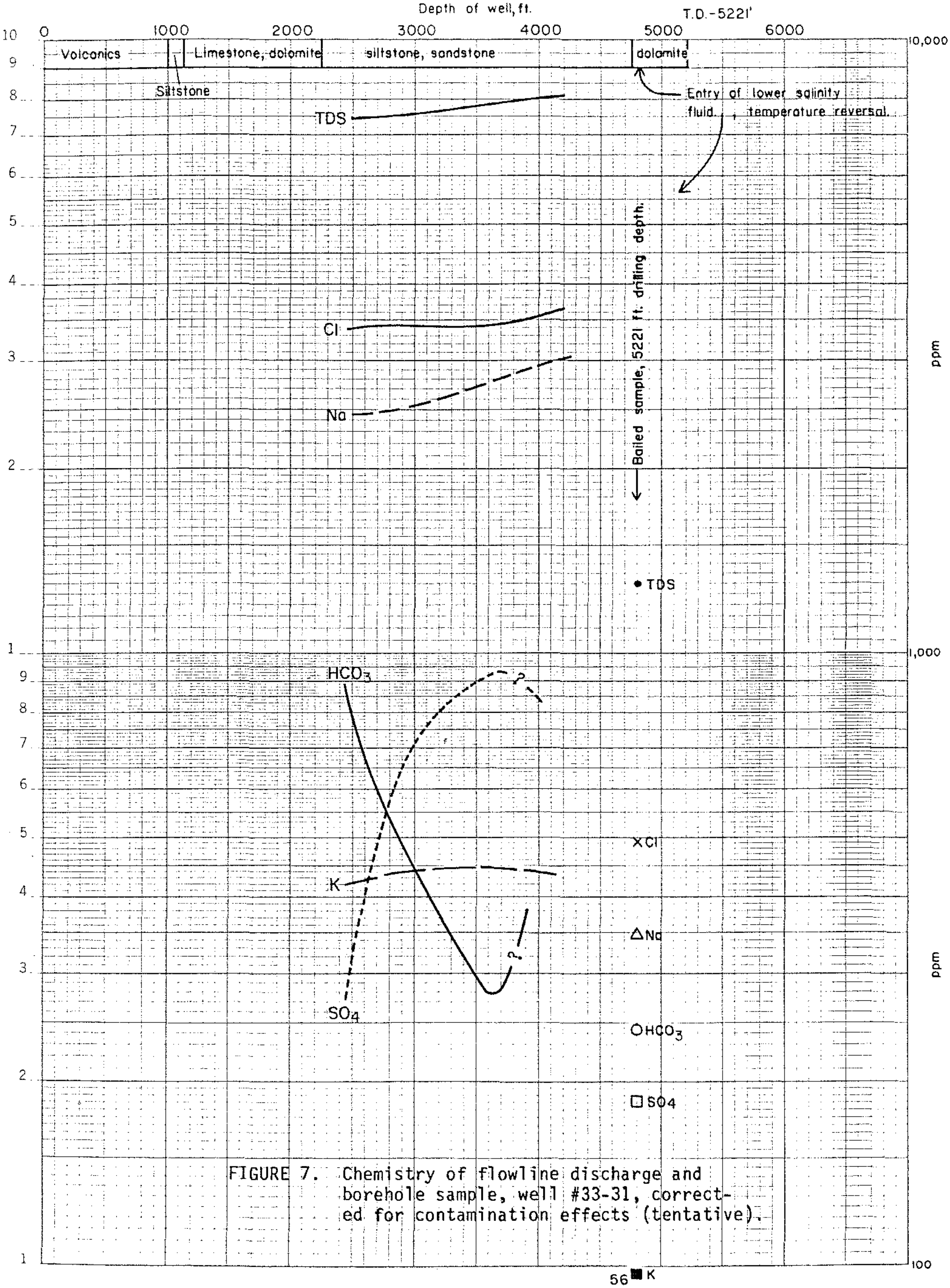


FIGURE 7. Chemistry of flowline discharge and borehole sample, well #33-31, corrected for contamination effects (tentative).

TABLE 1. Chemical analyses in mg/l,
Cove, Fort, Utah

Column headings (some may not appear):

N = sample number for tabulation
NAME = Well Number (N = 1.01 to 3.01) or sample Number (N = 4.00 to 23.00)
Samples N = 4.00-16.00 are from AMAX Geochem. files, N = 17.00-23.00 from McHugh and others (1980)
DATE = sample collection date, yr-mo-day
TIME = time of collection
DEPTH = drilling depth at time of collection
TYPE: FL = from flow line during aerated water drilling, for N = 1.01 to 3.01
B = bailed, for N = 1.01 to 3.01
SU = sump or suction pit, for N = 1.01 to 3.01
FT = flow test, for N = 1.01 to 3.01
SP = spring, for N = 4.00 to 23.00
WE = well, for N = 4.00 to 23.00
SS = spring or surface, for N = 4.00 to 23.00
PHL = pH
CA ... CL, F, MN = ionic species, concentrations in mg/l (NO3 as N)
SIO2 = silica in mg/l. Ru = measured in untreated sample. Rd = measured in sample diluted at time of collection
TDSM = total dissolved solids reported by data source.
TDSS = total dissolved solids by summation of CA through CL, plus SIO2
EC = conductivity at 25°C, micromhos/cm
B = atomic boron in mg/l
FET = total iron
FEF = filtrable iron
COM = Comment

Note = All 9's or blank means no data are available, does not apply, or insufficient data are available to permit calculation.
0.0 means below detection limit of analysis.

Detection limits:

For N = 1.01-3.01	Mg < 1.0	For N = 4.00-16.00: no limits given	
	CD < 0.001		
	FEF < 0.05	For N = 17.00-23.00:	BA < 0.001
	NO3 < 0.01		B < 0.01
			MN < 0.003

Comments:
Sample 2.01 FET reported as 3,200 mg/l
Sample 3.01 LI reported as 265 mg/l

LIN#	#	NAME	DATE	TIME	DEPTH	TYPE	PHL	CA	MG	NA	K	LI	HCO3	CO3	SO4	CL	Ru SIO2	Rd SiO_2
1	1.01	42-7	780126	9999	2633	FL	8.52	64.0	7.2	1060.0	1150.0	99.99	246.4	40.0	400.0	2220.0	110	231
2	1.02	42-7	780127	9999	2700	FL	9.54	32.0	4.0	1310.0	585.0	99.99	265.9	252.0	560.0	1820.0	170	181
3	1.03	42-7	780131	1240	3300	FL	8.99	12.0	7.2	1700.0	247.5	99.99	620.0	100.0	560.0	2100.0	140	
4	1.04	42-7	780207	1100	3760	FL	11.76	0.0	0.0	2653.0	247.0	99.99	634.4	0.0	760.0	2190.0	340	
5	1.05	42-7	780209	545	4540	FL	9.36	73.6	10.1	1885.0	241.0	99.99	817.4	360.0	920.0	2250.0	150	
6	1.06	42-7	780210	545	4940	FL	9.34	64.0	5.8	2495.0	242.0	99.99	1085.0	360.0	1080.0	2340.0	150	
7	1.07	42-7	780212	1700	5560	FL	9.98	26.4	0.1	3460.0	225.0	99.99	1322.0	0.0	1200.0	2450.0	180	
8	1.08	42-7	780214	1800	6100	FL	10.02	10.4	0.0	2820.0	199.0	99.99	1.1	700.0	1500.0	2000.0	210	
9	1.09	42-7	780218	910	6889	FL	9.14	7.2	6.2	2140.0	185.0	99.99	732.0	240.0	1100.0	1940.0	150	231
10	1.10	42-7	780218	910	6889	su	9.23	12.0	2.9	2240.0	195.0	99.99	768.6	264.0	1400.0	1930.0	150	
11	1.11	42-7	780218	910	6889	su	9.10	10.0	5.0	2200.0	212.0	99.99	603.0	267.0	1100.0	1920.0	9999	
12	1.12	42-7	780222	1030	7523	FL	9.27	10.4	1.0	1860.0	161.9	99.99	634.4	216.0	1160.0	1620.0	150	184
13	1.13	42-7	780224	1245	7607	FL	9.11	41.6	5.3	966.0	181.5	99.99	439.2	252.0	1160.0	340.0	160	214
14	1.14	42-7	780226	845	7735	FL	7.70	60.0	13.0	1830.0	280.0	99.99	412.0	0.0	900.0	2240.0	9999	
15	1.15	42-7	780516	9999	TD	FT	8.70	43.0	6.0	1500.0	209.0	99.99	101.0	55.0	0.5	1590.0	197	
16	2.01	31-33	780630	1200	2455	FL	8.77	5.6	2.4	2530.0	423.0	12.05	888.2	64.8	272.0	3440.0	77	105
17	2.02	31-33	780701	1100	2825	FL	7.30	200.0	14.4	2475.0	452.0	12.46	400.7	0.0	720.0	3550.0	25	171
18	2.03	31-33	780705	1200	3720	FL	7.94	62.4	7.7	2916.0	465.0	11.62	256.2	0.0	1000.0	3410.0	64	211
19	2.04	31-33	780707	600	4170	FL	9.79	14.4	3.4	4000.0	443.0	13.31	658.8	540.0	760.0	3900.0	79	241
20	2.05	31-33	780720	9999	5221	B	7.44	74.4	19.2	355.0	56.2	1.16	244.0	0.0	187.0	502.0	64	143
21	3.01	14-29	9999	9999	9999		7.41	332.0	115.2	1220.0	41.5	99.99	192.8	0.0	900.0	2060.0	92	
22	4.00	W10319	760000	9999	9999	WE	7.69	12.0	19.0	26.0	2.8	0.00	192.0	0.0	36.0	110.0	32	
23	5.00	W10320	760000	9999	9999	SP	8.10	4.0	10.0	18.0	0.8	0.00	144.0	0.0	0.0	20.0	22	
24	6.00	W10321	760000	9999	9999	SP	7.30	6.0	14.0	23.0	1.2	0.00	150.0	0.0	14.0	50.0	33	
25	7.00	W10322	760000	9999	9999	SP	7.52	14.0	26.0	45.0	0.3	0.00	360.0	0.0	13.0	77.0	42	
26	8.00	W10323	760000	9999	9999	WE	7.49	12.0	21.0	32.0	3.0	0.00	192.0	0.0	38.0	120.0	46	
27	9.00	W10324	760000	9999	9999	WE	7.74	50.0	13.0	42.0	3.4	0.10	164.0	0.0	22.0	53.0	45	
28	10.00	W10325	76000	9999	9999	SP	7.00	5.0	13.0	21.0	1.1	0.00	177.0	0.0	0.0	25.0	33	
29	11.00	W10326	760000	9999	9999	SP	7.52	4.0	8.0	16.0	1.9	0.00	122.0	0.0	0.3	19.0	26	
30	12.00	W10328	76000	9999	9999	SP	7.32	0.0	16.0	39.0	1.3	0.00	208.0	6.0	28.0	64.0	31	
31	13.00	W10329	76000	9999	9999	SP	8.40	10.0	18.0	31.0	1.5	0.00	212.0	12.0	39.0	54.0	32	
32	14.00	W10336	76000	9999	9999	SP	7.28	4.0	10.0	23.0	0.8	0.00	160.0	0.0	0.0	17.0	36	
33	15.00	W10481	76000	9999	9999	WE	7.90	70.0	13.0	20.0	4.1	0.00	156.0	0.0	19.0	51.0	42	
34	16.00	W10482	76000	9999	9999	WE	7.70	70.0	12.0	21.0	5.1	0.00	162.0	0.0	32.0	44.0	40	
35	17.00	7931	790000	9999	9999	SS	8.40	72.0	16.0	25.0	1.7	0.01	243.0	0.0	12.0	46.0	32	
36	18.00	7989	79000	9999	9999	SS	7.00	5.8	1.2	4.3	0.7	0.00	22.0	0.0	1.9	2.5	21	
37	19.00	7990	79000	9999	9999	SS	7.55	4.9	1.1	3.6	0.6	0.00	10.0	0.0	1.7	2.1	19	
38	20.00	7991	79000	9999	9999	SS	7.45	6.2	1.6	4.5	0.9	0.00	22.0	0.0	2.8	3.7	21	
39	21.00	7992	79000	9999	9999	SS	7.55	39.0	4.6	22.0	0.3	0.01	143.0	0.0	4.2	23.0	21	
40	22.00	7993	790000	9999	9999	SS	7.75	11.0	2.5	5.1	0.8	0.00	53.0	0.0	2.0	3.0	23	
41	23.00	7994	79000	9999	9999	SS	7.75	11.0	2.5	5.0	0.8	0.00	52.0	0.0	2.0	3.0	23	

LIN#	TDSM	TDSS	EC	B	F	NO3	AS	BA	CD	MN	FET	FEF	COM
1	5200	5334	8000	0.25	5.00	0.64	5.060	0.530	0.010	2.640	80.440	5.520	MAKING 300 BBLS/HR.
2	4775	5000	3746	0.30	2.30	0.83	2.880	0.570	0.010	4.261	64.880	3.620	MAKING 750 BBLS/HR.
3	5100	5495	7846	13.00	5.80	0.48	2.940	0.190	0.012	0.925	59.300	28.000	
4	8034	6832	12360	0.15	5.00	2.00	7.260	0.080	0.156	0.047	2.589	0.540	START CORR CTRL 2/7
5	6561	6707	10094	0.24	5.50	1.30	4.260	0.120	0.120	0.131	3.496	1.210	
6	7072	7022	10080	0.20	5.30	0.40	4.140	0.120	0.156	0.074	2.268	0.450	
7	9405	8943	14469	0.10	4.70	1.80	6.080	0.100	0.128	0.098	2.829	1.140	
8	8381	7528	12893	0.08	5.00	2.40	3.780	0.040	0.089	0.037	1.125	0.250	
9	5858	6580	8000	0.30	5.20	2.20	4.120	0.080	0.020	0.163	0.827	0.367	
10	6426	6962	8400	0.50	5.20	4.20	4.380	0.110	0.022	0.110	4.710	0.633	
11	9999	6317	99999	7.00	99.99	99.99	99.999	9.999	9.999	9.999	999.999	99.999	
12	5349	5822	7000	0.50	6.80	4.40	4.560	0.120	0.017	0.344	0.925	0.643	
13	3178	3546	5000	0.65	6.60	3.85	3.170	0.170	0.000	0.370	17.690	2.880	DIL BY LOW SAL INJ
14	9999	5751	99999	10.00	99.99	99.99	99.999	0.130	9.999	9.999	999.999	99.999	
15	3950	3701	5930	7.00	5.00	0.03	1.900	9.999	9.999	9.999	999.999	0.000	N2 LIFT. NO CORRECTIONS FOR STEAM SEP.
16	7600	7703	11700	0.15	3.10	0.04	0.970	0.070	0.004	0.249	999.999	0.347	CORR CTRL
17	7655	7918	11700	0.30	3.20	0.03	0.379	0.290	0.006	2.084	8.786	1.920	
18	8060	8181	12300	0.25	2.90	0.02	1.131	0.160	0.007	0.328	11.100	8.660	
19	10000	10399	15300	0.50	3.60	0.00	5.707	0.470	0.045	0.016	10.600	0.108	
20	1320	1502	2035	0.20	1.03	0.45	2.991	0.150	0.040	0.043	2.154	1.976	
21	4776	4953	99999	6.40	2.50	99.99	0.750	9.999	9.999	9.999	999.999	99.999	
22	431	430	99999	0.40	0.30	99.99	99.999	9.999	9.999	9.999	999.999	99.999	NO FLOW-13.5DEG.C.
23	219	219	99999	0.00	0.20	99.99	99.999	9.999	9.999	9.999	999.999	99.999	80 LPM-13 DEG.C.
24	291	291	99999	0.00	0.20	99.99	99.999	9.999	9.999	9.999	999.999	99.999	60 LPM-18 DEG.C.
25	578	577	99999	0.00	0.30	99.99	99.999	9.999	9.999	9.999	999.999	99.999	4 LPM-16 DEG.C.
26	465	464	99999	0.40	0.30	99.99	99.999	9.999	9.999	9.999	999.999	99.999	200 LPM-19 DEG.C.
27	401	400	99999	0.20	0.70	99.99	99.999	9.999	9.999	9.999	999.999	99.999	NO FLOW-23.5 DEG.C.
28	275	275	99999	0.00	0.20	99.99	99.999	9.999	9.999	9.999	999.999	99.999	40 LPM-10.5DEG.C.
29	197	197	99999	0.00	0.30	99.99	99.999	9.999	9.999	9.999	999.999	99.999	20 LPM-14 DEG.C.
30	402	401	99999	0.00	0.50	99.99	99.999	9.999	9.999	9.999	999.999	99.999	200 LPM-9 DEG.C.
31	410	409	99999	0.30	0.30	99.99	99.999	9.999	9.999	9.999	999.999	99.999	200 LPM-16 DEG.C.
32	251	251	99999	0.00	0.30	99.99	99.999	9.999	9.999	9.999	999.999	99.999	12 LPM-13 DEG.C.
33	376	375	99999	0.00	0.40	99.99	99.999	9.999	9.999	9.999	999.999	99.999	NO FLOW-16 DEG.C.
34	387	386	99999	0.20	0.40	99.99	99.999	9.999	9.999	9.999	999.999	99.999	NO FLOW-11 DEG.C.
35	9999	448	540	0.02	0.21	99.99	0.004	0.178	9.999	0.000	2.000	99.999	15.5 DEG.C.
36	9999	59	65	0.00	0.29	99.99	0.002	0.004	9.999	0.000	0.210	99.999	8 DEG.C.
37	9999	43	56	0.00	0.18	99.99	0.002	0.000	9.999	0.000	0.110	99.999	6 DEG.C.
38	9999	63	73	0.00	0.06	99.99	0.002	0.005	9.999	0.000	0.150	99.999	8.5 DEG.C.
39	9999	257	340	0.01	0.63	99.99	0.004	0.007	9.999	0.000	0.004	99.999	11 DEG.C.
40	9999	100	108	0.00	0.13	99.99	0.002	0.003	9.999	0.000	0.070	99.999	11 DEG.C.
41	9999	99	108	0.00	0.15	99.99	0.002	0.003	9.999	0.004	0.052	99.999	11 DEG.C.

TABLE 2. Analysis in milliequivalents, calculated conductivity, ionic balance, ionic ratios, Cove Fort, Utah

Column headings:

N = sample number for tabulation
CA ... CL, F = concentration in milliequivalents/liter
B = concentration of boron in millimoles/liter
ECOBS = measured conductivity, micromhos/cm at 25°C (laboratory)
ECCAL = calculated conductivity
OBCA = ECOBS/ECCAL
SCAT = sum of cations CA ... K (meq/l)
SAN = sum of anions HCO3 ... CL, F, (meq/l)
SUM = SCAT + SAN
DIF = ((SCAT - SAN)/(SCAT + SAN)) x 100
CAF = CA/SCAT
MGF = MG/SCAT
NKF = (NA + K)/SCAT
HCF = (HCO3 + CO3)/(HCO3 + CO3 + SO4 + CL)
SOF = SO4/(HCO3 + CO3 + SO4 + CL)
CLF = CL/(HCO3 + CO3 + SO4 + CL)
BCL = (B/CL) x 100
I = Ionic strength (calculated using molar concentrations)
NACA = Na/Ca
NAK = Na/K
FCL = (F/Cl)x100

Note: All 9's means no data are available, or insufficient data to permit calculation.
0.0 means below detection limit of analysis

Ax-03-E1

LINE#	N	CA	MG	NA	K	HCO3	CO3	SO4	CL	B	F	NO3
1	1.01	3.19	0.59	43.48	29.62	4.04	1.60	9.99	62.61	0.023	0.263	0.010
2	1.02	1.60	0.39	56.96	14.96	4.36	8.40	11.66	51.33	0.028	0.121	0.013
3	1.03	0.60	0.59	73.92	6.33	10.16	3.60	11.66	59.23	1.203	0.305	0.008
4	1.04	0.40	0.00	115.36	6.32	10.40	0.00	15.82	61.76	0.014	0.263	0.032
5	1.05	3.67	0.83	81.97	6.16	13.40	12.00	19.15	63.46	0.022	0.289	0.021
6	1.06	3.19	0.47	108.49	6.19	17.78	12.00	22.48	66.00	0.019	0.279	0.006
7	1.07	1.32	0.01	150.45	5.76	21.67	0.00	26.65	69.10	0.017	0.247	0.029
8	1.08	0.52	0.00	122.97	5.09	0.02	26.00	31.23	56.41	0.007	0.263	0.039
9	1.09	0.36	0.51	93.66	4.73	12.00	8.00	24.57	54.71	0.028	0.274	0.035
10	1.10	0.60	0.24	97.40	4.99	12.60	8.00	29.15	54.42	0.046	0.274	0.068
11	1.11	0.50	0.41	95.66	5.42	9.88	8.90	22.90	54.15	0.648	9.999	9.999
12	1.12	0.92	0.08	80.88	4.14	10.40	7.20	24.15	45.69	0.046	0.358	0.071
13	1.13	2.00	0.43	42.01	4.64	7.20	8.40	24.15	9.59	0.060	0.347	0.062
14	1.14	3.29	1.07	75.58	7.37	6.75	0.00	18.74	63.18	0.925	9.999	9.999
15	1.15	2.15	0.49	65.23	5.35	1.66	1.83	0.01	44.84	0.648	0.305	0.000
16	2.01	0.28	0.20	110.01	10.82	14.56	2.16	5.66	97.02	0.014	0.163	0.001
17	2.02	9.98	1.18	107.62	11.56	7.88	0.00	14.99	100.12	0.028	0.168	0.000
18	2.03	3.11	0.63	126.00	11.89	4.20	0.00	26.82	96.17	0.023	0.153	0.000
19	2.04	0.72	0.28	173.94	11.33	10.80	18.00	15.82	109.99	0.046	0.189	0.000
20	2.05	3.71	1.58	15.44	1.44	4.00	0.00	3.89	14.16	0.019	0.054	0.007
21	3.01	16.57	9.47	53.05	1.06	3.16	0.00	18.74	58.10	0.592	0.132	9.999
22	4.00	0.60	1.56	1.13	0.07	3.15	0.00	0.75	3.10	0.037	0.016	9.999
23	5.00	0.20	0.82	0.78	0.02	2.36	0.00	0.00	0.56	0.000	0.011	9.999
24	6.00	0.30	1.15	1.00	0.03	2.46	0.00	0.29	1.41	0.000	0.011	9.999
25	7.00	0.70	2.14	1.96	0.01	5.98	0.00	0.27	2.17	0.000	0.016	9.999
26	8.00	0.60	1.73	1.39	0.08	3.15	0.00	0.79	3.38	0.037	0.016	9.999
27	9.00	2.89	1.07	1.83	0.09	2.69	0.00	0.46	1.49	0.019	0.037	9.999
28	10.00	0.25	1.07	0.91	0.03	2.98	0.00	0.00	0.71	0.000	0.011	9.999
29	11.00	0.20	0.66	0.70	0.05	2.08	0.00	0.01	0.54	0.000	0.016	9.999
30	12.00	0.40	1.32	1.70	0.03	3.41	0.20	0.58	1.81	0.000	0.026	9.999
31	13.00	0.50	1.48	1.35	0.04	3.47	0.40	0.81	1.52	0.028	0.016	9.999
32	14.00	0.20	0.82	1.00	0.02	2.62	0.00	0.00	0.48	0.000	0.016	9.999
33	15.00	3.49	1.07	0.87	0.10	2.56	0.00	0.40	1.44	0.000	0.021	9.999
34	16.00	3.49	0.99	0.91	0.13	2.65	0.00	0.67	1.24	0.019	0.021	9.999
35	17.00	3.59	1.32	1.09	0.04	3.98	0.00	0.25	1.30	0.002	0.011	9.999
36	18.00	0.29	0.10	0.19	0.02	0.36	0.00	0.04	0.07	0.000	0.015	9.999
37	19.00	0.24	0.09	0.16	0.01	0.16	0.00	0.04	0.06	0.000	0.009	9.999
38	20.00	0.31	0.13	0.20	0.02	0.36	0.00	0.06	0.10	0.000	0.003	9.999
39	21.00	1.95	0.38	0.96	0.01	2.34	0.00	0.09	0.65	0.001	0.033	9.999
40	22.00	0.55	0.21	0.22	0.02	0.87	0.00	0.04	0.08	0.000	0.007	9.999
41	23.00	0.55	0.21	0.22	0.02	0.85	0.00	0.04	0.08	0.000	0.008	9.999

AX-03-E2

LIN#	ECOBS	ECCAL	OBCA	SCAT	SAN	SUM	DIF	CAF	MGF	NKF	HCF	SOF	CLF	BCL	NAK	I
1	8000	10255	0.780	76.889	78.516	155.41	-1.05	0.042	0.008	0.951	0.072	0.128	0.800	0.04	1.5	0.085
2	3746	9623	0.389	73.919	75.880	149.80	-1.31	0.022	0.005	0.973	0.168	0.154	0.678	0.05	3.8	0.086
3	7846	10234	0.767	81.444	84.959	166.40	-2.11	0.007	0.007	0.965	0.163	0.138	0.700	2.03	11.7	0.091
4	12360	12430	0.994	122.080	88.280	210.36	16.07	0.003	0.000	0.997	0.118	0.180	0.702	0.02	18.3	0.113
5	10094	12514	0.807	92.633	108.317	200.95	-7.80	0.040	0.009	0.951	0.235	0.177	0.588	0.03	13.3	0.118
6	10880	14401	0.756	118.350	118.546	236.90	-0.08	0.027	0.004	0.969	0.252	0.190	0.558	0.03	17.5	0.138
7	14469	16001	0.904	157.535	117.688	275.22	14.48	0.008	0.000	0.992	0.185	0.227	0.589	0.02	26.1	0.152
8	12893	15199	0.848	128.582	113.954	242.54	6.03	0.004	0.000	0.996	0.229	0.275	0.496	0.01	24.2	0.150
9	8000	12104	0.661	98.660	99.586	198.25	-0.47	0.004	0.005	0.991	0.201	0.247	0.551	0.05	19.7	0.116
10	8400	12748	0.659	103.227	105.316	208.54	-1.00	0.006	0.002	0.992	0.204	0.278	0.519	0.08	19.5	0.124
11	99999	12100	9.999	101.997	95.833	197.83	3.12	0.005	0.004	0.991	0.196	0.239	0.565	1.20	17.6	0.115
12	7000	10625	0.659	86.018	87.865	173.88	-1.06	0.011	0.001	0.988	0.201	0.276	0.523	0.10	19.5	0.103
13	5000	6858	0.825	49.158	49.746	98.90	-0.59	0.042	0.009	0.949	0.316	0.489	0.194	0.63	9.0	0.067
14	99999	11122	9.999	91.404	88.664	180.07	1.52	0.037	0.012	0.951	0.076	0.211	0.713	1.46	10.8	0.102
15	5930	7341	0.808	73.211	48.648	121.86	20.16	0.029	0.007	0.964	0.072	0.000	0.928	1.44	12.2	0.063
16	11700	14782	0.792	121.311	119.561	240.87	0.73	0.002	0.002	0.996	0.140	0.047	0.813	0.01	10.2	0.125
17	11700	15720	0.749	130.348	123.157	253.51	2.84	0.077	0.009	0.914	0.064	0.122	0.814	0.03	9.3	0.140
18	12300	16269	0.756	142.438	121.343	263.78	8.00	0.022	0.004	0.974	0.035	0.172	0.794	0.02	10.7	0.144
19	15300	20883	0.736	186.262	154.801	341.06	9.22	0.004	0.001	0.995	0.186	0.102	0.711	0.04	15.4	0.188
20	2035	2662	0.764	22.166	22.111	44.28	0.12	0.167	0.071	0.761	0.181	0.177	0.642	0.13	10.7	0.027
21	99999	9906	9.999	80.152	80.127	160.28	0.02	0.207	0.118	0.675	0.039	0.234	0.726	1.02	50.0	0.103
22	99999	592	9.999	3.364	7.014	10.38	-35.18	0.178	0.465	0.357	0.450	0.107	0.443	1.19	15.8	0.007
23	99999	234	9.999	1.825	2.934	4.76	-23.31	0.109	0.451	0.446	0.807	0.000	0.193	0.00	30.3	0.003
24	99999	356	9.999	2.482	4.170	6.65	-25.39	0.121	0.464	0.415	0.591	0.070	0.339	0.00	32.6	0.004
25	99999	674	9.999	4.801	8.358	13.16	-27.03	0.146	0.445	0.409	0.707	0.032	0.260	0.00	255.0	0.008
26	99999	632	9.999	3.794	7.338	11.13	-31.03	0.158	0.455	0.387	0.430	0.108	0.462	1.09	18.1	0.007
27	99999	568	9.999	5.877	4.677	10.55	11.36	0.492	0.182	0.326	0.579	0.099	0.322	1.24	21.0	0.007
28	99999	289	9.999	2.266	3.616	5.88	-23.08	0.110	0.473	0.417	0.804	0.000	0.196	0.00	32.5	0.004
29	99999	207	9.999	1.602	2.557	4.16	-22.97	0.125	0.411	0.465	0.787	0.002	0.211	0.00	14.3	0.003
30	99999	513	9.999	3.444	6.023	9.47	-27.24	0.116	0.382	0.502	0.602	0.097	0.301	0.00	51.0	0.006
31	99999	525	9.999	3.366	6.225	9.59	-29.81	0.148	0.440	0.412	0.624	0.131	0.245	1.02	35.1	0.006
32	99999	250	9.999	2.043	3.117	5.16	-20.83	0.098	0.403	0.500	0.845	0.000	0.155	0.00	48.9	0.003
33	99999	531	9.999	5.537	4.412	9.95	11.31	0.631	0.193	0.176	0.582	0.090	0.328	0.00	8.3	0.007
34	99999	541	9.999	5.523	4.583	10.11	9.30	0.632	0.179	0.189	0.582	0.146	0.272	1.49	7.0	0.009
35	546	595	0.908	6.039	5.541	11.58	4.31	0.595	0.218	0.187	0.720	0.045	0.235	0.18	25.0	0.008
36	65	54	1.200	0.594	0.486	1.08	10.04	0.487	0.166	0.347	0.766	0.084	0.150	0.00	9.7	0.001
37	56	40	1.404	0.506	0.268	0.77	30.74	0.483	0.179	0.338	0.634	0.137	0.229	0.00	10.9	0.001
38	73	61	1.190	0.659	0.526	1.19	11.20	0.469	0.200	0.331	0.689	0.111	0.199	0.00	8.7	0.001
39	340	324	1.049	3.288	3.113	6.40	2.74	0.592	0.115	0.293	0.761	0.028	0.211	0.19	130.5	0.004
40	109	98	1.104	0.996	1.082	2.08	-0.26	0.551	0.206	0.243	0.873	0.042	0.085	0.00	11.0	0.001
41	108	97	1.115	0.992	0.986	1.98	0.31	0.553	0.207	0.240	0.871	0.043	0.086	0.00	10.6	0.001

TABLE 3. Chemical geothermometers,
Cove Fort, Utah

Column headings:

N = sample number for tabulation
TC = temperature in degrees Centigrade

Silica geothermometers (0-250°C; SiO_2 in ppm)

OTZC = quartz, conductive cooling T°C = (1309/(5.19-log Si02))-273.15
QTZA = quartz, adiabatic cooling T°C = (1522/(5.75-log Si02))-273.15
CHAL = chalcedony, conductive cooling T°C = (1032/(4.69-log Si02))-273.15
AMOR = amorphous silica, conductive cooling T°C = (731/(4.52-log Si02))-273.15

NaKCa geothermometer (4-340°C; Na, K, Ca in moles/liter)

SQ = $(Ca)^{1/2}/Na$
B43 = temperature for B = 4/3
B13 = temperature for B = 1/3
NKC = NaKCa temperature =
B43 for SQ>1 and T°C<100
B13 for SQ<1 or B43>100

$$T°C = \left(\frac{1647}{\log\left(\frac{Na}{K}\right) + B\log(SQ) + 2.24}\right) - 273.15$$

Mg-corrected NaKCa geothermometer

R = (Mg/(Mg+Ca+K)) x 100, units in equivalents/l.
DMG = Mg-correction, T°C, for $1 \leq R \leq 50$ and $NKC \geq 70$°C. If R>50 assume that the underground temperature is relatively cool. If R<1 correction is negligible (Ref. 1).
CMG = Mg-corrected NaKCa temperature T°C = NKC-DMG (for $DMG \geq 0$).

P_{CO_2}-corrected NaKCa geothermometer

PH = sample pH, field measurement if available.
HC03 = HCO_3, meq/l
PC02 = P_{CO_2} at sample temperature, $-\log P_{CO_2}$ = pH -log (HC03)-7.689 $-4.22(10^{-3})T°C - 3.54(10^{-5}(T°C)^2$

PCC = P_{CO_2}-corrected NaKCa temperature.

$$T°C= \left(\frac{1647}{\log\left(\frac{Na}{K}\right) + \frac{4}{3}\log(SQ) + 3.6 + .253\log P_{CO_2}}\right) - 273.15$$

Applicable only to water equilibrated at less than 75°C.

		using Ru SiO_2*												using Rd SiO_2*									
N	TC	QTZC	QTZA	BCR	CHAL	AMOR	SQ	543	B13	MKC	CMG	FCC	NAK	QTZC	CHAL	N	R	DMG	CMG	PH	HCO3	PCO2	FCC
1.01	0	143	137	43	116	22	0.92	425	415	415	404	999	584	190	170	1.01	1.6	11	404	8.52	4.04	0.0006	999
1.02	0	169	159	69	146	46	0.50	469	333	333	317	999	391	174	150	1.02	2.3	16	317	9.54	4.36	0.0001	999
1.03	0	157	149	57	133	35	0.23	395	259	259	195	999	251			1.03	7.9	64	195	8.99	10.16	0.0005	999
1.04	0	219	200	122	205	94	0.12	447	242	242	242	999	211			1.04	0.0	0	242	11.76	10.40	0.0000	999
1.05	0	161	153	61	137	39	0.52	270	231	231	170	999	239			1.05	7.0	53	170	9.36	13.40	0.0003	999
1.06	0	161	153	61	137	39	0.37	294	220	220	194	999	214			1.06	4.0	26	194	9.34	17.78	0.0004	999
1.07	0	173	162	73	151	50	0.17	352	211	211	211	999	183			1.07	0.1	0	211	9.98	21.67	0.0001	999
1.08	0	183	171	84	163	59	0.13	400	222	222	222	999	189			1.08	0.0	0	222	10.02	0.02	0.0000	999
1.09	0	161	153	61	137	39	0.14	410	233	233	168	999	205	190	170	1.09	9.2	65	168	9.14	12.00	0.0004	999
1.10	0	161	153	61	137	39	0.10	370	229	229	207	999	205			1.10	4.1	22	207	9.23	12.60	0.0004	999
1.11	0	9999	9999	9999	9999	9999	0.17	401	237	237	193	999	214			1.11	6.5	45	193	9.16	9.88	0.0004	999
1.12	0	161	153	61	137	39	0.26	323	220	220	220	999	205	175	152	1.12	1.5	-0	220	9.27	10.40	0.0003	999
1.13	0	165	156	66	142	42	0.77	268	248	248	204	999	278	185	164	1.13	6.1	44	204	9.11	7.20	0.0003	999
1.14	0	9999	9999	9999	9999	9999	0.52	296	245	245	176	999	259			1.14	9.0	69	176	7.70	6.75	0.0066	999
1.15	0	179	167	79	158	55	0.50	289	237	237	195	999	247			1.15	6.2	42	195	8.70	1.66	0.0002	999
2.01	0	123	121	25	95	5	0.11	569	298	298	285	999	265	140	112	2.01	1.7	5	285	8.77	14.56	0.0012	999
2.02	0	73	77	-21	41	-38	0.66	282	250	250	213	999	275	169	146	2.02	5.2	37	213	7.38	7.88	0.0160	999
2.03	0	114	113	16	85	-4	0.31	362	258	258	231	999	261	183	163	2.03	4.0	27	231	7.94	4.20	0.0024	999
2.04	0	124	122	26	96	6	0.11	496	257	257	249	999	226	193	174	2.04	2.2	8	249	9.79	10.00	0.0001	999
2.05	0	114	113	16	85	-3	2.79	153	208	208	81	79	260	158	133	2.05	23.5	128	81	7.44	4.00	0.0071	79
3.01	0	133	129	34	105	13	1.72	114	137	137	43	53	139			3.01	35.0	94	43	7.41	3.16	0.0060	53
4.00	0	82	85	-13	51	-31	15.30	55	157	55	999	14	223			4.00	70.0	999	999	7.69	3.15	0.0031	14
5.00	0	67	72	-27	35	-43	12.76	38	120	38	999	7	156			5.00	70.9	999	999	8.10	2.36	0.0009	7
6.00	0	83	87	-12	52	-30	12.23	43	127	43	999	2	167			6.00	77.7	999	999	7.38	2.46	0.0050	2
7.00	0	94	96	-3	63	-21	9.55	4	50	4	999	-31	59			7.00	75.2	999	999	7.52	5.90	0.0087	-31
8.00	0	98	99	1	68	-17	12.44	59	153	59	999	14	212			8.00	71.9	999	999	7.49	3.15	0.0050	14
9.00	0	97	98	0	67	-18	20.83	36	138	36	999	1	200			9.00	26.4	999	999	7.74	2.69	0.0024	1
10.00	0	83	87	-12	52	-30	12.23	44	127	44	999	-3	167			10.00	79.4	999	999	7.00	2.98	0.0142	-3
11.00	0	74	78	-21	42	-38	14.36	60	162	60	999	18	232			11.00	72.6	999	999	7.52	2.00	0.0036	18
12.00	0	81	84	-14	49	-32	8.33	45	114	45	999	1	130			12.00	75.3	999	999	7.32	3.41	0.0080	1
13.00	0	82	85	-13	51	-31	11.72	43	124	43	999	13	162			13.00	73.4	999	999	8.40	3.47	0.0006	13
14.00	0	87	90	-9	56	-26	9.99	40	113	40	999	-2	141			14.00	70.9	999	999	7.20	2.62	0.0067	-2
15.00	0	94	96	-3	63	-21	40.05	32	170	32	999	-1	287			15.00	22.9	999	999	7.90	2.56	0.0016	-1
16.00	0	92	94	-5	61	-23	45.77	30	179	30	999	1	307			16.00	21.4	999	999	7.70	2.65	0.0026	1
17.00	0	82	85	-13	51	-31	38.99	13	122	13	999	-13	186			17.00	26.6	999	999	8.40	3.98	0.0008	-13
18.00	0	65	71	-28	33	-45	64.34	19	157	19	999	-3	270			18.00	24.2	999	999	7.80	0.36	0.0003	-3
19.00	0	62	67	-31	29	-48	70.63	14	150	14	999	-7	258			19.00	25.9	999	999	7.55	0.16	0.0002	-7
20.00	0	65	71	-28	33	-45	63.56	22	163	22	999	-5	282			20.00	28.4	999	999	7.45	0.36	0.0006	-5
21.00	0	65	71	-28	33	-45	32.61	-16	64	-16	999	-42	85			21.00	16.2	999	999	7.55	2.34	0.0032	-42
22.00	0	69	74	-25	37	-42	74.70	12	149	12	999	-14	258			22.00	26.5	999	999	7.75	0.87	0.0008	-14
23.00	0	69	74	-25	37	-42	76.20	12	150	12	999	-14	261			23.00	26.5	999	999	7.75	0.85	0.0007	-14

* see Table AX-03-A. pH-corrections have not be applied.