OFR Sept. 1979
SR-10
GRO 2369

SHALLOW TEMPERATURE GRADIENT HOLE RECORD

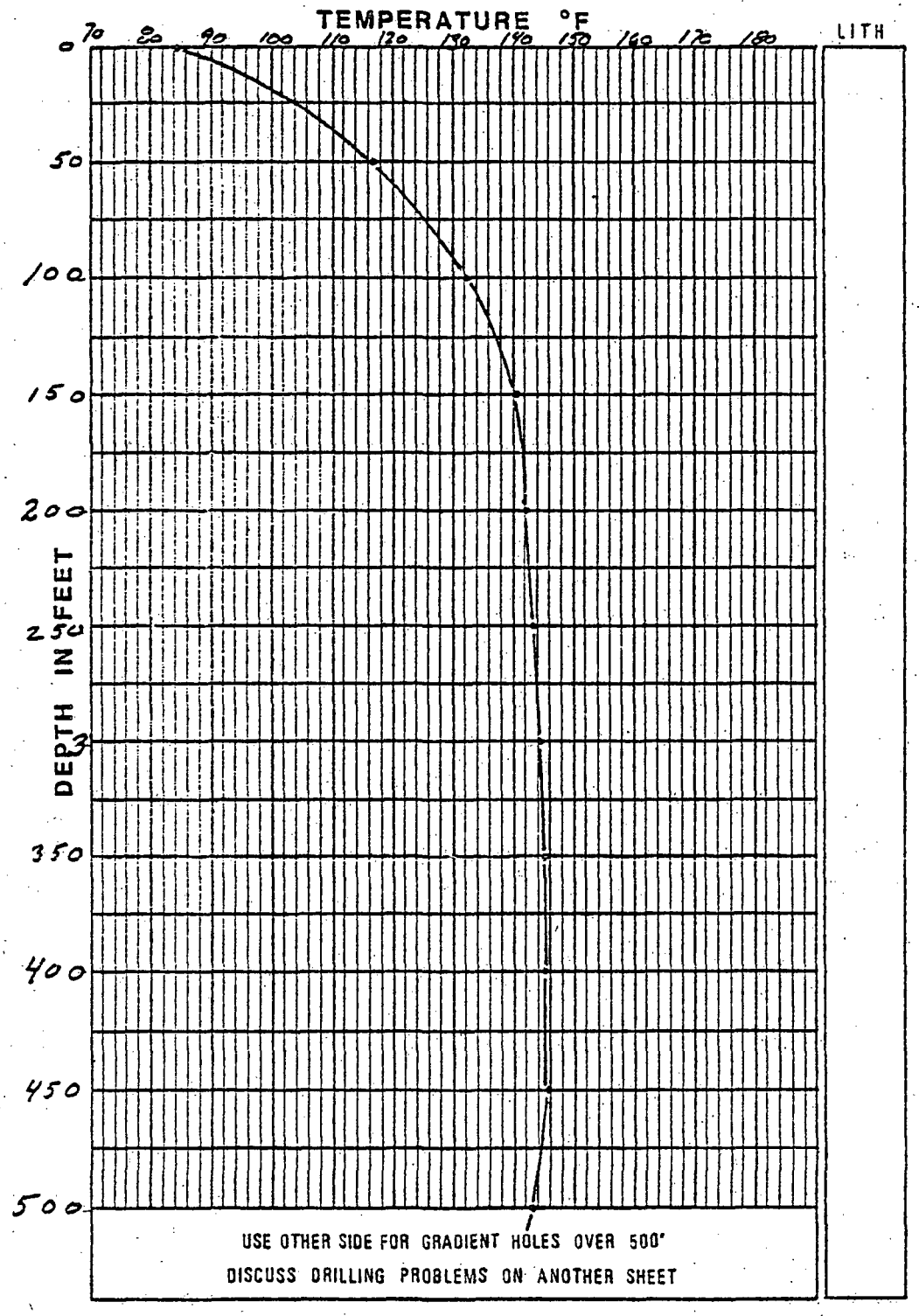
Southland Royalty Company

SR-2 — GRADIENT HOLE NO.
DIXIE VALLEY — PROSPECT

Appx 1300' W + 1300' S. NW. cor. — LOCATION
S 14 T 23 N. R 35 E. — SEC. TOWNSHIP RANGE
CHURCHILL, NEVADA — COUNTY STATE

22 June 1978 — SPUD DATE
15 July 1978 — COMPLETION DATE
143.2° F. — BOTTOM HOLE TEMP.
AT 510 FT. ISOTH. 143° F/100'
GRADIENT 200' TO 500'

523' — TOTAL DEPTH
M. Jadry — GEOLOGIST OR PERSON READING TEMP.
Christiansen Drilling, Ely, Nev. — COMPANY DRILLING HOLES



FOR HOLES 0-500'

TEMP	°C	°F	°F	°F
DATE OF SURVEY				
TIME SINCE COMPLETION				
See OTHER SIDE				

LOST CIRCULATION ZONES:

WATER ENTRIES: 495 to 500'
Water bearing Sand

Prep. by D.S. McKenzie

S-8

GRADIENT HOLE NO.

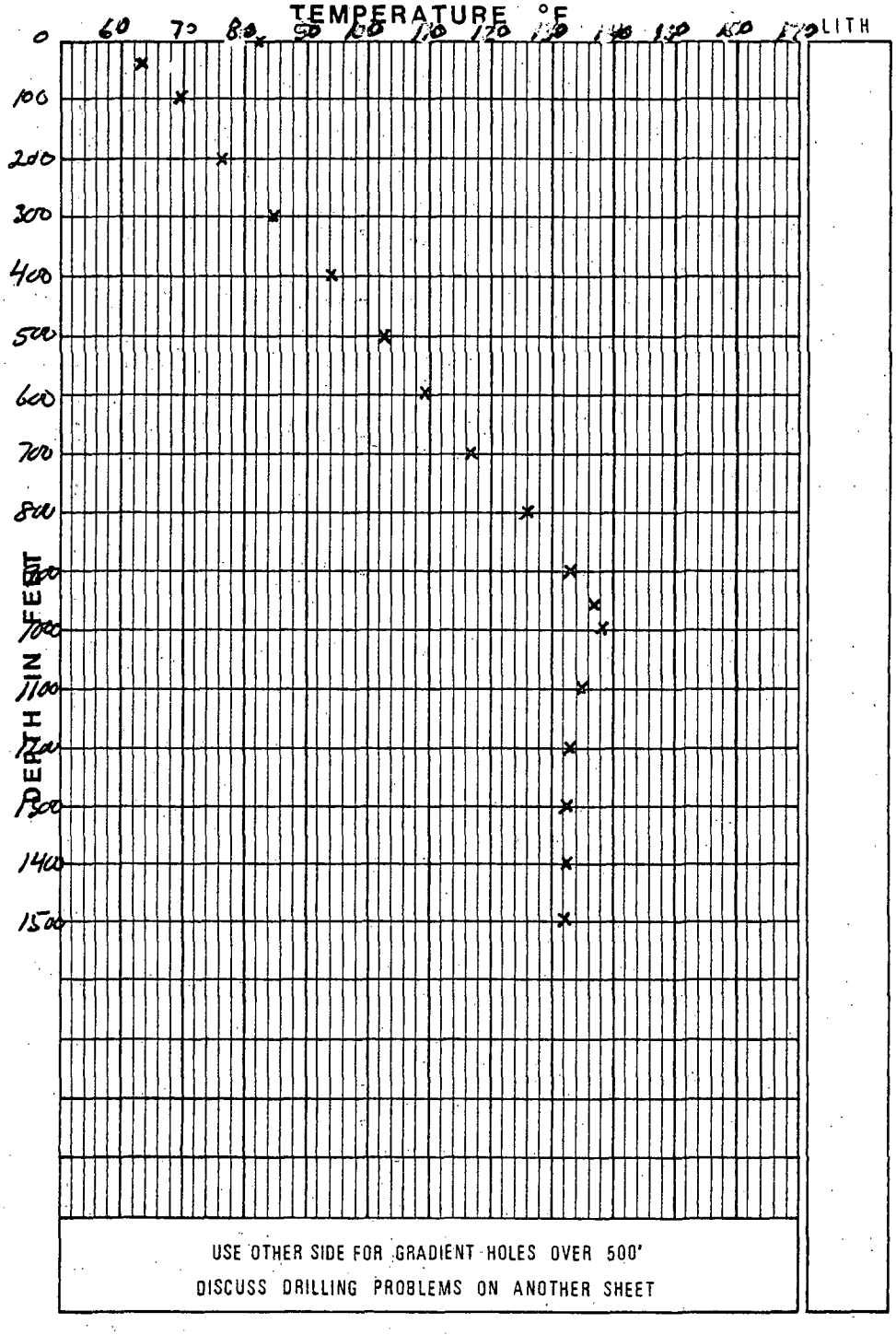
DATE OF SURVEY

DEPTH	°C	°F	DEPTH	°C	°F	DEPTH	°C	°F	DEPTH	°C	°F

SHALLOW TEMPERATURE GRADIENT HOLE RECORD

Southland Royalty Company

SR-4			
GRADIENT HOLE NO.	PROSPECT		
NW/SE	S 22 T 23N	R 38E	Churchill Nevada
LOCATION	SEC. TOWNSHIP	RANGE	COUNTY STATE
06/08/80			AT ____ FT. ____ F/100'
SPUD DATE	COMPLETION DATE	BOTTOM HOLE TEMP.	GRADIENT ____ TO ____
1,500'	Richard L. Jodry		
TOTAL DEPTH	GEOLOGIST OR PERSON READING TEMP.		COMPANY DRILLING HOLES



USE OTHER SIDE FOR GRADIENT HOLES OVER 500'

DISCUSS DRILLING PROBLEMS ON ANOTHER SHEET

FOR HOLES 0-500'

TEMP	°C	°F	°F	°F
DATE OF SURVEY				
TIME SINCE COMPLETION				

LOST CIRCULATION ZONES:

WATER ENTRIES:

SR-4

GRADIENT HOLE NO.

8/7/80

DATE OF SURVEY

DEPTH	°C	°F	DEPTH	°C	°F	DEPTH	°C	°F	DEPTH	°C	°F
0	28.2	82.76	460	37.5	99.5	920	57.5	135.5	1380	55.7	132.26
10	18.2	64.76	70	38.0	100.4	30	58.0	136.4	90	55.7	
20	16.8	62.24	80	38.5	101.3	40	58.4	137.12	1400	55.7	
30	17.1	72.78	90	39.0	102.2	50	58.7	137.66	10	55.7	
40	17.3	63.14	500	39.4	102.92	60	58.9	138.02	20	55.6	132.08
50	17.8	64.04	10	39.8	103.64	70	59.0	138.2	30	55.6	
60	18.5	65.3	20	40.2	104.36	80	59.9	138.38	40	55.6	
70	19.1	66.38	30	40.8	105.44	90	59.0	138.38	50	55.6	
80	19.7	67.46	40	41.1	105.98	1000	59.0	138.38	60	55.6	
90	20.3	68.54	50	41.5	106.7	10	58.9	138.02	70	55.6	
100	20.7	69.26	60	41.9	107.42	20	58.8	137.84	80	55.6	
10	21.0	69.8	70	42.3	108.14	30	58.5	137.3	90	55.5	136.9
20	21.3	70.34	80	42.6	108.68	40	58.2	136.76	1500	55.5	1
30	21.6	70.88	90	42.9	109.22	50	57.9	136.22			
40	22.1	71.78	600	43.2	109.76	60	57.6	135.68			
50	22.4	72.32	10	43.5	110.3	70	57.3	135.14			
60	22.8	73.04	20	43.8	110.84	80	57.0	134.6			
70	23.2	73.76	30	44.1	111.38	90	56.8	134.24			
80	23.7	74.66	40	44.4	111.92	1100	56.6	133.88			
90	24.1	75.38	50	45.0	113.0	10	56.4	133.52			
200	24.6	76.28	60	45.8	114.44	20	56.2	133.16			
10	25.1	77.18	70	46.1	114.98	30	56.2	133.16			
20	25.6	78.08	80	46.4	115.52	40	56.3	133.34			
30	26.1	78.98	90	46.9	116.42	50	56.3	133.34			
40	26.6	79.88	700	47.4	117.32	60	56.3	133.34			
50	27.1	80.78	10	47.9	118.22	70	56.2	133.16			
60	27.6	81.68	20	48.4	119.12	80	56.1	132.98			
70	28.1	82.58	30	48.9	120.02	90	56.1	132.98			
80	28.6	83.48	40	49.4	120.92	1200	56.0	132.98			
90	29.0	84.2	50	49.9	121.82	10	56.0	132.98			
300	29.4	84.92	60	50.4	122.72	20	55.9	132.62			
10	29.8	85.64	70	50.9	123.62	30	55.9	132.62			
20	30.2	86.36	80	51.4	124.52	40	55.9	132.62			
30	30.6	87.08	90	51.9	125.42	50	55.9				
40	31.1	87.98	800	52.4	126.32	60	55.9				
50	31.6	88.88	10	52.9	127.22	70	55.9				
60	32.1	89.78	20	53.3	127.94	80	55.8	132.44			
70	32.8	91.04	30	53.7	128.66	90	55.8				
80	33.3	91.94	40	54.1	129.38	1300	55.8				
90	33.9	93.02	50	54.5	130.1	10	55.8				
400	34.5	94.1	60	54.9	130.82	20	55.8				
10	35.0	95.0	70	55.3	131.54	30	55.8				
20	35.5	95.9	80	55.7	132.26	40	55.8				
30	36.0	96.8	90	56.1	132.98	50	55.7	132.26			
40	36.5	97.7	900	56.5	133.7	60	55.7				
50	37.0	98.6	10	57.0	134.6	70	55.7				

WHITE—DIVISION OF WATER RESOURCES
CANARY—CLIENT'S COPY
PINK—WELL DRILLER'S COPY

STATE OF NEVADA
DIVISION OF WATER RESOUR(

OFFICE USE ONLY
Log No.
Permit No.
Basin

WELL DRILLERS REPORT

Please complete this form in its entirety

1. OWNER Southland Royalty Company ADDRESS 1600 First National Bank Building Fort Worth, Texas 76102

2. LOCATION NW ¼ SE ¼ Sec. 22 T. 23 N/S R. 38 E. Churchill County
PERMIT NO. Thermal Gradient Hole No. SR-4

3. TYPE OF WORK				4. PROPOSED USE				5. TYPE WELL	
New Well	☒	Recondition	☐	Domestic	☐	Irrigation	☐	Test ☒	Cable ☐ Rotary ☒
Deepen	☐	Other	☐	Municipal	☐	Industrial	☐	Stock ☐	Other ☐

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
Top Soil		0	2	2
Rhyolite		2	310	308
Fault Gouge		310	330	20
Granite		330	340	10
Rhyolite		340	390	50
Granite		390	420	30
Rhyolite		420	530	110
Granite		530	650	120
Sandstone		650	660	10
Fault Gouge		660	670	10
Rhyolite		670	930	260
Shale		930	940	10
Rhyolite		940	1150	210
Shale		1150	1160	10
Rhyolite		1160	1180	20
Fault Gouge		1180	1190	10
Shale		1190	1210	20
Rhyolite		1210	1240	30
Shale		1240	1280	40
Granite		1280	1290	10
Shale		1290	1470	180
Rhyolite		1470	1500	30

Date started June 8, 19 80
Date completed June 27, 19 80

7. WELL TEST DATA

Pump RPM	G.P.M.	Draw Down	After Hours Pump

BAILER TEST
G.P.M. ..... Draw down ..... feet ..... hours
G.P.M. ..... Draw down ..... feet ..... hours
G.P.M. ..... Draw down ..... feet ..... hours

8. WELL CONSTRUCTION

Diameter hole 9-7/8 inches Total depth 1,500 feet
Casing record 7-5/8" 0 - 151 Ft.
Weight per foot 20 Lbs. Thickness
Tubing 1" 0 - 1,503 Ft.

Diameter		From		To	
6-1/4	inches	160	feet	1,260	feet
6-1/8	inches	1,260	feet	1,500	feet
	inches		feet		feet
	inches		feet		feet
	inches		feet		feet
	inches		feet		feet

Surface seal: Yes ☒ No ☐ Type Cement
Depth of seal 1" Tubing Cemented 32 feet
~~Gravel packed~~ Backfill: Yes ☒ No ☐
~~Gravel packed~~ Backfill from 1,500 feet to 1,468 feet

Perforations: None
Type perforation
Size perforation
From ..... feet to ..... feet
From ..... feet to ..... feet
From ..... feet to ..... feet
From ..... feet to ..... feet
From ..... feet to ..... feet

9. WATER LEVEL

No Water
Static water level 0 Feet below land surface 0
Flow ..... G.P.M.
Water temperature ..... ° F. Quality

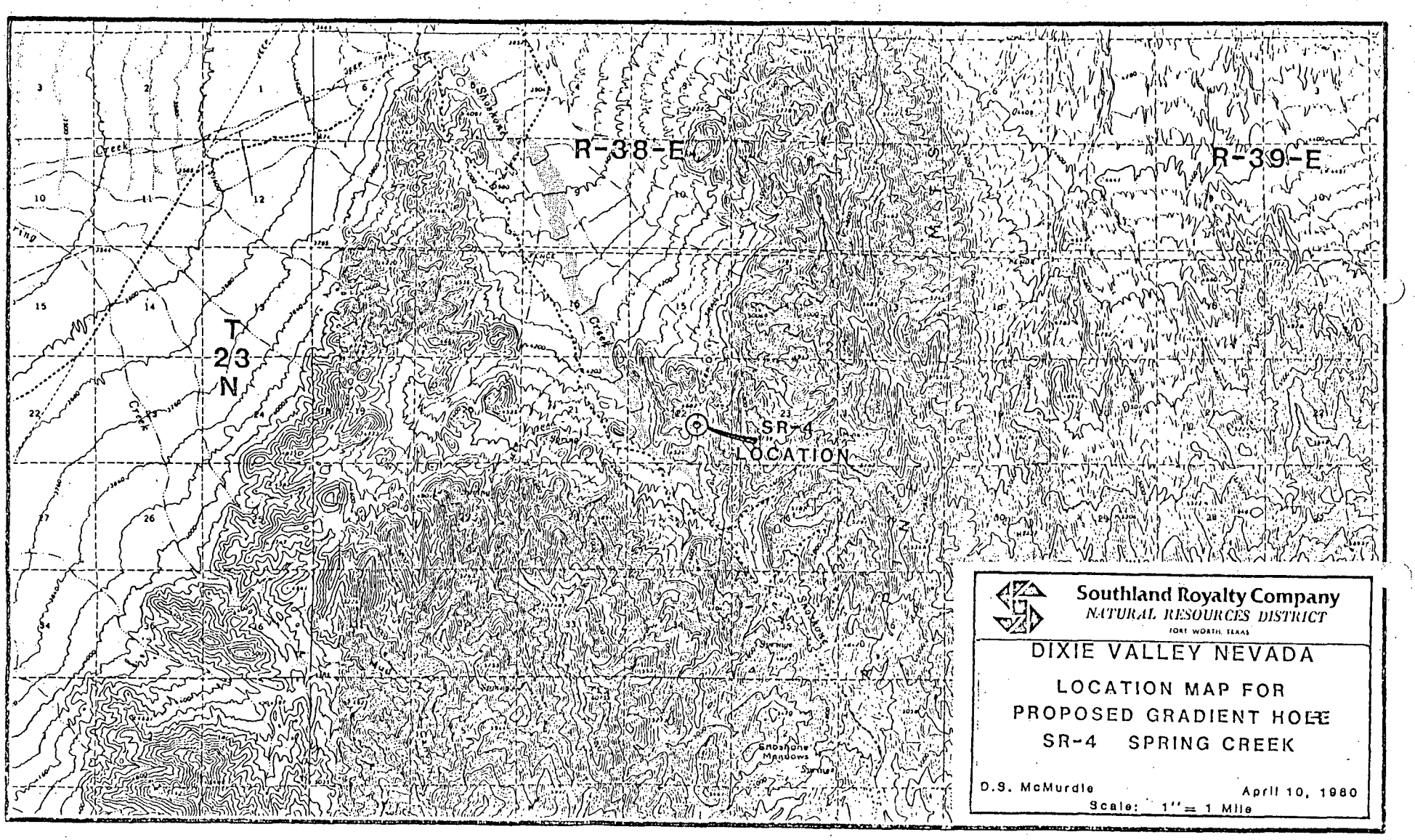
10. DRILLERS CERTIFICATION

This well was drilled under my supervision and the report is true to the best of my knowledge.

Name Jerrold D. Christiansen
Address 557 Ely Ave., Ely, Nevada 89301
Nevada contractor's license number 14790
Nevada driller's license number 641
Signed Jerrold D. Christiansen
Date July 5, 1980

USE ADDITIONAL SHEETS IF NECESSARY

O-627



Southland Royalty Company
NATURAL RESOURCES DISTRICT
FORT WORTH, TEXAS

DIXIE VALLEY NEVADA

LOCATION MAP FOR
PROPOSED GRADIENT HOLE
SR-4 SPRING CREEK

D.S. McMurdie — April 10, 1980

Scale: 1" = 1 Mile

SUMMARY OF LITHOLOGIES AND ALTERATION IN SR-4 DIXIE VALLEY, CHURCHILL COUNTY, NEVADA

M. J. Sweeney, September 1980

INTRODUCTION

Samples of washed, rotary cuttings taken every ten feet from drill-hole SR-4 were examined under a stereomicroscope. A thin-section of the cuttings was described from every 100 feet throughout the 1500 foot length of SR-4. Detailed descriptions of the cuttings and thin-sections are attached to this report. Photomicrographs of the thin-sections are also attached. X-ray diffraction patterns of two tuff samples are enclosed.

LITHOLOGIES

SR-4 intersects 900 feet of rhyolitic, vitric-crystal-lithic tuffs and 600 feet of carbonate rocks, limestones and dolomites, which are interbedded with narrow intervals of calcareous siltstones and sandstones. The tuffs overly the carbonate rocks.

Rhyolitic tuffs: The tuffs were originally composed largely of volcanic glass which was deposited as vitric shards, dust and pumice fragments. Shards and dust occurring in about subequal amounts usually comprise 75 to 85% of the tuffs and pumice fragments 5 to 15%. Devitrification of the volcanic glass is variably developed throughout this volcanic section.

Crystal clasts of sanidine, plagioclase and biotite occur throughout the tuff section. The abundances of the crystal clasts are variable; biotite is very rare in some intervals. Sanidine clasts usually comprise 5 to 7% of the tuff, plagioclases 1 to 5% and biotites 0 to 3%. Quartz crystal clasts were seen only in the samples at the bottom of the volcanic section. The feldspar crystal clasts usually range between 0.5 and 2 mm in length. They were originally subhedral to euhedral in shape, but most have been broken prior to deposition. The biotites, 0.2 to 1 mm across, exhibit very dark brown pleochroism, suggesting that they are very Fe-rich. Magnetite is locally exsolved from biotite.

Lithic clasts comprise 5 to 20% of the tuff; their abundance is variable throughout this section. Clasts of andesites, basalts, latites, quartzite and carbonate were seen; the first three types are the most ubiquitous. The lithic clasts observed are less than 10 mm in diameter.

The entire 900' section of this volcanic unit is very similar. Primary mineralogy and textures were virtually identical. One of the major variations seen in the tuff now is hardness. Most of the tuff is relatively soft and also gritty to the touch. However, between the depths of 520' and 640' the tuff is hard, exhibits a vitreous luster and fractures conchoidally. Examination of the thin-section at 590'-600' shows that the vitric components have been well compacted and welded. Devitrification to Kspar and quartz is complete. This well welded interval may be the base of a thick ignimbrite unit. Other intervals in the tuff have also been well devitrified, but no other intervals appear to have been as intensely compacted as the interval between 520 and 640 feet.

Dolomites, Limestones, Sandstones, Siltstones: Beneath the tuffs, SR-4 intersected dolomites, limestones (both of which are locally cherty), and calcareous sandstones and siltstones.

Cherty dolomites occur in the first 150 feet below the tuffs. Limestones occur in the next 60 feet, calcareous siltstones and sandstones in the next 110 feet, and then silty, locally cherty or argillaceous, limestones occur in the lowermost 280 feet of the drill hole.

The dolomites and limestones are dominantly fine-grained; they are micritic. Fossils were seen rarely.

The siltstones and sandstones are well sorted; the calcite in them is of detrital origin.

ALTERATION

Rhyolitic tuffs: Hydrothermal alteration in the tuffs is seen mainly in the glass and in the mafic minerals in the lithic clasts. Only rarely have crystal clasts suffered any alteration.

The volcanic glass has been replaced most commonly by clays and lesser calcite. Local occurrences of jarosite (90'-100'), gypsum (40'-50', 90'-100') and manganese-oxides (10'-20', 180'-240') were observed. Trace amounts of hematite and goethite occur throughout the tuff. These limonites replace disseminated and vein magnetite and sulfides; it was not often possible to determine which of these was the precursor of the limonites. Trace amounts of zeolites may occur in vugs in the upper portion of the tuff.

The extent and type of clay replacement is highly variable. Replacement may range between 5 and 100%. The most intensely clay-altered intervals are easily identified by observing the degree of rock disaggregation during washing; easily disaggregated rocks are intensely clay-replaced. The clay types present appear to be variable. X-ray diffraction analysis of clays in the sample at 590'-600' gives a strong 12.6A^{o} peak possibly indicative of the presence of a mixed layer clay or possibly of hydrobasaluminite. X-ray analysis of sample 930'-940' indicates that the abundant white clay is montmorillonite; this rock disaggregates completely on wetting.

The present color of the tuffs is controlled by the type and distribution of limonites and/or clays present. Red, pink and orange colored tuffs are the result of limonite staining. Bright green tuffs contain a bright kelly-green clay mineral, probably celadonite.

In the interval between 860' and 900', the tuff has been brecciated. The spaces among the fragments have been filled with microcrystalline quartz, celadonite (?) and calcite.

Only rarely was fresh pyrite seen in the tuffs (at 520' to 530').

Slickensided chips derived from fault zones are sporadically present throughout the tuff; the gouge chips are usually white and weakly stained with hematite.

Dolomites, Limestones, Sandstones, Siltstones: Evidence of hydrothermal alteration in the carbonates and sandstones is largely confined to veins. Thin calcite veins, less than 1-2 mm wide, with and without pyrite occur throughout this interval. Pyrite also is disseminated in these rocks; it usually occurs as very fine-grained crystals forming less than 0.2% of the rock. This disseminated pyrite may be syngenetic in origin. Traces of magnetite also occur as disseminations. Total pyrite content throughout the carbonate-siltstone interval never exceeds 0.3 volume % and is usually less.

Evidence of faulting occurs throughout the carbonate-siltstone interval. Slickensided chips are present in nearly every sample of every rock type. Weak hematite stains are present on these slickensided surfaces.

THIN-SECTION DESCRIPTIONS

OF SR-4 SAMPLES

SR-4 90'-100' Devitrified Vitric-Crystal Tuff

This tuff contains sanidine crystal clasts, 0.3 to 1 mm long, most of which are angular, broken fragments; they form 5-7% of rock. These sanidines are totally unaltered. A few phenocrysts of albite-twinned plagioclase are present, 1-2%; they are unaltered. The groundmass is composed of devitrified glass shards; the shard outlines are preserved by axiolitic devitrification structures. Spherulitic devitrification structures occur occasionally. Traces of zeolite minerals may be present in some vugs.

Jarosite occurs in this tuff; it pseudomorphically replaces individual shards and occurs in irregular blebs disseminated throughout rock. Jarosite chips as large as 0.5 mm across are present. There is no evidence as to the origin of the jarosite; it does not occur in pyrite-like pseudormorphs. Jarosite also lines vugs.

Traces of hematite occur as disseminations (after magnetite). A few, free chips of gypsum occur in the section.

PRIMARY MINERALS:		
Quartz	10-30%	Anhedral to subhedral; occurs only in groundmass. Grain size 0.01 mm or less.
Sanidine	5-7%	Crystal clasts: 0.2 to 1 mm long; unaltered.
	50-70%	Groundmass: anhedral to subhedral; grain size 0.01 mm or less.
Plagioclase	1-2%	Crystal clasts: 0.2 to 1 mm long; unaltered; albite-twinned.

SECONDARY MINERALS:		
Jarosite	3-5%	Pseudomorphically replaces vitric shards and biotites?; also in irregular blebs disseminated throughout tuff. Very fine-grained crystals, 0.005 mm or less.
Gypsum	tr	Free crystals in sample.
Zeolites??	1-5%	In vugs; minerals with birefringence up to first-order red occur in vugs. Colorless; lath shaped.
Hematite	tr	Disseminated.

SR-4 190'-200' Devitrified Vitric-Crystal Tuff

This tuff originally was composed largely of vitric shards; it also contains crystal clasts of: sanidine, 0.3-0.6 mm, 5-7%; plagioclase, 0.3-1 mm long, albite-twinned (An_{30-40}), 2-3%; and of biotite, 0.3-1 mm, very dark brown pleochroism, 1-3%. The phenocrysts (crystal clasts) are unaltered. The glass shards have devitrified to quartz, Kspar and clays. Irregular aggregates of Mn-oxides are distributed throughout rock; they form 2-3% of rock.

PRIMARY MINERALS:		
Quartz	10-35%	Anhedral to subhedral; occurs in groundmass intergrown with Kspar.
Kspar	5-7%	Sanidine crystal clasts: angular, crystal fragments.
	50-70%	Groundmass: anhedral to subhedral; grain size less than 0.01 mm.

Plagioclase	2-3%	Crystal clasts: unaltered.
Biotite	1-3%	Crystal clasts: very dark brown pleochroism.

SECONDARY MINERALS:

Clay	5-20%	Very fine-grained; occurs in matrix.
Mn oxides	2-3%	Black reflecting; brown streak, disseminated throughout tuff in clots up to 0.1 mm across.

SR-4 290'-300' Vitric-Crystal Tuff

This tuff is composed of: glass shards and even finer-grained, glass dust both of which form 80% of rock; glassy pumice fragments, 0.5 to 4 mm, 10% of rock; crystal clasts of sanidine, 0.1-0.5 mm, 5-7% of rock; crystal clasts of plagioclase, 0.1-0.5 mm, 1-2%; and crystal clasts of very dark brown biotite, 0.1-1.5 mm across, 2-4%. A very few, tiny lithic fragments of very fine-grained basalt are also present. Magnetite is disseminated throughout rock; magnetite replaces some of the biotite phenocrysts.

The glass particles have been less than 50% devitrified. Devitrification of pumice fragments is more advanced than that of vitric shards and ash. Spherulitic devitrification structures occur most commonly in pumice fragments. Devitrification products include Kspar, quartz and clay.

Calcite occurs in narrow veins (less than 0.1 mm wide); it also replaces feldspar phenocrysts, pumice fragments and vitric shards. Traces of celadonite (bright green) are disseminated throughout rock.

PRIMARY MINERALS:

Quartz	10-20%	Groundmass: devitrification product of glass. Very fine-grained.
Kspar	5-7%	Crystal clasts.
	10-20%	Groundmass: devitrification product of glass. Very fine-grained.
Plagioclase	1-2%	Crystal clasts: 0.2-1 mm long; 10-90% (average 15% replaced by calcite).
Biotite	2-4%	Crystal clasts: very dark brown; 0.1-1 mm across; locally, partially replaced by magnetite.
Magnetite	0.5-1%	Disseminated; also common in biotite sites.
Glass	30-40%	Vitric shards, ash, pumice fragments.

SECONDARY MINERALS:

Celadonite	tr-1%	Bright green; disseminated throughout groundmass.
Calcite	3%	Vein and disseminated.
Clay	5-20%	Alteration product of vitric clasts.

SR-4 390'-400' Vitric-Lithic-Crystal Tuff

This tuff is composed mostly of glass which includes shards, pumice fragments and very fine-grained vitric dust; glass forms 65 to 75% of the tuff. The fine dust has been altered to illite/sericite. Most of the shards and pumice fragments are unaltered. Crystal clasts of sanidine are present; they are

completely unaltered and form 7-10% of rock. Crystal clasts of unaltered plagioclase comprise 1-2% of rock. Crystal clasts of biotite constitute 2-4% of the tuff; the biotite exhibits dark brown pleochroism and is not altered.

Lithic fragments of andesite, basalt(?), quartzite(?), latite and carbonate occur; they are listed in order of abundance. The lithic fragments form about 10-20% of the tuff; most of these fragments are less than 5 mm across. The plagioclases, both phenocrysts and groundmass laths, are unaltered in these fragments. Original mafic minerals, excepting biotite phenocrysts, have been replaced by Fe-oxides and clays (montmorillonite?); biotite phenocrysts are unaltered. Primary magnetite is disseminated throughout the lithic fragments; it forms 0.5-1% of the fragments.

In one latite fragment, the feldspar phenocrysts have been replaced by epidote.

SECONDARY MINERALS:

Illite/sericite	10-30%	Alteration product of glass dust.
Montmorillonite?	5-7%	Alteration product of pyroxenes/hornblendes.
Fe-oxides (goethite/ hematite)	1%	Alteration product of pyroxenes/hornblendes.

SR-4 490'-500' Clay-altered Vitric-Crystal-Lithic Tuff

The tuff contains crystal clasts of sanidine which occur as either broken crystal fragments or euhedral, Carlsbad-twinned crystals up to 3 mm in length; they form 5 to 7% of rock. These sanidines are completely unaltered. Biotite crystals are rare, forming less than 0.5% of the rock. Plagioclase crystal clasts, up to 4 mm in length, form less than 1% of the tuff; they are completely unaltered. Lithic fragments of other tuffs and andesites are usually less than 2 mm across; they form about 3% of the tuff.

The groundmass or matrix of this tuff was originally composed of vitric shards and dust. The original glass is now composed mostly of fine-grained quartz and Kspar; locally devitrified shards exhibit axiolitic structures. Original vitric dust is locally replaced by fine-grained clays, celadonite?(green) and illite(colorless). Celadonite also occurs in aggregates filling gas bubbles and possibly replacing primary biotites. Minor amounts of carbonate are irregularly distributed throughout groundmass.

SECONDARY MINERALS:

Illite(?)	10-30%	Replaces glass in matrix.
Celadonite	5%	Occurs in groundmass; also fills vugs and may replace biotite phenocrysts.
Carbonate	1-3%	Occurs in irregular patches throughout groundmass.

SR-4 590'-600' Devitrified Welded Vitric-Crystal-Lithic Tuff

This tuff contains crystal clasts of: sanidine, 0.2-2mm long, 3 to 5% of rock; plagioclase, 0.2 to 1 mm long, 1-2% of rock; and of biotite, 0.1-0.5 mm across, 0.5-1% of rock, exhibits very dark brown pleochroism. None of these crystal clasts have suffered any alteration.

The groundmass was once composed of flattened pumic fragments, vitric shards

and dust. The glass has been devitrified to fine-grained, anhedral quartz, feldspar and very fine-grained disseminated magnetite. Clay also (celadonite? =green; montmorillonite?=orange) occurs in the groundmass; clay spottily replaces 10 to 40% (average 20%) of groundmass.

SECONDARY MINERALS:

Celadonite	7-10%	Alteration product of glass; bright kelly green.
Montmorillonite?	7-10%	Alteration product of glass; dirty orange.
Pyrite	0.1%	Vein and disseminated. Occurs in a vein in an intensely clay-replaced chip.

SR-4 690'-700' Vitric-Lithic-Crystal Tuff

This tuff is composed dominantly of vitric shards and dust. The dust has been partially devitrified to clay(sericite) and to very fine-grained orthoclase and quartz. It also contains crystal clasts of: sanidine, up to 2 mm long, 3 to 5% of rock; plagioclase, up to 2 mm long--these plagioclase crystals are strongly zoned, they form 5 to 7% of rock; and of biotites which exhibit very dark brown pleochroism--they form 1-2% of rock. None of the crystal clasts has suffered any alteration.

Lithic clasts, fine-grained andesites/basalts?, are usually less than 2 mm in diameter. Such clasts form 5-10% of the tuff. The feldspars are unaltered; mafic minerals have been replaced by clays (montmorillonite?, illite?) and Fe-oxides (goethite, hematite).

SECONDARY MINERALS

Sericite/clay	5-20%	Replaces glass dust; also replaces mafic minerals in lithic clasts.
Goethite/hematite	0.5-1%	Alteration product of mafic minerals; some primary magnetite is partially oxidized.
Carbonate	2-5%	Locally floods rock--replaces all components.

SR-4 790'-800' Devitrified Welded Vitric-Crystal Tuff

This rock was formed as a welded vitric-crystal tuff. The glass has been completely devitrified. Spherulites, usually about 0.5 mm across, are common devitrification structures. Axiolitic structures developed in shards are also common.

Crystal clasts of sanidine form 3-5% of rock; they are unaltered. Clasts of plagioclase(?) formed 1-3% of rock; they have been replaced by celadonite and illite. Biotites have also been replaced by celadonite. Primary magnetite is disseminated in trace amounts. A weak stain of hematite/goethite is disseminated throughout many chips.

Lithic clasts of latite/andesite form less than 50% of sample.

This tuff has been subjected to cataclasis or brecciation prior to devitrification. The breccia fragments are 0.1 to 2 mm across. The spaces among the fragments have been filled with microcrystalline quartz, celadonite and calcite.

SECONDARY MINERALS:

Sericite	2-5%	Replaces plagioclase clasts.
Celadonite	3-5%	Replaces mafic minerals; fills vugs; occurs with chert in interbreccia spaces.
Quartz	1-10%	Fills spaces among breccia clasts; microcrystalline or cherty.
Calcite	1-2%	Occurs in interbreccia spaces; occurs in post-brecciation fractures.
Hematite/goethite	1-2%	Stains rock.

SR-4 890'-900' Devitrified Crystal-Vitric Tuff

This is the first tuff sample from this drill hole to contain quartz crystal clasts. Several of those present are rounded and embayed by resorbtion. The quartz clasts are usually about 1 mm in diameter; they comprise about 5% of the tuff. Crystal clasts of sanidine form about 10% of rock; those of plagioclase about 1%. Biotite phenocrysts occur in trace amounts. None of these phenocrysts have suffered any alteration.

The groundmass once composed of vitric shards and dust is now composed mostly of anhedral quartz and Kspar; spherulites occur occasionally. Clay alteration (sericite/illite) of groundmass is weak to moderate. Trace amounts of magnetite are disseminated throughout groundmass.

Calcite and rarely microcrystalline quartz occur as fracture fillings.

Lithic fragments of andesites/basalts form less than 5% of this rock.

SECONDARY MINERALS:

Sericite/clay	10-25%	Very fine-grained material occurs in groundmass.
Calcite	3-7%	Vein and disseminated.
Quartz	1-3%	Microcrystalline; occurs in fracture fillings with calcite.

SR-4 990'-1000' Carbonates (limestones/dolomites), Cherts and Devitrified Welded Tuffs

This thin-section contains chips of fine- to medium-grained, recrystallized carbonates; these chips form 50-60% of the section. A few of these chips contain disseminated chert. Pyrite fills fractures in a few of the carbonate chips.

The next most abundant rock type is chert; most of these chips are carbonate-free. Chert comprises 30-40% of rock chips in this thin-section.

Quartz "eye" tuff constitutes 5-10% of the chips. The matrix and plagioclase phenocrysts are weakly clay (illite)-altered.

SECONDARY MINERALS:

Pyrite	tr	Fills or coats fractures in carbonate rocks.
Illite	2-5%	Alteration product of tuff.

SR-4 1090'-1100' Limestones, Sandy Limestones and Cherty Limestones

This sample contains pure limestones, sandy limestones and cherty limestones.

About 30% of the chips are composed of pure carbonate, mostly calcite judging by how reactive the rock is to cold, dilute HCL. The calcite is mostly very fine-grained (micritic). A few chips contain relict fossil structures (bryozoans?, shell fish). A small proportion of these chips have been recrystallized to medium-grained marbles.

About 50% of the limestone chips contain 10-15% silt and fine-sand sized quartz. Disseminated pyrite occurs most commonly in these chips; pyrite occurs in trace amounts up to 0.5 volume %.

About 15% of the limestone chips contain chert which occurs as microcrystalline quartz or fibrous chalcedony. Chert occurs in limestones with and without sand. Pyrite also occurs in cherty limestones.

Thin calcite veins occur in all of the above described chips.

SECONDARY MINERALS:

Pyrite	0.5%	Vein and disseminated.
Calcite	2-3%	Vein.

SR-4 1190'-1200' Calcareous Siltstone

This rock is composed largely of angular, detrital quartz grains which average 0.04 mm in size. Quartz comprises about 50% of the rock. Silt-sized orthoclase grains form about 5% of the rock. The remainder of the rock is composed of calcite. This calcite is also fine-grained; it is disseminated throughout the sandstone. The calcite is usually orange or brown in color, presumably from exsolved iron. Locally illite is common as a matrix for quartz grains; it may form 5-15% of rock.

Thin calcite and calcite-quartz veins crosscut the sandstone. Vein calcite is colorless. Euhedral cubes of hematite-replaced pyrite (or magnetite) up to 0.1 mm across are disseminated through the sandstone.

SECONDARY MINERALS:

Pyrite	tr	
Calcite	1-2%	In veins by itself and with quartz.
Quartz	1-2%	In veins with calcite.

SR-4 1290'-1300' Silty Limestones, Argillaceous Calcareous Siltstones and Limestones

Silty limestone is the most common rock type in this sample. Angular, silt-sized, quartz grains comprise 5 to 30% of these limestones. Most of the calcite in these chips is colorless in thin-section; however, orange or brown-stained calcite constitutes up to 30% of some rock chips.

The argillaceous rocks contain 10 to 40% clays (illite? and kaolinite?). Silt and fine-grained calcite, present in subequal amounts, are the other constituents of the clayey rocks; such chips comprise about 25% of this sample.

A few pure calcite chips are present. The calcite in these chips is mostly very fine-grained (micritic) and colorless.

Traces of pyrite, both fresh and oxidized, occur in silty limestones and argillaceous siltstones. Pyrite occurs in veins and as disseminations.

SECONDARY MINERALS:
Pyrite/hematite 0.1-0.2% Vein and disseminated.

SR-4 1390'-1400' Silty Limestones

These rocks are composed dominantly of very fine-grained calcite. Angular, detrital, silt-sized grains of quartz and feldspar form 5 to 20% of these limestones. Clay (illite, kaolinite) can comprise near 15% of the limestone; usually clay are present in small amounts.

Trace amounts of magnetite are disseminated throughout the limestones. Pyrite occurs in trace amounts in calcite veins.

SECONDARY MINERALS:

Calcite	1-2%	Occurs in veins.
Pyrite	tr	Occurs in veins with calcite.

SR-4 1490'-1500' Limestones

The rocks in this sample are micritic limestones which contain 2 to 20% silt. Clay comprises 5 to 25% (average 10% or less) of these limestones.

Thin calcite veins, some with goethite (after pyrite?), occur. Traces of very fine-grained pyrite and magnetite are disseminated throughout these limestones; these disseminated minerals are probably syngenetic.

SECONDARY MINERALS:

Calcite	2-3%	Veins, sometimes with goethite (after pyrite?).
Pyrite/goethite	0.2%	Vein and disseminated; the disseminated pyrite may be of syngenetic origin.

WELL: SR-4 **GEOLOGICAL REPORT** PAGE: 1 of 10

LOCATION: Dixie Valley, Churchill Co., Nevada WELL CUTTINGS SAMPLE DESCRIPTION DATE: September 1980

ELEVATION: DEPTH: 0 TO 150'

HOLE SIZE: EXAMINED BY: M. J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
0 10	Mottled pale green and pale orange-pink	Tuff: Rock contains crystal clasts of sanidine and biotite; they range between 1 and 3mm in size. Feldspars form 5 to 10 volume % of rock; biotites 1-3%. The groundmass is soft and gritty to the touch. Dark green spots (0.2-1mm across) are possibly concentrations of celadonite which locally replaces phenocrysts.	Rare veins, 1-2mm wide, contain a soft, pink mineral -- a zeolite? Goethite occurs in 1 2mm wide veins; it also occurs as disseminations (after mafics)
10 20	Pale pink, pale green	Tuff: Very similar to above sample. Less celadonite occurs, therefore less green.	Manganese oxides coat some fractures -- this black material is very fine-grained. It has a brown streak. Traces of goethite/hematite as disseminations.
20 30	Very pale pinkish buff	Tuff: Very similar to above sample.	Mn-oxides, traces. Traces of disseminated goethite/hematite.
30 40	Very pale buff; mottled pale green and pink	Tuff: Very similar to above sample. Rock contains crystal clasts of sanidine and biotite in a soft matrix.	Traces of goethite/hematite occur as disseminations and as coatings on fractures. Disseminated oxides may be in mafic mineral sites.
40 50	Pale green	Tuff: Very similar to above sample.	Traces of goethite in vugs. "Satin" spar gypsum crystals are present; they are rare. Disseminated celadonite (bright green clay) occurs.
50 60	Pale green	Tuff: same as above. As in all previous samples, the sanidine crystals are very clear; they have not suffered any alteration.	Goethite and/or hematite occurs in vugs, 0.2-0.5%. A few gypsum crystals are present.
60 70	Pale green	Tuff: Same rock as above.	Tiny aggregates of crystalline goethite and of earthy hematite are disseminated throughout rock, 0.5-0.75%.
70 80	Pale green	Tuff: Same rock as above. Crystal clear clasts of sanidine are present, 5-15 volume % of rock; clasts of very black biotite occur in trace amounts. Some original biotite may have been replaced by celadonite and limonites.	Traces of disseminated goethite and hematite. Tiny clots of green celadonite also occur as disseminations.
80 90	Very pale green	Tuff: Similar to above sample.	Same as above.
90 100	Very pale buff and green	Tuff: Contains phenocrysts of sanidine. No biotite present. See thin-section description. Original biotites probably replaced by jarosite; jarosite also replaces vitric shards.	Contains almost no goethite or hematite; that present occurs as thin films on slickensided surfaces. Contains disseminated Jarosite.
100 110	Very pale buff and green	Tuff: Same as above. No biotite present.	Traces of goethite/hematite. Traces of celadonite.
110 120	Very pale buff and green	Tuff: Same as above.	Same as above.
120 130	Pale buff	Tuff: Same as above.	Traces of hematite disseminated throughout rock.
130 140	Pale buff with tinges of green.	Tuff: Same as above. Contains crystal clasts of sanidine, 0.5 to 3mm in length, 5 to 10% of rock.	Traces of hematite. Traces of calcite.
140 150	Pale pink	Tuff: Same as above. Rock rapidly disaggregates on wetting. Sanidines are unaltered.	Contains traces of calcite, traces of hematite. Rock rapidly disaggregates on wetting - groundmass is clay-rich.

WELL: SR-4

LOCATION: Dixie Valley, Churchill Co., Nevada

ELEVATION:

HOLE SIZE:

GEOLOGICAL REPORT

WELL CUTTINGS SAMPLE DESCRIPTION

DATE: September 1980

DEPTH: 150' TO 300'

EXAMINED BY: M.J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
150 160	Pale pink, green	Tuff: Pink tuff disaggregates on wetting; it is very clay-rich; green tuff remains intact. Traces of unoxidized magnetite remain.	Traces of hematite. Clay replacement of vitric shards is locally intense.
160 170	Pale pink, green.	Tuff: Same as above.	Same as above.
170 180	Pale brown-pink with green patches	Tuff: looks very different than previous sample. This rock remains intact on wetting. Groundmass is pale brown-pink with greenish patches. Contains crystal clasts of sanidine, 0.1-1mm long, 5-10% and of biotite, 5-7%, the same crystal clasts as present in above samples	Traces of goethite irregularly disseminated throughout rock.
180 190	Pale green with pink and white patches	Tuff: similar to above sample.	Traces of goethite. Mn oxides (black) intergrown with green clays disseminated throughout rock; Mn oxides = ~2%
190 200	Pale green	Tuff: Same rock as above. See thin-section description.	Tiny; Mn-oxide dendrites disseminated throughout rock; Mn-oxides also coat fractures. Traces of disseminated goethite.
200 210	Nearly white to pale green	Tuff: same rock as above.	Mn-oxides disseminated throughout rock. A dark green mica/clay occurs in veins, sometimes it is associated with MnOx.
210 220	Very pale brown-orange with green patches	Tuff; same rock as above.	Same as above.
220 230	Very pale orange-pink	Tuff: same rock as above. Contains trace amounts of disseminated magnetite.	Contains only traces of Mn oxides.
230 240	Very pale pink and white	Tuff: Very similar to previous sample. Contains crystal clasts of sanidine and biotite. Traces of disseminated magnetite present.	Contains traces of disseminated Mn oxides and of calcite. Hematite (red) stains fractures.
240 250	Pale grey to white	Tuff: same as above. Disseminated magnetite present in trace amounts.	Traces of disseminated goethite / hematite.
250 260	Pale grey to white	Tuff: same as above.	Traces of disseminated goethite and calcite present.
260 270	Light green	Tuff: very similar to above sample. Green color due to disseminated celadonite(?).	Traces of disseminated Mn oxides, celadonite(?)
270 280	Light green	Tuff: same as above.	Same as above.
280 290	Light green with patches of dark green	Tuff: same as above.	Celadonite (= bright green mica/clay) occurs both as disseminations and in veinlets, less than 0.1mm wide.
290 300	Pale green	Tuff: same as above. See thin-section description.	Contains calcite both as disseminations and in rare veins (less than 0.1mm wide). Green color due to presence of celadonite.

WELL: SR-4

LOCATION: Dixie Valley, Churchill Co., Nevada

ELEVATION:

HOLE SIZE:

GEOLOGICAL REPORT

WELL CUTTINGS SAMPLE DESCRIPTION

PAGE: 3 of 10

DATE: September 1980

DEPTH: 300' TO 450'

EXAMINED BY: M.J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
300 310	Pale grey to white	Tuff: contains crystal clasts of sanidine and biotite. Also disseminated, very fine-grained magnetite. Matrix is so clay-rich, it disappears during sample washing.	Clay replacement of vitric matrix is intense.
310 320	Light grey to white. Dark grey.	Tuff: very similar to above sample, but not as strongly clay-altered. Does not disaggregate so completely during washing. Dark grey rhyolite porphyry chips comprise 30% of this sample; rhyolite = dike?, flow?, xenoliths?, welded interval?	Clay alteration of vitric groundmass of tuff.
320 330	Light grey to white. Dark grey.	Tuff: same as above. Dark grey rhyolite porphyry forms 10-15% of this sample.	Same as above; also traces of disseminated celadonite.
330 340	Very pale brown.	Tuff: same rock as above. Only a few chips, less than 1% of sample, are from the dark grey rhyolite porphyry present in previous two samples.	Traces of disseminated calcite.
340 350	Grey-green	Tuff: Very similar to above samples. Contains crystal clasts of sanidine and biotite. Trace amounts of disseminated magnetite occur. The groundmass is colored like epidote or montronite.	Clay replaced groundmass; epidote present ?? Traces of disseminated Mn oxides.
350 360	Grey-green	Tuff: same as above.	Same as above.
360 370	Grey	Tuff: contains crystal clasts of sanidine and biotite. Trace amounts of disseminated magnetite present. Pumaceous lithic fragments form 5-10% of rock.	Mn-oxides occur rarely. A few, loose pyrite crystals present in this sample.
370 380	Grey	Tuff: same as above.	Minor amounts of a pale lime-green clay replaces matrix; occurs in irregular patches.
380 390	Grey to grey-green	Tuff: same rock as above. Groundmass is more clay-altered than previous sample; rock disaggregates a lot during washing. Tuff contain pumice fragments and lithic fragments of andesite which form less than 10% of rock. Andesites more mgt-rich than tuff.	Pale lime-green clay more abundant than in previous sample.
390 400	Grey to grey-green	Tuff: same as above. Groundmass disaggregates on wetting. See thin-section description.	Same as above.
400 410	Grey to grey-green	Tuff: same as above. Disaggregates on wetting.	Same as above.
410 420	Grey to grey-green.	Tuff: same rock as above. This sample remained intact during washing. Lithic fragments of andesites, etc., are common; they are more magnetic than tuff.	Patches of translucent lime-green clay.
420 430	Light lime-green	Tuff: same rock as above. Rock disaggregates when wet.	Groundmass strongly replaced by translucent lime-green clay.
430 440	Grey and earthy red	Tuff: same rock as above; disaggregates on wetting.	Groundmass strongly replaced by grey clay. Irregular stains of hematite throughout rock.
440 450	White and pink.	Tuff: same as above. Contains crystal clasts of sanidine and biotite. Lithic fragments of andesite form 5% of sample. Rock disaggregates on wetting.	Specks of earthy hematite disseminated throughout rock. Groundmass strongly clay-replaced.

WELL: SR-4 | GEOLOGICAL REPORT | PAGE: 4 of 10

LOCATION: Dixie Valley, Churchill Co., Nevada | WELL CUTTINGS SAMPLE DESCRIPTION | DATE: September 1980

ELEVATION: | DEPTH: 450' TO 600'

HOLE SIZE: | EXAMINED BY: M. J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
450 460	Deep maroon red	Tuff: contains crystal clasts of sanidine and biotite in abundances similar to previously described samples. Tuff also contains andesite lithic fragments.	Groundmass (= vitric shards) has been clay-altered and flooded with earthy hematite.
460 470	White and pale earthy red	Tuff: similar to above sample.	Weak hematite staining. Weak to moderate clay-alteration of groundmass.
470 480	Light grey-green	Tuff: same as above. Lithic fragments form 3-5% of rock.	Weak hematite staining on fractures. Groundmass replaced by green-grey clays; tiny spots of celadonite (bright green) also present.
480 490	Grey-green	Tuff: similar to above sample.	Clay-alteration of groundmass.
490 500	Light Kelly green	Tuff: contains crystal clasts of sanidine and biotite. Groundmass disaggregates when rock is wetted. See thin-section description.	Clay-alteration of vitric components; some celadonite (?) present (= bright green clay/mica).
500 510	Light Kelly green	Tuff: same as above.	Same as above.
510 520	Light Kelly green	Tuff: same as above.	Same as above. Traces of disseminated goethite present.
520 530	Dark grey with patches of Kelly green	Tuff: grey portions of the tuff are quite hard — these portions were probably well welded and are not now clay-altered. Rock contains crystal clasts of sanidine and of biotite. Trace amounts of magnetite occur as disseminations.	Celadonite/clay replaces groundmass. Pyrite (fresh) coats fractures - only trace amounts seen.
530 540	Dark grey with patches of Kelly green.	Tuff: same as above. These rock chips are hard; grey-colored portions exhibit a vitreous luster.	Celadonite/clay alteration of groundmass. Traces of calcite present.
540 550	Dark grey with patches of light green	Tuff: same as above. Hard.	Celadonite/clay replacement of groundmass. Trace amounts of disseminated goethite (after pyrite).
550 560	Green-grey	Tuff: same as above. Hard.	Same as above.
560 570	Green-grey	Tuff: same as above. Hard.	Same as above.
570 580	Green-grey	Tuff: same as above. Hard.	Same as above.
580 590	Green-grey	Tuff: same as above. Hard.	Same as above.
590 600	Greenish grey-brown.	Tuff: same as above. Hard. See thin-section description and X-ray diffraction pattern - main clay peak at 12.6 Å.	Clay replacement of vitric components averages ~20%. Trace of pyrite in a vein.

WELL: SR-4

LOCATION: Dixie Valley, Churchill Co., Nevada

ELEVATION:

HOLE SIZE:

GEOLOGICAL REPORT

WELL CUTTINGS SAMPLE DESCRIPTION

DATE: September 1980

DEPTH: 600' TO 750'

EXAMINED BY: M. J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
600 610	Brownish grey-green	Tuff: contains crystal clasts of sanidine, 3-5% of rock; biotites are very rare. Rock is hard; it was probably well welded and is now largely devitrified. Very similar to previously described sample.	Celadonite/clay alteration of groundmass. Traces of goethite and calcite.
610 620	Green-grey.	Tuff: same as above. Hard.	Same as above.
620 630	Grey-brown	Tuff: similar to above sample. Hard.	Contains very little celadonite. Traces of calcite, goethite present.
630 640	Dark grey with green patches	Tuff: similar to above samples. Hard.	Patchy celadonite. Thin veins, 0.1-0.5mm wide, filled with pale green and white minerals.
640 650	White with grey and green patches	Tuff: contains crystal clasts of sanidine in a white, gritty groundmass with patches of grey and green.	Patches of celadonite. Groundmass (a vitric components) partially replaced by clay.
650 660	Pale lime-green pale red	Tuff: very clay-rich -- groundmass disaggregates on wetting. Crystal clasts same as in previous samples.	Groundmass very clay-altered.
660 670	Pale lime-green	Tuff: same as above. Contains crystal clasts of sanidine and biotite. Groundmass disaggregates readily on wetting.	Same as above
670 680	Pale lime-green	Tuff: same as above.	Same as above.
680 690	White with pale-green patches	Tuff: same as above.	Same as above.
690 700	Greyish white	Tuff: contains crystal clasts of sanidine and biotite in a greyish white, gritty groundmass. See thin-section description.	Weakly to moderately clay-altered. Minor carbonate present.
700 710	Greyish white	Tuff: same rock as above. Groundmass disaggregates on wetting.	Same as above.
710 720	Greyish white	Tuff: same as above.	Same as above.
720 730	Light grey-green, black	Tuff: similar to above sample. Clay-altered vitric groundmass disaggregates on wetting. Andesite/basalt lithic fragments form ~ 30% of this tuff sample.	Same as above.
730 740	Light grey with green patches	Tuff: similar to above samples. Contains irregular patches of celadonite (bright green clay/mica) alteration.	Same as above. Also contains patches of celadonite. Moderate calcite alteration.
740 750	Light grey	Tuff: similar to above sample. Clay-altered vitric groundmass disaggregates on wetting. Lithic fragments comprise 10-15% of rock.	Weak to moderate clay alteration including patchy celadonite. Calcite present in moderate amounts.

WELL: SR-4

LOCATION: Dixie Valley, Churchill Co., Nevada

ELEVATION:

HOLE SIZE:

GEOLOGICAL REPORT

WELL CUTTINGS SAMPLE DESCRIPTION

DATE: September 1980

DEPTH: 750' TO 900'

EXAMINED BY: M. J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
750 760	Light grey	Tuff: same as previous samples. Clay-altered matrix disaggregates on wetting.	Moderate clay-alteration. Calcite moderately abundant.
760 770	Light grey	Tuff: similar to previous samples. Contains crystal clasts of feldspar and biotite. Lithic clasts of latite/andesite form 10 to 15% of tuff. Matrix disaggregates on wetting.	Moderate clay alteration of vitric groundmass. Calcite moderately abundant. Hematite/goethite present in 1mm wide veins (after pyrite?)
770 780	Pale green and pale red	Tuff: distinctly different from above sample. Does not disaggregate when wet. Contains crystal clasts of sanidine and biotite in a green- or a red-colored groundmass. Flattened pumice fragments form about 5% of rock. Lithic fragments form 5% of rock (= andesites, etc.).	Green matrix contains minor, disseminated celadonite. Red matrix is weakly hematite stained. Traces of calcite present.
780 790	Pale green and red	Tuff: same as above. Green and red patches may occur both in the same chip.	Same as above.
790 800	Pale green and purple	Tuff: about 30% of these chips are very similar to above sample. Remainder are mottled in color; mottling is on a small scale. These chips are green, creamy white or mottled purplish and creamy white -- this white has the appearance of opal or chert. Many chips exhibit features of small-scale brecciation -- result of faulting? SEE THIN-SECTION DESCRIPTION	Celadonite on fractures. Weak hematite staining present; calcite moderately abundant. Chert-celadonite-calcite fills spaces among breccia fragments.
800 810	Light buff, green, red	Tuffs: A pale buff, gritty, vitric-crystal tuff forms ~50% of this sample. Green and red vitric-lithic tuffs each form ~25% of sample.	Clay alteration is moderately well developed. Calcite is abundant. Traces of goethite (after py?/mgt?) occur.
810 820	Grey-green, red	Tuff: contains crystal clasts of feldspar and biotite in a grey-green (clay-rich) or red (hematite-stained) groundmass.	Moderate clay-alteration. Calcite fairly abundant.
820 830	Pale buff with grey streaks	Tuff: contains crystal clasts of feldspars and biotite in a pale buff - almost white - groundmass with vitreous grey streaks (bands of devitrification?).	Same as above.
830 840	Pale buff with grey streaks	Tuff: same as above. Examination in thin-section shows that the groundmass has been totally devitrified to fine-grained, anhedral quartz and Kspar.	Weak to moderate clay-alteration of groundmass. Calcite disseminated and in veins.
840 850	Grey-white	Tuff: dominantly vitric -- contains few feldspar and biotite phenocrysts.	Same as above.
850 860	Grey-white	Tuff: same as above.	Same as above.
860 870	Grey-white	Tuff: same as above. Examination in thin-section reveals that this is a vitric-crystal tuff. Glass has been completely replaced by fine-grained, anhedral Kspar and quartz. Crystal clasts of sanidine, plagioclase and biotite are present.	Same as above. Calcite occurs in veins and locally floods groundmass. Microcrystalline quartz occurs in veins.
870 880	Grey-white	Tuff: same as above.	Same as above.
880 890	Grey-white	Tuff: similar to above sample. Ratio of feldspar clasts to groundmass is higher; groundmass may be relatively more prone to disaggregation on wetting.	Same as above.
890 900	Grey-white	Tuff: contains quartz "eyes", otherwise similar to previous samples. SEE THIN-SECTION DESCRIPTION	Clay-alteration of groundmass. Vein and disseminated calcite. Microcrystalline quartz occurs in fractures with calcite.

WELL: SR-4

LOCATION: Dixie Valley, Churchill Co., Nevada

ELEVATION:

HOLE SIZE:

GEOLOGICAL REPORT

WELL CUTTINGS SAMPLE DESCRIPTION

DATE: September 1980

DEPTH: 900' TO 1050'

EXAMINED BY: M.J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
900 910	Grey white	Tuff: same as previous sample. Groundmass (clay-altered vitric shards and dust) disappears during washing.	Same as above.
910 920	Mottled dark grey and grey-white	Cherty Dolomite: fine-grained; even textured.	Pyrite fills fractures; py forms ~0.5% of rock.
920 930	Same as above	Cherty Dolomite	Same as above.
930 940	Dark grey, white	Dolomite is dark grey. White rock is a vitric-crystal tuff; it contains crystal clasts of sanidine and biotite in a white, clay-rich matrix which disaggregates on wetting. X-ray diffraction analysis indicates clay is montmorillonite.	Pyrite occurs in fractures in dolomite. clay developed in tuff.
940 950	Same as above	Dolomite and Tuff: same as above.	Same as above.
950 960	Same as above	Dolomite and Tuff: same as above.	Same as above.
960 970	Same as above	Dolomite and Tuff: same as above.	Same as above.
970 980	Mottled grey and white	Dolomite: fine-grained; cherty. About 10 to 20% of the chips in this sample are from same white, clay-rich tuff described above.	Same as above.
980 990	Same as above.	Dolomite: same as above.	Traces of pyrite on fracture surfaces.
990 1000	Same as above	Dolomite: Same as above. SEE THIN-SECTION DESCRIPTION	Same as above.
1000 1010	Mottled dark grey and white	Dolomite: Same as above.	Pyrite on fractures forms 0.1% of rock.
1010 1020	Same as above	Dolomite: same as above.	Same as above.
1020 1030	Same as above	Dolomite: Same as above.	Same as above.
1030 1040	Mottled dark grey and white, buff.	Dolomites are mottled grey and white; these chips form 40-50% of sample. Fine-grained sandstones are buff; these chips form 40-50% of sample. A few chips have slickensided surfaces.	Pyrite occurs on fractures in dolomite. Traces of goethite occurs on fractures in sandstones.
1040 1050	Same as above	Dolomites and sandstones: same as above.	Same as above.

WELL: SR-4

LOCATION: Dixie Valley, Churchill Co., Nevada

ELEVATION:

HOLE SIZE:

GEOLOGICAL REPORT

WELL CUTTINGS SAMPLE DESCRIPTION

PAGE: 8 of 10

DATE: September 1980

DEPTH: 1050' TO 1200'

EXAMINED BY: M.J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
1050 1060	Light grey	Limestone: fine-grained.	Thin (less than 1mm wide) calcite veins occur.
1060 1070	Light grey	Limestone: fine-grained.	Thin calcite veins. Traces of pyrite in fractures.
1070 1080	Mottled dark and light grey	Limestone: fine-grained.	Same as above.
1080 1090	Same as above	Limestone: same as above.	Same as above.
1090 1100	Same as above	Limestone: sandy and cherty; fine-grained. SEE THIN-SECTION DESCRIPTION	Disseminated and vein pyrite. Thin calcite veins.
1100 1110	Light grey	Sandy Limestone: rock contains a small proportion of fine-sand. A few chips of slickensided fault gouge occur in this sample.	Traces of vein and disseminated pyrite, both fresh and oxidized. Some pyrite is in quartz veins.
1110 1120	Light grey-buff	Calcareous Sandstone: composed of fine sand and calcite. Yellow carbonate (Fe-rich?) coats some fracture surfaces- it also disseminated in parts of rock.	Traces of pyrite. Slickensided fault gouge chips present. A few, bleached, hematite-stained and veined siltstones present.
1120 1130	Light grey and buff	Calcareous Sandstone: same as above.	Pyrite (mostly oxidized) occurs in trace amounts as disseminations (0.1%). Fault gouge chips present.
1130 1140	Light grey	Calcareous Sandstone: same as above.	Traces of fresh and oxidized pyrite, mostly in thin veins, less than 1mm wide. Less pyrite than in previous sample.
1140 1150	Light grey	Calcareous Sandstone: same as above.	Traces of oxidized pyrite -- less than in above sample.
1150 1160	Light brown-orange	Calcareous Siltstone: finer-grained than above sample. Thinly laminated.	Contains traces of oxidized and fresh disseminated pyrite.
1160 1170	Light brown-orange	Calcareous Siltstone: same as above.	Contains less pyrite than above sample. Fault gouge chips present.
1170 1180	Light brown-orange	Calcareous Siltstone: same as above.	Same as above.
1180 1190	Light brown	Calcareous Sandstone: coarser-grained than previous sample.	Same as above.
1190 1200	Light orange-brown	Calcareous Sandstone: similar to previous sample. SEE THIN-SECTION DESCRIPTION	Traces of oxidized, disseminated magnetite. Thin calcite and calcite/qtz veins. Fault-gouge chips present.

WELL: SR-4

LOCATION: Dixie Valley, Churchill Co., Nevada

ELEVATION:

HOLE SIZE:

GEOLOGICAL REPORT

WELL CUTTINGS SAMPLE DESCRIPTION

DATE: September 1980

DEPTH: 1200' TO 1350'

EXAMINED BY: M.J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
1200	Pale orange, pale red	Calcareous Siltstones: fine-grained; well cemented. Reacts vigorously to cold, dilute HCL.	Traces of oxidized mgt and/or pyrite -- gone to hematite/goethite. Some fresh pyrite as loose crystals.
1210			
1210	Pale brown-orange	Calcareous Siltstones: same as above.	Traces of oxidized mgt/py. Chips of limonite-stained, slickensided fault gouge.
1220			
1220	Medium grey	Limestone: fine-grained; not laminated.	Thin (1mm wide or less) calcite veins. Traces of fresh pyrite on fractures.
1230			
1230	Medium to dark grey	Limestone: same as above.	Same above. Py also seen in wider (1-5mm) calcite veins.
1240			
1240	Same as above	Limestone: same as above.	Same as above.
1250			
1250	Same as above	Limestone: same as above.	Same as above.
1260			
1260	Medium grey	Limestone: same as above.	Thin calcite veins. Traces of disseminated pyrite (oxidized). Slickensided chips present.
1270			
1270	Medium to dark grey	Limestone: same as above.	Thin calcite veins occur, a few contain pyrite. Pyrite also coats fractures.
1280			
1280	Medium grey and grey-brown	Limestones: same as above.	Same as above. Pyrite often oxidized. Slickensided chips present.
1290			
1290	Medium grey and grey-brown	Limestone: same as above. SEE THIN-SECTION DESCRIPTION	Pyrite (partially oxidized to hematite) occurs in veins and as disseminations.
1300			
1300	Medium grey	Limestone: same as above.	Thin calcite veins present; some contain goethite/hematite (after pyrite?). Slickensided chips present.
1310			
1310	Medium grey	Limestone: same as above.	Thin calcite veins present. Fresh pyrite seen on a few fracture surfaces. Slickensided chips present.
1320			
1320	Medium grey	Limestone: same as above.	Thin calcite veins occur. Traces of disseminated goethite.
1330			
1330	Medium grey	Limestone: same as above.	Thin calcite veins occur, some of which contain pyrite.
1340			
1340	Medium grey	Limestone: same as above.	Same as above.
1350			

WELL: SR-4

LOCATION: Dixie Valley, Churchill Co., Nevada

ELEVATION:

HOLE SIZE:

GEOLOGICAL REPORT

WELL CUTTINGS SAMPLE DESCRIPTION

PAGE: 10 of 10

DATE: September 1980

DEPTH: 1350' TO 1500'

EXAMINED BY: M.J. Sweeney

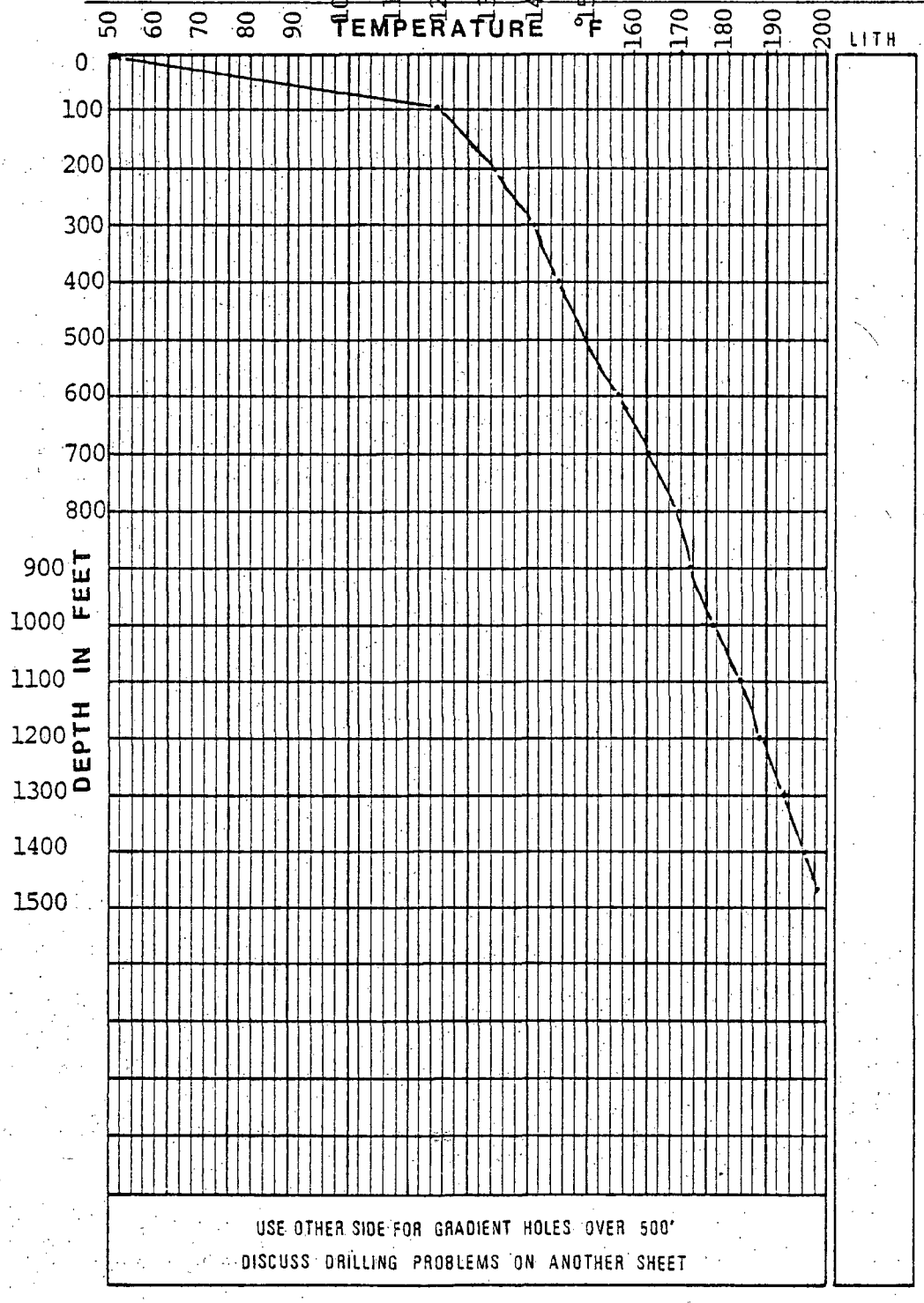
DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
1350	Medium grey	Limestone: very fine-grained; even textured.	Thin calcite veins present, some of which contain fresh pyrite. Slickensided chips occur.
1360			
1360	Medium grey	Limestone: same as above.	Same as above.
1370			
1370	Light grey	Limestone: same as above.	Rare calcite veins, some of which contain hematite | goethite (after pyrite?). Pyrite in thin discontinuous seams (~0.1%)
1380			
1380	Light grey	Limestone: same as above.	Thin calcite veins present; some contain pyrite (~0.2%). Slickensided chips present.
1390			
1390	Grey	Limestone: Same as above. SEE THIN-SECTION DESCRIPTION	Calcite veins contain pyrite some of which is oxidized to hematite.
1400			
1400	Grey	Limestone: Same as above.	Same as above.
1410			
1410	Grey	Limestone: same as above.	Same as above.
1420			
1420	Brown-grey and grey	Limestone: Same as above.	Traces of fresh pyrite. Slickensided chips present.
1430			
1430	Same as above.	Limestone: Same as above.	Rare, thin, calcite veins.
1440			
1440	Grey	Limestone: same as above.	Same as above.
1450			
1450	Grey	Limestone: same as above.	Same as above. Slickensided chips present.
1460			
1460	Grey	Limestone: same as above.	Same as above.
1470			
1470	Grey, red	Limestone: Same as above. Fault gouge (?): hematite-red, clayey material which is often slickensided forms 1-3% of sample.	Rare, thin, calcite veins present, some of which contain fresh and oxidized pyrite.
1480			
1480	Grey, red.	Limestone: same as above. Fault gouge (!): red; forms 3-5% of sample.	Rare, thin, calcite veins occur.
1490			
1490	Grey and light grey, red	Limestone: Same as above. SEE THIN-SECTION DESCRIPTIONS Fault gouge (?): red; forms 2-5% of sample.	Pyrite (partially oxidized) in thin veins, less than 1 mm wide. Thin calcite veins also present.
1500			

SHALLOW TEMPERATURE GRADIENT HOLE RECORD

Southland Royalty Company

SR-3	Dixie Valley			
GRADIENT HOLE NO.	PROSPECT			
NW NE	S 32 T 24N	R 37E	Churchill	Nevada
LOCATION	SEC. TOWNSHIP	RANGE	COUNTY	STATE
1/27/80	2/14/80	198.32 AT 1472 FT.	4.83	F/100'
SPUD DATE	COMPLETION DATE	BOTTOM HOLE TEMP.	GRADIENT 570 TO 1470	
1,500'	R. Jodry		Christiansen Bros.	
TOTAL DEPTH	GEOLOGIST OR PERSON READING TEMP.		COMPANY DRILLING HOLES	

3-5-80



USE OTHER SIDE FOR GRADIENT HOLES OVER 500'
DISCUSS DRILLING PROBLEMS ON ANOTHER SHEET

FOR HOLES 0-500'

TEMP	°C	°F	°F	°F
DATE OF SURVEY	3-5-80	3-5-80	5-29-80	
TIME SINCE COMPLETION	20	20	105	
0	10.4	50.7	75.2	
100	48.0	118.4	121.5	
200	55.2	131.3	134.6	
300	59.2	139.	142.2	
400	62.8	145.0	147.4	
500	65.5	149.9	152.4	
600	68.7	155.6	157.1	
700	71.6	160.8	162.1	
800	74.8	166.6	167.4	
900	77.8	172.0	172.0	
1000	80.6	177.0	176.5	
1100	83.4	182.1	181.0	
1200	85.8	186.4	185.4	
1300	88.2	190.7	189.5	
1400	90.6	195.0	193.6	
1474	92.4	198.3	196.2	

LOST CIRCULATION ZONES:

WATER ENTRIES: 150'-160'

Static Water Level-140'

SR-3

GRADIENT HOLE NO.

3/5/80

DATE OF SURVEY

DEPTH	°C	°F	DEPTH	°C	°F	DEPTH	°C	°F	DEPTH	°C	°F
0	10.4	50.72	460	64.7	148.46	920	78.4	173.12	1380	90.2	194.36
10	19.6	67.28	470	65.0	149.0	930	78.7	173.66	1390	90.4	194.72
20	29.1	84.38	480	64.8	148.64	940	79.0	174.2	1400	90.6	195.08
30	33.5	92.3	490	65.2	149.36	950	79.2	174.56	1410	90.8	195.44
40	36.8	98.24	500	65.5	149.9	960	79.5	175.1	1420	91.1	195.98
50	39.6	103.28	510	66.0	150.8	970	79.8	175.64	1430	91.3	196.34
60	43.6	110.48	520	66.4	151.52	980	80.0	176.0	1440	91.6	196.7
70	44.7	112.46	530	66.7	152.06	990	80.3	176.54	1450	91.9	197.06
80	45.8	114.44	540	67.1	152.78	1000	80.6	177.08	1460	92.1	197.42
90	46.9	116.42	550	67.4	153.32	1010	80.9	177.62	1470	92.3	197.78
100	48.0	118.4	560	67.7	153.86	1020	81.2	178.16	1472	92.4	198.32
110	48.9	120.02	570	67.9	154.22	1030	81.5	178.7			
120	49.8	121.64	580	68.2	154.76	1040	81.8	179.24			
130	50.6	123.08	590	68.5	155.3	1050	82.0	179.6			
140	51.3	124.34	600	68.7	155.66	1060	82.3	180.14			
150	52.0	125.6	610	69.0	156.2	1070	82.5	180.5			
160	52.6	126.68	620	69.2	156.56	1080	82.8	181.04			
170	53.2	127.76	630	69.5	157.1	1090	83.1	181.58			
180	53.9	129.02	640	69.8	157.64	1100	83.4	182.12			
190	54.6	130.28	650	70.1	158.18	1110	83.7	182.66			
200	55.2	131.36	660	70.4	158.72	1120	83.9	183.02			
210	55.7	132.36	670	70.7	159.26	1130	84.1	183.38			
220	56.2	133.16	680	71.0	159.8	1140	84.4	183.92			
230	56.7	134.06	690	71.3	160.34	1150	84.7	184.46			
240	57.2	134.96	700	71.6	160.88	1160	84.9	184.82			
250	57.5	135.5	710	72.1	161.78	1170	85.1	185.18			
260	58.0	136.4	720	72.5	162.5	1180	85.4	185.72			
270	58.3	136.94	730	72.8	163.04	1190	85.6	186.08			
280	58.8	137.84	740	73.0	163.4	1200	85.8	186.44			
290	59.2	138.56	750	73.3	163.94	1210	86.1	186.98			
300	59.5	139.1	760	73.7	164.66	1220	86.3	187.34			
310	59.8	139.64	770	74.0	165.2	1230	86.5	187.7			
320	60.0	140.0	780	74.3	165.74	1240	86.8	188.24			
330	60.3	140.54	790	74.6	166.28	1250	87.0	188.6			
340	60.7	141.26	800	74.8	166.64	1260	87.2	188.96			
350	61.1	141.98	810	75.2	167.36	1270	87.5	189.5			
360	61.4	142.52	820	75.4	167.72	1280	87.7	189.86			
370	61.7	143.06	830	75.7	168.26	1290	88.0	190.4			
380	62.0	143.60	840	76.0	168.8	1300	88.2	190.76			
390	62.4	144.32	850	76.3	169.34	1310	88.5	191.3			
400	62.8	145.04	860	76.6	169.88	1320	88.7	191.66			
410	63.1	145.58	870	76.9	170.42	1330	88.9	192.02			
420	63.5	146.3	880	77.2	170.96	1340	89.1	192.38			
430	63.8	146.84	890	77.5	171.5	1350	89.4	192.92			
440	64.1	147.38	900	77.8	172.04	1360	89.7	193.46			
450	64.4	147.92	910	78.1	172.58	1370	90.0	194.0			

Fig 4-4

SHALLOW TEMPERATURE GRADIENT HOLE RECORD

Southland Royalty Compan

SR-3	Dixie Valley	
GRADIENT HOLE NO.	PROSPECT	
NW NE	S 32 T 25N	R 37E
LOCATION	SEC. TOWNSHIP	RANGE
01/27/80	02/14/80	196.2°F
SPUD DATE	COMPLETION DATE	BOTTOM HOLE TEMP.
1500	Richard Jodry	
TOTAL DEPTH	GEOLOGIST OR PERSON READING TEMP.	

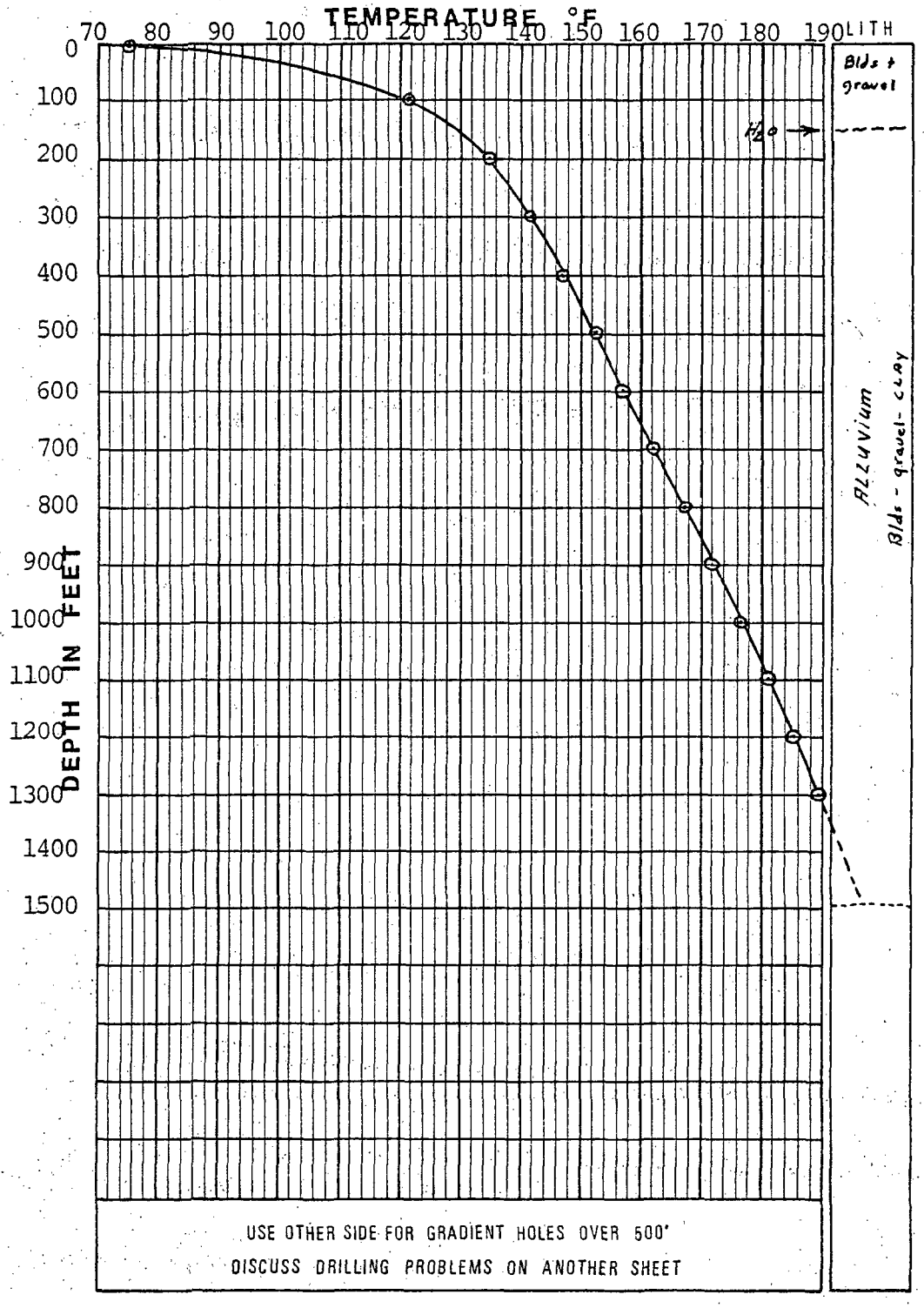
Churchill Nevada
COUNTY STATE

1474 AT 4.38°
FT. F/100

GRADIENT 500 TO 147

J. D. Christiansen Drilling
COMPANY DRILLING HOLES Ely

Reading for 05/29/80



USE OTHER SIDE FOR GRADIENT HOLES OVER 500'
DISCUSS DRILLING PROBLEMS ON ANOTHER SHEET

FOR HOLES 0-500'

TEMP	°C	°F	°F	°F
DATE OF SURVEY	6-29-80	5-29-80		
TIME SINCE COMPLETION	105 DAYS	105 DAYS		
0	24.0	75.2		
100	49.7	121.2		
200	57.0	134.6		
300	61.2	142.6		
400	64.1	147.4		
500	66.9	152.4		
600	69.5	157.1		
700	72.3	162.1		
800	75.2	167.4		
900	77.8	172.0		
1000	80.3	176.5		
1100	82.8	181.0		
1200	85.2	185.4		
1300	87.5	189.4		
1400	89.8	193.5	193.6	
1474	91.2	196.2		

LOST CIRCULATION ZONES:

WATER ENTRIES: 150'-160'

Gravel bed.

Prep. by dem.

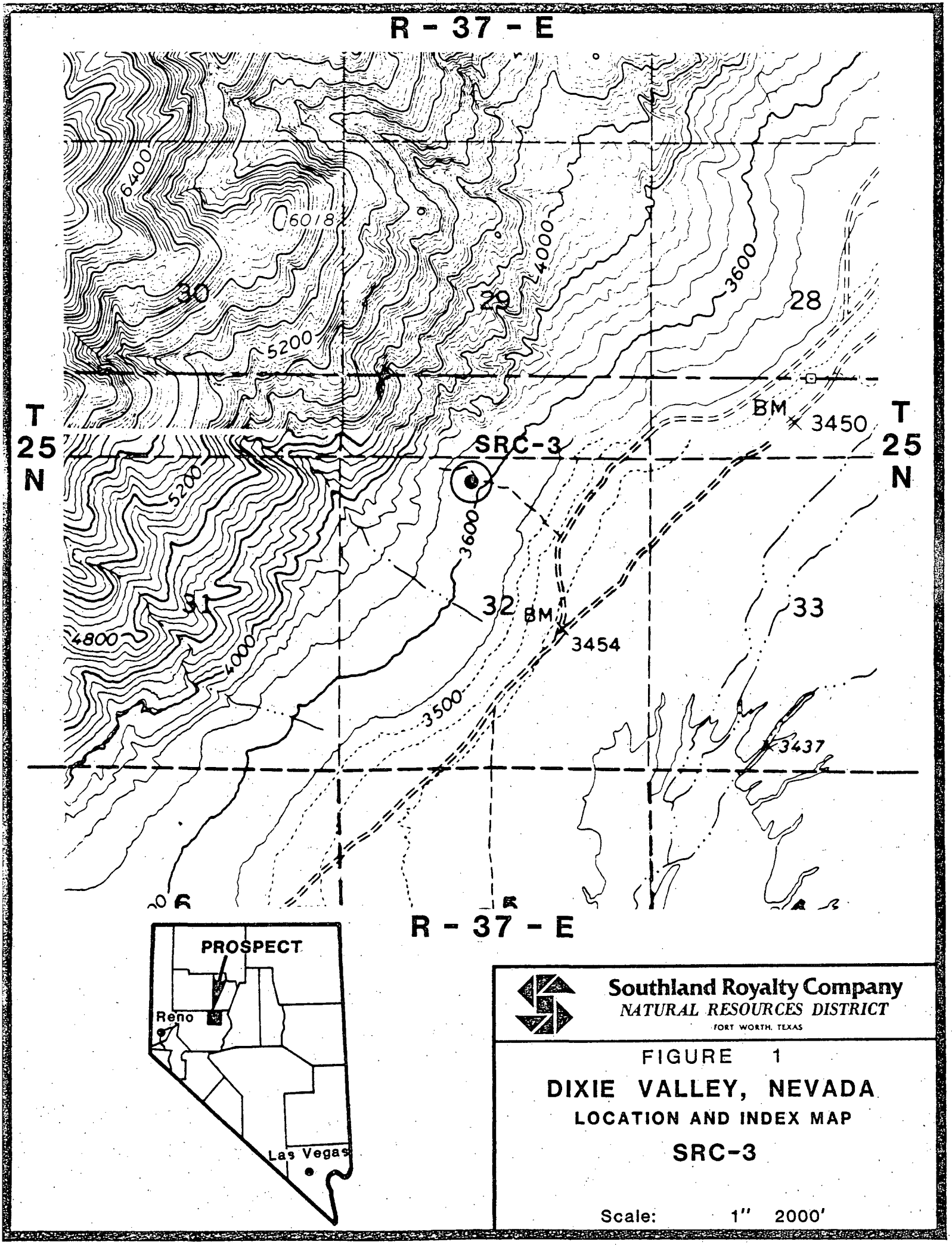
SR-3

GRADIENT HOLE NO.

5/29/80

DATE OF SURVEY

DEPTH	°C	°F	DEPTH	°C	°F	DEPTH	°C	°F	DEPTH	°C	°F
0	24.0	75.2	410	64.4	147.9	810	75.5	167.9	1210	85.4	185.7
10	24.8	76.6	420	64.7	148.4	820	75.7	168.2	1220	85.6	186.0
20	26.0	78.8	430	65.0	149.0	830	76.0	168.8	1230	85.9	186.6
30	33.3	91.9	440	65.2	149.3	840	76.2	169.1	1240	86.1	186.9
40	37.8	100.0	450	65.4	149.7	850	76.4	169.5	1250	86.4	187.5
50	42.0	107.6	460	65.6	150.0	860	76.7	170.0	1260	86.6	187.8
60	45.2	113.3	470	65.9	150.6	870	77.0	170.6	1270	86.9	188.4
70	46.4	115.5	480	66.2	151.1	880	77.3	171.1	1280	87.1	188.7
80	47.6	117.6	490	66.6	151.8	890	77.6	171.6	1290	87.3	189.1
90	48.7	119.6	500	66.9	152.4	900	77.8	172.0	1300	87.5	189.5
100	49.7	121.5	510	67.1	152.7	910	78.1	172.5	1310	87.7	189.8
110	50.7	123.2	520	67.3	153.1	920	78.3	172.9	1320	87.9	190.2
120	51.6	124.8	530	67.6	153.6	930	78.6	173.4	1330	88.2	190.7
130	52.4	126.3	540	67.8	154.0	940	78.8	173.8	1340	88.4	191.1
140	53.2	127.7	550	68.0	154.4	950	79.1	174.3	1350	88.6	191.4
150	53.9	129.0	560	68.2	154.7	960	79.3	174.7	1360	88.9	192.0
160	54.4	129.9	570	68.7	155.6	970	79.6	175.2	1370	89.1	192.3
170	54.9	130.8	580	69.1	156.3	980	79.9	175.8	1380	89.4	192.9
180	55.7	132.2	590	69.2	156.5	990	80.1	176.1	1390	89.6	193.2
190	56.5	133.7	600	69.5	157.1	1000	80.3	176.5	1400	89.8	193.6
200	57.0	134.6	610	69.8	157.6	1010	80.6	177.0	1410	90.0	194.0
210	57.5	135.5	620	70.1	158.1	1020	80.8	177.4	1420	90.2	194.3
220	58.0	136.4	630	70.4	158.7	1030	81.1	177.9	1430	90.4	194.7
230	58.5	137.3	640	70.7	159.2	1040	81.5	178.3	1440	90.6	195.0
240	58.8	137.8	650	70.8	159.4	1050	81.6	178.8	1450	90.8	195.4
250	59.3	138.7	660	71.1	159.9	1060	81.8	179.2	1460	90.9	195.6
260	59.7	139.4	670	71.4	160.5	1070	82.1	179.7	1470	91.0	195.8
270	60.1	140.1	680	71.7	161.0	1080	82.5	180.5	1474	91.2	196.2
280	60.5	140.9	690	72.0	161.6	1090	82.6	180.6			
290	60.9	141.6	700	72.3	162.1	1100	82.8	181.0			
300	61.2	142.2	710	72.6	162.6	1110	83.0	181.4			
310	61.5	142.1	720	72.9	163.2	1120	83.2	181.7			
320	61.8	143.2	730	73.2	163.7	1130	83.5	182.3			
330	62.1	143.7	740	73.5	164.3	1140	83.7	182.6			
340	62.4	144.3	750	73.7	164.6	1150	83.9	183.0			
350	62.7	144.8	760	74.0	165.2	1160	84.2	183.5			
360	63.0	145.4	770	74.3	165.7	1170	84.4	183.9			
370	63.2	145.7	780	74.6	166.2	1180	84.7	184.4			
380	63.6	145.4	790	74.9	166.8	1190	84.9	184.8			
390	63.9	147.0	800	75.2	167.4	1200	85.2	185.4			
400	64.1	147.4									



Southland Royalty Company
NATURAL RESOURCES DISTRICT
FORT WORTH, TEXAS

FIGURE 1

DIXIE VALLEY, NEVADA

LOCATION AND INDEX MAP

SRC-3

Scale: 1" 2000'

It is composed 1) of clay which appears in thin-section to be a montmorillonite, 2) of angular sand grains of quartz, feldspar, mafic minerals, and carbonate, 3) of very fine-grained calcite cement, and 4) of sand-, pebble- and cobble-sized lithic clasts. The lithic clasts include all of the rock types described above in this report.

The clay-sand-lithic material is locally abundant in the hole; its abundance seems to correlate with how clayey the unwashed samples are. The letters, n, s, m and st in the depth column of the stratigraphic log indicate how clayey the unwashed samples are. The symbol "n" indicates that the sample was fairly free of clay, "s" slightly clayey, "m" moderately clayey and "st" strongly clay-cemented. The clay-sand-lithic material is compositionally and behaviorly similar to the bentonite-gel drilling mud used in SR-3; there is no definitive way of deciding which type of material, drilling mud or clay-sand-lithic material, is dominant in the clayey horizons. Some of the clay-rich samples, particularly those at 600', contain pyritic mudstone; the mudstone may have been deposited originally as a lacustrian bed.

The clay-sand material may have originated as volcanic ash. This is suggested by the heterogenity of the crystal clasts and by the possibility that the clay could be a product of altered glass shards. The clay-sand material and the lithic clasts are thoroughly mixed together; the clasts and ash were probably transported together to the site of SR-3.

Thin (less than 1 mm wide) calcite veins were seen in consolidated fragments of clay-sand-lithic material which survived the washing process. Only once was a pyrite crystal seen in the calcite veins; the pyrite was attached to the surface of the vein. No disseminated pyrite was seen in the clay-sand material.

14) Pyrite crystals$^{+}_{-}$clay: Loose pyrite crystals, which occasionally are associated with a white clay (kaolinite?), very fine-grained sericite? and calcite occur in all samples below 590 feet. Frequently these crystals are oxidized. Possibly, these loose crystals were derived from pyrite deposited in open fractures in the consolidated gravels.

Alteration

Unraveling the alteration history of gravels, especially those sampled by rotary drilling, is not straightforward. The lithic clasts may contain alteration assemblages developed originally at their sources and not at the present site. Soft or friable assemblages and veins are easily disaggregated by the process of drilling rotary holes and these same assemblages are removed from the sample by washing.

Pyritization. Pyrite occurs 1) as loose particles of subhedral crystal aggregates, sometimes associated with a white clay and calcite, 2) as loose euhedral crystals 1 mm or less across, and 3) as disseminations in siltstone, metasandstones, phyllites and mudstones. Nearly all of the pyrite? in the metasandstones has been replaced by goethite. A smaller proportion of the pyrite in siltstones has been oxidized and even less of that in mudstones has been oxidized. The significance of the disseminated pyrite cannot be evaluated without knowing if pyrite is present at the source area of these clasts.

WHITE—DIVISION OF WATER RESOURCES
CANARY—CLIENT'S COPY
PINK—WELL DRILLER'S COPY

STATE OF NEVADA
DIVISION OF WATER RESOURCES

WELL DRILLERS REPORT

Please complete this form in its entirety

OFFICE USE ONLY
Log No.
Permit No.
Basin

1. OWNER Southland Royalty Company ADDRESS 1600 First National Bank Building Fort Worth, Texas 76102

2. LOCATION NW ¼ NE ¼ Sec. 32 T. 22N N/S R. 37 E. Churchill County
PERMIT NO. Thermal Gradient Hole No. SR-3

3. TYPE OF WORK: New Well ☒ Recondition ☐ Deepen ☐ Other ☐

4. PROPOSED USE: Domestic ☐ Irrigation ☐ Test ☒ Municipal ☐ Industrial ☐ Stock ☐

5. TYPE WELL: Cable ☐ Rotary ☒ Other ☐

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
Boulders & Gravel		0	150	150
Water Bearing Gravel	X	150	160	10
Boulders, Gravel & Clay		160	220	60
Boulders & Gravel		220	440	220
Boulders, Gravel & Clay		440	820	380
Very Hard Rock		820	840	20
Boulders & Clay		840	1500	660

Date started January 27, 19 80
Date completed February 14, 19 80

7. WELL TEST DATA

Pump RPM	G.P.M.	Draw Down	After Hours Pump

BAILER TEST
G.P.M. Draw down feet hours
G.P.M. Draw down feet hours
G.P.M. Draw down feet hours

8. WELL CONSTRUCTION
Diameter hole 9-7/8 inches Total depth 1,500 feet
Casing record 7-5/8" 0 - 155 Ft.
Weight per foot 20 Lbs. Thickness
Casing 1" 0 To 1,472

Diameter	From	To
6-1/4 inches	165 feet	820 feet
6-1/8 inches	820 feet	1,500 feet
inches	feet	feet
inches	feet	feet
inches	feet	feet
inches	feet	feet

Surface seal: Yes ☒ No ☐ Type Cement
Depth of seal 32 feet
Gravel packed: Yes ☐ No ☒
Gravel packed from feet to feet

Perforations: None
Type perforation
Size perforation
From feet to feet
From feet to feet
From feet to feet
From feet to feet
From feet to feet

9. WATER LEVEL
Static water level 140 Feet below land surface 140
Flow G.P.M.
Water temperature Warm ° F. Quality

10. DRILLERS CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.

Name Jerrold D. Christiansen
Address 557 Ely Ave., Ely, Nevada 89301
Nevada contractor's license number 14790
Nevada driller's license number 641
Signed Jerrold D. Christiansen
Date February 26, 1980

USE ADDITIONAL SHEETS IF NECESSARY

O-627

SUMMARY OF LITHOLOGY AND ALTERATION IN SR-3, DIXIE VALLEY, CHURCHILL COUNTY, NEVADA

M. J. Sweeney, July 1980

INTRODUCTION

Samples of washed, rotary cuttings taken every ten feet from drill-hole SR-3 were examined under a stereomicroscope. A thin-section of the cuttings was described from every 100 feet throughout the 1500 foot length of SR-3. Detailed descriptions of the cuttings and thin-sections are attached to this report. Photomicrographs of the thin-sections are also attached.

LITHOLOGIES

SR-3 is in gravels for its entire 1500 foot depth. All the gravel was derived from a common source. It is of nearly uniform composition for 1500 feet, i.e., the same types of clasts occur in about the same proportions throughout the entire hole. Metasandstones and phyllites are the most common lithic clasts. Locally the gravels are cemented by a mixture of clay$\pm$calcite containing sand-sized lithic and crystal clasts; this clay-sand material may be derived from volcanic ash.

The rock types present in the gravel are listed below.

1) Limestone: Black, foliated, very fine-grained, carbonaceous, locally phlogopitic limestone.

2) Phyllites: Black, foliated, carbonaceous phyllites composed of varying proportions of biotite, sericite and silt-sized quartz and feldspar. Occassionally porphyroblasts of biotite or of clinozoisite occur in some of the phyllite particles. Often disseminated anhedral magnetite is present. Pyrite was observed rarely.

3) Diorite: Dark grey to dark grey green, fine-grained diorite or diabase. The original mafic minerals in this rock type were pyroxenes; in some particles, unaltered pyroxene remains, but most often it has been replaced by chlorite and/or montmorillonite or sericite$\pm$carbonate. Black Fe-oxides, most probably mixtures of ilmenite/magnetite, are present in the diorite; locally ilmenite/magnetite is oxidized to earthy red hematite. Pyrite was not observed in any diorite fragments.

4) Metasandstones: White, buff, pale pink, orange and greenish. These particles are well indurated and never friable. A small proportion of the metasandstones in most every sample contain goethite pseudomorphing a disseminated cubic mineral (pyrite??). Only rarely was unoxidized pyrite observed in metasandstone particles.

The loose pyrite crystals are possibly from open veins or from a mudstone disaggregated by drilling/sample washing. The total volume of pyrite in the samples from SR-3 ranges between 0.1 and 0.5 volume % through the hole, including both disseminated and loose pyrite crystals. There is a fair probability that little of this pyrite was deposited as the result of hydrothermal processes occurring at the site of this drill hole, SR-3. The possibility that little of the pyrite was locally deposited is supported by the following observations: 1) only a trace of pyrite was observed in a vein in the clay-sand-lithic matrix material, and 2) no pyrite was seen in the diorite/diabase fragments. Both of these lithologies are usually more susceptible to pyritization than quartz-rich rocks.

Calcite Veining. Thin calcite veins occur in particles of clay-sand-lithic matrix material. Only once was a small pyrite crystal observed on the surface of one of these calcite veins. Very fine-grained calcite was observed occasionally on the surface of lithic clasts; this material is possibly caliche.

Quartz Veining. Drusy quartz veins occur in metasandstones and phyllites. Most probably this veining is related to events at the source area of these particles.

Opal(?) Veining. Opal-quartz occurs in thin veins in clay-sand matrix material. They were observed only in upper 600' of the drill hole.

Summary. Drill hole SR-3 has sampled 1500 feet of gravels locally cemented by sand-clay-carbonate material that is possibly derived from volcanic ash. Many of the clasts in the gravel are weakly pyritized; the pyrite possibly was deposited initially at the source area of these clasts.

The only alteration definitely related to the site of the drill hole is weak calcite as well as opal-quartz veining developed in the sand-clay matrix material.

Oxidation of pyrite is fairly complete down to 1500', the total depth of the hole.

Clay Analysis

An unwashed sample of strongly clay-cemented drill cuttings was prepared for clay analysis. The sample selected for analysis is from the 1130'-1140' interval. The sample of chips was washed in de-ionized water in a blender. Sodium tripolyphosphate was added to peptize suspended clays. The suspended material was then centrifuged at 1000 r.p.m. to remove larger than clay-sized material. Suspended clay was dropped by centrifuging at 4000 r.p.m. A portion of the dropped clay fraction was smeared on a glass slide and air dryed. This sample was analyzed by x-ray diffraction. The clay fraction from the 1130'-1140' interval contains calcite, montmorillonite, illite and kaolinite in order of decreasing abundance.

Clay analysis was also made of a composite of clay-sand fragments which had survived washing. The sample consisted of fragments collected from throughout the hole during chip logging. X-ray diffraction analysis shows that this sample also contains calcite, montmorillonite, illite and kaolinite. Relative peak intensities on this XRD pattern and the previously discussed pattern are very similar. Drilling mud does not appear to have strongly affected peak intensities obtained on the 1130'-1140' sample.

The two patterns are attached to this report.

DESCRIPTIONS OF THIN-SECTIONS FROM SR-3,
DIXIE VALLEY, CHURCHILL CO., NEVADA

100'-110'

Rock Type	Number of Particles	Percentage of Sample
Limestone: Mostly very fine-grained; grain size 0.1 mm or less, usually 0.01 mm. Rock exhibits fine-scale foliation. Contains porphyroblasts? or detrital flakes of phlogopite; these mica flakes oriented parallel to rock foliation. Very fine-grained carbonaceous? particles (=black dust) occur throughout rock, distributed both inter- and intragranularly. One of the limestone chips contains a vein filled with elongate quartz crystals oriented perpendicularly to vein walls. Ghosts of fossils are still recognizable in most chips.	7	33
Phyllite: Very fine-grained. Composed of foliated biotite, muscovite and silt-sized quartz and feldspar grains.	2	10
Diorite/Diabase: One unaltered chip is composed of unoriented plagioclase laths, and lesser pyroxene and possibly olivine. In another chip, mafic minerals have been replaced by chlorite. In another, montmorillonite has replaced mafic minerals, and kaolinite has replaced plagioclase.	3	14
Metasandstone: One grain composed of sand-sized quartz grains and muscovite-chlorite porphyroblasts. One composed of subangular to subrounded quartz grains about 0.1 mm across; sorting good. Silica, clay and calcite occur as cement.	2	10
Marble: Grain size about 1 mm; granoblastic. One chip contains patches of chert. Another contains patches of more coarsely crystalline quartz (recrystallized chert?). The latter also contains patches of montmorillonite after an unidentified mineral (low birefringence=first order grey; low 2V, 10-30°; opt +; good cleavage).	3	14
Chert: Recrystallized; quartz occurs as fine-grained feathery crystals.	3	14
Silicified Cataclasite: Original rock type not known; now composed of subhedral quartz of variable grain size. Patches of brown clay (montmorillonite?) form 5-10% of chip.	1	5
Total Number of Chips Examined	21	100%

190'-200'

Rock Type	Number of Particles	Percentage of Sample
Phyllite: This catagory also includes a few clasts of hornfelsed muddy siltstones; the only significant difference between hornfelses and phyllites is the degree or complete lack of foliation of mica in the phyllites. Very fine-grained, metamorphosed clayey siltstones and silty mudstones; usually composed of subequal amounts of silt-sized quartz and feldspar and of very fine-grained white micas, lesser biotite and of variable amounts of chlorite (0-50%). Micas are usually well foliated. In some chips, biotite occurs in sparse, small clots of unoriented crystals; these are spotted hornfelses. Porphyroblasts of clinozoisite also occur in some biotite-spotted hornfelses. Variable amounts of very fine-grained, black (= carbonaceous material?, magnetite?) are disseminated throughout these rocks. Trace amounts of goethite occur (after disseminated magnetite?, pyrite?).	27	73
Diorite: Composed of 0.3 to 1.5 mm long laths of plagioclase, interstitial chlorite-clay altered mafic crystals which comprise 7 to 15% of rock. Interstitial quartz forms 2 to 4% of rock. Alteration of plagioclase varies from chip to chip; sericite-clay$^{\pm}$carbonate replacement of feldspar ranges between 20 and 70%. In the least altered chip, disseminated magnetite/ilmenite forms 1 to 2% of rock.	4	11
Metasandstones: Fine-grained; sand grains of quartz; one contains 5-10% carbonate as cement; one is moderately foliated.	3	8
Marble: Fine- to medium-grained.	2	5
Clay-Sand-Lithic Matrix Material: Clayey matrix containing sand-sized, angular crystal fragments of quartz, feldspar and pyroxene. This material is attached to one of the phyllite chips; presumably, the clay-sand material is the matrix for the alluvial clasts.	1	3
Total Number of Particles Examined	37	100%

290'-300'

Rock Type	Number of Particles	Percentage of Sample
Limestone: Very fine-grained; foliated.	11	10
Phyllite: Usually composed of foliated, fine-grained sericite and biotite in variable proportions and of silt-sized quartz and feldspar. Also contains very fine-grained, disseminated, black material (=graphite?, magnetite?).	20	18
Diorite: Mafic minerals altered to chlorite, montmorillonite and calcite.	14	12
Metasandstone: Composed of fine-grained, well sorted quartz; calcite cement present in some particles.	25	22
Siltstone	1	1
Clayey Siltstone	2	2
Mudstone: Composed of very fine-grained sericite/illite, sometimes with biotite porphyroblasts. Traces of goethite (after pyrite?) in a few chips.	14	12
Volcanics: Rhyolite?, composed of feathery feldspar crystals and quartz.	3	3
Marble	5	4
Chert: Recrystallized. Composed of very fine-grained, feathery crystals of quartz; contains variable proportions of silt-sized quartz grains.	16	14
Vein Quartz	2	2
Total Number of Particles Examined	113	100%

390'-400'

Rock Type	Number of Particles	Percentage of Sample
Limestone: Very fine-grained; foliated; ±mica; contains abundant, fine-grained, carbonaceous? material. Black or dark grey in hand-specimen.	2	2
Phyllite: Fine-grained; foliated; contains variable proportions of sericite and biotite, as well as, silt-sized grains of quartz and feldspar. Very fine-grained, black material (graphite?, Fe-oxides?) is disseminated throughout most clasts.	43	33
Diorite: Sericite-chlorite-clay altered.	2	2
Metasandstones: Such particles range in composition from nearly pure quartzites to containing 30% sericite±chlorite and/or calcite. Goethite/hematite (after pyrite?) porphyroblasts(?) poikilitically encloses quartz grains in one chip; no other chips contained disseminated goethite and/or pyrite.	65	50
Clayey Siltstone: Contains abundant sericite/illite as well as silt.	2	2
Mudstone: Composed of very fine-grained unfoliated sericite and chlorite in varying proportions; also contains 0 to 30% silt.	3	2
Granite	1	1
Marble: Fine- to medium-grained.	4	3
Chert: Recrystallized to feathery quartz.	6	5
Pyrite: Unoxidized; a free, 0.5 mm grain.	1	1
Chlorite Schist	2	2
Total Number of Particles Examined	131	100%

490'-500'

Rock Type	Number of Particles	Percentage of Sample
Limestone: Very fine-grained; usually foliated; carbonaceous; rarely contains phlogopite flakes.	15	19
Phyllite: Very fine-grained; composed of variable proportions of sericite, biotite and silt-sized quartz and feldspar. Foliated. Contains very fine-grained, disseminated black material, graphite?, Fe-oxides?. Coarse-grained Fe-oxides, magnetite$^{\pm}$ hematite, occur in trace amounts as disseminations.	23	29
Metasandstone	14	18
Siltstone: Very fine-grained; contains silt-sized quartz and feldspar as well as variable amounts of sericite/illite$^{\pm}$chlorite.	3	4
Marble	12	15
Chert: Composed of fine-grained feathery quartz with variable amounts of carbonate and silt- and/or sand-sized quartz grains.	10	13
Clay-Sand-Lithic Matrix Material: Sand- and pebble-sized clasts in a clay-rich matrix; this material is probably the matrix of the alluvium.	2	3
Total Number of Particles Examined	79	100%

590'-600'

Rock Type	Number of Particles	Percentage of Sample
Limestone	5	6
Phyllite	28	36
Diorite	3	4
Metasandstones	26	33
Siltstone	4	5
Mudstone: Pyritic; very soft; pale grey-green in hand-specimen; disaggregates on wetting; forms about 30% of washed sample, most chips were destroyed in thin-section making process so they are rare in thin-section.	1	1
Volcanics: Latite?	1	1
Marble	2	3
Chert	6	8
Vein Quartz	1	1
Clay-Sand-Lithic Matrix Material	1	1
Total Number of Particles Examined	78	100%

790'-800'

Rock Type	Number of Particles	Percentage of Sample
Limestone	10	6
Phyllite: Composed of very fine-grained foliated sericite, biotite (10-70%) and silt-sized grains of quartz and feldspar. Contains 0 to 1% disseminated pyrite. Rarely contains porphyroblasts of feldspar and/or biotite. Almost always contains finely disseminated black material, graphite?	46	25
Diorite: Mafic minerals have gone to montmorillonite.	3	2
Metasandstone: Goethite (after pyrite?) in a few particles.	49	27
Siltstone: Usually sericitic.	12	7
Mudstone: Composed of very fine-grained, clay-sized material. Contains 0.1-0.3% pyrite (usually oxidized to goethite); contains 0 to 15% silt-sized quartz and feldspar.	26	14
Volcanics: Andesite, illite-replaced.	2	1
Marble	14	8
Chert	11	6
Vein Quartz	1	1
Vein Calcite	1	1
Quartz and/or Feldspar Schist	4	2
Chlorite Schist	1	1
Sand-Clay Matrix Material	1	1
Total Number of Particles Examined	181	100%

890'-900'

Rock Type	Number of Particles	Percentage of Sample
Limestone	14	12
Phyllite	17	14
Diorite	1	1
Metasandstones	40	33
Siltstones	14	12
Mudstone	6	5
Volcanics: Andesite?, altered to clay and hematite.	1	1
Marble	10	8
Chert: Recrystallized.	5	4
Vein Quartz: One piece coated with limonite and quartz; one vein cuts marble; one contains vugs filled with clay-pyrite.	5	4
Vein Calcite: Associated with hematite and quartz.	1	1
Schist	2	2
Clay-Sand-Calcite Matrix Material	4	3
Total Number of Particles Examined	120	100%

990'-1000'

Rock Type	Number of Particles	Percentage of Sample
Limestones: Black; foliated; very fine-grained; sometimes contains phlogopite flakes; contains black, carbonaceous? material.	27	13
Phyllites	25	12
Diorite	1	0.5
Metasandstones	91	45
Siltstone	8	4
Mudstone: Occasionally contains large flakes of phlogopite.	8	4
Marble	27	13
Chert	12	6
Vein Quartz	2	1
Schist	2	1
Clay-Sand-Lithic Matrix Material	1	0.5
Total Number of Particles Examined	204	100%

1090'-1100'

Rock Type	Number of Particles	Percentage of Sample
Limestone	13	8
Phyllite	20	12
Diorite	1	1
Metasandstone	87	51
Siltstone: Some are chloritic.	8	5
Mudstone: Composed of very fine-grained clay-sized material.	9	5
Volcanics: Chlorite-carbonate replaced.	1	1
Marble	13	8
Chert	12	7
Vein Quartz	5	3
Clay-Sand-Lithic Matrix Material	3	2
Total Number of Particles Examined	172	100%

1190'-1200'

Rock Type	Number of Particles	Percentage of Sample
Limestone	25	15
Phyllite	17	10
Diorite	2	1
Metasandstone	81	50
Siltstone	7	4
Mudstone	11	7
Volcanics: Andesite; plagioclase replaced by montmorillonite and calcite.	1	0.5
Marble	8	5
Chert: Recrystallized.	9	6
Vein Quartz	1	0.5
Quartz Schist	1	0.5
Total Number of Particles Examined	163	100%

1290'-1300'

Rock Type	Number of Particles	Percentage of Sample
Limestones	13	8
Phyllites	32	20
Metasandstones	65	41
Siltstones	9	6
Mudstones	7	4
Volcanics: Andesites, clay-chlorite and clay-hematite replaced.	4	3
Marble	12	8
Chert	9	6
Vein Quartz	7	4
Quartz-Feldspar Schist	1	0.6
Sericite Schist	1	0.6
Total Number of Particles Examined	160	100%

1390'-1400'

Rock Type	Number of Particles	Percentage of Sample
Limestones	13	7
Phyllites	38	19
Diorite: Primary pyroxene preserved in one chip; in most, montmorillonite replaced mafic minerals.	5	3
Metasandstones	96	49
Siltstone	17	9
Mudstone	14	7
Volcanics: Andesites; one replaced by hematite-clay; another by montmorillonite-illite.	2	1
Marble	7	4
Chert	4	2
Total Number of Particles Examined	196	100%

1490'-1500'

Rock Type	Number of Particles	Percentage of Sample
Limestone	14	6
Phyllite	35	16
Diorite: Mafic minerals replaced by chlorite$^{\pm}$ clays$^{\pm}$carbonate.	8	4
Metasandstone	88	41
Siltstone	18	8
Mudstone	11	5
Volcanics: Some are partially sericitized.	2	1
Marble	27	13
Chert	11	5
Vein Quartz: In phyllite	1	0.5
Chlorite Schist	1	0.5
Total Number of Particles Examined	216	100%

WELL: SR-3 | GEOLOGICAL REPORT | PAGE: 1 of 10 pages

LOCATION: Churchill Co., Nevada | WELL CUTTINGS SAMPLE DESCRIPTION | DATE: July 1980

ELEVATION: _____ | DEPTH: 0 TO 150'

HOLE SIZE: _____ | EXAMINED BY: M.J. Swanson

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
Feet			
0 to 10 s*	Black, white, pink, pale orange	Estimated proportions: 25% black, fine-grained, foliated, micaceous limestone; 30% black to green diorite/diabase; 40% white, pink, orange metasandstones; 5% calcite vein fragments; 3% drusy quartz vein fragments	Diorite, weakly to strongly clay-chlorite altered. Drusy quartz vein in metasandstone.
10 to 20 m*	Same as above.	Estimated proportions: 20% dark grey to black, fine-grained, foliated limestone; 40% black to green, fine- to medium-grained diorite/diabase; 10% white to light grey marble; 25% metasandstones; 1-2% drusy quartz.	Drusy quartz veins in chlorite-clay altered basalts. Traces of goethite in diorite and metasandstones.
20 to 30 m*	Same as above.	Based on examination of 64 chips: 10% black foliated limestone; 35% diorite/diabase; 11% black phyllite; 2% sericite phyllite; 27% metasandstone; 5% marble; 2% chert; 5% quartz veins; 5% calcite veins;	2% rhyolite. Traces of goethite in diorite. Drusy quartz veining.
30 to 40 m*	Same as above.	Based on 69 chips: 15% black limestone; 23% black phyllite; 21% diorite/diabase; 2% sericite phyllite; 2% marble; 25% metasandstone; 2% latite porphyry; 2% calcite veins; 2% quartz veins.	Traces of goethite (after pyrite?) in metasandstones and diorite. Quartz veins in black phyllite.
40 to 50 m*	Same as above.	Based on 123 particles: 27% black, foliated, micaceous limestone; 20% diorite/diabase; 14% black phyllite; 6% marble; 2% sericite phyllite; 17% metasandstone; 2% meta siltstone; 2% latite porphyry; 7% clay-sand	particles; 2% vein calcite; 1% vein quartz. Opal(?) veins occur in clay-sand matrix; goethite in metasandstone.
50 to 60 m*	Black, dark grey, white, pink	Based on 121 particles: 17% black, foliated limestone; 15% black phyllite; 20% diorite/diabase; 7% white and grey marble; 12% white, pink, buff metasandstone; 3% vein quartz; 1.0% vein calcite; 24% clay-sand matrix.	Traces of goethite in metasandstone. Quartz vein fragments.
60 to 70 m*	Same as above	Based on 90 particles: 20% black, foliated, limestone; 6% black phyllite; 3% sericite phyllite; 25% diorite/diabase; 2% latite porphyry; 8% marble; 1% meta-arkose; 2% chert; 22% metasandstone; 2% vein calcite; 3% clay-sand matrix.	Clay-sand coated with opal(?)/quartz veins; also occur on limestone and phyllite particles
70 to 80 s*	Same as above	Based on 75 particles: 25% black, foliated limestone; 18% diorite/diabase; 8% black phyllite; 3% sericite phyllite; 25% marble; 15% metasandstone; 1% vein quartz; 1% vein calcite; 3% clay-sand matrix.	Caliche coats a few diorite particles. Goethite in diorite. Opal/quartz veins on limestones.
80 to 90 m*	Same as above.	Based on 87 particles: 24% black, foliated limestone; 21% diorite/diabase; 6% black phyllite; 30% marble; 10% metasandstone; 1% vein quartz; 3% vein calcite; 6% clay-sand matrix.	Quartz vein in quartzite; weak chlorite-epidote in some diorite chips.
90 to 100 m*	Same as above	Based on 77 particles: 30% black, foliated limestone; 27% diorite/diabase; 6% black phyllite; 13% grey/black and white flow-banded marble; 8% metasandstone; 5% siltstone and clayey siltstone; 1% arkose; 3% vein quartz; 8% clay-sand	Quartz/opal(?) veins in metasandstone; phyllite, clay-sand material. Chlorite-clay alteration of diorite.
100 to 110 m*	Black, white, pink.	Based on 21 particles examined in thin-section: 35% black, foliated, micaceous limestone; 5% black phyllite; 15% diorite/diabase; 15% white to grey cherty marbles; 10% white, pink metasandstone; 20% chert.	Quartz-calcite veins in limestones contain goethite (after pyrite?)
110 to 120 m*	Same as above.	Alluvium. Particle distribution similar to previously described samples.	Traces of goethite (after pyrite?) in metasandstone and in diorite, clay-chl altered
120 to 130 m*	Same as above	Alluvium. Same as above.	Diorite weakly to moderately clay-chlorite altered; also andesites. Rare ribbon quartz veins in phyllites.
130 to 140 s*	Same.	Alluvium. Same.	Traces of goethite (after pyrite?) in diorite which is chlorite-clay or sericite-clay altered.
140 to 150 s*	Same.	Based on 69 particles: 17% black, foliated limestones; 6% basalt and andesite; 16% black phyllite; 15% diorite/diabase; 1% meta-arkose; 16% foliated grey and white marble; 1% sericite phyllite; 25% metasandstone; 1% vein quartz;	3% vein calcite. Traces of goethite in metasandstone; also rare qtz veins. Chlorite-clay alteration of diorite.

* These letters are explained in text of report.

WELL: SR-3 | GEOLOGICAL REPORT | PAGE: 2 of 10

LOCATION: Churchill Co., Nevada | WELL CUTTINGS SAMPLE DESCRIPTION | DATE: July 1980

ELEVATION: | DEPTH: 150' TO 300'

HOLE SIZE: | EXAMINED BY: M.J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
150' to 160' n	Same.	Based on 63 particles: 10% black, micaceous limestone; 16% black phyllite; 27% diorite; 16% grey and white, foliated marble; 8% clayey metasiltstone; 18% grey, white, buff metasandstone; 3% metaconglomerate; 3% clay-sand.	Diorite, weakly to moderately chlorite-clay altered. Traces of goethite (after py?) in metasandstone.
160' to 170' n	Same.	Alluvium. Particle distribution similar to previously described samples.	Diorite, chlorite-clay altered. Very minor quartz/opal veining in metasandstone.
170' to 180' n	Same.	Alluvium. Same.	Diorite, chlorite-clay altered.
180' to 190' m	Same	Alluvium. Same	Traces of goethite (after py?) in some metasandstone chips. Diorite, chl-clay altered.
190' to 200' n	Same.	Based on 80 particles (37 in thin-section): 1% black limestone; 60% black phyllites and sericite and chlorite phyllites; 11% diorite; 8% marble; 16% metasandstones; 1% vein quartz.	Diorite, sericite-clay-chlorite-carbonate altered.
200' to 210' n	Same.	Alluvium. Same.	Diorite, strongly chl-calcite altered. Traces of goethite (after py?) in metasandstone which also contains qtz veins.
210' to 220' n	Same	Alluvium. Same.	Same.
220' to 230' n	Same	Alluvium. Same	Same.
230' to 240' s	Same	Alluvium. Same	Same.
240' to 250' m	Same.	Alluvium. Same.	Same.
250' to 260' m	Same.	Based on 73 particles: 1% black, foliated limestone; 30% black phyllite; 6% chlorite phyllite; 7% diorite; 4% marble; 43% metasandstone; 1% vein quartz; 8% clay-sand.	Same.
260' to 270' m	Same.	Alluvium. Same.	Same.
270' to 280' m	Same	Alluvium. Same.	Same.
280' to 290' s	Same.	Alluvium. Same.	Same.
290' to 300' s	Same	113 particles examined in thin-section: 10% black, foliated limestone; 18% phyllite; 12% diorite; 4% marble; 2% clayey siltstone; 1% siltstone; 12% mudstone; 22% metasandstone; 14% chert; 2% vein quartz; 3% latite.	Diorite, chl-mont-calcite altered. Traces of goethite (after py?) in mudstone.

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LOCATION: Churchill Co., Nevada | WELL CUTTINGS SAMPLE DESCRIPTION | DATE: July 1980

ELEVATION: | DEPTH: 300' TO 450'

HOLE SIZE: | EXAMINED BY: M. J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
300' to 310' s	Same.	Very similar to previous sample. Clay-sand material is attached to surface of some clasts.	Same.
310' to 320' st	Same.	Based on 75 particles: 50% black, foliated phyllite; 10% andesite; 5% diorite; 15% grey and white marble; 5% chloritic meta-sandstone; 18% meta sandstone; 1% chert; 3-5% clay-sand matrix.	Same.
320' to 330' st	Same.	Alluvium. Same as above.	Same.
330' to 340' m	Same	Alluvium. Same as above.	Same.
340' to 350' m	Black, buff, white.	Based on 50 particles: 26% black phyllite; 2% chlorite phyllite; 2% sericite phyllite; 66% metasandstone; 2% vein quartz; 2% chert.	Traces of goethite (after py?) in metasandstone; goethite in qtz vein in phyllite.
350' to 360' m	Same	Alluvium. Same as above.	Same.
360' to 370' m	Same.	Alluvium. Same as above.	Same.
370' to 380' s	Same.	Alluvium. Same as above.	Same.
380' to 390' s	Same.	Alluvium. Same as above.	Same
390' to 400' s	Same	131 particles examined in thin-section: 2% black, foliated limestone; 33% black phyllite; 2% diorite; 3% marble; 2% clayey siltstone; 2% mudstone; 50% metasandstone; 5% chert; 2% chlorite schist; 1% pyrite.	One fragment of fresh pyrite seen. Thin quartz veins in most rock types. Tr goethite in metasandstones.
400' to 410' s	Same.	Alluvium. Same as above.	Same.
410' to 420' st	Same	Alluvium. Same as above.	Same.
420' to 430' st	Same	Alluvium. Same as above.	Same.
430' to 440' s	Same.	Alluvium. Same as above.	Same.
440' to 450' s	Same	Alluvium. Same as above.	Same.

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LOCATION: Churchill Co., Nevada | WELL CUTTINGS SAMPLE DESCRIPTION | DATE: July 1980

ELEVATION: | DEPTH: 450' TO 600'

HOLE SIZE: | EXAMINED BY: M.J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
450' to 460' s	Buff, black, pink	Based on 63 particles: 30% black phyllite; 3% diorite; 3% marble; 62% buff, grey or white metasandstone; 2% clay-sand matrix.	Traces of goethite (after py?) in metasandstone; goethite also in qtz vein in phyllite.
460' to 470' st	Same.	Alluvium. Same as above.	Same.
470' to 480' m	Same.	Alluvium. Same as above.	Same.
480' to 490' m	Same.	Alluvium. Same as above.	Same.
490' to 500' m	Same.	Based on 79 particles examined in thin-section: 19% black, foliated limestone; 29% phyllite; 15% marble; 4% siltstone; 18% metasandstone; 13% chert; 3% clay-sand matrix.	Same.
500' to 510' st	Same.	Alluvium. Same as above.	Traces of goethite (after pyrite?) in meta sandstones.
510' to 520' st	Same.	Alluvium. Same as above.	Same. Quartz vein in phyllite.
520' to 530' s	Same	Alluvium. Same as above.	Same.
530' to 540' s	Same.	Alluvium. Same as above.	Same.
540' to 550' st	Same.	Alluvium. Same as above.	Same.
550' to 560' st	Same.	Alluvium. Same as above.	Same.
560' to 570' st	Same.	Alluvium. Same as above.	Same.
570' to 580' st	Same.	Alluvium. Same as above.	Same.
580' to 590' st	Same.	Alluvium. Same as above.	Same.
590' to 600' st	Black, green-grey, buff, white.	Alluvium. About 30% of sample is composed of dark green-grey mudstone which contains 0.1 to 0.5 volume % pyrite. Mudstone disaggregates on wetting. Remainder of sample same as above.	Fresh pyrite disseminated in mudstone.

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LOCATION: Churchill Co., Nevada | WELL CUTTINGS SAMPLE DESCRIPTION | DATE: July 1980

ELEVATION: | DEPTH: 600' TO 750'

HOLE SIZE: | EXAMINED BY: M.J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
600' to 610' st	Same	Alluvium. Same as above.	Traces of goethite (after py?) in metasandstones.
610' to 620' st	Same.	Alluvium. Same clast types as described above. Sand-clay material attached to a few particles.	Same.
620' to 630' st	Same.	Alluvium. Same as above.	Same. A few particles from drusy quartz veins. A few, free, partially oxidized py.
630' to 640' st	Same.	Alluvium. Same as above. Contains a few, free or loose pyrite crystals.	An unoxidized pyrite-quartz fragment; py also in chert(?); goethite in metasandstones.
640' to 650' st	Same.	Alluvium. Same as above.	Same.
650' to 660' st	Same.	Alluvium. Same as above.	Pyrite unoxidized in some meta-sandstone particles.
660' to 670' n	Black, green-grey, white.	Based on 68 particles: 1% black limestone; 13% black phyllite; 3% dark red mudstone; 31% diorite/andesite; 6% marble; 4% siltstone; 4% clayey siltstone; 28% metasandstone; 3% chloritic sandstone;	4% chert; 3% clay-sand matrix. Tr py in metasandstone.
670' to 680' n	Same.	Alluvium. Same as above.	Loose pyrite crystals in sample; calcite veins in clay-sand material.
680' to 690' n	Same.	Alluvium. Same as above.	Same.
690' to 700' s	Same.	Alluvium. Essentially same as above. See thin-section description.	Calcite veining in clay-sand material; trace of py. in siltstone.
700' to 710' n	Same.	Alluvium. Same as above.	Narrow drusy quartz veins in diorite and metasandstone.
710' to 720' n	Same.	Alluvium. Same as above.	Goethite (after py? in metasandstone; loose py grains.
720' to 730' st	Same.	Alluvium. Same as above.	Same as above; also py in siliceous particles, chert?
730' to 740' n	Same	Alluvium. Same as above.	Same.
740' to 750' m	Same.	Alluvium. Same as above.	More loose py crystals in this sample than previous ones.

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LOCATION: Churchill Co. Nevada | WELL CUTTINGS SAMPLE DESCRIPTION | DATE: July 1980

ELEVATION: _____ | DEPTH: 750' TO 900'

HOLE SIZE: _____ | EXAMINED BY: M.J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
750'to 760'st	Black, buff, white	Alluvium. Same as above.	Loose, euhedral pyrites, Py also attached to siliceous particles. Fragments of botryoidal goethite w/ pyrite.
760'to 770'n	Same	Alluvium. Same	Same.
770'to 780'st	Same.	Alluvium. Same	Same. Py forms about 0.5% of washed sample.
780'to 790'n	Same	Alluvium. Same	Same.
790'to 800'n	Black, grey, buff, white	Based on 181 particles examined in thin-section: 6% limestone; 25% phyllite; 1% clay-altered volcanics; 2% diorite; 8% marble; 7% siltstone; 27% metasandstone; 1% vein quartz; 1% vein calcite; 2% quartz-feldspar schist;	6% chert; 14% mudstone; 1% sand-clay matrix material. Py in siltstone.
800'to 810'n	Same.	Alluvium. Same.	Same.
810'to 820'n	Same.	Alluvium. Same.	Same as above. Also particles of py associated with calcite and clay - from veins? Transported limonite also.
820'to 830'n	Same.	Alluvium. Same.	Same.
830'to 840's	Same.	Alluvium. Same.	Same.
840'to 850'n	Same.	Alluvium. Same.	Same.
850'to 860'm	Same	Alluvium. Same.	Fragments of drusy qtz veins more abundant than usual.
860'to 870's	Same.	Alluvium. Same.	Same.
870'to 880'st	Same	Alluvium. Same.	Same.
880'to 890'm	Same.	Alluvium. Same.	Same.
890'to 900'm	Same.	120 particles examined in thin-section: 12% limestone; 14% phyllite; 1% andesite; 1% diorite; 8% marble; 12% siltstone; 33% meta sandstone; 4% chert; 4% vein quartz; 1% vein calcite; 5% mudstone; 2% schist; 3% clay-carbonate-sand material.	Py content less than 1%; fragments of transported limonites in veins.

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LOCATION: Churchill Co., Nevada | WELL CUTTINGS SAMPLE DESCRIPTION | DATE: July 1980

ELEVATION: _____ | DEPTH: 900' TO 1050'

HOLE SIZE: _____ | EXAMINED BY: M. J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
900' to 910' m	Black, buff, white	Alluvium. Same as previously described sample.	Most py is oxidized to goethite. Py comprises less than 0.5 volume % of sample.
910' to 920' st	Same.	Alluvium. Same.	Same.
920' to 930' m	Same	Alluvium. Same	Same.
930' to 940' m	Same.	Alluvium. Same.	Py is about half replaced by goethite.
940' to 950' s	Same	Alluvium. Same.	Same.
950' to 960' m	Same.	Alluvium. Same.	Some
960' to 970' s	Same	Alluvium. Same.	Same.
970' to 980' s	Some	Alluvium. Same.	Same.
980' to 990' s	Some.	Alluvium. Same.	Same.
990' to 1000' s	Buff, white, black.	204 particles examined in thin-section: 13% black limestone; 12% black phyllite; 0.5% diorite; 13% white and grey marble; 4% siltstone; 4% mudstone; 45% buff and white metasandstone; 6% grey chert; 1% vein qtz; 1% schist; 0.5% clay-sand.	Disseminated py is oxidized; pieces of transported limonite crust present.
1000' to 1010' s	Same.	Alluvium. Same.	Loose py crystals are oxidized; otherwise same as above.
1010' to 1020' s	Same.	Alluvium. Same.	Same.
1020' to 1030' s	Same.	Alluvium. Same.	Same.
1030' to 1040' s	Same	Alluvium. Same.	Same.
1040' to 1050' s	Same	Alluvium. Same.	Same.

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LOCATION: Churchill Co., Nevada | WELL CUTTINGS SAMPLE DESCRIPTION | DATE: July 1980

ELEVATION: _____ | DEPTH: 1050' TO 1200'

HOLE SIZE: _____ | EXAMINED BY: M.J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
1050' to 1060's	Black, buff, white	Alluvium. Clast lithology similar to description of sample at 990'-1000'.	Goethite (after py?) disseminated through siltstone, metasandstone. Loose py crystals oxidized.
1060' to 1070's	Same	Alluvium. Same.	Same.
1070' to 1080's	Same.	Alluvium. Same.	Same.
1080' to 1090's	Same.	Alluvium. Same.	Same.
1090' to 1100's	Same.	172 particles examined in thin-section: 8% black, foliated limestone; 12% black phyllite; 1% andesite (chlorite-carbonate altered); 1% diorite; 8% marble; 5% siltstone; 5% mudstone; 51% metasandstone; 7% chert; 3% vein quartz; 2% clay-sand.	Traces of pyrite in siltstone and mudstone.
1100' to 1110'm	Same.	Alluvium. Same.	Same. Loose py grains and all disseminated py oxidized.
1110' to 1120'm	Same.	Alluvium. Same.	Same. Narrow calcite veins in clay-sand lithic material. Some fresh py; most oxidized.
1120' to 1130'm	Same.	Alluvium. Same.	Py all oxidized.
1130' to 1140'st	Same.	Alluvium. Same.	Py mostly oxidized.
1140' to 1150'm	Same	Alluvium. Same	Py mostly oxidized. Colloidal, transported limonite fragments present as in-most of cavities
1150' to 1160'st	Same.	Alluvium. Same.	Same.
1160' to 1170'm	Same.	Alluvium. Same.	Same.
1170' to 1180's	Same.	Alluvium. Same.	Same.
1188' to 1190's	Same.	Alluvium. Same.	Trace of py in thin calcite vein on metasandstone. Most py oxidized.
1190' to 1200's	Same.	162 particles examined in thin-section: 10% phyllite; 1% diorite; 1% andesite; 5% marble; 4% siltstone; 50% metasandstone; 6% chert; 0.5% vein quartz; 0.5% qtz-feldspar schist.	Loose py crystals and disseminated py mostly oxidized.

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LOCATION: Churchill Co., Nevada | WELL CUTTINGS SAMPLE DESCRIPTION | DATE: July 1980

ELEVATION: _____ | DEPTH: 1200' TO 1350'

HOLE SIZE: _____ | EXAMINED BY: M. J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
1200' to 1210' n	Buff, black	Alluvium. Clast lithology similar to previous sample.	Same as above.
1210' to 1220' n	Same.	Alluvium. Same.	As above; most py is oxidized.
1220' to 1230' m	Same.	Alluvium. Same.	Proportion of fresh py slighty higher. Py-qtz vein attached to metasandstone.
1230' to 1240' n	Same.	Alluvium. Same.	Same. Py content less than 0.5 volume %.
1240' to 1250' n	Same.	Alluvium. Same.	Same.
1250' to 1260' n	Same.	Alluvium. Same.	Same.
1260' to 1270' m	Same.	Alluvium: Same. Clay-sand matrix material is darker red than in previous samples.	Same.
1270' to 1280' n	Same.	Alluvium. Same.	Same.
1280' to 1290' n	Same.	Alluvium. Same.	Same.
1290' to 1300' n	Buff, black.	160 particles examined in thin-section: 8% black, foliated limestone; 20% black phyllite; 3% clay-altered andesites; 8% marble; 6% siltstone; 40% mudstone; 41% metasandstone; 6% chert; 4% vein quartz; 1% schist.	Most py oxidized; py occurs as loose crystals and as disseminations in metasandstones, shullites.
1300' to 1310' n	Same	Alluvium. Same.	Same.
1310' to 1320' n	Same	Alluvium. Same.	Same
1320' to 1330' n	Same.	Alluvium. Same.	Same.
1330' to 1340' n	Same.	Alluvium. Same.	Same.
1340' to 1350' n	Same	Alluvium. Same.	Same.

WELL: SR-3 | GEOLOGICAL REPORT | PAGE: 10 of 10

LOCATION: Churchill Co., Nevada | WELL CUTTINGS SAMPLE DESCRIPTION | DATE: July 1980

ELEVATION: _____ | DEPTH: 1350' TO 1500'

HOLE SIZE: _____ | EXAMINED BY: M.J. Sweeney

DEPTH	COLOR	SAMPLE DESCRIPTION	
		PRIMARY	SECONDARY
feet			
1350' to 1360' n	Same.	Alluvium. Same.	Same.
1360' to 1370' n	Same.	Alluvium. Same.	Same.
1370' to 1380' n	Same	Alluvium. Same.	Same.
1380' to 1390' n	Same	Alluvium. Same.	Py fresh in mudstones; oxidized in metasandstones.
1390' to 1400' n	Same.	196 particles examined in thin-section: 7% black, foliated limestone; 19% phyllite; 1% clay-altered andesites; 3% diorite (w/fresh px); 4% marble; 9% siltstone; 7% mudstone; 49% metasandstone; 2% chert.	Same
1400' to 1410' n	Same	Alluvium. Same.	Same. Some of loose py grains are fresh.
1410' to 1420' n	Same	Alluvium. Same.	Same.
1420' to 1430' n	Same.	Alluvium. Same.	Same.
1430' to 1440' n	Same.	Alluvium. Same.	Most py oxidized.
1440' to 1450' n	Same.	Alluvium. Same.	Same.
1450' to 1460' n	Same	Alluvium. Same.	Same.
1460' to 1470' n	Same.	Alluvium. Same.	Same.
1470' to 1480' n	Same	Alluvium. Same	Same.
1480' to 1490' n	Same.	Alluvium. Same.	Same.
1490' to 1500' n	Same.	216 particles examined in thin-section: 6% black, foliated limestone; 16% phyllite; 1% clay-altered volcanics; 4% diorite; 13% marble; 8% siltstone; 5% mudstone; 41% metasandstone; 5% chert; 1% vein quartz-	1% chlorite schist. Some of loose py crystals are unoxidized.