FILE NOTATIONS

Entered in N I D File	✓	Checked by Chief	PMB
Entered On S R Sheet	✓	Copy N I D to Field Office	
Location Map Pinned		Approval Letter	10-2-67
Card Indexed	✓	Disapproval Letter	
I W R for State or Fee Land			

COMPLETION DATA:

Date Well Completed 10-8-68   Location Inspected ....

OW........ WW........ TA........   Bond released

GW........ OS........ PA ✓   State of Fee Land ....

LOGS FILED

Driller's Log 11-4-68

Electric Logs (No.) 10

E........ I........ E-I........ GR........ GR-N (2) Micro........

DI Lat 2 Mi-L........ BHC Sonic (2) Others........

Dual Caliper (2)

Formation Density (2)

SHELL OIL COMPANY
1700 BROADWAY
DENVER, COLORADO 80202

September 29, 1967

Subject: Shell-Government 21X-9
NE NW Section 9-T 2N-R 14E
Dahlgreen Creek Unit
Summit County, Utah

Mr. Cleon Feight
Utah Oil and Gas Conservation Commission
348 East South Temple
Suite 301
Salt Lake City, Utah 84111

Dear Mr. Feight:

We have attached two copies of the Application for Permit to Drill the captioned well. As you will note, the staked location does not comply with Rule C-3 specifying that no well be located less than 500 feet from any property or lease lines or from the boundary of any legal subdivision comprising a governmental quarter quarter section. The location, as staked, was agreed to by Mr. Marvin H. Combs, District Forest Ranger, U. S. Department of Agriculture, Mountain View, Wyoming, who accompanied our drilling personnel to the location. The drilling site is best situated to alleviate drainage problems and also minimizes the destruction of timber.

The Shell-Government 21X-9 is located in the Dahlgreen Creek Unit which has been preliminarily approved by the U. S. Geological Survey in their letter dated March 28, 1967. The ownership of all oil and gas leases within a radius of 660 feet of the proposed location is common with the ownership of the oil and gas leases under the proposed location. We respectfully request that the location as staked be approved.

Very truly yours,

J. W. Zoller
Division Production Manager
Rocky Mountain Division

Attachments

Form 9-331 C
(May 1963)

SUBMIT IN TRIPLICATE*
(Other instructions on reverse side)

Form approved.
Budget Bureau No. 42-R1425.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

APPLICATION FOR PERMIT TO DRILL, DEEPEN, OR PLUG BACK

1a. TYPE OF WORK
DRILL [X] DEEPEN [ ] PLUG BACK [ ]

b. TYPE OF WELL
OIL WELL [X] GAS WELL [ ] OTHER SINGLE ZONE [X] MULTIPLE ZONE [ ]

2. NAME OF OPERATOR
Shell Oil Company (Rocky Mountain Division Production)

3. ADDRESS OF OPERATOR
1700 Broadway, Denver, Colorado 80202

4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.*)
At surface 1096' FNL and 2243' FWL Section 9
At proposed prod. zone

5. LEASE DESIGNATION AND SERIAL NO.
U-0120765

6. IF INDIAN, ALLOTTEE OR TRIBE NAME

7. UNIT AGREEMENT NAME
Dahlgreen Creek Unit

8. FARM OR LEASE NAME
Government

9. WELL NO.
21X-9

10. FIELD AND POOL, OR WILDCAT
Wildcat

11. SEC., T., R., M., OR BLK. AND SURVEY OR AREA
NE/4 NW/4 Section 9-T 2N-R 14E

12. COUNTY OR PARISH
Summit

13. STATE
Utah

14. DISTANCE IN MILES AND DIRECTION FROM NEAREST TOWN OR POST OFFICE*

15. DISTANCE FROM PROPOSED* LOCATION TO NEAREST PROPERTY OR LEASE LINE, FT. (Also to nearest drlg. unit line, if any) 1096'

16. NO. OF ACRES IN LEASE
2079

17. NO. OF ACRES ASSIGNED TO THIS WELL
0

18. DISTANCE FROM PROPOSED LOCATION* TO NEAREST WELL, DRILLING, COMPLETED, OR APPLIED FOR, ON THIS LEASE, FT. 8600'

19. PROPOSED DEPTH
15,800'

20. ROTARY OR CABLE TOOLS
Rotary

21. ELEVATIONS (Show whether DF, RT, GR, etc.)
9,000' GL Est

22. APPROX. DATE WORK WILL START*
Immediately

23.
PROPOSED CASING AND CEMENTING PROGRAM

SIZE OF HOLE	SIZE OF CASING	WEIGHT PER FOOT	SETTING DEPTH	QUANTITY OF CEMENT

Designation of Operator has been sent directly to the U.S.G.S. by Mobil Oil Company.

As per attached survey plat. Complete drilling prognosis to follow.

We plan to drill 12¼" hole to 3,000' - and set 9-5/8" casing, drill to 11,000' - and DST Mesaverde formation, drill 8-3/4" hole to 14,300 - and DST Dakota formation, drill to TD of 15,800' and, if tests warrant, run 7" casing and complete as a producing well.

43-043-20292

/2 cc: Utah Oil and Gas Conservation Commission
348 East South Temple
Suite 301
Salt Lake City, Utah 84111

IN ABOVE SPACE DESCRIBE PROPOSED PROGRAM: If proposal is to deepen or plug back, give data on present productive zone and proposed new productive zone. If proposal is to drill or deepen directionally, give pertinent data on subsurface locations and measured and true vertical depths. Give blowout preventer program, if any.

24.
ORIGINAL SIGNED BY
SIGNED R. L. SPOTTSWOOD TITLE Division Exploitation Engr. DATE September 29, 1967

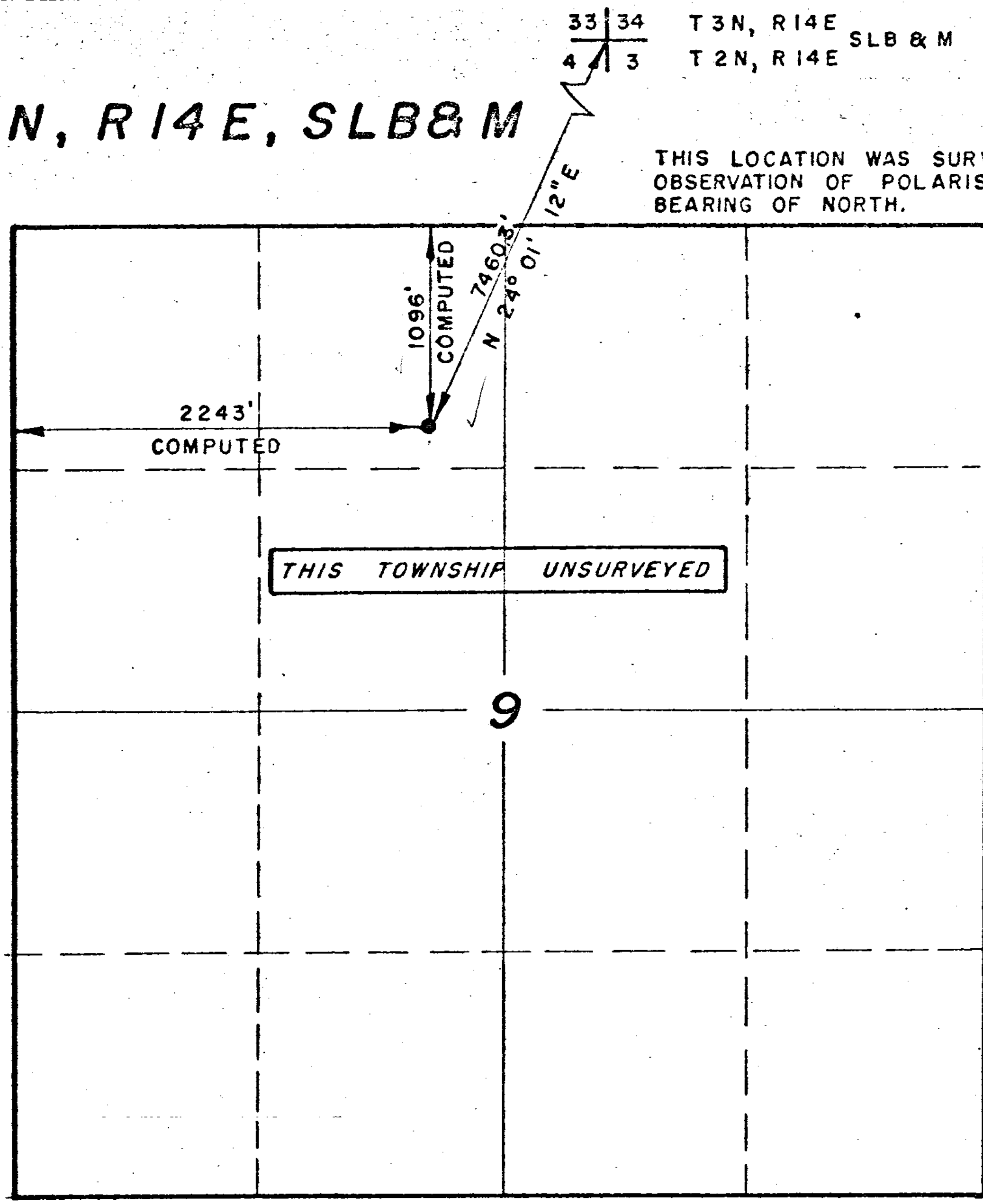
(This space for Federal or State office use)

PERMIT NO. ________ APPROVAL DATE ________

APPROVED BY ________ TITLE ________ DATE ________
CONDITIONS OF APPROVAL, IF ANY:

*See Instructions On Reverse Side

T2N, R14E, SLB&M



THIS LOCATION WAS SURVEYED BY A USING A OBSERVATION OF POLARIS FOR THE TRUE BEARING OF NORTH.

PROJECT

Shell Oil Co. Dahlgreen Creek A
1670 Location, Located as shown
the NW1/4 of Section 9, T 2 N, R 1
SLB & M, (Unsurveyed Township), Summ
County, Utah. Section information and
ation taken from UTAH PROTRACTION N
Bureau of Land Management U.S.A.

CERTIFICATE

THIS IS TO CERTIFY THAT THE ABOVE PLAT WAS PREPA FROM FIELD NOTES OF ACTUAL SURVEYS MADE BY ME OR UND MY SUPERVISION AND THAT THE SAME ARE TRUE AND CORREC TO THE BEST OF MY KNOWLEDGE AND BELIEF.

REGISTERED LAND SURVEYO
REGISTRATION Nº 2454 UTA

Uintah Engineering & Land Surveying BOX Q VERNAL, UTAH	SCALE 1" = 1000'	DATE SEPT., 18, 19
	PARTY L.K., L.T., G.L.	REFERENCES GLO PLAT
	WEATHER COOL	FILE SHELL

amerada

Dan Fuers - Amerada Hammell

390' Sufac 9 5/8 32.30 # per ft

Cemented 300 sax

Follow 95 SE Hites crossing

14 miles then turn to right on sign

To Grand Staircase follow 2 miles &

then right on new + pay off

Lewis Stock - Shell oil min

sec 9 2N - 14E

1096 FNL 2243 FWL

Gave 2-1x9 U-0120765

will send topographer because

ranger said not here will cost to

go - approved this date 9/29/67

[illegible]

October 2, 1967

Shell Oil Company,
1700 Broadway,
Denver, Colorado 80202

Re: Well No. Dahlgreen Creek Unit #21X-9,
Sec. 9, T. 2 N., R. 14 E.,
Summit County, Utah.
API number 43-043-20293

Gentlemen:

This letter is to confirm verbal approval granted by Mr. Cleon B. Feight, Director on September 29, 1967 in accordance with Rule C-3(c) General Rules and Regulations and Rules of Practice and Procedure.

Should you determine that it will be necessary to plug and abandon this well, you are hereby requested to immediately notify the following:

PAUL W. BURCHELL, Chief Petroleum Engineer
HOME: 277-2890 - Salt Lake City, Utah
OFFICE: 328-5771

Enclosed please find Form OGC-8-X, which is to be completed whether or not water sands (aquifers) are encountered while drilling. Your cooperation with respect to completing this form will be greatly appreciated.

Very truly yours,

DIVISION OF OIL & GAS CONSERVATION

CLEON B. FEIGHT
DIRECTOR

CBF:sc

cc: U. S. Geological Survey
Rodney Smith, District Engineer
8416 Federal Building
Salt Lake City, Utah 84111

DRILLING PROGNOSIS
GOVERNMENT 21X-9
DAHLGREEN CREEK UNIT

LOCATION: 2243' FWL, 1096' FNL, Section 9, T2N, R14E, Summit County, Utah
ELEV: 9950'
EST. TD: 15,500'

1. Drill 26" hole to 200'±.

2. Run 20" casing to 200'±. Cement casing w/cement treated w/$CaCl_2$. Recement if cement returns are not obtained. WOC 12 hours. (Casing: 20", 94#, H-40, ST&C).

3. Install 20" Series 600 casing head, choke spool, and 20" Series 600 Hydril.

4. Drill 12 1/4" hole.

   (a) If water flow and/or excessive sloughing shale are not experienced drill to 3000 ± feet. If lost circulation zone present at or near 3000 feet drill 200 feet below LC zone. Casing pt. to also be 500' below Henry's Fork Fault.

   (b) If water flow and/or excessive sloughing occur relatively shallow (800'±), open hole to 17 1/2". Run 13 3/8" casing and cement WOC 12 hours. (Casing: 13 3/8", 48#, H-40, ST&C). Cut off 20" at GL.

   Install 12" Series 900 casing head, choke spool and 12" nominal preventors and Hydril.

   Continue with 12 1/4" hole to 3000± feet. If lost circulation zone present at or near 3000 feet drill 200 feet below LC zone. Csg. pt. 500' below fault.

5. Run 9 5/8" casing to TD of 12 1/4" hole. Cement casing as follows: First Stage: 1:1 pozmix; 2% gel & tail w/200 sacks Class "G" neat cement. Second Stage: wait 2 hours, cement thru DV (location subject to LC experience), 1:1 pozmix with 2% $CaCl_2$. Recement if returns are not obtained. WOC 12 hours (min). (Casing: 9 5/8", 40#, J-55, ST&C - Drifted to 8 3/4" ID).

6. Flange up casing and install blowout prevention equipment and casing head wear flange (as per Shell Drawing Z1-1141, BOP for high pressure well--See Note i.). Test BOP equipment and casing with 1500 psi for 15 minutes before drilling casing shoe. Cut off 13 3/8" or 20" at GL.

7. Drill 8 3/4" hole to the Lower Hilliard at 14,500'±. Consult with Division office if mud weight must be increased.

8. Continue drilling 8 3/4" hole to TD* or consider running 7" casing and drilling 6 1/8" hole depending on conditions encountered in the Lower Hilliard. See Mud Prognosis for mud details. Run Survey's, DST's and case as directed. Supplemental work sheet will cover casing, cementing and completion or abandonment.

NOTES:

   a. Check BOP equipment daily and enter operating condition on tour sheet.

*Depths to be determined by Exploitation Engineer.

b. Use drill pipe casing protectors (one per joint) and casing head wear ring while drilling in casing.

c. Record drilling time on penetration rate recorder from surface to TD.

d. Tally DP @ 3,000'±, 10,000'±, 14,500'± and TD and/or prior to DST's. Retally discrepancy of more than 3'. Enter tally on tour sheets.

e. Lag and collect 20' samples from surface to 10,500'±* (1 wet, 1 dry). Lag and collect 10' samples from 10,500 to TD. (1 wet/1 dry to 12,650', 2 wet/1 dry 12,650 to TD.)

f. Measure hole deviation at 500' intervals or less as required and record on tour sheets. Maintain within following limits:

Sfc to 200' not more than	1^o
200' to 1,000'	2^o
1,000' to 2,000'	3^o
2,000' to 3,000'	4^o
3,000' to TD	

Mechanical hole consideration are to govern deviation control, however, hole must bottom in a target where critical boundary is a lease line 1096' to the north. Single shot surveys are to be taken every 500' until it is established that hole will bottom in desired target area. Division management will establish additional deviation controls as necessary.

g. Provide for two DST's.

h. Provide for two 50' cores in the Dakota*

i. Prior to penetrating the Hilliard @ 12,500'± if warranted, consider installing 1. pit level recorder and warning device, 2. mud weight recorder, 3. flow rate analyzer, 4. degasser and, 5. Swaco adjustable choke.

*Depths to be determined by Exploitation Engineer.

MUD PROGNOSIS

Depth	Type Mud	(Max) Weight #/gal	Water Loss API	Plastic Viscosity	Oil
0 - 3,000'±	Dextrid Cypan	9.0	4-8 cc	As req'd	None
3,000 - 12,500'±	Dextrid Cypan	As req'd	4-8 cc	As req'd	5%
12,500'± - TD	To be determined	As req'd	4 or less	As req'd	5%

1. Maintain mud weight and viscosity as low as hole conditions permit for better bit performance.

2. Run Desander and Desilter at all times with unweighted mud system. If mud weight must be increased with barite in the Lower Hilliard, run Desander only. Record weight and loss on daily drilling and mud report.

ACM:AKD:st
Revised 10-13-67

J. G. Yope

DAHLGREEN CREEK UNIT
GOVERNMENT 21X-9
NE/4 NW/4 SECTION 9-T 2N-R 14E
SUMMIT COUNTY, UTAH

The above location does not comply with Rule C-3 of the Oil and Gas Conservation Commission of the State of Utah. We have requested that the Commission waive Rule C-3 for this location in view of topographic restrictions.

O-432 (REV. 3-63) PRINTED IN U.S.A.

INTEROFFICE MEMORANDUM

TO	OIL AND GAS CONSERVATION COMMISSION - SALT LAKE CITY ATTENTION: MR. CLEON FEIGHT	DATE	NOVEMBER 28 1967
FROM	M. K. GRIGORAKIS - SHELL OIL COMPANY ROCKY MOUNTAIN DIV. PROD. DEPT.	SUBJECT	DRILLING PROGNOSIS GOVERNMENT 21X-9
COPIES TO		REPLYING TO YOUR LETTER	DAHLGREEN CREEK AREA SUMMIT COUNTY, UTAH

Attached are three (3) copies of the above-captioned prognosis for your information regarding the procedures of our drilling program on the subject well.

(Miss) M. K. Grigorakis

Attachments

COMPLETION PROGNOSIS
DAHLGREEN CREEK UNIT
GOV'T 21X-9
2243' FWL & 1096' FNL
SECTION 9, 2N, 14E
SUMMIT COUNTY, UTAH

PERTINENT DATA:

ELEV:	9940' KB	9 5/8" CASING:	4,900'
KB-CHF:	17'	7" CASING:	13,889'
TD:	17,100'	5" LINER:	17,069'
13 3/8" CASING:	461'		

Ran 86 jts 18# P-110 NWS and N-80 5" Hydril FJ Liner at 17,069'. Shoe at 17,069', back pressure valve at 17,024', landing collar at 16,981', crossover bushing at 13,669', BOT boll weevil hanger at 13,663' and tie-back sleeve at 13,655'. Cemented with 400 sx Class "G" neat cement. Good returns throughout job. Did not bump plug.

Pressure tested well with 10.7#/gallon mud. Injected 52 gallons per minute at 1100 psi. Pressure bled to 75 psi in three hours. (Possible liner hanger leak.)

Hole is loaded with 10.7# per gallon drilling mud.

PROCEDURE: (All depths refer to the Gamma Ray-Neutron log run August 30, 1968.)

1. MIRU completion rig. Install blowout preventors. Run 3 1/2" tubing string with 2 joints 2 7/8" tubing on bottom and 5" retrievable packer on lower joint of 2 7/8". Set packer @ 13,700'± and pressure test 5" liner to 2000 psi. Pull tubing and packer.

2. Run 7" retrievable packer on 3 1/2" tubing and set packer @ 13,600±. Pressure test casing above packer to 1500 psi. Pressure test liner hanger to 1500 psi. Pull tubing and packer.

3. If liner hanger is source of leak, run 7" Model "K" Mercury series cement retainer on wire line and set @ 13,500'±. Squeeze liner hanger w/150 sacks Class "G" neat cement containing 1% D-60 and enough D-13 to allow for four hours pumpability @ 200°F. (Pre-test cement in Dowell's Casper laboratory. For tests, use location water that will actually be used on job.)

4. WOC 24 hours.

5. Clean out to 17,020'. Pressure test casing and liner hanger to 1500 psi.

6. Displace hole w/clean produced water.

7. Run OWP Cement Bond Log and Gamma Ray-Neutron Log from PBTD to liner hanger. Run velocity survey from PBTD to 13,813' (top of Mesa Verde). (Exploration Dept. will furnish details and supervision for this item.)

8. Check liner w/gauge ring and run 5" Baker production packer on wire line and set near top of 5" liner in section where good bonding is indicated by CBL.

Information released to news media serving the petroleum industry by Shell Oil Company indicates that Shell's #1 Dahlgreen Creek Unit test, SE NE NW Section 9, T2N, R14E, Summit County, penetrated the North Flank Fault at shallow depth thus proving that the fault is a reverse type or thrust fault with a south-dipping plane (see Quarterly Review, Feb. '67, p. 1 and Aug. 67, p. 7).

The well is located 3.5 miles southwest of the Bridger Lake Oil Field under development by Phillips Petroleum. It is about one mile south (mountainward) of the concealed trace of the North Flank Fault and four miles north of the boundary of the proposed High Uintas Wilderness Area.

Spudded on glacial deposits, the well encountered questionable Madison Limestone (Mississippian age) at 445 feet, then drilled limestone for about another 370 feet. The North Flank Fault was crossed at about 815 feet and the drilling passed into formations identified as Tertiary, possibly the Fort Union Formation of Paleocene age. Between 2434 and 2602 three thin porous sandstones with shows of live oil were encountered. However, a drill stem test from 2400 to 2605 recovered only drilling mud.

Preliminary information from this single well thus indicates the North Flank Fault is a very shallow thrust which dips to the south beneath the Uinta Mountains at between 10° and 15°. The hypothesis that oil-bearing formations of the Green River Basin might extend southward for many miles beneath the overthrust sheet has become a distinct geologic possibility.

Shell was last reported drilling below 4800 feet toward the Dakota Formation oil sands expected at 15800 feet.

9. Run 3 1/2" tubing & 2 7/8" w/20' seal assembly and sting through production packer. Hydrotest tubing to 9000 psi above slips while going in hole. Remove BOP and install Christmas Tree. Swab fluid level down to 3000'.

10. Run through-tubing decentralized aluminum capsule perforating gun and perforate @ each of the following depths with one 3/8" jet: (Use high pressure lubricator pre-tested to 2500 psi.)

16,917, 16,918, 16,919, 16,920, 16,921, 16,922, 16,923, 16,924, 16,925, 16,926, 16,927, 16,928, 16,933, 16,934, 16,935, 16,936, 16,937, 16,938, 16,939, 16,940, 16,941, 16,942, 16,948, 16,949, 16,950, 16,951, and 16,952.

10. Run 6-hour static bottom hole pressure survey. Run bomb to 16,900'.

11. If well is dead, swab tubing load and make production test. Contingent on results of swab test, either a) put well on production and complete, b) consider fracture treating Dakota gross perfs 16,917-16,952', or c) consider opening and testing zones at 16,782-85', 16,806-11' & 16,860-71'. (Note: Details of fracture treatment, if needed, will be supplied at a later date.)

F. D. Burnside

Div. E. E.

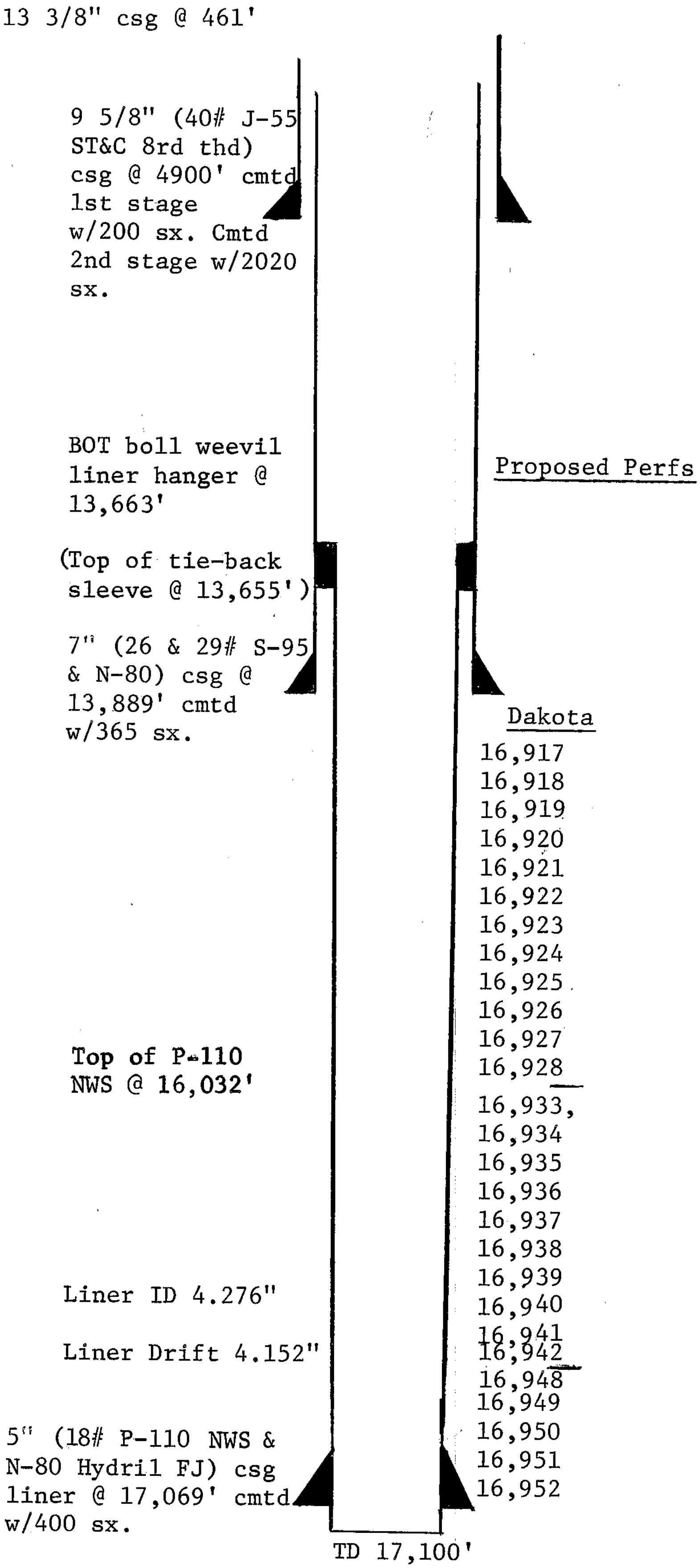
Concurred: Division Exploration Department

Div. M. E.

NJM:JDS:kw
9/10/68

*If well is completed as producer, additional prognoses for BHP surveys will be issued.

DAHLGREEN CREEK 21X-9
SUMMIT COUNTY, UTAH



Conf.

University of Utah
Salt Lake City, Utah 84112
College of Mines and Mineral Industries

Office of the Utah Geological and Mineralogical Survey
103 Utah Geological Survey Building

Library of Samples for Geologic Research

January 16, 1968

Department of Natural Resources
Division of Oil and Gas Conservation
1588 West North Temple
Salt Lake City, Utah

Gentlemen:

The attached news item has been prepared for publication in the next issue of the Utah Geological and Mineralogical Survey Quarterly Review. This information, prepared by Howard Ritzma, Petroleum Geologist, Utah Geological and Mineralogical Survey, on information released by the Shell Oil Company, has considerable bearing on the controversy over the angle of the North Flank Fault and other flanking faults along the Uinta Mountains. The angle of the North Flank Fault, particularly the unexpected very shallow dip to the south, has important ramifications in consideration of petroleum possibilities of the region and the north boundary of the proposed High Uintas Wilderness Area.

Development of this knowledge by Shell Oil Company should spur additional exploratory activity along the flanks of the Uintas, notably in the northern Uinta Basin of Duchesne and Uintah Counties. This will be especially so if the present well is a commercial success in its deep objective, the Dakota Formation.

Yours very truly,

W. P. Hewitt

William P. Hewitt
Director, Utah Geological and Mineralogical Survey

WPH:nn
Enc.

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UTAH GEOLOGICAL AND MINERALOGICAL SURVEY

QUARTERLY REVIEW

Vol. 2, No. 1 — *Geologic Investigation in the State of Utah* — February, 1968

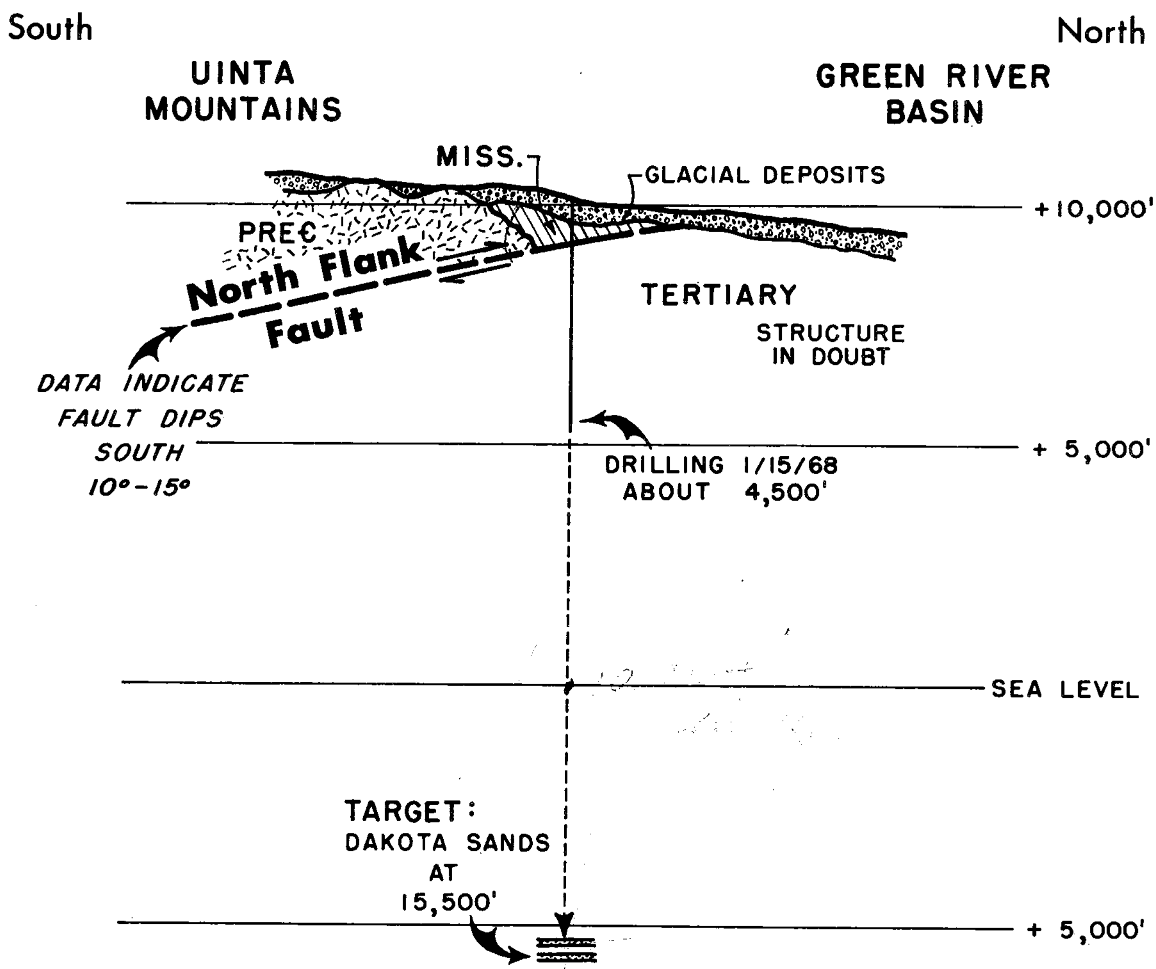
Shell Drills 4 Miles From Wilderness

Shell Oil Company has confirmed drilling information released in the last *Quarterly* relative to the significant Shell No.1 Dahlgreen Creek Unit test in Summit County, Utah.

The well is located 3.5 miles southwest of the Bridger Lake Oil Field and about 1 mile south of the projected trace of the North Flank Fault. This is about *4 miles north of the boundary of the proposed High Uintas Wilderness area.*

From information released by Shell, the Utah Geological Survey concludes the test spudded in Quaternary glacial deposits, entered Madison Limestone (Mississippian age) at 445 feet, and crossed the North Flank Fault at 815 feet. Beds beneath the fault are believed to be Tertiary in age.

As shown in the accompanying cross section, the fault definitely can be tagged an overthrust, and, based upon the projected surface trace and one point of subsurface control, appears to dip southward under the Uinta Mountains at a very low angle, perhaps 10° to 15°. Thus oil-bearing formations of the Green River Basin may extend to the south for many miles beneath the overthrust sheet.



SHELL OIL COMPANY
No. 1 DAHLGREEN CREEK
SE,NE,NW, SEC. 9, 2N., 14E.

SURVEY PROBES ASPHALT RIDGE

Explosions reverberating across the hills and valleys south of Vernal in mid-July accompanied the Survey's probe of the deep-seated structure of the Asphalt Ridge.

The reflection seismograph program was carried out by Petty Geophysical Engineering Company, under contract to the Utah Geological Survey.

Data were recorded from 36 shot holes, evenly spaced along three lines having a total length of nine miles. Two northeast-southwest lines were shot at right angles to the strike of Asphalt Ridge; a connecting line paralleled the ridge along its base. One of the northeast-southwest lines was extended to the south edge of the Ashley Valley Oil Field. There, depth control was obtained from a 7,366-foot well that tested this structure to the Madison Limestone (Mississippian age).

Techniques used in seismic exploration for petroleum were employed. Shot holes were drilled about 1,320 feet apart to a depth of approximately 120 feet. Average explosive charge per shot hole was 50 pounds, and a little more than one ton of dynamite was used for the whole program. Records were obtained from depths exceeding 24,000 feet.

As interpreted, seismic data disclose that Asphalt Ridge is underlain by a major northeast-dipping overthrust fault (see geologic section), concealed by post-fault Tertiary sediments, probably the Green River Formation of Eocene age, overlying a postulated unconformity.

A broad, gentle anticline can be discerned in the beds beneath the plane of the thrust. Strike of the fault is about N. 70° W. The axis of the anticline closely parallels this, indicating the fold probably is a companion structure related to overthrusting. Depth of the Precambrian "basement," beneath the thrust and to the southwest, is about 20,000 feet below sea level.

The concept of an unconformity at the base of the Green River Formation is supported by UGMS surface geologic mapping in 1967.

Deep-seated thrusting probably is reflected upward to the surface by a zone of fracturing and small-scale faulting of random displacement. This zone controls the drainage course of Walker Hollow and the 90° zig-zag bend in the Green River through the north half of T. 6 S., R. 22 E.

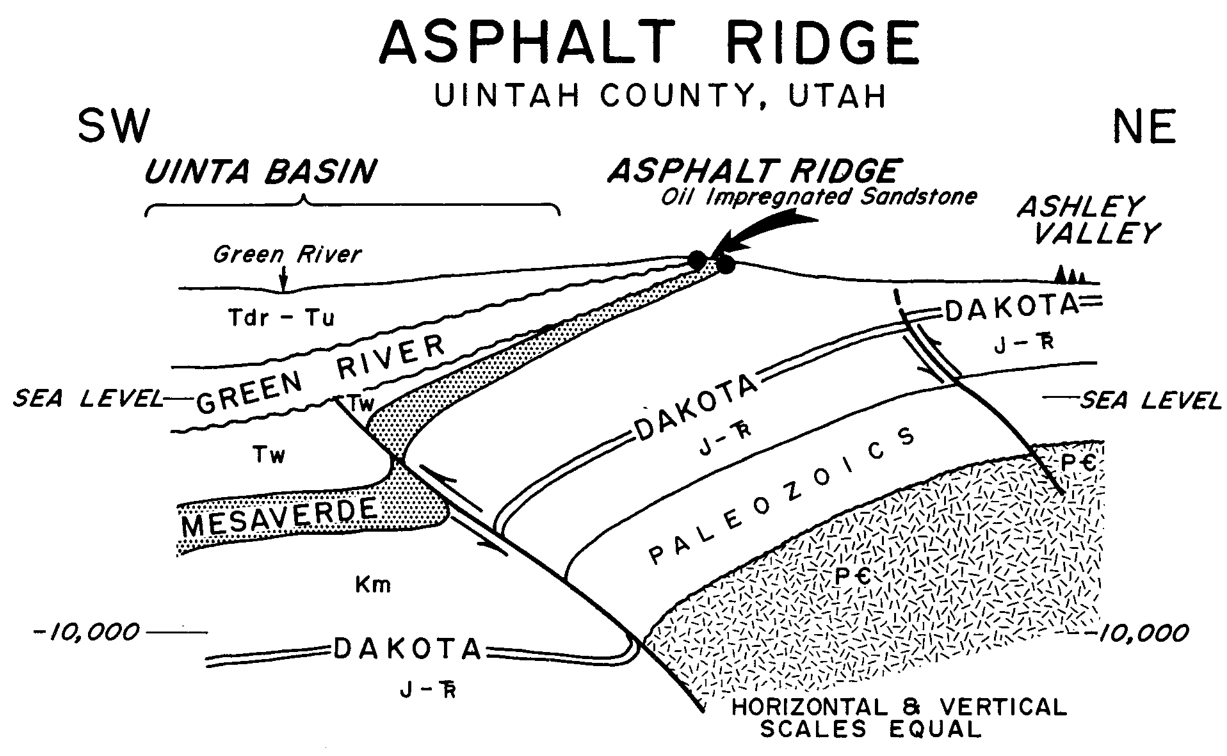
Results of the seismic survey strongly suggest overthrusting exists beneath the entire south flank of the Uinta Mountains and along subsidiary folds, such as Blue Mountain Anticline.

Deep exploratory drilling has proved overthrusting along the south flank of Blue Mountain (Willow Creek) Anticline, five miles east of the Utah boundary in Colorado.

Structural concepts developed by this program are expected to figure importantly in petroleum exploration in future years. Faulting of this kind and associated fracturing and jointing also may have provided conduits for migration of petroleum from depth to form the many deposits of oil-impregnated standstone scattered along the north margin of the Uinta Basin from Tabiona, through Whiterocks, Asphalt Ridge and Raven Ridge.

Surface reconnaissance has turned up one sizable and one minor deposit of oil-impregnated sandstone previously unmapped.

The seismic program and surface mapping were directed by Howard R. Ritzma, UGMS. J. Wallace Gwynn and Wayne Jones assisted with the field work.



Southwest to northeast cross section, southeast Asphalt Ridge, Uintah County, Utah. Based on a combination of surface, subsurface, and seismic data.

NUCLEAR CRATERING?

Survey Geologist Ends Canal Study

Editor's Note — Bruce N. Kaliser recently returned to his duties following a six months' leave of absence. While away, Mr. Kaliser worked with the Atlantic-Pacific Interoceanic Canal Study Commission in the Canal Zone. The drawings, used to illustrate Mr. Kaliser's article, are the work of artist Brent Roland Jones, chief draftsman, UGMS.

by Bruce N. Kaliser[1]

Although the Panama Canal has been termed the "gateway for world trade," seemingly no place could be further from such a designation than that part of the Republic of Panama that lies some 125 miles to the east of the Zone.

Here, in the least explored part of the Isthmus, lies one of the new sea level canal routes open for consideration by the U. S. Atlantic-Pacific Interoceanic Canal Study Commission.

Natives engaged in "world trade" today in this area haul plantains by dugout to coastal villages and barter coconuts with merchants from neighboring Colombia. Tomorrow promises more.

Nuclear explosives one day may blast a gateway across the Isthmus, permitting a lone vessel to carry more cargo than has traversed the area since the Spanish conquistadores landed in 1501.

The question as to the feasibility of tracing a sea level canal route across Balboa's historical trans-Isthmus road engaged the writer while on a six-month leave of absence from the Utah Geological Survey.

Scientific disciplines represented in the field included geology, ecology, meteorology, hydrology, agricultural ecology, and anthropology. It was the objective of the field party to collect maximal on-site geologic and other scientific data.

Both surface and subsurface geological methods were employed, including full geophysical logging and down-hole photography for each bore hole.

Studies along the Sasardi-Morti Route (more commonly referred to as Route 17) were oriented toward nuclear excavation. Route 25, another alignment simultaneously being explored, also is being considered as a nuclear-excavated possibility. Route 25 is in Colombia, near the Panamanian frontier.

The writer's contribution consisted primarily of detailed structural mapping for the Nuclear Cratering Group of Lawrence Radiation Laboratory. Purpose of the mapping was to provide information on the distribution and spacing of rock fractures.

The mapping was performed along relatively continuous outcrops of each major rock type at locations both near and removed from drill sites. More information will be obtained, when comparisons are made with structural data obtained from exploratory borings. Hopefully, field-derived data will assist in extending structural data obtained from the borings to other areas in each rock type.

The varied and exotic life in the dense jungle filled this "gringo" geologist with an awe of the total environment. He learned regard for the culture of the native Cuna and Choco Indians. He shared their foods, their knowledge of terrain and jungle lore, and their avenues of communication, rivers and language. Instinctively, he treated creatures encountered in the bush with a gargantuan respect. Finally, he learned to appreciate the bare rock walls of the arid state he left behind.

[1]Engineering Geologist, UGMS.

OIL-IMPREGNATED SANDSTONE SOUGHT

Three field parties under the direction of Howard R. Ritzma, Petroleum Geologist, UGMS, devoted the summer to a search for new oil-impregnated sandstone deposits.

Areas of search included:

- —Northeast Uinta Basin;
- —San Rafael Swell, Capitol Reef, San Rafael - Green River Desert areas;
- —"Tar-sand triangle" between Dirty Devil and Colorado Rivers, north of Hite Marina, at inlet end of Lake Powell;
- —Miscellaneous localities in southern Utah.

As the result of the extensive summer field work the number of known deposits rose from 33 to 45 at summer's end, with leads on four or five more.

Assisting in the project were Wallace Gwynn and William Dalness, field party chiefs, Wayne Jones, Craig Bean, and Alan Pratt, field party chief in the Circle Cliffs area.

One sizable new deposit (the Rim Rock deposit) was discovered in northeast Uinta Basin, within sight of U.S. 40 and the giant Red Wash Oil Field. Findings established that Raven Ridge, in the northeast corner of Uinta Basin, extends for 13 miles from northwest to southeast pushing into Colorado.

Reconnaissance mapping in the area between the Colorado and Dirty Devil Rivers revealed three new deposits, two of which are large and important, and established the large size of another deposit, previously known only from casual reference in the literature.

Although many of the new discoveries appear to be of small size and minor commercial value, several may provide teasing clues to the presence of concealed oil and gas deposits. Much basic information on migration and entrapment of oil was gathered, particularly on the importance of faults, fractures and joints as controls in migration. Field work in northeast Uinta Basin also indicates probable major revision of published stratigraphic and structural concepts in that area.

Deposits of oil-impregnated sandstone fall into two principal groups, in situ and migrated. The in situ deposits are oil fields trapped close to where the oil originated. These traps have been exposed by erosion. Typical of these are the giant P. R. Springs and Sunnyside deposits on the south flank of the Uinta Basin. Migrated deposits are those formed by the rupture of deep-seated oil traps. Such ruptures allow the oil to "leak" to the surface where it is presently found. Most of the deposits on the north flank of the Uinta Basin — Tabiona, Whiterocks, Asphalt Ridge, and Raven Ridge — are thought to be migrated deposits.

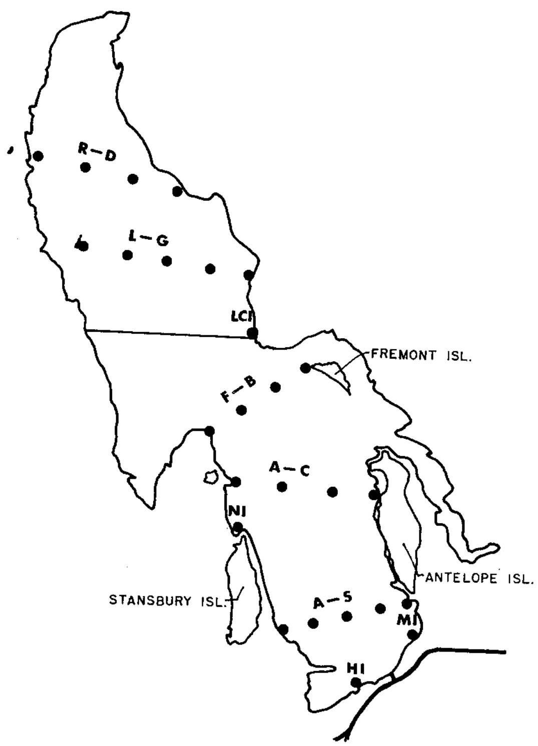
Of great importance was the field investigation conducted by Mr. Pratt in the Circle Cliffs area of central Garfield County. In addition to finding many small deposits, mapping of part of the middle Moenkopi Sandstone around Wagon Box Mesa has revealed what may be one of the largest "tar-sand" deposits in Utah. Limited time and funds prevented completion of this important work.

Field work has outlined about half of the deposits and has pointed out three areas covering nine deposits that need more detailed work. In the meantime, as time and weather permit, other deposits will be examined to insure that no major resources are overlooked.

Reserves of oil in oil - impregnated sandstones and limestones within the Uinta Basin probably total between five and eight billion barrels. Reserves in central-southeast Utah cannot be estimated on the basis of present information, but are without doubt as large as those of the Uinta Basin.

Lake Mineral Sampling Study

Although it has been known for years that the content of dissolved solids in Great Salt Lake is anything but uniform, it was the growing commercial interest in recovery of chemicals, other than sodium chloride, that gave birth to current research.



Great Salt Lake Sampling Sites

If recovery methods are to be effective, both the amounts of chemicals present in the lake's water and their distribution must be known.

Many factors influence the distribution and relative amounts of the several components and dissolved solids present in the lake. These include the increment of fresh water; evaporation rates; temperature fluctuations; wind-induced and density currents; basin configuration; organic effects; pollutants; amount of brine withdrawal by commercial operations; contributions from springs and subsurface sources; and particularly, possible effects of the Southern Pacific Railroad causeway.

Then, too, the lake is noted for its treachery. Fierce, sudden storms imperil any lake research.

All the same, perennial sampling of critical areas over a period of years was an obvious requirement; so, in 1963 the Utah Geological Survey, in cooperation with the Water Resources Division of the U. S. Geological Survey, began a series of investigations on a quarterly basis. Those initial results and conclusions have been published by the USGS (Handy and Hahl, 1963, 1964 and 1966) and Handy (1967).

Three years later (April, 1966) the Utah Survey began an independent program of sampling at monthly intervals. To date more than 1,000 samples have been taken for analysis. In order to make the results of sampling meaningful, sites (shown on the accompanying map) were selected for sampling at the indicated intervals.

The sample positions are described as follows:

—(LG) Little Valley Harbor to Gunnison Island Line — Station numbers 1, 2, 3, 4, and 5.

—(LCI) Lake Crystal Salt Company (mouth of intake canal).

—(FB) Fremont Island to Bird Island Line — Station numbers 1, 2, 3, and 4.

—(AC) Antelope Island to Carrington Island Line — Station numbers 1, 2, 3, and 4.

—(NI) National Lead Company (mouth of intake canal).

—(AS) Antelope Island to Stansbury Island Line — Station numbers 1, 2, 3, 4, and 5.

—(MI) Solar Salt Company (mouth of intake canal).

—(HI) Hardy Salt Company (mouth of intake canal).

—(RD) Rozell Point to Dolphin Island Line — Station numbers 1, 2, 3, and 4 (this line was established in July, 1967).

The present method of sampling has evolved through experience. Various bottle sampling techniques were tried but proved too cumbersome and slow. In May, 1967, a pumping system was successfully tried.

Now, a hand-operated pump with plastic coated parts is attached to the gunnel of the boat and to an ordinary garden hose, marked at one-foot intervals.

The pumping procedure provides:
- —Less contamination;
- —Faster operation;
- —More accurate temperature and density readings;
- —Less weight and bulk to handle and
- —Easier operation for personnel.

Although the pumping action entrains air into the sample, this is not known to be a disadvantage.

Each sample is analyzed in the Geological Survey Laboratory for the components listed. In addition, current, time, temperature, density and turbidity characteristics are noted.

From the results of analyses, average compositions of brines are being computed monthly for the north and south positions of the lake, and for each five-foot depth interval. Averages are weighted for area of influence of the station.

The results of plotting analytical data indicate periods of evaporation from the lake and areas of groundwater inflow. Averages are furnishing new data on the seasonal variation in the composition of the lake, and will lead to revised evaluation of the cause of this variation.

The above research, together with studies made in cooperation with the USGS and Morton Salt Company, are detailing the effects of the causeway, and particularly the growth and character of the salt cake on the lake bottom north of the causeway. These studies also are offering possible explanations for the dense brines found by Handy (1967) in the deeper portions of the south half of the lake.

IS GREAT SALT LAKE REALLY TWO?

*by Harry Suekawa**

The railroad causeway, built in 1957 to replace the old Lucin wooden trestle, essentially has divided the Lake into two very different parts.

The only effective "free flow" of brine between the northern arm and the southern arm is through two, 15-foot wide culverts.

As a result of this division, the north arm has reached — and, at times, surpassed — the saturation point in dissolved solids, while the south arm fluctuates in amount of dissolved solids and may even be losing some to the north arm. This condition of imbalance is due to unequal amounts of fresh water inflow into the separate arms.

The south arm is fed by the Bear, Jordan, and Weber Rivers and a considerable amount of groundwater. The only sources of fresh water inflow available to the north arm are Locomotive Springs and groundwater. Consequently, since the railroad fill was completed, brines from the south arm have been *and are now* a source of inflow to the north end.

Due to the greater amounts of inflow into the south arm, there is a difference in elevation between the two arms. The north arm is lower; so a surface current from south to north rushes through the causeway culverts. This current is variable in flow from season to season.

The strong current observed during the spring, summer, and fall seasons lessens in the winter. Another current was found to be flowing through the culvert, approximately six feet below the surface. However, this current *flowed in the opposite direction.* Apparently, the denser brine of the north end is flowing *beneath* the lighter waters from the south (mainly because of the hydrostatic head difference).

This phenomenon prompts an hypothesis that density stratification in the south arm is a direct result of en masse infiltration of dense water from the north sliding beneath the waters of the south arm. This seems to be an attempt by the lake to impose an equilibrium condition upon itself. A cooperative program, with the USGS, Morton Salt Company, and the UGMS participating, was begun in 1966 to determine just what overall effect the causeway has on the lake.

In addition to the study of lake waters in the immediate vicinity of the causeway (research done mostly by the USGS), the UGMS is trying to delineate the boundaries and characteristics of a dense layer of brine on the bottom of the south arm.

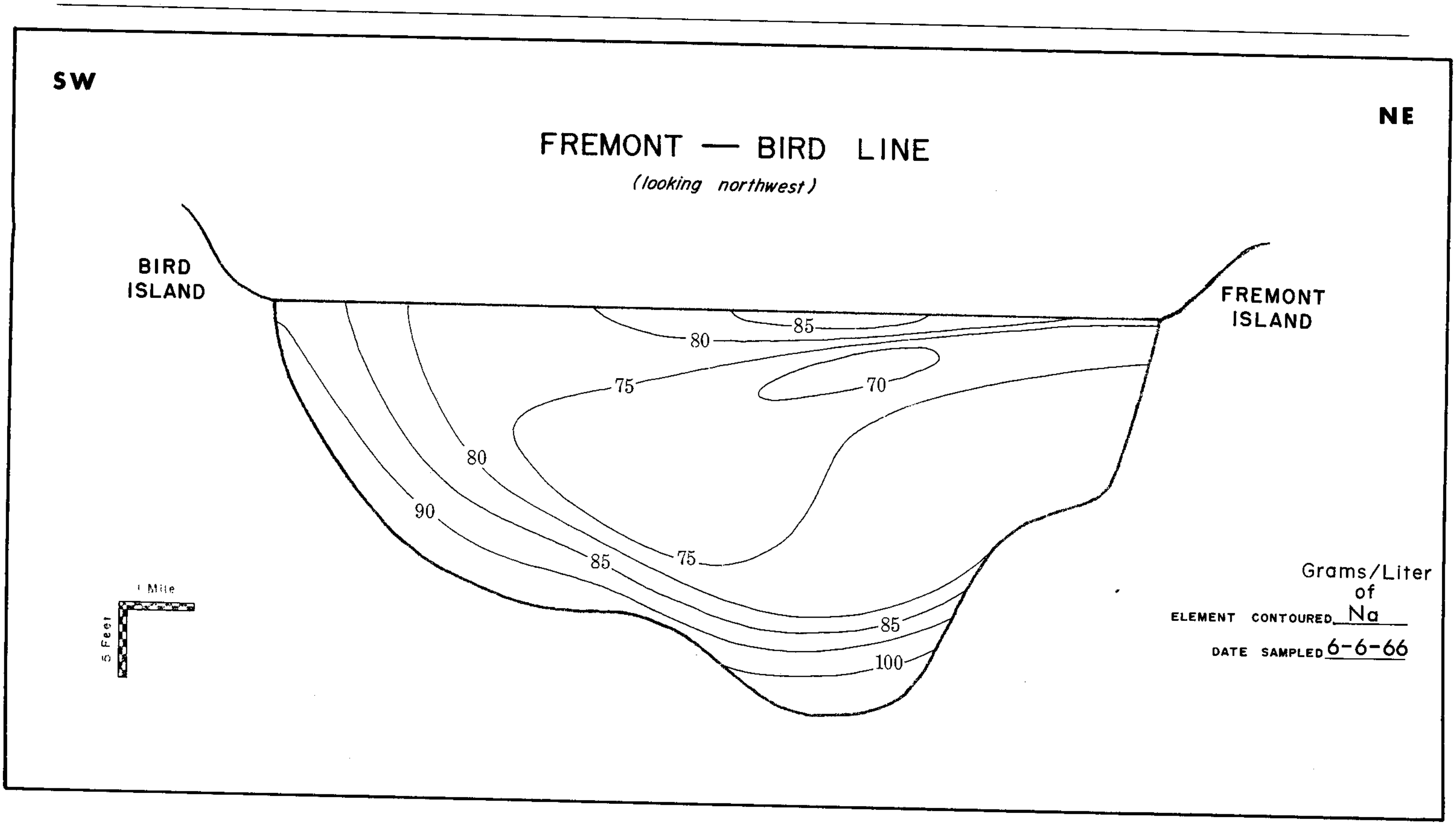
The fact that a layer of almost saturated brine exists over the bottom of the whole southern arm of the lake is difficult to accept. Any mixing of waters in such a shallow body of water should rule out such a possibility.

However, in almost every case where samples are taken from a bottom depth of 20 feet or more, the water shows a considerable increase in specific gravity and chemical constituents contrasting with the water immediately above. These bottom samples are of a murky brown color and smell of hydrogen sulfide. Temperature and water level changes during the year do not seem to affect the presence of this layer.

However, the layer does fluctuate both in vertical and horizontal directions. There is limited mixing at the interface, between the denser water and the typical water of the south arm. The dense water compares with water of the northern arm in ionic concentration versus specific gravity ratios.

It is thought that some relationship between the water of the northern arm and the causeway is causing this phenomenon in the south.

*Geologist, UGMS.



QUAKE DAMAGE YEARLY EVENT!

by Kenneth L. Cook[1]

During the past 15 years, Utah has experienced an average of nearly one damaging earthquake per year. This past year, one such earthquake occurred to maintain the average.

An earthquake is considered damaging, if (at least) dishes or windows are broken, plaster cracked, or bricks toppled from chimneys.

The damaging 1967 earthquake had an epicenter three miles north of the town of Marysvale, and occurred at 4:20 a.m., Oct. 4. The Richter magnitude was 5.5, according to the Wood-Anderson seismograph of the U. of U.'s Department of Geophysics.

That quake was felt over a wide area in southern Utah — to Dugway on the north, Green River on the east, Kanab on the south, and Milford on the west.

The temblor damaged plaster on a wall and dislodged bricks from the chimney of the LDS ward in Joseph; cracked plaster on a home in Elsinore; knocked bricks from chimneys in Monroe; and caused a small rockslide along the main highway in Marysvale Canyon.

Quakes are not new to this area, however. The epicenters of the recent quakes lie in the active Sevier-Tushar fault, along which there have been about 50 earthquakes in the last 115 years.

The largest quakes recorded were in Richfield in 1901 (Richter magnitude of 6.7) and in Elsinore in 1921 (two with Richter magnitude of 6.1), which did about $200,000 damage.

5-MONTH TALLY

Date	*Location**	*Approx. Magnitude**
Aug. 1	Near Strawberry Reservoir	
Aug. 2	Near Logan, Utah	<2.0
Aug. 2	Colorado	<3.5
Aug. 4	Colorado	<3.5
Aug. 4	Colorado	<3.5
Aug. 5	Green River Desert, Utah	<3.0
Aug. 7	Near Glen Canyon, Ariz., Utah Border	<3.0
Aug. 7	Near Glen Canyon, Ariz., Utah Border	<3.0
Aug. 8	Southwest Wyoming	<3.0
Aug. 9	Denver, Colo.	<5.3
Aug. 9	Southwest Wyoming	<3.0
Aug. 11	Southwest Wyoming?	<3.0
Aug. 11	Near Logan, Utah	<2.0
Aug. 12	Colorado	<3.0
Aug. 13	Near Logan, Utah	<2.0
Aug. 13	NE Idaho Area (3 aftershocks)	<4.0
Aug. 13	Near Price, Utah	<3.0
Aug. 14	Southwest Wyoming	<3.5
Aug. 16	Near Strawberry Reservoir	<3.0
Aug. 16	Near Logan, Utah	<2.0
Aug. 17	Colorado	<3.0
Aug. 17	Near Price, Utah	<3.0
Aug. 18	Colorado	<3.0
Aug. 18	Southwest Wyoming	<3.5
Aug. 18	Wyoming	<3.5
Aug. 19	Wyoming-Idaho Border—North of Logan	<3.5
Aug. 21	Near Logan, Utah	<2.0
Aug. 21	Near Logan, Utah	<2.0
Aug. 21	Near Logan, Utah	<2.0
Aug. 22	Near Logan, Utah	<2.0
Aug. 22	Wyoming-Idaho Border	<3.5
Aug. 23	Near Fillmore, Utah	<3.0
Aug. 23	Near Logan, Utah	<3.0
Aug. 24	Idaho-Wyoming Border	<3.0
Aug. 24	Near Logan, Utah	<2.0
Aug. 25	Colorado	<3.0
Aug. 25	Near Logan, Utah	<2.0
Aug. 27	Henry Mountain Area, Utah	<3.0
Aug. 29	South of Spanish Fork, Utah	<3.5
Aug. 29	South of Spanish Fork, Utah	<3.5
Aug. 29	Southwest Wyoming	<3.5
Aug. 30	Wyoming	<3.5
Aug. 30	Near Logan, Utah	<2.0
Aug. 31	Wyoming-Idaho Border	<3.0

NOTE: There were only 12 recognized rockbursts near Price, Utah, that were of significant size. These are not included in the above tally.

Sept. 1	NE of Thistle, Utah (3 poss. aftershocks)	2.2
Sept. 1	Near Thistle, Utah	2.0
Sept. 1	Near Castle Dale, Utah	2.5-3.0
Sept. 2	Near Huntsville, Utah	3.0
Sept. 3	Near Price, Utah	<2.0
Sept. 4	Yellowstone Nat'l Park	3.2
Sept. 5	Utah-Wyoming Border—ENE of Logan, Utah	2.5
Sept. 6	Near Richfield, Utah, Possible foreshock	2.0
Sept. 8	Near Fillmore, Utah	2.5
Sept. 8	Near Price, Utah	2.8
Sept. 9	Near Price, Utah	3.3
Sept. 11	Near Soda Springs, Idaho	3.0
Sept. 11	SE Idaho	3.0
Sept. 11	SW Wyoming	2.5
Sept. 12	Promontory Mountains	2.0
Sept. 12	Near Huntsville, Utah	2.2
Sept. 13	Salt Lake-Ogden Area	2.0
Sept. 14	Utah-Wyoming Border—East of Ogden, Utah	2.5
Sept. 15	Near Richfield, Utah—Possible foreshock	2.5
Sept. 16	SW Wyoming	2.7
Sept. 16	Salt Lake City, Utah	<2.0
Sept. 16	Near Fillmore, Utah	<2.3
Sept. 17	W of Enterprise, Utah (2 small aftershocks)	3.0
Sept. 17	Near Strawberry Reservoir	2.0
Sept. 18	Near Price, Utah	2.3
Sept. 18	Near Fillmore, Utah	2.5
Sept. 20	Near Castle Dale, Utah	2.6
Sept. 22	Near Heber City, Utah	2.0
Sept. 22	Terrace Mountains	3.3
Sept. 23	Central Idaho	3.3
Sept. 23	Bryce Canyon	2.3
Sept. 24	Magna, Utah — Felt in Salt Lake	Final 2.6
Sept. 24	Magna, Utah-Felt in Salt Lake (Cracked Plaster)	Final 3.0
Sept. 24	Terrace Mountains?	2.0
Sept. 24	Terrace Mountains	2.5
Sept. 25	Magna, Utah — Prob. aftershock	<2.0
Sept. 25	Magna, Utah — Prob. aftershock	<2.0
Sept. 25	Magna, Utah — Prob. aftershock	<2.0
Sept. 25	Magna, Utah — Prob. aftershock	<2.0
Sept 26	Magna, Utah — Prob. aftershock	<2.0
Sept. 26	Near Salt Lake City, Utah	<2.0
Sept. 29	Utah-Wyoming Border — East of Logan, Utah	2.3
Sept. 29	Near Richfield, Utah — Poss. foreshock	2.5
Sept. 30	Near Castle Dale, Utah	2.6

NOTE: There were only 8 recognized rockbursts near Price, Utah, that were of significant size. These are not included in the above tally.

Oct. 2	Southwest Wyoming	<2.8
Oct. 4	Marysvale Canyon, Utah Area (Prob. foreshock)	2.1
Oct. 4	Marysvale Canyon, Utah, 3 miles north of Marysvale, Utah. Damage to church in Joseph, Utah. Some Monroe and Joseph. Damage in Elsinore. Other areas reported minor damage. Seven felt aftershocks reported	Final 5.5
Oct. 4	Marysvale Canyon, Utah**	3.2
Oct. 4	Marysvale Canyon, Utah**	2.7
Oct. 4	Marysvale Canyon, Utah**	2.4
Oct. 4	Marysvale Canyon, Utah**	2.3
Oct. 4	Marysvale Canyon, Utah**	2.3
Oct. 4	Marysvale Canyon, Utah**	2.1
Oct. 4	Marysvale Canyon, Utah**	2.0
Oct. 4	Marysvale Canyon, Utah**	2.3
Oct. 4	Marysvale Canyon, Utah**	1.6
Oct. 4	Marysvale Canyon, Utah**	2.1
Oct. 4	Marysvale Canyon, Utah**	2.2
Oct. 4	Marysvale Canyon, Utah**	2.8
Oct. 4	Marysvale Canyon, Utah**	2.4
Oct. 4	Marysvale Canyon, Utah**	3.2
Oct. 4	Marysvale Canyon, Utah**	3.2
Oct. 4	Marysvale Canyon, Utah**	3.4
Oct. 4	Marysvale Canyon, Utah**	2.3
Oct. 4	Marysvale Canyon, Utah**	1.7
Oct. 5	Near Salt Lake City, Utah	1.0
Oct. 5	Marysvale Canyon, Utah	3.0
Oct. 6	Marysvale Canyon, Utah	1.8
Oct. 6	Near Utah Lake, Utah	2.0
Oct. 7	Marysvale, Utah	2.3
Oct. 7	Colorado	<3.0
Oct. 9	Marysvale Canyon, Utah	2.4
Oct. 9	Marysvale Canyon, Utah	1.7
Oct. 13	Near Price, Utah	<2.5
Oct. 16	Marysvale Canyon, Utah	1.7
Oct. 16	Near Logan, Utah	<2.0
Oct. 16	Southwest Wyoming	<2.8
Oct. 18	Near Logan, Utah	<2.0
Oct. 18	Northeast of Fillmore, Utah	<2.8
Oct. 18	Southwest of Levan, Utah	2.5-3.0
Oct. 19	Near Logan, Utah	<2.0
Oct. 20	Near Salt Lake City, Utah	2.1
Oct. 21	Near Marysvale Canyon, Utah area	2.5
Oct. 22	Near Marysvale Canyon, Utah area	2.1
Oct. 22	Southeast of Cedar City, Utah	<3.1
Oct. 22	Near Manti, Utah	2.0-2.5
Oct. 23	Near Moroni, Utah	<2.5
Oct. 24	Marysvale Canyon, Utah	2.5
Oct. 25	Near Salt Lake City, Utah	1.7
Oct. 25	Four rockbursts near Sunnyside, Utah measured from	2.6-3.3
Oct. 26	Near Logan, Utah	<2.0
Oct. 28	Marysvale Canyon, Utah	1.7

[1]Chairman, Department of Geophysics, University of Utah.

*The locations and approximate magnitudes given are preliminary determinations. The final determinations will be printed in the Seismological Bulletin published by the Department of Geophysics. This list was compiled by J. Larry Wilson, technician-analyst, Department of Geophysics, U. of U.
**Probable aftershock.

Reports Placed On Open File

Two reports of significance have been placed on open file and are available for inspection and reproduction in the offices of the Utah Geological Survey.

They are:

"Determination of Oil Shale Potential, Green River Formation, Uinta Basin, Northeast Utah," by H. R. Ritzma and de Benneville, K. Seeley, Jr., (Report of Investigation No. 37, November 3, 1967);

"Reflection Seismograph Survey, Asphalt Ridge Area, Uintah County, Utah," by Petty Geophysical Engineering Company, (unnumbered report, November, 1967).

The report discusses depositional pat- study of the Green River Formation, based on mechanical (electrical, gamma ray-neutron, etc.) logs, combined with lithologic information when possible. The paper's focus is on the western two-thirds of the basin where sections of the shale-rich Green River Formation are thickest. Depths of 2,000 to 4,500 feet to possible rich shale preclude exploitation by mining. However, in situ processes of converting kerogen in the shale to oil — particularly by some thermonuclear means — may be possible at safe depths.

The report discusses depositional patterns in the Green River and regional structural history. Seven thickness maps of the Green River Formation and its principal members are included.

In the main, the report supports proposals for deep-core drilling in the western Uinta Basin (see page 2).

Devastation of Caracas Wasatch Front Portent?

Last summer,* Caracas, Venezuela, was devastated by an earthquake that flattened dozens of buildings and claimed hundreds of lives.

Using the U. S. Uniform Building Code as a standard, Caracas is a Zone 2 seismic zone (on a scale from 0, no destruction, to 3, complete destruction).

All its structures were required to comply with earthquake resistive specifications comparable to those outlined in the American building code.

However, the quake caused pancake-collapsing of four high-rise apartment buildings, as well as destruction of many one- and two-story houses.

The state of Utah also falls within Zone 2. Its city buildings,** like those of Caracas, are based on California practice. Its buildings are not dissimilar to those of Caracas.

The magnitude of the Caracas temblor was moderate—6.5 on the Richter scale. Its epicenter, approximately 30 miles from the city, was believed to lie in the Caribbean.

History records four other ravaging Caracas quakes, which occurred between 1641 and 1900.

The period of time during which Utah's history has been recorded would encompass only one, the last, of these shocks. Earthquakes have exceeded a magnitude of 6.5 twice (1901, 1909) in this state's 130-year history.

The southern slopes of the Sierra de Avilla mountain range, which border Caracas on the north, are characterized by triangular facets, believed by many geologists to be a clear indication of recent fault displacement of considerable magnitude. Most of Utah's metropolitan population today can see similar truncated spurs on the western slope of the Wasatch Mountains.

Shaking and ground failure were responsible for the damage resulting from the Caracas earthquake. In addition, there were landslides—fortunately isolated in their occurrence. Although all structures were founded on alluvium in the Caracas Valley and on large alluvial fans along the Caribbean coast, intensity of destruction varied throughout the city. The unconsolidated sediments, which underlie most of the Wasatch Front—Utah's most populous area—could not be expected to behave in better fashion to seismic vibrations.

Obviously, recognizable similarities exist between the Wasatch Front and the Caracas region, but is recognition enough to assure the preservation of Utah communities?

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*July 29, 1967.

**The uniform Building Code has not been officially adopted. Architects conform to it in designing practice.

QUAKES — Continued

Oct. 30	Near Moroni, Utah	2.0-2.5
Oct. 31	Idaho-Wyoming Border — North of Logan, Utah	3.0-3.5
Oct. 31	Marysvale Canyon, Utah	1.7-2.0
NOTE:	There were only 12 recognized rockbursts near Price, Utah, that were of significant size. These are not included in the above tally.	
Nov. 1	Near Nephi, Utah	2.0-2.5
Nov. 1	West of Enterprise, Utah-Nevada Border	2.5-3.0
Nov. 1	Northwest Utah	2.0-2.5
Nov. 2	West of Enterprise, Utah-Nevada Border	2.5-3.0
Nov. 2	Near Nephi, Utah	2.0-2.5
Nov. 4	Near Ephraim, Utah	3.0
Nov. 8	Near Nephi, Utah	1.5-2.0
Nov. 8	Near Price, Utah	<2.0
Nov. 8	Near Nephi, Utah	2.0-2.5
Nov. 9	West of Enterprise, Utah-Nevada Border	2.5-3.0
Nov. 13	West of Enterprise, Utah-Nevada Border	3.8
Nov. 13	Near Logan, Utah	<1.0
Nov. 13	Near Salt Lake City, Utah	1.0-1.5
Nov. 15	Near Logan, Utah	1.0
Nov. 15	Southwest Wyoming	2.5-3.0
Nov. 16	Near Logan, Utah	1.0
Nov. 17	Near Logan, Utah	1.0
Nov. 17	Southwest Wyoming	2.0-2.5
Nov. 22	Near Salina, Utah	2.0-2.5
Nov. 24	Southwest Wyoming	2.0-2.5
Nov. 26	Near Logan, Utah	1.0
Nov. 26	Near Dugway, Utah	1.0
Nov. 27	Denver, Colorado (felt over wide area, minor damage)	5.1
Nov. 27	Denver, Colorado (felt)	4.5
Nov. 27	Denver, Colorado	3.5
Nov. 28	North Central Utah	2.0-2.5
Nov. 29	Near Salt Lake City, Utah	1.0-1.5
Nov. 29	Near Green River, Utah	2.5-3.0
Nov. 29	Ephraim, Utah	2.0-2.5
NOTE:	There were only 12 recognized rockbursts near Price, Utah, that were of significant size. These are not included in the above tally.	
Dec. 1	Southwest Wyoming, ESE of Logan, Utah	2.0-2.5
Dec. 3	Sunnyside, Utah	1.5-2.0
Dec. 3	Near Price, Utah	1.5-2.0
Dec. 4	Near Logan, Utah	1.0
Dec. 5	Near Marysvale, Utah	2.0-2.5
Dec. 6	Sunnyside, Utah	1.5-2.0
Dec. 6	Southwest Wyoming	2.5-3.0
Dec. 7	Huntsville, Utah (felt)	Final 3.5
Dec. 7	Huntsville, Utah	2.0-2.5
Dec. 7	Logan, Utah	1.0
Dec. 8	Near Gunnison, Utah	2.0-2.5
Dec. 9	Huntsville, Utah	Final 3.0
Dec. 10	Huntsville, Utah	2.0-2.5
Dec. 10	Huntsville, Utah	1.5-2.0
Dec. 10	Project Gas Buggy, near Farmington, New Mexico	5.3
Dec. 11	Near Sunnyside, Utah	1.5-2.0
Dec. 13	Near Levan, Utah	2.0-2.5
Dec. 14	Near Sunnyside, Utah	1.5-2.0
Dec. 15	Near Sunnyside, Utah	2.0-2.5
Dec. 15	East of Ogden, Utah, on Border	2.0-2.5
Dec. 18	California earthquake	5.5
Dec. 20	Near Salt Lake City, Utah	1.0-1.5
Dec. 20	Near Green River, Utah	1.5-2.0
Dec. 22	Soda Springs, Idaho	3.0-3.5
Dec. 22	West of Enterprise, Utah-Nevada Border	2.0-2.5
Dec. 22	North Central Utah	1.0-1.5
Dec. 24	Near Price, Utah	1.5-2.0
Dec. 24	Near Logan	1.0
Dec. 24	Near Logan	1.0-1.5
Dec. 27	Near Logan	1.0
Dec. 28	Near Heber City, Utah	1.5-2.0
Dec. 29	Northeast of Kamas, Utah, on Border	1.5-2.0
NOTE:	16 recognized rockbursts near Price, Utah, were not included in the above tally.	

Exciting reports from the southwestern part of the State tell of a significant oil discovery in Washington County.

Willard Pease Drilling Company, Grand Junction, Colorado, has drilled the well on "farm-out" from Buttes Gas and Oil of Oakland, California, and Lloyd Corporation, Los Angeles. The company is testing in SWNE Sec. 25 T. 40 S., R. 13 W., about 2.5 miles northeast of Toquerville.

The well was shut down for repairs at a depth of 4,333 feet. Upon re-entry it was found that oil had filled the hole to 2,033 feet. Reportedly the oil is 40° gravity and of very good quality. The operators are preparing to complete the well at a depth of about 4,600 feet.

Leasing activity in Washington County has quickened and a number of significant wildcat test wells are expected to be announced shortly.

The Utah Geological Survey has the following publications on sale in which various aspects of the geology of Washington County are discussed:

—Bulletin 70, Geologic Atlas of Utah, Washington County, $3.50.

—I.A.G. Guidebook, 1963, Guidebook to the Geology of Southwestern Utah, $9.00.

—Utah Geol. Soc. Guidebook No. 19, 1965, Geology and Resources of South-Central Utah, $5.00.

—Reprint 95, Regional Gravity Survey of the Hurricane Fault Area and Iron Springs District, Utah, by K. L. Cook and Elwood Hardman, 75¢.

Reprint 90 (50¢), a paper by Andrew Edmunds Kurie reprinted from the Geological Society of America Bulletin, contains a map which covers the drill site of the discovery and section A-A′ almost bisects the well site. A review of this paper in the *Quarterly*, November, 1967 discussed oil prospects and stated prophetically: "a number of hitherto unsuspected structural traps appear to exist along the fold."

QUARTERLY REVIEW

State of Utah ....*Calvin L. Rampton*, *Governor*

University of Utah ......*James C. Fletcher*, *President*

College of Mines & Mineral Industries ....*George R. Hill*, *Dean*

Utah Geological & Mineralogical Survey ....*William P. Hewitt*, *Director*

UTAH GEOLOGICAL AND MINERALOGICAL SURVEY
103 Utah Geological Survey Building
University of Utah
Salt Lake City, Utah
84112

Diggin's . . .

The Utah Survey hopes to publish as part of it's Special Studies series a part of the talks given during the Governor's Conference on Geologic Hazards and Federal Disaster Assistance recently held on the University of Utah campus.

These will include: "Cloudburst Floods As A Geologic Hazard," Ray E. Marsell, Professor Emeritus of Geology, U. of U.; "Earthquake Hazards in Utah," Kenneth L. Cook, Chairman, Geophysics, U. of U.; "Geologic Aspects of Foundation Damage," William P. Hewitt, Utah Survey Director; "Community Action and Natural Hazards," (with particular reference to California's attempts to solve them) Lloyd Cluff, Chief Engineering Geologist, Woodward, Clyde, Sherard and Associates, Oakland, California.

An excellent presentation on landslide hazards in Utah by Harry D. Goode, U. of U. Geology Department, will be covered in a UGMS bulletin dealing with "Landslides of Utah" by John Ford Schroeder, Jr.

The Utah Survey wishes to remind those planning field work in Utah in 1968 to advise, UGMS of their place of the interest, in order that information may be included in the May issue of the *Quarterly Review.*

The total amount of drilling for uranium in Utah for the year 1967 was 606,000 feet, or 5.6 percent of the national total of 10,764,000 feet, according to a recent U. S. Atomic Energy Commission release.

Two of Utah's neighbors, Wyoming and New Mexico, accounted for 54.8 percent and 23.4 percent, respectively, of the national total.

Of the 10,674 feet of drilling in 1967, 51 percent was in search of new deposits and 49 percent was devoted to blocking out previously known ore bodies. The national total of surface drilling for 1966 was 4,200,000 feet.

Ore was found,* for the national net reserves increased by 7,000 tons of U_3O_8 after shipment in 1967 of ore containing 10,700 tons of U_3O_8. Estimated ore reserves for the nation, exploitable at $8 per pound of U_3O_8, stood at 148,000 tons of U_3O_8 at the end of the year.

*See *Quarterly Review*, August, 1967, page 4.

The U. of U. Chemistry Department's research division on chromatographic theory, long-time occupants of the Utah Survey Building's second floor, moved to new laboratories and offices Jan. 16.

Situated in a multimillion dollar structure north of the Ute Stadium, the chemists — postdoctorates, graduates and work-study students — now occupy four recently completed offices and three labs.

Several weeks earlier, the Civil Engineering Department vacated laboratories it occupied in the Utah Geological Survey Building.

Consequently, except for space allotted for a classroom, the entire building — one of the oldest and smallest on the campus — now is available to the Survey.

A fireproof map vault, a laboratory area and an office for the petroleum geologist have been readied on the first floor. The second floor is being remodeled to accommodate a drafting room, ladies' lounge, laboratories, and additional offices.

Better service to the public and better functioning of the now-scattered components of the Survey may be expected.

Bridger Lake Oil Field chalked up its one million-barrel mark early in December.

Five wells were producing by the end of November, and — upon completion of a pipeline outlet into Wyoming — the field is expected to show a significant increase in production during the early months of 1968.

Petroleum Information tentatively reports a total of 61 "wildcat" exploratory tests were drilled in Utah last year. Of these, 52 were unsuccessful and 9 were oil finds. No gas discoveries were made. The discovery ratio, 14.75 percent, was the highest in the Rocky Mountain region.

The total number of wells drilled for oil and gas in Utah during 1967 was 139 — 71 dry holes, 58 oil and 10 gas wells.

Activity, down slightly from that reported in 1966, showed a marked increase as the year ended.

During the month of December, the UGMS Analytical Laboratory conducted 356 analyses, of which 338 were brines and the remainder rock analyses.

The laboratory performed a total of 8,650 analyses during 1967, an average of 720 per month.** This was an increase of better than 140 analyses over the monthly average for the year previous.

**Addition of 105 standards would bring 1967's monthly average to 825 analyses.

Confidential 10/1/68

~~J~~ J. Thompson – Shell – Summit C.
Dahlgren
sec 9 T 2N R14E

→17069
All casing in hole – Cement – cover Dakota

T.D. 17,100

1) Perf Dakota SS produced water (5-8 bbl/hr small)
~~16000~~ 16917-52

75 sk – 1600 to 16970

2) Dispose ~~[illegible]~~ of mud

5" = 13655 to 17069

50 sk liner hang @ 13655 (50' above & 50' below)

7" surface to 13889

50 sk Plug at surface + pump cement in annulus.

P&A ≈ 10/2/68
Lloyd Burnside → Prod Super.

[signature]

STIMULATION PROGNOSIS FOR
DAHLGREEN CREEK UNIT
GOV'T 21X-9
2243' FWL and 1096' FNL
SECTION 9-2N-14E
SUMMIT COUNTY, UTAH

(For pertinent data, see Completion Prognosis)

1. "Ball-out" Dakota gross perforations 16,917-16,952' w/total 4000 gal. mud acid and 25 7/8-inch matched-density Neoprene jacketed ball sealers as follows: (Use one turbine pump truck)

   a. Unseat packer and lower to 16,900'. Displace 1000 gal. mud acid to bottom of tubing. Raise packer to former setting depth. Set packer and displace acid into formation.

   b. Open circulating ports and spot 3000 gal. mud acid and 25 ball sealers in bottom of tubing in following order: 500 gal. mud acid, 10 ball sealers, 1000 gal. mud acid, 10 ball sealers, 1000 gal. mud acid, 5 ball sealers, and 500 gal. mud acid. Close ports.

   c. Displace acid and ball sealers to perfs and observe pressure increases as balls seat in perforations.

   d. When acid displaced through perfs and balls seated, shut well in for one hour. Record instantaneous shut-in pressure for use in redesign of frac treatment if necessary.

   e. After one hour shut-in period, swab test.

2. Contingent on results of "balling-out" process, fracture treat Dakota gross perfs 16,917-16,952' down 3 1/2" N-80 tubing and 5" liner w/40,000 gal. clean produced water containing 40#/1000 gal. J-133 and 17,500# glass beads as follows:

   a. Unsting from packer and displace tubing w/5000 gal. frac water system without prop. Sting back into packer.

   b. Pump 5000 gal frac system without prop to establish rate and follow with:

   c. 10,000 gal. containing 1/4#/gal. 20-40 glass beads followed by:

   d. 10,000 gal. containing 1/2#/gal 20-40 glass beads followed by:

   e. 10,000 gal. containing 1/2#/gal 20-40 glass beads plus 1/2#/gal 12-20 glass beads.

   Displace to perfs w/7500 gal clean produced water containing 40#/1000 gal J-133. Maintain maximum injection rates utilizing 6000 HHP within a maximum pressure limitation of 9000 psi. Strive for a rate of 25-30 barrels per minute which should be attained at about 8500-9000 psi surface pressure. Do not exceed 9000 psi surface treating pressure. Pressure annulus to 2000 psi. (Install two spring loaded relief valves set at 2000 psi on the casing. Pumping system should be rigged with 9000 psi maximum pressure relief valves at automatic shut downs.)

3. Shut well in. Break frac line connections. Hook up wellhead to pits. Open well. Flow and/or swab back load and make production test.

F. D. Burnside

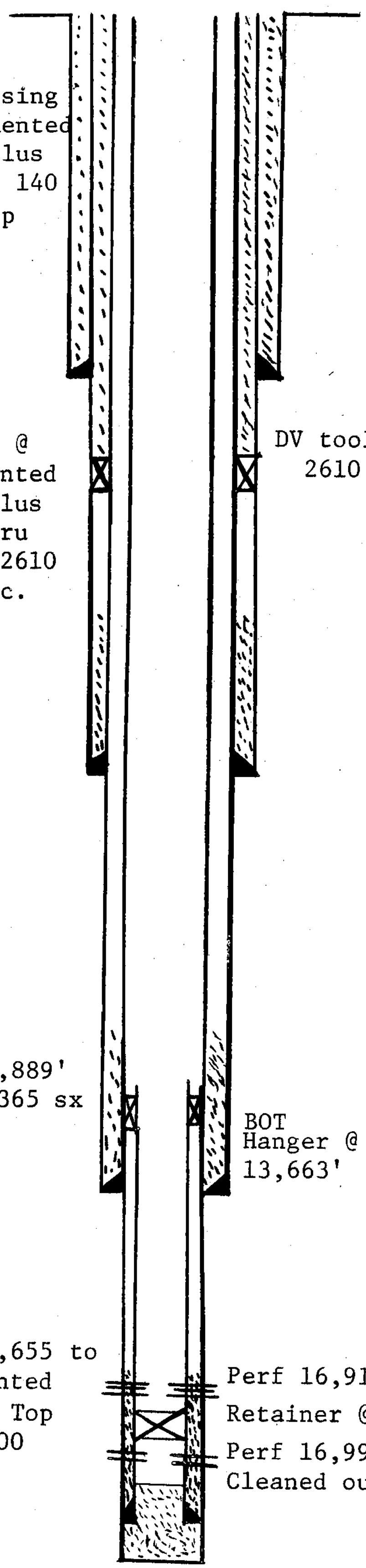
F. D . Burnside

Div. E. E.

Div. M. E.

JDS:ls
9/27/68

PLUGGING PROGNOSIS
DAHLGREEN CREEK UNIT
GOV'T 21X-9
SECTION 9-2N-14E
SUMMIT COUNTY, UTAH



PERTINENT DATA:

ELEV: 9940' KB KB-CHF: 17'

PRESENT STATUS:

Well is presently being evaluated through completion operations.

PROPOSED WORK:

1. After testing of Dakota is complete, cover interval from 16,000-16,970' w/75 sx regular cement.

2. Pull tubing into 7" and displace water with heaviest mud on location.

3. Lay down drill tubing and release completion rig. WOC min. 72 hours.

4. Move in high pressure pumping truck. Attempt to break down formation in 5" x 7" annulus w/3000 psi (assuming 10.5# mud). Leave 7" x 9 5/8" annulus open and vented to pits. If formation does not break down, try 3000 psi down 7" x 9 5/8" annulus.

5. Pump away mud if rates can be achieved where disposal costs less than 30¢/bbl.

6. When mud disposal is completed or further mud disposal uneconomic, mix two 50 sx cement slugs for 7" string. Displace one across liner hanger, place second immediately below casinghead. Mix 50 sx slug and displace down 7" x 9 5/8" annulus so that cement is placed immediately below casinghead. WOC min. 72 hours.

7. Cut casing 2' below surface and weld plate across 13 3/8", 9 5/8" & 7". Install abandonment marker.

F. D. Burnside
F. D. Burnside

Div. E.E. [signature] Div. M.E. [signature]

AKD:lem
10/1/68

Div. Drill Supt. [signature]

S[illegible]ll 21 X-

pmb

	MADISON LS & DOL	440
FAULT	Pre Є	490
	Tertiary	820
	Pre Є SD, SILT, Sh	2950
FAULT	Race Rod Pine (Pe)	11,718
	"Inverted" Park City Dol	11,718
	Moenkopi Sh	11,776
	Thaynes Dol	12,260
	Shinarump	12,575
	Nugget SS	12 850
FAULT	Normal Shinarump	13425
	MesAverde SS	13813
	Hilliard Sh	14,866
	Frontier SS	16,243
	Mowry Sh	16,440
	Dakota	16784

Conf.

FORM OGC-8X

FILE IN QUADRUPLICATE

STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF OIL & GAS CONSERVATION
348 EAST SOUTH TEMPLE
SUITE 301
SALT LAKE CITY, UTAH

October 3, 1968

REPORT OF WATER ENCOUNTERED DURING DRILLING

Well Name & Number **Government 21X-9 U-0118353**

Operator **Shell Oil Company** Address **1700 Broadway Denver, Colo. 80202** Phone **222-8454**

Contractor **Loffland Brothers** Address **Tulsa, Oklahoma** Phone **-**

Location **NE** ¼ **NW** ¼ Sec. **9** T. **2N** N R. **14** E **Summit** County, Utah

Water Sands:

	Depth		Volume	Quality
	From	To	Flow Rate or Head	Fresh or Salty
1.	220	390	Not Tested	Unknown
2.	540	820	"	"
3.	2985	3000	"	"
4.	12,850	13,440	"	Prob salty
5.	13,813	13,950	"	"

(Continued on reverse side if nec.)

Formation Tops: **(See attached list)**

Remarks:

NOTE:
(a) Upon diminishing supply forms, please inform the Commission,
(b) Report on this form as provided for in Rule C-20, General Rules and Regulations and Rules of Practice and Procedure, (See back of form.)
(c) If a water analysis has been made of the above reported zone, please forward a copy along with this form.

Drillers Log: (Continued)

FROM	TO	Flow Rate or Head	Fresh or Salty
14,070	14,080	Not Tested	Prob Salty
14,140	14,145	"	"
14,170	14,180	"	"
14,598	14,604	"	"
14,670	14,680	"	"
14,745	14,752	"	"
14,796	14,862	"	"
16,320	16,470	"	"
16,860	16,872	"	"
16,917	16,952	Swab 8.5 BW/H FL 12,900' SF 13,500'	5700 ppm NaCl
16,985	17,000	AT 16,990 Swabbed 2.6 BW/H FL 13,000' SF 13,004'	3300 ppm NaCl (May be mud filtrate)
17,038	17,048	Not Tested	Prob as above

Rule C-20 REPORTING OF FRESH WATER SANDS.

It shall be the duty of any person, operator or contractor drilling an oil or gas well or drilling a seismic, core or other exploratory hole to report to the Commission all fresh water sands encountered; such report shall be in writing and give the location of the well or hole, the depth at which the sands were encountered, and the thickness of such sands, and the rate of flow of water if known.

If no fresh water sands are encountered, it is requested that a negative report to that effect be filed.

OCT 4 1968

DM-281 (REV. 9/59)

SHELL OIL COMPANY
PRODUCTION LABORATORY WATER ANALYSIS REPORT
DENVER, COLORADO

FROM: – PRODUCTION LABORATORY
DENVER, COLORADO

TO: ______________________

LABORATORY NUMBER 24853
SAMPLE TAKEN September 29, 1968
SAMPLE RECEIVED September 30, 1968
RESULTS REPORTED October 3, 1968

SAMPLE DESCRIPTION FIELD NO. ________

COMPANY Shell Oil Company LEASE Unit WELL NO. 21X-9

NE NW SEC. 9 TWP. 2N RGE. 14E SUR. ________

DISTRICT ________ FIELD Dahlgreen Creek COUNTY Summit STATE Utah

SAMPLE TAKEN FROM

PRODUCING FORMATION ________ TOP ________

REMARKS Sample taken at 11:30 a.m. after 148 bbls produced.

SAMPLE TAKEN BY Larry Menke

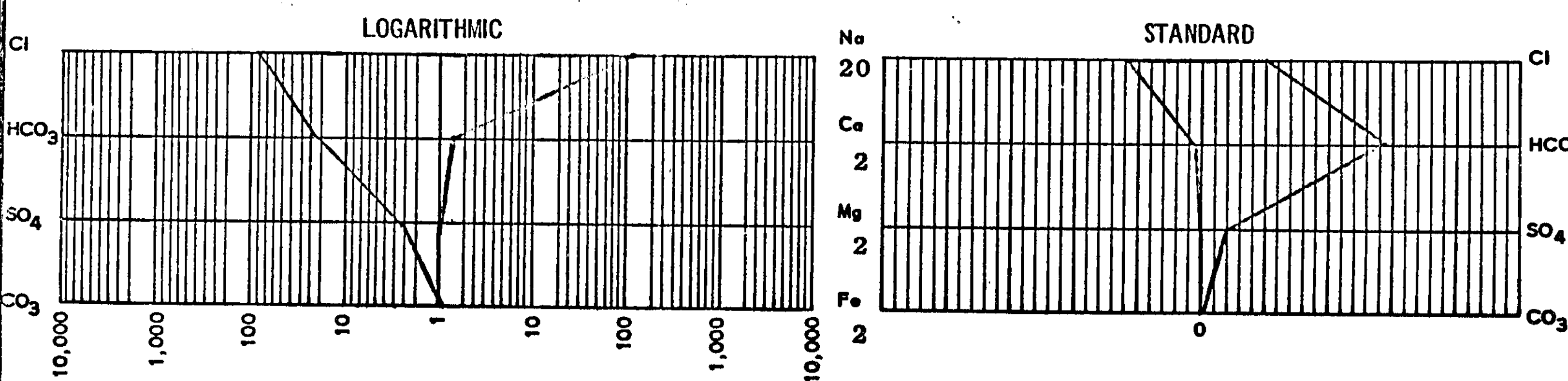
CHEMICAL AND PHYSICAL PROPERTIES

SPECIFIC GRAVITY @60/60° F. 1.009 pH 7.9 RES. 0.840 OHM METERS @ 77°F

TOTAL HARDNESS Mg/L as $CaCO_3$ 88 TOTAL ALKALINITY Mg/L as $CaCO_3$ 1401

CONSTITUENT	MILLIGRAMS PER LITER Mg/L.	MILLEQUIVALENTS PER LITER MEQ/L		REMARKS
CALCIUM - Ca^{++}	27	1.35		
MAGNESIUM - Mg^{++}	5	0.41		
SODIUM - Na^{+}	2909	126.54		
BARIUM (INCL. STRONTIUM) - Ba^{++}	0	-		
TOTAL IRON - Fe^{++} AND Fe^{+++}	Absent	-		
BICARBONATE - HCO_3^{-}	1708	28.01		
CARBONATE - CO_3^{--}	-	-		
SULFATE - SO_4^{--}	185	3.85		
CHLORIDE - CL^{-}	3420	96.44		
TOTAL DISSOLVED SOLIDS	8254	256.60		

MILLEQUIVALENTS PER LITER



( ) AREA OFFICE
( ) EXPLORATION MANAGER
( ) DIVISION OFFICE
( ) DIVISION EXPL. MANAGER
( ) DISTRICT OFFICE
( ) DISTRICT GEOLOGIST
( ) SHELL DEVELOPMENT – EPR

ANALYST L. A. Johnson, Jr.

CHECKED C. E. Davis

Form OGCC-1 b•

STATE OF UTAH
OIL & GAS CONSERVATION COMMISSION

SUBMIT IN TRIPLICATE* (Other instructions on reverse side)

5. LEASE DESIGNATION AND SERIAL NO. U-0118353

SUNDRY NOTICES AND REPORTS ON WELLS

(Do not use this form for proposals to drill or to deepen or plug back to a different reservoir. Use "APPLICATION FOR PERMIT—" for such proposals.)

6. IF INDIAN, ALLOTTEE OR TRIBE NAME

1. OIL WELL ☐ GAS WELL ☐ OTHER **Notice to P & A**

7. UNIT AGREEMENT NAME **Dahlgreen Creek Unit**

2. NAME OF OPERATOR **Shell Oil Company (Rocky Mountain Division Production)**

8. FARM OR LEASE NAME **Government**

3. ADDRESS OF OPERATOR **1700 Broadway, Denver, Colorado 80202**

9. WELL NO. **21X-9**

4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.* See also space 17 below.)
At surface **1096' FNL and 2243' FWL Sec 9**

10. FIELD AND POOL, OR WILDCAT **Dahlgreen Creek Area**

11. SEC., T., R., M., OR BLK. AND SURVEY OR AREA **NE/4 NW/4 Section 9-T 2N-R 14E**

14. PERMIT NO.

15. ELEVATIONS (Show whether DF, RT, GR, etc.) **9923 GL, 9940 KB**

12. COUNTY OR PARISH **Summit** 13. STATE **Utah**

16. Check Appropriate Box To Indicate Nature of Notice, Report, or Other Data

NOTICE OF INTENTION TO:				SUBSEQUENT REPORT OF:			
TEST WATER SHUT-OFF	☐	PULL OR ALTER CASING	☐	WATER SHUT-OFF	☐	REPAIRING WELL	☐
FRACTURE TREAT	☐	MULTIPLE COMPLETE	☐	FRACTURE TREATMENT	☐	ALTERING CASING	☐
SHOOT OR ACIDIZE	☐	ABANDON*	X	SHOOTING OR ACIDIZING	☐	ABANDONMENT*	☐
REPAIR WELL	☐	CHANGE PLANS	☐	(Other)			☐
(Other)			☐	(NOTE: Report results of multiple completion on Well Completion or Recompletion Report and Log form.)			

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones pertinent to this work.) *

As per verbal conversation between Messrs. Paul Burchell and G. L. Thompson on October 1, 1968, regarding the plugging and abandonment of this well.

APPROVED BY DIVISION OF
OIL & GAS CONSERVATION

DATE 11-4-68

BY

18. I hereby certify that the foregoing is true and correct

SIGNED Original Signed by: J. W. MOORE TITLE **For: C. N. Tinker Division Exploitation Engr.** DATE **November 1, 1968**

(This space for Federal or State office use)

APPROVED BY ______ TITLE ______ DATE ______
CONDITIONS OF APPROVAL, IF ANY:

*See Instructions on Reverse Side

Form OGCC-1 b

STATE OF UTAH
OIL & GAS CONSERVATION COMMISSION

SUBMIT IN TRIPLICATE*
(Other instructions on reverse side)

SUNDRY NOTICES AND REPORTS ON WELLS

(Do not use this form for proposals to drill or to deepen or plug back to a different reservoir. Use "APPLICATION FOR PERMIT—" for such proposals.)

1. OIL WELL ☐ GAS WELL ☐ OTHER Plugging and Abandonment
2. NAME OF OPERATOR: Shell Oil Company (Rocky Mountain Division Production)
3. ADDRESS OF OPERATOR: 1700 Broadway, Denver, Colorado 80202
4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.* See also space 17 below.)
   At surface: 1096' FNL and 2243' FWL Sec 9

5. LEASE DESIGNATION AND SERIAL NO.: U-0118353
6. IF INDIAN, ALLOTTEE OR TRIBE NAME:
7. UNIT AGREEMENT NAME: Dahlgreen Creek Unit
8. FARM OR LEASE NAME: Government
9. WELL NO.: 21X-9
10. FIELD AND POOL, OR WILDCAT: Dahlgreen Creek Area
11. SEC., T., R., M., OR BLK. AND SURVEY OR AREA: NE/4 NW/4 Section 9-T 2N-R 14E

14. PERMIT NO.:
15. ELEVATIONS (Show whether DF, RT, GR, etc.): 9923 GL, 9940 KB
12. COUNTY OR PARISH: Summit
13. STATE: Utah

16. **Check Appropriate Box To Indicate Nature of Notice, Report, or Other Data**

NOTICE OF INTENTION TO:				SUBSEQUENT REPORT OF:			
TEST WATER SHUT-OFF	☐	PULL OR ALTER CASING	☐	WATER SHUT-OFF	☐	REPAIRING WELL	☐
FRACTURE TREAT	☐	MULTIPLE COMPLETE	☐	FRACTURE TREATMENT	☐	ALTERING CASING	☐
SHOOT OR ACIDIZE	☐	ABANDON*	☐	SHOOTING OR ACIDIZING	☐	ABANDONMENT*	X
REPAIR WELL	☐	CHANGE PLANS	☐	(Other)			☐
(Other)			☐				

(NOTE: Report results of multiple completion on Well Completion or Recompletion Report and Log form.)

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones pertinent to this work.) *

Plugging procedures were as follows:

10-3-68 Spotted cement plug w/75 sx reg Class "G" cement from 16,970-16,107.

10-4 - 10-8-68 Disposed of all possible mud - total 15,200 barrels. Spotted cement plugs as follows:

Sx	Interval
50	13,670-13,435 in 7" csg
50	260-Top of 7" csg
50	225-Sfc in 9-5/8"-7" annulus

P & A COMPLETE 10-8-68.

18. I hereby certify that the foregoing is true and correct

SIGNED J.W. Moore For: C. N. Tinker TITLE Division Exploitation Engr DATE November 1, 1968

(This space for Federal or State office use)

APPROVED BY ________ TITLE ________ DATE ________
CONDITIONS OF APPROVAL, IF ANY:

*See Instructions on Reverse Side

Form OGCC-3

3

STATE OF UTAH

OIL & GAS CONSERVATION COMMISSION

SUBMIT IN DUPLICATE* (See other instructions on reverse side)

WELL COMPLETION OR RECOMPLETION REPORT AND LOG *

1a. TYPE OF WELL: OIL WELL [ ] GAS WELL [ ] DRY [X] Other

b. TYPE OF COMPLETION: NEW WELL [X] WORK OVER [ ] DEEP-EN [ ] PLUG BACK [ ] DIFF. RESVR. [ ] Other

2. NAME OF OPERATOR
Shell Oil Company (Rocky Mountain Divisinn Production)

3. ADDRESS OF OPERATOR
1700 Broadway, Denver, Colorado 80202

4. LOCATION OF WELL (*Report location clearly and in accordance with any State requirements*)*
At surface 1096' FNL and 2240' FWL Sec 9
At top prod. interval reported below
At total depth

5. LEASE DESIGNATION AND SERIAL NO.
U-0118353

6. IF INDIAN, ALLOTTEE OR TRIBE NAME

7. UNIT AGREEMENT NAME
Dahlgreen Creek Unit

8. FARM OR LEASE NAME
Government

9. WELL NO.
21X-9

10. FIELD AND POOL, OR WILDCAT
Dahlgreen Creek Area

11. SEC., T., R., M., OR BLOCK AND SURVEY OR AREA
NE/4 NW/4 Section 9-T 2N-R 14E

14. PERMIT NO. | DATE ISSUED

12. COUNTY OR PARISH: Summit | 13. STATE: Utah

15. DATE SPUDDED: 11-17-67 | 16. DATE T.D. REACHED: 8-13-68 | 17. DATE ~~COMPL. (Ready to prod.)~~ P & A'd 10-8-68 | 18. ELEVATIONS (DF, RKB, RT, GR, ETC.)*: 9923 GL, 9940 KB | 19. ELEV. CASINGHEAD: 17.80'

20. TOTAL DEPTH, MD & TVD: 17,100 | 21. PLUG, BACK T.D., MD & TVD: 17,020 | 22. IF MULTIPLE COMPL., HOW MANY* | 23. INTERVALS DRILLED BY → ROTARY TOOLS: Total | CABLE TOOLS

24. PRODUCING INTERVAL(S), OF THIS COMPLETION—TOP, BOTTOM, NAME (MD AND TVD)*

25. WAS DIRECTIONAL SURVEY MADE: Multishot Survey

26. TYPE ELECTRIC AND OTHER LOGS RUN Induction, Density, Dipmeter, Integrated BHCS GR w/cal, Dual Ind LL-8, Proximity Log Caliper, Velocity Survey, GRN&ES, CBL, and Dual Caliper Log

27. WAS WELL CORED: No

28. CASING RECORD (*Report all strings set in well*)

CASING SIZE	WEIGHT, LB./FT.	DEPTH SET (MD)	HOLE SIZE	CEMENTING RECORD	AMOUNT PULLED
20"	94#	193	12¼"	775 sx	0
13-3/8"	48#	461	17½"	565 sx	0
9-5/8"	40#	4900	12¼"	3020 sx	0
7"	23,26 & 29#	13,889	8-3/4"	365 sx	0
5" liner	18#	17,069	6"	400 sx	0

29. LINER RECORD

SIZE	TOP (MD)	BOTTOM (MD)	SACKS CEMENT*	SCREEN (MD)
	As above	and as per	attachment	

30. TUBING RECORD

SIZE	DEPTH SET (MD)	PACKER SET (MD)

31. PERFORATION RECORD (*Interval, size and number*)

32. ACID, SHOT, FRACTURE, CEMENT SQUEEZE, ETC.

DEPTH INTERVAL (MD)	AMOUNT AND KIND OF MATERIAL USED
As per attachments	

33.* PRODUCTION

DATE FIRST PRODUCTION | PRODUCTION METHOD (*Flowing, gas lift, pumping—size and type of pump*): Well Plugged and Abandoned | WELL STATUS (*Producing or shut-in*)

DATE OF TEST	HOURS TESTED	CHOKE SIZE	PROD'N. FOR TEST PERIOD →	OIL—BBL.	GAS—MCF.	WATER—BBL.	GAS-OIL RATIO

FLOW. TUBING PRESS.	CASING PRESSURE	CALCULATED 24-HOUR RATE →	OIL—BBL.	GAS—MCF.	WATER—BBL.	OIL GRAVITY-API (CORR.)

34. DISPOSITION OF GAS (*Sold, used for fuel, vented, etc.*) | TEST WITNESSED BY

35. LIST OF ATTACHMENTS
Well Log and History, Csg & Cmtg Detail, Log Tops, and Sample Description

36. I hereby certify that the foregoing and attached information is complete and correct as determined from all available records

SIGNED J W Moore TITLE For: C. N. Tinker Division Exploitation Engr. DATE November 1, 1968

*(See Instructions and Spaces for Additional Data on Reverse Side)

NEW WELL PLUGGED & ABANDONED (DAHLGREEN CREEK UNIT) DAHLGREEN CREEK AREA
SHELL OIL COMPANY

FROM: 10-20-67 - 10-8-68	ASE	GOVERNMENT	WE NO.	21X-9
	IVISION	ROCKY MOUNTAIN	ELEV	9940 KB
	COUNTY	SUMMIT	STATE	UTAH

UTAH

DAHLGREEN CREEK UNIT

DAHLGREEN CREEK AREA

Government 21X-9
(WC) Loffland

"FR" Building roads and location.
Sulenta Construction Company
(Estimate 40% complete).
Located 1096' FNL and 2243' FWL
Section 9-T2N-R14E, Summit County, Utah.
Estimated GL - 9000'
15,800' Dakota Test
Shell's Working Interest - 53.7%
Drilling Contractor - Loffland
Finished rough grade on location. Building 4.1 miles roadway. Installed culverts on all large drainages. Prep to MI dry-hole digger. Will carry progress report weekly until road and location are complete.

OCT 20 1967

Government 21X-9
(WC) Loffland

(RRD 10-20-67) Estimate 50% complete. Prep to pour concrete footings for rig substructure foundation. Burned timber. Completed all rough grades on roads. Installed all culverts. MI dry-hole digger 10-25-67 and dug 26" conductor hole and 10' collar, rat hole, and mouse hole. Will carry progress report weekly until they spud the well. OCT 27 1967

Government 21X-9
(WC) Loffland

(RRD 10-27-67) MIRT. Locations and roads approx 80% complete. Completed cellar, rat hole & mouse hole. Set conductor pipe and poured concrete foundations for rig substructure. NOV 3 1967

Government 21X-9
(WC) Loffland

(RRD 11-3-67) RURT. NOV 10 1967

Government 21X-9
(WC) Loffland

RURT. NOV 13 1967

Government 21X-9
(WC) Loffland

RURT. NOV 14 1967

Government 21X-9
(WC) Loffland

RURT. NOV 15 1967

Government 21X-9
(WC) Loffland

RURT. NOV 16 1967

Government 21X-9
(WC) Loffland

Prep to drill rat hole. Rig on daywork 12 noon 11-16-67.
Mud: 8.8 x 83 x 3 (Oil 3%) (LCM 12#/bbl) NOV 17 1967

Government 21X-9
(WC) Loffland

230/140/3/230 Reaming 26" hole at 116'. Dev: 1/4° at 89' and 1/2° at 155'. Drilled 230' 12 1/4" hole and reamed 12 1/4" hole to 17 1/2" to 218'. Spudded 4 PM 11-17-67.
Mud: 9.6 x 69 x 2.4 NOV 20 1967

Government 21X-9
(WC) Loffland

230/140/4/0 Reaming 26" hole at 192'. NOV 21 1967
(Correction to wire of 11-20-67 - Spud date should have been 4 PM 11-17-67 instead of 11-18-67.)
Mud: 9.5 x 185 x 3.7

Government 21X-9
(WC) Loffland
NOV 22 1967

230/140/5/0 Reaming 26" hole @ 123'. Attempted to run 20" csg. Ran to 130' and could go no further. Laid down 2 jts, stood back 3 jts. Picked up (2) 26" hole openers spaced 10' apart.
Mud: 9.5 x 115

Government 21X-9
(WC) Loffland

289/140/10/59 Drilling boulders and river sd. Dev: 1° at 268. Rereamed 26" hole to 193'. Ran and cem 6 jts (175.20') 20" USS smls H-40 94# 8rd csg at 193' KB w/775 sx Class "G" Neat cement w/2% $CaCl_2$ and 1/4#/sx Clinton plate. Plug down 3:00 PM 11-23-67. Cement circ (Dow) WOC. Cut off csg, weld on csghd, nipple up, tested 20" hydril w/ and w/o DP (500 psi), held ok. Tested casing head to 475 psi, held ok. Drilled firm cement 173-193 (4 AM 11-25-67). Redrilled boulders in 17 1/2" hole from 193-221'. Made trip for 12 1/2" bit. Redrilled boulder from 221-230' in 12 1/4" hole. Began drilling new hole at 230'. Drilled 36' new hole in 11 hrs; dulled bit. Trip out for new bit and pick up of square DC's.
Mud: 8.7 x 48 x 4.8 (Oil 1%) NOV 27 1967

Government 21X-9
(WC) Loffland

373/140/11/84 Drilling. Dev: 1° at 314 and 1 1/2° at 360.
Mud: 8.6 x 71 x 4.5 (Oil trc) NOV 28 1967

Government 21X-9
(WC) Loffland

401/140/12/28 Cleaning out cavings and large boulders at 293. Lost circ at 401' at 7:45 AM 11-27-67. Pulled out of hole and mixed mud and LCM. Hole bridged at 276'.
Mud: 8.8 x 84 x 4 (Oil Trc) NOV 29 1967

Government 21X-9
(WC) Loffland

401/140/13/0 Redrilling boulders.
Mud: 9.2 x 105 x 3.3 (Oil 1%) (LCM 16#/bbl) NOV 30 1967

Government 21X-9
(WC) Loffland

401/140/14/0 (-9 days) Tripping for new bit at 387'. Spent 17 1/2 hrs redrilling from 355-387', 5 1/2 hrs for trip at 355. Magnofluxed DC's, no defects.
Mud: 9.2 x 116 x 3.3 (Oil Trc) DEC 1 1967

Government 21X-9
(WC) Loffland

434/140/17/33 Drilling. Dev: 1 1/4° at 403'. On trip for new bit at 387', lost 30 bbls mud. Spent 12 1/4 hrs redrilling from 322-395'. At 395', lost 60 bbls mud, FL 75'. Mixed pill of 55% LCM and spotted with openended DP. Regained circ. On trip in with new bit, hit bridges at 308, 353, and 386'. 19 hrs drilling from 401-428'. At 428, lost circ. Mixed pill of LCM and obtained full returns. Drilled additional 4"; lost returns. Spent 19 1/2 hrs mixing five pills and circulating. Lost total of 885 bbls mud. On last pill spotted, recovered 200 bbls muddy water. Obtained full returns. Spent 5 hrs redrilling from 385-429'. Drilled from 429-434' in three hrs.
Mud: 8.8 x 100 x 4 (LCM 18#/bbl) DEC 4 1967

Government 21X-9
(WC) Loffland

462/140/18/28 Redrilling at 387'. Dev: 1° at 446'. While drilling at 462', lost circ - total of 750 bbls. Hole filled w/water; plugged to 293'.
Mud: 9 x 117 x 3 DEC 5 1967

Government 21X-9
(WC) Loffland

469/140/19/7 Redrilling at 320'. CO from 387-462'. Drilled 7' and lost circ; hole plugged. Worked pipe into surf csg. Redrilled at 263' and lost approx 250 bbls mud.
Mud: 8.9 x 110 x 4 (LCM 22#/bbl) DEC 6 1967

Government 21X-9 (WC) Loffland	469/140/20/0 Circulating at 460'; prep to open hole to 17 1/2"; CO w/12 1/4" bit from 320-460'. Mud: 9 x 117 x 3.6 (LCM 18#/bbl) DEC 7 1967
Government 21X-9 (WC) Loffland	469/140/21/0 (-16 days) Reaming out 12 1/4" hole to 17 1/2" hole at 344'. Reamed from 193-344'. Mud: 9.1 x 90 x 3.6 (LCM 17#/bbl) DEC 8 1967
Government 21X-9 (WC) Loffland	469/140/24/0 Nippling up to 13 3/8" csg. Reamed 12 1/4" hole to 17 1/2" to 461'. Ran and cemented 14 jts (444') 13 3/8" ST&C Lone Star H-40 48# 8rd casing at 461' w/565 sx 1:1 poz, 4% gel, 2% CaCl, 1/2# Clinton Flake per sx. Good returns throughout. Cement did not circ. Plug down 10:30 PM 12-9-67. Ran 10 jts 1" & cem at 210' w/220 sx Class "G" Neat, 4% $CaCl_2$. Good returns throughout. Cement did not circ. Job complete 9:15 AM 12-10-67. Ran 7 jts 1" and cem at 147' w/140 sx Class "G" Neat, 3% $CaCl_2$. Cement circ. Job complete 4:30 PM 12-10-67. DEC 11 1967
Government 21X-9 (WC) Loffland	469/140/25/0 Nippling up; prep to press test BOP's. DEC 12 1967
Government 21X-9 (WC) Loffland	558/140/26/89 Tripping. Dev: 1° at 482, 513, & 558'. Mud: 8.9 x 128 x 5 (LCM 17#/bbl) DEC 13 1967
Government 21X-9 (WC) Loffland	727/140/27/169 Drilling. Dev: 1° at 600' and 676'. Mud: 8.9 x 38 x 5 (Oil 1%) DEC 14 1967
Government 21X-9 (WC) Loffland	1015/140/28/288 (-21 days) Drilling. Dev: 1° at 770 and 861, 1 3/4° at 968, 1 1/2° at 997. Mud: 9.1 x 41 x 5 DEC 15 1967
Government 21X-9 (WC) Loffland	1528/140/31/513 Drilling. Dev: 2° at 1026, 1094, 1125, 2 1/4° at 1157, 1231, 1262, 2°+ at 1294, 2 1/4° at 1325, 2° at 1360, 1392, 1475. DEC 18 1967 Mud: 8.8 x 36 x 4.8
Government 21X-9 (WC) Loffland	1774/140/32/246 Drilling. Dev: 2° at 1518, 1 3/4° at 1565, 2° at 1659, 2 1/4° at 1722, and 2°+ at 1753. Mud: 9 x 33 x 3.9 DEC 19 1967
Government 21X-9 (WC) Loffland	1929/140/33/155 Drilling. Dev: 2 1/4° at 1860, 2 1/2° at 1880 and 1920. Mud: 9 x 35 x 3.6 DEC 20 1967
Government 21X-9 (WC) Loffland	1977/140/34/48 Tripping. Dev: 2 3/4° at 1943. Made 20-day magnoflux inspection; changed bottom hole assembly. Mud: 9 x 35 x 4.2 DEC 21 1967
Government 21X-9 (WC) Loffland	2128/140/35/151 (-23 days) Tripping. Dev: 2 1/2°+, -3° at 2041, 3 3/4° at 2104. Mud: 9 x 37 x 4.2 DEC 22 1967

Government 21X-9
(WC) Loffland

2780/140/39/652 Drilling. Dev: 4^{o} at 2167, 3 $3/4^{o}$ at 2230, 3 $1/2^{o}$ at 2356, 3^{o} at 2482, 2^{o} at 2577, and $3/4^{o}$ at 2729.
Mud: 9.1 x 35 x 4.5 (Oil 2%) DEC 26 1967

Government 21X-9
(WC) Loffland

2906/140/40/126 Logging. Dev: 2^{o} at 2823 and $2+^{o}$ at 2886. 5 1/2 hrs logging (Schl). Ran Induction and Density logs; had to rerun Density Log. DEC 27 1967
Mud: 9.2 x 39 x 4 (Oil 2%)

Government 21X-9
(WC) Loffland
DEC 28 1967

2906/140/41/0 Prep to DST. 6 hrs logging. Encountered total 24' porosity in 3 sand zones in the interval 2434-2602' (possibly Fort Union). Samples indicated good live oil shows. Water saturation calculations questionable.
Mud: 9.2 x 40 x 4 (Oil 2%)

Government 21X-9
(WC) Loffland

2960/140/42/54 (-28 days) Reaming to bottom w/tandem 12 1/4 square DC.
DST No. 1 2400-2605.
Open 15 mins. SI 30 mins. Open 1 1/2 hrs, SI 1 1/2 hrs. Opened w/weak blow, decreasing to extremely weak in 90 mins. Reversed out mud through reversing sub located three collars above test tool. Remaining three collars contained drilling mud (R_m = 8.2 at 58^{o}). No shows of oil, gas, or water.
IHP 1138, ISIP 677, IFP 22, FFP 51, FSIP 908, FHP 1132. BHT - 102^{o} F.
Positive Test. DEC 29 1967

Government 21X-9
(WC) Loffland

3569/140/46/609 Drilling. Dev: 2^{o} at 2937, 1 $3/4^{o}$ at 3032 and 3137, 1 $1/2^{o}$ at 3326, and $3/4^{o}$ at 3514.
Mud: 9.1 x 38 x 5.3 (Oil 2%) JAN 2 1968

Government 21X-9
(WC) Loffland

3725/140/47/156 Drilling. Dev: 1° at 3609. Pulled bit due to pressure loss and found one 9" DC cracked at bottom of box. Magnofluxed DC's on 10-day inspection.
Mud: 9.1 x 35 x 4 (Oil 2%) JAN 3 1968

Government 21X-9
(WC) Loffland

3922/140/48/197 Drilling. Dev: 1^{o} at 3705, 1 $1/2^{o}$ at 3800, and 3889'.
Mud: 9.2 x 36 x 3.6 (Oil 2%) JAN 4 1968

Government 21X-9
(WC) Loffland

4078/140/49/156 (-24 days) Drilling. Dev: 2^{o} at 3962 & 4056.
Mud: 9.3 x 37 x 3.6 (Oil 6%) JAN 5 1968

Government 21X-9
(WC) Loffland

4546/140/52/468 Drilling. Dev: 1 $3/4^{o}$ at 4171, 4230, 2^{o} at 4359, 3^{o} at 4422 & 4519.
Mud: 9 x 32 x 6 (Oil 2%) JAN 8 1968

Government 21X-9
(WC) Loffland

4721/140/53/175 Drilling. Dev: 3^{o} at 4582 and 4645.
Mud: 9.1 x 32 x 6 (Oil 3%) JAN 9 1968

Government 21X-9
(WC) Loffland

4803/140/54/82 Drilling. Dev: -4° at 4740. Changed BHA and laid down (2) 12 1/4" square DC's. Picked up 10' - 10" BHDC and two threepoint string reamers.
Mud: 9.1 x 32 x 6.8 (Oil 3%) JAN 10 1968

Government 21X-9
(WC) Loffland

4894/140/55/91 Drilling. Dev: 4° at 4788 and 4 1/2° at 4850.
Mud: 9 x 33 x 5.6 (Oil 4%) JAN 11 1968

Government 21X-9
(WC) Loffland

4900/140/56/6 (-26 days) Logging. Dev: 5° at 4897. 14 3/4 hrs logging (Schl). Ran Dipmeter and Integrated BHCS-GR; Dual Induction Log and Integrator failed.
Mud: 9 x 32 x 4.8 (Oil 4%) JAN 12 1968

Government 21X-9
(WC) Loffland

4900/140/59/0 Nippling up. Finished logging; total time - 38 hrs.
Logging Operations as follows:
1-11-68 Waited 2 1/2 hrs on Schlumberger truck. Attempted to run Dual Ind LL-8; LL-8 malfunctioned. Ran dipmeter.
1-12-68 Attempted to run Integrated BHC-GRS. Integrator failed, caliper faulty. Ran FDC log. "F" log failed. Ran Dual Ind LL-8. Tool malfunctioned intermittently, had to repeat log from 2700 ft to sfc. Ran proximity log caliper - caliper arms extended to only 16 inches instead of normal 23 inches. Ran dual caliper log. Generator engine locked up while running dual caliper - tied into rig power. Reran proximity log caliper - arms extended to 21 inches.
1-13-68 Finished logging 3:30 AM 1-13-68.
Conditioned hole to run casing. Laid down 12 1/4 tools and DC's. Ran and cem 151 jts (4882.20') 9 5/8" 40# J-55 ST&C 8rd thd casing at 4900'. Cemented 1st stage through shoe w/800 sx 1:1 poz, 2% gel, 1/4# Clinton Flake/sx followed by 200 sx Class "G" Neat, 1/4# Clinton Flake/sx. Plug down 2:35 AM 1-14-68. Second stage through DV stage tool w/2020 sx 1:1 poz, 2% gel, 1/4# Clinton Flake/sx. Plug down 8:45 AM 1-14-68. Good returns throughout both stages. Cement circ. Float shoe at 4900, float collar at 4836, baffle collar at 4804, DV stage tool at 2610. WOC 19 1/4 hrs. JAN 15 1968

Government 21X-9
(WC) Loffland

4900/140/60/0 Tripping hole w/bit; prep to drill DV tool.
Mud: 8.9 x 32 x 5.2 (Oil 3%) JAN 16 1968

Government 21X-9
(WC) Loffland

4928/140/61/28 Reaming from 4920-4925; prep to drill ahead.
Mud: 8.8 x 34 x 5 (Oil 3%) JAN 17 1968

Government 21X-9
(WC) Loffland

4990/140/62/62 Reaming stabilizer to bottom. Picked up 4' integral blade stabilizer 40' above bit.
Mud: 8.7 x 33 x 4.5 (Oil 2%) JAN 18 1968

Government 21X-9
(WC) Loffland

5078/140/63/88 (-33 days) Tripping. Dev: 4 3/4° at 5038 and 5074.
Mud: 8.6 x 33 x 4.8 (Oil 2%) JAN 19 1968

Government 21X-9
(WC) Loffland

5478/140/66/400 Drilling. Dev: 4 3/4° at 5151, 6° at 5242, 7° at 5294, 6 3/4° at 5356, 7° at 5387, and 7 3/4° at 5419.
Mud: 8.6 x 32 x 6.9 (Oil 2%) JAN 22 1968

Government 21X-9
(WC) Loffland

5541/140/67/63 Drilling. Dev: 8° at 5473 and 5526.
Mud: 8.6 x 31 x 6 (Oil 2%) JAN 23 1968

Government 21X-9
(WC) Loffland

5592/140/68/51 Drilling. Dev: 9 1/4° at 5566.
Mud: 8.6 x 33 x 5.1 (Oil 3%) JAN 24 1968

Government 21X-9
(WC) Loffland

5640/140/69/48 Tripping. Magnofluxing DC's. Dev: 8 3/4° at 5595' and 9° at 5635'.
Mud: 8.8 x 32 x 5 (Oil 2%) JAN 25 1968

Government 21X-9
(WC) Loffland

5689/140/70/49 (-37 days) Tripping. Dev: 9 1/2° at 5685.
Mud: 8.7 x 31 x 4.8 (Oil 2%) JAN 26 1968

Government 21X-9
(WC) Loffland

5955/140/73/266 Tripping. Dev: 9 1/4° at 5714, 10° at 5767, 10 1/2° at 5839, 10 1/4° at 5870, 11° at 5913, 10 3/4° at 5950.
Mud: 8.8 x 34 x 5 (Oil 3%) JAN 29 1968

Government 21X-9
(WC) Loffland

6045/140/74/90 Drilling. Dev: 11° at 6030.
Mud: 8.8 x 36 x 4.2 (Oil 5%) JAN 30 1968

Government 21X-9
(WC) Loffland

6217/140/75/172 Drilling. Dev: 12° at 6159.
Mud: 8.8 x 35 x 4 (Oil 5%) JAN 31 1968

Government 21X-9
(WC) Loffland

6411/140/76/194 Tripping. Dev: 14° at 6300.
Mud: 8.8 x 35 x 4.2 (Oil 4%) FEB 1 1968

Government 21X-9
(WC) Loffland

6544/140/77/133 (- 39 days) Drilling. Dev: 15¼° at 6405, 16½° at 6517.
Mud: 8.8 x 33 x 4.8 (Oil 4%) FEB 2 1968

Government 21X-9
(WC) Loffland

6732/140/80/188 Drilling. Dev: 16 3/4° at 6620 and 6660', 16 1/2° at 6692. On trip in w/bit, 19 hrs CO to bottom from 5715-6665. FEB 5 1968
Mud: 9 x 46 x 3 (Oil 5%)

Government 21X-9
(WC) Loffland

6804/140/81/72 Drilling. Dev: 16 1/2° at 6750.
Mud: 8.9 x 44 x 2.6 (Oil 5%) FEB 6 1968

Government 21X-9
(WC) Loffland

6874/140/82/70 Drilling. Dev: 16 1/4° at 6814.
Mud: 8.9 x 43 x 2.5 (Oil 5%) FEB 7 1968

Government 21X-9
(WC) Loffland

6942/140/83/68 Drilling. Dev: 15 3/4° at 6881.
Mud: 8.9 x 43 x 3.6 (Oil 5%) FEB 8 1968

Government 21X-9
(WC) Loffland

7034/140/84/92 (-42 days) Drilling. Dev: 15½° at 6974.
Mud: 8.9 x 44 x 3.3 (Oil 5%) FEB 9 1968

Government 21X-9
(WC) Loffland

7262/140/87/228 Drilling. Dev: 15 3/4° at 7049, 16° at 7253.
Mud: 8.8 x 43 x 3 (Oil 5%) FEB 12 1968

Government 21X-9
(WC) Loffland

7343/140/88/81 Drilling. Dev: 15 3/4° at 7330.
Mud: 8.8 x 44 x 3.2 (Oil 5%) FEB 13 1968

Government 21X-9
(WC) Loffland

7423/140/89/80 Drilling. Dev: 15 1/2° at 7396.
Mud: 8.8 x 45 x 3.8 (Oil 5%) FEB 14 1968

Government 21X-9
(WC) Loffland

7510/140/90/87 Drilling. Dev: 14 3/4° at 7445.
Mud: 8.8 x 46 x 3.4 (Oil 4%) FEB 15 1968

Government 21X-9
(WC) Loffland

7631/140/91/121 (-43 days) Drilling. Dev: 14 3/4° at 7565.
Mud: 8.8 x 42 x 3.6 (Oil 4%) FEB 16 1968

Government 21X-9
(WC) Loffland

7958/140/94/327 Making trip. Dev: 14 1/4° at 7705 and 7813.
Mud: 8.8 x 42 x 3.2 (Oil 5%) FEB 19 1968

Government 21X-9
(WC) Loffland

8045/140/95/87 Drilling. Dev: 14 1/2° at 7953'.
Mud: 8.8 x 44 x 3.4 (Oil 4%) FEB 20 1968

Government 21X-9
(WC) Loffland

8089/140/96/44 Drilling. Dev: Misrun at 8074.
Mud: 8.8 x 44 x 3.9 (Oil 5%) FEB 21 1968

Government 21X-9
(WC) Loffland

8112/140/97/23 Drilling. Dev: 14 1/4° at 8072. SLM at 8096 (No correction). Ran Sperry Sun magnetic multi-shot survey from 8072-4900. All readings from bottom of 9 5/8" csg. Greatest angle of inclination - 17° at 6632. At 8072, direction is south, 26° east. Displacement 610.70' south, 281.95' east. Horizontal displacement 672.65' at south 24°, 47 mins east.
Mud: 8.9 x 42 x 3.6 (Oil 5%) FEB 22 1968

Government 21X-9
(WC) Loffland

8187/140/98/75 (-45 days) Tripping. Dev: 14 1/4° at 8114.
Mud: 9 x 45 x 3.3 (Oil 5%) FEB 23 1968

Government 21X-9
(WC) Loffland

8430/140/101/243 Drilling. Dev: 14 1/2° at 8182, 13 1/2° at 8288 and 8348. Pulled bit because of hole washed in DP.
Mud: 9 x 46 x 3.5 (Oil 4%) FEB 26 1968

Government 21X-9
(WC) Loffland

8504/140/102/74 Drilling. Dev: 14 3/4° at 8498.
Mud: 9.1 x 45 x 3.5 (Oil 5%) FEB 27 1968

Government 21X-9
(WC) Loffland

8556/140/103/52 Drilling.
Mud: 8.8 x 47 x 3.4 (Oil 5%) FEB 28 1968

Government 21X-9
(WC) Loffland

8605/140/104/49 Making trip. Dev: 14 1/4° at 8558, 14° at 8600.
Mud: 9 x 44 x 4.4 (Oil 4%) FEB 29 1968

Government 21X-9 (WC) Loffland

8687/140/105/82 (-49 days) Drilling. Dev: 14° at 8600. Mud: 8.9 x 45 x 4 (Oil 4%) MAR 1 1968

Government 21X-9 (WC) Loffland

8910/140/108/223 Washing to bottom at 8740. Dev: 16° at 8867, 14 3/4° at 8906.
Mud: 8.9 x 42 x 4.2 (Oil 4%) MAR 4 1968

Government 21X-9 (WC) Loffland

8971/140/109/61 Drilling. Dev: 14 3/4° at 8961. Mud: 9 x 52 x 3.6 (Oil 5%) MAR 5 1968

Government 21X-9 (WC) Loffland

9073/140/110/102 Tripping. Dev: 14 1/2° at 9070'. Mud: 8.9 x 45 x 3.6 (Oil 5%) MAR 6 1968

Government 21X-9 (WC) Loffland

9169/140/111/96 Tripping. Mud: 8.9 x 46 x 3 (Oil 5%) MAR 7 1968

Government 21X-9 (WC) Loffland

9201/140/112/32 (-53 days) Tripping. Dev: 15° at 9165, 14 3/4° at 9197. Magnofluxed DC's, 10 day inspection.
Mud: 9 x 45 x 3 (Oil 5%) MAR 8 1968

Government 21X-9 (WC) Loffland

9466/140/115/265 Drilling. Dev: 13 1/2° at 9375'. Mud: 8.9 x 48 x 3.4 (Oil 5%) MAR 11 1968

Government 21X-9 (WC) Loffland

9511/140/116/45 Drilling. Dev: 14 1/4° at 9465. Mud: 8.9 x 45 x 4 (Oil 4%) MAR 12 1968

Government 21X-9 (WC) Loffland

9591/140/117/80 Drilling. Dev: 13° at 9532. Mud: 8.9 x 48 x 3.6 (Oil 4%) MAR 13 1968

Government 21X-9 (WC) Loffland

9668/140/118/77 Drilling. Dev: 13° at 9600. Mud: 9 x 48 x 3.6 (Oil 4%) MAR 14 1968

Government 21X-9 (WC) Loffland

9734/140/119/66 (-57 days) Drilling. Dev: 13° at 9685. Mud: 9 x 50 x 3.6 (Oil 4%) MAR 15 1968

Government 21X-9 (WC) Loffland

9965/140/122/231 Drilling. Dev: 10 1/2° at 9946, 12 3/4° at 9840, 10 3/4° at 9754.
Twenty day magnoflux inspection, no defects.
Mud: 9 x 49 x 3 (Oil 4%) MAR 18 1968

Government 21X-9 (WC) Loffland

10,047/140/123/78 Tripping. Washing to bottom to 9503. Dev: 12° at 10,043.
Mud: 9 x 49 x 3 (Oil 4%) MAR 19 1968

Government 21X-9 (WC) Loffland

10,081/140/124/34 Drilling. Dev: 11 1/4° at 10,066. Mud: 9.1 x 48 x 3 (Oil 5%) MAR 20 1968

Government 21X-9 (WC) Loffland

10,103/140/125/22 Tripping. Washing on bridge at 9306. Dev: 10° at 10,098. 5 1/2 hrs rig repair.
Mud: 9 x 49 x 3.2 (Oil 5%) MAR 21 1968

Government 21X-9 (WC) Loffland

10,103/140/126/0 (-61 days) Tripping in hole. Pulled out and changed BHA to bit, BH reamer, square DC, IBS, and jars. Unable to get below 9506'. Reamed for 8 hrs from 9318-9506'; high torque. Pulled out and changed BHA to bit, square DC, string reamer, square DC, IBS, and jars.
Mud: 9 x 49 x 2.6 (Oil 6%) MAR 22 1968

Government 21X-9
(WC) Loffland
MAR 25 1968

10,252/140/129/147 Drilling. Dev: 10° at 10,149, 10 1/2° at 10,206.
Mud: 9.0 x 49 x 2.4 (Oil 6%)

Government 21X-9
(WC) Loffland
MAR 26 1968

10,291/140/130/39 Repairing stand pipe. Dev: 9 1/4° at 10,227.
Mud: 9.1 x 49 x 2.9 (Oil 6%)

Government 21X-9
(WC) Loffland
MAR 27 1968

10,318/140/131/27 Washing to bottom. Dev: survey at 10,314 misrun.
Mud: 9 x 50 x 2.6 (Oil 6%)

Government 21X-9
(WC) Loffland
MAR 28 1968

10,318/140/132/0 Going in hole w/magnet. Dev: 9° at 10,314. Lost all cones off bit. Recovered one cone on first run w/magnet.
Mud: 9 x 48 x 3.9 (Oil 6%)

Government 21X-9
(WC) Loffland

10,318/140/133/0 (-67 days) Milling over junk with Globe basket. During trip w/magnet on run #2, recovered two pieces shale. Ran bit #124 and drilled on junk; conditioned hole.
Mud: 9 x 45 x 2.8 (Oil 6%) MAR 29 1968

Government 21X-9
(WC) Loffland

10,390/140/136/72 Pulling fish. WO tong parts w/24 stands DP, 26 DC's & tools setting in slips. Pulled Globe basket, no junk recovered. Ran bit & CP junk sub. Recovered several pieces of cone & brass catcher sinkers out of Globe basket; junk sub basket was full. Ran bit & CP junk sub, run #2. Recovered a small amount of cones. 10,318=10,324, hole was made while drilling on junk. Ran bit & drilled ahead to 10,361. Ran new bit. At 10,390 drilling string torqued up and twisted off. Pulled 8 stands and one single. DP was backed off, no damage to pin. Changed out jt. Tripped in and screwed into box. Picked up string weight of 112,000#. Set down on lower fish & screwed in. Broke circ, press normal. On trip out w/fish torque had swelled box 53 stands in. DP very tight, breaking tong heads.
Mud: 9.0 x 47 x 2.8 (Oil 7%) APR 1 1968

Government 21X-9
(WC) Loffland

10,425/140/137/35 Drilling. Recovered all of fish. Laid down 22 jts Grade "E" DP to straighten.
Mud: 9 x 46 x 2.8 (Oil 7%) APR 2 1968

Government 21X-9
(WC) Loffland

No report. APR 3 1968

Government 21X-9
(WC) Loffland

10,538/140/139/113 (2 days drlg report) Drilling.
Dev: 8° at 10,495.
Mud: 9 x 49 x 2.6 (Oil 7%) APR 4 1968

Government 21X-9
(WC) Loffland

10,591/219/140/53 (-10 days) Drilling.
Dev: 7 3/4° at 10,585. 3 3/4 hrs rig repairs. (Cost and progress targets revised with supplement #1)
Mud: 9.1 x 50 x 2.4 (Oil 7%) APR 5 1968

Government 21X-9
(WC) Loffland

10,765/219/143/174 Tripping. Dev: 7 1/2° at 10,655 and 6 3/4° at 10,723. Changed out and tuboscoped Grade "E" DP.
Mud: 9 x 49 x 2.4 (Oil 7%) APR 8 1968

Government 21X-9
(WC) Loffland

10,821/219/144/56 Drilling. Dev: 6 3/4° at 10,760. Changed out 28 jts Grade "E" DP to tuboscope. Twenty-day magnoflux inspection, no defects.
Mud: 9 x 47 x 2.8 (Oil 7%) APR 9 1968

Government 21X-9
(WC) Loffland

10,872/219/145/51 Drilling. Dev: 6 1/4° at 10,840.
Mud: 9.1 x 49 x 2.8 (Oil 7%) APR 10 1968

Government 21X-9
(WC) Loffland

10,887/219/146/15 Drilling. Ran multishot survey from 10,850-8072'. Est. BH location at 10,850 = 1253', 523° 51'E of 9 5/8" casing shoe. Est. TVD = 10,706 at 10,850'. (SLM - no correction) APR 11 1968
Mud: 9.1 x 48 x 3 (Oil 7%)

Government 21X-9
(WC) Loffland

11,110/219/150/223 Drilling. Dev: 6¼° at 10,929', 6° at 10,998', and 5½° at 11,091'. APR 15 1968
Mud: 9 x 48 x 2.8 (Oil 7%)

Government 21X-9
(WC) Loffland

11,180/219/151/70 Making trip. Dev: 5° at 11,176.
Mud: 9 x 50 x 2.5 (Oil 8%) APR 16 1968

Government 21X-9
(WC) Loffland

11,230/219/152/50 Drilling. Lost 10 hrs looking for hole in drill string at 11,196; box and pin washed out 10 stands above DC's.
Mud: 9 x 50 x 2.4 (Oil 7%) APR 17 1968

Government 21X-9
(WC) Loffland

11,295/219/153/65 Drilling. Dev: 4 3/4° at 11,262.
Mud: 9.1 x 47 x 2.5 (Oil 7%) APR 18 1968

Government 21X-9
(WC) Loffland

11,354/219/154/59 (-13 days) Tripping. Dev: 4° at 11,349. Magnofluxed DC's and tools, no defects.
Mud: 9.1 x 47 x 2.4 (Oil 7%) APR 19 1968

Government 21X-9
(WC) Loffland

11,623/219/157/269 Drilling. Dev: 3 1/4° at 11,423, 2° at 11,530.
Mud: 9.1 x 47 x 3 (Oil 8%) APR 22 1968

Government 21X-9
(WC) Loffland

11,702/219/158/79 Drilling. Dev: 3° at 11,620.
Mud: 9.1 x 50 x 2.6 (Oil 8%) APR 23 1968

Government 21X-9
(WC) Loffland

11,760/219/159/58 Making trip. Dev: 3¼° at 11,705.
Mud: 9.1 x 51 x 2.4 (Oil 7%) APR 24 1968

Government 21X-9
(WC) Loffland

11,796/219/160/36 Making trip. Dev: 3½° at 11,755 and 3° at 11,792.
Mud: 9.1 x 50 x 2.2 (Oil 7%) APR 25 1968

Government 21X-9
(WC) Loffland

11,886/219/161/90 (-13 days) Making trip. Dev: 3° at 11,792.
Mud: 9.1 x 46 x 2.6 (Oil 7%) APR 26 1968

Government 21X-9
(WC) Loffland

12,109/219/164/223 Drilling. Dev: 2 3/4° at 11,881, 4¼° at 11,962 and 4° at 12,059.
Mud: 9.2 x 49 x 2.8 (Oil 6%) APR 29 1968

Government 21X-9
(WC) Loffland

12,165/219/165/56 Drilling. Dev: 4 3/4° at 12,133.
Mud: 9.2 x 46 x 3 (Oil 6%) APR 30 1968

Government 21X-9
(WC) Loffland

12,235/219/166/70 Making trip. Dev: 6° at 12,231.
Mud: 9.1 x 46 x 3 (Oil 5%) MAY 1 1968

Government 21X-9
(WC) Loffland

12,311/219/167/76 Making trip. Dev: 6¼° @ 12,306.
Mud: 9.1 x 46 x 3.2 (Oil 5%) MAY 2 1968

Government 21X-9
(WC) Loffland

12,354/219/168/43 (-16 days) Making trip.
Mud: 9.1 x 47 x 3.8 (oil 6%) MAY 3 1968

Government 21X-9
(WC) Loffland

12,564/219/171/210 Drilling. Dev: 6° at 12,349 and 12,432, 6¼° at 12,528.
Mud: 9.1 x 48 x 2.6 (Oil 7%) MAY 6 1968

Government 21X-9
(WC) Loffland

12,618/219/172/54 Tripping. Dev: 7° at 12,595.
Mud: 9.1 x 50 x 2.5 (Oil 7%) MAY 7 1968

Government 21X-9
(WC) Loffland

12,658/219/173/40 Tripping. Dev: 6 3/4° at 12,613.
Mud: 9.1 x 47 x 2.7 (Oil 6%) MAY 8 1968

Government 21X-9
(WC) Loffland

12,683/219/174/25 Tripping. Dev: 6 3/4° at 12,654.
Mud: 9.1 x 49 x 2.6 (Oil 7%) MAY 9 1968

Government 21X-9
(WC) Loffland

12,770/219/175/87 (-20 days) Drilling.
Mud: 9 x 44 x 2.8 (Oil 7%) MAY 10 1968

Government 21X-9
(WC) Loffland

12,876/219/178/106 Drilling. Dev: 6° at 12,780, 5 3/4° at 12,846. Lost two cones while drilling at 12,851. Ran #1 CT junk sub; recovered one-half of cone and a bearing. Ran #2 with CT junk sub; stuck DP at 12,768. Bit was plugged. Worked DP free in 2 3/4 hrs. Broke circ. Washed and reamed to bottom.
Mud: 9 x 46 x 2 (Oil 6%) MAY 13 1968

Government 21X-9
(WC) Loffland

12,896/219/179/20 Reaming and washing to bottom. On trip out, had tight spots and pumped and worked 6 jts out of hole. Changed out all reamer cutters. Recovered approx enough pieces to make one cone in CP junk sub. Picked up all DC's. Started in hole and hit bridge at 12,742. Plugged bit and stuck string; worked loose. Pulled 11 stands; unplugged bit. Broke circ. Went back and hit bridge at 12,112. Drilled out bridge to 12,159. (Total trip time - 20 1/2 hrs).
Mud: 9.1 x 46 x 2.6 (Oil 6%) MAY 14 1968

Government 21X-9
(WC) Loffland

13,036/219/180/140 Tripping.
Mud: 9 x 45 x 2.6 (Oil 7%) MAY 15 1968

Government 21X-9
(WC) Loffland

13,153/219/181/117 Drilling. Dev: 6 1/4° at 13,030. On trip in w/bit, spent five hrs working through tight spot at 12,253 and 12,711. Went to bottom w/no difficulty.
Mud: 9.1 x 47 x 3.6 (Oil 7%) MAY 16 1968

Government 21X-9
(WC) Loffland

13,215/219/182/62 (-23 days) Drilling. Dev: 11° at 13,185. Trip into hole improved; worked through tight spots from 12,741-13,190 and remainder of hole ok.
Mud: 9.1 x 48 x 2.5 (Oil 7%) MAY 17 1968

Government 21X-9
(WC) Loffland

13,290/219/185/75 Tripping. Dev: 12° at 13,237 and 9 1/2° at 13,273. Due to continued build-in deviation, set back 12 DC's and rearranged reamer placement. Trip in at 13,241 required 21 1/4 hrs reaming and washing new assembly to bottom. Second trip with new assembly at 13,278 required only 1 3/4 hrs reaming and washing in last 4 jts.
Mud: 9.1 x 46 x 2.6 (Oil 11%) MAY 20 1968

Government 21X-9
(WC) Loffland

13,303/219/186/13 Drilling. Dev: 9 3/4° at 13,287. Magnofluxed DC's. Three-fourths hr washing & reaming 12,728-12,790, 1 1/4 hrs washing & reaming 13,229-13,290.
Mud: 9.1 x 48 x 2.5 (Oil 6%) MAY 21 1968

Government 21X-9
(WC) Loffland

13,343/219/187/40 Tripping. Dev: 12° at 13,339.
Mud: 9.1 x 46 x 2.6 (Oil 7%) MAY 22 1968

Government 21X-9
(WC) Loffland

13,393/219/188/50 Tripping.
Mud: 9.2 x 46 x 2.6 (Oil 7%) MAY 23 1968

Government 21X-9
(WC) Loffland

13,413/219/189/20 (-29 days) Tripping. Dev: 13° at 13,408.
Mud: 9.2 x 48 x 2.5 (Oil 7%) MAY 24 1968

Government 21X-9
(WC) Loffland

13,581/219/192/168 Tripping. Dev: 13° at 13,437 and 15° at 13,576.
Mud: 9.1 x 44 x 3.7 (Oil 4%) MAY 27 1968

Government 21X-9
(WC) Loffland

13,654/219/193/73 Tripping.
Mud: 9 x 48 x 2.5 (Oil 7%) MAY 28 1968

Government 21X-9
(WC) Loffland

13,706/219/194/52 Drilling. Dev: 14½° at 13,650.
Mud: 9 x 46 x 2.7 (Oil 7%) MAY 29 1968

Government 21X-9
(WC) Loffland

13,767/219/196/61 (-33 days) Washing and reaming at 12,165. Dev: 14½° at 13,708', 13½° at 13,762.
Mud: 9 x 44 x 3.0 (Oil 7%) MAY 31 1968

Government 21X-9
(WC) Loffland

13,879/219/199/112 Tripping. Dev: 13½° at 13,802, and 13 3/4° at 13,874.
Working pipe in tight hole at 13,863 for one hr at 6 AM.
Mud: 9.1 x 49 x 2.6 (Oil 7%) JUN 3 1968

Government 21X-9
(WC) Loffland

13,901/219/200/22 Tripping out to log. Worked pipe free 8:15 AM 6-3-68. Made short trip of 23 stands.
Mud: 9 x 52 x 2.6 (Oil 7%) JUN 4 1968

Government 21X-9
(WC) Loffland

13,901/219/201/0 Tripping in to condition hole. SLM 13,901 = 13,889 (12' correction or fill). Ran Integrated BHC Sonic and GR w/caliper to 13,870. Ran Dual Induction Log to 12,280'; unable to go further. Logged from 12,100 to 11,850. Tool stuck in hole. Tool came loose after 30 minutes and logged remainder of hole from 11,670' to 4,900'. JUN 5 1968

Government 21X-9
(WC) Loffland

13,901/219/202/0 Laying down DP to run 7" csg. Conditioned hole 7 hrs. Running multishot survey and tallying DP. JUN 6 1968

Government 21X-9
(WC) Loffland

13,889/219/203/0 (-39 days) Circulating csg prior to cementing. Strapped pipe, 12' correction. Laid down Grade "E" DP and DC. Sperry Sun multishot survey did not function. Ran 332 jts (13,906') 7" csg to 13,889'. Started shoe jt in hole at 4 PM 6-6-68.
Mud: 9 x 48 x 2.7 (Oil 7%) JUN 7 1968

Government 21X-9
(WC) Loffland

13,889/219/206/0 Picking up DP. Ran and cemented 332 jts (13,906') 7" csg at 13,889. Shoe at 13,889, float collar at 13,793. Broke circ w/400 psi. Circ three hrs. Preceded slurry w/10 BW, 12 bbls CW-7, and 10 BW. Cemented through shoe w/365 sx Class "G" Neat cement w/.2% D-8. Displaced slurry w/528 barrels mud in water (50-50). Pumped first 450 bbls at 7 B/M. Displaced 75 bbls slurry out shoe at 2 B/M. Overdisplaced three bbls. Did not bump plug. Bled back one bbl, held ok. Avg displacement press - 300 psi, final press - 900 psi. Good returns throughout. Job complete 10:15 AM 6-7-68. Set slips. Cut off csg and nippled up. Tested BOP's and 7" csg at 2500 psi, held ok. Laid down 201 jts Grade "G" DP. Pumped reserve pit water down annulus of 7" csg. Broke down at 1900 psi. Press increased from 1700-3000 psi in 30 hrs. Pumped total of 8400 barrels into annulus. Flowed back 1900 barrels on choke in 2 hrs 5 mins leaving 1500 psi surf press on annulus. Disposed total of 6500 barrels reserve pit water. Picked up DC's and tools. JUN 10 1968

Government 21X-9
(WC) Loffland

13,889/219/207/0 Drilling cement at 13,800. Drilled 182' cement in six hrs. JUN 11 1968
Mud: 8.9 x 45 x 3.4 (Oil 4%)

Government 21X-9
(WC) Loffland

13,917/219/208/28 Drilling.
Mud: 8.9 x 46 x 4.8 (Oil 4%) JUN 12 1968

Government 21X-9
(WC) Loffland

13,964/219/209/47 Drilling. Picked up bottom hole motor- turbo drill at 13,929 averaging 8'/hr vs. 3'/hr conventional.
Mud: 8.7 x 43 x 3.9 (Oil 2%)

Government 21X-9
(WC) Loffland

14,091/219/210/127 (-45 days) Drilling.
Dev: 13 1/2° at 14,031.
Mud: 8.8 x 40 x 4 (Oil 4%) JUN 14 1968

Government 21X-9
(WC) Loffland

14,370/219/213/279 Drilling. Dev: 14° at 14,125. JUN 17 1968
Mud: 8.8 x 42 x 3 (Oil 5%)

Government 21X-9
(WC) Loffland

14,487/219/214/117 Drilling.
Mud: 8.7 x 40 x 3.8 (Oil 5%) JUN 18 1968

Government 21X-9
(WC) Loffland
JUN 19 1968

14,514/219/215/27 Tripping. Dev: 16° at 14,477.
Pulled Turbo-drill #2 after 84 1/2 hrs. Going in hole w/Dyna-drill.
Mud: 8.8 x 44 x 2.7 (Oil 6%)

Government 21X-9
(WC) Loffland

14,570/219/216/56 Drilling. JUN 20 1968
Mud: 8.7 x 46 x 2.1 (Oil 8%)

Government 21X-9
(WC) Loffland

14,630/219/217/60 (-46 days) Drilling. JUN 21 1968
Mud: 8.8 x 45 x 2.7 (Oil 7%)

Gov't 21X-9
(WC) Loffland

14,824/219/220/194 Drilling with dynadrill #2.
Dev: 19 1/2° at 14,703 & 14,760. On dynadrill run #1, time 70 hrs.
Mud: 8.7 x 42 x 4 (Oil 8%) JUN 24 1968

Government 21X-9
(WC) Loffland

14,898/219/221/74 Drilling. Dev: 19 1/2° at 14,824.
Mud: 8.7 x 42 x 4 (Oil 7%) JUN 25 1968

Government 21X-9
(WC) Loffland

14,925/219/222/27 Drilling. Dev: 19 3/4° at 14,885.
Drlg w/rock bit Type OWBJ. Magnofluxed DC's - 15-day inspection; no defects.
Mud: 8.7 x 43 x 3.8 (Oil 7%) JUN 26 1968

Government 21X-9
(WC) Loffland

14,993/219/223/68 Drilling. Dev: 20° at 14,920.
Drlg w/turbodrill and Christiansen diamond bit.
Mud: 9.7 x 44 x 3.3 (Oil 7%) JUN 27 1968

Government 21X-9
(WC) Loffland

15,025/219/224/32 (-46 days) Drilling. Dev: 19 1/2° at 14,963. Drilling w/turbodrill and Christiansen diamond bit.
SAMPLE TOP
Hilliard 14,843 (-4903)
Mud: 8.7 x 42 x 3.3 (Oil 6%) JUN 28 1968

Government 21X-9
(WC) Loffland

15,383/219/227/358 Drilling. Dev: 18 3/4° at 15,035, 18° at 15,152.
Mud: 8.6 x 44 x 2.1 (Oil 6%) JUL 1 1968

Government 21X-9
(WC) Loffland

15,494/219/228/111 Drilling.
Mud: 8.6 x 42 x 2.8 (Oil 6%) JUL 2 1968

Government 21X-9
(WC) Loffland

15,545/219/229/51 Drilling. Dev: 12° at 15,490.
Mud: 8.6 x 42 x 2.7 (Oil 6%) JUL 3 1968

Government 21X-9
(WC) Loffland

15,764/219/231/219 (-38 days) Drilling. JUL 5 1968
Dev: 12° at 15,565.
Mud: 8.6 x 43 x 3 (Oil 6%)

Government 21X-9
(WC) Loffland

16,046/219/234/282 Making trip. Dev: 9° at 15,840.
Mud: 8.7 x 40 x 4 (Oil 5%) JUL 8 1968

Government 21X-9
(WC) Loffland

16,046/219/235/0 Washing to bottom. Spent 10 hrs washing from 15,593-16,046.
Mud: 8.7 x 43 x 3.2 (Oil 6%) JUL 9 1968

Government 21X-9 (WC) Loffland	16,161/219/236/115 Drilling. Mud: 8.7 x 44 x 3.8 (Oil 8%) JUL 1 0 1968
Government 21X-9 (WC) Loffland	16,280/219/237/119 Drilling. Mud: 8.8 x 45 x 3.2 (Oil 8%) JUL 1 1 1968
Government 21X-9 (WC) Loffland	16,336/219/238/56 (-28 days) Tripping in to condition hole. Dev: 4 3/4° at 16,286. On trip out, experienced tight hole from TD-15,850. RU Schl and attempted to run Dual Induction Log. Hit bridge at 15,360 (976' off bottom). Logging tool hung up at bottom of 7" csg; worked free. Mud: 8.8 x 47 x 3.5 (Oil 6%) JUL 1 2 1968
Government 21X-9 (WC) Loffland	16,348/219/241/12 Tripping out to log. On trip, after first logging attempt, hit bridge at 15,608; fell through. Spent 11½ hours washing from 15,818-TD. Circ and cond 4½ hrs. Made short trip of 15 stands and hit bridge at 15,906. Went back to bottom and spent 10 hours washing to TD. Circ and cond for 2½ hrs. Strapped out of hole. SLM 16,336 = 16,348 (12' correction). Ran Sperry Sun multishot survey and hit bridge at 15,800. Ran survey from 15,800 - 13,900. Ran gyroscopic multishot survey from 13,890 - 10,800. On trip in to condition, hit bridge at 15,840. Washed from 15,840 - 15,900. Open hole from 15,900 - 16,251. Spent four hrs washing to bottom and five hrs circ and cond hole and mud. Mud: 9 x 50 x 3 (Oil 5%) JUL 1 5 1968
Government 21X-9 (WC) Loffland	16,348/219/242/0 Going in hole w/turbodrill and diamond bit. Found bridge at 15,720. Spent 18 hrs logging. Ran Dual Induction GRS w/cal and velocity logs from 15,720. Mud: 9 x 50 x 3 (Oil 5%) JUL 1 6 1968
Government 21X-9 (WC) Loffland	16,348/219/243/0 Washing and reaming at 16,326. Spent 20 hrs washing and reaming from 15,870 - 16,326. Mud: 9.1 x 46 x 3.2 (Oil 5%) JUL 1 7 1968
Government 21X-9 (WC) Loffland	16,363/219/244/15 Washing, reaming and redrilling to make connection at 16,363. Had 3¼ hrs rig repair, 10 3/4 hrs washing and reaming from 16,346-16,348 and 6 3/4 hrs washing, reaming and redrilling to make connection at 16,363. Very high rotary torque. LOG TOP: HILLIARD 14,880 (-4940) Mud: 9 x 45 x 3 (Oil 5%) JUL 1 8 1968
Gov't 21X-9 (WC) Loffland	16,396/219/245/33 (- 26 days) Tripping. Dev: 4½° at 16,360. Spent ¼ hour reaming and washing on connection at 16,363, 5 3/4 hrs reaming and washing on connection at 16,392, and 3½ hrs attempting to drill after connection at 16,392. Mud: 9.1 x 42 x 3.4 (Oil 4%) JUL 1 9 1968

Government 21X-9
(WC) Loffland

16,396/219/248/0 Tripping in hole w/rock bit. Washed and reamed 8 hrs with dynadrill and diamond bit from 15,962-16,034. Pulled same. Ran rock bit and washed and reamed 29 hrs from 15,842-16,247. Lost 250# pump pressure. Chained out of hole; found cracked jt of Grade "E" DP 39 stands above DC's. 5 1/2 hrs rig repairs changing out swivel.
Mud: 9.1 x 47 x 3.2 (Oil 6%) JUL 22 1968

Gov't 21X-9
(WC) Loffland

16,396/219/249/0 Washing and reaming from 16,244-16,274. 20 3/4 hrs washing and reaming from 16,096-16,274.
Mud: 9.2 x 53 x 3.8 (Oil 4%) JUL 23 1968

Gov't 21X-9
(WC) Loffland

16,396/219/250/0 Washing and reaming from 16,339-16,369. 24 hrs washing and reaming from 16,274-16,369.
Mud: 9.2 x 62 x 2.0 (Oil 4%) JUL 24 1968

Gov't 21X-9
(WC) Loffland

16,396/219/251/0 Tripping in w/dynadrill and diamond bit. 5 1/2 hrs washing and reaming from 16,365-16,395. 4 hrs short trip of 28 stands. Encountered some fill at 16,371. Magnofluxed DC's, no defects.
Mud: 9.2 x 62 x 2 (Oil 4%) JUL 25 1968

Gov't 21X-9
(WC) Loffland

16,463/219/252/67 (-44 days) Drilling with dynadrill and Christiansen diamond bit.
Mud: 9.2 x 60 x 2.4 (Oil 3%) JUL 26 1968

Gov't 21X-9
(WC) Loffland

16,594/219/255/131 Washing and reaming at 16,589. Dev: 3 1/4° at 16,565. 4 1/4 hrs washing and reaming from 16,444-16,589. Drilling w/dynadrill 66 hrs.
Mud: 9.1 x 65 x 3 (Oil 3%) JUL 29 1968

Gov't 21X-9
(WC) Loffland

16,640/219/256/46 Drilling.
SAMPLE TOP Frontier 16,320 (-6380)
Mowry 16,475 (-6535)
Mud: 9.1 x 58 x 2.6 (Oil 5%) JUL 30 1968

Gov't 21X-9
(WC) Loffland

16,650/219/257/0 Tripping. Pulled bit to find hole in DP 3540' above bit.
Mud: 9 x 61 x 2.2 (Oil 5%) JUL 31 1968

Gov't 21X-9
(WC) Loffland

16,673/219/258/23 Drilling.
Mud: 9 x 63 x 2.3 (Oil 4%) AUG 1 1968

Gov't 21X-9
(WC) Loffland

16,732/219/259/59 (-40 days) Drilling.
Mud: 9 x 62 x 2.2 (Oil 5%) AUG 2 1968

Gov't 21X-9
(WC) Loffland

16,864/219/262/132 Washing and reaming at 16,862. 5 3/4 hours making short trip from 16,752-15,816, 14 hrs making short trip from 16,864-15,727. AUG 5 1968
Mud: 8.9 x 54 x 2.4 (Oil 5%)

Gov't 21X-9
(WC) Loffland

16,911/219/263/47 Drilling.
SAMPLE TOP DAKOTA 16,725 ? (-6785)
Mud: 8.9 x 63 x 2.2 (Oil 5%) AUG 6 1968

Gov't 21X-9
(WC) Loffland

16,976/219/264/65 Drilling. AUG 7 1968
Mud: 8.9 x 62 x 2.9 (Oil 4%)

Gov't 21X-9
(WC) Loffland

16,981/219/265/5 Drilling. 21½ hrs short trip 16,980-15,156.
Mud: 8.9 x 58 x 2.3 (Oil 4%) AUG 8 1968

Gov't 21X-9
(WC) Loffland

17,011/219/266/30 (-43 days) Tripping out of hole.
Total hrs w/turbodrill - 157¼ hrs drilling
27¼ hrs washing and reaming
184½ hrs
Magnofluxed DC's, no defects.
Mud: 8.9 x 58 x 2.2 (Oil 5%) AUG 9 1968

Gov't 21X-9
(WC) Loffland
AUG 12 1968

17,082/219/269/71 Drilling.
32 hrs washing and reaming from 16,236 to 17,011 on last trip. Mixing mud to raise weight prior to logging.
Mud: 9.0 x 60 x 2.0 (Oil 6%)

Gov't 21X-9
(WC) Loffland

17,100/219/270/18 Conditioning hole to run logs.
SLM 17,100 = 17,101 no correction. Circ 2½ hours to cond hole before trip out. AUG 13 1968
Mud: 9.7 x 64 x 1.8 (Oil 6%)

Gov't 21X-9
(WC) Loffland

TD 17,100/219/271/0 Tripping out w/3 DC's and 5 5/8" bit, prep to go in hole open ended DP. Could not go below 16,338 w/bit. Washed and reamed 8 3/4 hours from 16,280 to 16,338. AUG 14 1968
Mud: 9.8 x 62 x 1.8 (Oil 5%)

Gov't 21X-9
(WC) Loffland

TD 17,100/219/272/0 Waiting on key seat wiper. Ran 3½" open-ended DP, could not get below 16,338. Pulled DP. AUG 15 1968
Mud: 9.7 x 80 x 1.9 (Oil 5%)

Gov't 21X-9
(WC) Loffland

TD 17,100/219/273/0 (-52 days) Washing and reaming @ 16,029. 11½ hrs washing and reaming from 15,088 to 16,029 w/14 DC's and 6" bit.
Mud: 9.7 x 67 x 1.7 (Oil 5%) AUG 16 1968

Gov't 21X-9
(WC) Loffland

TD 17,100/219/276/0 Washing and reaming @ 16,509. Washed and reamed from 16,020 to 16,359 w/bit. Could not go below 16,359. Made trip for key seat wiper while washing and reaming 16,359 to 16,509. Made four short trips to work key seat wiper. AUG 19 1968
Mud: 10.6 x 66 x 1.8 (Oil 5%)

Gov't 21X-9
(WC) Loffland

TD 17,100/219/277/0 Washing on bridge @ 16,340. Washed and reamed to 16,609. Tripped for new bit and lost three cones in hole. Washed and reamed out bridge @ 16,068 on trip in. AUG 20 1968
Mud: 10.6 x 64 x 1.8 (Oil 5%)

Gov't 21X-9
(WC) Loffland

TD 17,100/219/278/0 Conditioning mud & adding weight material. Prep to run eccentric bi-center diamond bit to drill out bridges.
Mud: 11.4 x 64 x 1.8 (Oil 4%) Circ @ 16,361. AUG 21 1968

Gov't 21X-9
(WC) Loffland

TD 17,100/219/279/0 Washing & reaming @ 16,241 w/Christensen bi-center bit. Raised mud weight to 11.8 ppg, magnofluxed DC's and removed DP rubbers. Tripped to 16,241 without problems. Washing and reaming since 6 AM. AUG 22 1968
Mud: 11.8 x 62 x 1.8 (Oil 4%)

Gov't 21X-9
(WC) Loffland
17,100' Dakota

TD 17,100/219/280/0 (-59 days)
Washing and reaming @ 16,841. Plan to make short trips after reaching TD. AUG 23 1968
Mud: 11.9 x 100 x 1.5 (Oil 4%)

Gov't 21X-9
(WC) Loffland
17,100' Dakota

TD 17,100/219/283/0 Tripping out after backoff at 13,707'. Washed and reamed from 16,841-17,100. Circ to condition hole and mud. Made short trip to csg; bridge at 16,305. Washed and reamed from 16,305-17,100. Circ and cond hole and mud. Attempted short trip and had stuck pipe at 16,370. Ran freepoint and stuck at bit. Could not break circ after running freepoint. Backed off at 13,707' with dialog.
Mud: 12.1 x 122 x 1.6 (Oil 4%) AUG 26 1968

Gov't 21X-9
(WC) Loffland
17,100' Dakota

TD 17,100/219/284/0 Prep to drift DC's. Rec'd entire fish. AUG 27 1968

Gov't 21X-9
(WC) Loffland
17,100' Dakota

TD 17,100/219/285/0 Tripping up into csg. Lost circ while cleaning at 16,330. Drill assembly consists of open ended wash over shoe 5 3/4 x 4, 14 DC's and Bowen drlg jars. High viscosity of mud standing in hole required circulating pressures up to 2800 psi. Hole broke down, pumped away 20 bbls. Stopped circulating and hole continued to take fluid. Lowering viscosity and mud weight. AUG 28 1968

Gov't 21X-9
(WC) Loffland
17,100' Dakota

TD 17,100/219/286/0 Circ at 16,300. 24 hrs cond mud due to loss of circ. Could not circ at 13,800. Circ w/full returns at the following depths: 5,000, 6,440, 8,400, 10,380, 12,180, 14,060 and 15,320. Lost approx 125 bbls mud in formation. Circ at 16,330 w/full returns at 6:45 AM. AUG 29 1968

Gov't 21X-9
(WC) Loffland
17,100' Dakota

TD 17,100/219/287/0 Logging. Washed from 16,330-17,100. Pulled up to 16,682 and running GR-Neutron logs w/3 1/2" DP.
Mud: 11 x 68 x 2.2 (Oil 2%) AUG 30 1968

Gov't 21X-9
(WC) Loffland
17,100' Dakota

TD 17,100/219/291/0 Running 5" liner. Finished logging; ran GR Neutron & ES in 10 1/4 hrs. Made short trips, circ'd, and conditioned hole to run liner. Tallied pipe out of hole 17,100' = 17,102 (no correction). SEP 3 1968

Gov't 21X-9
(WC) Loffland
17,100' Dakota

TD 17,100/219/292/0 WOC. Ran and cem 86 jts (3413.81') 18# P-110 NWS and N-80 5" hydril FJ csg liner @ 17,069. Christiansen diamond washover shoe @ 17,069, back press valve at 17,024, landing collar at 16,981, crossover bushing at 13,669, BOT boll-weevil hanger at 13,663 and tie-back sleeve at 13,655. SEP 4 1968
Cemented w/400 sx Class "G" neat w/1% D-60 and .4% D-13. Plug down 12:35 AM 9-4-68. Did not bump plug. Good returns throughout. Picked up BOT swivel in order to circ to bottom. Could not move liner. Appeared that slips were set on hanger. WOC 5½ hrs.

Gov't 21X-9
(WC) Loffland
17,100' Dakota

TD 17,100/219/293/0 WOC. While WOC, ran 111 jts Grade "E" DP and laid down same. Ran 15 DC's w/bit and tagged liner. No cement. Pulled 14 stands and circ mud. SEP 5 1968

Gov't 21X-9
(WC) Loffland
17,100' Dakota

TD 17,100/219/294/0 Prep to remove BOP's. Went in hole 6 AM 9-5-68 and tagged liner, no cement. Attempted to press test w/1500 psi. Formation broke down w/1300 psi. Pumped into formation w/62 gal/min at 1100 psi. Laid down DP and cleaned mud tanks. SEP 6 1968

Gov't 21X-9 (WC) 17,100' Dakota	TD 17,100. (3 days) RD & MORT. Removed BOP's and installed wellhead equipment. Released rig 9 PM 9-6-68. SEP 9 1968
Gov't 21X-9 (WC) 17,100' Dakota	TD 17,100. (4 days) MORT. SEP 10 1968
Gov't 21X-9 (WC) 17,100' Dakota	TD 17,100. (5 days) MORT. SEP 11 1968
Gov't 21X-9 (WC) 17,100' Dakota	TD 17,100. (6 days) MORT. SEP 12 1968
Gov't 21X-9 (WC) 17,100' Dakota	TD 17,100. (7 days) Prep location for completion rig. SEP 13 1968
Gov't 21X-9 (WC) Maddox Well Service 17,100' Dakota	TD 17,100. (10 days) Prep to run tbg and pkr. MI & RU Maddox Well Service Rig 9-15-68. SEP 16 1968
Gov't 21X-9 (WC) Maddox Well Service 17,100' Dakota	TD 17,100 (11 days) Prep to set pkr in 5" csg and check liner for leaks. Ran Bkr 5" ret pkr on 5 jts 2½" tbg and 462 jts 3" tbg. Broke circ five times while running tbg. SEP 17 1968
Gov't 21X-9 (WC) Maddox Well Service 17,100' Dakota	TD 17,100. (12 days) Running tubing and bit. Unable to get pkr to set in 5" liner. Pulled tbg and pkr. SEP 18 1968
Gov't 21X-9 (WC) Maddox Well Service 17,100' Dakota	TD 17,100. (13 days) Drlg cement at 16,943. Ran 112 jts 2 7/8" tbg and 463 jts 3½" tubing w/4 1/8" bit. Tagged top of tie-back sleeve at 13,661. Hit cement at 16,913. Circ 5 hours. SEP 19 1968
Gov't 21X-9 (WC) Maddox Well Service 17,100' Dakota	TD 17,100. PB 17,020 (14 days) Logging. CO to 17,020. Displaced mud w/water. Pulled tbg and bit. SEP 20 1968
Gov't 21X-9 (WC) Maddox Well Service 17,100' Dakota	TD 17,100. PB 17,020. (17 days) Running cement retainer. Ran GRN log w/collar locator. Corrected back 28' to correspond w/Schl OH log. Logged from 16,976 to top of 5" tie-back sleeve at 16,945 (OWP). Ran velocity survey using Century Geophysical and Schl. Ran CBL (OWP). Ran 2 7/8" and 3 1/2" tbg w/Bkr 5" ret pkr and set at 13,740. Press tested tbg w/2,000 psi for 30 minutes, held ok. Press tested annulus w/1500 psi for 20 minutes, held ok. Bled off rapidly and repressured twice to 1500 psi for 30 minutes, held ok. Pulled tbg and pkr. Ran 2 7/8" and 3 1/2" tbg w/4 1/8" bit. CO to 17,020. Circ 5 hours. Pulled tbg and bit. Ran gauge ring and junk basket to 17,015. Perf'd at 16,990 w/4 squeeze holes (OWP). SEP 23 1968

Gov't 21X-9
(WC) Maddox Well Service
17,100' Dakota

TD 17,100. PB 17,020. (18 days) Swabbing. Set Bkr Model "K" Mercury Series cement retainer on WL at 16,970 (OWP). Ran 2 7/8" and 3 1/2" tbg and started into retainer. Began swabbing 6 PM 9-24-68. Swabbed to 13,450 in 9 hours and rec'd 149 BW; then swabbed 7 bbls in three hours. Total recovery as of 6 AM 9-24-68 - 156 bbls or 7 bbls less than tbg volume. SEP 24 1968

Gov't 21X-9
(WC) Maddox Well Service
17,100' Dakota

TD 17,100. PB 17,020. (19 days) Prep to squeeze. Swabbed 63 BW in 24 hours from 6 AM 9-24-68 to 6 AM 9-25-68. FL 13,000', SF 13,004', sal 2,000 ppm. In total of 219 BW swabbed, 10% mud. SEP 25 1968

Gov't 21X-9
(WC) Maddox Well Service
17,100' Dakota

TD 17,100. PB 17,020. (20 days) Running tbg and pkr. Press'd up tbg to 3,000 psi and bled off to 2,000 psi in 15 minutes. Fixed minor leak in line and repressured to 3,000 psi, bled off to 2175 psi in 15 minutes. Repressured to 3,000 psi and bled off to 2,000 psi in 25 minutes. Pulled tbg and stinger assembly. Dropped sealing balls. SEP 26 1968

Gov't 21X-9
(WC) Maddox
17,100' Dakota

TD 17,100. PB 17,020. (21 days) Running gauge ring and junk basket. Ran 3½" and 2 7/8" tbg w/Bkr 5" pkr. With 3 jts 2 7/8" tail below pkr, encountered some difficulties going through top of 5" liner. Attempted to set pkr at 16,737 but unable to do so. Pulled tbg and pkr. Pkr would hang up at top of 5" liner at 13,650-13,645. Worked pipe for four hours and circ hole for two hours and worked through top of liner. Pulled tbg and pkr. Found parts of two slips and two packing elements missing from pkr. SEP 27 1968

Gov't 21X-9
(WC) Maddox
17,100' Dakota

TD 17,100. PB 17,020. (24 days) Swabbing. Ran tbg and set Bkr 5" ret pkr at 16,800. Swabbed fluid down to 3,000' (29 bbls). Perf interval w/decentralized 3/8" alum jet as follows (OWP): 16,917, 16,918, 16,919, 16,920, 16,921, 16,922, 16,923, 16,924, 16,925, 16,926, 16,927 & 16,928; 16,933, 16,934, 16,935, 16,936, 16,937, 16,938, 16,939, 16,940, 16,941, 16,942; 16,948, 16,949, 16,950, 16,951, & 16,952. Ran BHP bomb on bottom at 9:30 PM 9-27-68. Pulled bomb at 3:30 AM 9-28-68. Pressure built up from 5946-6266 in 6 hours. Made gradient stops at 16,675, 16,575, 15,575 and 14,575. Started swbg at 5:30 AM 9-28-68. Swabbed 117 bbls load water in 9 hours as of 2:30 PM 9-28-68 as follows: 13% mud, FL 11,800'. SF 12,400', sal 2,000 ppm. Then swabbed 41 BW in four hours. 2½% mud, 1% thick brown emulsion, FL 11,600', SF 12,200', sal 1500 ppm. No visible gas as of 6:30 PM 9-28-68. Swabbed 97 BW in 14 hours, .2% mud, .5% emulsion. FL 11,800', SF 12,600', sal 1500, no visible gas as of 8:30 AM 9-29-68. From 8:30 AM 9-29 - 6:30 AM 9-30-68, swabbed 125 BW, .2% mud, .5% emulsion, no gas. Avg rate last four hours - 8.9 B/H, FL 12,900', SF 13,500'. Swabbed 260 BNF as of 6:30 AM 9-30-68.
SEP 30 1968

Gov't 21X-9
(WC) Maddox
17,100' Dakota

TD 17,100. PB 17,020. (25 days) Swabbing. Swabbed 134 BW last 24 hours from 6:30 AM 9-30 - 6:30 AM 10-1-68. Shut down for 4 hours repairing sand line when FL rose from 12,900 to 11,500'. Avg rate last 4 hours - 8.5 B/H, .2% mud, .4% emulsion, FL 12,900', SF 13,500', sal 1500 ppm. (394 bbls water over load rec'd as of 6:30 AM 10-1-68). OCT 1 1968

Gov't 21X-9
(WC) Maddox
17,100' Dakota

TD 17,100. PB 17,020. (26 days) Running tbg openended. Swabbed 53 BW in 9 hours, .2% mud, .5% emulsion, FL 12,800', SF 13,500', sal 1500 ppm. (Total swabbed - 595 bbls or 446 BW over load as of 3:30 PM 10-1-68. Released pkr. Circ for one hour. Pulled tbg and pkr. OCT 2 1968

Gov't 21X-9
(WC) Maddox
17,100' Dakota

TD 17,100. PB 17,020. (27 days) Laying down tbg. Ran tbg openended to 16,970. Spotted cement plug w/75 sx reg Class "G" cement from 16,970-16,107. Pulled tbg to 13,600. Displaced water w/mud. OCT 3 1968

Gov't 21X-9
(WC) Maddox
17,100' Dakota

TD 17,100. PB 17,020. (28 days) Pumping mud down annulus. Laid down tbg. Removed BOP's. Released rig 8 PM 10-3-68. Attempted to pump down 7" csg at 3,000 psi; unable to do so. Tied into 9 5/8" annulus w/9 5/8" annulus and 7" casing tied together. Injecting down 9 5/8" csg at 2 3/4 B/M at 3200 psi. As of 6 AM 10-4-68, injected 1540 bbls. OCT 4 1968

Gov't 21X-9
(WC) Maddox
17,100' Dakota

TD 17,100. PB 17,020. (31 days) Pumping mud and water @ 3½ B/M at 3200 psi. Pumped 10,660 bbls of mud and water in last 72 hours. Total bbls of mud disposed - 12,200 bbls. OCT 7 1968

Gov't 21X-9
(WC)
17,100' Dakota

TD 17,100. PB 17,020. NEW WELL PLUGGED AND ABANDONED. Disposed of all possible mud; a total of 15,200 bbls. Spotted the following cement plugs:

SX	INTERVAL
50	13,670-13,435 in 7" csg
50	260-Top of 7" csg
50	225-Sfc in 9 5/8"-7" annulus

Job complete 2 AM 10-8-68.
Released Maddox Completion Rig 8 AM 10-3-68.
P&A Complete 10-8-68. Will install abandonment marker later.
Elev: 9940 KB, 9923 GL

SAMPLE TOP:	MESAVERDE	13,813	(-3873)
LOG TOPS:	HILLIARD	14,866	(-4926)
	FRONTIER	16,243	(-6303)
	MOWRY	16,450	(-6510)
	DAKOTA	16,784	(-6844)
	MORRISON	17,048	(-7108)

FINAL REPORT. OCT 8 1968

CASING AND CEMENTING

Field Dahlgreen Creek Area Well Gov't 21X-9 KB to CHF 17.80

Shoe joint started in hole at 6:45 PM (Date) September 2, 1968

Ran 86 joints 5", Smls, Hydril FJ casing to 17,069'.

Jts.	Wt.	Grade	ST&C LT&C	New	Feet	From	To	
Boll Weevil Rotating Hanger and Tie-back sleeve					15.53	13,655.19	13,670.72	
61	18	N-80	Hyd. FJ	New	2,361.48	13,670.72	16,032.20	
23	18	P-110	Hyd. FJ	New	949.40	16,032.20	16,981.60	(NWS)
		Landing collar			.75	16,981.60	16,982.35	
1	18	P-110	Hyd. FJ	New	42.39	16,982.35	17,024.74	(NWS)
		Back Pressure Valve			1.18	17,024.74	17,025.92	
1	18	P-110	Hyd. FJ	New	41.53	17,025.92	17,067.45	(NWS)
		Acme-Christensen Diamond Washover Shoe			1.55	17,067.45	17,069.00	

86 joints Total

Landing Collar at 16,981

Back Press Valve at 17,024

Bottom of Washover Shoe at 17,069

Cementing: Broke circulation at 8:30 PM 9-3-68, 2100 psi. Circulated 110 minutes. With 500 gal CW-7 & 10 bbls water ahead, cemented through shoe at 17,069' with 400 sx Class "G" Neat cement, w/1% D-60 and .4% D-13.
Wt. 15 - 8 #/gal. Mixing complete in 22 minutes. Pressure: Max 1800; min 200; avg 1000. Plug down 12:35 AM 9-4-68. Pressure: Max 1200; min 0; avg 600. Pressure to 1200 psi in 68 minutes. Bled back ½ bbl. Did not bump plug. Stopped pumping w/calc'd bbls of displacement.

CASING AND CEMENTING

Field Dahlgreen Creek Area Well Gov't 21X-9 KB to CHF 17.80

Shoe joint started in hole at 1:30 PM 1/13/68.

Ran 151 jts 9 5/8", Smls, 8rd thd casing to 4900.00.

Jts.	Wt.	Grade	ST&C LT&C	New	Feet	From	To
151	40	J-55	ST&C	New	4882.20	0	4900.00

151 jts total

DV stage collar @ 2610'
Float collar @ 4836'
Float shoe @ 4900'
Baffle collar @ 4804'

4 Larkin, 2 Halliburton Centralizers: Spaced @ 4896', at 4830 and 4772. Spaced @ 4706', 2618', and @ 2604'.

Cementing: Broke circulation at 11:35 PM 1/13/68. Reciprocated and circulated 60 min. With 10 bbls water ahead, cemented through shoe at 4900' with 800 sx 1:1 poz, 2% gel, & 200 sx "G" neat 1/4# Clinton flake/sx. Wt. 13.8 & 15.3#/gal. Mixing complete in 30 min. Pressure: max 300; min 300; avg 300. Plug down 2:35 AM 1/14/68. Pressure: max 1000; min 0; avg 200. Pressure to 2000 psi in 46 min. Held 2 min. Bled back 2 1/2 bbls.

2nd stage through DV @ 2610 w/2020 sx 1:1 poz, 2% gel 1/4# Clinton flake/sx. 13.8# mix complete 46 min. Max 400, min 300, avg 200. Plug down @ 8:45 AM 1/14/68. Max 1000, min 400, avg 700. Press to 1500 for 5 min. Bled back 1 bbl. Good returns on both stages. Cement circ'd on 2nd stage.

CASING AND CEMENTING

Field Dahlgreen Creek Well Gov't 21X-9 KB to CHF 17.80

Shoe joint started in hole at 11:00 P.M. (Date) 11-22-67

Ran 6 jts. 20", Smls, H-40 94# 8rd casing to 193'

Jts.	Wt.	Grade	ST&C LT&C	New	Feet	From	To
6	94	H-40	ST&C	New	175.20	0	193.00

6 jts. Total

Guide shoe at 193'

No. Make & Type:

1 - #905 R Larkin, centralizers spaced @ 35.73'

Cementing: Broke circulation at 1:30 A.M. @ 400 psi. Reciprocated and circulated 25 min. With 20 bbls water ahead, cemented through shoe at 193' with 775 sx Class "G" Neat cement, 2% CACl, 1/4# Clinton Flake/sx

Wt. 15.8 - 16.0 #/gal. Mixing complete in 26 min. Pressure: Max 200; Min. 200 Avg. 200. Plug down 3:00 A.M. 11-23-67. Pressure: Max 300; Min 0; Shut in head.

Good cement returns. Left 30' cement in csg.

CASING AND CEMENTING

Field Dahlgreen Creek Area Well Government 21X-9 KB to CHF 17' - 11"

Shoe joint started in hole at 4:00 P M (Date) June 6, 1968

Ran 332 jts. 7" casing to 13,889

Jts.	Wt.	Grade	ST&C LT&C	New	Feet	From	To
Float Shoe				New	1.84	13,889.00	13,887.16
2	26#	S-95	ST&C	New	92.69	13,887.16	13,794.47
Float Collar				New	1.10	13,794.47	13,793.37
63	26#	S-95	ST&C	New	2,871.30	13,793.37	10,922.07
1	29#	N-80	X-L Coup to ST PIN	New	40.50	10,922.07	10,881.57
122	29#	N-80	X-Line	New	4,983.85	10,881.57	5,897.72
1	26#	N-80	LT Coup to X-Line PIN	New	41.88	5,897.72	5,855.84
32	23#	S-95	ST&C	SH	1,479.49	5,855.84	4,376.35
1	26#	N-80	LT Coup to ST PIN	New	32.89	4,376.35	4,343.46
3	26#	N-80	LT&C	SH	129.16	4,343.46	4,214.30
63	26#	N-80	LT&C	New	2,364.55	4,214.30	1,849.75
1	26#	N-80	BUTT Coup to LT PIN	New	33.21	1,849.75	1,816.54
26	26#	N-80	BUTT	SH	1,102.48	1,816.54	714.06
14	26#	N-80	BUTT	New	601.00	714.06	113.06
3	29#	N-80	BUTT	New	130.45	113.06	SCF (17.39' UP)
332 Jts. Total					13,906.39		

Float Collar at 13,793

Float Shoe at 13,889

No. Make & Type:

2 Centralizers: Spaced 1 ' @ 13,883 & - 1 @ 13,747 ;

None Scratchers

Cementing: Broke circulation at 4:45 AM 6-7-68 psi. Circulated 180 min. With 10 bbls water, 12 barrels CW-7 & 10 barrels H20 ahead, cemented through shoe at 13,889' with 365 sx (75 bbl) cement,* Class "G" Neat, 0.2% D-8.

Wt. 15.4 - 15.8 #/gal. Mixing complete in 16 min. Pressure: Max 300 ;

Overdisplaced 3 bbls @ 10:15 AM 6-7-68 .

Pressure: Max 900 ; Min 300 . Bled Back 1 bbls. Held o.k.

*Yield 1.145 cu ft/sx
Displacement 525.4 bbl. Overdisplaced 3 bbl. Shut-down
Pumped first 450 bbl @ 7 BPM, displaced Slurry out Shoe @ 2 BPM.

CASING AND CEMENTING

Field Dahlgreen Creek Area Well Gov't 21X-9 KB to CHF 17.80.

Shoe joint started in hole at 6:15 P.M. (Date) 12-9-67.

Ran 14 jts. 13 3/8", Smls., 8rd thd casing to 461.

Jts.	Wt.	Grade	ST&C LT&C	New	Feet	From	To
14	48	H-40	ST&C	New	444	0	461

14 jts. Total

Guide Shoe at 461

3 Larkin centralizers, spaced @ 454', 191', and 50'.

Cementing: Broke circulation at 8:30 P.M. 100 psi. Reciprocated and circulated 30 min. With 5 bbls Water ahead, cemented through shoe at 461 with 565 sx 1:1 poz, 4% gel w/1/2# flake/sx, 150 sx Class "G" Neat cement, 2% CACl 1/2# flake/sx. Wt. 14.5 - 16#/gal. Mixing complete in 43 min. Pressure: Max 200; Min. 200; Avg. 200. Plug down 10:30 P.M. 12-9-67. Pressure: Max 300; Min 300; Avg. 300. Pressure to 0 psi in 14 min. Good retruns. Cem't did not circ. Cemt'd 210' of 1" w/220 sx Class "G" Neat, 4% CACl. Job complete @ 9:15 A.M. 12-10-67. Good returns. Cement did not circ. Cemt'd 47' of 1" w/140 sx Class "G" Neat, 3% CACl. Cem't circ'd. Job complete @ 4:30 P.M. 12-10-67.

LOG AND SAMPLE TOPS

DAHLGREEN CREEK AREA
GOVERNMENT 21X-9
1096' FNL, 2243' FWL
SECTION 9, T2N, R14E
SUMMIT COUNTY, UTAH
9940' KB

SAMPLE TOPS:

MADISON	440	(+9500)
BASE RED PINE	11,718	(-1778)
"INVERTED" PARK CITY	11,718	(-1778)
MOENKOPI	11,776	(-1836)
THAYNES	12,260	(-2320)
SHINARUMP	12,575	(-2635)
NUGGET	12,850	(-2910)
"NORMAL" SHINARUMP	13,425	(-3485)
MESAVERDE	13,813	(-3873)

LOG TOPS:

PRE-CAMBRIAN	490	(+9450)
TERTIARY	810	(+9130)
PRE-CAMBRIAN	2,983	(+6957)
HILLIARD	14,866	(-4926)
FRONTIER	16,243	(-6303)
MOWRY	16,450	(-6510)
DAKOTA	16,784	(-6844)
MORRISON	17,048	(-7108)

DAHLGREEN CREEK UNIT
SHELL OIL 21X-19 GOVERNMENT
SECTION 9, T 2 N, R 14 E
SUMMIT COUNTY, UTAH

Elevation: 9940 KB

Sample Description

Feet	Description
Samples begin at 230' in Paleozoic rubble	
230	Ss., free drlg., C-XC, reddish, feld.
250	100% cement.
270	Ss., wh. to pink, f-m, subrd., clean, tr. poro.
290	W/Ss., C-pebb., free drlg., feld.
350	XC-pebb., free drlg.
390-445	No samples - (lost circulation).
In Mississippian at 445'	
445	Ls., gry-brn, m. pelletal, hd. ti w/Ls., gry, mudstone, ti.
449-480	No samples - (lost circulation)
480	Ls., yell-brn., "weathered", Xf xln., soft.
Possible pre-Cambrian Red Pine Shale	
490	Ss., gry to red, C-XC, feld. subrd., sl. free drilling, sl. calc., ti., w/Sh., gry-blk, mica., sdy.
500	Sh., gry-blk, a.a., v. soft.
540	Ss., gry, XC-pebb., feld., free drlg., poss. dk. clay matrix.
700	Sh., gry-blk, v. soft, silty, sandy.
720	Ss., gry, C-pebb., feldspar, free drilling,
740	w/tr. Sh., a.a.
760	Ss., dk. gry, C, v. sil., hd., tr. Sh.
800	Ss., as at 720.

Tertiary Fort Union 820'

Feet	Description
820	Sandy Shale, gry-blk, soft, C sdy., carb.
840	Sh., v. lt. grn-gry, sl. fiss., sl. waxy.
860	Sh., v. dk. gry, sandy, Ostracodal,
900	w/feld. Ss., M-C, pyr., hd.
940	Sh., v. pale grn, sl. fissile, grades to m. gry.
980	Gry Sh., a.a., tr. reddish, sl. carb.
1000	A.A. w/grn-gry Sh.
1040	Sh., gry, a.a. w/ tr. Ss., pink, M-C, sil.
1100	Sh., a.a., silty.
1180	Sh., a.a., sdy in pt.
1200	Sh., m. gry to dk. gry, fiss.
1240	Sh., a.a., w/tr. grn. Sh.
1270	Sh., m. gry, v. silty w/interbeds Ss., gry-reddish, f-xc, feld., sil., hd.
1340	Sh., gry to reddish w/grn., v. mica., sl. phyllitic app.
1360	Sh., a.a. w/Shly Ss. lam., M-C, dk. gry.
1420	Sh., olive grn to gry, sl. fiss., hd.
1480	Sh., a.a. w/Ss. lam., f-c, gry, argill.
1510	Sh, v. dk. gry to gry-blk, fiss., hd.
1530	Sh., a.a., w/Ss. lam., crm-wh., f-c, dolm., ti.
1580	Sh., blk, a.a.
1640	Sh., drab., gry-grn, blocky.
1660	Sh., a.a., v. sandy, pyr.
1680	Argill. Ss., gry, v.f., hd., ti. w/Sh., a.a.
1710	Sh., a.a., v. silty.

Feet	Description
1760	Sh., a.a., w/Ss., wh., v. f.
1820	Sh., gry-grn, a.a. w/Sh., blk.
1840	Sh., a.a., w/cglm., qtz-chert, pebbly, tr. weak cut F.
1880	Ss., gry-brn, f-xc, argill., glauc., tr. poro., weak cut F.
1920	Ss., a.a. w/Sh., gry-grn, v. silty.
1980	Ss., dk. gry to wh., M-C to pebb., ark., v. argill. to clean, tight, w/Sh., blk, sandy.
2020	Sh., m. gry to sl. greenish, blocky to splint., silty.
2040	Ss., as 1980, v. pyr. in pt.
2050	Sh., as 2020, sl. greener - (Source Rocks).
2120	Sh., a.a., blk, silty to sandy - (Source Rocks).
2140	Sh., a. a., grn-gry.
2160	Sh., a.a., w/tr. Ss., M-C, argill.
2180	Sh., a.a., w/Silt., brn, soft.
2220	Sh., olive grn, waxy, blocky.
2240	Sh, a.a. w/thin Ss., wh., f., sub. ang., calc., tr. poro., weak cut fluor.
2280	Ss., wh.-tan, xf-f, sub. ang., v. dolm., sl. argill., tight.
2300	Silt. to Ss., brn, xf, v. argill., hard, tight, weak cut fluor.
2330	Sh., m. gry, v. silty, blocky.
2340	Sh., a.a., v. silty to Silt. in pt.
2360	Sh., m. gry-grn-blk, silty (Source Rocks).
2420	Ss., wh., f., sub. ang., clean, v. calc., fair spot OS, exc. cut fluor., 12-18% poro.
2440	Interbed. Sh., m. gry w/Ss., wh., v.f.-f., sub. ang., sl. calc., tight to 8% poro., poor OS, fair cut fluor.

Feet	Description
2460	A.A., sil., tight to 5% poro., fair spot OS, good-exc. cut fluor.
2490	Sh., m. gry to grn, sl. silty w/Silt., brn, v. argill.
2550	Sh., a.a., v. silty.
2595	Ss., gry, M-XC w/tr. f., tight to tr. poro., poor spot OS, fair cut fluor.
2605	Sh., gry to blk, sl. silty, blocky.
2760	Sh., a.a., w/Ss., wh., v.f., sub. ang., calc., glauc., tight, weak cut fluor.
2800	Sh., a.a., v. silty in pt., sl. grn cast.
2820	Sh., a.a. w/Shly. Silt., brn.
2920	Sh., v. lt. grn-gry, sl. silty w/Sh., blk, mica., blocky.

Pre-Cambrian Red Pine Shale 2940'

Feet	Description
2940	Sh., blk, silty w/Ss., M-VC, ang., tight.
2980	Ss., wh.-v. lt. gry, f-bebb., very poorly sorted, dolm., tight.
3000	Ss., a.a. w/blk Sh. interbeds.
3060	Sh., blk, blocky to splint., sl. silty to sl. sandy in part.
3080	Ss., crm-wh., f-pebb., very poor sorted, v. dolm., tight.
3100	Sh., black, blocky, sl. silty in streaks.
3120	Sh., a.a., w/streaks argill. Ss., gry-blk, f-m, tight.
3160	Sh., m. gry to blk, silty w/lam. Ss., f., crm., tight.
3200	Ss., crm., f-m, sub.rd., wh. clay band, tight.
3220	Sh., blk, silty, flaky.
3250	Argill. Ss., gry-crm, v.f.-m, sl. dolm., tight w/Sh., a.a.
3300	Sh., blk, v. silty-sandy, blocky, pyr. clusters, v. mica., w/Ss., lam., f-m, shaly.
3340	Sh., a.a. w/siderite.

Feet	Description
3390	Sh., a.a., sl. lighter color.
3400	Ss., crm, f-c, rd., wh. clay cem., tight, few sh. clasts.
3430	Argill. Ss. to sandy Sh., gry-blk, v.f.-f., sil., hard.
3440	Sh., m. gry-blk, blocky.
3460	Ss., gry-crm, f-m w/C, sub.rd. to rd., sl. dolm., tight.
3470	Sh., blk, sl. waxy, tr. slickensides.
3510	Ss., crm-wh., f.-pebb., poorly sort., tight to 8% poro., NS.
3525	Sh., blk as 3470.
3540	Ss., crm-tan, f-m, sub. ang.-sub.rd., few sh. clasts, tr. 10% poro., NS.
3560	Sh., blk, v. silty, sandy, v. mica., blocky.
3600	Sh., a.a., w/tr. Ss., crm., f-m, tight.
3640	Ss., gry, f.-pebb., shaly, pyr. w/Sh., a.a.
3680	Sh., m. gry to blk, sl. fissile, sl. silty.
3700	Sh., a.a., tr. grn, v. silty to sandy in part.
3730	Ss., crm-wh., f.-pebb., sub. rd., sl. calc.
3740	Sh., tan-olive-black, blocky.
3760	Sh., olive drab-black, blocky.
3795	Ss., wh., m-c, sub. rd., sl. calc. to sl. dolm., sh. clasts, broken 10% poro., NS.
3830	Sh., grnish to brn-blk, lam., soft w/tr. Ss., Xf, brn, soft.
3860	Ss., wh.-tan, v.f.-c., sub. rd., sh. clasts, broken 8% poro., NS.
3875	Sh., blk., ex. mica., soft w/Ss. lam. a.a.
3900	Sh., brn-olive grn, blocky w/Sh., black, ex. mica, tr. Ss., a.a.
3920	Ss., tan-wh-gry, v.f.-m w/occ. C, sub. rd., calc. in strks., tight w/Sh. lam., a.a.

Feet	Description
3940	Sh., olive grn-m. gry to blk, v. mica., silty in strks. w/ Ss. lam. a.a.
3980	Ss., crm-wh., f-c, non-calc., sub. rd., glauc., tight.
4000	Ss., a.a., tr. poro.
4010	Sh. as at 3940.
4040	Sh., a.a., w/Ss. lam. as 3980, sl. tan.
4080	Ss., wh., f-pebb., very poorly sorted, gry-wh. chert, sh. clasts, tr. wh. feldspar, tr. poro., NS.
4100	Sh., m. gry-blk, slickensides, v. mica., silty in streaks.
4120	Ss., crm-wh., v.f.-pebb., very poor sorted, tr. chert, tr. poro., NS.
4140	Ss., a.a., f-m, tr. poro.
4150	Sh., m. gry to olive w/Sh., blk, mica., silty in strks.
4190	Ss., wh., C-pebb., sub. rd., shaly in part, tr. poro.
4210	Ss., a.a. w/Sh. as 4150.
4240	Ss. as 4190.
4260	Ss., a.a. w/interbeds Sh., gry-blk.
4310	Sh., gry-gry-blk, mica., silty,slickensides.
4340	Sh., lt. grn, silty w/C-M clear sand grains imbedded.
4360	Sh., gry-blk, sl. feldspathic w/ark. Ss., f-m, soft, num. slickensides.
4380	A.A. w/pebb. quartz and feldspar in Ss.
4400	A.A., v. lt. gry-tan, silky, w/pebbles.
4440	A.A. w/ark. Ss., f-~~x~~c, soft w/Sh., brn-blk.
4460	Sh., grn-lt. gry-blk, silky w/Ss., a.a.
4480	Sh., lt. grn, waxy.
4500	Sh., grn to black, waxy w/occ. m-c clear quartz grain.

Feet	Description
4520	Sh., a.a., w/Ss., lam., f-m, sil., tight.
4550	Ss., wh., C-pebb., non-calc., tight.
4580	Sh., blk, v. mica. w/Sh., blk-gry-grn, silky.
4600	Sh., a.a., w/Ss., f-c, rd., tight.
4640	Ss., wh., C-pebb., non-calc., ang. to sub. rd., tr. chlorite, tight.
4660	Ss., crm.-tan, f., sil, hd., sl. S&P, w/Sh., a.a.
4680	Sh., black, v. mica., soft.
4700	Sh., m. gry to grn, silky, blocky.
4710	Ss., wh., XC-pebb., rd., sl. sil., tr. lt. gry chert.
4740	Ss., a.a. w/interbeds Sh., grn-m. gry, firm.
4760	Sh., a.a. w/Sh., blk, v. mica., scat. quartz pebbles.
4800	Sh., green, a.a.
4820	Sh., blk, firm, w/Sh. blk, mica., w/quartz and feldspar pebbles w/Claystone, brown.
4840	A.A. w/tr. Ss., wh.-lt. gry, v.f.-f., soft, tight.
4890	Ss., wh.-tan, Xf-vf, v. sl. dolm., pyr., tight.
4935	Sh. to Silt., gry to sl. brn., non-calc., sl. mica.
4938	Ss., C-pebb., very poorly sorted, wh. clay cem., sub. rd., sl. free drilling, tight.
5000	Ss., crm, f., sub. ang. to sub. rd., sl. sil., tight.
5020	Interbed. Ss. to Silt., gry w/Sh., m. gry, silty.
5030	Ss., tan-crm, f-m, wh. clay cem., w/Sh., m. gry, silty.
5045	Ss., wh.-tan, f-pebb., sub. ang. to sub. rd., very poor sorting, tight.
5065	Sh., m. gry, sl. silty, sl. calc.
5090	Ss., grn, Xf-pebb., chloritic, sl. ark., v. argill.

Feet	Description
5115	Interbed. Sh., m. gry - sl. blk, soft w/ark., C-pebb., tight.
5130	A.A. w/tr. grn Sh.
5150	Silty Sh. to shly. Silt., m. gry, blocky.
5175	Ss., wh., XC-pebbles, sl. ark. in top, tight.
5195	Sh., black, mica.
5200	Sh., a.a. w/brn Silt. interbeds.
5210	Sh., a.a., w/ark. Ss., gry-wh., C-pebb., tight.
5225	Ss., grn, chloritic, v.f.-pebb., ark., weathered appearance, v. argill., tight w/pale olive.
5260	Sh., blk, mica w/Sh., olive-grn, waxy.
5270	Sh., a.a. w/ark., C-pebb.
5290	Ss., grn, v.f.-pebb., chloritic w/drab Sh., gry-grn.
5300	Arkose, wh. w/grn clay, C-pebb., sl. free drilling, tight.
5310	A.A. w/Sh., blk, grn-gry.
5325	Sh., blk, v. mica w/gry-grn, waxy.
5340	Ss., wh., C-pebb., free drilling, tight.
5350	Ss., a.a. w/Sh., blk, mica w/Sh., grn-lt. gry, waxy.
5365	Silty Sh., m. gry, platy, tr. grn, slickensides.
5385	Ss., tan, C-pebb., sl. ark., sl. math. appearance, tight w/tr. chloritic Ss., f.
5400	Ss., a.a., w/Shs., gry-grn to m. gry.
5415	Sh., blk, v. mica. w/Sh., drab grn-gry, waxy.
5430	Sh., a.a. w/Ark., C-pebb., sl. weathered appearance.
5450	Ark., a.a. w/Sh., drab gry-grn, waxy.
5465	Sh., m. gry-blk, v. mica. w/Sh. a.a.
5490	Ark., grn to wh., f-c to pebbles, sub. rd., w/Sh. a.a.

Feet	Description
5500	Ark., a.a., w/interbedded waxy brn-grn-gry Sh.
5530	Sh., olive grn to m. gry, waxy w/Ss., C-pebb., wh., tight.
5540	A.A. w/Silt., brn, hard, appears weathered w/brn waxy Sh.
5550	Sh., a.a., w/blk.
5560	Sh., a.a. w/Ark., grn-brn, C-pebb., w/brn Silt., w/brn Claystone.
5590	A.A. w/cons. brn. Claystone.
5600	Sh., blk, v. mica. w/Sh. a.a., brn w/Ss., brn, v.f.-C, hard, tight.
5620	Interbed. Sh., a.a. w/Quartz Wash Ss., C-pebb., tr. feld., tight.
5630	A.A. w/varieg. grn-brn, v. waxy Sh.
5640	Ark., wh., m-pebb., sl. calc., tr. clay, tight w/Sh. a.a.
5650	Sh., blk, v. mica., sl. silty.
5660	Sh., a.a. w/Silt., gry w/Sh., grn-brn, waxy.
5670	Ark., wh., C-pebb., sli. dolm., sl. free drilling, tight w/Sh., grn, waxy.
5680	Interbeds Sh., blk. mica. to brn-gry, waxy w/Ark., a.a., brn, sl. weathered appearance.
5725	Ark., C-pebb., sl. free drilling w/Sh., a.a.
5760	Interbed. Ark.-Sh., a.a. w/chloritic Ark., f-c, v. mica.
5780	Ark., wh., C-pebb., sl. dolm., tight.
5790	Ark., a.a. w/Sh., m. gry-blk, v. sl. calc.
5800	Sh., brn-gry-grn w/blk, soapy w/Ark., brn, C-pebb.
5850	Ark., brn, C-pebb. w/Shs., brn-gry-grn.
5865	Ark., grn. to wh., C-pebb., sl. chloritic.
5880	Silt. to Ss., brn, v.f.-C, soft.
5885	Sh., brn to m. gry, v. sl. calc.

Feet	Description
5900	Ark., gry-wh., c-pebb.
5910	Sh., m. gry-blk w/brn.
5920	Sh., a.a., w/Ark., brn, f-pebb.
5970	Sh., grn-m. gry, waxy w/Ark., tan-gry, c-pebb.
6030	Ark., grn-wh. to brn, fiss. streaks to c-pebb., chloritic in part.
6050	Sh., lt. gry-m. gry-grn, sl. silky.
6060	Sh., a.a., w/Ark., grn, c-pebb.
6085	Ark., wh.-grn, c-pebb., v. feldspathic, tight w/tr. Sh., a.a.
6100	Ark., brn. c-pebb., w/blk-brn, Sh. interbeds.
6120	Ark., a.a. w/grn-gry, Sh. interbeds.
6140	Sh., lt. m. gry-brn w/tr. grn, silky.
6150	Sh., a.a. w/Ark., c-pebb., interbeds.
6170	Sh., grn-gry, silky w/Ark., a.a.
6190	Sh., a.a., w/brn-blk, silty in streaks.
6210	Sh., a.a., w/Ark., wh., c-pebb., interbeds.
6230	Ark., wh., c-pebb., tr. chlorite w/Sh., a.a.
6260	Ark. to Ss., wh., f-m to c-pebb., wh. clay cem., tight, free drilling.
6270	Ark., a.a., w/Sh., blk to m. gry interbeds.
6340	Sh., a.a. to grn w/Ark., a.a. interbeds.
6380	Sh., grn-m. gry w/blk, silky.
6390	Ark., wh.-grn, c-pebb.
6400	Ark., sl. tan-brn, c-pebb., weath. app. w/Sh., brn, waxy.
6410	Ark., a.a., interbed w/Sh., olive grn to m. gry, waxy.
6430	Ark., a.a. w/Sh., brn, waxy.

Feet	Description
6440	Ark., a.a. w/Sh., olive grn to m. gry.
6450	Ark., a.a. w/Sh., tan-brn, waxy.
6460	Ark., a.a. w/Sh., grn-m. gry.
6500	Ark., grn, c-pebble, chloritic w/Sh., olive grn, hard, silky.
6520	A.A., w/thin Silt., gry-blk, hard w/Sh., blk, mica.
6550	Sh., grn-m. gry-blk, w/thin Ark. as at 6500.
6580	Ark., grn to wh., v.f.-pebb., w/Sh., lt. gry-grn, silky, hard.
6620	Sh., grn-gry-blk, silty to silky w/Ark., a.a.
6640	Ark., grn-tan, c-pebb., sl. weath. app., v. feldspathic.
6650	Ark., a.a. w/Sh., m. gry to grn w/blk, w/Ss., grn, v.f.-f., v. mica.
6670	Ark., gry-tan-grn, v.f.-m, v. argill., w/Sh. a.a.
6680	Ark., wh., c-pebb., w/interbeds Sh., blk, silty and m. gry, waxy.
6700	Sh., m. gry to gry-blk, v. silty to sandy, w/Sh., grn, silky.
6720	Sh., brn, silty w/Sh. m. gry w/Ark., brn, f-c, soft.
6740	Ark., brn, c-pebb. w/brn Silt., shaly.
6750	Sh., m. gry to blk, mica. w/Sh., olive grn.
6760	Sh., olive grn to brn, waxy w/brn Silt.
6770	Sh., m. gry to blk, interbed w/Ark., brn, c-pebb., tr. chloritic ark.
6790	Ark., brn to grn, f-pebb., w/Sh., a.a., tr. brn waxy Sh.
6810	Ark., a.a. w/Sh., m. gry-grn.
6820	Sh., brn, silky w/thin brn Silt in top.
6855	Ark., brn to grn, f-pebb., rd., tight.
6870	Ark., a.a. w/Sh., lt. grn to m. gry-brn, silky.
6880	Sh., v. lt. grn, silky, hard.

Feet	Description
6890	Ark., grn., v.f.-pebb., w/Sh., m. gry-grn.
6900	Ark., wh.-brn, v.c.-pebb. w/Sh., a.a.
6910	Ark., brn-grn, v.f.-pebb. w/Sh. interbeds, blk-m. gry-brn-grn.
6945	Sh., brn w/grn-m. gry, silky.
6960	Ark., grn, v.c.-pebb., clay cem.
6970	Ark., a.a., interbed w/Shs., brn-m. gry-blk.
6990	Sh., m. gry-grn, silky w/Ss., c., sl. dolm., tight.
7000	Very poor sample.
7010	Ark., grn, f-pebb. interbed w/Shs., brn-gry-grn.
7040	Sh., blk, v. mica. w/Sh., m. gry-grn-brn, silky.
7050	Sh., a.a., increase in brn.
7060	Sh., a.a., w/Ark., f-m, grn, v. argill., mica., tight.
7070	Ark., a.a., w/Sh., blk-gry-brn-grn.
7100	Ark., brn, v.f.-m. to pebb., sl. dolm. w/Sh., brn.
7110	Ark., grn, m-c, sl. dolm., clay cem. w/Sh., m. gry to lt. grn, sandy.
7130	Ark., a.a., grn-brn.
7135	Sh., blk-m. gry-brn, mica., blocky, non-calc.
7155	Ark., grn, v.f.-v.c., tight.
7160	Ark., a.a., sl. free drilling, v. sl. dolm. w/tr. blk, mica. Sh.
7190	Sh., blk. mica. to olive grn, silky.
7210	Ark., wh., v.c.-pebb., free drlg., cons. wh. feldspar.
7230	Ark., a.a., w/blk Sh. lam.
7240	Ark., a.a., w/grn Ark.
7250	Sh., m. gry-blk-brn, silky, blocky to sl. splint.

Feet	Description
7260	Sh., a.a., w/Ark., grn, f.f.-c.
7270	Sh., a.a., w/brn Silt. to Ss., hard, app. weathered.
7280	Sh., a.a., w/Ark., wh., v.c.
7290	Sh., grn to m. gry, silky w/Sh., blk, v. mica.
7300	Ark., grn-wh., v.c.-pebb.
7310	Ark., brn., f-pebb. w/Sh., grn-brn-m. gry.
7340	Sh., blk-m. gry brn-olive grn, silty to sandy in part w/tr. brn Ark., v.f.-f., weath. app.
7355	Ark., grn-wh., v.c.-pebb., v. feld.
7370	Sh. as 7340 w/tr. brn Ark., f-m, weathered appearance.
7380	Ark., as at 7355 w/Sh. a.a.
7390	Sh., brn-m. gry, v. brittle w/brn. Ark., f-m.
7400	Sh., a.a., v. lt. grn.
7410	Ark., grn, f-pebb., v. sl. dolm., sl. free drilling.
7420	Ark., brn, c-pebb.
7435	Sh., brn-gry-blk w/thin brn Silt., tr. Ark., brn, c.
7470	Sh., olive grn-m. gry, waxy.
7480	Sh., a.a., w/Silty Sh., blk, v. mica.
7490	Ark., v.c.-pebb., v. feld., sl. free drilling.
7500	Ark., brn, f-pebb. w/brn v. mica. sandy Sh. to Sh., brn, non-mica., waxy.
7510	Ark. grn-tan, v.c.-pebb., dolm.
7520	Ark., a.a., w/interbeds Sh., gry-blk to brn.
7630	Sh., brn-gry-blk, silky to sl. silty w/tr. Ark., brn, c.
7645	Ark., wh.-grn, v.c.-pebb., pyr., sl. dolm.

Feet	Description
7660	Sh., gry-blk, v. mica., sl. silty w/Sh., brn-gry, silky, w/tr. Ark., brn, c-pebb.
7690	Ark., reddish-brn, v.f.-pebb., v. weath. app., tr. brn-red Sh.
7700	Interbed. Ark., wh.-tan, v.c.-pebb. w/Sh., m. gry-grn-brn, silky.
7740	Ark., a.a., grn w/Sh., brn, silky.
7750	Ark. as at 7700.
7840	Ark., grn, f-pebb.
7860	Sh., m. gry-tan-grn w/Silt., brn, shaly.
7875	Ark., brn-grn, v.c.-pebb. w/thin Sh., m. gry-blk, mica., silty.
7930	Ark., brn, v.c.-pebb. w/Sh., brn, silky.
7950	Ark., a.a. w/Sh., blk, v. mica., soft.
7980	Sh., brn to brn-gry, v. mica., silty w/thin Ark.
7990	Sh., m. gry to olive grn, silky w/grn Ark., c-pebb., sl. dolm.
8000	Ark., brn, Xc-pebb., w/Sh., blk, ex. mica., soft.
8030	A.A., w/Sh., red-brn, silky to Silt., brn.
8055	Interbed. Sh., blk, ex. mica., phylittic, soft w/Ark., a.a.
8120	Ss., wh., Xc-pebb., tr. feld.
8140	Ark., brn, v.c.-pebb., w/Sh., blk, mica., phylittic.
8150	Ss., as at 8120, pebb.
8160	Interbed. Ark., brn, m-pebb., and Sh., blk, v. mica.
8215	Ss., quartz pebb., occ. tr. wh. feldspar, tr. blk, mica. Sh.
8330	Ss., a.a., sl. Ark.
8380	Interbed. Sh., blk, v. mica. w/brn-olive grn w/Ss., brn-grn, v.f.-pebb.
8400	Sh., a.a., w/Ark., m-pebb., brn-gry.
8430	Ark., grn-wh., v.c.-pebb., free drilling, tr. blk Sh.
8520	Interbed. Ark., f-m to v.c. pebb., w/Sh., grn-gry-brn-blk.

Feet	Description
8545	Ss., grn, v.c.-granules, sub. rd., occ. tr. wh. feldspar.
8580	Ss. to Ark., tan, v.f.-pebb., occ. thin blk Sh., v. mica.
8635	Sh., blk, mica., soft w/tr. Ark., v.c.
8650	Sh., a.a., sl. talcy, phyllitic app.
8685	Ark., brn, v.c.-pebb., weath. app. w/tr. Sh., brn, waxy w/Sh., blk, mica.
8700	Sh., blk, mica., soft.
8710	Sh., a.a., w/Ark., grn, v.c.-pebb.
8740	Ark., tan, v.c.-pebb.
8750	Ark., a.a., w/Sh., blk, mica. and brn, waxy.
8760	Ark., grn., v.c.-pebb., w/occ. tr. Sh., blk to m. gry.
8870	Sh., blk. - m. gry-lt. grn, w/Ark., brn, f-pebb., tr. Silt., brn.
8900	Sh., a.a., w/Ark., grn, v.c.-pebb.
8910	Sh., blk, v. mica., w/Ark., brn, v.f.-c, v. mica.
8920	Ark., grn to brn, v.c.-pebb., sl. free drlg., v. feld., w/tr. blk Sh., v. mica.
9038	Sh., mar.-red, blocky, silty w/Sh., grn-gry, waxy, tr. Ark.
9050	Interbed Sh., red-grn, w/Ss., grn, v.f.-m., v. mica., tr. blk. Sh., mica.
9070	A.A. w/Ark., grn, m-v.c.
9110	Ark., tan-grn, v.c.-pebb., weath., mica., w/red Sh., a.a.
9120	Sh., grn, sub-waxy w/Ss., pale grn, v.f.-f.
9145	Ark., grn-flesh pink-orange, v.c., fresh w/Sh., interc., blk-grn.
9190	Ark., a.a., w/Sh., red-mar., mica.
9240	Ark., a.a., w/interbed. Sh., blk to dk. grn, mica. in part.
9250	Ark., grn w/clear qtz., weath. feld. w/Sh., dk. gry to mar., mica.

Feet	Description
9300	Sh., dk. gry to dk. grn-dk. red, mica. w/Ark., a.a.
9310	Sh., dk. gry-dk. red, mica., w/Ark., grn-orange, fresh.
9325	Ark., wh.-pink-grn, v.c.-pebb., fresh.
9340	Ark., a.a., w/Sh., gry to grn-gry.
9370	Sh., dk. gry to dk. grn, w/dk. red, mica., w/Ark., a.a.
9400	Ark., green w/orange feldspar and quartz pebbles, w/Sh., a.a.
9450	Sh., blk-red, mica. w/interbed. Ark., green w/orange feldspar, m-c.
9470	Ark., a.a., w/Sh., green-gry.
9510	Ark., brn., m-c, mica., tite w/tr. Sh., a.a.
9530	Ark., grn, w/orange feld., c-pebb. w/Sh., gry-grn, mica.
9560	Ark., a.a., no Sh.
9590	Ark., a.a., w/Sh., gry, sub-waxy.
9610	Ark., a.a., no Sh.
9670	Ark., a.a., and Sh., m. gry-gry grn, sub-waxy, mica.
9790	Sh., olive grn-gry, sub-waxy w/thin Ss., grn, v.f.-f., chloritic.
9810	Ark., grn to wh., w/orange feld., v.c., fresh.
9830	Sh., dk. gry to dk. grn, mica. w/tr. Ss., grn, m-c, mica., pyr.
9850	Ss., tan to brn, f-c w/pebb., tr. weath. feldspar.
9860	Ark., grn, mica. w/Sh., green to gry, silty to sandy, mica.
9910	Sh., gry to dk. green, mica., sub-waxy in part.
9930	Sh., a.a. w/Ark., grn, mica., v.c.
9960	Ark., grn, m-pebb., fresh, mica., pyr., w/Sh., gry, silty.
9970	Ark., tan to brn, m-pebb., weath., mica. w/Sh., mar-brick red, mica.

Feet	Description
9990	Ark., a.a., grn, no shale.
10,000	Ark., a.a., w/Sh., red-dk. gry-blk, mica.
10,080	Sh., dk. mar-red, silty, mica., w/Sh., m. gry, silty w/strks. Ark., grn, f-m.
10,120	Ark., grn, c., w/Sh., lt. grn, v. silty to sandy.
10,135	Sh., as at 10,080 w/tr. Ark.
10,155	Ark., tan, c-granules, weath. app. w/tr. Sh., a.a., w/Sh., blk.
10,180	Ark., gry-grn, v.c.-pebb., fresh app., occ. Sh., a.a.
10,220	Sh., mar.-red-gry grn, hard, brittle w/tr. Ark., red-grn-gry, m.-pebb.
10,250	Interbed. Sh.-Ark., a.a., reds predom.
10,300	Ark., pink, v.c.-pebb., tr. qtz. pebb., w/Sh., blk-m. gry to red.
10,320	A.A., red Sh. increases.
10,350	Sh., blk, m. gry-grn-red w/Ark., a.a.
10,390	Interbed., Ark., pink, m-pebb. w/red Sh., a.a.
10,450	Ark., a.a., w/Sh., gry to blk., mica.
10,520	Ark., red-gry, f-c, sil., w/Sh., red-gry, silty.
10,560	Sh., red, silty, mica. w/Ark., grn-wh., c., mica.
10,580	Sh., m. gry, silty w/Ark., a.a.
10,590	Intercalated Sh., gry-red w/Ark., a.a.
10,660	Ark., a.a., w/Sh., red-gry, v.c. mica.
10,720	Ark., pink-sl. grn, v.c.-pebb., fresh w/Sh., v. lt. grn w/Sh., red, silty.
10,740	A.A., red Sh. increases.
10,760	Sh., gry-blk, v. mica., silty w/tr. red Sh.
10,780	Sh., red, silty, blocky, mica., tr. gry-blk., Sh.

Feet	Description
10,800	Sh., a.a., w/Ark., red, f-m, sil., app. frac.
10,830	Ark., pink-wh., fresh, c-pebb., w/Sh. lt. grn, mica., silty.
10,850	Ark., a.a., w/interbed. Sh., gry-blk and mar.-red, silty, mica.
10,885	Ark., pink, v.c.-pebb., fresh.
10,910	Sh., v. lt. grn to m. gry blk w/tr. mar.-red, sl. silty.
10,920	Sh., a. a., w/Ark., pink, v.c.-pebbly.
10,975	Ark., a.a., w/Sh., mar., silty to gry-blk.
11,060	Ark., tan-grn, f-c w/v-c, sl. weath. app. w/Sh., mar.-blk.
11,150	Sh., mar., silty, sandy w/Ark., grn, f-m.
11,160	Sh., a.a., w/Sh., blk, brittle.
11,190	Ark., grn-pink, f-pebb.
11,200	Ark., a.a., w/interbed. Sh., mar.-blk.
11,230	Sh., mar.-red, silty, sandy, blocky w/Sh., blk, greasy app.
11,250	Sh., a.a., w/Ark., pink, f-pebb., sl. sil.
11,300	Ark., grn, f-c, mica., w/Chloritic Sh., grn-gry, w/Sh. a.a.
11,330	Ark., pink, c-pebb., fresh app. w/Sh., mar.-blk.
11,340	Ss., grn, vf-f w/m, v. sl. feld., w/Sh., m. gry-mar., silty.
11,350	Ark., tan-grn, c-pebb., sl. weath. app. w/Sh. interbeds, mar.-blk to grn-gry.
11,440	Ss., vf-f w/Ark. strks., f-c, chloritic, grn, clay cem. w/Sh., v. pale grn-gry, greasy app.
11,460	Ark., and Ss., a.a., w/Sh., m. gry-blk, silty.
11,490	A.A. w/Sh., pale grn, sandy, silty.
11,525	Sh., blk to olive grn, greasy app. w/Ark., grn-pink, m-pebb.
11,535	A.A. w/pale grn Sh.
11,560	Sh, a.a., w/Ss., grn, vf-f, v. mica., chloritic.

Feet	Description
11,570	Ark., grn, v.c.-pebb., w/Sh., blk, m. gry-grn.
11,610	Sh., blk, sl. greasy w/olive grn and dk. mar.
11,620	Sh., blk-m. gry w/v. lt. grn, tr. Ark., pink, c.
11,630	A.A. w/dk. mar. Sh.
11,650	Ark., pink-grn, v.c.-pebb., sl. dolm., w/Ss., grn-pink, f., sl. dolm. w/Sh., a.a.
11,690	Ark., a.a., w/Sh., dk. mar., waxy.
11,705	Ark., grn, v.f.-c. w/Sh., v. lt. grn, mar.

Thrust Fault 11,730'

Overturned Phosphoria 11,730'

11,730	Sh., blk, soft w/Ls., gry-tan, dense, v. lt. OS, fair S.F., fair cut F., tight.
11,750	Ls., crm. to blk, sl. frag. to dense, good OS, fair cut F., w/Ss., crm., v.f.-f., rd., v. calc., tight, good even OS, good cut F.
11,780	A.A. w/lam. Sh., blk, organic,hd.

Base overturned Moenkapi 11,800'

11,800	Sh., br. red to v. lt. red, v. calc., gypsiferous, soft.
11,810	Sh., br. red to dk. mar., splint.
11,820	Sh., a.a., w/Silst., pink, v. soft, ex. calc., gypsif.
11,880	Sh., a.a. to dk. red, v. silty in part w/lam. Silt., crm., calc.
11,920	Silt., wh. to crm, v. calc., poor spot OS, poor cut fluor., tight.
11,935	Sh., br. red to dk. red, soft to brittle, sl. gyp., v. calc. in part.
11,960	Sh., a.a., w/Sh., Or.-red, v. silty, v. calc., w/Ss., crm to wh., Xf, ex. calc., soft.
12,000	Sh., a.a., predom. Or.-red, sl. rust stn. on pt.
12,050	Sh., dk. mar., splint. w/Ss., pink-crm., Xf, v. sl. calc.
12,070	A.A. w/occ. spot dead OS, poor cut fluor., tight.

Feet	Description
12,090	Sh., a.a., w/tr. Ss., wh., Xf, v. pyr.
12,100	Ss. to Silt., crm-wh., Xf, dolm. to sl. calc., tr. spot dead OS to live OS, fair cut fluor.
12,120	Ss., a.a., w/Sh., br. red, v. silty, calc., shaly, Silt. in pt.
12,130	Sh., v. dk. mar., waxy, splint.
12,140	Sh., a.a., w/Ss., crm., Xf, v. w. sort., tr. spot dead and live OS, fair cut fluor.
12,170	Sh., a.a., w/Sh., br. red, v. silty to Shaly Silt., w/Ss., a.a., poor OS.
12,210	Sh.-Ss., a.a., w/Anhy., wh.-pink, hd.
12,220	Sh., v. dk. mar., waxy, splint.
12,240	Sh., a.a., w/Sh., Or.-red, v. silty, calc., w/gypsum stringers.
12,250	Sh., a.a., w/Silt. to Ss., Xf, crm-pink, v. calc., good spot OS, dead OS, weak cut fluor.
12,260	Silt., Or.-red, v. calc., gyp., w/Ss., pink, f., sub-ang., tight.

Base overturned Thaynes Limestone 12,280'

Feet	Description
12,280	Ls., wh., earthy, v. anh., sl. dolm. sl. silty, v. micro-pyr., w/Ls., gry, dense, v. pyr., anh., sl. silty.
12,310	Ls., a.a., w/Sh., Or.-red, v. silty, calc., w/Silt., crm., dolm., micro-pyr., lt. OS, fair cut fluor.
12,350	Silt. to Ss., Xf, crm-wh., dolm. to calc., soft, micro-pyr., occ. lt. OS, w/Sh., dk. mar. to Or.-red, silty.
12,375	A.A., w/Ls., lt. gry to crm., chalky, pyr., sl. anhy.
12,390	Sh., Or.-red, v. gyp., soft, sl. calc. w/Silt., crm-wh., calc., pyr.
12,420	Sh., Or.-red, v. silty, calc. w/Sh., dk. mar., shiny w/thin Silt., crm., calc.
12,470	Sh., a.a., w/red chert pebbles.
12,480	Sh., a.a., weath. app., w/Sh., br. red, sl. silty w/Silt. to Ss., Xf, crm., calc.

Feet	Description
12,510	Sh., dk. mar. to lt. Or., weath., app., silty, v. sl. calc. w/Silt., Or.-red, sl. calc.
12,560	Sh., a.a., ochre stn. in pt., tr. blk dolo. pebb., tr. chert, Or.-red-wh.

Top Moenkopi - Bas overturned Shinarump Conglomerate 12,575'

Feet	Description
12,575	Cglm., qtz., chert (red-or.-lav.-wh.), dk. and gry Ls., dk. Dolo., v. hard, in Silt. matrix, v. dk. brn to ochre.
12,650	Cglm., a.a., in clay-Sh. matrix, v. dk. brn-mar. to sl. ochre.
12,680	Cglm., a.a., in yellow-ochre matrix.
12,690	Cglm., a.a., in mar.-dk. brn matrix.
12,715	Cglm., a.a., w/tr. ochre Sh., tr. Dolo., crm, Xf.
12,750	Cglm., a.a., cherts predom. wh.-lt. gry, w/Ss., wh., v.f., v. sil., hd., v. pyr. in pt.
12,780	Cglm., wh., predom. clear qtz, w/Ss. wh., poorly sorted, v.f.-v.c., v. pyr., v. sl. calc., well rd. in pt., occ. tr. ochre-mar. Sh.

Top Shinarump Conglomerate - Base overturned Nugget Sandstone 12,865'

Feet	Description
12,865	Ss., wh., m., RFP, friable, non-calc., pyr., tr. v. poor poro., NS.
12,870	Ss., a.a., v.f., well sorted, friable, tr. wh. clay cem., tr. v. poor poro.
12,910	Ss., a.a., f-m w/occ. c, RFP in pt., tr. pyr., occ. tr. blk min., scat. fair poro.
12,950	Ss., a.a., v.f.-f, tr. wh. clay, tr. pyr., occ. tr. poro.
13,000	Ss., a.a., f-m, RFP, scat. fair poro., sl. sil., tr. wh. clay.
13,010	Ss., a.a., v.f.-f., tr. wh. clay, tight.
13,060	Ss., a.a., tr. poro.
13,100	Ss., a.a., f-m, RFP, streaks poor to occ. fair poro.
13,120	Ss., a.a., w/Ss., salmon, v. dolm., tight.
13,125	Ss., a.a., v.f.-f., sl. sil., tight.

Feet	Description
13,140	Ss., a.a., f-m, RFP, occ. tr. poro.
Fault Zone	- In Shinarump Conglomerate at 13,160' (Section Normal)
13,160	Siltst., Or.-red brn, calc., sl. sandy.
13,170	Ss., wh., Xf w/Xc chert frags. included, sl. calc.
13,180	Cglm., w/chert pebb. (yell.-or.-red-wh.-gry) w/qtz pebb., w/Ls. pebb.
13,220	Sh., mar.-red, waxy w/chert-qtz pebb., a.a.
13,250	Ss., wh., sil., f-m, v. hd. w/chert, wh.
13,260	Ss., a.a., w/Silt., or.-red, calc.
13,270	Cglm. as at 13,180 in Ss. matrix, wh., f., dolm., sl. sil., tight.
Possible Fault Zone	- in Nugget Sandstone at 13,290'
13,290	Ss., crm-wh., m., sub-ang. to sub-rd., sl. sil., dolm., hard, tight.
13,300	Ss., a.a., f-m, RFP, v. calc. in streaks, pyr. in pt.
13,320	Ss., a.a., f. w/m., scat. poor to fair poro., NS.
13,350	Ss., a.a., predom. f., scat. calcite cem., pyr., scat. poro.
13,390	Ss., a.a., pyritized, v. hard in streaks, RFP in part.
Top Shinarump Conglomerate	13,440'
13,440	Sh., Or.-red to dk. red, "rusty", silty, calc. in pt., w/Ss. a.a., w/pebb. cglm., chert (varicolored), Ls., qtz, qtzite, ochre Sh., num. slickensides.
13,460	Cglm., a.a., w/Silt., grn, v. calc.
13,480	Cglm., a.a., in red matrix.
13,520	Cglm., a.a., w/Sh., mar.-red, fissile to blocky, silty.
Top Moenkopi Formation	13,560'
13,560	Sh. to Silt., dk. mar. to or.-red, calc., tr. gyp. weak OS and and cut fluor. in silt. streaks.

Feet	Description
13,610	A.A., w/occ. strks. Ss., crm-wh., v.f.-f., sub-ang. to sub-rd, tight.
13,655	Ss., dirty wh., v.f.-f., sub-ang., sl. sil., non-calc., occ. carb. (?) lam., w/Ss., wh., f-m, well rd., blk carb(?) inclusions, pyr., occ. tr. poro.
13,710	Silt., or.-red, v. calc., argill, w/Sh., mar.-red, platy.
13,720	Ss., as at 13,655 w/num. carb.(?) frags.
13,725	Ss., crm-wh., f. w/m., well rd., v. calc. in pt., sil. in pt.
13,735	Ss., a.a., w/Ss., crm, v.f., ang. to sub-ang., carb. w/Sh., or.-red, calc.
13,755	Sh., or.-red, v. calc. to Silt., or.-red, v. calc., soft.
13,770	A.A., w/Silt., crm-wh., calc., poor spot OS, fair cut fluor.
13,800	Sh.-Silt., a.a., w/occ. chert pebb., wh., sl. devit. w/Ss., crm., f., rd., calc.

Thrust Fault - in Mesaverde at 13,813'

Feet	Description
13,813	Ss., gry-wh., S&P, poorly sorted f-c, gry chert frags., tr. clay, non-calc.
13,910	Ss., a.a., v.f.-f., sl. sil, wh. clay, v. sl. dolm., tight.
13,920	Ss., a.a. w/Sh., gry-blk, sandy, splint., carb., non-calc.
13,950	Interbed. Ss., crm-wh., v.f.-f., sub-ang., to rd., sl. fri., tr. poro. w/Sh., blk, blocky, hard, sandy, carb. in pt.
14,040	Ss., wh., v.f.-c., poorly sorted, sl. sil., carb. particles, non-calc., tight.
14,050	Ss., gry-wh., S&P, f. w/occ., c., sub-ang., v. cherty, tr. wh. clay, w/Sh., gry-blk.
14,080	Ss., a.a., w/Ss., crm. wh., v.f.-f., sub-rd.
14,100	Ss., a.a., w/Sh., gry, sandy, tr. coal.
14,125	Sh., gry-blk, sl. sandy, blocky, non-calc., occ. carb. w/Ss. a.a.
14,160	Interbed. Ss., gry, f., v. argill.,"dirty", carb., w/Sh., gry, blocky, silty, non-calc.

Feet	Description
14,170	Ss., wh.-crm., S&P, v.f. w/strks. m-c, ang., gry chert, carb. w/Sh., lam., gry.
14,210	Ss., a.a., w/Sh. increase, a.a.
14,220	Sh., m. gry, silty, sandy, w/Sh., v. lt. grn, w/coal.
14,255	Ss., gry-wh., v.f.-f., S&P, non-calc. carb., cherty w/Ss., crm.-wh., v.f., good poro., NS.
14,280	Ss., a.a., w/Silt., m. gry., carb.
14,290	Sh., lt. grn., waxy to grn.-gry, silty, non-calc., carb.
14,320	Sh., a.a., w/occ. blk. chert and wh. qtz. pebble.
14,340	Sh., a.a., w/occ. lam. Ss., gry-wh., S&P, wh. clay, non-calc., tight.
14,360	Sh., m. gry, silty to sandy, carb., w/coal lam., pyr.
14,370	Ss., gry, S&P, f-c, c. gry chert frags., ang., sl. sil., carb. to coal frags., v. sl. calc., occ. tr. poor poro.
14,380	Ss., a.a., w/Ss., crm.-gry, vf-f, v. argill., tight, carb., w/tr. Sh., m. gry, silty.
14,420	Ss., a.a., scat. granules-pebb., occ. pink qtz. grain, tr. pyr., fair-good poro.
14,455	Sh., m. lt. gry to grn-gry, sandy to silty, carb. w/Silt., tan-gry., carb.
14,475	Ss., gry-wh., c-vc w/occ. granuls, v. cherty, fair poro. in pt., tr. coal.
14,495	Sh., m. gry to sl. brownish, v. sandy, carb., non-calc., w/ Silt., brn-gry, non-calc., pyr.
14,510	Sh., a.a., w/coal bed, vit., blk.
14,520	Ss., gry-wh., c-vc w/gry and wh. chert pebbles, tr. clay, tr. pyr., scat. poor poro.
14,600	Ss., a.a., pebble conglomerate in part.
14,610	Ss., a.a., w/strks. Ss., brn, v.f., w/Sh., gry-brn.

Feet	Description
14,620	Ss., gry-wh., S&P, f-Xc w/dk gry-blk chert pebbles, tr. coal frags., tr. fair poro.
14,650	Ss., a.a., w/strks. vf-f, v. sl. dolm.
14,740	Sh., m. gry, v. sandy, carb., coaly, non-calc., w/argill. Ss., gry-brn, carb.
14,750	Ss., gry-wh., v.c.-pebbles, v. cherty.
14,765	Sh., v. lt. gry, soft, non-calc., carb.
14,780	Sh., a.a., w/Sh. gry-blk., splint. w/tr. Ss., gry.
14,785	A.A., w/Sh., m. gry, sandy, carb. w/Silt., gry, carb., pyr.
14,800	Sh., m. gry, sandy, carb., w/Silt., gry, carb., pyr.
14,815	Ss., gry-wh., v.c.-pebb., non-calc. w/Sh., a.a.
Top Hilliard Shale 14,840'	
14,840	Sh., dk. gry, v. sl. siliceous.
14,850	Sh., m. gry, silty to v.f. sandy, pyr.
14,870	Sh., m. gry, v. sl. calc. w/Silt. varves.
14,880	Sh., a.a., w/Ss., gry, v.f. to Silt., v. argill., sl. calc.
14,890	Sh., m. gry, sl. silty, sl. calc.
14,940	Sh., a.a., w/intercal. Silt., lt. gry, sl. calc.
15,220	Sh., a.a., w/thin Ss., S&P, v.f.-f., tight.
15,230	Sh., dk. gry, v. sl. calc.
15,260	Sh., a.a., w/calcite veinlets. Numerous slickensides at 15,390'.
15,400	Sh., dk. gry, v. sl. calc., v. sl. silty.
15,445	Silt., lt. gry, S&P, sl. calc.
15,450	Sh., dk. gry, silty, calcite veinlets and slickensides.
15,500	Sh., a.a., w/Ss., wh., v.f., sl. sil., tight.
15,510	Sh., m. to dk. gry, sl. calc. w/interc. Silt., lt. gry.

Feet	Description
15,550	Sh., dk. gry, sl. calc., sl. silty.
15,570	Sh., a.a., Inoceramus, calcite veinlets w/interbeds Silt., lt. gry, calc.
15,600	Sh., dk. gry, sl. calc., calcite veinlets.
15,620	Sh., a.a., w/intercal., Silt. to Ss., lt. gry, v.f.
15,650	Sh., dk. gry to blk, splint., Inoceramus, slickensides.
15,670	Sh., a.a., w/interbeds. Silt., m. gry, sl. calc.
15,750	Sh., m. to dk. gry, v. sl. calc., Inoceramus, calcite veinlets, num. slickensides.
15,900	Sh., a.a., w/thin Silt., gry-wh., calc.
15,990	Sh., a.a., sl. silty to strks. Silt., gry, calc., num. slickensides.
16,060	Sh., m. gry to dk. gry, v. sl. calc., sl. silty in pt., occ. Inoceramus.
16,100	Sh., a.a., w/tr. blue-gry. Bentonite.
16,210	Sh., a.a., w/tr. Silt., gry-wh., calc., tr. wh. Bentonite.

Top Frontier Formation 16,330'

Feet	Description
16,330	No samples.
16,350	Silt., gry-tan, v. argill., v. calc., v. sl. spot OS, w/coal, blk, brittle w/Sh., a.a., blk.
16,385	Ss., lt. gry, c., S&P, non-calc. w/Ss., gry, Xf, calc. w/Sh., a.a.
16,410	Ss., a.a., w/tr. Ls., brn, SL, foss.
16,420	Ss., a.a., w/tr. red Sh., v. pyr.
16,425	Silt. to Ss., gry-crm., calc.
16,440	Sh., dk. gry to gry blk, sl. splint., w/coal, blk, brittle.
16,450	Ss., crm-gry, f-v.c., S&P, calc., w/Sh., a.a.

Feet	Description
Top Mowry Shale 16,475'	
16,475	Sh., blk. v. splint., non-calc. w/num. Bent., blue-wh.-crm.
16,490	Sh., a.a., w/Silt., gry-tan, sl. sandy in part.
16,575	Sh., m. gry, silty w/coal, blk, brittle, w/Sh., v. lt. gry-grn, soft, bent., w/Bentonite.
16,600	Sh., a.a., w/tr. Silt. to Ss., Xf, calc., glauc.
16,630	Interbed. Coal, blk., brittle w/Sh., m. gry to dk. gry, v. carb. w/tr. Silt., gry-tan, calc., w/Bentonite, wh.
16,670	A.A. w/Silt., gry, carb., glauc., calc. w/Sh., brn, lignitic, soft.
16,680	Sh., blk., blocky, v. sl. sil., non-calc.
16,695	Sh., a.a., w/Silt., gry, non-calc. w/Sh., olive grn, waxy, pyr.
16,710	Sh., grn., a.a.
16,720	Silt., m. gry, v. shaly, v. calc., w/Sh., m. gry, blocky.
16,725	Sh., a.a., carb.-coaly, w/Sh., lt. grn, waxy, pyr. w/Ss., brn, Xf-vf, v. calc., tight.
16,730	Ss., gry, vf-f, pyrite cem., ex. hard, tight w/Sh., v. lt. pastels of grn-gry.
16,740	Sh., pastels of grn-gry-ochre, waxy w/Ss., f, tan, sl.-calc. w/Ss., c., S&P, calc., tight.
16,750	Ss., wh., f., v. calc. w/Sh., lt. gry, to grn brn w/Silt., m. gry, calc.
16,760	Sh., m. gry to grnish, w/Silt., gry, non-calc.
16,770	Sh., v. lt. grn to olive gry-grn, waxy, sl. foss.
Top Dakota Sandstone 16,790'	
16,790	Ss., to Silt., crm, clay filled, sl. carb.
16,800	Sh., grn-gry, soft, waxy, sl. carb.
16,810	Sh., a.a., w/Ss., tan to wh., f., ang., soft, clay filled w/thin coal.

Feet	Description
16,850	Sh., a.a., v. sandy to silty in part, carb.
16,864	Ss., wh., vf-f w/occ. m., sl. friable, scat. good OS, tr. fair SF, good cut fluor., tr.-12% poro.
16,880	Sh., m. gry to grn, sl. waxy, soft.
16,900	Sh., m. gry-gry grn, sl. waxy to silty w/tr. Ss., wh., vf-f w/occ. gry chert pebb., tr. OS, tr. SF, fair cut fluor., occ. tr. poor poro.
16,915	Ss., wh., f. w/m., sub-ang., occ. gry chert grain, clay cem. to tr. fair poro., occ. tr. OS, tr. SF, fair cut fluor.
16,925	Ss., a.a., sl. sil., tr. qtz. overgrowths, tr. coal, tight w/ Sh., m. gry to grn.
16,935	Sh., v. lt. gry to lt. grn, waxy.
16,940	Ss., wh., f-m, occ. tr. gry chert, tr. OS, tr. SF, poor cut fluor., fair-good poro. in pt.
16,970	Sh., brn-gry, v. sandy, waxy, soft w/Ss., crm. vf, clay filled, soft.
16,980	Sh., a.a., w/Ss., wh., Xf, ang., soft, clay cem.
16,985	Ss., wh., f., ang., tr. chert pebb., soft to sl. sil., tight to tr. poro., no OS, poor SF.
17,002	Sh., v. pale grn, waxy, sandy w/Ss., wh., sil., hd., tight, NS.
17,010	Sh., m. gry to lt. gry, sl. carb. w/Sh., v. lt. grn, waxy.
17,020	Sh., a.a., w/Ss., crm., vf-xf, soft, tight, NS.
17,030	Sh., a.a., w/Ss., wh., f, clay cem., soft, tight.

Top Morrison Formation 17,048'

17,048	Marlstone to calc. Sh., gry-brn w/reddish spots, v. soft, tr. lt. purple Sh.,
17,060 to 17,100	Sh., pastel mar.-purple, v. soft, v. limy w/Ls. pebb., red and Ls., crm., Li. T.D.

J.R. Taylor
October 1968

UTAH GEOLOGICAL AND MINERALOGICAL SURVEY

QUARTERLY REVIEW

Vol. 3, No. 1 | Geologic Investigation in the State of Utah | February 1969

Dahlgreen Creek Test Evaluated

by Howard R. Ritzma*

The February 1968 *Quarterly Review* featured a geologic section depicting the startling geology then revealed by Shell Oil's No. 1 Dahlgreen Creek test well, SE NE NW Section 9, T. 2 N., R. 14 E., Summit County. At that time, Shell was drilling slowly at about 4,500 feet.

Months went by and bits ground steadily deeper. The geology became more confusing and puzzling. By September, at a total depth of 17,100 feet, the well had penetrated the objective, the Dakota Formation, and topped the Jurassic Morrison Formation.

Encouraging oil shows were found in the Dakota, and, for a time, it seemed No. 1 Dahlgreen Creek might become the discovery well of Summit County's second oil field.

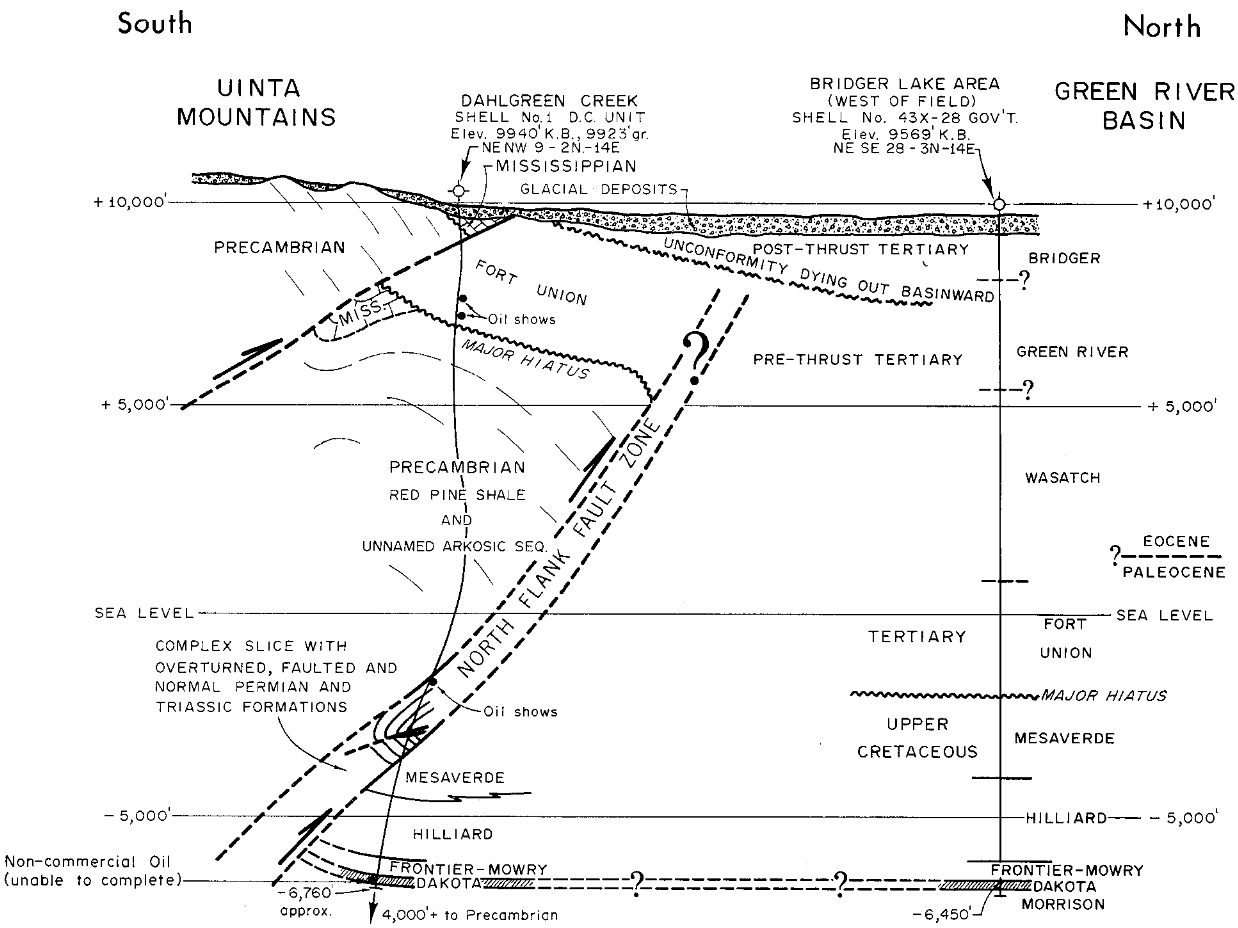
However, the 50 or so feet of oil-stained sandstone scattered through the Dakota section could not be coaxed into production. The well was abandoned in October 1968. Drilling costs exceeded $1 million.

The 17,100-foot depth was the length of a very crooked hole. The well apparently bottomed (mountainward beneath the fault overhang) nearly half a mile south of the surface location and at a level about 16,700 feet below the ground elevation.

Between the 4,500-foot depth shown in the section of February 1968 and total depth, Shell's geologic interpretation of the well underwent continuing

(Continued on page 2)

*Petroleum geologist, Utah Geological Survey.



SOUTH-NORTH CROSS SECTION
DAHLGREEN CREEK-BRIDGER LAKE AREA
Ts. 2 & 3 N., R. 14 E., SUMMIT COUNTY, UTAH
HORIZONTAL AND VERTICAL SCALES EQUAL

(Continued from page 1)

revision and reappraisal. Drilling 8,790 feet of Precambrian basement formation required considerable corporate stamina.

With most pertinent data at hand (thanks to Shell and cooperating companies), the Utah Geological Survey presents its current preferred interpretation of the geology revealed by this most interesting, significant test.

The well logged the following topsy-turvy section:

Surface-445? —Glacial deposits
445-490 —Mississippian limestone
490-820 —Red Pine Shale? (Precambrian)

Thrust fault (Major)
820-2,940 —Fort Union Formation (Tertiary, Paleocene)

Probable unconformity
2,940-11,730 —Red Pine Shale and unnamed arkosic sequence (Precambrian)

Thrust fault (Major)
11,730-11,800—Phosphoria Formation (Permian)—overturned
11,800-12,280—Moenkopi Formation (Triassic)—overturned
12,280-12,575—Thaynes Limestone (Triassic)—overturned
12,575-12,865—Shinarump Conglomerate (Triassic)—overturned
12,865-13,160—Nugget Sandstone (Triassic-Jurassic)—overturned

Fault
13,160-13,290—Shinarump Conglomerate (Triassic)—normal

Fault?
13,290-13,440—Nugget Sandstone (Triassic-Jurassic)—normal
13,440-13,560—Shinarump Conglomerate (Triassic)—normal
13,560-13,813—Moenkopi Formation (Triassic)—normal

Thrust fault (Major)
13,813-14,840—Mesaverde Formation (Upper Cretaceous)
14,840-16,330—Hilliard Shale
16,330-16,475—Frontier Formation
16,475-16,790—Mowry Shale
16,790-17,048—Dakota Formation (Lower Cretaceous)
17,048-17,100—Morrison Formation (Jurassic)

Formations below 13,813 feet appeared to be in a normal, undisturbed sequence, except for a small decrease in Hilliard Shale thickness.

The accompanying section may not please all concerned and is certainly not to be considered a final version. There are many unknown and uncertain factors involved that can only be assumed and surmised. Understandably, there is much regional geologic information derived from seismic surveys that must remain in closed company files. *Of course, publishing the section does not imply either agreement or disagreement with this geologic interpretation by Shell Oil or cooperating companies in the Dahlgreen Creek Unit.*

Data from the well suggest the following sequence of structural events in this area:

—Late Cretaceous and Paleocene uplift in the vicinity of the western Uinta Mountains caused the Paleocene (Fort Union) to rest unconformably on the Precambrian core of the range. The unconformity is probably the same as that responsible for a hiatus between Cretaceous and Tertiary along the buried Moxa-Church Buttes Arch beneath the Green River Basin and elsewhere in southwest Wyoming. Thus, the unconformity is probably not an exclusive feature of Uinta tectonics.

—Northward thrusting of the Uintas displaced the Fort Union and the Wasatch (Paleocene-Eocene), but probably is overlapped by Green River? and Bridger? (post-fault Eocene). This tectonic episode corresponds in time with the major uplift of the mountain range recorded elsewhere in northeast Utah and northwest Colorado. The root zone of the thrusting apparently lies at great depth beneath the ruptured flank of the Uinta Mountain Arch.

—Possibly younger thrusting carried Paleozoic and Precambrian over the older fold and fault complex. This thrusting may be younger, or it may be part of the older faulting with the leading edge effaced by erosion.

One matter of scientific importance seems settled — the nature of the North Flank Fault (or Faults). The boundary of the Uinta Mountain uplift is a zone of reverse faulting, possibly of low enough angle (less than 45°) to be classified as a thrust.

There may be two thrusts of varying age as shown in the accompanying section, but other interpretations can be constructed that eliminate one fault entirely or combine two into one system of branching faults.

Complex geology, difficult drilling, crooked hole problems, rough terrain and severe winter weather combined to make Dahlgreen Creek No. 1 a geological and engineering achievement worthy of note. Shell Oil Co., other cooperating companies in the Dahlgreen Creek Unit, and the Loffland Brothers Drilling Co. are to be commended on a tough, often frustrating, job well done.

These difficulties and the great expense involved will undoubtedly act as a deterrent to further extensive testing of petroleum possibilities to the south beneath the North Flank Fault, particularly in the rugged mountainous terrain. Based on present technology and economics, petroleum possibilities, *undoubtedly present,* appear to be elusive.

We also wish — undoubtedly along with others — that the well had been a commercial success as well.

Mobil "Bomb" — A Scientific Success

Last September, Mobil Oil Corp. drilled, plugged, and abandoned its No. 1 Antelope Flat prospect (SE SE NE Sec. 35, T. 3 N., R. 22 E.) in Daggett County.

The test was devoid of oil shows but significant, all the same. *It established the plane of overthrusting to be about 45°, and proved beyond doubt the reverse nature of the Uinta Fault in this area.*

In short, as one Mobil spokesman noted, the well was a "commercial 'bomb,' but a scientific success."

The No. 1 Antelope Flat was spudded in Precambrian Uinta Mountain Quartzite approximately 1,500 feet south of the surface trace of the Uinta Fault, 2 miles north of the town of Dutch John, and about 3 miles from Flaming Gorge Dam.

At a depth of 1,510 feet, the well crossed the Uinta Fault and penetrated a slice of Paleozoic limestone; at 1,605 feet, it entered Weber Sandstone (Pennsylvanian); and at total depth, 2,047 feet, it bottomed in the Morgan Formation, also Pennsylvanian.

Mobil drilled its No. 1 Antelope Flat prospect 45 miles east of Shell's No. 1 Dahlgreen Creek Unit test, and the two geologic situations appear to be parallel.

Slips Showing

by Bruce N. Kaliser*

Italy's shocking Vaiont Dam tragedy, the worst disaster of its kind in history, was triggered by a massive landslide — and not by an inherent weakness in either the structure or the foundation.

On Oct. 9, 1963, six hundred million tons of rock from Mt. Toc poured into Vaiont Reservoir, sending 800-foot waves over the top of the world's highest, thin-arch dam.

In almost less time than it takes to tell it, the mountain of water claimed the town of Longarone and its population of more than 2,000 people.

The fate of Longarone tragically emphasizes the need for geologic investigations of slopes bordering reservoirs as well as of dams and the reservoir areas themselves. Slope material should be examined in situ, and its deformation capability assessed. Time is a dimension that must be taken into consideration also, since time could be the critical factor in failure.

For the past few years, the U.S. Bureau of Reclamation has made reservoir landslide studies part of its periodic review of the safety of its dams.

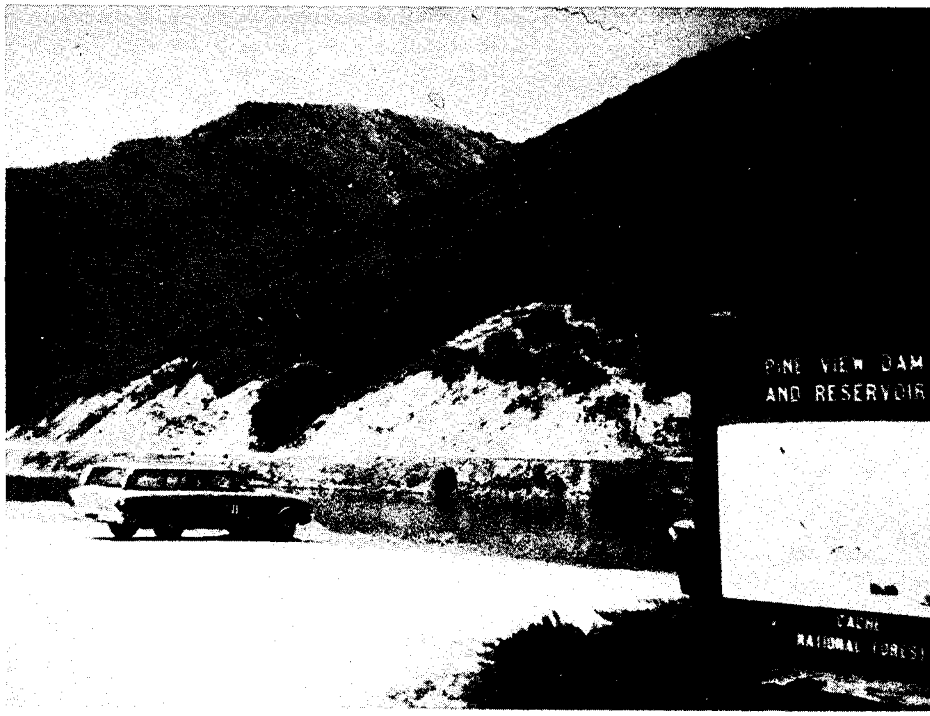
But, the Bureau appears to stand alone in this respect. Other agencies monitor their dams and structures, but not slope conditions in the vicinity of their reservoirs.

It's heartening to be able to say that some agencies intend to remedy the oversight.

Pine View Reservoir in Ogden Canyon is one place in the State of Utah where slope failures have gone almost unnoticed.

The slides occur on steep slopes bounding the narrow, neck-like portion of the reservoir that extends for about 1 mile above the dam.

Depths of failure planes are undetermined, but if they extend beneath the road shoulder bench that skirts the reservoir, *a first class hazard exists.*



Pine View Reservoir showing slope failure on north side.

Even if the failure is superficial, there is still a risk involved. Debris could be swept into the aqueduct intake.

The zone of failure at Pine View Reservoir is coincident with the outcrop of Precambrian Mineral Fork Formation, which in that area is thrust upon Mississippian limestones. Inherently weak, the Mineral Fork metasediments, particularly the phyllites, possess a low-shearing resistance.

Rock units that participated in the thrust have been fractured and deformed, and resultant movement along bedding planes has weakened frictional bonds.

Moreover, canyon walls, oversteepened by road cuts, harbinger viscoelastic, gravitational creep and sliding.

In short, the rock and soil mass at Pine View Reservoir constitutes a slope-stability problem.

Because of the tremendous amount of potential energy stored in a rock and soil mass on an incline, all slopes alongside reservoirs should be considered potential hazards — unless proven otherwise.

Geologic field investigations of slopes bordering planned or existent reservoirs can be a factor in preventing release of this destructive energy.

*Engineering geologist, Utah Geological Survey.

We Didja Dirt!

As published, the retouched photograph at the top of Page 7 of the November 1968 *Quarterly Review* left something to be desired.

The brushwork was intended to emphasize the northwest dip of beds in the vicinity of a major slide.

That it didn't merely indicates our instructions to the artist (the best anywhere) were not clear.

We goofed, and we apologize.

Report, Quad Map Now on Open File

A U.S. Geological Survey map and a Utah Survey report of investigation have been placed on open file.

The USGS preliminary uncolored geologic map of the Park City East quadrangle, Summit and Wasatch Counties, Utah, was prepared by Calvin S. Bromfield and Max D. Crittenden.

Drawn to a scale of 1:24,000, the map clearly identifies all geologic formations and structural features throughout an area that extends 7 miles north, 1 mile south and 6 miles east of the village of Park City.

The map is a compilation of work performed during the field seasons of 1961 and 1963-67.

It can be inspected at the offices of the Utah Survey, 103 Geological Survey Building, University of Utah, or studied and reproduced at 8102 Federal Office Building, Salt Lake City.

Utah Survey Report of Investigation No. 38, "Engineering Geology of the Victory Road Reservoir Site, Salt Lake City, Utah," by Bruce N. Kaliser, points out problems of a geologic nature that exist at the Victory Road Reservoir site.

Numerous photographs and a geologic map are included.

The 15-page report has been submitted to Salt Lake's Engineering and Water Department authorities. Hopefully, it will serve an immediate need and, at the same time, stress the ever-increasing importance of on-site geological investigations when civic works are planned.

Figure A

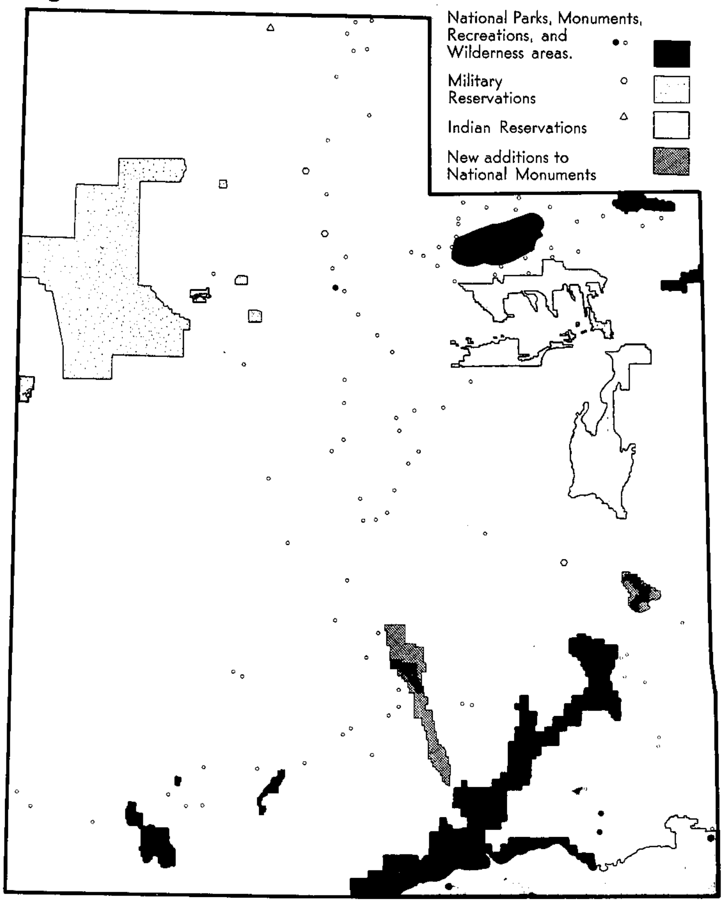


Figure B

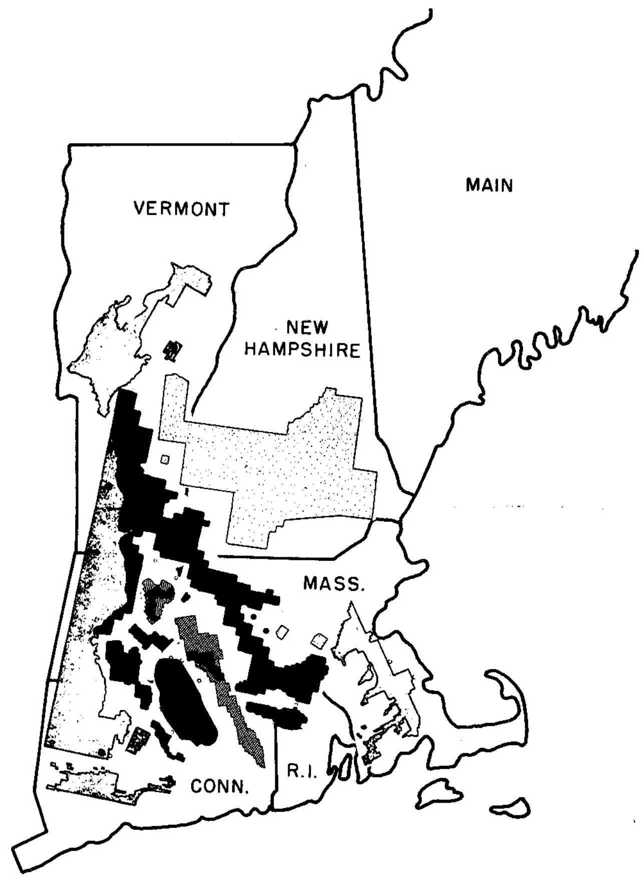
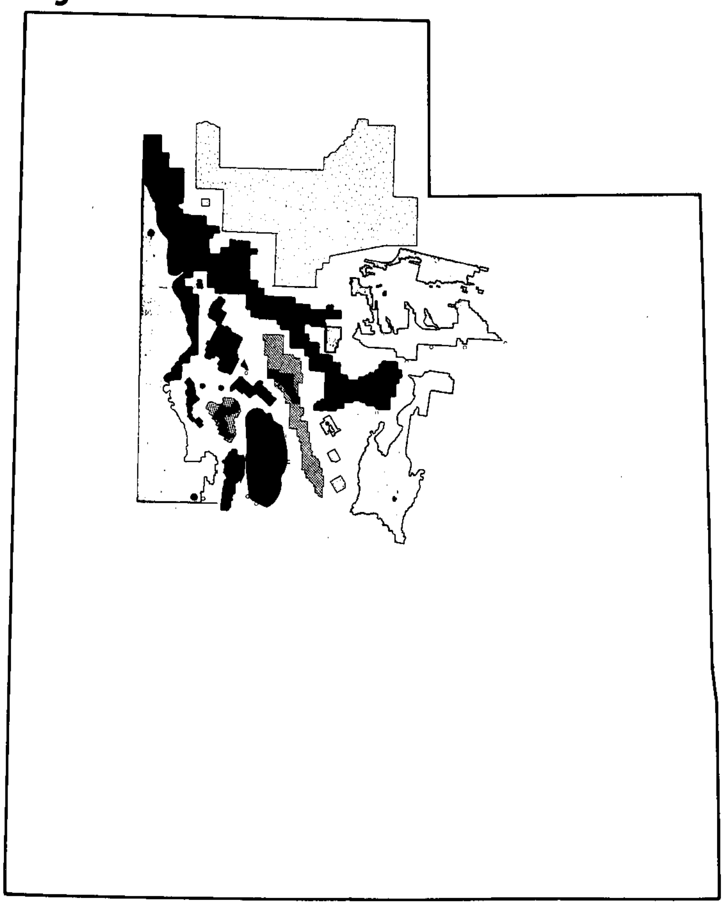


Figure C



LAND GRAB PIRATES

264,000-ACRE BOOTY?

by Hellmut H. Doelling*

On the 20th of January President Lyndon B. Johnson signed Proclamations 3887 and 3888, enlarging the Capitol Reef and Arches National Monuments in Utah by a total of approximately 263,999 acres.

To refresh our memories, *this amounts to 412.5 square miles or about 11.5 townships — an area equal to 39 percent of Rhode Island's land area.*

Most of the land withdrawn from the Public Domain was under the jurisdiction of the Bureau of Land Management, but about 42 square miles of Utah State lands also fell by the wayside.

Those who support ex-President Johnson's action contend that the lands withdrawn from public, private, or State ownership still belong to the public. We suggest this is not the case.

By law 37½ percent of the rentals and royalties collected from Federal Lands are returned to the State and county of origin. These returns are earmarked by the State for education and by the county for road development.

In the first half of 1968, the Federal Mineral Leasing Fund returned $1,499,000 to Utah, and the total for 1968 is expected to be about $3,000,000. To a State falling behind in its expenditures for education, this is important money.

Areas indicated in Figure A, which include those areas newly withdrawn, now are locked up with respect to mineral

*Economic geologist, Utah Geological Survey.

(Continued on next page)

(Continued from page 4)

development, and such monies are no longer available to Utah.

Certainly, we do not object to National Parks and Monuments — but we do protest large withdrawals (take another look at Figure A) that exempt an area from mineral exploration and development and so eliminate a potential source of revenue.

Eventually, State lands will be exchanged, but normally this is a lengthy process.

Indian reservation lands are open to mineral development, but the money is returned to the reservation and not to the State. Theoretically, minerals can be exploited on military reservations, but imagine the improbability of developing mineral values while military operations, such as bombing, strafing, missile testing, and chemical and biological warfare tests, are being carried out.

Preservation groups currently are campaigning for other large tracts of land to form new wilderness and recreation areas. (One brochure mentions a parcel of land about the size of Delaware.)

Such groups oppose any kind of development on this land — even roads. Mineral potential is ignored. They maintain proposed areas have not produced vast amounts of minerals and therefore are no great economic loss, and that revenue derived from tourist trade will more than make up for this.

Several facts refute these contentions:

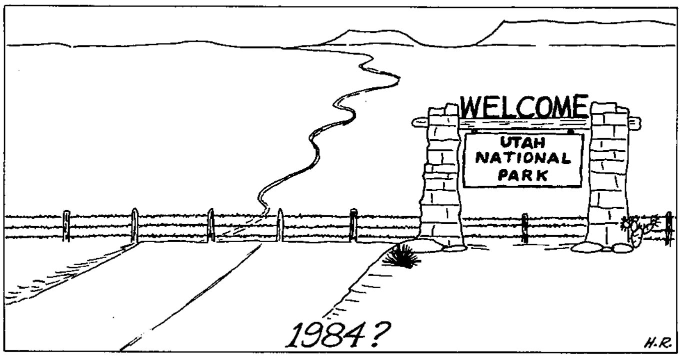
—Technologies change and improve, often making formerly worthless deposits valuable;

—In order to attract the kind of tourists whose dollars would substantially affect the financial situation of southern Utah, the area must be made accessible.

Establishment of wilderness areas invites only a small percentage of the tourist trade; most visitors cannot afford to rent the horses, planes and guides needed in this country.

The few that take advantage of it, enjoy camping out. They avoid motels and restaurants, and buy their groceries in large metropolitan areas where supplies are priced lower than the local merchant could afford to sell them.

Many Utah towns now take in about twice as much money from mineral developers (seismic crews, geologists, and engineering crews) as from tourists.



In one of the withdrawals just enacted, Utah lost half of a high-potential (500-million barrel) oil-sand deposit, several potentially productive uranium mines, and some less important coal and gypsum deposits.

The recent withdrawals are in southern Utah, where there is scarcely enough industry to sustain the present population.

But this country is the southern Utahn's birthright, the place in which he would like to see his children live. He can't afford to have any more areas of high-economic potential closed to development.

However, if the area is to be sacrificed for tourists, we whole-heartedly recommend full development — roads, playgrounds, marinas, picnic tables, the whole kit and caboodle.

We firmly believe in conserving natural resources, but we also believe in full development without waste. When an area is preserved, mineral resources are wasted. It is argued that in times of emergency these could be extracted, *but those familiar with the mineral industry know it takes years to develop deposits.*

Mineral development and natural beauty are not incompatible. In recent years, some companies have even improved the looks of areas in which they have worked.

Perhaps more Utahns would appreciate the immensity of the problem, if all withdrawn lands were arranged as shown in either Figure B or C. Withdrawal of the lands shown in the two figures would result in financial chaos for those areas involved.

It is producing consternation in southern Utah.

Analyses Donated

Utah Portland Cement has analyzed 21 limestone samples collected during the Utah Survey's Bear Lake environmental geology study last summer. The company's contribution has been significant.

Bruce N. Kaliser, UG&MS engineering geologist, assisted by the Economic Geology Division, is conducting the survey at the request of the Rich County Commission.

The study includes an inventory of all economic materials existent in the area. Carbonate rocks comprise most of the Paleozoic column and a good part of the Mesozoic column in this part of Utah.

Quarterly staff: Gladys V. Isakson, editor; Paula Young, assistant; Gordon Keller, Ann Allen, Terry Talcott and Sharon Monson; Roger Holland, critical reader.

SURVEY SPEAKERS ADDRESS AAPG

When the Rocky Mountain Section, American Association of Petroleum Geologists met recently in Albuquerque, N. M., two UG&MS-sponsored speakers were on the agenda.

Joe L. Bowman, Federal Resources, Newcastle, Wyo., discussed the oil-impregnated sandstones of the Tar Sand Triangle, bordered by the Dirty Devil, the Colorado, and the Green Rivers in Garfield and Wayne Counties, Utah. Mr. Bowman mapped the extensive deposits for the Utah Survey during the summer of 1968.

To promote interest in petroleum exploration, Howard R. Ritzma, reviewed the "Petroleum Potential of Utah." Mr. Ritzma currently chairs the Utah Field Names Advisory Committee.

Novel Fossil Finds

Fossil finds, thought to be the first of their kind in Utah, have been reported by Dr. R. W. Moyle, Weber State College, and Earl P. Olson, U.S. Forest Service.

The men made their discoveries last September while collecting in the Soldier Canyon type section of the Manning Canyon Formation.

Dr. Moyle collected nine specimens of the Paleozoic echinoderm, *Pentremites,* from Chester age rocks. While the tiny blastoid quite commonly is found in midcontinent rocks of Late Mississippian age, prior to Dr. Moyle's find it had been associated with Middle Mississippian sediments in Utah.

Mr. Olson took the bryozoan, *Archimedes,* from Unit 5 of the Dry Lakes section of Williams. So far as is known, this is the first time specimens of *Archimedes* have been recovered from northern Utah rocks.

MINERAL PRODUCTION IN UTAH BY COUNTY, 1966-1967

Compiled from U.S. Bureau of Mines data

Annual value of mineral output in Utah rose from $354.5 million in 1967 to $423.6 million in 1968 — a 19 percent increase — according to the U.S. Bureau of Mines.

Even so, the 1968 value was $25.3 million less than 1966's record high of $448.9 million.

In 1967, Utah experienced its first drop in annual mineral production since 1963. The 1967 figure was lower than that of any year since 1957 when the 10-year low, $359.3 million, was recorded.

Because the crippling Kennecott Copper Corp. strike lasted from mid-July 1967 until the end of March 1968, metals production was low for both years.

The 1968 output value in metals was 34 percent higher than that of 1967, but 5 percent lower than that of 1966. The 29 percent decrease in production of metals between 1966 and 1967 was mainly responsible for the drop in mineral output during 1967.

Copper, gold, lead, and zinc production amounted to $171.1 million in 1967, $76.5 million less than the 1966 value. Copper contributed 36 percent to the total value of mineral production in 1967, compared with 43 percent in 1966. All metals (except uranium and vanadium), mineral fuels, and nonmetals showed losses during 1967.

In 1968, however, output and value of nonmetals increased for 10 of the 16 commodities and remained about the same for the other four. Phosphate rock decreased substantially in terms of both output and value. Potassium-salts output increased slightly, but value decreased sharply. Decreases in output and value resulted in a $1.5 million (4 percent) loss for the nonmetals.

The 1968 value of mineral fuels production changed little from that of 1967. Output of natural gas continued to increase in response to a growing demand, but losses were recorded for carbon dioxide. Production of natural gas liquids was up 50 percent, primarily because Union Oil Co.'s Lisbon gasoline plant completed its first full year of operation.

In 1968, new discoveries of crude petroleum failed to offset depletion of older reserves.

Exploratory wells drilled during the first half of 1968 resulted in one oil discovery and 19 dry holes. Sixty more wells were planned for the last half year. If all schedules were met, 1968's total of 80 wells topped the previous year's total by 25.

Sixteen field wells were drilled in the first 6 months of 1968, producing one gas well, six oil wells, and nine dry holes. Forty-one additional wells were forecast by year-end. The total number of field wells planned for 1968 was well under the 85 drilled the previous year. The total amount of drilling anticipated for 1968 fell short of 1967's total by three wells.

Output values of commodities produced in each of Utah's 29 counties in 1966 and 1967 are listed below:

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
BEAVER COUNTY				
Gold	$ 23,835		$ W[1]	
Silver	217,382		W	
Copper	2,058,507		W	
Lead	7,421		W	
Zinc	4,480		W	
Sand & Gravel	179,000		188,000	
Stone	63,103			
Uranium	W[1]			
Total	$2,578,591		$2,188,944	
BOX ELDER COUNTY				
Petroleum		<½ T42GB[2]		<½ T42GB
Sand & Gravel	$ 589,000		$ 612,000	
Stone	299,077		115,655	
Total	$1,243,578		$1,175,133	
CACHE COUNTY				
Sand & Gravel	$ 220,000		$ 279,000	
Stone	183,422		W	
Total	$ W		$ 516,203	
CARBON COUNTY				
Coal		3,379,907 s.t.[3]		2,971,422 s.t.
Petroleum		2 T42GB		2 T42GB
Sand & Gravel	$ 72,000		$ 65,000	
Uranium				
Total	$21,257,554		$18,630,198	
DAGGETT COUNTY				
Petroleum		5 T42GB		3 T42GB
Sand & Gravel	$ W		$ 51,000	
Stone	1,650			
Total	$ 349,650		$ 331,000	
DAVIS COUNTY				
Sand & Gravel	$1,203,000		$ 363,000	
Stone	9,182		60	
Total	$1,212,182		$ 363,060	

1. W = withheld to avoid disclosing individual company confidential data.
2. T42GB = thousand 42 gallon barrels.
3. s.t. = short tons.

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
DUCHESNE COUNTY				
Petroleum		145 T42GB		215 T42GB
Sand & Gravel	$ W		$ W	
Stone	15,486		120,906	
Total	$ 756,371		$1,005,351	
EMERY, PIUTE, AND WAYNE COUNTIES				
Uranium	$ 184,582		$ W	
Coal		1,170,402 s.t.		1,113,017 s.t.
Petroleum		16 T42GB		11 T42GB
Sand & Gravel			48,000	
Stone			213	
Total	$6,099,224		$6,112,976	
GARFIELD COUNTY				
Uranium	$ W		$ 92,714	
Petroleum		224 T42GB		432 T42GB
Sand & Gravel	62,000		W	
Stone	70			
Total	$ 769,783		$1,300,489	
GRAND COUNTY				
Uranium	$ 378,148		$ 844,322	
Petroleum		162 T42GB		139 T42GB
Sand & Gravel	23,000		24,000	
Total	$8,311,494		$9,004,385	
IRON COUNTY				
Coal		3,500 s.t.		3,000 s.t.
Sand & Gravel	$ 338,000		$ 287,000	
Stone	1,982		W	
Gold	W			
Silver	W			
Copper	W			
Lead	W			
Zinc	W			
Total	$14,004,961		$12,218,864	

(Continued on next page)

JUAB COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Gold	$ 15,295		$ 16,800	
Silver	34,338		46,145	
Copper	1,845		10,436	
Lead	16,763			
Sand & Gravel	123,000		4,000	
Stone	W		W	
Uranium	W			
Total	$1,509,223		$1,208,994	

KANE COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Coal		1,719 s.t.		2,117 s.t.
Sand & Gravel	$ 59,000		$ 50,000	
Stone	70			
Total	$ 68,837		$ 55,823	

MILLARD COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Sand & Gravel	$ 20,000		$ 15,000	
Stone			90	
Gold				
Silver	3			
Lead	60			
Zinc	87			
Total	$ 20,150		$ W	

MORGAN COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Sand & Gravel	$ 169,000		$ 113,000	
Stone	837,607		W	
Total	$ W		$ W	

PIUTE COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Gold	$ W		$ W	
Silver	W		W	
Copper	W		W	
Lead	W		W	
Zinc	W		W	
Uranium	W		W	
Total	$ 586,639		$ 358,162	

RICH COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Sand & Gravel	$ 41,000		$ 27,000	
Stone	1,102		5,625	
Total	$ W		$ W	

SALT LAKE COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Gold	$ 13,046,670		$ 7,715,365	
Silver	5,179,098		4,163,342	
Copper	188,426,385		125,835,252	
Lead	7,791,828		7,097,916	
Zinc	4,518,302		3,805,039	
Sand & Gravel	4,695,000		3,114,000	
Stone	341,002		W	
Total	$251,156,406		$171,873,213	

SAN JUAN COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Silver	$ 1,283		$ 936	
Copper	485,618		393,995	
Uranium	4,550,242		8,945,104	
Petroleum		15,948 T42GB		15,304 T42GB
Sand & Gravel	148,000		20,000	
Stone	41,154		4,443	
Total	$58,320,958		$56,513,155	

SANPETE COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Sand & Gravel	$ 125,000		$ 46,000	
Gold	W			
Silver	W			
Copper	W			
Lead	W			
Zinc	W			
Stone	2,400			
Total	$ 215,216		$ 121,531	

SEVIER COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Gold			$ 35	
Silver			2	
Coal		64,739 s.t.		72,255 s..t
Sand & Gravel	94,000		106,000	
Total	$1,265,072		$1,366,125	

SUMMIT COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Gold	$ 70,840		$ 43,190	
Silver	652,661		481,196	
Copper	113,538		66,475	
Lead	1,688,905		1,164,730	
Zinc	1,920,540		1,367,038	
Coal		15,063 s.t.		13,446 s.t.
Petroleum		241 T42GB		861 T42GB
Sand & Gravel	865,000		53,000	
Stone	65,988		74,367	
Total	$6,163,526		$5,685,055	

TOOELE COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Gold	$ 70,840		$ 5,390	
Silver	652,661		365,798	
Copper	194,667		136,123	
Lead	926,958		963,424	
Zinc	632,678		602,904	
Sand & Gravel	615,000		524,000	
Stone	845,717		W	
Total	$8,408,685		$8,147,164	

UINTAH COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Petroleum		7,368 T42GB		7,081 T42GB
Sand & Gravel	$ 428,000		$ 311,000	
Stone	600			
Total	$29,604,838		$27,612,152	

UTAH COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Gold	$ W		$ W	
Silver	W		W	
Copper	W		W	
Lead	W		W	
Zinc	W		W	
Sand & Gravel	1,895,000		1,169,000	
Stone	W		W	
Total	$14,948,000		$10,854,987	

WASATCH COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Gold	$2,155,825		$2,274,580	
Silver	858,401		856,683	
Copper	668,964		655,002	
Lead	1,895,209		1,588,650	
Zinc	1,359,907		1,332,846	
Sand & Gravel	W		90,000	
Stone	W		4,880	
Total	$6,965,546		$6,802,641	

WASHINGTON COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Silver			$ 5,704	
Copper			612	
Petroleum		1 T42GB		1 T42GB
Sand & Gravel	$ 177,000		396,000	
Stone	W		3,134	
Total	$ 183,196		$ 405,450	

WAYNE COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Sand & Gravel			$ 32,000	
Stone			214	
Uranium			W	
Total			$ W	

WEBER COUNTY

Commodity	1966 Value	1966 Quantity	1967 Value	1967 Quantity
Sand & Gravel	$ 636,000		$ 457,000	
Stone	44,060		2,345	
Total	$ W		$ W	

GSA—8 FIELD TRIPS TO PUNCTUATE MAY MEET

The Rocky Mountain Section of the Geological Society of America will hold its annual meetings and field trips May 7-10 in Salt Lake City, Utah.

Field trips planned include: *Tintic Mining District,* May 7, guides, T. S. Lovering, H. T. Morris;

Structural Geology of Northern Wasatch Range, May 7, guides, A. J. Eardley, M. D. Crittenden;

Geology of Wasatch Front, May 7, guides, R. E. Marsell, H. C. Lambert, Roger B. Morrison, Richard Van Horn;

Bingham Canyon Mining District, May 10, guides, Allen H. James, Wilbur H. Smith;

Paleozoic Stratigraphy of North-Central Utah as Typified in the Lakeside Range, May 10, guides, William T. Stokes, Hellmut H. Doelling, James H. Madsen, Jr.;

Great Salt Lake Boat Trip and Antelope Island, May 10, guides, Ted Arnow, R. E. Marsell, J. H. Feth, Richard Van Horn, J. W. Hood, M. D. Crittenden;

The Utah Survey reminds those planning field work in Utah in 1969 to advise the UG&MS of their areas of interest, in order that information may be included in the May issue of the *Quarterly Review.*

Engineering Geology and Landslides, May 10, guide, William T. Parry.

Arrangements can be made with Western Rivers Expeditions to join a float trip on the Green River through Split Mountain, May 11, guides, W. F. Scott, Arthur S. Gallenson.

About 500 geologists are expected to attend the meetings and trips.

William Lee Stokes, chairman of the meetings, is being assisted by Kenneth L. Cook. Both professors are staff members of the Department of Geological and Geophysical Sciences, University of Utah.

The Utah Geological and Mineralogical Survey is preparing a GSA *Guidebook to Northern Utah* (Bulletin 82).

The bulletin, designed to supplement the GSA field trips, can be purchased for $4 at the UG&MS office, 103 Utah Geological Survey Building, University of Utah, after April 28.

SHAKE RATTLE 'N' ROLL

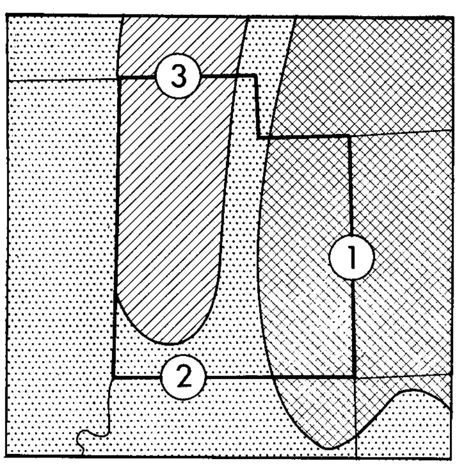
Beehive State Has Its Faults

Just released, the new seismic risk map for the coterminous U.S. places a portion of Utah in Zone 3 (most hazardous) for the first time.

The map was prepared by research geophysicists in the Environmental Sciences Service Administration (ESSA). The original map long has been incorporated in the Uniform Building Code published by the International Conference of Building Officials in Pasadena, California.

Four zones again are used to illustrate the degree to which areas in the U.S. currently are considered vulnerable to damaging earth tremors. Of course, the map is subject to further revision.

Approximately 43 percent of the State is placed in Zone 3 (major destructive earthquakes likely); 26 percent falls in Zone 2 (moderate damage likely); and 31 percent of the State in Zone 1 (minor damage likely).



None of Utah has been placed in Zone 0, which includes areas where earthquake damage is not expected to occur. Formerly, the entire State was located in Zone 2. The new map has revised the classification of three-fourths of Utah.

According to Dr. S. T. Algermissen who heads this C&GS project, general risk prediction has three main objectives:

—providing information which may be used to re-establish, or update, design criteria for earthquake-resistant structures, such as buildings, dams, and bridges;

—providing information useful in planning land use on a very broad scale;

—constructing a seismotectonic map. This involves establishing the variation of earthquake occurrences in the U.S., based on both historical accounts of earthquakes and earth movements that have left visible traces in the form of geologic faults and other topographic changes.

Vulnerability to earth tremors is one aspect of environmental geology included by the UG&MS's Engineering Geology Division in its studies of an area for planning purposes.

For example, evidence of relatively recent major damaging earthquakes was observed in the vicinity of Bear Lake, Utah, last summer.

The Wasatch Fault which borders Zone 3 on the east in Utah — and along which some 85 percent of Utah's population lives — is under continual investigation.

Brine Tests Fix Trace Elements

Among trace elements in Great Salt Lake brines rarely measured quantitatively, but recorded in UG&MS files, are iodine, rubidium, and strontium.

The following results were obtained by a major chemical company.

Iodine (ppm) — 2.3; 2.5; 2.7; 2.7

Rubidium (ppm) — 10; 8

Strontium (ppm) — 6; 4

Rubidium, understood to be the subject of considerable corporate research, finds minor usage in radio and photo cells.

A fourth element, cesium, has been reported to be present in the brines in less than 10 parts per million.

QUARTERLY REVIEW

State of Utah .... *Calvin L. Rampton*, *Governor*
University of Utah ...... *James C. Fletcher*, *President*
College of Mines & Mineral Industries .... *George R. Hill*, *Dean*
Utah Geological & Mineralogical Survey .... *William P. Hewitt*, *Director*

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