

**AQUIFER STORAGE  
RECOVERY FEASIBILITY  
INVESTIGATION**

**PHASE IIA  
MONITORING WELL PZ-1  
VOLUME II -- APPENDIXES**

PREPARED FOR

**Upper Guadalupe River Authority  
Kerrville, Texas**

December 1989

**CHM HILL**

**AQUIFER STORAGE RECOVERY  
FEASIBILITY INVESTIGATION**

**PHASE IIA: MONITORING WELL PZ-1**

**Prepared for:**

**Upper Guadalupe River Authority  
Kerrville, Texas**

**By:**

**CH2M HILL  
AUSTIN, TEXAS**



*John S. McLeod*  
Dec. 2, 1989

**TEX24486.A1**

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**Appendix A**  
**GEOLOGIC LOGS**



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ROCK CORE LOG

PROJECT Aquifer Storage and Recovery LOCATION UGRA WTP  
 DRILLING METHOD Mud Rotary DRILLERS & EQUIPMENT TWDB-Failing 1500  
 ELEVATION \_\_\_\_\_ ORIENTATION Vertical BORE HOLE: Well PZ-1  
 WATER LEVEL \_\_\_\_\_ DATE: 7/17/89 START: 8:45 AM FINISH: 16:05 INSPECTOR Petrus

DEPTH	COMMENTS TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES			LITHOLOGY		GRAPHIC LOG
					ROD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE	
	Use 11 inch ROLLER BIT (MUD ROTARY) TO 37' REAM WITH 14 3/4" ROLLER BIT TO 39', SET 10 3/4" OD. STEEL PIPE TO 39' PIPE WAS TWO JOINTS AND ONE COUP- LING. GROUT ANNULUS USING 19 BAGS OF PORTLAND I AND 1/2 BAG OF BENTONITE							0-15 OLIVE GRAY (S Y 4/1) SILT, TRACE CLAY, DRY, MEDIUM SOFT VERY CALCAREOUS (ML)		
10								15-70 DARK REDDISH BROWN (10 YR 4/2) SILT, SOME FINE GRAINED SAND, MOIST TO DRY, MEDIUM SOFT. OCCASIONAL SANDY ZONE WITH TRACE GRAVEL (ML)		
								70-20' DARK REDDISH BROWN (10 YR 4/2) GRAVEL, SOME SILT, LOOSE, GRAVEL IS MAINLY A MICRITIC LIAESTONE WITH LESSER FINE GRAINED SANDS. ANGULAR TO SUBROUND. OCCASIONAL SILT AND V. FINE GRAINED SAND MATRIX (GW)		
	DRILLING EASY 0-23'									
20								20-23.0 GRAVEL AND WEATHERED LIMESTONE -CONTACT-		
	23 HARD DRILLING ALSO LOSING CIRCULATION							23-26' LIMESTONE, - PALE YELLOWISH BROWN ( ) MICRITIC MED HARD TO HARD, FRESH		
	26-28 EASY DRILLING							26-28' CLAYEY SHALE, - LIGHT GRAY ( ) to MEDIUM GRAY ( ), CALCAR- EONS, NOT WELL LITHIFIED.		
30								28-30 see next page		



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 WATER LEVEL \_\_\_\_\_ DATE: 7/18-7/20 START: 0845 FINISH: 1600 INSPECTOR Petrus

DEPTH	COMMENTS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES		LITHOLOGY	
					ROD	FRACTURES PER FOOT	DESCRIPTION	MINERALOGY CLASSIFICATION
	Drilled to 38' from 0845-1010hr							28-39 LIMESTONE, light gray (N7) soft to medium hard, argillaceous, fresh
	1235-1345 Ream hole to 14 3/4"							thinly laminated
	Grout 10 3/4" pipe w/ couplings to 40'							
	Finish grouting at 1605 on 7/18							stop @ 39' on 7-19-89 then ream to 40'
40	Let grout cure for 40 hrs start drilling again on 7-26-89 drill rate 2 min/ft						40'	Mudstone lt gray (N7), soft, laminated, calcareous fresh
	Roller bit drilling							
50							50'	Limestone, lt gray (N7) and grayish orange (10YR 7/4) finely crystalline soft to med hard, argillaceous seams, trace chert, slight weathering
	8 min / 5 feet							
60								



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 WATER LEVEL \_\_\_\_\_ DATE: 7/20/89 START: \_\_\_\_\_ FINISH: \_\_\_\_\_ INSPECTOR Petrus

DEPTH	COMMENTS TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES			LITHOLOGY		GRAPHIC LOG
					ROD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE	
	ROLL 22617 DRILLING 2 MIN PER FOOT, NO MUD LOSS							LIMESTONE lt brown, (5YR 5/6) to LT GRAY (N7), FINELY CRYSTALLINE, SOFT TO MED. HARD, SL. WEATHERED PELYCYPOD FOSSILS.		
70	NOT MAKING WATER  DRILLING RATE = 8 MIN / 5 FT							LIMESTONE, LIGHT GRAY (N7) SOFT, FINELY CRYSTALLINE, ARGILLACEOUS, TRACE FOSSILS THINLY LAMINATED TO LAMINATED, SLIGHTLY WEATHERED TO FRESH	70'	
								SANDSTONE U.F. GRAINED LT GRAY (N7) v. CALCAREOUS, SOFT TO MEDIUM HARD, TRACE FOSSILS, THINLY BEDDED	75'	
80	POOR CUTTING RETURN  7 MIN / 5 FT.							MUDSTONE, LT GRAY (N7) SOFT, CALCAREOUS, THINLY LAMINATED, MARL.	80'	
								SAME AS ABOVE	85'	
	6 MIN / 5 FT.									
90										





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DEPTH	COMMENTS TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES		LITHOLOGY	
					RQD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION
	MUD ROTARY ROLLER BIT							MUDSTONE, LT GRAY (N7), SOFT TO MED. HARD, V. CALCAREOUS POSSIBLE CLAY SEAMS, TRACE V. F. GRAINED SAND. FOSSIL CASTS. MICRO TO THINLY LAMINATED
	GETTING HARDER TO CUT 17 MIN/5 FT.							
100						100		SILTSTONE, LT GRAY (N7) TO OLIVE GRAY (5Y 4/1) SOFT TO MEDIUM HARD, SLIGHTLY WEATHERED, CEMENTED WITH CALCITE, INTERBEDDED WITH V. F. GRAINED SAND- STONE, HEPTIC, SUBROUND, TRACE FOSSIL CASTS, THINLY TO LAMINATED.
	108-109 VERY SOFT. 20 SEC. TO DRILL							
110						110		MUDSTONE, LT GRAY (N7) TO OLIVE GRAY (5Y 4/1) SOME V. FINE GRAINED SANDSTONE SOFT TO MEDIUM HARD. CALCAREOUS FRESH TO SLIGHTLY WEATHERED, THINLY LAMINATED TO LAMINATED.
120								



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DEPTH	COMMENTS TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES		LITHOLOGY	
					ROD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION
	MUD ROTARY ROLLER BIT DRILLING						120'	SANDSTONE (?) WITH SOME ANHYDRITE CRYSTALS, ROUNDED & ELLIPTICAL HABITS
	Geophysical notes 10' anhydrite bed							LT GRAY (N7) to MEDIUM OLIVE GRAY (5Y 4/4)
	DRILLING RATE = 2 MIN / FT							
130							130'	MUDSTONE, LT GRAY (N7) TO MEDIUM GRAY (N6) SOFT, V. CALCAREOUS ABUNDANT FOSSIL CASES.
								VERY BROKEN
	DRILL RATE = 2 MIN / FT.							
140	MORE RIG CHATTER						140'	MUDSTONE / SILTSTONE, LT. GRAY (N7) LAMINATED SLIGHTLY CALCAREOUS TO CALCAREOUS, TRACE V.F. GRAINED SAND. FRESH FOSSILS.
	SOME CLAY BUT MAY BE FROM PIT, 140-144 SOFT ZONE							
150								



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					ROD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE
	DRILLS @ 1' MIN.							INTERBEDDED CLAYSTONE LT, GRAY (N7) SOFT TO V. SOFT, SLIGHTLY CALC. TO CALCAREOUS, INTRD. W/ LIGHT OLIVE GRAY (SY 6/1) SANDS.	
	CUTS EASILY							SAME AS ABOVE, BUT MORE CLAYSTONE.	
	DRILLS 15 MIN/10 FT								
160									
170								SILTSTONE INTERBEDDED WITH V. FINE GRAINED SANDSTONE Light gray (N7) THINLY LAMINATED QZ SANDS ARE CEMENTED WITH CALCITE, SANDS ARE SUBROUND.	
	14 MIN/10 FT.								
180									



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					RQD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	
	Stop drilling on 7/20 @ 180'						180'	SAME AS ABOVE WITH A FEW THINLY LAMINATED LIMESTONE FRAGMENTS LIGHT GRAY	
190							190'	SILTY SANDSTONE, LT GRAY (N7) to MED. LT GRAY (N6) V. FINE GRAINED QTZITIC, SUBROUND, SLIGHTLY CALCAREOUS, SOFT, THINLY TO LAMINATED.	
	15MM/10FT.								
200							200'	INTERBEDDED, LT. GRAY CALCAREOUS MUDSTONE AND ARGILLACEOUS LIMESTONE, SOFT, PREDOMINANTLY MUDSTONE	
	200-207 DRILLER WTRS ALT. HARD & SOFT ZONES								
	V. HARD @ 208'								
210									



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DEPTH	COMMENTS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES			LITHOLOGY		GRAPHIC LOG
					ROD	FRACTURES PER FOOT	DESCRIPTION	MINERALOGY CLASSIFICATION	CEMENTATION	
	TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS						TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	COLOR GRAIN SIZE ALTERATION	HARDNESS WEATHERED STATE	
							210'	PREDOMINANTLY MUDSTONE LIGHT GRAY (N7), SOFT, WITH SOME CLAY, LT GRAY, AND OCCASIONAL LIMESTONE, GRAYISH ORANGE (10YR 7/4) LIMESTONE IS MEDIUM HARD.		
	Drills EASY 10 FEET IN 5 MINUTES									
	Driller NOTES SOME HARD ZONES									
220	Poor SAMPLE RECOVERY						220	CLAYSTONE, LIGHT GRAY, (N7) SOFT, TRACE LIMESTONE GRAYISH ORANGE (10YR 7/4) CLAY HAS FOSSIL CARDS,		
	Driller notes SOFT ZONES									
	w/ THIN INTERBEDDED HARDCR ZONES									
230							230	POOR SAMPLE (?) MAY CONTAIN CORE FROM ABOVE CLAYSTONE, LIGHT GRAY, (N7) SOFT, INTERBEDDED WITH ARGILLACEOUS LT. GRAY LIMESTONE, AND MEDIUM LIGHT GRAY (N6) SILTSTONE, SOFT SLIGHTLY CALCAREOUS		
	STOP DRILLING ON 7/21/89									
	AT 230 FEET									
240										



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					ROD FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE
	Mud Rotary Rollerbit						240'	LIMESTONE, MULTICOLORED MOD. BROWN (5YR 3/4), LT GRAY (N7) AND OLIVE GRAY, SOME CHERT, INTER- BEDDED WITH FINE GRAINED SANDSTONE, SOFT TO MEDIUM HARD SOME RETURN OF CONGLOMERATE WITH CALCITE MATRIX.
	13min/10ft							
250							250'	SILTSTONE, SANDY, LT GRAY (N7) SOFT, SLIGHTLY CALCAREOUS TO VERY CALCAREOUS, SLIGHTLY FOSSILIFEROUS, TRACE LIMESTONE AND CLAY
	DRILLING SMOOTHLY WITH A LITTLE CHATTER CAUSED BY ALTERNATING HARD & SOFT UNITS							
260	CLAY ZONE @ 259'						260'	MUDSTONE, REDDISH BROWN, SOFT TO VERY SOFT, THINLY LAMINATED CALCAREOUS
	13 minutes/10 ft.							
270								

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					ROD FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE
	Mud Rotary Rollerbit						270'	SILTSTONE AND v. FINE TO FINE GRAINED SANDSTONE SOFT TO MEDIUM HARD.
	15 MIN TO CUT 10'							FeOx STAINED. MEDIUM REDDISH BROWN TO LIGHT GRAY, THINLY LAM- INATED, SLIGHTLY CAL- CARCIOUS, SANDS ARE QUARTZITIC AND SUB ROUND
280	17 MIN TO DRILL 10'						280'	SAME AS ABOVE BUT SLIGHTLY MORE SILTSTONE
	Driller notes soft between 283 & 285							
290	ARRD @ 290' 5 MIN / FOOT						290'	SILTSTONE, GRAYISH RED (10R 4/2) AND MED. LT. GRAY (NG) SOFT TO MEDIUM HARD, DOLOMITIC IN PLACES
	292' OUT OF HARD ZONE 1' MIN							
	297 HARD DRILLING LIMESTONE RETURN							
300								



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					RQD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION
300'								SANDSTONE, U. LT GRAY (WB) FINE TO MEDIUM GRAINED MED. HARD, CEMENTED WITH CALCITE. SANDS ARE QUARTZITIC & SUBROUND, OCCASIONAL LIMESTONE CHIP.
310								
320								GRAVULE CONGLOMERATE, GRAVULES ARE LIMESTONE, QUARTZ, AND FELDSPAR, ANGULAR TO SUBROUND, SOFT, CEMENTED WITH CALCITE
	END DAY 7/21/89 @ 320'							
330								SILTSTONE, LIGHT GRAY AND REDDISH BROWN, SOFT TO MEDIUM HARD, LIMCY IN PLACES,



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					ROD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE
	MUD ROTARY Collector						330	LIMESTONE, VERY FINELY CRYSTALLINE, AND CALCAREOUS MARL, PALE REDDISH BROWN (10R5/4) AND VERY LIGHT GRAY (N9) MED. HARD, THINLY LAMINATED.	
	At 336 ft cuts @ 4-5 MIN/FT.								
340							340	Limestone, v. lt gray (N9) Finely crystalline, and CALCAREOUS SILTSTONE, (MUSTLY LIMESTONE) MEDIUM HARD, THINLY LAMINATED.	
	@ 340' quit for day (7/24/89)								
350							350	LIMESTONE, VERY LT. GRAY MEDIUM HARD, FINELY CRYSTALLINE, SLIGHTLY CLAYCY.	
	358-359 took 10 MIN TO CUT.								
360									



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DEPTH	COMMENTS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES			LITHOLOGY	
					ROD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE
	MUD ROTARY DRILLING.						360'	Limestone Lt gray (N7) to very Lt. gray (N8), CHALKY IN PLACES, MED. HARD TO HARD, TRACE SMALL FOSSILS, SOME PINK STAINING, FRESH, CORAL STRINGERS IN RETURN	
	18 min to CUT 361-362'							361 dolomite in return	
	367' PALE RED SHALE IN RETURN							367' PALE RED SHALE	
370							370'	MUDSTONE, LT. OLIVE GRAY (S4 G/1) AND FINELY CRYSTALLINE LIMESTONE, TRACES OF V.F. GRAINED SANDSTONE CEMENTED w/ CALCITE	
380	2-3'/min						380'	CLAYY SHALE, PALE RED (10 R G/2), SOFT, THINLY LAMINATED NON TO SLIGHTLY CALCAREOUS	
	383-387 CUTS AT 5min/FT								
390									



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	Mud Rotary Roller bit to 400'							390-400 FEET, RETURN IS A MIXTURE, INDISCERNABLE CAN'T BE SURE OF LOG, DECIDE TO SWITCH TO CORING	
400	END DAY @ 400' ON 7/25/89							MOVE TO SHEET 15	
<del>_____</del>									

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 ELEVATION \_\_\_\_\_ ORIENTATION Vertical BORE HOLE: Well PZ-1  
 WATER LEVEL \_\_\_\_\_ DATE: \_\_\_\_\_ START: \_\_\_\_\_ FINISH: \_\_\_\_\_ INSPECTOR Petrus

DEPTH	COMMENTS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES			LITHOLOGY	
					ROD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE
401	Core w/ 4" barrel 6mm/ft					2	Rough FRACTURES, FeOx STAINS, MODERATE	400-400.5 SANDSTONE, v. fine GRAINED, PALE REDDISH BROWN & LT. OLIVE GRAY 4+2. SUBROUND SILICEOUS CEMENT CLASTS	
402	6mm/ft			1		2	WEATHERING ON FRACTURES (HORIZONTAL) VESICLES	400.5-401.6 S.S. v. f.g. to f. GRAINED, OCC. GRAVEL, CONGLOMERATIC AT BASE, SL.	
403	5mm/ft					1	MOTTLED, SL. BROKEN	CALC., MOSTLY SILICEOUS, MED. BEDDED.	
404	5mm/ft	RUN #1				0		GRAINED, OCC. COARSE GRAINS, GZITIC SUBROUND, HONEY- COMBED, CONVULATED BEDDING	
405	5mm/ft	85% Recovery		2	70%	0	UNBROKEN w/ PLANAR BEDDING	SILICEOUS, SL. CALC. HARD	
406	5mm/ft					0		402.2-403.7 AS ABOVE but CROSS BEDDED	
407	5mm/ft					0		403.7-405.5 Sandstone, gztitic, PALE REDDISH ORANGE STAINING LITHOLOGY SAME AS ABOVE	
408	4mm/ft			3		0	slightly BROKEN w/ PLANAR MASSIVE BEDDING CLAY FILLING ON FRACTURE	405.5-408. - Sandstone, GZITIC, LT GRAY (UM) w/ 10% FeOx STAINING, SLIGHTLY HONEY COMBED. VERY FINE to MEDIUM GRAINED, SILICEOUS CEMENT, SL. CALC AREOLAS, HARD CLAYCY	
409	8mm/ft					0		408-408.5 Sandstone, very FINE GRAINED, GZITIC, HARD PALE REDDISH BROWN,	
410	6mm/ft		LOSS			0		SLIGHTLY WEATHERED, SILICEOUS, ARGILLACEOUS Low Porosity	
411	8mm/ft					0	MASSIVE	410-413.6 Same as ABOVE.	
412	2mm/ft	RUN #2		4	70	0			
413	1mm/ft					0		413.6 SANDSTONE, silty, v. fine GRAINED, GREENISH GRAY (5 GY/1)	
414	2mm/ft					0	413.6 WEATHERED FRACTURE	WITH SOME MODERATE RED BROWN STAINING, OCCASIONAL GRAVEL up to 3 cm in Ø, ARKOSIC	
415	1mm/ft			5		2	414.4 WEATHERED FRACTURE	subangular to subround, OOLITE gztitic regrowth, slightly micaceous Conglomeratic zone 414-414.6	



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DEPTH	COMMENTS TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	ROD FRACTURES PER FOOT	DISCONTINUITIES		LITHOLOGY		GRAPHIC LOG
						DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE		
416		↑		5	3	WEATHERED	415-415.4	Conglomerate, pebbly matrix of med. grained SAND. SANDS ARE SUBROUND PEBBLES ARE QTZ AND ROCK FRAGMENTS GREENISH GRAY		
417		Run 2		6	1	416.5 - Coarse grained sandstone	415.4-417.3	SILTSTONE w/ OCCASIONAL FINE GRAIN SANDSTONE, GRAYISH GREEN (5 G 5/2) TO GREENISH GRAY (5 GY 6/1)		
418		70%	LOSS		2	2ndary calcite or carbonate growths		Occ. bedding plane with pebble CNGL. FeOx stain near base		
419		↓	LOSS							
420	Poor recovery.		LOSS							
421	Decide to Ream hole		LOSS							
422	to 430' to clean it out	Run 3	LOSS							
423		58%	LOSS		40%	CLAY FILLING ON JOINTS, WEATHERED	423.6-425.4	MUDSTONE, MODERATE REDDISH BROWN, (DR 4/6) CLASTS OF LIMESTONE AND CLAYSTONE,		
424			LOSS			ANGLED high angle joints		WEATHERED, VERY BROKEN, SLIGHTLY CALCAREOUS TO MOD. CALCAREOUS, MED HARD.		
425	Rock is "WEATHERED"		LOSS			EROSIONAL LOWER CONTACT @ 428.5	425.4-429.5	MUDSTONE, MODERATE REDDISH BROWN w/ DARK YELLOW BROWN CLASTS, HARD, SL. CALCAREOUS, MASSIVE		
426	BY CORING		LOSS							
427	Cuts at ~15min/FT.		LOSS							
428			LOSS			FRACTURES ARE VERY WEATHERED	428.5-430	SANDSTONE, VERY FINE GRAINED, YELLOWISH GRAY (5Y 9/1) AND GREENISH GRAY (5GY 6/1)		
429			LOSS					CLAYSTONE, BROKEN, HIGHLY WEATHERED, MED HARD TO HARD, VERY CALCAREOUS		
430		↓	LOSS		↓					



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					ROD FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE	
431	2 min/ft					1	HORIZONTAL FLASER TYPE BEDDING, UGGY	430-432.9 INTERBEDDED SILTSTONE LT. GRAY GREEN, AND LT GREEN GRAY V. FINE GRAINED SAND- STONE, SUBBEDDING, PARTIALLY SILICEOUS, SL. CALCAREOUS HARD, BROKEN, RELATIVELY FRESH	
432	2 min/ft					?	WEATHERED OR CORE LOSS		
433	3 min/ft	Run #4			7	3	UGGY & POROUS MASSIVE CALCITE JOINT FILLING	432.9-434 SANDSTONE, V. FINE GRAINED, SL. SILTY, MOSTLY QTZ, -T GRAY TO PALE YELLOWISH BROWN, HARD TO VERY HARD, CALCAREOUS	
434	4 min/ft	85%			9	1		434-435.5 - SANDSTONE, V. FINE GRAINED, WITH CLAY ZONES, VARI- GATED PALE BROWN AND LT OLIVE GRAY, & PALE REDDISH BROWN, UGGY W/ QTZ & CALCITE FILLING, SUBSTRATE	
435	5 min/ft					0	MODERATELY WEATHERED, UGGY & POROUS		
436	6 min/ft					1	MASSIVE, UNBEDDED		
437	6 min/ft				10	0		435.5-438.9 SILTSTONE VARIGATED, PALE REDDISH BROWN & LT. OLIVE GRAY, VERY FINE GRAINED, SUBBEDDING, SL. SANDY IN PLACES, DOLOMITIC (?) TRACE CLAY (BROWN) ZONES.	
438	6 min/ft					0		438.3-440 SANDY SILTSTONE -T OLIVE GRAY TO MOD. YELLOW BROWN, CALCAREOUS, WEATHERED TRACE PEBBLES, (GRAY WACKE)	
439	9 min/ft					0			
440	3 min/ft				11	0		440-441.4 SILTSTONE AND quartzitic SILTY SANDSTONE V. FINE TO FINE GRAINED. GRAYISH GREEN (10 G X 5/2) SL. CALCAREOUS, HARD, SL. WEATHERED W/ CLAY FILLING.	
441						0	Lower GRADATIONAL CONTACT		
442						1		441.4-447.5 SILTY SANDSTONE LT GREENISH GRAY (5G 8/1) TO LT OLIVE GRAY (5X 6/1) V. FOSSILIFEROUS CALCARENITE, HARD, UGGY, CALCITE IN	
443	5 ft/min avg	Run #5			12	0			
444		100			99 %	1	FOSSILS WEATHER & FORM UGS THAT INCREASE POROSITY	447.5-449.2 SANDSTONE, FINE MED. GRAINED, quartzitic, with some calcite cement, HARD, OCC GRAVEL, INC. SILT & ORGANICS TOWARDS BASE, LT GRAY TO LT OLIVE GRAY.	
445						1	MOD. WEATHERED		



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DEPTH	COMMENTS TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES		LITHOLOGY		GRAPHIC LOG
					ROD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	
446	4' CORE 5-7 min/ft	↑		13	↑	1			
447		Run 5				1			
448		100%			99%	3	BROKEN		
449	LAST 2 FEET DEILLED IN 2 minutes	↑		14	↑	2	BROKEN w/ SHARP BASAL	449.2-450.0 CARBONACEOUS SANDSTONE, gtz feldspar v.f.	
450		↑			↑	1	CONTACT 2449.2 WEATHERED JOINTS	GRAINER, OLIVE BLACK (SY2/1) ARGILLACEOUS, HARD, SL. CALCAREOUS, SUBANGULAR TO SUBROUND, OCC. PEBBLE.	
451	3 min/ft	↑			↑	0		450-452.7 SANDSTONE, GRAYISH BLACK (N2) TO OLIVE GRAY	
452	2 min/ft	↑		15	↑	0	moderately weathered	(SY 4/1) very fine to fine grain, quartzitic, subround to sub angular, THINLY LAMINATED	
453	3 min/ft	Rec 80%			80%	1	COAL stringers @	CARBONACEOUS STREAKS, SL CALCAREOUS, HARD, TRACE PEBBLES AND FOSSILS	
454	5 min/ft	Run 6		16	↑	1	453-451.5' EROSIONAL SURFACE @	452.7-453.1 CONVOLUTED CLASTS OF ARGILLACEOUS LIMESTONE w. v. fine gr. SANDSTONE,	
455	6 min/ft	↑	LOSS (S)		↑	1	452.7-453.1 SECONDARY CALCITE crystals	HARD, SL. WEATHERED, v. CALC., SL CARBONACEOUS Olive gray & greenish black.	
456	4 min/ft	↑			↑	0	MASSIVE BEDS SL vuggy & fresh	453.1-454 SANDSTONE, Lt GRAY, v. fine grained, gztitic, very HARD, CALCITE cement, subcong	
457	6 min/ft	Run		17	↑	0	FOSSILS ARE CASTS	fossiliferous, CALC. ARONITE 455-455.9 SANDSTONE, v.f.g, very H gray @ top olive gray	
458	7 min/ft	#7 105			105	1	CARBONACEOUS w/ MICACEOUS TOWARDS BASE.	@ BASE, gztitic, subcong, CALCITE cement	
459	9 min/ft	↑		18	↑	0		455.9-457.7 Very fossiliferous Limestone, ACCREACCIOUS IN PLACES, FOSSILS, DOLOMITIZED, Upper 0.1 FT IS glauconitic	
460	11	↑			↑	1	vuggy w/ CALCITE crystals	sand, TRACE glauconite elsewhere. 457.7-458 As above, no Dolomite	



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DEPTH	COMMENTS TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES		LITHOLOGY		GRAPHIC LOG
					ROD FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE	
462	12 min	↑		18	0		458.4-460 - Limestone, very fossiliferous, sparry, sl. arenaceous, lt gray, v. pr. hard	?	
	9 min			19	0	U4597	460 - 463.4 Limestone, marbled olive gray & lt gray, sl fossil, hard, arenaceous in places		
	12 min			19	2		463.4 - 465.2 Limestone, olive gray to light gray, argill-accous, very fossiliferous, sl. carbonaceous coral @ 465'		
464	11 min	105%			1		465.2 - 468.5 Sandstone v.f. grained and int'd. siltstone very fossiliferous, sl. vuggy		
466	7 min	*		20	*	0	lots of secondary calc. v. lt gray (NE) to olive gray (SY 4/1) hard		
	8 min				2		468.5-468.9 Transition Zone		
468	9 min			21	1		468.9 - 471.7 - Sandstone, fine-grained, g.titic, subround, calcareous @ top slightly @ base, porous, sl. fossil. thinly laminated to		
	4 min				1		sl. weathered thin bedded med hard pale brown to olive gray		
470	1 min	Run 8 98%			57%	4	very broken & porous		
				22	3		471.7 - 475.0 Interbedded claystone &		
472					4		fine grained silty sandstone thinly laminated by carbonaceous stringers		
					2	Fe Ox stains	non calcareous, trace fossils, med hard		
474				23	2				
					3				





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					ROD FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE	
476	3 in / FT			24			475.6-476.6 Convoluted v. lt gray Limestone (argillaceous) and siltstone DOLOMITIC, MED HARD, FOSSILIFEROUS SL. ARGILLACIOUS & CARBONACEOUS		
478	8 min / FT				2		476.6-478.5 Interbedded DARK GREENISH GRAY (SGX 4/1) AND GREENISH GRAY (SGX 6/1) VERY FINE GRAINED gztic SANDSTONE AND CLAYCY SHALE		
478	8 min / FT				3		SLIGHTLY WEATHERED DOLOMITIC, SLIGHTLY MICACEOUS, CARBONACEOUS STRINGERS,		
478	7 min / FT	Run 9		25	1		478.5-479.3 = SAME AS 475.6-476.6		
480	8 min / FT	77 %			69 %	3	479.3-482.3 MUDSTONE, DARK GREEN GRAY, MED HARD DOLOMITIC, SLIGHTLY CARBONAC.		
482	6 min / FT 481.1-481.8 LAB SAMPLE				1		TRACE FOSSILS, THINLY LAMINATED, OCC. SAND LENS, gztic Lt gray		
482	10 min / FT				4		(N7) HARD w/ calcite cement, slightly pyritic		
484	9 min / FT			26	2		482.3-482.7 SANDSTONE, FINE TO MED. GRAINED, DARK OLIVE GRAY, 40% MAFIC & CARBON, 60% gztic		
484	11 min / FT		LOSS		?		sharper upper contact WEATHERED		
484	11 min / FT				?		CALCAREOUS cement, subwds, COAL FRAGMENTS		
486	3 min / FT				0		485-487.5 Interbedded SILTSTONE, AND FINE GRAINED SANDSTONE, Dk olive gray		
488	5 min / FT	Run 10			67 %	2	TO BLACK, MED HARD LOTS OF lignite, 2-4 mm BEDS, CLASTS TO 3 cm		
488	6 min / FT	83 %		27	0		1 in Ø, porous v. CALCAREOUS 487.5-488.3 Intbd. Silt-stone, AND SILTY FINE GRAINED SANDSTONE THINLY LAMINATED, CALCAREOUS, OLIVE GR.		
488	13 min / FT			28	0		FRIABLE ~ POROUS SANDS ARE MAFIC & gztic		



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490		83%		28	1	UNDULATORY BASAL CONTACT	488.3 - 489.8 Conglomeratic SILTSTONE, up to 1.5cm in Ø, OLIVE GRAY TO OLIVE BLACK VERY CALC AND CARBONACEOUS, LIGHT PLANT FRAGMENTS	
492		Run 10			3	Vuggy @ 490.2' 2" Ø w/ calcite FILLING.	489.8 - 492.3 Irregularly BEDDED ARGILLACEOUS, FINE GRAINED SANDSTONE, FRIABLE, MEDIUM GRAY TO BROWNISH BLACK SAND	
494			550K	29	2	porous	15 SUBANGULAR TO SUB- ROUND. ABUNDANT CARBON VERY VUGGY, DOLOMITIC AND CALCAREOUS	
496								
498								
500								
502								
504								



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500	497-503 = 3 min 503-507 = 12 min upper 3.3 foot of run was probably disturbed during grouting + reaming	Run 11 47%						502.3 - 505.8 Sandstone Greenish Gray (5G 6/1) FINE GRAINED, MOD. HARD CALCAREOUS			
					23		CALCITE RESEAL IN VUGS		At 503.2 GRADES DOWNWARD INTO 4 SILTSTONE.		
					28	1	vugs upto 5cm in ø slightly weathered ON JOINTS.		TRACE glauconite. SANDS ARE quartzitic. Slightly conglomeratic @ 503.2 up to 2cm. Slightly pyritic (cuboidal, FRESH) LIAESTONE in places. very vuggy		
					30	2					
						0					
505						3	CALCITE FILLING VERY WEATHERED FeOx stains H. Angle		505.8-508.5 SILTSTONE, GREENISH GRAY (5CY 6/1) AND DARK REDDISH BROWN (10R 3/4) DOLOMITIC		
	3 min/ft				31	2		SOFT, VERY BROKEN, LOTS OF CLAY WEATHERING PRODUCTS HIGH SECONDARY POROSITY			
	3 min/ft					1	FRACTURE @ 506.8		508.5-509.4 SANDSTONE, LIGHT GRAY TO DARK REDDISH BROWN, FINE GRAINED, THINLY LAMINATED & IRREGULARLY BEDDED, CALCAREOUS, MOD. HARD.		
	3 min/ft					1	FeOx stained LOW POROSITY				
510	2 min/ft	Run			32	1			509.4-512 SANDSTONE DOLOMITIC GRAYISH RED, to lt olive		
	2 min/ft	12				3	vugs open & up to 3 in. in ø WEATHERED		GRAY, MED. GRAINED, quartzitic SUBROUND, HI POROSITY (40%) MOD. HARD, IRREG. BEDDING, secondary dolomite XTALS		
	2 min/ft	99%			71	1			512-515.8 SANDSTONE - v.f. grain med. HARD TO HARD, MOSTLY MOD. BROWN (5YR 4/4) 20% OLIVE GRAY, quartzitic, DOLOMITIC, 5-10% mafics. INTBD. w/ SANDY DOLOMITE.		
	2 min/ft				33	1	MASSIVE				
	2 min/ft					1	slightly vuggy MOD. POROSITY				
	2 min/ft					1	Crystal on bedding planes		CONGLOMERATIC @ 514.2		
515	2 min/ft					1					



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					ROD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	
	2 min / FT	Run 12 99%			71	1	518.9 - VERY VUGGY w CRISTY CALCITE	518.7 SANDSTONE, v. fine to fine GRAINED, VERY DOLOMITIC ARGILLACEOUS some	
	2 min / FT				34	2	FeOx STAIN,	4 mm Ø ROCK FRAGMENTS. VERY CALCAREOUS (ARENACEOUS DOLOMITE IN PLACES)	
	2 min / FT					0		REDDISH BROWN to LIGHT GRAY	
					35	1	CLAY AREAS 519.7 - HAVE FeOx STAIN	520.3 SANDY DOLOMITE, DARK REDDISH BROWN (10 TO 3/4) to LT. OLIVE GRAY (SYG/1) VERY	
520						1	SLIGHT VUGGY VUGS HAVE FeOx CALCITE	FINE GRAINED, CLAYEY IN PLACES, HARD, LOTS OF DOLOMITE TO CALCAREOUS FINE GRAVEL	
		Run 13			85	3	VERY VUGGY	520.3-521.5 SAME AS ABOVE Highly porous	
		97			36	3	2-3 cm Ø VUGS w/ CALCITE FILLING	521.5-527 DOLOMITE, SANDY INTERMIXED WITH SOAR SANDSTONE	
						2	VERY BROKEN	FINE GRAINED, OCCASIONAL MED. GRAINED, LIGHT BROWN (SYG 5/6) to MOTHY	
	1 min / FT					2	MASSIVE, SLIGHTLY BROKEN	LT OLIVE GRAY, gztitic, SUBBROWN, NOT VERY POROUS. CALCITE cement INCREASES	
525	1 min / FT				37	2		WITH depth. Matrix MATERIAL CONTAINS WEATHERED CLAY OR FELDSPAR	
	Tungston Bit 1 min / FT					1			
	1 min / FT					1	527 - CALCAREOUS	528.7 SANDSTONE, yellowish GRAY (SY 7/2) FINE GRAINED, gztitic, SUBBROWN, med HARD, MODERATE porosity	
	2 min / FT				38	1	VUGGY 528.5 528.9	OCCASIONAL CLAY LENSES. 533.3 DOLOMITIC SANDSTONE, lt OLIVE GRAY (SY 5/2) medium	
	1 min / FT	Run 14				3	MASSIVE BEDDED but	GRAINED, VERY POROUS, 30 % gzt. SOME FELDSPAR AND MAFICS, CLAYEY AT	
530	1 min / FT	98			39	2	BROKEN	BASE, med HARD, SUBBROWN TO SUBANGULIM MORE CALCAREOUS @ BASE	



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PROJECT Aquifer Storage and Recovery LOCATION UGRA WTP  
 DRILLING METHOD Mud Rotary DRILLERS & EQUIPMENT TWDB-Failing 1500  
 ELEVATION \_\_\_\_\_ ORIENTATION Vertical BORE HOLE: Well PZ-1  
 WATER LEVEL \_\_\_\_\_ DATE: \_\_\_\_\_ START: \_\_\_\_\_ FINISH: \_\_\_\_\_ INSPECTOR Petrus

DEPTH	COMMENTS TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES		LITHOLOGY		GRAPHIC LOG
					ROD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	
	1 MIN/FT TUNGSTEN BIT	RUN		39		4		531.7-531.9 Conglomeratic CLAYSTONE CLAST ZONE	
	1 MIN/FT	14 98%				60	3		
	1 MIN/FT						1	533.3-535.4 SANDSTONE, VERY FINE GRAINED, SILTY, LIGHT BROWN TO LIGHT OLIVE GRAY, WEATHERED FOX STAINING	
	2 MIN/FT			40			3	MASSIVE, 41 ANG FRACTURE @	QUARTZITIC, CALCAREOUS CEMENT, MOD HARD SLIGHTLY VUGGY
535	2 MIN/FT						1	533.1 NON POROUS except for fracture	DOLOMITIC IN PLACES,
	3 MIN/FT						1	535.4-537 - SANDY DOLOMITE, MOD. REDDISH BROWN, HARD, CLAYEY @ BASE	
	3 MIN/FT			41			2		
	3 MIN/FT						0	537-539 SANDY DOLOMITE, SPOTTED LT OLIVE GRAY (516/11) TO MODERATE REDDISH BROWN (10R4/6) qtzitic, sub	
	2 MIN/FT						1	FRESH, UNBROKEN	ROUND, MODERATE TO LOW POROSITY, SLIGHTLY ARGILLACEOUS, HARD
540	2 MIN/FT	RUN 15	X	42	41	1	1	539-539.9 - VERY COARSE GRAINED SANDY DOLOMITE AND CONGLOMERATE 4 - (up to 4 cm in Ø)	
	2 MIN/FT	88 %					3	close to upper & lower CONTACT	CEMENTED WITH CLAY AND CALCITE, MODERATE RED BROWN, MOD HARD, VERY POROUS.
	2 MIN/FT						2	539.9- VERY STAINED	542, SANDY DOLOMITE M. YELLOW BROWN, LT OLIVE GRAY, &
	2 MIN/FT		X				3	BROWN & SLIGHTLY WEATHERED	MOD RED BROWN, FINE GR CONVOLUTE BEDS, OCC. FOX FRAGMENT 542-542.2
	2 MIN/FT			43			5	2. ARGILLACEOUS 542.2	CONGLOMERATIC ZONE 544.8 Interbedded SILTY V. FINE GRAINED SAND
545	2 MIN/FT						1	VERY BROKEN VERY ARGILLACEOUS in places, FOX	STONE & FINE TO MOD GR SANDSTONE, VARIATED COLOR MOSTLY qtz, OCC GRAVEL HIGH SECONDARY POROSITY



PROJECT NUMBER  
TEX24486.A1

ROCK CORE LOG

PROJECT Aquifer Storage and Recovery LOCATION UGRA WTP  
 DRILLING METHOD Mud Rotary DRILLERS & EQUIPMENT TWDB-Failing 1500  
 ELEVATION \_\_\_\_\_ ORIENTATION Vertical BORE HOLE: Well PZ-1  
 WATER LEVEL \_\_\_\_\_ DATE: \_\_\_\_\_ START: \_\_\_\_\_ FINISH: \_\_\_\_\_ INSPECTOR Petrus

DEPTH	COMMENTS TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES		LITHOLOGY		GRAPHIC LOG
					ROD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	
	2 MIN/FT	Run 15			41	4	546.8- WEATHERED	546.8 Conglomerate (in D) with matrix of fine to COARSE SAND, slightly dolomitic?	
	3 MIN/FT	88 %		44	42	2	GRADATIONAL UPPER CONTACT	24.5 SANDSTONE, MOD. HARD, LOW POROSITY, MOD. HARD, DOLOMITIC?	
	7 MIN/FT	↑			*	0	546.8- SLIGHTLY WEATHERED, FINE	547 SANDSTONE, REDDISH BROWN & LT GRAY, VERY FINE GRAINED, DOLOMITIC SILTY, GYTTIC, LOW POROSITY	
	4 MIN/FT					0	547 -	550.1 SANDSTONE, VERY FINE TO FINE GRAINED, MOSTLY	
550	3 MIN/FT	Run 16		45	43	0	UNFRACTURED	MOD. REDDISH BROWN (10R4/6) SLIGHTLY GREENISH GRAY	
	4 MIN/FT	93%			44	0	& FRESH MASSIVE STRUCTURE	(SGY 611) MOD. HARD, GYTTIC, DOLOMITIC COMPACT, LOW POROSITY	
	5 MIN/FT					0		YELLOWISH BROWN TO GRAY SILTY DOLOMITE	
	6 MIN/FT			46		0		LAMINAR @ 547.2, 552.6 & 554.4. Convolute & thinly bedded	
	5 MIN/FT					0			
555	5 MIN/FT					0			
	2 MIN/FT					0	556.1 FRIABLE,	556.1 Conglomeratic med grained SANDSTONE, QUARTZITIC SUBROUND, SOFT, MATRIX	
	1 MIN/FT				47	1		OF silty gtz, very calcareous pebbles up to 1.5 cm.	
	5 MIN/10 FT	Run 17 <5%			*	↑		557-567 Little return Includes cobbles up to 3 inches in Ø subround to round. Gravels are fine grained sandstone	
560						0 N A			



PROJECT NUMBER  
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ROCK CORE LOG

PROJECT Aquifer Storage and Recovery LOCATION UGRA WTP  
 DRILLING METHOD Mud Rotary DRILLERS & EQUIPMENT TWDB-Failing 1500  
 ELEVATION \_\_\_\_\_ ORIENTATION Vertical BORE HOLE: Well PZ-1  
 WATER LEVEL \_\_\_\_\_ DATE: \_\_\_\_\_ START: \_\_\_\_\_ FINISH: \_\_\_\_\_ INSPECTOR Petrus

DEPTH	COMMENTS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES		LITHOLOGY		GRAPHIC LOG
					ROD	FRACTURES PER FOOT	DESCRIPTION	MINERALOGY	
	TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS						TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	CLASSIFICATION COLOR GRAIN SIZE ALTERATION	HARDNESS WEATHERED STATE
	5min/10 FT								
	Core loss un certain	Run 17							Included in return is a reddish disturbed city sandstone. Can't tell if it is cave in material
	Hit gravel zone estimate	<5%			0 %	NA			
	3' thick			47					
565									
	Hard drilling feels like sitting on a boulder as	Run 18 0%			NA %	NA			Probably hard sandstone but gravel in hole prohibited recovery
570	BIT IS WORN completely in 3 feet								
	Use 6" roller bit to clean and condition hole from 570 to 575 feet								Cutting returns are tan v fine grained to fine grained sandstone, hard, cemented with calcite
575									



PROJECT NUMBER  
TEX24486.A1

ROCK CORE LOG

PROJECT Aquifer Storage and Recovery LOCATION UGRA WTP  
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 ELEVATION \_\_\_\_\_ ORIENTATION Vertical BORE HOLE: Well PZ-1  
 WATER LEVEL \_\_\_\_\_ DATE: \_\_\_\_\_ START: \_\_\_\_\_ FINISH: \_\_\_\_\_ INSPECTOR Petrus

DEPTH	COMMENTS TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES		LITHOLOGY		GRAPHIC LOG
					ROD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	
	Collar above core barrel twisted off during run. Fished out but no core in barrel.	Run 19 0%		NA		?		UNKNOWN, NO RECOVERY	
580	DIAMOND BIT Twisted off again. This time 200' When fishing out, barrel dropped 30' Face fall with 350' of pipe could have caused core loss.	Run 20 0%		NA	0	?		No recovery. Drilling was hard. Probably a well cemented sandstone	
585	581-582 (5min) 582-583 (5min) 583-585 (8min) 585-588 HARD took 25 min 588-589 10min 589-590 11min							Drilled the core interval later with rotary bit. Chips were mixture of clay, chert, & fine grained sandstone. Probably in a conglomerate cemented w/ calcite. Buff colored	
590									





PROJECT NUMBER  
TEX24486.A1

### ROCK CORE LOG

PROJECT Aquifer Storage and Recovery LOCATION UGRA WTP  
 DRILLING METHOD Mud Rotary DRILLERS & EQUIPMENT TWDB-Failing 1500  
 ELEVATION \_\_\_\_\_ ORIENTATION Vertical BORE HOLE: Well PZ-1  
 WATER LEVEL \_\_\_\_\_ DATE: \_\_\_\_\_ START: \_\_\_\_\_ FINISH: \_\_\_\_\_ INSPECTOR Petrus

DEPTH	COMMENTS TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	ROD	FRACTURES PER FOOT	DISCONTINUITIES		LITHOLOGY		GRAPHIC LOG
							DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE		
	7min Alt. hard and easy zones									No recovery, in something very hard (chert?)	
	20min Load chatter	Run 21		NA	0 %	NA					
	25min Very hard	0%									
	16min										
595	32min Ruined diamond bit in 5 feet										
	Roller bit to 606'						Chip	Returns are medium reddish brown & tan very fine grained sand, slightly calcareous Also lots of chert chips some with calcareous sand matrix Probably Conglomerate			
	Alternating hard & soft zones										
600											
	602 cuts smoothly							Returns are soft to med hard v. fine grained sandstone			
								At 604' we get some soft dark reddish brown Mudstone. Decide to core			
605											



PROJECT NUMBER  
TEX24486.A1

ROCK CORE LOG

PROJECT Aquifer Storage and Recovery LOCATION UGRA WTP  
 DRILLING METHOD Mud Rotary DRILLERS & EQUIPMENT TWDB-Failing 1500  
 ELEVATION \_\_\_\_\_ ORIENTATION Vertical BORE HOLE: Well PZ-1  
 WATER LEVEL \_\_\_\_\_ DATE: \_\_\_\_\_ START: \_\_\_\_\_ FINISH: \_\_\_\_\_ INSPECTOR Petrus

DEPTH	COMMENTS TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES		LITHOLOGY	
					ROD	FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION
5min		↑			↑	↑	Ext neck broken or	Mostly Boulder conglomerate boulders > 4 inches in Ø
7min gets hard							unconsol. later	well rounded, mostly fine grained sands matrix
5min.		Run 22					Can't tell if drilling has washed away matrix	where present is a mod. reddish brown sandstone fine grained. comprised of
4min		0%			0%	N		qtz, feldspar, mica, and trace pyrite, friable. and possibly cemented
17min lots of chatter				48		A		
5min								
17min								
28min								
19min								
615 615 615	Could't drill past 615w/ run Rollerbit to	↓			↓	↓		Rollerbit, hard drilling. Cuttings are, sandstone and chert.
625'								Probably still in conglomerate
617-620= 2/min								
hard drilling								
620								



PROJECT NUMBER  
TEX24486.A1

ROCK CORE LOG

PROJECT Aquifer Storage and Recovery LOCATION UGRA WTP  
 DRILLING METHOD Mud Rotary DRILLERS & EQUIPMENT TWDB-Failing 1500  
 ELEVATION \_\_\_\_\_ ORIENTATION Vertical BORE HOLE: Well PZ-1  
 WATER LEVEL \_\_\_\_\_ DATE: \_\_\_\_\_ START: \_\_\_\_\_ FINISH: \_\_\_\_\_ INSPECTOR Petrus

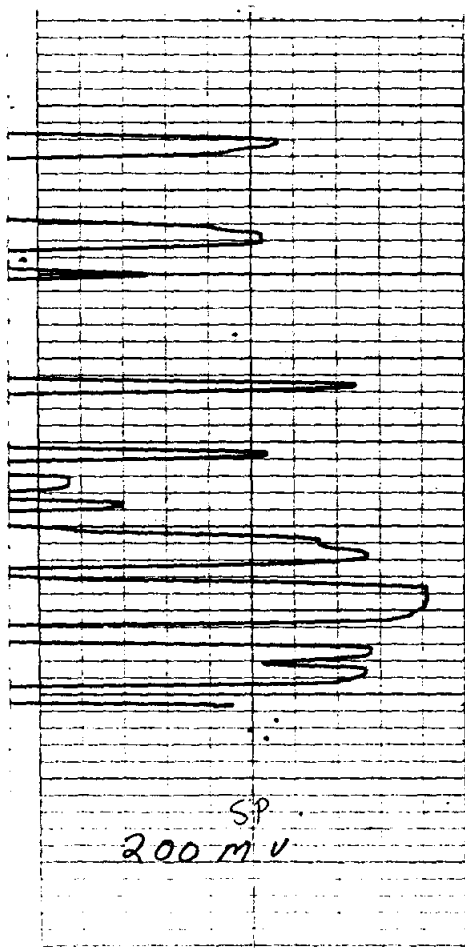
DEPTH	COMMENTS TESTS INSTRUMENTATION CORING RATE AND SMOOTHNESS CORING FLUID LOSS	CORE RUN LENGTH AND RECOVERY (%)	CORE LOSS ZONE	BOX NUMBER	DISCONTINUITIES		LITHOLOGY	
					ROD FRACTURES PER FOOT	DESCRIPTION TIGHTNESS PLANARITY SMOOTHNESS FILLING, STAINING ORIENTATION	MINERALOGY CLASSIFICATION COLOR GRAIN SIZE ALTERATION	CEMENTATION HARDNESS WEATHERED STATE
	puller bit to 625' smooth drilling. IN clay?							@ 620' drilling is smooth out of core! Returns are minimal probably a shale or claystone
	620-25' = 19min							
625	4" core ↓							
	7min/ft							No recovery but inside of barrel contains clay,
	8min/ft							light gray (wt) slightly sandy, very sticky, soft.
	10min/ft							slightly calcareous.
	7min/ft	Run 24						Need to run geophysical for confirmation
630	6min/ft	0%		NA	0%			
	5min/ft							
	7min/ft							
	6min/ft							
	7min/ft							
635	7min/ft							TDD 635'

**Appendix B**  
**GEOPHYSICAL LOGS**

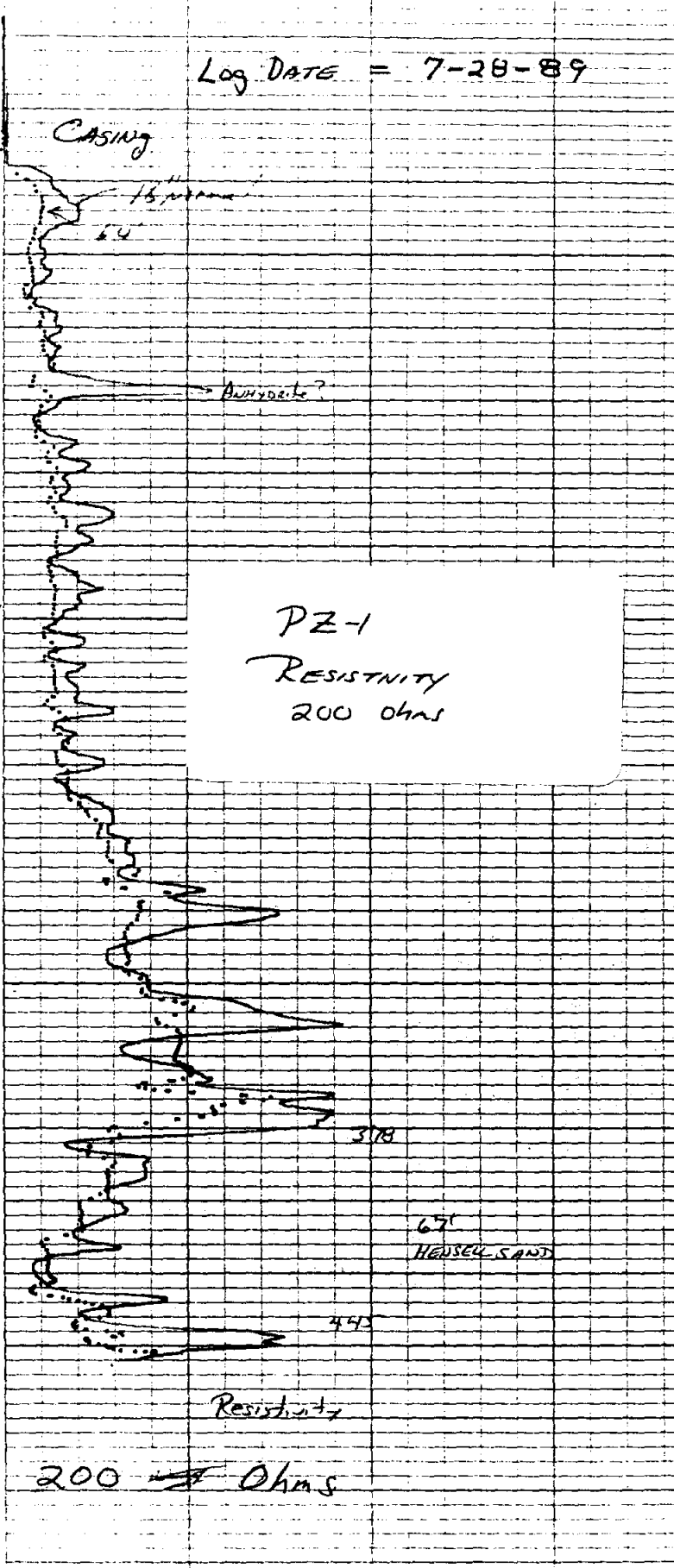
Log DATE = 7-28-89

100  
200  
300  
400  
454

PZ-1  
Spontaneous  
Potential  
200 MV

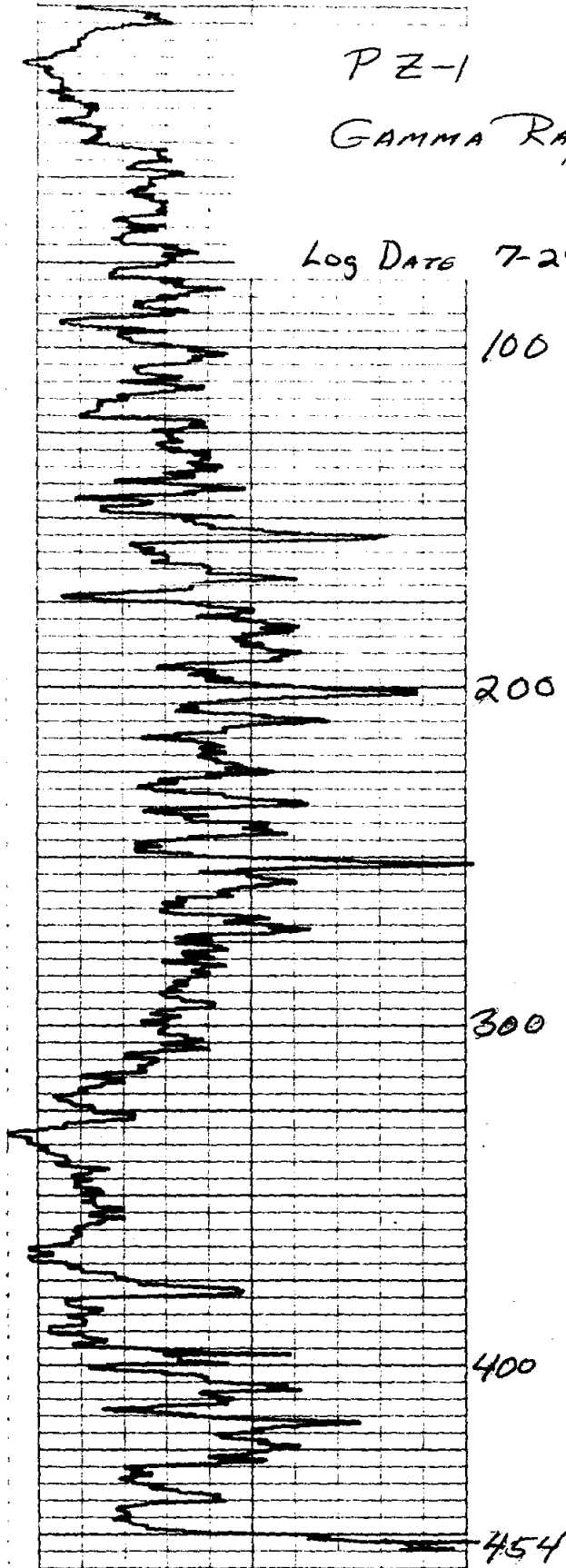


PZ-1  
RESISTIVITY  
200 Ohms

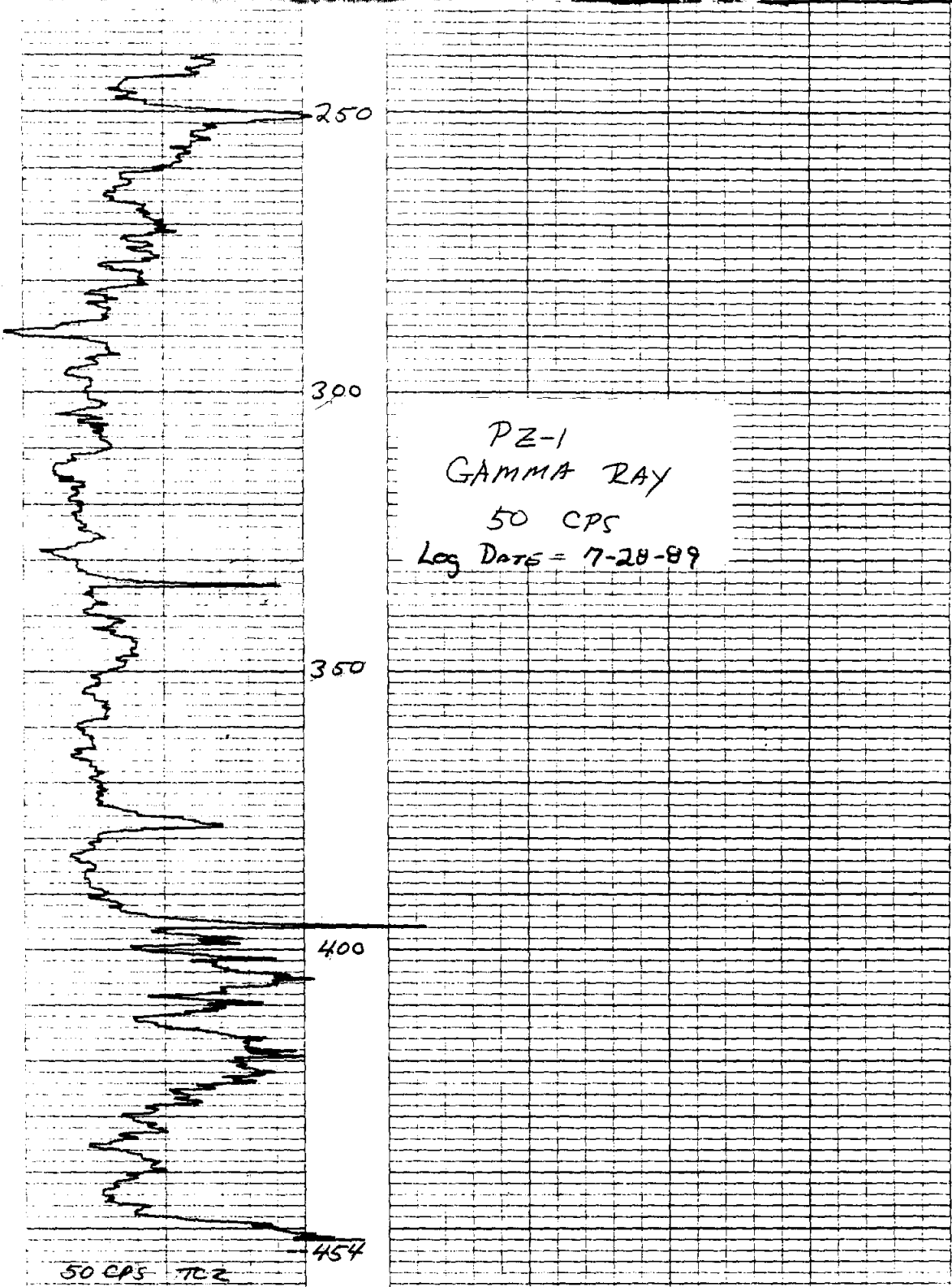


PZ-1  
GAMMA RAY

Log DATE 7-28-89



50 CPS TC 2



250

300

350

400

454

PZ-1  
GAMMA RAY  
50 CPS  
Log DATE = 7-20-89

50 CPS TCZ

658-83

12-1

Vertical scale markings on the right side of the grid.

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TYPES OF LOGS THIS DATE: 8-2-87: E-log

OPERATOR (S) C&S LOCATION: \_\_\_\_\_

COUNTY: Kerr NEAREST TOWN: Kerrville DRILLER: TWDB, McCarty

OWNER: H.G.R.A ADDRESS: \_\_\_\_\_

TYPE OF DRILL: A Cased BIT SIZE: 9 7/8" to 400', 6" to 495'

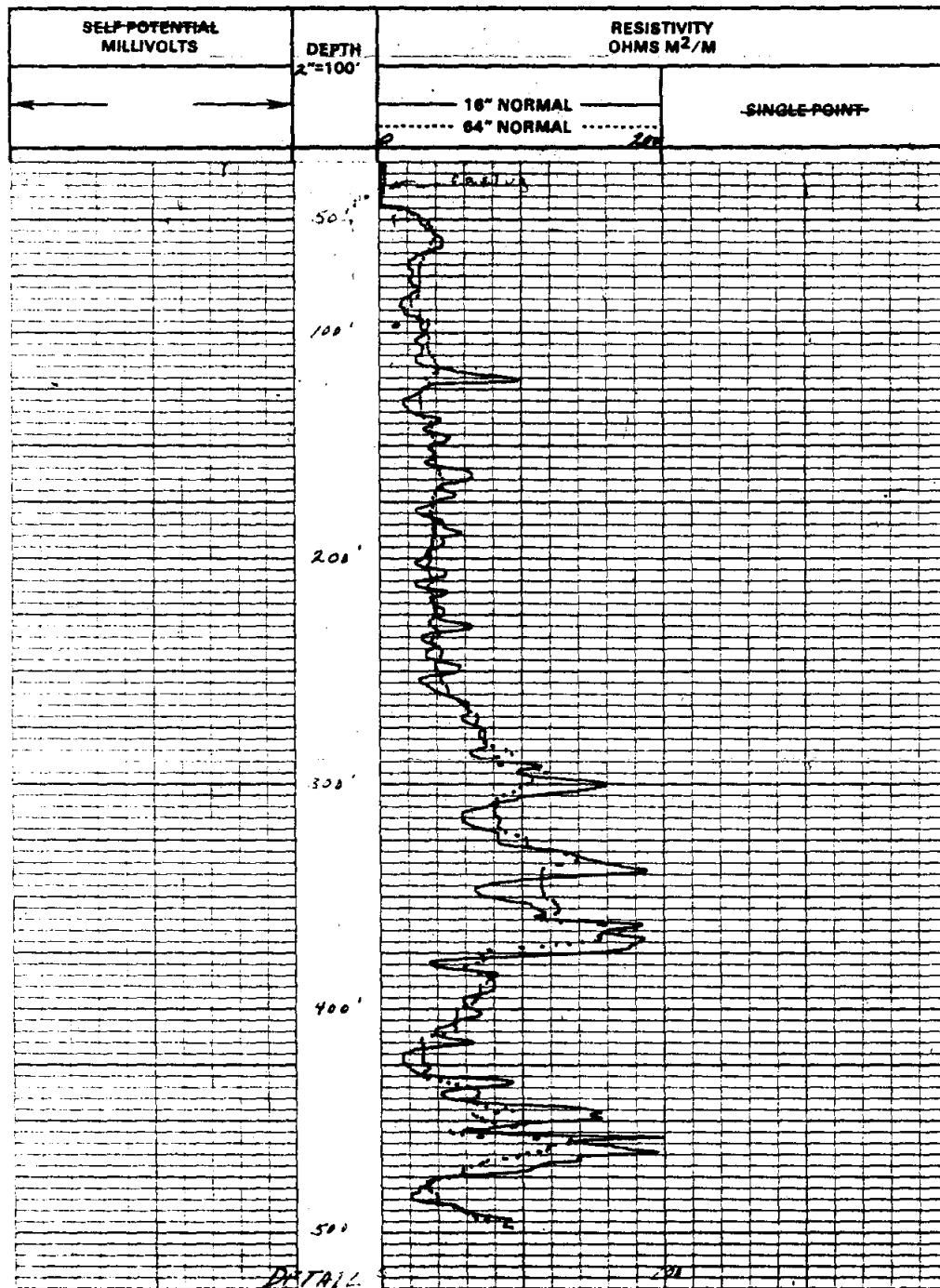
ALTITUDE OF LAND SURFACE: 1635' LOGGED DEPTH: 477' DRILLED DEPTH: 495'

FLUID LEVEL: \_\_\_\_\_ FLUID TYPE: Fresh Mud LOG REFERENCE POINT: Ground level

CASING DATA: 10 3/4" x 39' OPEN HOLE DIA.: 6"

CEMENTED FROM: Surf TO 39' SCREEN: 40' to 50' AQUIFER: \_\_\_\_\_

FLUID RESISTIVITY: \_\_\_\_\_ OHMS AT \_\_\_\_\_ ° F. REMARKS: \_\_\_\_\_





OPERATOR (S) Chin LOCATION: \_\_\_\_\_

COUNTY: Kerr NEAREST TOWN: Kerrville DRILLER: TWDB, McCarty

OWNER: H.G.R.A ADDRESS: \_\_\_\_\_

TYPE OF DRILL: Cored BIT SIZE: 9 7/8" to 400', 6" to 495'

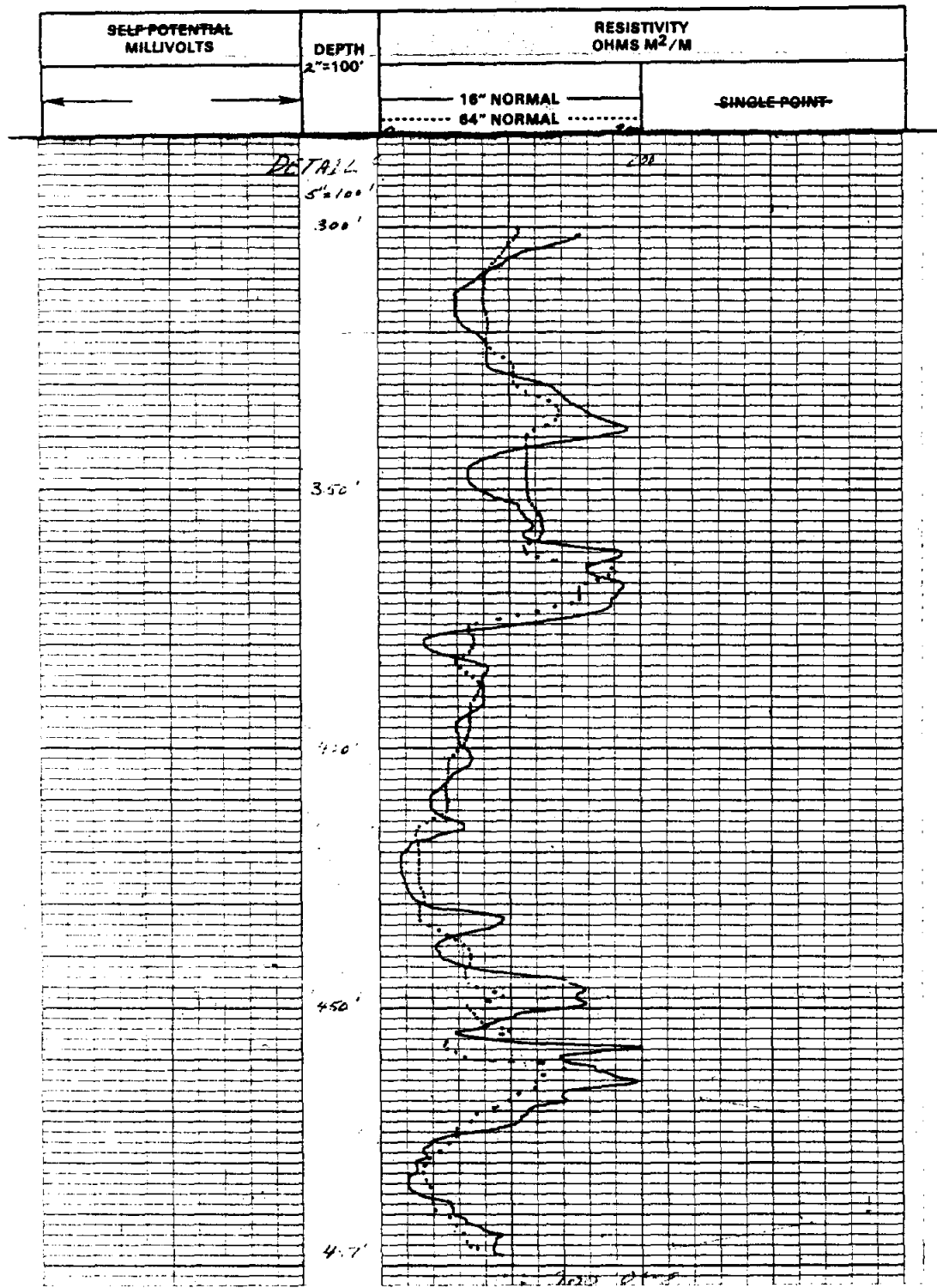
ALTITUDE OF LAND SURFACE: 1635' LOGGED DEPTH: 497' DRILLED DEPTH: 495'

FLUID LEVEL: \_\_\_\_\_ FLUID TYPE: Fresh Mud LOG REFERENCE POINT: Ground level

CASING DATA: 10 3/4" to 39' OPEN HOLE DIA.: 6"

CEMENTED FROM: Surf TO 39' SCREEN: 4 1/2" to \_\_\_\_\_ AQUIFER: \_\_\_\_\_

FLUID RESISTIVITY: \_\_\_\_\_ OHMS AT \_\_\_\_\_ ° F. REMARKS: \_\_\_\_\_



NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TYPES OF LOGS THIS DATE: R-2-89

OPERATOR (S) C B M LOCATION: \_\_\_\_\_

COUNTY: Kerr NEAREST TOWN: Kerrville DRILLER: \_\_\_\_\_

OWNER: U. G. R. A. ADDRESS: \_\_\_\_\_

TYPE OF DRILL: Cave BIT SIZE: 9 7/8" - 400', 6" 400' to 497'

ALTITUDE OF LAND SURFACE: 1635' LOGGED DEPTH: 497' DRILLED DEPTH: 495'

FLUID LEVEL: \_\_\_\_\_ FLUID TYPE: Fresh Water LOG REFERENCE POINT: Ground level

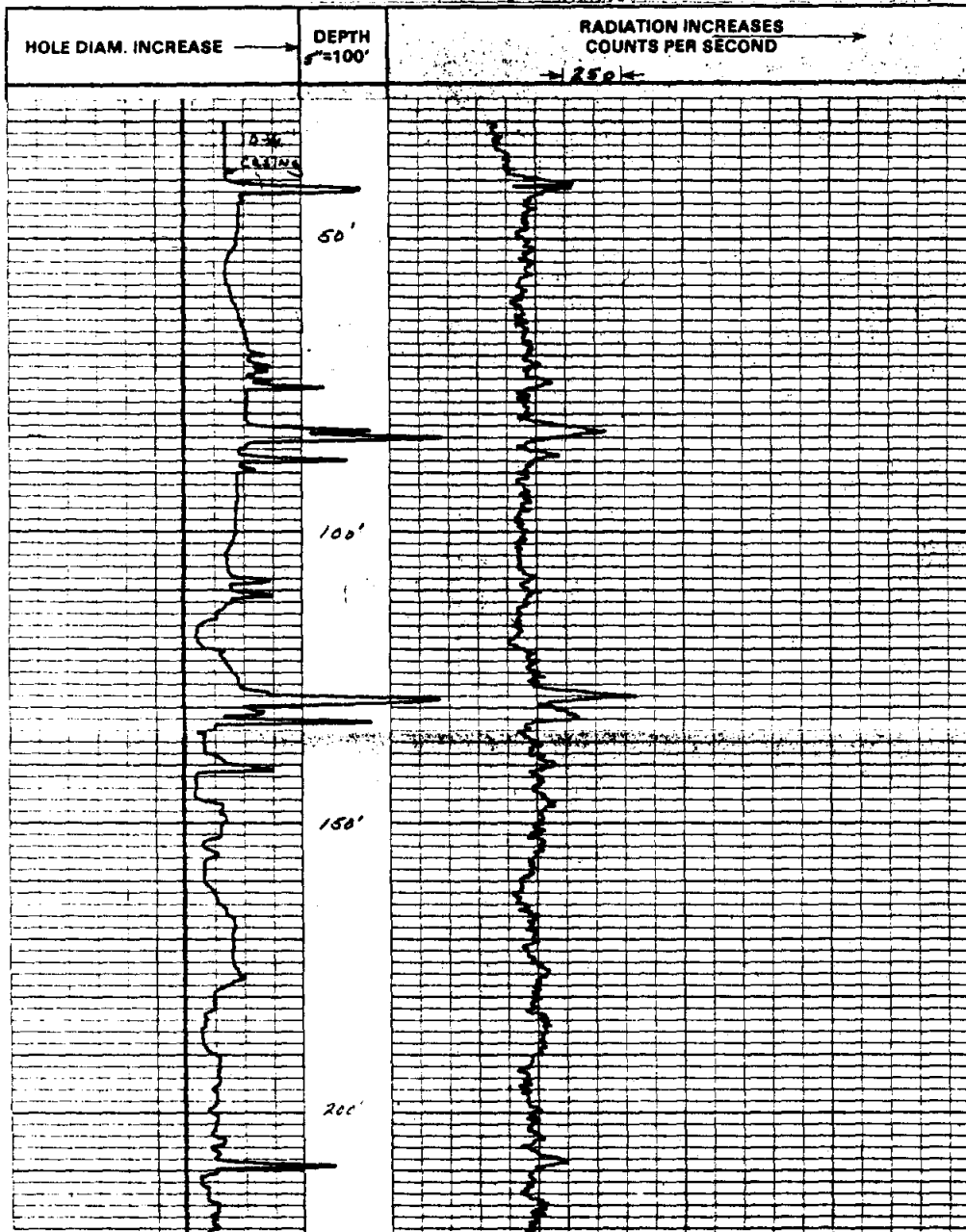
CASING DATA: 10 3/4" Surf - 39' OPEN HOLE DIA.: 6"

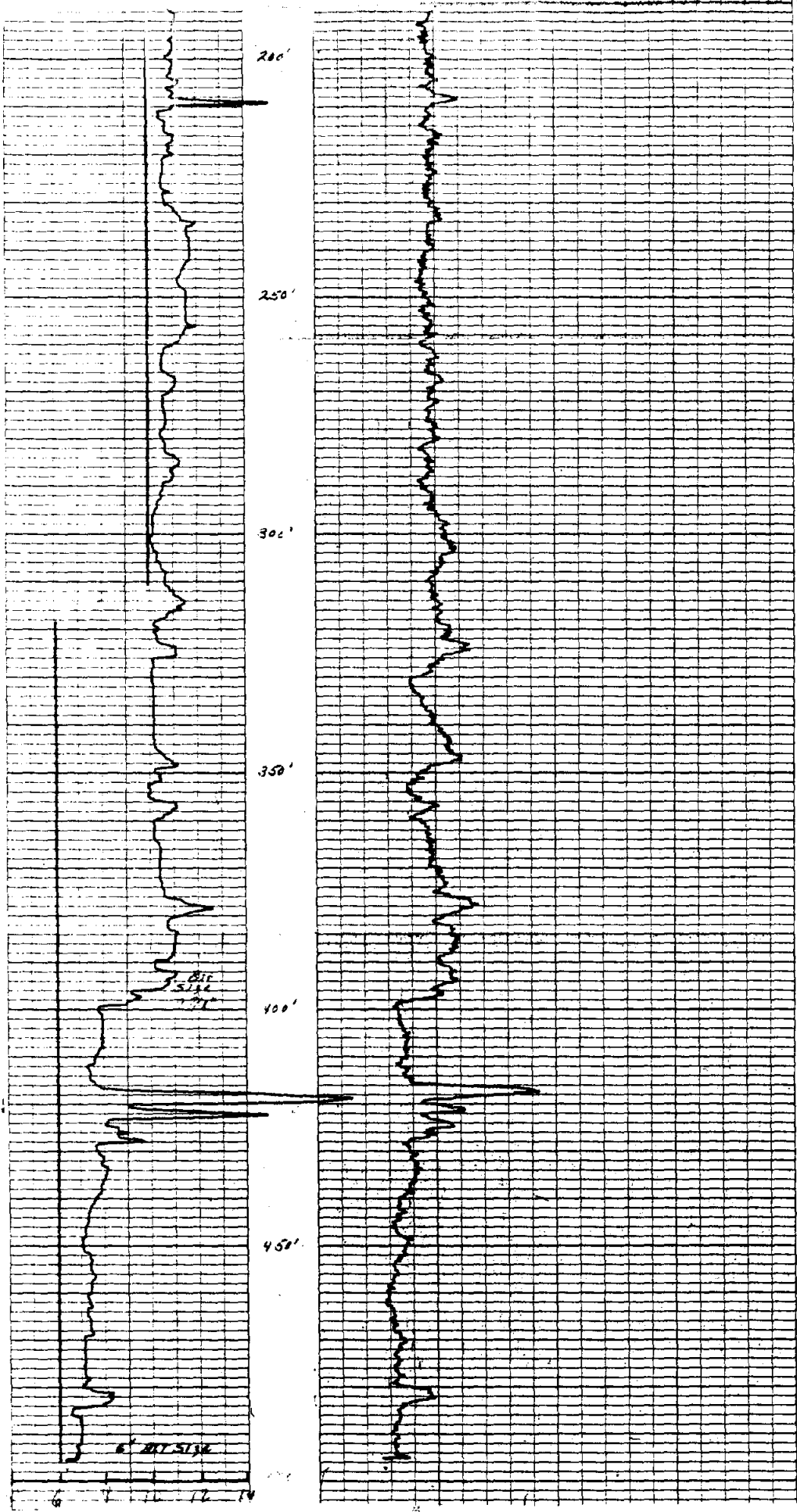
CEMENTED FROM: Surf TO 39' SCREEN: Open hole TO AQUIFER: \_\_\_\_\_

FLUID RESISTIVITY: \_\_\_\_\_ OHMS AT \_\_\_\_\_ ° F. REMARKS: \_\_\_\_\_

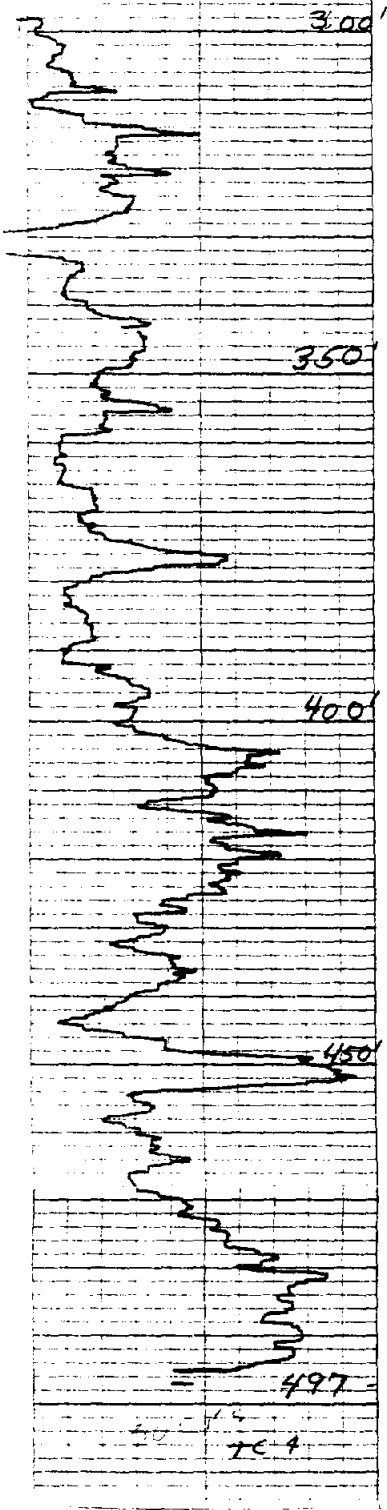
CALIPER  
HOLE DIAMETER IN INCHES  
FROM 4" TO 14"

GAMMA GAMMA  
COUNTS PER SECOND 25000  
TIME CONSTANT 1 SPACING 21"



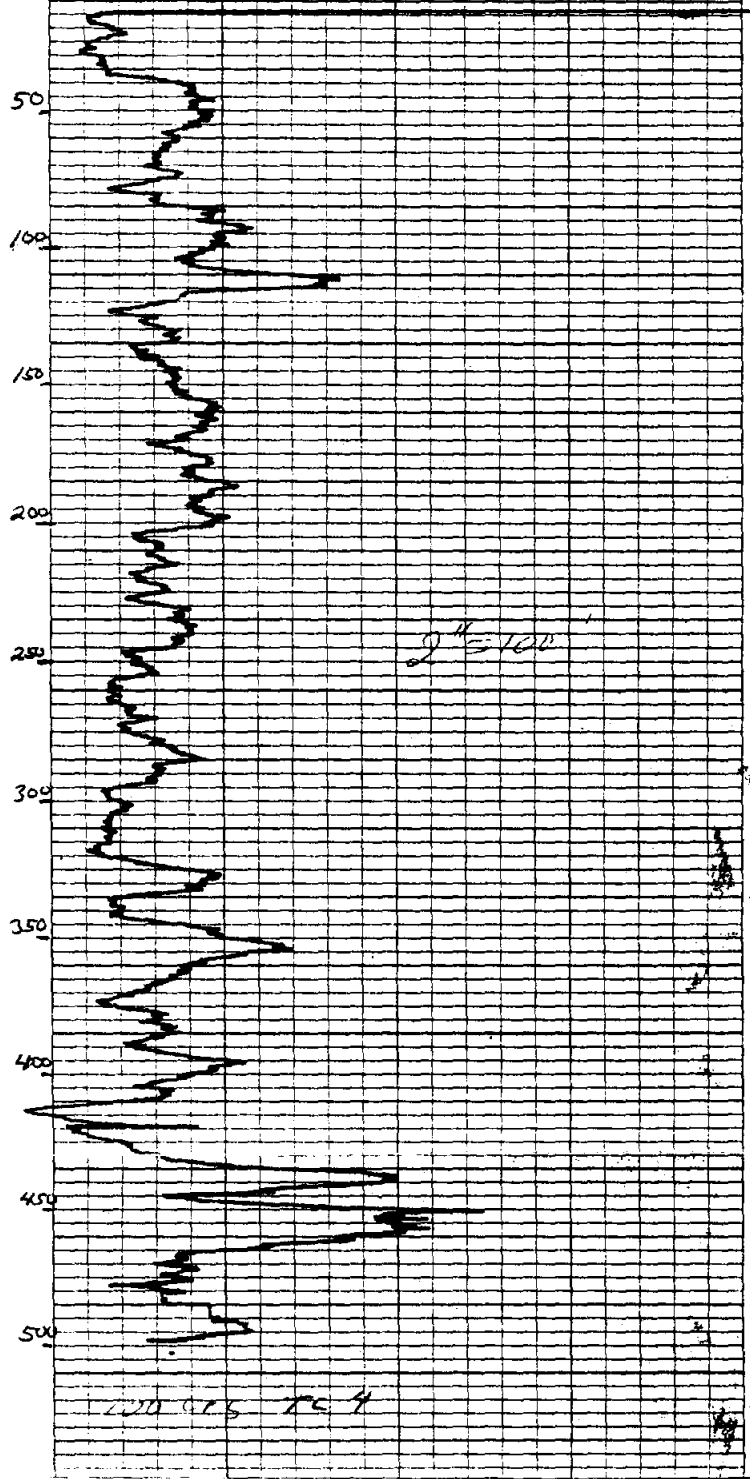


PZ-1  
GAMMA RAY  
50 CPS



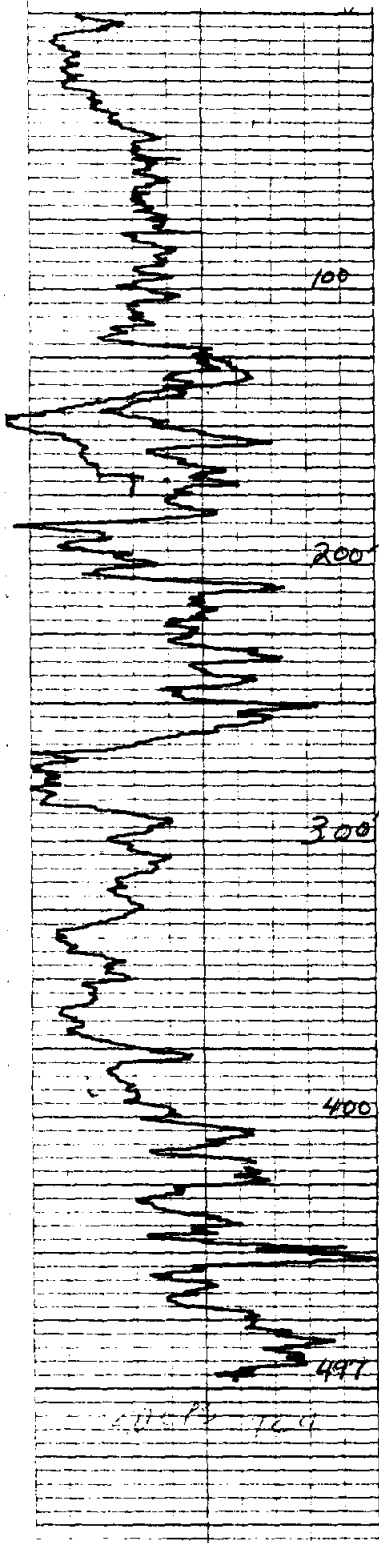
50  
TC 1

497  
CPS  
TC 2  
PZ-1  
NEUTRON LOG  
100 CPS  
LOG DATE = 8-28-89

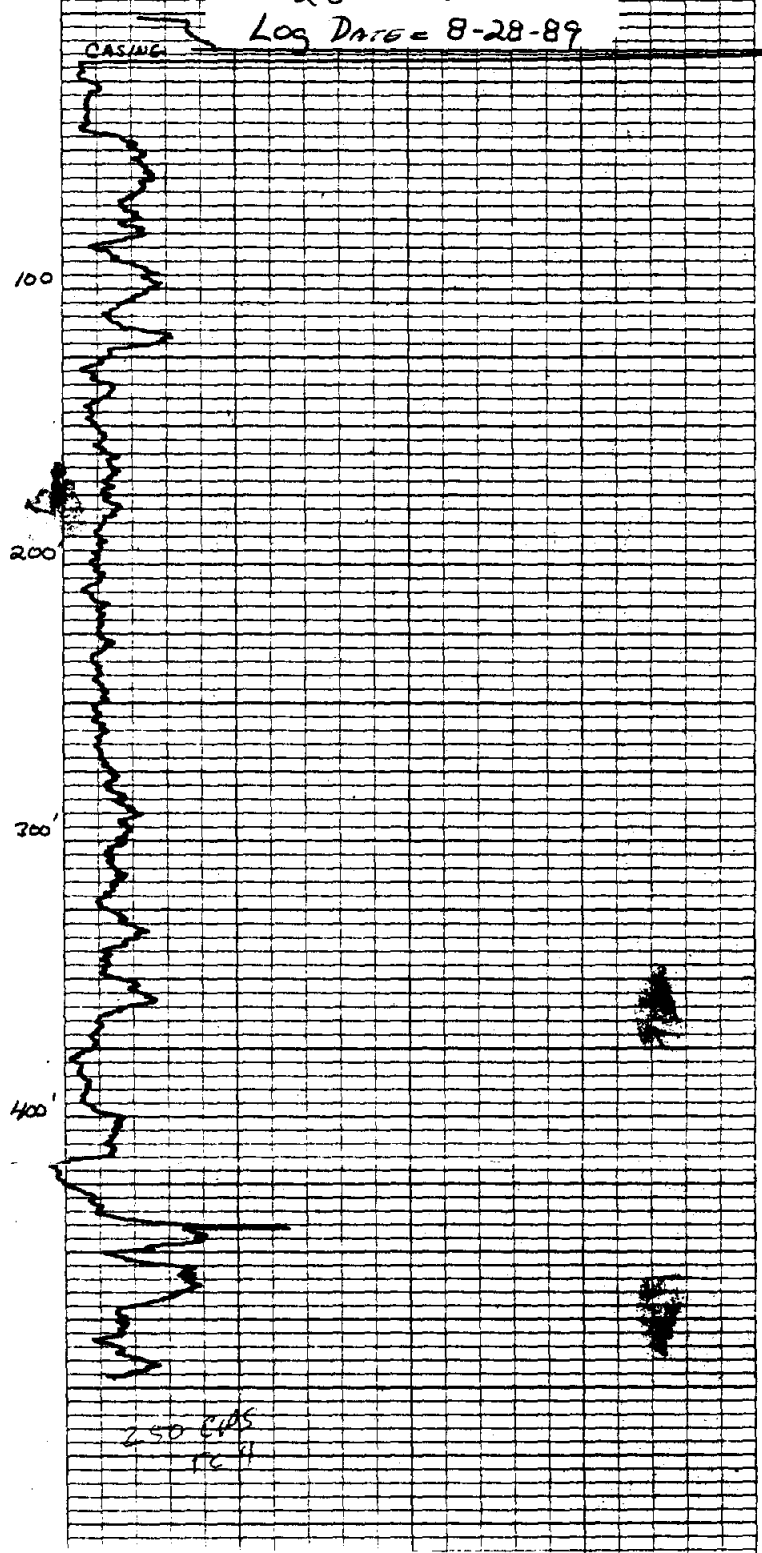


100  
CPS  
TC 4

PZ-1  
GAMMA RAY Log  
50 CPS

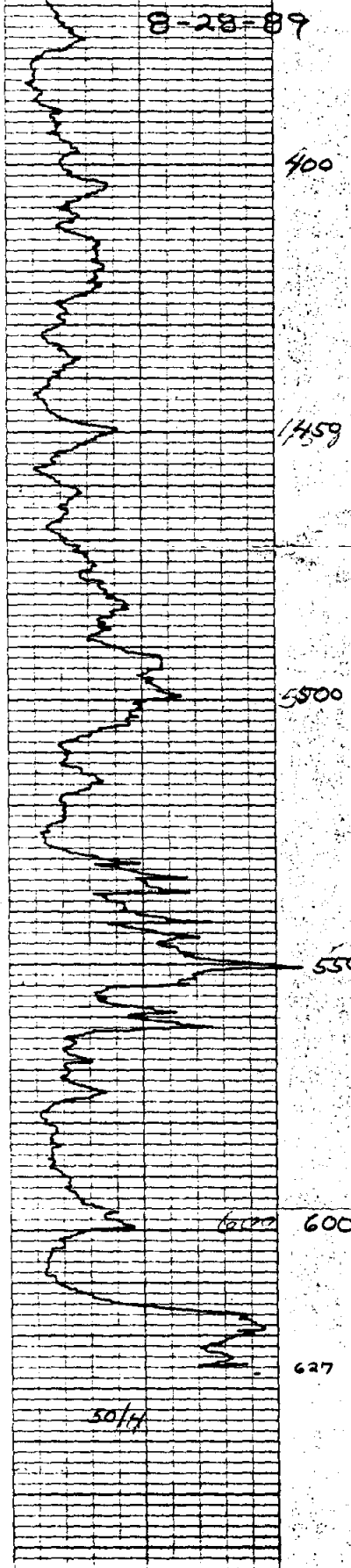


PZ-1  
NEUTRON Log  
250 CPS  
Log DATE = 8-28-89



PZ-1  
Gamma Ray  
50 CPS  
TC4

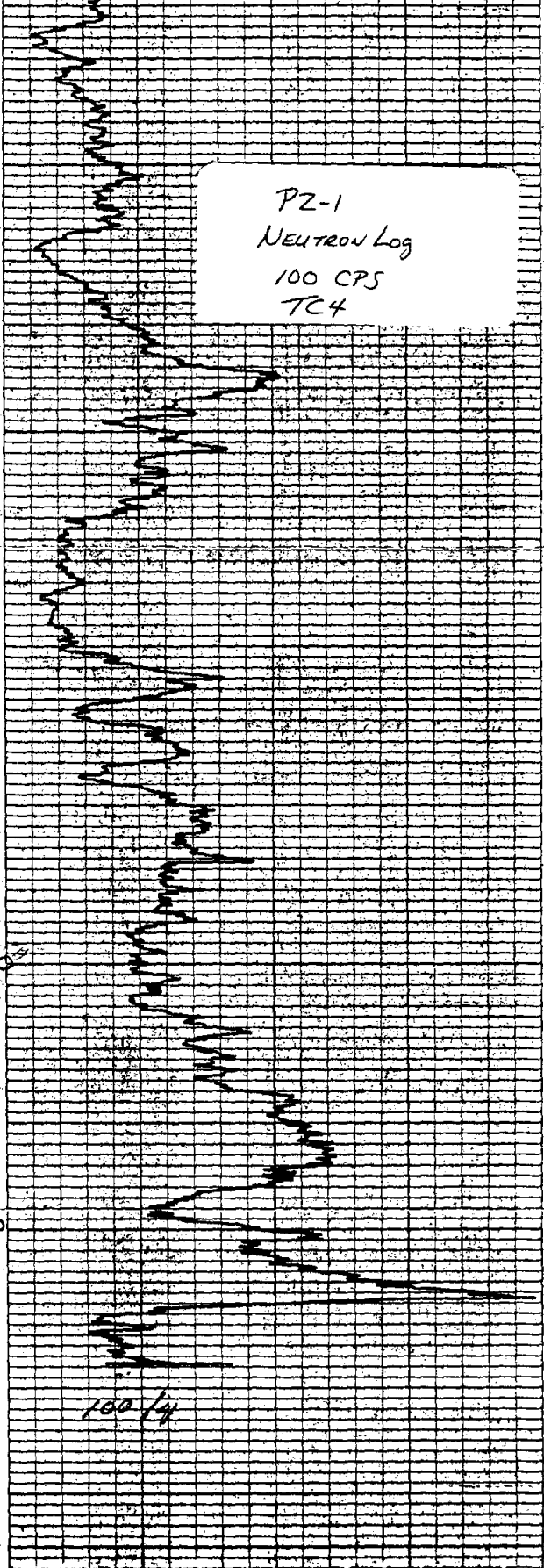
8-28-89



50/4

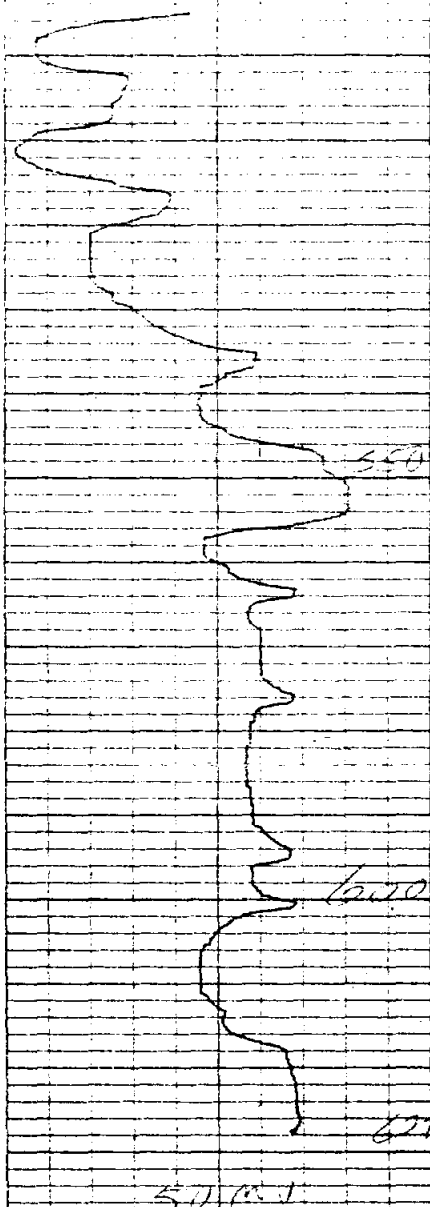
NEUTRON LOG PZ-1 TC4

PZ-1  
Neutron Log  
100 CPS  
TC4

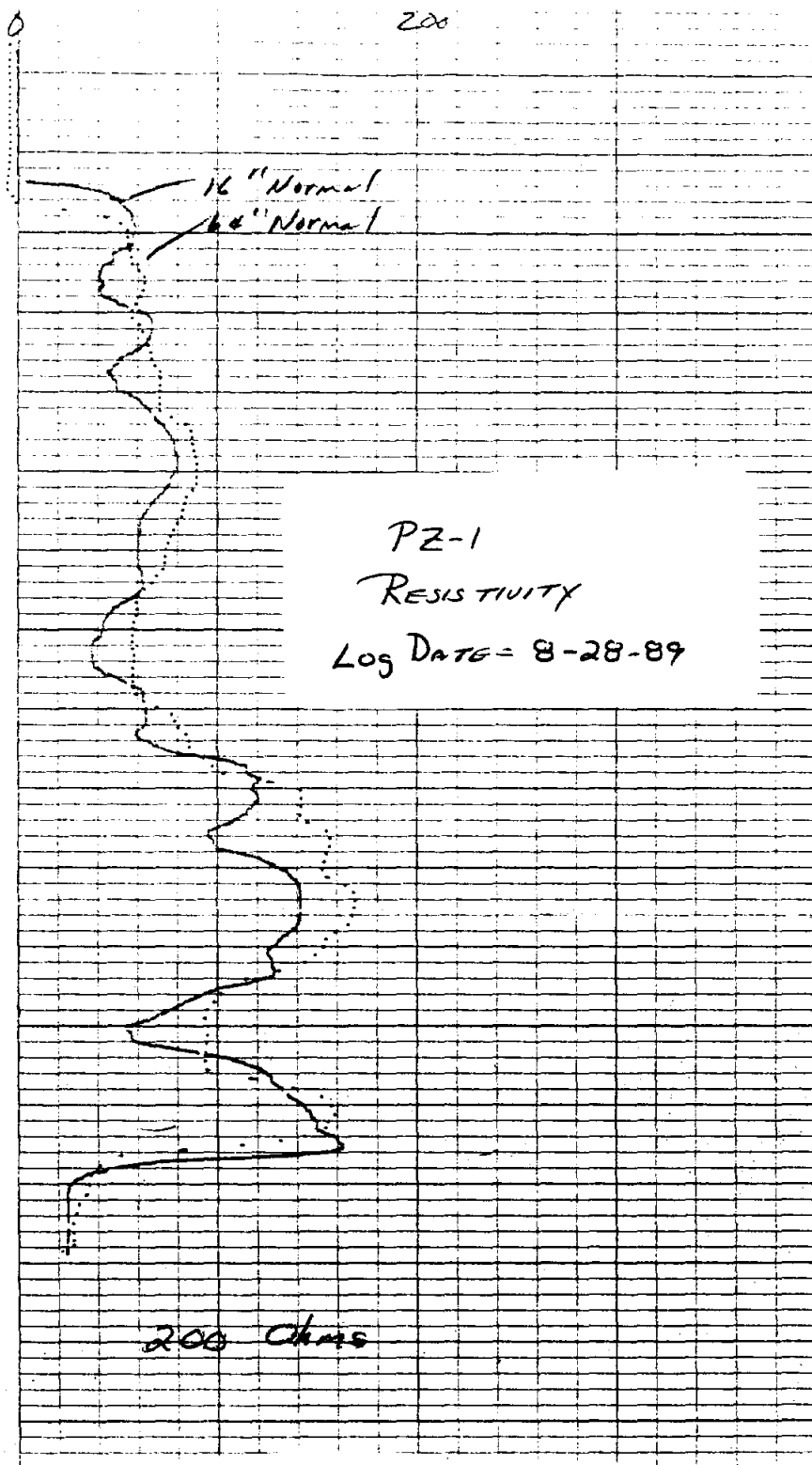


100/4

SP  
50 MV



PZ-1  
SPONTANEOUS  
POTENTIAL



PZ-1  
RESISTIVITY  
Log DATE = 8-28-89

200 Ohms

CALIPER

PZ-1

7" CASING

INCHES

3 4 5 6 7 8 9 10 11 12 13

627

GAMMA-GAMMA  
1000 CPS TC 2

8-28-89

450

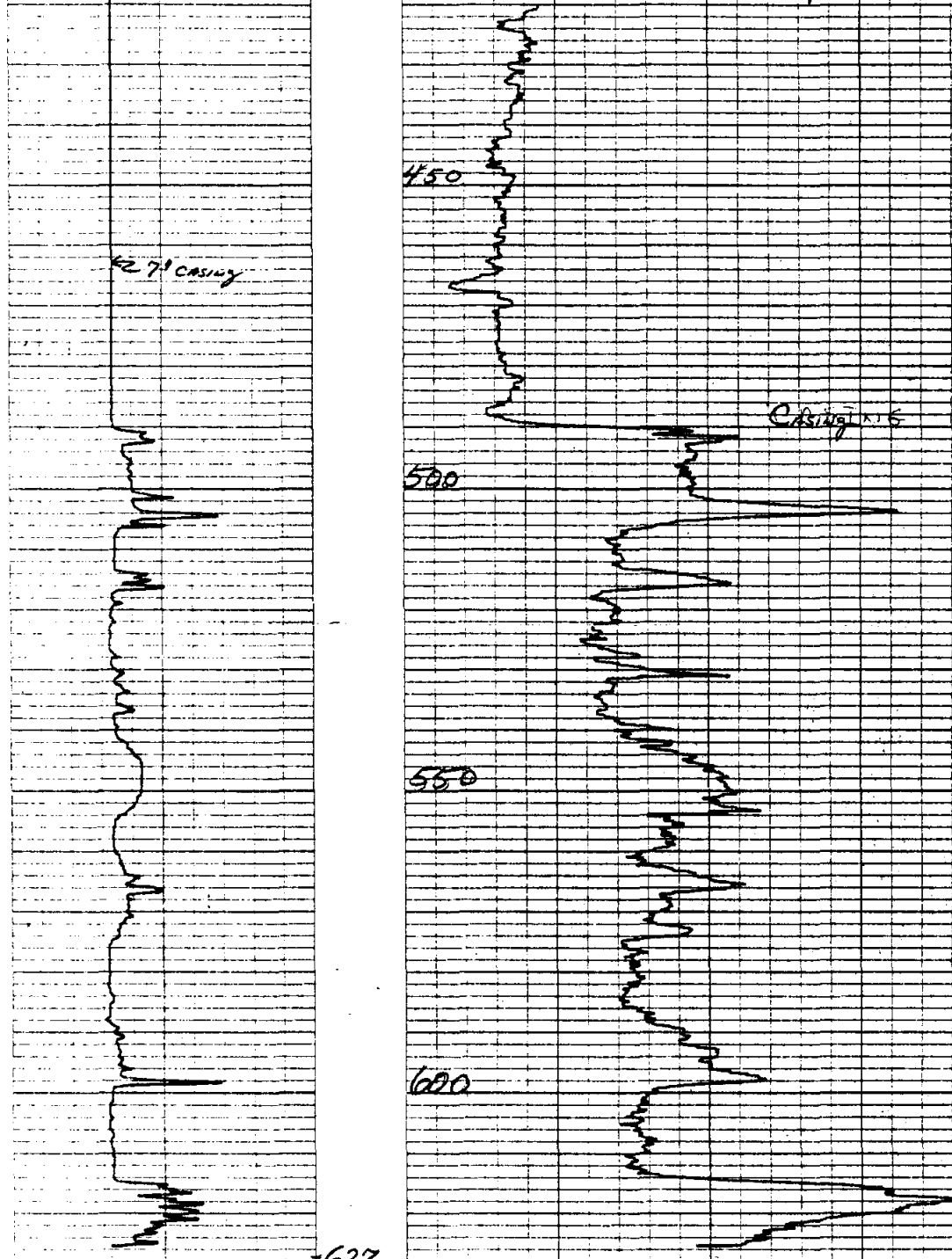
500

550

600

CASING

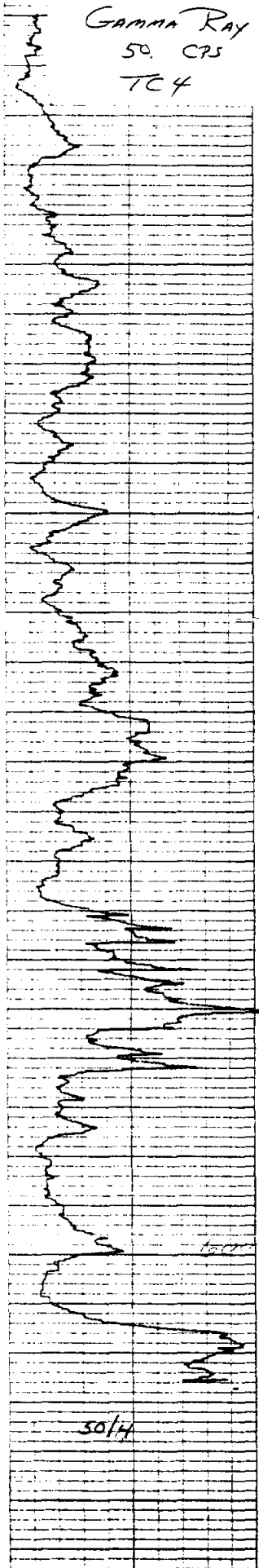
1000 CPS TC 2





NEUTRON LOG

PZ-1  
GAMMA RAY  
50 CPS  
TC4



50/4

8-28-89  
PZ-1  
NEUTRON Log  
100 CPS  
TC4

400

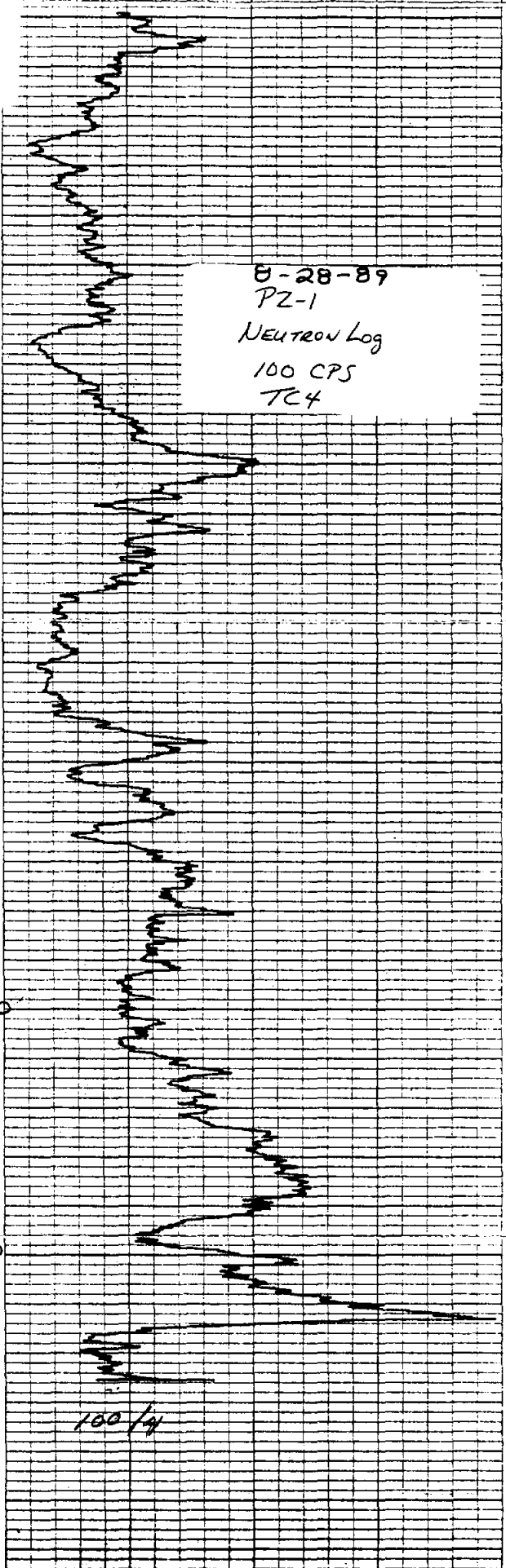
450

500

550

600

627



100/4

140

Acoustic  
μsec/ft  
ΔT

PZ-1

8-28-89

450

500

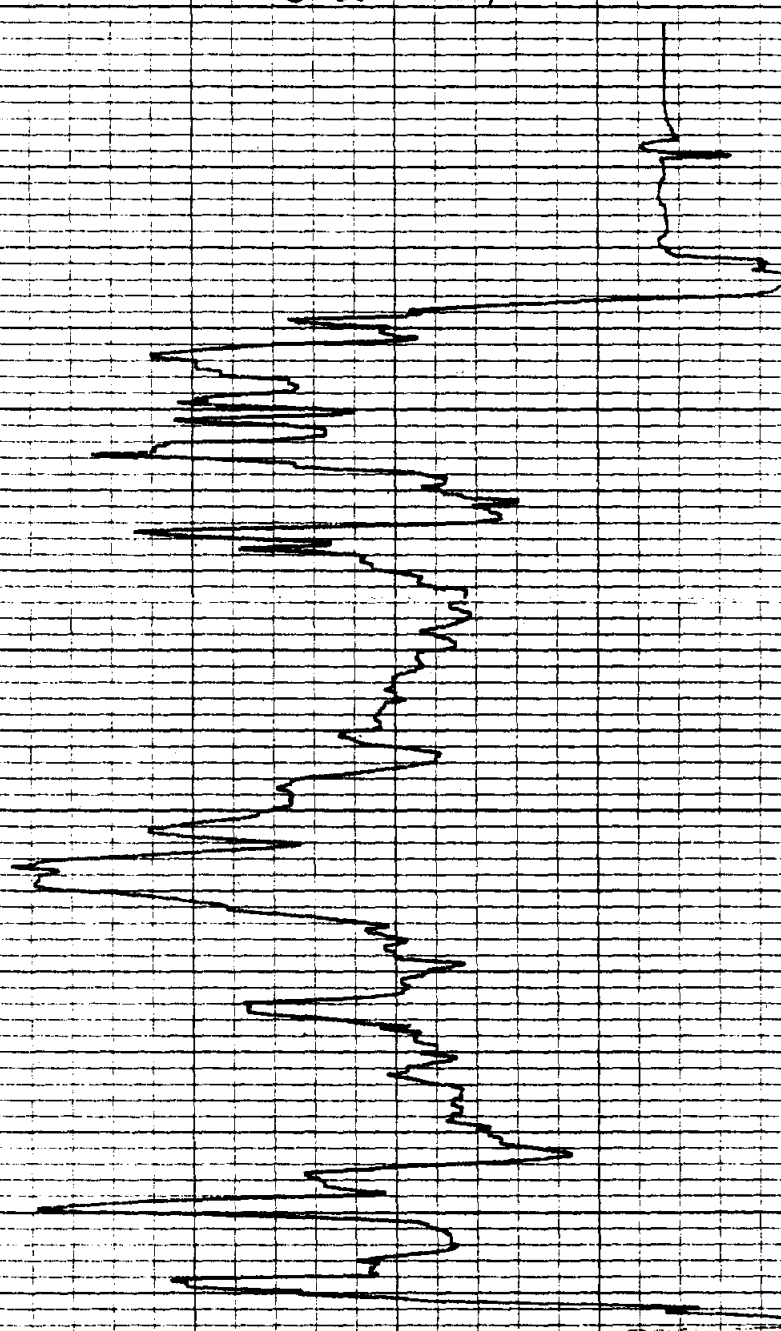
550

600

627/140

← ⊕

4



TEXAS WATER DEVELOPMENT BOARD  
 WATER AVAILABILITY DATA AND STUDIES SECTION  
 AUSTIN, TEXAS

STATE WELL NUMBER \_\_\_\_\_  
 FILE NUMBER 89-26  
 PROJECT 3245

**NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.**

TYPES OF LOGS THIS DATE: 9/25/89 : E-LOG : GR : H : GG : CAL : SONIC :

OPERATOR (S) CRIM . LOCATION: UGRA TEST WELL # 1

COUNTY: KERR NEAREST TOWN: KERRVILLE DRILLER: TWDB, McCARTY

OWNER: UGRA ADDRESS: \_\_\_\_\_

TYPE OF DRILL: CORED BIT SIZE: 6"

ALTITUDE OF LAND SURFACE: 1635' LOGGED DEPTH: 603' DRILLED DEPTH: 627'

FLUID LEVEL: 197' ± FLUID TYPE: FRESH WATER LOG REFERENCE POINT: GROUND LEVEL

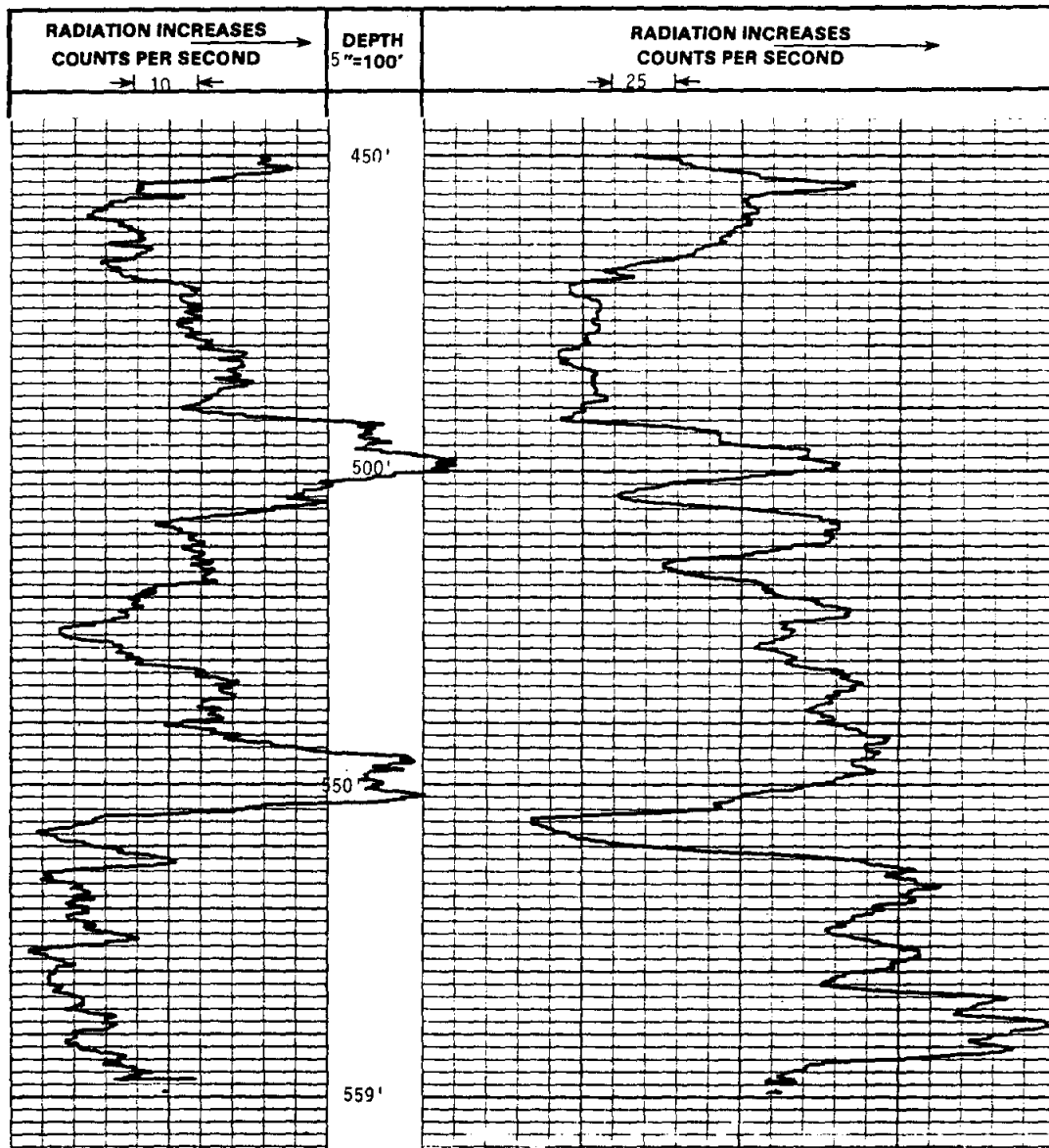
CASING DATA: 7" STEEL OPEN HOLE DIA. : 6"

CEMENTED FROM: SURF. TO 490' SCREEN OPEN HOLE TO \_\_\_\_\_ AQUIFER: HOSSTON

FLUID RESISTIVITY: \_\_\_\_\_ OHMS AT \_\_\_\_\_ ° F. REMARKS: \_\_\_\_\_

GAMMA RAY  
 COUNTS PER SECOND 50  
 TIME CONSTANT 4

NEUTRON  
 COUNTS PER SECOND 250  
 TIME CONSTANT 4 SPACING 21"



#DB-0271

TEXAS WATER DEVELOPMENT BOARD  
WATER AVAILABILITY DATA AND STUDIES SECTION  
JUSTIN, TEXAS

STATE WELL NUMBER \_\_\_\_\_  
FILE NUMBER 89-26  
PROJECT 3245

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TYPES OF LOGS THIS DATE: 9/25/89 : E-LOG : GR : N : GG : CAL : SONIC :

OPERATOR (S) CRIM . LOCATION: UGRA TEST WELL # 1

COUNTY: KERR NEAREST TOWN: KERRYVILLE DRILLER: TWDB, McCARTY

OWNER: UGRA ADDRESS: \_\_\_\_\_

TYPE OF DRILL: MUD ROTARY CORED BIT SIZE: 9 7/8" - 400' 6" 400' 627-ft.

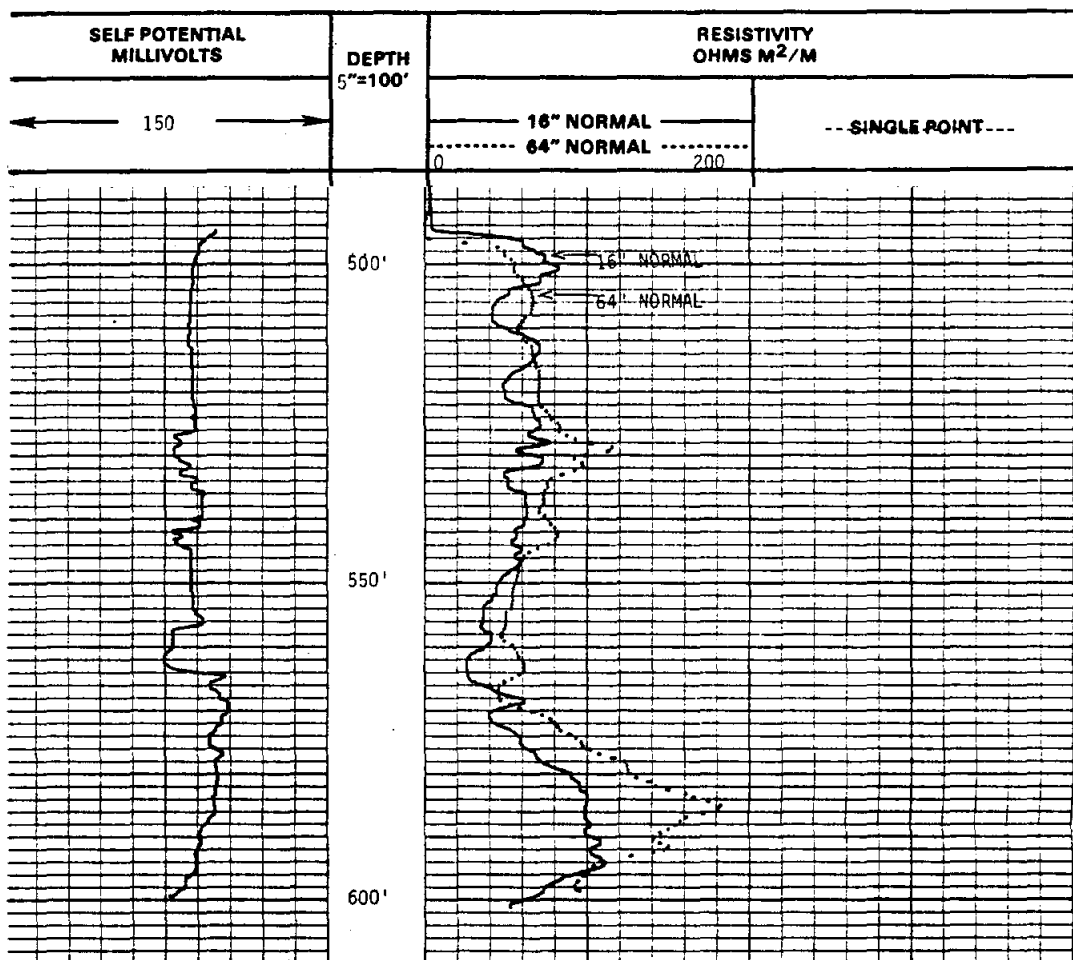
ELEVATION OF LAND SURFACE: 1635' LOGGED DEPTH: 627' 603' DRILLED DEPTH: 603' 627'

FLUID LEVEL: 197' \* FLUID TYPE: FRESH WATER LOG REFERENCE POINT: GROUND LEVEL

CASING DATA: 7" STEEL OPEN HOLE DIA.: 6"

CEMENTED FROM: SURF. TO 490' SCREEN: OPEN HOLE TO AQUIFER: HOSSTON

FLUID RESISTIVITY: \_\_\_\_\_ OHMS AT \_\_\_\_\_ ° F. REMARKS: \_\_\_\_\_



TEXAS WATER DEVELOPMENT BOARD  
 WATER AVAILABILITY DATA AND STUDIES SECTION  
 AUSTIN, TEXAS

STATE WELL NUMBER \_\_\_\_\_  
 FILE NUMBER 89-26  
 PROJECT 3245

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TYPES OF LOGS THIS DATE: 9/25/89 : E-LOG : GR : N : GG : CAL : SONIC :

OPERATOR (S) CRIM . LOCATION: UGRA TEST WELL # 1

COUNTY KERR . NEAREST TOWN: KERRVILLE . DRILLER: TWDB, McCARTY

OWNER: UGRA . ADDRESS: \_\_\_\_\_

TYPE OF DRILL: CORED . BIT SIZE: 6"

ALTITUDE OF LAND SURFACE: 1635' . LOGGED DEPTH: 603' . DRILLED DEPTH: 627'

FLUID LEVEL: 197' ± . FLUID TYPE: FRESH WATER . LOG REFERENCE POINT: GROUND LEVEL

CASING DATA: 7" STEEL . OPEN HOLE DIA.: 6"

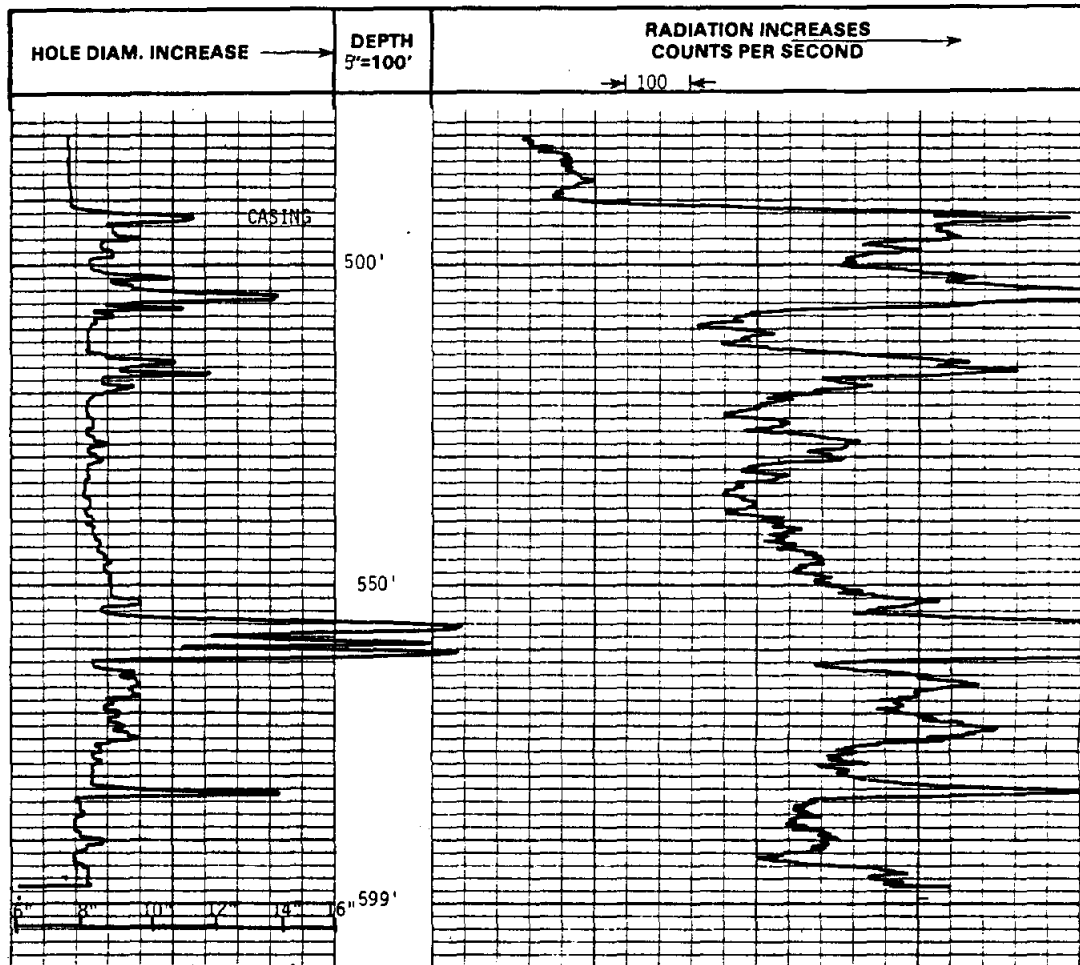
CEMENTED FROM: SURF. TO 490' . SCREEN: OPEN HOLE TO \_\_\_\_\_ . AQUIFER: HOSSTON

FLUID RESISTIVITY: \_\_\_\_\_ OHMS AT \_\_\_\_\_ ° F. REMARKS: CALIPER TOOL IS OFF APPROXIMATELY

ONE DIVISION----SEE CASING SIZE ON LOG.

CALIPER  
 HOLE DIAMETER IN INCHES  
 FROM 6 " TO 16 "

GAMMA GAMMA  
 COUNTS PER SECOND 1000  
 TIME CONSTANT 2 . SPACING 21 "



TWDB-0751

TEXAS WATER DEVELOPMENT BOARD  
WATER AVAILABILITY DATA AND STUDIES SECTION  
AUSTIN, TEXAS

STATE WELL NUMBER \_\_\_\_\_  
FILE NUMBER 89-26  
PROJECT 3245

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TYPES OF LOGS THIS DATE: 9/25/89 :E-LOG : GR : N : GG : CAL : SONIC :

OPERATOR (S) CRIM LOCATION: UGRA TEST WELL #1

COUNTY: KERR NEAREST TOWN: KERRVILLE DRILLER: TWDB, McCARTY

OWNER: UGRA ADDRESS: \_\_\_\_\_

TYPE OF DRILL: CORED BIT SIZE: 6"

ALTITUDE OF LAND SURFACE: 1635' LOGGED DEPTH: 603' DRILLED DEPTH: 627'

FLUID LEVEL: 197' ± FLUID TYPE: FRESH WATER LOG REFERENCE POINT: GROUND LEVEL

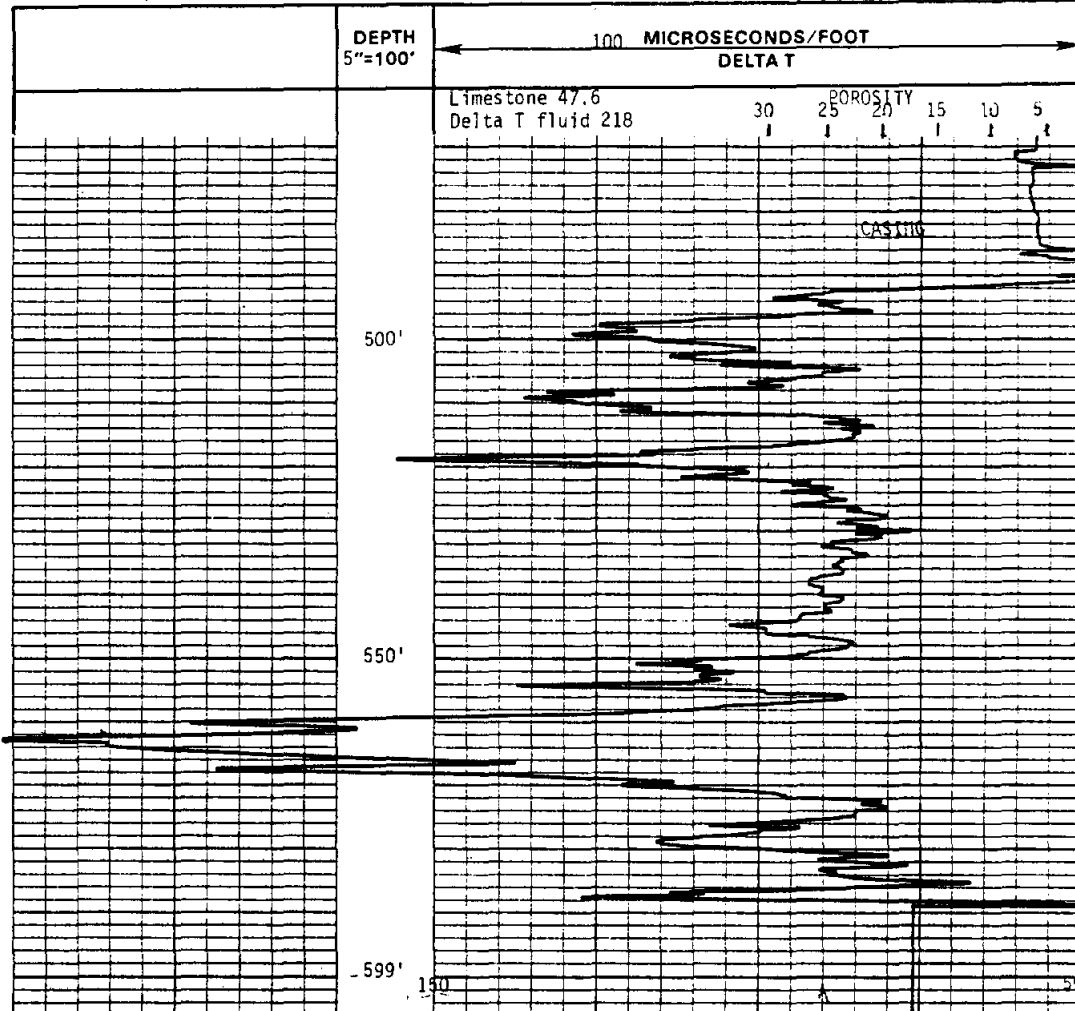
CASING DATA: 7" STEEL OPEN HOLE DIA.: 6"

CEMENTED FROM: SURF. TO 490' SCREEN: OPEN HOLE TO AQUIFER: HOSSTON

FLUID RESISTIVITY: \_\_\_\_\_ OHMS AT \_\_\_\_\_ ° F. REMARKS: WELL HAS BEEN ACIDIZED.

- GALIPER -  
HOLE DIAMETER IN INCHES  
FROM \_\_\_\_\_ TO \_\_\_\_\_

BOREHOLE COMPENSATED SONIC VELOCITY  
CALIBRATED FROM 50 TO 150 MICROSECONDS PER FOOT



P. O. Box 541332



Dallas, Texas 75354-1332

Well Logging Service

# Caliper Survey

COMPANY UPPER GUADALUPE RIVER AUTHORITY  
 WELL A.S.R. WELL PROJECT MONITOR WELL PZ-1  
 FIELD WATER WELL  
 COUNTY KERR STATE TEXAS

Location \_\_\_\_\_ Type Log **CALIPER**

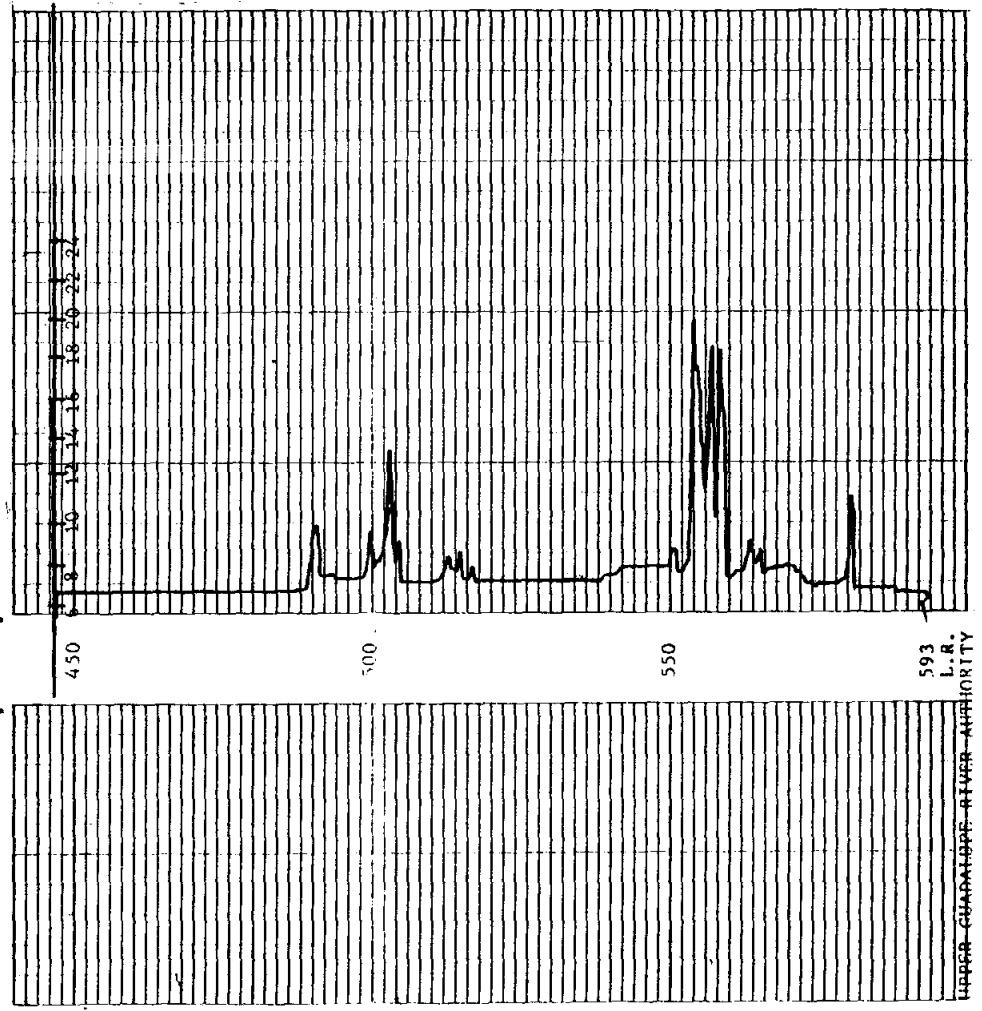
Permanent Datum: G.L. Elev: 1630' Elev. K.B. \_\_\_\_\_  
 Log Measured From: G.L. Ft. Above Perm. Datum \_\_\_\_\_ D.F. \_\_\_\_\_  
 Drilling Measured From: G.L. G.L. \_\_\_\_\_

Date 9-20-89  
 Run No. ONE  
 Depth Driller 593'  
 Depth Logger 593'  
 Max. Log Interval 50'  
 Depth Logged Interval 450'  
 Logging Driller 7"  
 Logging Logger \_\_\_\_\_  
 Bit Size 6-1/8"  
 Type Fluid in Hole WATER  
 Inside Gauge Circ. \_\_\_\_\_  
 Recorded By: M.A. LARGENT  
 Witnessed By: R. PETRUS

IN	BORE HOLE RECORD			CASING RECORD		
	Bit Size	From	To	Size	From	To
NE	6-1/8"	495'	620'	7"	SURFCAE	495'

REMARKS

CALIPER  
HOLE DIAM. IN INCHES



593  
L.R.  
UPPER GUADALUPE RIVER AUTHORITY



# Radioactivity Log

COUNTY _____	STATE _____	COMPANY <u>UPPER GUADALUPE RIVER</u>	LOCATION _____
LOCATION _____	WELL _____	WELL <u>A.S.R. WELL PROJECT</u>	LOCATION _____
COMPANY _____	FIELD <u>WATER WELL</u>	MONITOR WELL <u>PZ-1</u>	LOCATION _____
LOCATION _____	COUNTY <u>KERR.</u>	Elev. D.F. _____	K.B. _____
STATE <u>TEXAS</u>	Elev. <u>1630'</u>	Grd. _____	
Log. Meas. From <u>G.L.</u>	Elev. _____		
Drig. Meas. From <u>g.l.</u>	Elev. _____		
Perm. Datum <u>g.l.</u>	Elev. _____		

Type of Log	FLOWMETER	
Run No.	ONE	TWO
Date	9-20-89	9-20-89
Total Depth Reached	594'	594'
Total Depth Logged	594'	594'
Footage Logged	194'	194'
Fluid Level	206'	206'
Type of Fluid in Hole	water	water
Maximum Temp °F		
O.D. of Instrument	1-7/16"	1-7/16"
Length Meas Device-In	42"	42"
Time Constant-Sec.	1	1
Logging Speed Ft/Min.	100'	50'
Source Strength		
Source Spacing-In		
Sensitivity	100 cts	100 cts
Truck No.		
Opr Rig Time		
Recorded By	M.A. LARGENT	
Witness	R. PETRUS	

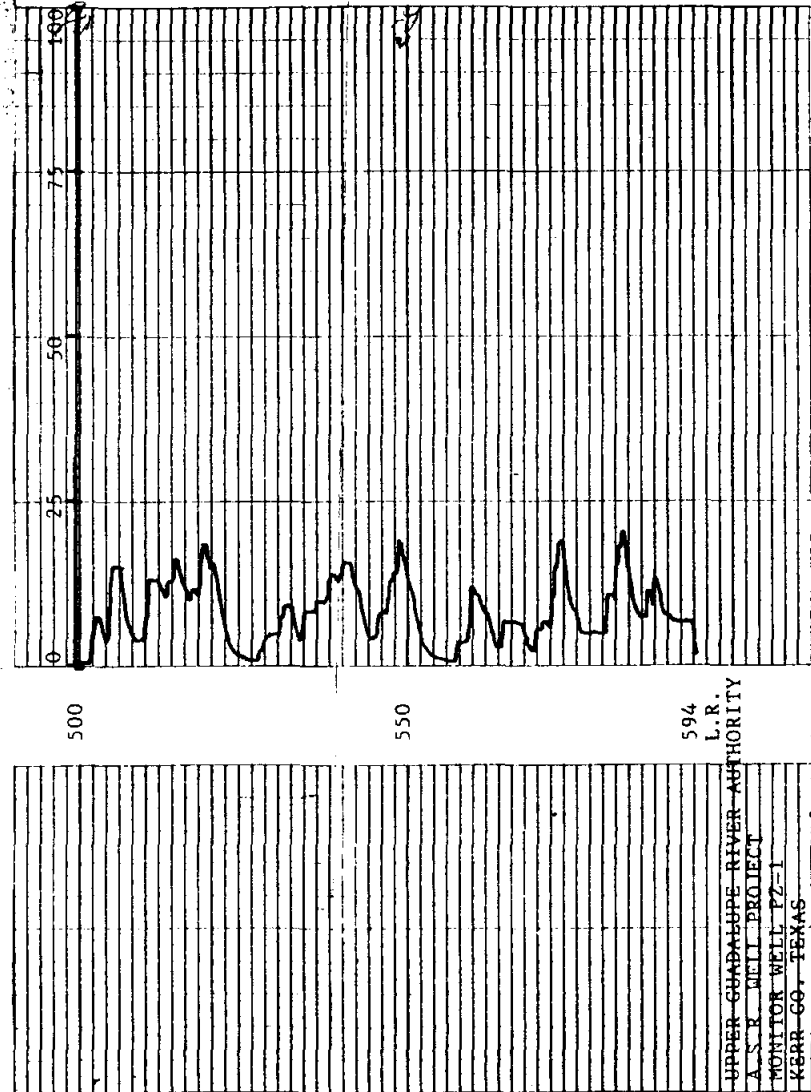
OPEN HOLE RECORD  
 Bit Size-in. Interval  
 6-1/8" 10 620'

CASING RECORD  
 Interval  
 495'

Run No. ONE	Size-in. 7"	Wt.-Lb. SURFACE	Interval
			10
			10
			10

Remarks FLOWMETER RUN IN OPEN HOLE WHILE BEING PRODUCED BY AIR INJECTION

RUN NO. 2







# Radioactivity Log

COUNTY _____	STATE _____	COMPANY <u>UPPER GUADALUPE RIVER</u>	LOCATION _____
LOCATION _____	WELL <u>A.S.R. WELL PROJECT</u>	FIELD <u>WATER WELL</u>	LOCATION _____
WELL _____	MONITOR WELL <u>PZ-1</u>	LOCATION _____	COUNTY <u>KERR.</u>
COMPANY _____	Log. Meas. From <u>G.L.</u>	Elev. <u>1630'</u>	K.B. _____
	Orig. Meas. From <u>g.l.</u>	Elev. _____	Grd. _____
	Perm. Datum <u>g.l.</u>	Elev. _____	

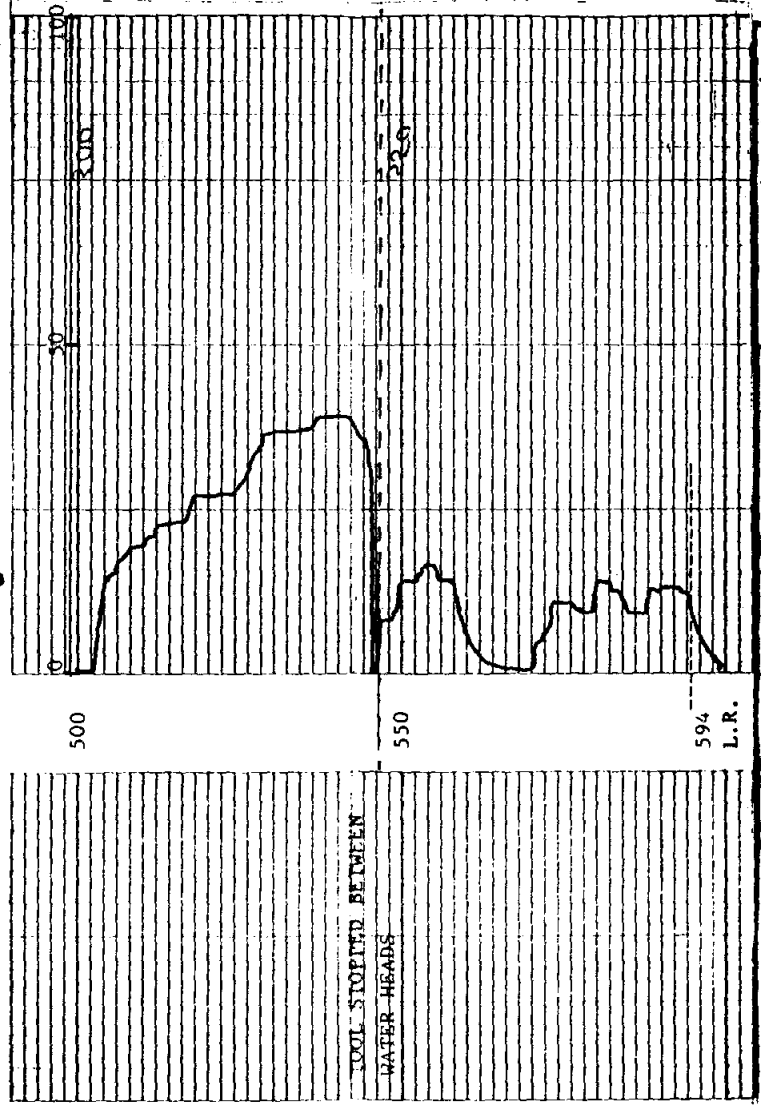
Type of Log	FLOWMETER	
Run No.	ONE	TWO
Date	9-20-89	9-20-89
Total Depth Reached	594'	594'
Total Depth Logged	594'	594'
Footage Logged	194'	194'
Fluid Level	206'	206'
Type of Fluid in Hole	water	water
Maximum Temp °F		
O.D. of Instrument	1-7/16"	1-7/16"
Length Meas Device-In.	42"	42"
Time Constant-Sec	1	1
Logging Speed Ft/Min	100'	50'
Source Strength		
Source Spacing-In		
Sensitivity	100 cts	100 cts
Truck No.		
Opr Rig Time		
Recorded By	M.A. LARGENT	
Witness	R. PETRUS	

Run No. <u>ONE</u>	Size-in. <u>7"</u>	Interval <u>to 495'</u>	Interval <u>to 620'</u>
Wt.-Lb. <u>SURFACE</u>			

Remarks FLOWMETER RUN IN OPEN HOLE WHILE BEING PRODUCED BY AIR INJECTION

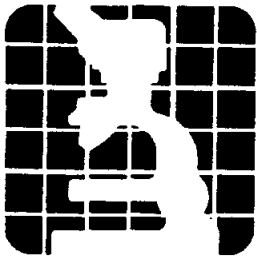
DEPTH AND CASING COLLARS	0	50	100
--------------------------	---	----	-----

Flow Log



**Appendix C**  
**MINERALOGY, INC. REPORT**

MINERALOGY  
INCORPORATED



3228 East 15th Street/Tulsa, Oklahoma 74104/(918) 744-8284

Where Science Gets Down to Earth

RECEIVED

SEP 21 1989

CH<sub>2</sub>M HILL  
AUSTIN

August 20, 1989

B. W. Bruns, P.E.  
Upper Guadalupe River Authority  
215 West Water Street  
Kerrville, TX 78029

XC: R. Petrus/DFW  
D. Pyne/GNV  
J. McLeod/AUS  
ORIG: D. Glanzman/1

SUBJECT

X-ray diffraction mineralogy, acid insoluble residue analysis, sieve analysis, porosity, permeability, grain density, specific gravity, cation exchange capacity, SEM, thin section, energy dispersive chemical analysis, and core photographs with descriptions of five (5) samples from four (4) cores from the Kerrville ASR Project.

CONCLUSIONS

The samples from four cores were:

481.1'-481.8' A gray dolomitic shale with good porosity (24.3%) but little or no permeability. The shale contained silty, sandy, dolomite streaks and burrows with some scattered glauconite grains. Some of the fine micro shell fragments in the shale were removed by dissolution leaving scattered minor fine dissolution porosity.

511.5'-512.0' A mottled fractured reddish to brownish, silty, sandy dolomite. The fractures were healed by a fine crystalline grayish dolomite. The porosity was good at 19.2%, but the permeability was low at 4.48 md. vertical permeability and 38.2 md. horizontal permeability.

539.6'-540.3' A fine sandy dolomite grading abruptly into a dolomite-cemented conglomerate. The conglomerate had 29.8% porosity and 1505.0 md. horizontal permeability. The vertical permeability was only 24.7 md. The good permeability follows horizontal bedding planes containing high variable porosity. The fine

sandy dolomite with the conglomerate had 24.7% porosity and 91.6 md. vertical permeability and 95.3 md. horizontal permeability. The low permeability in the crystalline dolomite is due to the fine pore size. Most of the porosity in the dolomites is micro intercrystalline porosity.

552.5'-553.4' A reddish, very fine crystalline, silty dolomite, with light gray to tan irregular inclusions and streaks. At 552.5'-552.7' the dolomite was tannish with grayish mottles. The porosity was 18.3%. The permeability was very low at 0.32 md. vertical and 1.71 md. horizontal permeability.

The dolomite samples were originally deposited as sandy, silty limestone containing shell fragments and scattered glauconite grains. Dissolution of some shell fragments created vuggy porosity in some core examined. The limestone was recrystallized as fine crystalline dolomite with intercrystalline micro porosity.

The clay in these samples is primarily allogenic and was deposited with the fine silt and sand. Some of the illite and mixed-layer illite/smectite is glauconite. Glauconite is the physical form, a greenish pellet and not a mineral.

## DISCUSSION OF RESULTS

### 1. X-RAY MINERALOGY (Table 1)

Four of the samples were sandy dolomites to dolomitic, silty, sands. One sample was a dolomitic shale. Most of the illite and mixed-layer illite/smectite shown in x-ray results is glauconite with the exception of the shale sample at 481'6"-481'7", where most of the reported illite and mixed-layer illite/smectite is not mostly glauconite pellets. The feldspar in the samples is K-feldspar.

### 2. ACID RESIDUE ANALYSIS (Table 2)

The acid residues reflect the amount of carbonate present, primarily dolomite.

### 3. GRAIN SIZE DISTRIBUTION SIEVE ANALYSIS (Table 3)

These samples were fine to very fine-grained with the exception of the conglomerate at 539.6'. The particle size of the authigenic dolomite in the samples was very fine. This was also reflected in the high porosities with low permeabilities.

4. POROSITY, PERMEABILITY AND GRAIN DENSITY (Table 4)

The porosities were high but permeabilities were generally low due to dolomite crystal size. The horizontal permeability in the conglomerate was excellent, but due to porosity variations from thin bed to thin bed and to pore size changes, the vertical permeabilities were very low. The grain densities were generally high due to the predominance of dolomite in the samples.

5. SPECIFIC GRAVITY (Table 5)

The specific gravity was lowest in the shale (2.42) and was highest in the conglomerate and the sandy dolomite associated with the conglomerate. The sandy dolomite was 2.63.

6. CATION EXCHANGE CAPACITY (Table 6)

The cation exchange capacity was greatest in the shale (11.1) but was low in other samples, ranging from 0.7 to 4.5 meg/100 grams. The low cation exchange reflects the low clay percentages, particularly the small amounts of the illite/smectite mixed-layering. Smectite is the clay mineral with the high CEC.

7. SCANNING ELECTRON MICROSCOPE-SEM (Figures 1-5)

The results primarily show the dolomite with fine micro inter-crystalline porosity. Figure 2 (511'11"-512'0") shows dolomite with fine intercrystalline porosity in the left side of photograph "A" at 50X and on the right-hand side of the photograph, a very fine crystalline vuggy dolomite. Associated with the vugs is very fine intercrystalline porosity.

8. THIN SECTION PHOTOGRAPHS WITH DESCRIPTIONS (Figures 6-10)

The thin section results show the fine crystal size of the dolomite. Figure 6 shows a burrow infilled with silt and carbonate in the left side of the photograph. The burrow is perpendicular to the black organic, thin parallel bedding streaks. The porosity is in streaks parallel to bedding planes and varies from thin bed to thin bed.

9. ENERGY DISPERSIVE-CHEMICAL ANALYSIS (Figures 11-15)

The energy dispersive analysis reflects the mineralogy which is primarily dolomite, a calcium magnesium carbonate, and quartz, which is silica. Energy dispersive analysis does not detect light elements well. A small magnesium peak is indicative of a considerable amount of magnesium. Aluminum reflects feldspar and clay. Iron is associated with clay, dolomite, and primarily as red iron oxide staining samples. Potassium reflects the K-feldspar and illite.

10. THIN SLAB PHOTOGRAPHS AND DESCRIPTIONS (Figure 16-4 pages)

These results show the general physical appearance of the core with descriptions of the core. Most of the core analyzed was a fine, sandy, silty, dolomite. The physical appearance and rock properties varied from thin bed to thin bed within each core.

If there are any questions, please call.

A. Jack Nash

A handwritten signature in cursive script, appearing to read "A. Jack Nash". The signature is written in black ink and is positioned to the left of the typed name.

AJN/mcj

cc: John S. McLeod

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Thin section photographs and descriptions.....Figures 6-10

Energy dispersive chemical analysis.....Figures 11-15

Photos of thin slab core with descriptions.....Figure 16





TABLE 2

ACID INSOLUBLE RESIDUE ANALYSIS

<u>DEPTH</u>	<u>PERCENT ACID SOLUBLE</u>
481'6"-481'7".....	14.0%
511'11"-512'0".....	71.4%
539'11".....	63.7%
540'½"-540'1½".....	54.7%
552'7"-552'8".....	34.5%

KERRVILLE ASR PROJECT TEX24486.A1

GRAIN SIZE DISTRIBUTION-SIEVE ANALYSIS

TABLE 3

(3 pages)

SIEVE ANALYSIS

Sample: 481.8'

Well: Kerrville ASR Project

Sieve Size (in microns)

Weight Percent

> 2000	Pebbles	
< 2000 > 1000	Very coarse grained sandstone	
< 1000 > 500	Coarse grained sandstone	
< 500 > 250	Medium grained sandstone	
< 250 > 125	Fine grained sandstone	.7%
< 125 > 62	Very fine grained sandstone	2.2%
< 62 (pan)	Silt and clay	97.1%

---

Sample: 512.0'

Well: Kerrville ASR Project

Sieve Size (in microns)

Weight Percent

> 2000	Pebbles	
< 2000 > 1000	Very coarse grained sandstone	
< 1000 > 500	Coarse grained sandstone	
< 500 > 250	Medium grained sandstone	.1%
< 250 > 125	Fine grained sandstone	.2%
< 125 > 62	Very fine grained sandstone	31.3%
< 62 (pan)	Silt and clay	68.4%

SIEVE ANALYSIS

Sample: 539.6'

Well: Kerrville ASR Project

<u>Sieve Size (in microns)</u>		<u>Weight Percent</u>
> 2000	Pebbles	4.9%
< 2000 > 1000	Very coarse grained sandstone	29.1%
< 1000 > 500	Coarse grained sandstone	25.1%
< 500 > 250	Medium grained sandstone	15.6%
< 250 > 125	Fine grained sandstone	4.4%
< 125 > 62	Very fine grained sandstone	6.4%
< 62 (pan)	Silt and clay	14.5%

Sample: 540.5'

Well: Kerrville ASR Project

<u>Sieve Size (in microns)</u>		<u>Weight Percent</u>
> 2000	Pebbles	
< 2000 > 1000	Very coarse grained sandstone	trace
< 1000 > 500	Coarse grained sandstone	trace
< 500 > 250	Medium grained sandstone	.3%
< 250 > 125	Fine grained sandstone	10.7%
< 125 > 62	Very fine grained sandstone	54.4%
< 62 (pan)	Silt and clay	34.6%

SIEVE ANALYSIS

Sample: 552.6'

Well: Kerrville ASR Project

Sieve Size (in microns)

Weight Percent

> 2000		Pebbles	
< 2000	> 1000	Very coarse grained sandstone	trace
< 1000	> 500	Coarse grained sandstone	trace
< 500	> 250	Medium grained sandstone	.1%
< 250	> 125	Fine grained sandstone	1.5%
< 125	> 62	Very fine grained sandstone	16.0%
< 62	(pan)	Silt and clay	82.4%

---

Sample: \_\_\_\_\_

Well: \_\_\_\_\_

Sieve Size (in microns)

Weight Percent

> 2000		Pebbles	
< 2000	> 1000	Very coarse grained sandstone	
< 1000	> 500	Coarse grained sandstone	
< 500	> 250	Medium grained sandstone	
< 250	> 125	Fine grained sandstone	
< 125	> 62	Very fine grained sandstone	
< 62	(pan)	Silt and clay	



TABLE 5

SPECIFIC GRAVITY

<u>DEPTH</u>		<u>SPECIFIC GRAVITY</u>
481'6"-481'7"	Gray shale with silty dolomitic streaks	2.42
511'11"-512'0"	Silty dolomitic sandstone to sandy dolomite	2.46
539'11"	Conglomerate sandstone with silty dolomitic matrix	2.58
540'½"-540'1½"	Silty dolomitic sandstone to sandy dolomite	2.63
552'7"-552'8"	Silty dolomitic sandstone to sandy dolomite	2.54

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TABLE 6

CATION EXCHANGE CAPACITY

<u>DEPTH</u>	<u>CEC (meg/100 grams of core)</u>
481'2"	11.1
512'0"	1.2
539'6"	0.7
540'½"	2.6
552'7"	4.5

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TEX24486.A1



SEM ANALYSIS

FIGURES 1-5

FIGURE 1

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

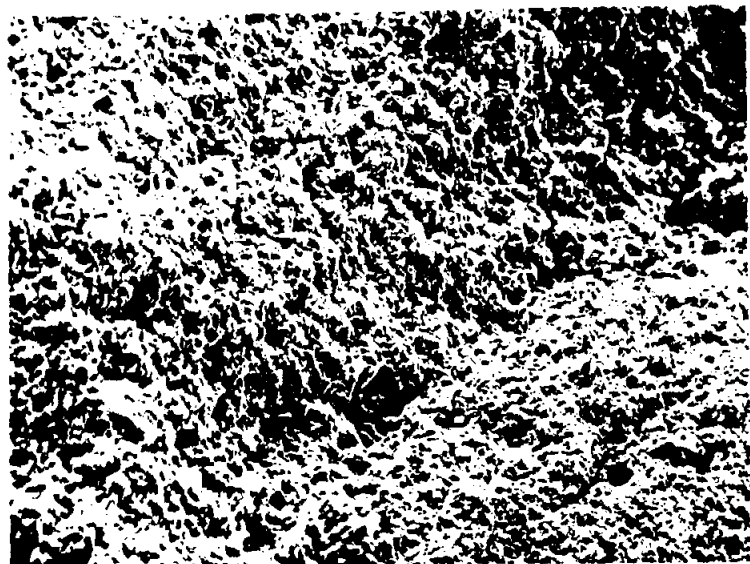
481'6"-481'7"

- A&B      Black, thin-bedded shale. Small fossil shell fragments. No visible porosity.
- C&D      Carbonate fragment with pinhole dissolution. Thin-bedded shale platelet shown in photograph at 2000X.

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

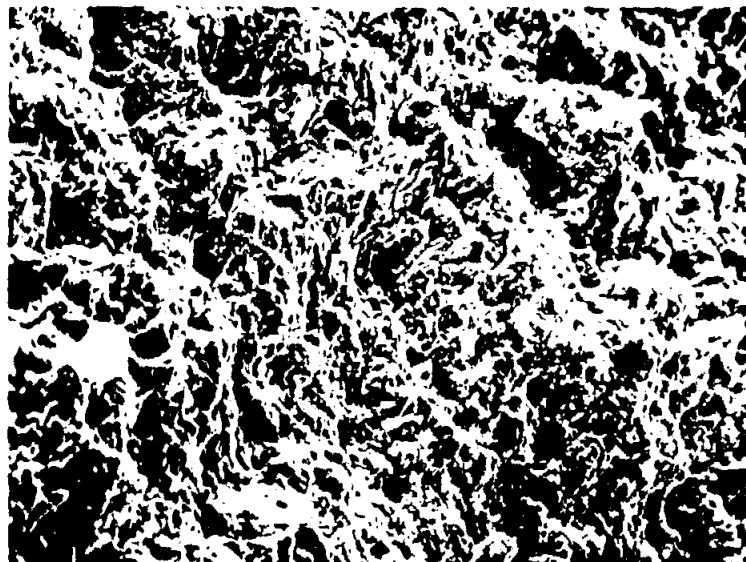
481'6"-481'7"



A.

50X

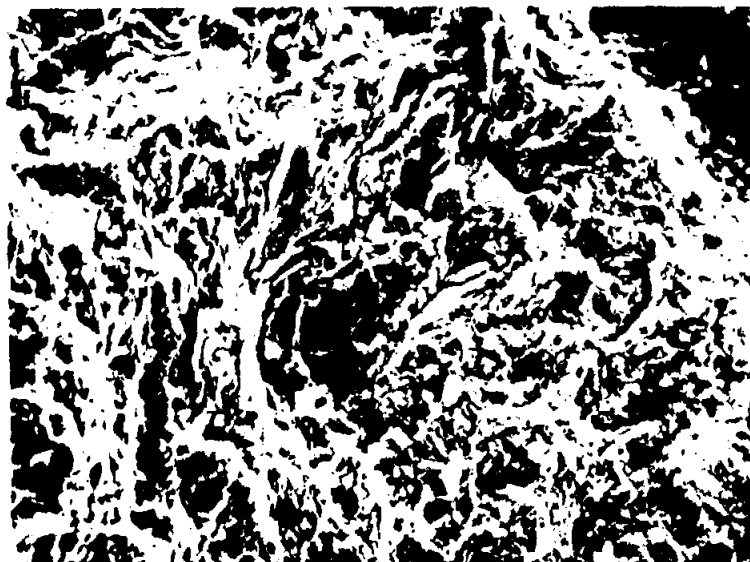
200  $\mu$



B.

200X

50  $\mu$



C.

500X

20  $\mu$



D.

2000X

5  $\mu$

TS. NO.

DATE

FIGURE 1.

FIGURE 2

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

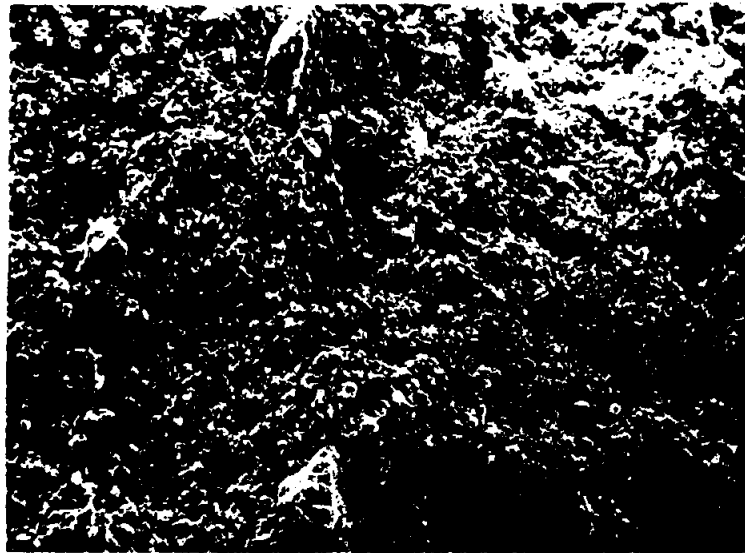
511 '11"-512 '0"

- A&B Sandy dolomite with well-rounded fine sand and silt grains. Intercrystalline porosity and dissolution of scattered grains on the left side of the photograph at 50X. On the right side of the photograph at 50X is finer crystalline dolomite with vuggy and fine dissolution pores.
- C&D Dolomite crystals with intercrystalline porosity. Dolomite crystals and a rounded fine sand grain in photograph at 500X.

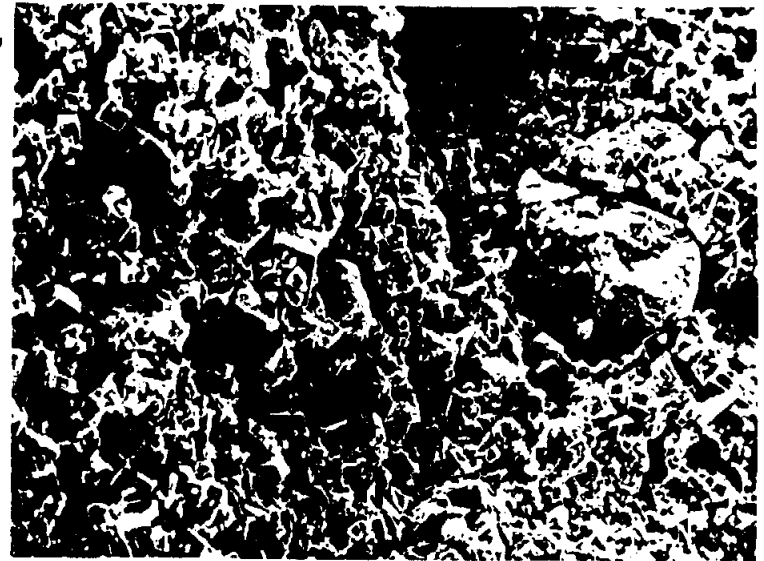
UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

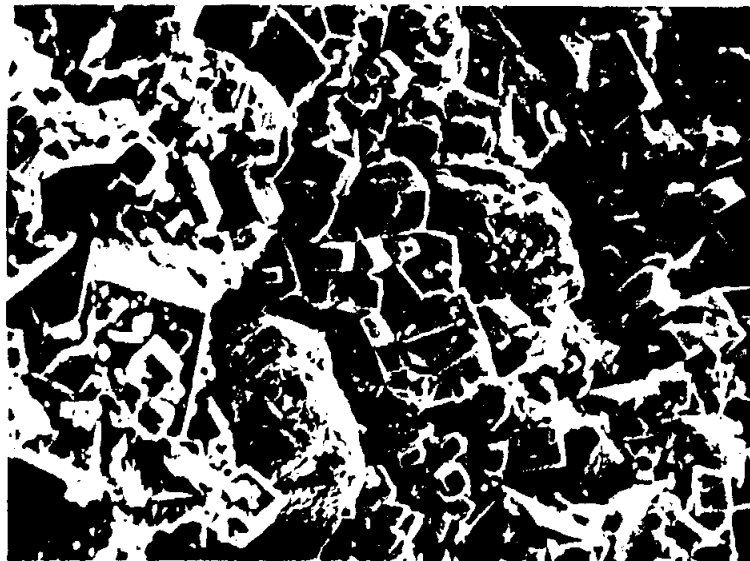
511'11"-512'0"



A. 50X 200 μ



B. 200X 50 μ



C. 500X 20 μ



D. 2000X 5 μ

TS. NO.

DATE

FIGURE 2.

FIGURE 3

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

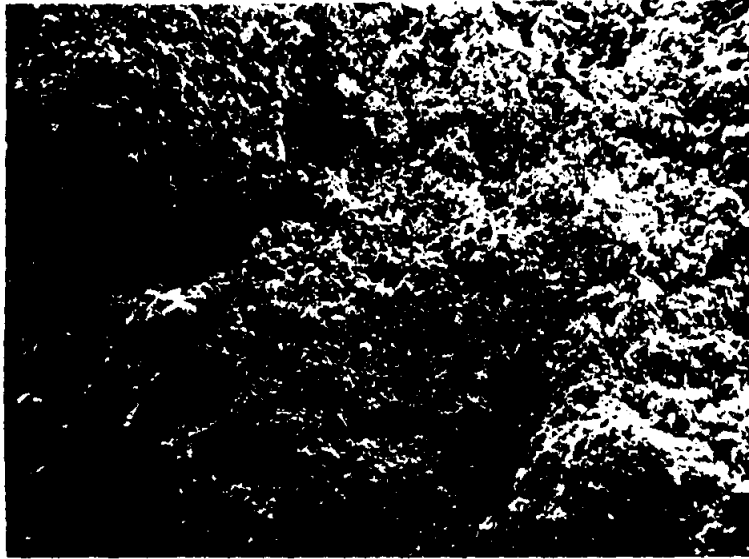
539'11"

- A&B Dolomite cemented conglomerate pebble in upper left side of photograph at 50X.
- C&D Dolomite crystals cementing conglomerate grains. Intercrystalline porosity between dolomite crystals.

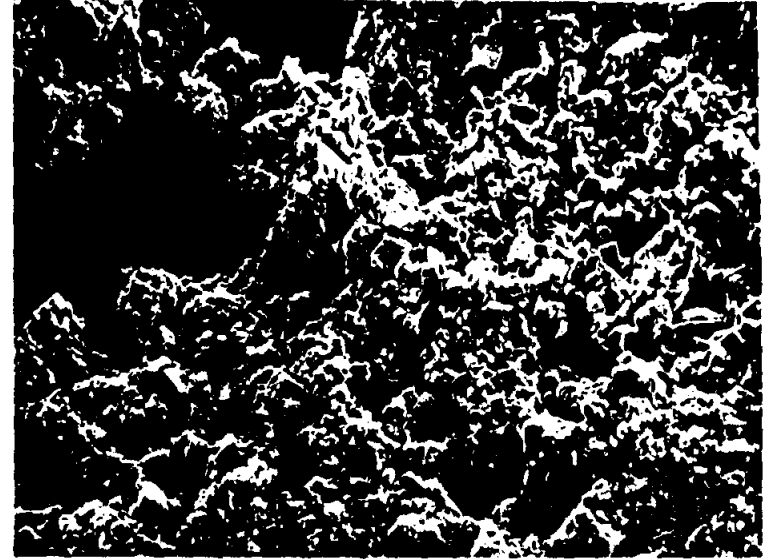
UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486 .A1

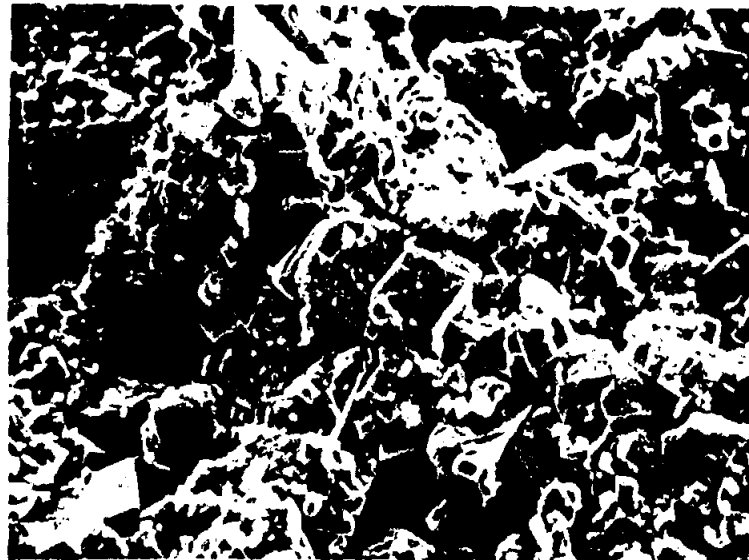
539 '11"



A. 50X 200 μ



B. 200X 50 μ



C. 500X 20 μ



D. 2000X 5 μ

TS. NO.

DATE

FIGURE 3.

FIGURE 4

UPPER GUADALUPE RIVER AUTHORITY

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TEX24486.A1

540'½"-540'1½"

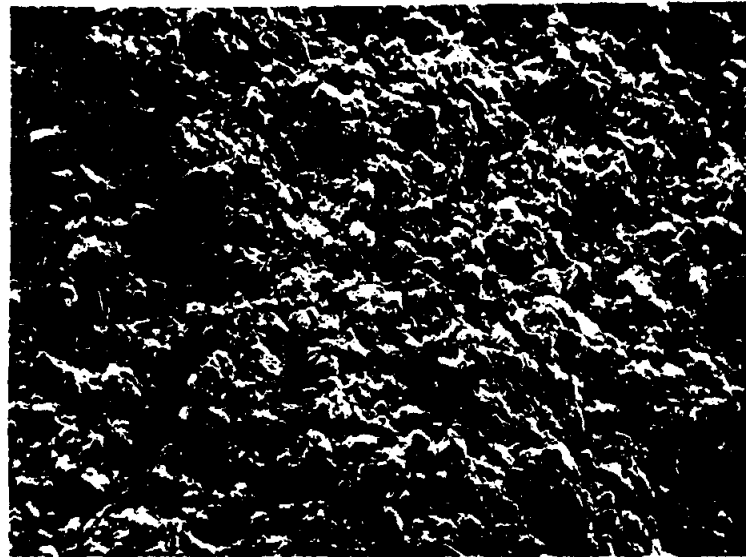
- A&B Sandy, fine crystalline dolomite. Well-rounded fine sand grains.
- C&D Intercrystalline porosity between dolomite grains.



UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

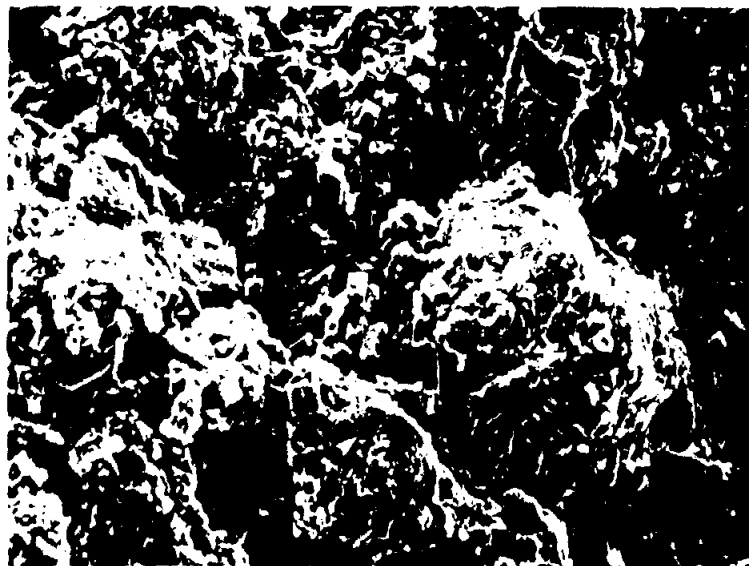
540'  $\frac{1}{2}$ " - 540'  $1\frac{1}{2}$ "



A. 50X 200  $\mu$



B. 200X 50  $\mu$



C. 500X 20  $\mu$



D. 2000X 5  $\mu$

TS. NO.

DATE

FIGURE 4.

FIGURE 5

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486 .A1

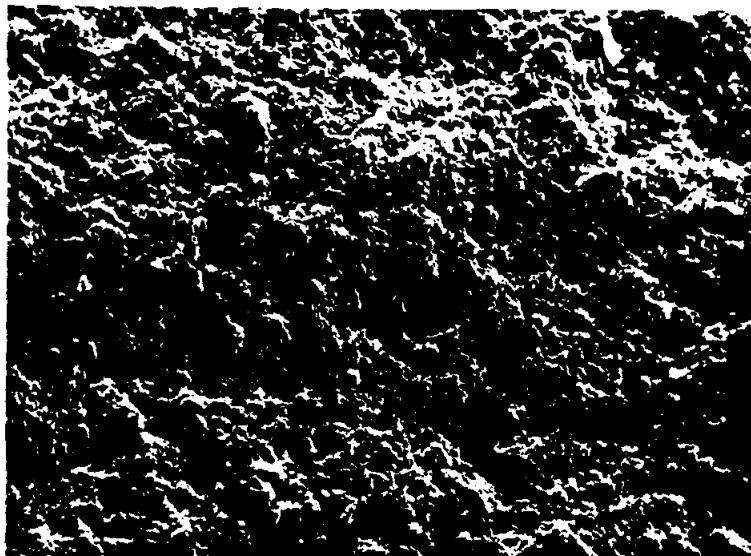
552'7"-552'8"

- A&B Very fine-grained, silty dolomitic sandstone to sandy fine crystalline dolomite. No visible macro porosity.
- C&D Small dissolution pore with authigenic koalinite crystals and scattered fine dolomite crystals attached to the surface of the pore.

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

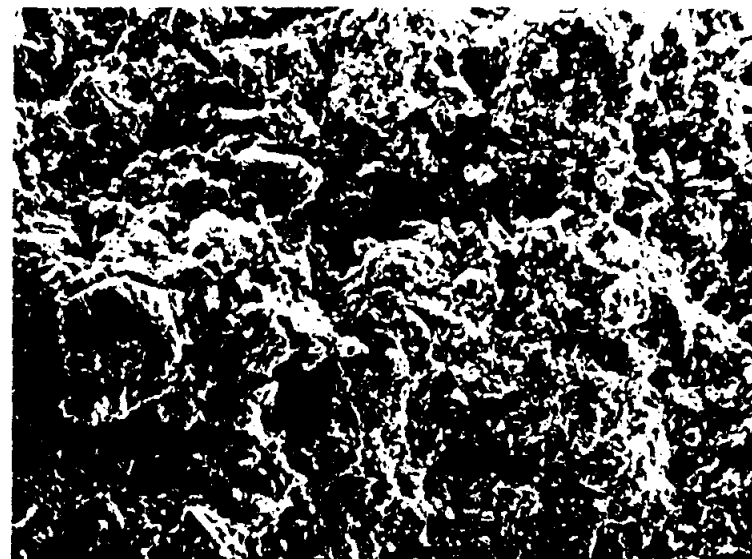
552'7"-552'8"



A.

50X

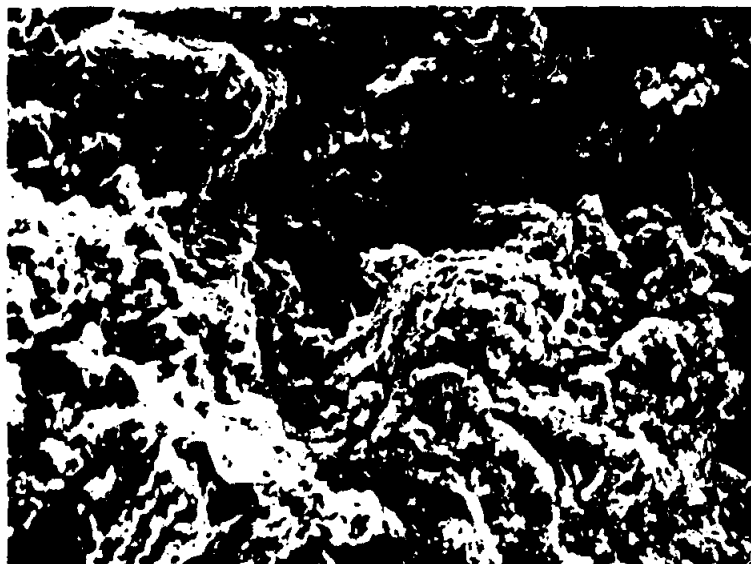
200  $\mu$



B.

200X

50  $\mu$



C.

500X

20  $\mu$



D.

2000X

5  $\mu$

TS. NO.

DATE

FIGURE 5

THIN SECTION PHOTOGRAPHS AND DESCRIPTIONS

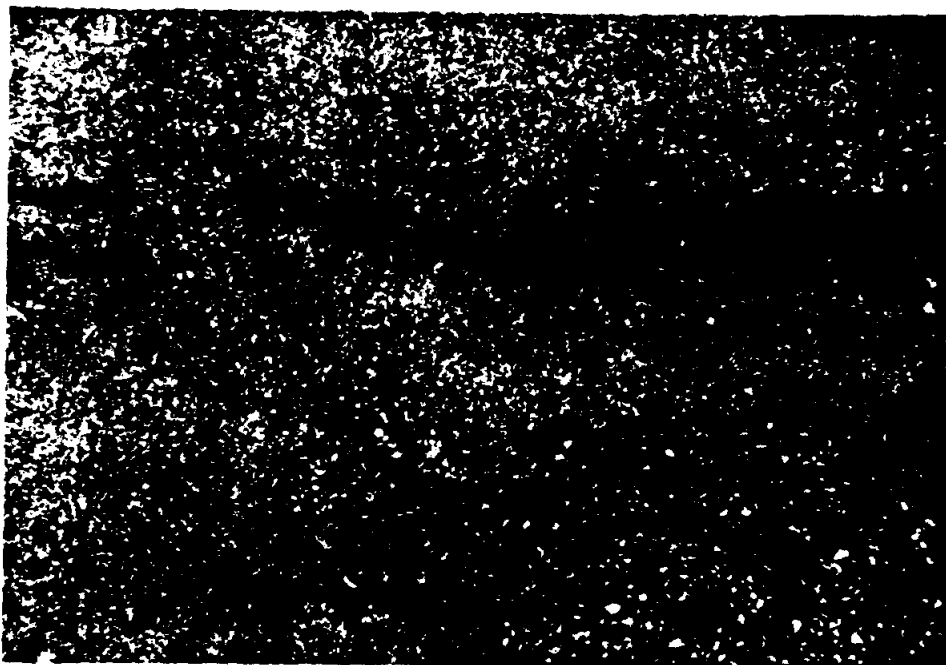
FIGURES 6 - 10

FIGURE 6

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

481'6"-481'7"



THIN SECTION PHOTO  
40X

THIN SECTION DESCRIPTION

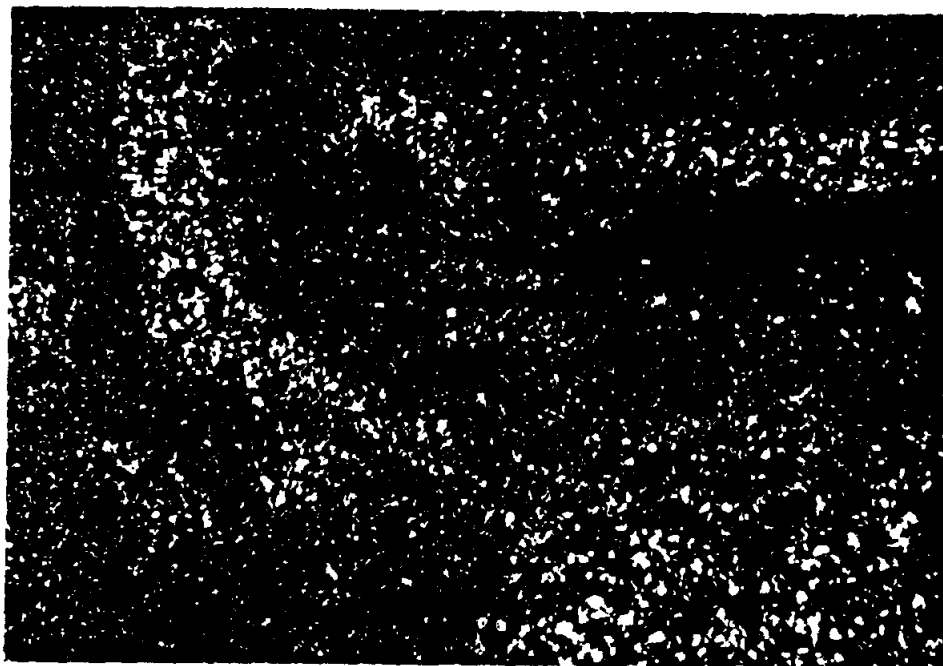
Gray shale, silty dolomitic streaks. Burrows, some containing pyrite as scattered inclusions. Scattered silt-size to very fine sand-size glauconite grains. Dolomite occurs as fine to very fine grains and crystals in the silty streaks. The silty streaks contain scattered minor dissolution porosity. No visible porosity except for minor to trace amounts of dissolution porosity associated with the dolomitic silt and very fine dolomitic sand.

FIGURE 6

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

481'6"-481'7"



THIN SECTION PHOTO  
40X

x-nicols

THIN SECTION DESCRIPTION

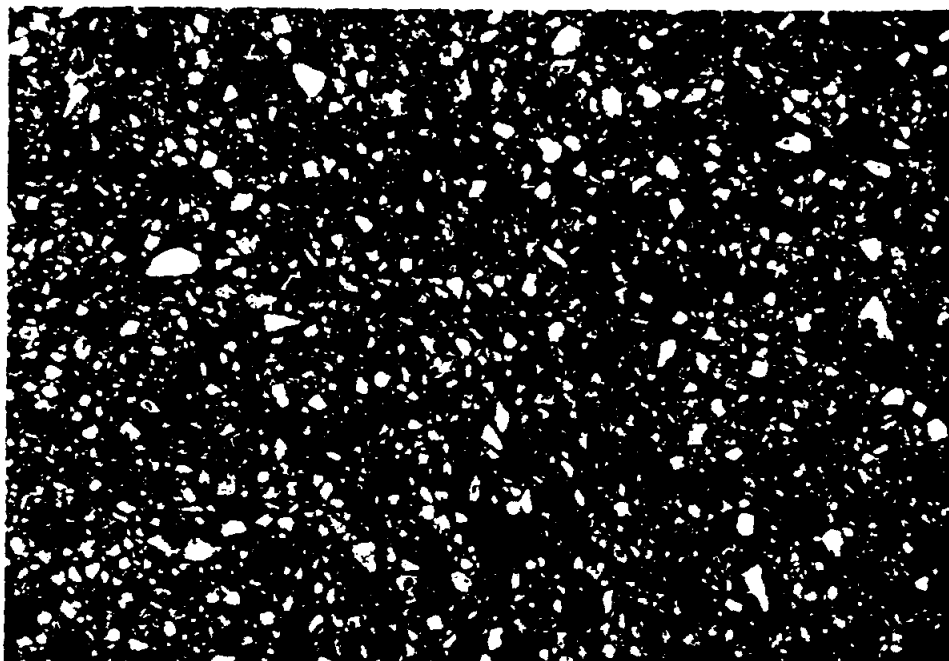
Gray shale, silty dolomitic streaks. Burrows, some containing pyrite as scattered inclusions. Scattered silt-size to very fine sand-size glauconite grains. Dolomite occurs as fine to very fine grains and crystals in the silty streaks. The silty streaks contain scattered minor dissolution porosity. No visible porosity except for minor to trace amounts of dissolution porosity associated with the dolomitic silt and very fine dolomitic sand.

FIGURE 7

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

511'11"-512'0"



THIN SECTION PHOTO  
40X

THIN SECTION DESCRIPTION

Very fine, silty dolomitic sandstone to sandy dolomite. Sand grains are subrounded. Scattered glauconite grains. Scattered visible fine dissolution pores in half of the sample with pink hematite staining. The grayish-colored part of the sample has vuggy dissolution porosity. The pores are much larger than in the pink part of the sample.

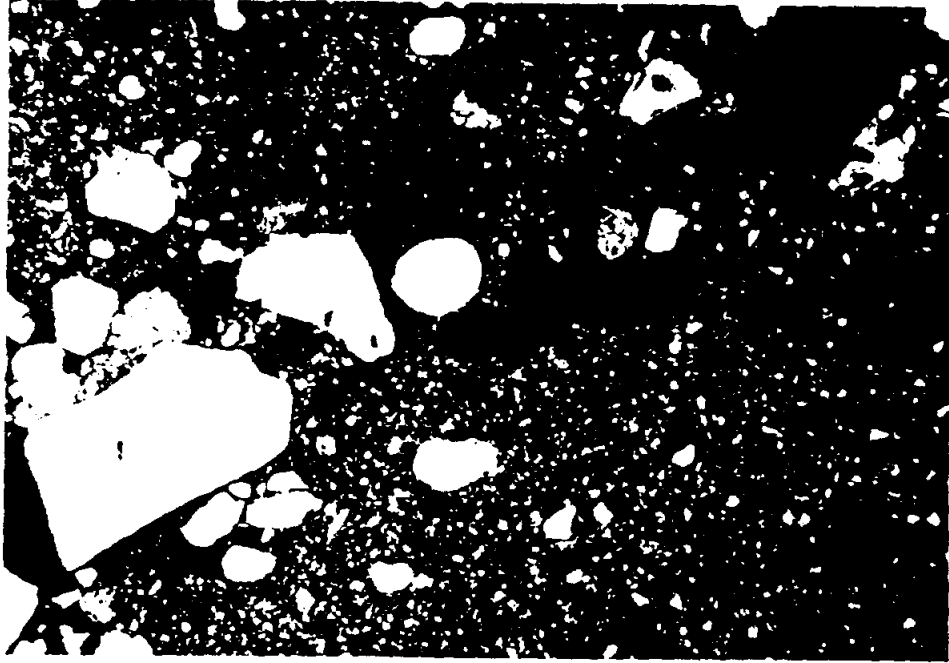
Porosity in the thin section photograph is shown in blue.

FIGURE 8

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

539'11"



THIN SECTION PHOTO  
40X

THIN SECTION DESCRIPTION

This thin section shows the contact between a very fine dolomitic sand to siltstone and a conglomerate sandstone made up of rounded quartz and rock fragment grains up to pebble size, cemented by fine crystalline, silty, sandy dolomite. One or two well-rounded dolomite pebble grains. Scattered macro and micro dissolution porosity in the conglomerate matrix. Some fractured pebbles and grains with inherited healed fractures. Some grains show undulatory extinction due to metamorphic strain. The finer dolomitic sand to siltstone has scattered minor dissolution porosity, and is cemented with red hematite-stained dolomite. There are a few scattered fine glauconite grains. The contact between the fine sand to siltstone and the conglomerate is irregular with scattered coarse grains scattered into the fine siltstone to sandstone. The conglomerate has fair visible macro porosity.

Porosity in the thin section photograph is shown in blue.

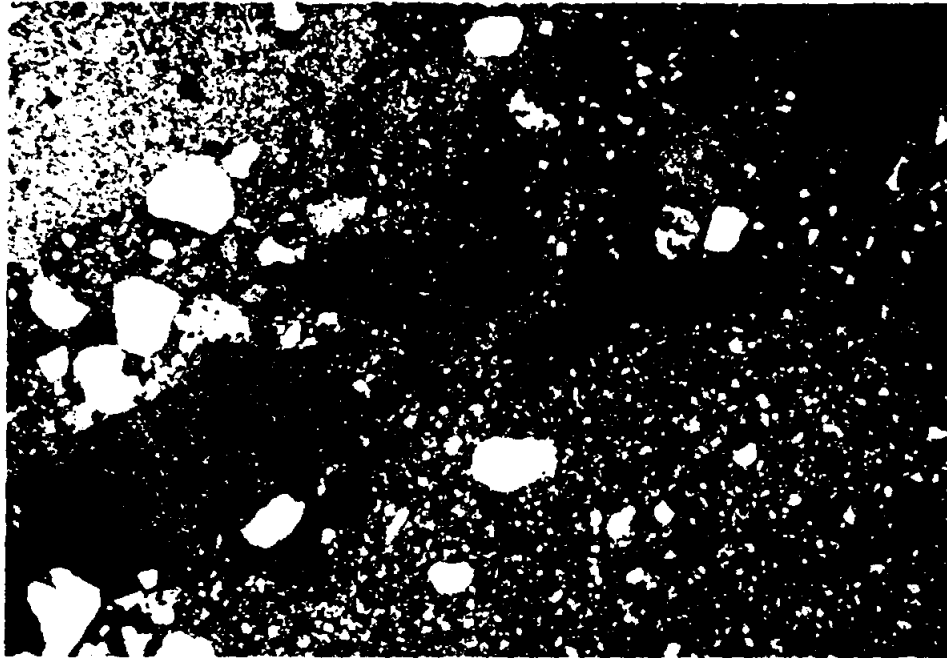


FIGURE 8

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

539'11"



THIN SECTION PHOTO

40X  
x-nicols

THIN SECTION DESCRIPTION

This thin section shows the contact between a very fine dolomitic sand to siltstone and a conglomerate sandstone made up of rounded quartz and rock fragment grains up to pebble size, cemented by fine crystalline, silty, sandy dolomite. One or two well-rounded dolomite pebble grains. Scattered macro and micro dissolution porosity in the conglomerate matrix. Some fractured pebbles and grains with inherited healed fractures. Some grains show undulatory extinction due to metamorphic strain. The finer dolomitic sand to siltstone has scattered minor dissolution porosity, and is cemented with red hematite-stained dolomite. There are a few scattered fine glauconite grains. The contact between the fine sand to siltstone and the conglomerate is irregular with scattered coarse grains scattered into the fine siltstone to sandstone. The conglomerate has fair visible macro porosity.

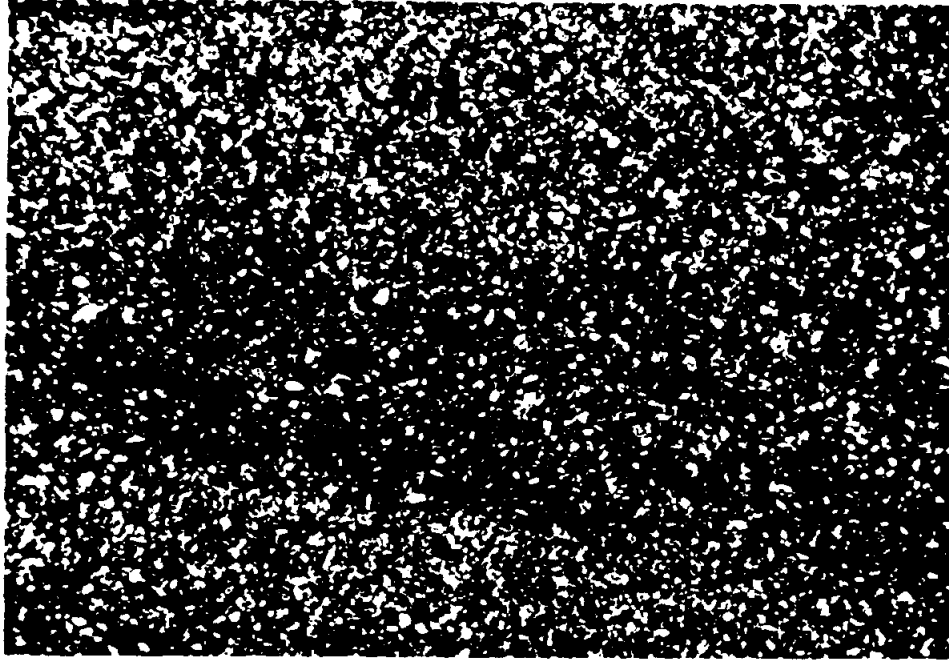
Porosity in the thin section photograph is shown in blue.

FIGURE 9

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

540'½"-540'1½"



THIN SECTION PHOTO  
40X

THIN SECTION DESCRIPTION

Very fine crystalline, sandy, silty, dolomite. Scattered dissolution porosity. Scattered green glauconite grains. Thin-bedded streaks of pink iron-staining, marking thin bedding planes. Some quartz grains are partially replaced by dolomite along grain edges. Minor intercrystalline porosity.

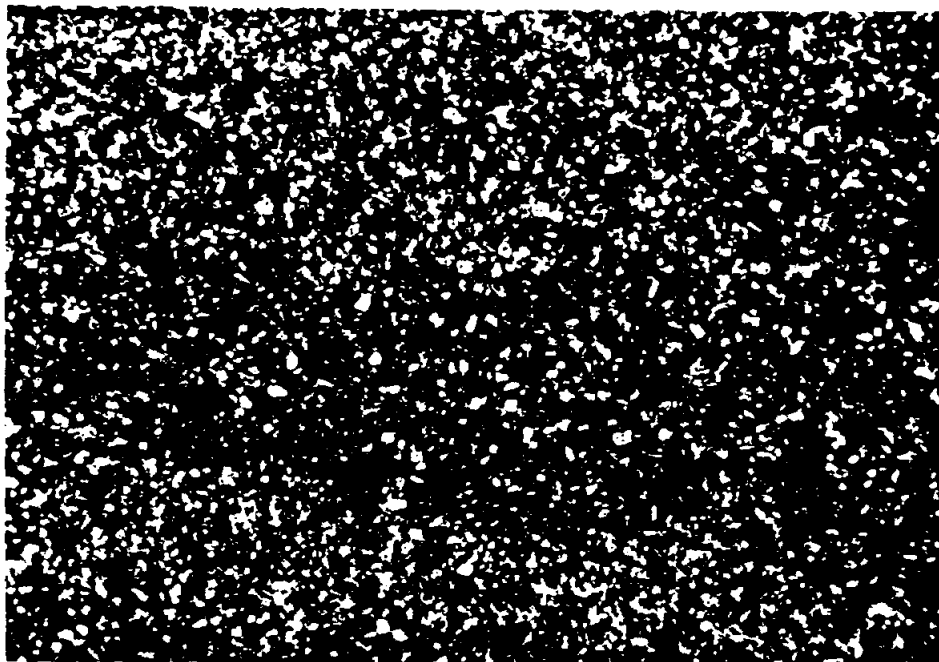
Porosity in the thin section photograph is shown in blue.

FIGURE 9

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

540'½"-540'1½"



THIN SECTION PHOTO  
40X

x-nicols

THIN SECTION DESCRIPTION

Very fine crystalline, sandy, silty, dolomite. Scattered dissolution porosity. Scattered green glauconite grains. Thin-bedded streaks of pink iron-staining, marking thin bedding planes. Some quartz grains are partially replaced by dolomite along grain edges. Minor intercrystalline porosity.

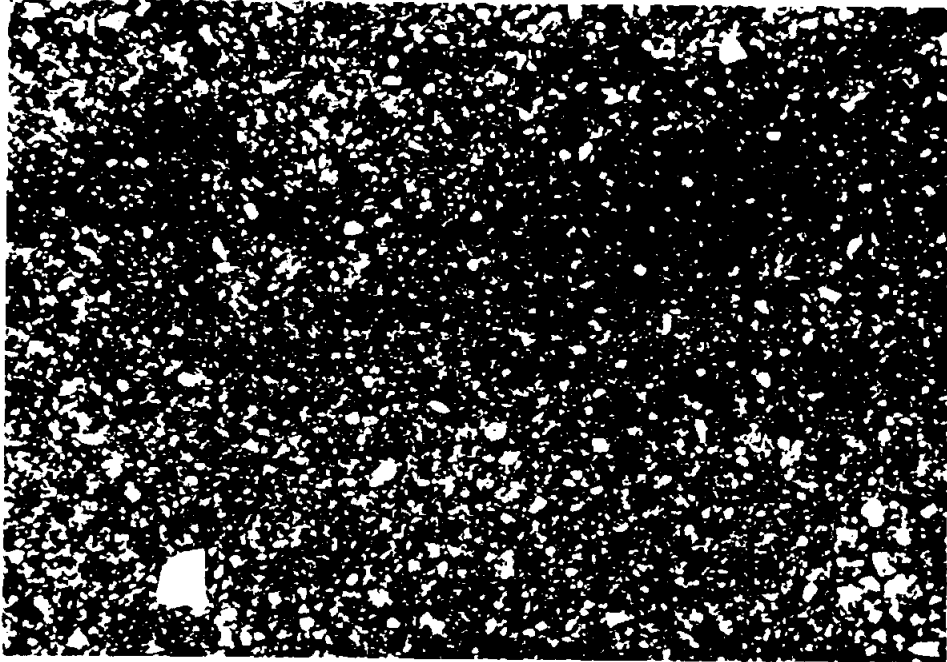
Porosity in the thin section photograph is shown in blue.

FIGURE 10

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

552'7"-552'8"



THIN SECTION PHOTO  
40X

THIN SECTION DESCRIPTION

Thin-bedded, very fine silty dolomitic sand to sandy dolomite. Pink staining from oxidized iron. Scattered thin argillaceous beds. Brownish color in some thin beds may be organic streaks. A few scattered fine sand grains. Scattered fine particle-sized green glauconite grains. Minor amounts of very fine dissolution porosity. Some quartz grains are angular and other grains are well rounded.

Porosity in the thin section photograph is shown in blue.

ENERGY DISPERSIVE CHEMICAL ANALYSIS

Figures 11-15

FIGURE 11

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

481'6"-481'7"

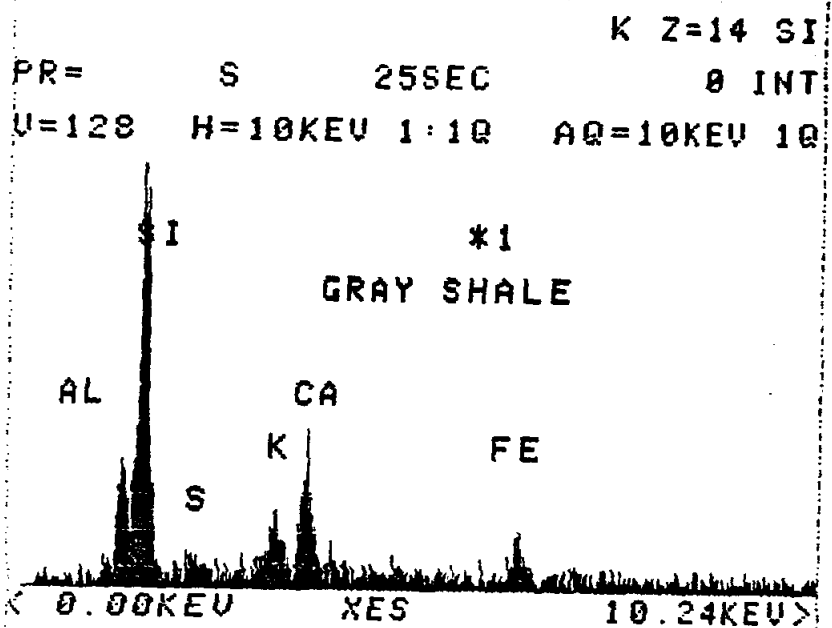


FIGURE 12

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

5-1'11"-512'0"

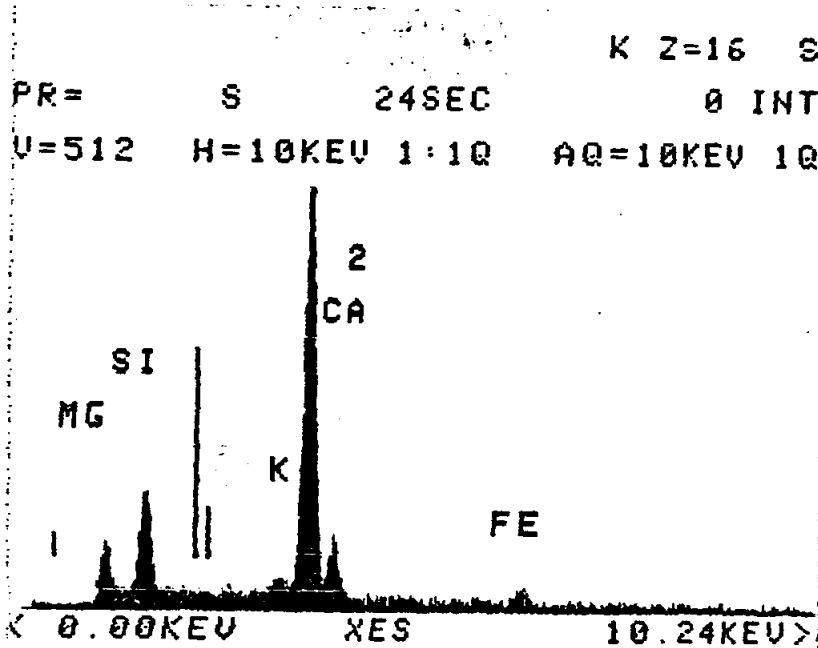


FIGURE 13

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

539'11"

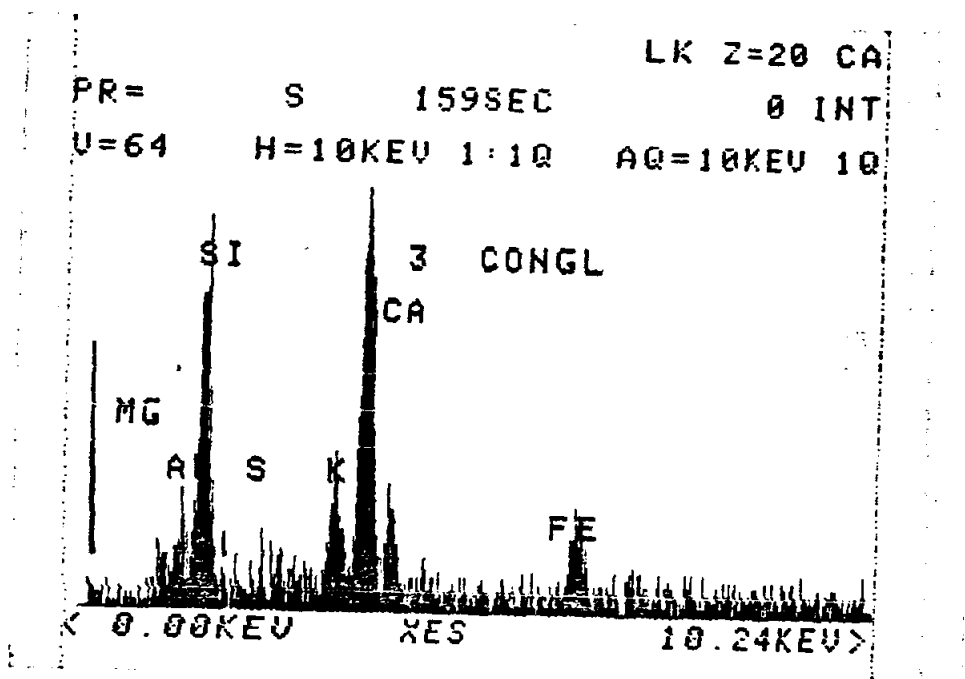




FIGURE 14

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

540'½"-540'1½"

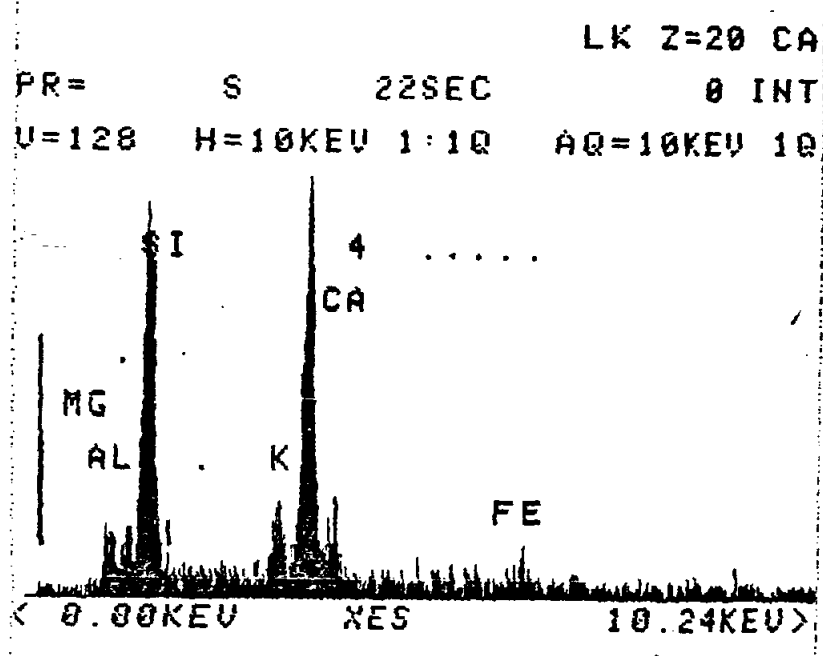
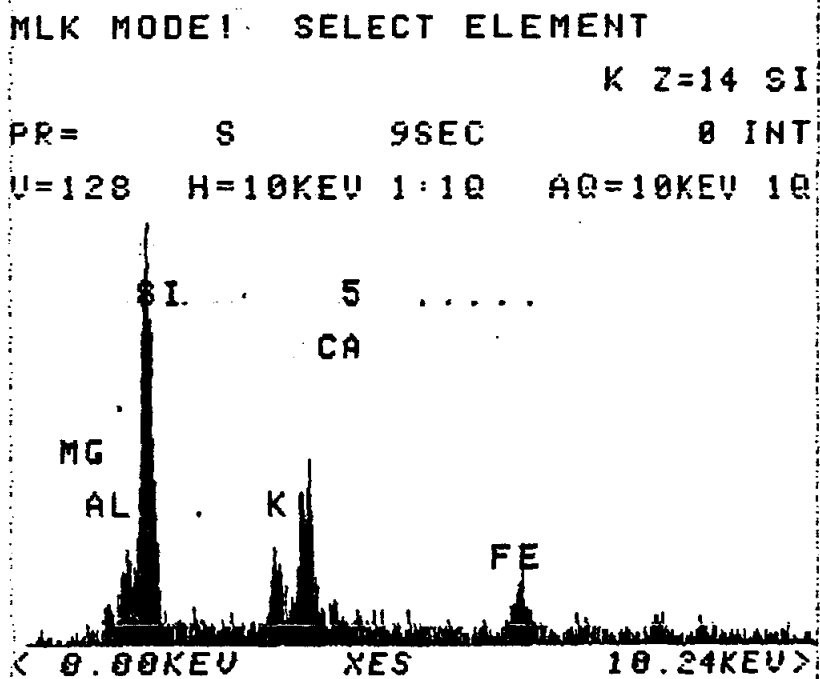


FIGURE 15

UPPER GUADALUPE RIVER AUTHORITY

KERRVILLE ASR PROJECT  
TEX24486.A1

552'7"-552'8"

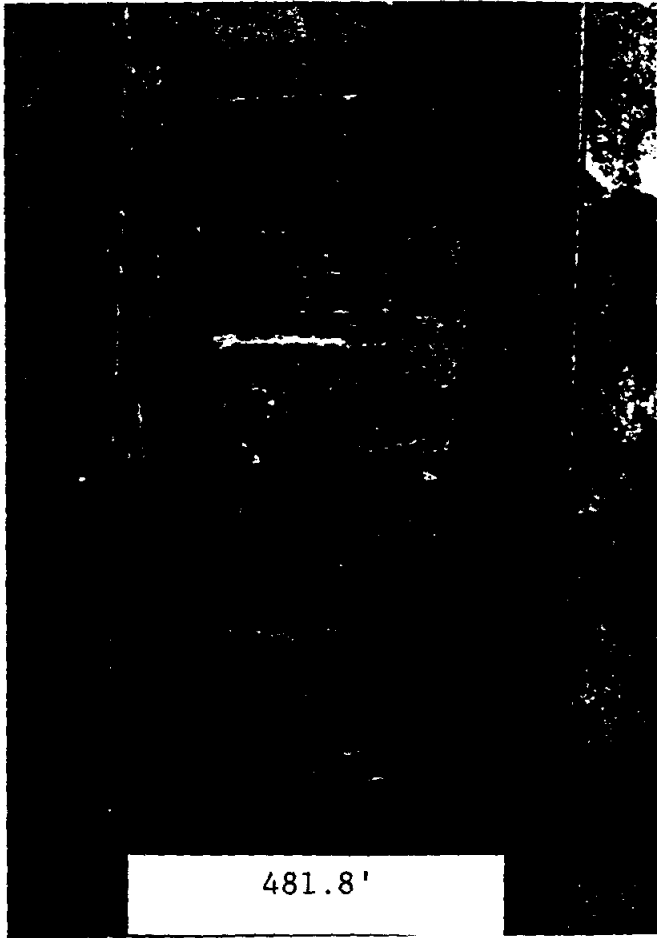


DESCRIPTION OF CORE

Figure 16

(4 pages)

481.1'



481.1'-481.8'

Gray, Thin-bedded shale. Light tannish gray-colored dolomite streaks and inclusions. Scattered calcareous micro fossil inclusions. Scattered burrows infilled with fine sand.

481.8'

539.6'



540.3'

539.6'-539.10'

Tan to pinkish; coarse-grained well-rounded, dolomite-cemented conglomerate sand. There is a coarsening upward in particle size from coarse sand to conglomerate sand with pebbles, changing to fine sand at 539.10'.

539.10'-540.0'

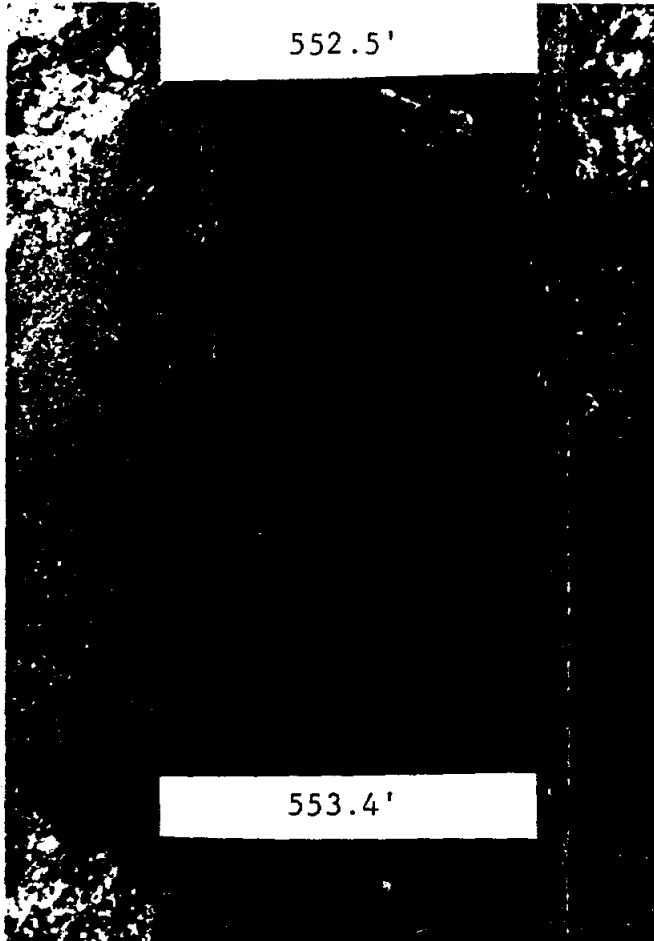
A fine-grained dolomitic sandstone to sandy dolomite with mottled gray streaks and inclusions. Somewhat grayish, very thin streaks of fine cross bedding.

540.0'-540.3'

Tan to gray, fine-grained dolomite-cemented sandstone to sandy fine crystalline dolomite.

552.5'-552.7'

Mottled gray and yellowish fine grained dolomite-cemented sandstone to sandy fine crystalline dolomite. Some very thin parallel bedding.



552.7'-553.2'

Red to pink, very fine-grained dolomitic sandstone to sandy fine crystalline dolomite showing slight undulated bedding with white to grayish inclusions.

553.2'-553.4'

Red and pink fine-grained dolomitic sandstone to sandy fine crystalline dolomite with tannish grayish-white irregularly shaped blob-like inclusions.

**Appendix D**  
**PUMP TEST RESULTS**

PUMP TEST 2 - DRAWDOWN  
UGRA SITE WELL PZ-1

TIME (MIN)	DRAW- DOWN (FT)	FLOW (GPM)	DEPTH TO WATER (FT)
0	0	0	204.2
0.1	20	196	224.2
4	43	150	247.2
15	92	150	296.2
30	85.5	148	289.7
65	80.8	150	285
90	85.5	150	289.7
120	80.8	150	285
150	83	150	287.2
185	67	150	271.2
210	83	150	287.2
240	81	150	285.2



PUMP TEST 2 - RECOVERY  
 UGRA SITE WELL PZ-1

TIME (MIN)	T RECOV. TIME	DEPTH TO WATER (FT)	T/T'	RECOVERY FEET	RESIDUAL FEET
240.50	0.00	285.20	ERR	204.20	81.00
242.00	1.50	223.00	161.33	142.00	18.80
242.30	1.80	221.00	134.61	140.00	16.80
242.60	2.10	220.00	115.52	139.00	15.80
243.50	3.00	218.00	81.17	137.00	13.80
245.00	4.50	216.00	54.44	135.00	11.80
249.00	8.50	214.00	29.29	133.00	9.80
261.00	20.50	212.00	12.73	131.00	7.80
275.00	34.50	211.00	7.97	130.00	6.80
295.00	54.50	210.00	5.41	129.00	5.80
310.00	69.50	209.50	4.46	128.50	5.30

PUMP TEST 3 - DRAWDOWN POST ACIDIFICATION  
 UGRA SITE WELL PZ-1 9-21-89

TIME (MIN)	DRAW- DOWN (FT)	FLOW (GPM)	DEPTH TO WATER (FT)
0	0	0	201
0.03	5	155	206
0.3	15	155	216
0.6	12.8	155	213.8
1	13.1	155	214.1
1.5	13.3	155	214.3
2	13.4	155	214.4
2.5	13.55	155	214.55
5	14.1	155	215.1
10	15.3	155	216.3
15	15.7	155	216.7
30	16.4	155	217.4
60	18.2	155	219.2
90	19.25	155	220.25
105	19.6	155	220.6
120	19.95	155	220.95
120.5	21.5	175	222.5
121	21.6	175	222.6
122	21.7	175	222.7
125	21.9	175	222.9
127.5	22	175	223
130	22.15	175	223.15
135	22.3	175	223.3
150	22.8	175	223.8
165	23.15	175	224.15
180	23.5	175	224.5
181	25.3	195	226.3
182	25.4	195	226.4
183	25.6	195	226.6
185	25.75	195	226.75
190	26	195	227
195	26.25	195	227.25
210	26.7	195	227.7
211	28.1	210	229.1
212	28.2	210	229.2
213	28.3	210	229.3
215	28.4	210	229.4
225	28.8	210	229.8
230	29	210	230
240	29.25	210	230.25

TOTAL Q (GALLONS) = 41250

PUMP TEST 3 POST ACID - RECOVERY  
 UGRA SITE WELL PZ-1 9-21-89

TIME (MIN)	T <sup>*</sup> RECOV. TIME	T/T <sup>*</sup>	DEPTH TO WATER (FT)	RECOVERY (FEET)	RESIDUAL (FEET)
240	0	ERR	230.25	0	29.25
240.1	0.1	2401	225	5.25	24
240.2	0.2	1201	221	9.25	20
240.5	0.5	481	217	13.25	16
241.2	1.2	201	215	15.25	14
242.3	2.3	105	214	16.25	13
244.5	4.5	54	213	17.25	12
248.5	8.5	29	212	18.25	11
255.6	15.6	16	211	19.25	10
266.9	26.9	10	210	20.25	9

PUMP TEST NO. 4  
8 HOUR DURATION  
200 GPM FLOW VOLUME  
UCRA WTP PZ-1  
SEPTEMBER 22, 1989

TIME (MIN)	DRAWDOWN (FEET)	WATER LEVEL
0	0	202.4
0.05	5	207.4
0.06	9.6	212
0.33	12.6	215
0.75	14.6	217
1.16	15.6	218
1.6	16.6	219
2.3	17.6	220
3	18.1	220.5
5	17.8	220.2
8.5	18.6	221
10	18.9	221.3
12	19.25	221.65
15	19.66	222.06
30	21.5	223.9
45	22.58	224.98
60	23.46	225.86
75	24.12	226.52
95	25.02	227.42
105	25.35	227.75
120	25.86	228.26
135	26.33	228.73
150	26.8	229.2
165	27.18	229.58
180	27.55	229.95
195	27.87	230.27
210	28.36	230.76
225	28.76	231.16
240	29	231.4
270	29.55	231.95
300	30.04	232.44
365	30.72	233.12
390	31.24	233.64
420	31.56	233.96
450	31.94	234.34
480	32.22	234.62

PUMP TEST NO. 4 - RECOVERY  
 UGRA SITE WELL PZ-1  
 SEPTEMBER 22, 1989

TIME (MIN)	T' RECOV. TIME	T/T'	DEPTH TO WATER (FT)	RECOVERY (FEET)	RESIDUAL (FEET)
480	0	ERR	234.62	0	32.22
480.1	0.1	4801	230	4.62	27.6
480.13	0.13	3693.307	225	9.62	22.6
480.2	0.2	2401	220	14.62	17.6
483.75	3.75	129	217	17.62	14.6
487.2	7.2	67.66666	216	18.62	13.6
492.5	12.5	39.4	215	19.62	12.6
500.5	20.5	24.41463	214	20.62	11.6
511.7	31.7	16.14195	213	21.62	10.6
527.5	47.5	11.10526	212	22.62	9.6
549.5	69.5	7.906474	211	23.62	8.6
584.5	104.5	5.593301	210	24.62	7.6
591.25	111.25	5.314606	209.5	25.12	7.1
617	137	4.503649	208.8	25.82	6.4
1650	1170	1.410256	203.65	30.97	1.25



SUBJECT UGRA PZ-1

BY R. PETRUS DATE 10-30-83

Pump Test 4

SHEET 1 OF 2

THEIS DRAWDOWN ANALYSIS

PROJECT NO. TEX 24486 A1.01

NUMBER OF KNOWN POINTS = 24

POINT NUMBER= 1

X (TIME)-COORDINATE OF POINT (MIN)= 5.0000D+02

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 5.0000D+00

POINT NUMBER= 2

X (TIME)-COORDINATE OF POINT (MIN)= 6.0000D+02

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 9.6000D+00

POINT NUMBER= 3

X (TIME)-COORDINATE OF POINT (MIN)= 3.3000D+01

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 1.2600D+01

POINT NUMBER= 4

X (TIME)-COORDINATE OF POINT (MIN)= 7.5000D+01

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 1.4600D+01

POINT NUMBER= 5

X (TIME)-COORDINATE OF POINT (MIN)= 1.1600D+00

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 1.5600D+01

POINT NUMBER= 6

X (TIME)-COORDINATE OF POINT (MIN)= 1.6000D+00

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 1.6600D+01

POINT NUMBER= 7

X (TIME)-COORDINATE OF POINT (MIN)= 2.3000D+00

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 1.7600D+01

POINT NUMBER= 8

X (TIME)-COORDINATE OF POINT (MIN)= 3.0000D+00

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 1.8100D+01

POINT NUMBER= 9

X (TIME)-COORDINATE OF POINT (MIN)= 8.5000D+00

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 1.8600D+01

POINT NUMBER= 10

X (TIME)-COORDINATE OF POINT (MIN)= 1.0000D+01

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 1.8900D+01

POINT NUMBER= 11

X (TIME)-COORDINATE OF POINT (MIN)= 1.2000D+01

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 1.9250D+01

POINT NUMBER= 12

X (TIME)-COORDINATE OF POINT (MIN)= 1.5000D+01

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 1.9660D+01

POINT NUMBER= 13

X (TIME)-COORDINATE OF POINT (MIN)= 3.0000D+01

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 2.1500D+01

POINT NUMBER= 14

X (TIME)-COORDINATE OF POINT (MIN)= 4.5000D+01

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 2.2580D+01

POINT NUMBER= 15

X (TIME)-COORDINATE OF POINT (MIN)= 6.0000D+01

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 2.3460D+01

POINT NUMBER= 16

X (TIME)-COORDINATE OF POINT (MIN)= 7.5000D+01

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 2.4120D+01

POINT NUMBER= 17

X (TIME)-COORDINATE OF POINT (MIN)= 9.5000D+01

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 2.5020D+01

POINT NUMBER= 18

X (TIME)-COORDINATE OF POINT (MIN)= 1.0500D+02

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 2.5350D+01

POINT NUMBER= 19

X (TIME)-COORDINATE OF POINT (MIN)= 1.2000D+02

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 2.5860D+01

POINT NUMBER= 20

X (TIME)-COORDINATE OF POINT (MIN)= 1.3500D+02

Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 2.6330D+01

POINT NUMBER= 21

X (TIME)-COORDINATE OF POINT (MIN)= 1.5000D+02



SUBJECT UGRA PZ-1

BY PETRU

DATE 10-30-99

Pump Test 4

SHEET 2 OF 2

Their Drawdown

PROJECT NO. \_\_\_\_\_

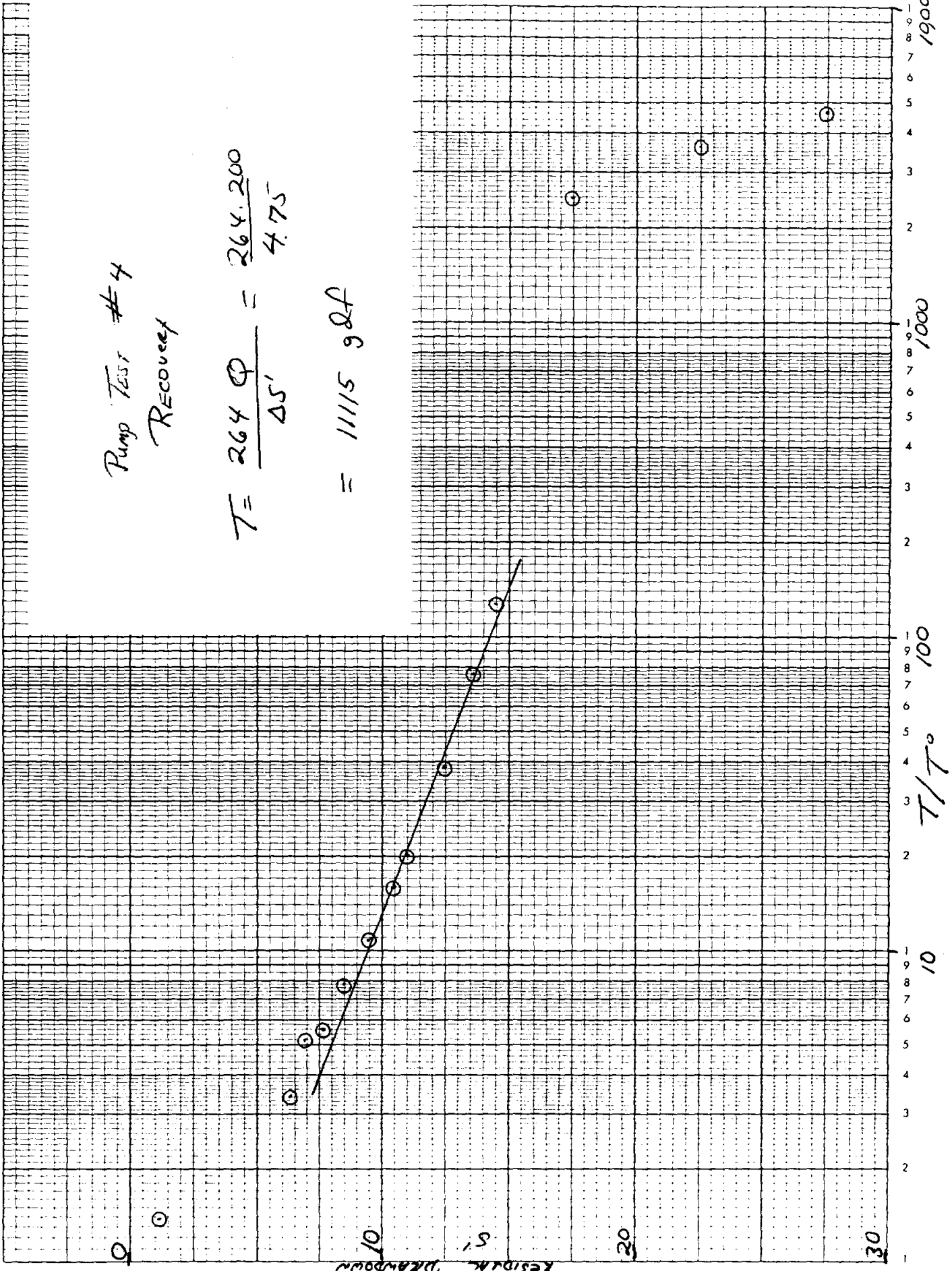
POINT NUMBER= 22  
 X (TIME)-COORDINATE OF POINT (MIN)= 1.6500D+02  
 Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 2.7180D+01  
 POINT NUMBER= 23  
 X (TIME)-COORDINATE OF POINT (MIN)= 1.8000D+02  
 Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 2.7550D+01  
 POINT NUMBER= 24  
 X (TIME)-COORDINATE OF POINT (MIN)= 1.9500D+02  
 Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 2.7870D+01  
 POINT NUMBER= 25  
 X (TIME)-COORDINATE OF POINT (MIN)= 2.1000D+02  
 Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 2.8360D+01  
 POINT NUMBER= 26  
 X (TIME)-COORDINATE OF POINT (MIN)= 2.2500D+02  
 Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 2.8760D+01  
 POINT NUMBER= 27  
 X (TIME)-COORDINATE OF POINT (MIN)= 2.4000D+02  
 Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 2.9000D+01  
 POINT NUMBER= 28  
 X (TIME)-COORDINATE OF POINT (MIN)= 2.7000D+02  
 Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 2.9550D+01  
 POINT NUMBER= 29  
 X (TIME)-COORDINATE OF POINT (MIN)= 3.0000D+02  
 Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 3.0040D+01  
 POINT NUMBER= 30  
 X (TIME)-COORDINATE OF POINT (MIN)= 3.6500D+02  
 Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 3.0720D+01  
 POINT NUMBER= 31  
 X (TIME)-COORDINATE OF POINT (MIN)= 3.9000D+02  
 Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 3.1240D+01  
 POINT NUMBER= 32  
 X (TIME)-COORDINATE OF POINT (MIN)= 4.2000D+02  
 Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 3.1560D+01  
 POINT NUMBER= 33  
 X (TIME)-COORDINATE OF POINT (MIN)= 4.5000D+02  
 Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 3.1940D+01  
 POINT NUMBER= 34  
 X (TIME)-COORDINATE OF POINT (MIN)= 4.8000D+02  
 Y (DRAWDOWN)-COORDINATE OF POINT (FT)= 3.2220D+01  
 PRODUCTION WELL DISCHARGE RATE (GPM)= 2.5000D+02  
 DISTANCE FROM PRODUCTION WELL (FT)= 1.0000D+00

COMPUTATION RESULTS:

AQUIFER TRANSMISSIVITY (GPD/FT)= 11128.00  
 AQUIFER STORATIVITY (DIM)= 8.668E-03

Pump Test #4  
Recovery

$$T = \frac{264 \text{ Q}}{45'} = \frac{264 \cdot 200}{4.75} = 11115 \text{ gal}$$

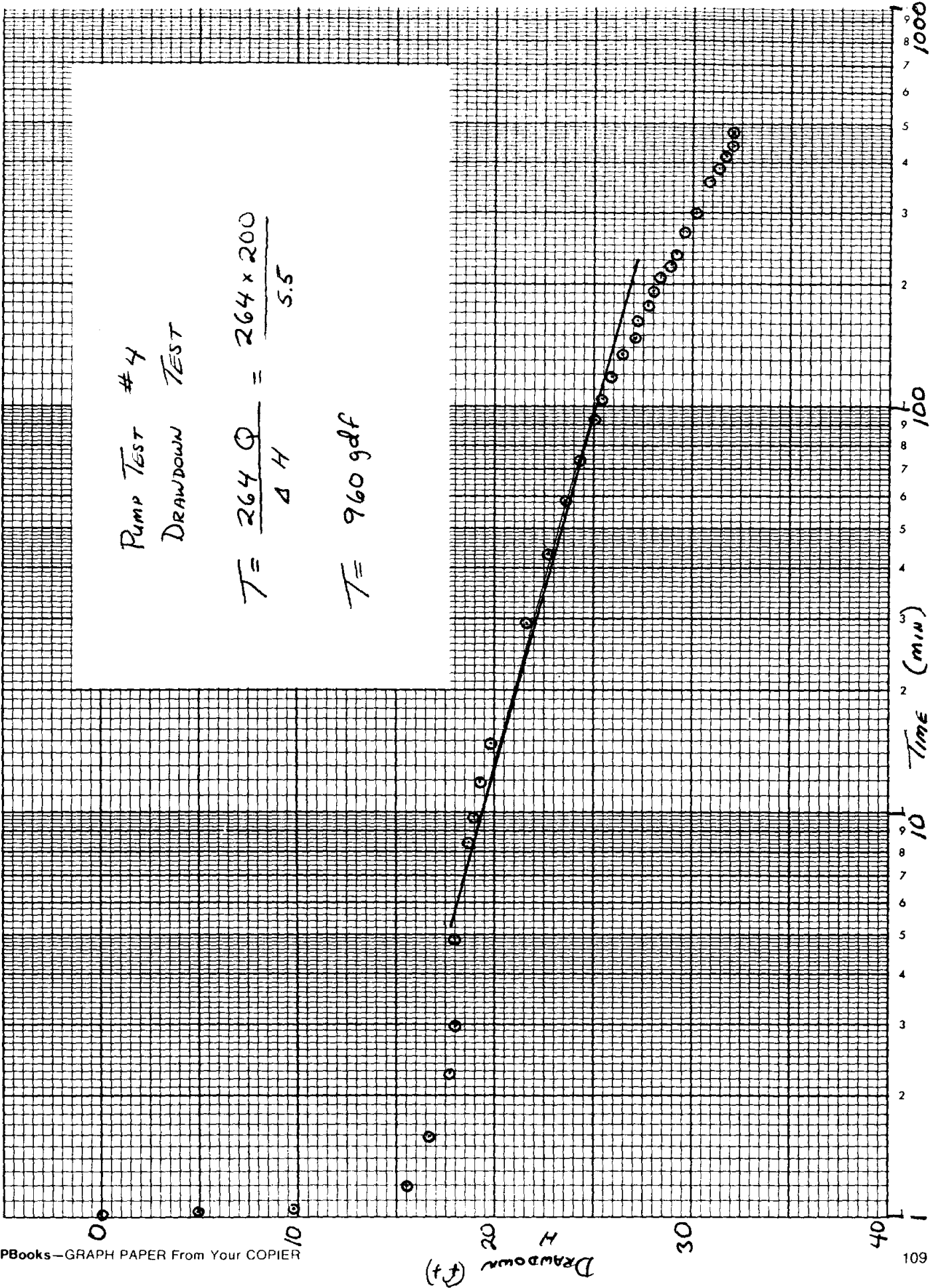




PUMP TEST #4  
DRAWDOWN TEST

$$T = \frac{264 \text{ Q}}{4 \text{ H}} = \frac{264 \times 200}{5.5}$$

$$T = 960 \text{ gdf}$$



**Appendix E**  
**CHEMICAL DATA**

# SAN ANTONIO TESTING LABORATORY

4733 RITTIMAN ROAD  
201 E. SPRING ST.

SAN ANTONIO, TEXAS 78218  
BRACKETTVILLE, TEXAS 78832

(512) 599-7670  
(512) 563-2124

## REPORT OF CHEMICAL ANALYSIS

REPORT NO. 1648

Page 1

Upper Guadalupe River Authority  
P.O. Box 1278  
Kerrville, TX 78029

Date Reported: 10-05-89

Date Received: 9-22-89

Sample: Water

ATTN: Mr. Charlie Wiedenfeld

PARAMETER	ASR WEST WELL		UGRA WTP FINISHED	
	FILTERED RESULTS		H2O RESULTS	
Silica	3.3	mg/L	4.9	mg/L
Mg	48	mg/L	19	mg/L
K	7.5	mg/L	1.3	mg/L
Al	0.1	mg/L	0.2	mg/L
Cu	<0.02	mg/L	<0.02	mg/L
Mn	0.07	mg/L	<0.01	mg/L
Zn	0.04	mg/L	0.05	mg/L
Cd	<0.01	mg/L	<0.01	mg/L
Se	<0.01	mg/L	<0.01	mg/L
Na	37	mg/L	11	mg/L
Color	39	Color Units	1	Color Units
Fluid Density	0.992	g/ml	0.991	g/ml
H2S	<1	mg/L	<1	mg/L

mg/L:

Milligrams per Liter

g/ml:

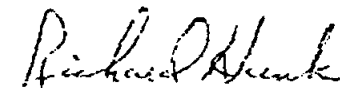
Grams per Milliliter

Test Method:

Methods for Chemical Analysis of Water and Wastes,  
EPA-600/4-79-020, Revised March 1983  
Standard Methods for the Examination of Water and  
Wastewater, 16th Edition, 1985

Test Conducted by: John D. Burch

Respectfully Submitted,



Richard Hawk  
General Manager

CHEMICAL ANALYSIS BY UGRA LAB  
09/17/89

Parameter	ASR TEST WELL			UGRA WTP FINISHED WATER		
	Sp1 1	Sp1 2	Avg	Sp1 1	Sp1 2	Avg
*pH	F	7.3	7.3	7.3	7.6	7.6
*Turb.	U	2.8	2.8	2.8	0.22	0.22
*Spec Cond	F	942	942	942	398	399
*Temp (C°)	U	23.0	22.9	23.0	24.9	25.0
*D.D.	U	4.14	4.01	4.08	7.69	7.69
*Ttl Col	U	0-0	0-0	0	0	0
*C Alkalinty	F	0	0	0	0	0
*Ttl Alkalinty	F	334	328	331	172	166
*Bi Alkalinty	F	334	328	331	172	166
TDS	F	559	607	583	262	-
TSS	U	4.4	4.4	4.4	0.20	0.22
Cl	F	97	96	96	23	24
Fl	F	1.0	1.0	1.0	0.9	0.9
SO4	F	23	25	24	11	-
Calcium	F	60	57	58	28	26
Sodium	F					
*Iron	F	1.35	1.37	1.36	0.05	0.05
Ttl Hardness	F	416	416	416	206	206
Non-Car Hard	F	82	88	85	34	40
Ca Hardness	F	150	142	146	70	65
Nitrate	F	0.1	0.1	0.1	0.1	0.1
O-PO4	F	0.030	0.051		0.012	0.010
Ammonia	F	0.068	0.070	0.069	0.049	-
TOC	U	1.4	1.4	1.4	2.3	2.3

\* On-site Determination

# SAN ANTONIO TESTING LABORATORY

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UPPER GUADALUPE RIVER AUTHORITY

PAGE 4

SAMPLE I.D.: UGRA WTP  
FINISHED H2O

## HALOGENATED AND AROMATIC VOLATILE ORGANICS

PARAMETERS	METHOD	RESULTS ug/L	DETECTION LIMITug/L	ANALYST
Bromoform	EPA 624	<5	5	DM
Carbon Tetrachloride	EPA 624	<5	5	DM
Chlorobenzene	EPA 624	<5	5	DM
Chlorodibromomethane	EPA 624	<5	5	DM
Chloroethane	EPA 624	<5	5	DM
2-Chloroethylvinyl Ether	EPA 624	<5	5	DM
Chloroform	EPA 624	35	5	DM
Dichlorobromomethane	EPA 624	23	5	DM
Dichlorodifluoromethane	EPA 624	<5	5	DM
1,1-Dichloroethane	EPA 624	<5	5	DM
1,2-Dichloroethane	EPA 624	<5	5	DM
1,1-Dichloroethylene	EPA 624	<5	5	DM
1,2-Dichloropropane	EPA 624	<5	5	DM
trans-1,3-Dichloropropylene	EPA 624	<5	5	DM
1,1,2,2-Tetrachloroethane	EPA 624	<5	5	DM
Tetrachloroethylene	EPA 624	<5	5	DM
trans-1,2-Dichloroethylene	EPA 624	<5	5	DM
1,1,1-Trichloroethane	EPA 624	<5	5	DM
1,1,2-Trichloroethane	EPA 624	<5	5	DM
Trichloroethylene	EPA 624	<5	5	DM
Trichlorofluoromethane	EPA 624	<5	5	DM

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UPPER GUADALUPE RIVER AUTHORITY

PAGE 3  
SAMPLE I.D.: ASR WEST WELL  
FILTERED

PARAMETERS	METHOD	RESULTS ug/L	DETECTION LIMITug/L	ANALYST
Vinyl Chloride	EPA 624	<5	5	DM
Bis(2-chloroethoxy)methane	EPA 624	<10	10	DM
Bis(2-chloroisopropyl)ether	EPA 624	<10	10	DM
1,2-Dichlorobenzene	EPA 624	<5	5	DM
1,3-Dichlorobenzene	EPA 624	<5	5	DM
1,4-Dichlorobenzene	EPA 624	<5	5	DM
Benzyl chloride	EPA 624	<5	5	DM
Bromobenzene	EPA 624	<5	5	DM
Bromomethane	EPA 624	<5	5	DM
Chloroacetaldehyde	EPA 624	<5	5	DM
1-Chlorohexane	EPA 624	<5	5	DM
Chloromethane	EPA 624	<5	5	DM
Chloromethylmethyl ether	EPA 624	<5	5	DM
Chlorotoluene	EPA 624	<5	5	DM
Dibromomethane	EPA 624	<5	5	DM
Dichloromethane	EPA 624	<5	5	DM
1,1,1,2-Tetrachloroethane	EPA 624	<5	5	DM
Trichloropropane	EPA 624	<5	5	DM
Benzene	EPA 624	<5	5	DM
Ethyl Benzene	EPA 624	<5	5	DM
Toluene	EPA 624	<5	5	DM
Xylenes	EPA 624	<5	5	DM

# SAN ANTONIO TESTING LABORATORY

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UPPER GUADALUPE RIVER AUTHORITY

PAGE 5

SAMPLE I.D.: UGRA WTP  
FINISHED H2O

PARAMETERS	METHOD	RESULTS ug/L	DETECTION LIMITug/L	ANALYST
Vinyl Chloride	EPA 624	<5	5	DM
Bis(2-chloroethoxy)methane	EPA 624	<10	10	DM
Bis(2-chloroisopropyl)ether	EPA 624	<10	10	DM
1,2-Dichlorobenzene	EPA 624	<5	5	DM
1,3-Dichlorobenzene	EPA 624	<5	5	DM
1,4-Dichlorobenzene	EPA 624	<5	5	DM
Benzyl chloride	EPA 624	<5	5	DM
Bromobenzene	EPA 624	<5	5	DM
Bromomethane	EPA 624	<5	5	DM
Chloroacetaldehyde	EPA 624	<5	5	DM
1-Chlorohexane	EPA 624	<5	5	DM
Chloromethane	EPA 624	<5	5	DM
Chloromethylmethyl ether	EPA 624	<5	5	DM
Chlorotoluene	EPA 624	<5	5	DM
Dibromomethane	EPA 624	<5	5	DM
Dichloromethane	EPA 624	<5	5	DM
1,1,1,2-Tetrachloroethane	EPA 624	<5	5	DM
Trichloropropane	EPA 624	<5	5	DM
Benzene	EPA 624	<5	5	DM
Ethyl Benzene	EPA 624	<5	5	DM
Toluene	EPA 624	<5	5	DM
Xylenes	EPA 624	<5	5	DM

# SAN ANTONIO TESTING LABORATORY

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201 E. SPRING ST.

SAN ANTONIO, TEXAS 78218  
BRACKETTVILLE, TEXAS 78832

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(512) 563-2124

UPPER GUADALUPE RIVER AUTHORITY

PAGE 2

SAMPLE I.D.: ASR WEST WELL  
FILTERED

## HALOGENATED AND AROMATIC VOLATILE ORGANICS

PARAMETERS	METHOD	RESULTS ug/L	DETECTION LIMITug/L	ANALYST
Bromoform	EPA 624	<5	5	DM
Carbon Tetrachloride	EPA 624	<5	5	DM
Chlorobenzene	EPA 624	<5	5	DM
Chlorodibromomethane	EPA 624	<5	5	DM
Chloroethane	EPA 624	<5	5	DM
2-Chloroethylvinyl Ether	EPA 624	<5	5	DM
Chloroform	EPA 624	<5	5	DM
Dichlorobromomethane	EPA 624	<5	5	DM
Dichlorodifluoromethane	EPA 624	<5	5	DM
1,1-Dichloroethane	EPA 624	<5	5	DM
1,2-Dichloroethane	EPA 624	<5	5	DM
1,1-Dichloroethylene	EPA 624	<5	5	DM
1,2-Dichloropropane	EPA 624	<5	5	DM
trans-1,3-Dichloropropylene	EPA 624	<5	5	DM
1,1,2,2-Tetrachloroethane	EPA 624	<5	5	DM
Tetrachloroethylene	EPA 624	<5	5	DM
trans-1,2-Dichloroethylene	EPA 624	<5	5	DM
1,1,1-Trichloroethane	EPA 624	<5	5	DM
1,1,2-Trichloroethane	EPA 624	<5	5	DM
Trichloroethylene	EPA 624	<5	5	DM



Texas Water Development Board  
Chemical Water Analysis Report

BOTTLE #  
BOTTLE #

MISC. UGRA - ARTW. 89-9-1

TOTAL ORGANICS FORM

TWDB Use Only  
Work No. 3202  
IAC No. \_\_\_\_\_

Send Reply To:  
Ground Water Unit  
Texas Water Development Board  
P.O. Box 13231  
Austin, Texas 78711

Attention: BOB BLUNTZER/ERIC ADIDAS State Well Number: \_\_\_\_\_  
County: KERR Date & Time: 9/22/89  
Owner: UPPER GUADALUPE RIVER AUTHORITY  Send Copy To Owner  
Address: \_\_\_\_\_ Sampled After Pumping: \_\_\_\_\_ Hours  
Date Drilled: \_\_\_\_\_ Depth: \_\_\_\_\_ Yield: 200 GPM  Measured  Estimated  
Collection Point: DISCHARGE POINT pH \_\_\_\_\_ Use: TEST WELL Temperature: 22.7 °C  
By: ERIC ADIDAS Specific Conductance: 927

Requested Chemicals: \_\_\_\_\_  
Laboratory No.: EB0 19 Date Received: NOV 25 1989 Date Reported: NOV 9 1989

Total Organic Carbon < 1 mg/l

Texas Water Development Board  
**Chemical Water Analysis Report**

Bottle # 1

GWR-UGRA - ARTW-89-9-1  
 (Anions)

TWDB Use Only
Work No. <u>3202</u>
IAC No. _____

Send Reply To:  
 Ground Water Unit  
 Texas Water Development Board  
 P.O. Box 13231  
 Austin, Texas 78711

Attention: BOB BUNTZER/ERIC ADIDAS State Well Number: \_\_\_\_\_

County: KERR Date & Time: 9/22/89

Owner: UPPER GUADALUPE RIVER AUTHORITY (UGRA)  Send Copy To Owner

Address: KERVILLE Sampled After Pumping: \_\_\_\_\_ Hours

Date Drilled: \_\_\_\_\_ Depth: \_\_\_\_\_ Yield: \_\_\_\_\_ GPM  Measured  Estimated

Collection Point: DISCHARGE POINT pH 7.45 Use: TEST WELL FOR ARTIFICIAL RECHARGE Temperature: 22.7 °C

By: ERIC ADIDAS Specific Conductance: 927 micromhos/cm @ 22.7°C

Requested Chemical Analysis

Laboratory No. 580-157 Date Received: SEP 25 1989 Date Reported: OCT 31 1989

		me/l	mg/l		
Sulfate	(00946)	<u>370.65</u>	<u>86531</u>		
Chloride	(00941)	<u>972.57</u>	<u>25291</u>		
Flouride	(00950)	<u>0.06</u>	<u>1.1</u>		
Nitrate NO <sub>3</sub> -N		<u>0.01</u>	<u>0.0</u>		
Nitrite NO <sub>2</sub> -N		<u>&lt;0.01</u>	<u>0.0</u>		
			mg/l		µg/l
Silica	(00955)		<u>11</u>	<del>Boron</del>	(01020)
Phenol Alkalinity (Calcium)	(00415)		<u>0</u>	<del>Bromide</del>	(82298)
Total Alkalinity	(00410)		<u>320</u>		
Iodide	(71865)		<u>&lt;0.10</u>		
Orthophosphate			<u>0.15</u>		
Bicarbonate Alkalinity			<u>390</u>		

NOTE \* FILTER AND ANALYSE



**Appendix F**  
**GEOCHEMICAL MODELING RESULTS**

EQ3NR, version 3245R111

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Lawrence Livermore National Laboratory. All rights reserved.

Supported by EQLIB, version 3245R136

Copyright (c) 1987 The Regents of the University of California,  
Lawrence Livermore National Laboratory. All rights reserved.

Run 11:54:55 12-0C89

--- reading the input file ---

input file name= kerr2.31 revised=10/11/89 revisor= rg  
Kerrville, Texas - ASR Project; Charge No.: TEX24486.a1

Basic data for EQ3 modeling of Kerrville project received  
from Dick Glanzman/DEN on October 10, 1989.

This is one of four scenarios.

- 1) Equilibrium for ASR groundwater at a pH of 8.2
- 2) Equilibrium for ASR groundwater at a pH of 7.3
- 3) Equilibrium for ASR Water Treatment Plant (WTP) recharge water
- 4) Equilibrium of a 50-50 mixture of one of the above ASR  
groundwaters and the WTP water.

This run is for the <sup>first</sup> ~~second~~ scenario with pH 8.2.

endit.

temp= 0.23000E+02  
rho= 0.10000E+01 tuspkg= 0.00000E+00 tdspl= 0.00000E+00  
fep= -0.10000E+00 uredox=  
tolbt= 0.00000E+00 toldl= 0.00000E+00 tolsat= 0.00000E+00  
itermx= 0

	1	2	3	4	5	6	7	8	9	10
iopt1-10=	-1	0	0	0	0	0	0	0	0	0
iopg1-10=	0	0	0	0	0	0	0	0	0	0
iopr1-10=	0	0	0	0	0	0	0	0	0	0
iopr11-20=	0	0	0	0	0	0	0	0	0	0
iodb1-10=	0	0	0	0	0	0	0	0	0	0

uebal= none

uacion= cl-

nxmod= 0

data file master species= na+

switch with species=

jflag= 2 csp= 0.37000E+02

aqueous species accounting for 99% or more of o2(aq)

species	molal conc	per cent
o2(aq)	0.4375E-04	100.00
total		100.00

aqueous species accounting for 99% or more of ch3coo-

species	molal conc	per cent
ch3coo-	0.4297E-03	97.58
mgch3coo+	0.9796E-05	2.22
total		99.80

aqueous species accounting for 99% or more of nh4+

species	molal conc	per cent
nh4+	0.7198E-05	90.17
nh3	0.4672E-06	5.85
cu(nh3)2+	0.1571E-06	3.94
total		99.95

----- summary of aqueous redox reactions -----

couple	eh, volts	pe-	log fo2	ah, kcal
default	-0.100	-0.1702E+01	-57.696	-2.306
o2(aq) /h2o	0.726	0.1235E+02	-1.473	16.741
h2(aq) /h2o	-0.100	-0.1702E+01	-57.696	-2.306
ch3coo- /hco3-	-0.364	-0.6200E+01	-75.687	-8.401
cu++ /cu+	-0.100	-0.1702E+01	-57.696	-2.306
fe+++ /fe++	-0.100	-0.1702E+01	-57.696	-2.306
hs- /so4--	-0.100	-0.1702E+01	-57.696	-2.306
nh4+ /no3-	0.160	0.2723E+01	-39.997	3.690
no2- /no3-	-0.100	-0.1702E+01	-57.696	-2.306

----- summary of aqueous non-equilibrium non-redox reactions -----

couple            affinity, kcal

none

----- summary of stoichiometric mineral saturation states -----

(minerals with affinities .lt. -10 kcal are not listed)

mineral	log q/k	aff, kcal	state	mineral	log q/k	aff, kcal	state
---------	---------	-----------	-------	---------	---------	-----------	-------

albite	-1.704	-2.309	
albite low	-1.704	-2.309	
amph.silica	-1.538	-2.084	
analcime	-1.652	-2.238	
andradite	2.724	3.692	ssatd
annite	3.302	4.475	ssatd
antigorite	6.928	9.388	ssatd
artinite	-3.624	-4.911	
bassanite	-3.693	-5.004	
beidellit-k	0.345	0.468	satd
beidellit-na	0.314	0.425	satd
boehmite	-0.820	-1.111	
brucite	-3.092	-4.190	
calcite	1.095	1.484	ssatd
caso4.1/2h2o	-3.864	-5.236	
chalcedony	-0.509	-0.690	
chamosite-7a	1.615	2.189	ssatd
clinocl-14a	3.149	4.267	ssatd
clinoptil-ca	-2.445	-3.313	
clinoptil-mg	-6.564	-8.895	
clinozoisite	-3.852	-5.220	
corundum	-3.855	-5.223	
cris.beta.a	-1.236	-1.675	
cufco2(c)	9.411	12.753	ssatd
dachiardite-	-1.781	-2.413	
daphnite-7a	2.960	4.012	ssatd
diaspore	0.035	0.047	satd
dolomite	3.242	4.393	ssatd
dolomite-ord	3.242	4.393	ssatd
epidote	2.363	3.203	ssatd
epistilbite	-0.193	-0.262	satd
erionite-ca	-0.899	-1.219	
faujasite-na	-4.067	-5.511	
fe(oh)2(ppd)	-2.018	-2.734	
feo(c)	-0.532	-0.720	
ferrite-cu	0.384	0.520	ssatd
ferrite-zn	6.652	9.014	ssatd
fluorapatite	21.583	29.248	ssatd
forsterite	-5.700	-7.724	
gibbsite	0.844	1.144	ssatd
gmelinite-ca	0.447	0.606	ssatd
goethite	3.823	5.180	ssatd
gypsum	-2.869	-3.888	
hedenbergite	-3.873	-5.248	
hercynite	-1.063	-1.441	
heulandite-n	-5.013	-6.793	
huntite	0.865	1.173	ssatd
hydroxyapatit	11.282	15.289	ssatd
jadeite	-3.092	-4.190	
kalicinite	-6.389	-8.658	
kaolinite	1.694	2.295	ssatd
kyanite	-2.991	-4.054	
laumontite	-0.287	-0.389	satd
leonhardtite	-6.337	-8.588	
magnesite	0.506	0.686	ssatd
margarite	-2.309	-3.129	
melanterite	-7.319	-9.919	
mesolite-ss	-2.146	-2.908	
minnesotaite	1.704	2.310	ssatd

albite high	-3.036	-4.114	
amesite-14a	1.438	1.949	ssatd
analc-dehydr	-6.395	-8.666	
andalusite	-3.271	-4.433	
anhydrite	-3.062	-4.149	
anorthite	-4.793	-6.496	
aragonite	0.930	1.260	ssatd
ashcroftite	-2.020	-2.738	
beidellit-ca	0.797	1.080	ssatd
beidellit-mg	0.838	1.136	ssatd
berlinite	-6.542	-8.865	
brewsterite-	-0.193	-0.262	satd
cahpo4.2h2o	-2.354	-3.190	
cas12o5.2h2o	-5.214	-7.066	
chabazite	0.447	0.606	ssatd
chalcocite	-7.265	-9.845	
chrysotile	0.090	0.123	satd
clinocl-7a	-0.240	-0.326	satd
clinoptil-k	-1.036	-1.404	
clinoptil-na	-6.275	-8.504	
copper	0.616	0.834	ssatd
crystalbite	-0.791	-1.072	
cronstedt.-7	9.973	13.515	ssatd
cuprite	-1.477	-2.002	
daphnite-14a	6.351	8.607	ssatd
dawsonite	-0.982	-1.331	
diopside	-2.870	-3.889	
dolomite-dis	1.683	2.281	ssatd
enstatite	-2.359	-3.197	
epidote-ord	2.363	3.203	ssatd
epsomite	-5.340	-7.236	
faujasite-ca	0.441	0.598	ssatd
fayalite	-1.626	-2.204	
fe(oh)3(ppd)	-0.590	-0.800	
ferrite-ca	0.252	0.342	satd
ferrite-mg	0.828	1.123	ssatd
ferrosilite	-0.820	-1.111	
fluorite	0.818	1.108	ssatd
garronite	-0.238	-0.323	satd
gismondine	1.101	1.491	ssatd
gmelinite-na	-4.046	-5.483	
greenalite	1.492	2.022	ssatd
halite	-7.057	-9.563	
hematite	8.598	11.651	ssatd
heulandite-c	-0.520	-0.704	
hexahydrate	-5.591	-7.577	
hydromagnesi	-6.454	-8.746	
illite	1.590	2.155	ssatd
k-feldspar	0.421	0.570	ssatd
kalsilite	-2.304	-3.122	
kieserite	-7.100	-9.622	
lansfordite	-1.936	-2.624	
lawsonite	-0.370	-0.501	
levyne	0.447	0.606	ssatd
magnetite	9.183	12.445	ssatd
maximum micr	0.421	0.571	ssatd
mesolite	2.840	3.848	ssatd
mgf2(c)	-1.847	-2.503	
mn(oh)2(am)	-6.013	-8.148	

mnhpo4(c)	0.120	0.162	satd	monohydrocal	0.103	0.140	satd
montmor-ca	1.273	1.726	ssatd	montmor-mg	1.385	1.876	ssatd
montmor-na	0.857	1.161	ssatd	montmor-k	0.892	1.209	ssatd
mordenite-k	-0.523	-0.708		mordenite-na	-3.142	-4.258	
muscovite	3.532	4.787	ssatd	nahcolite	-5.013	-6.793	
natrolite	-3.617	-4.902		nepheline	-4.289	-5.812	
nesquehonite	-2.190	-2.967		nontronit-ca	9.743	13.203	ssatd
nontronit-k	9.291	12.591	ssatd	nontronit-mg	9.784	13.258	ssatd
nontronit-na	9.259	12.548	ssatd	paragonite	0.506	0.686	ssatd
pd-oxyannite	13.893	18.827	ssatd	pentahydrate	-5.925	-8.029	
phengite	1.695	2.297	ssatd	phillipsite-	1.007	1.365	ssatd
phillipsite-	-3.953	-5.357		phillipsite-	-5.736	-7.774	
phlogopite	2.389	3.237	ssatd	prehnite	-1.968	-2.667	
pseudowollas	-5.062	-6.859		pyrophyllite	-0.428	-0.580	
quartz	-0.236	-0.320	satd	rhodochrosit	-0.866	-1.173	
rhodonite	-4.677	-6.338		ripidolit-14	4.710	6.383	ssatd
ripidolit-7a	1.321	1.790	ssatd	sanidine hig	-0.791	-1.072	
saponite-ca	2.835	3.842	ssatd	saponite-h	1.616	2.191	ssatd
saponite-k	2.383	3.230	ssatd	saponite-mg	2.876	3.898	ssatd
saponite-na	2.352	3.187	ssatd	scolecite	1.606	2.177	ssatd
sepiolite	-2.910	-3.943		siderite	0.637	0.864	ssatd
sillimanite	-3.634	-4.925		smectite-hig	1.598	2.166	ssatd
smectite-low	1.358	1.841	ssatd	smectite-rey	6.759	9.159	ssatd
smithsonite	-1.191	-1.614		stilbite-ca	-0.526	-0.713	
stilbite-k	-3.829	-5.188		stilbite-na	-5.020	-6.803	
strengite	-3.742	-5.072		sylvite	-7.331	-9.934	
talc	1.609	2.181	ssatd	tenorite	-5.641	-7.644	
tremolite	-2.268	-3.101		tridymite	-0.404	-0.548	
vivianite	-0.346	-0.469	satd	wairakite	-4.762	-6.453	
whitlockite	5.314	7.201	ssatd	wollastonite	-4.664	-6.320	
wustite	-2.833	-3.840		yugawaralite	0.134	0.181	satd
zincite	-1.472	-1.995		zn3(po4)2.4h	-4.144	-5.616	
zoisite	-3.898	-5.282					

15 approx. saturated pure minerals  
0 approx. saturated end-members of specified solid solutions  
0 saturated end-members of hypothetical solid solutions

72 supersaturated pure minerals  
0 supersatd. end-members of specified solid solutions  
0 supersatd. hypothetical solid solution phases

----- summary of gases -----

gas	fugacity	log fugacity
ch4(g)	0.221978E-31	-31.65369
co2(g)	0.208240E-02	-2.68144
h2(g)	0.906970E-13	-13.04241
h2s(g)	0.138269E-30	-30.85928
n2(g)	0.100000E+35	87.76520
o2(g)	0.000000E+00	-57.69581
s2(g)	0.000000E+00	-61.47081
steam	0.277603E-01	-1.55658



----- end of output -----  
----- pickup file successfully written -----

--- reading the input file ---

--- no further input found ---

start time = 11:54:55 12-0C89  
end time = 11:55:31 12-0C89

-----  
9 completed 11  
normal exit

```
data file master species= (o-phth)--
  switch with species=
  jflag= 0   csp= 0.00000E+00
data file master species= clo4-
  switch with species=
  jflag= -1  csp= 0.00000E+00
ndit.
```

```
--- the input file has been successfully read ---
--- reading the data1 file ---
--- the data1 file has been successfully read ---
```

```
eeee  qqq  3333  n  n  rrrr
e   q  q  3  nn  n  r  r
eeee  q  q  33  n  n  n  rrrr
e   q  q  q  3  n  nn  r  r
eeee  qqq  3333  n  n  r  r
q
```

```
eq3nc.3245R111
supported by eqlib.3245R136
```

```
input file name= kern1.3i revised=10/11/89   revisor= rg
Kerrville, Texas - ASR Project; Charge No.: TEX24486.a1
```

```
Basic data for EQ3 modeling of Kerrville project received
from Dick Glanzman/DEN on October 10, 1989.
```

This is one of four scenarios.

- 1) Equilibrium for ASR groundwater at a pH of 8.2
- 2) Equilibrium for ASR groundwater at a pH of 7.3
- 3) Equilibrium for ASR Water Treatment Plant (WTP) recharge water
- 4) Equilibrium of a 50-50 mixture of one of the above ASR groundwaters and the WTP water.

*second*

This run is for the ~~first~~ scenario.

```
data file data0.3245R54
  1 atm steam saturation curve data
last modified 18feb88 (da0r)
```

nh4+	0.4889E-05	99.08
total		99.08

----- summary of aqueous redox reactions -----

couple	eh, volts	pe-	log fo2	ah, kcal
default	-0.100	-0.1702E+01	-61.296	-2.306
o2(aq) /h2o	0.786	0.1337E+02	-1.009	18.118
h2(aq) /h2o	-0.100	-0.1702E+01	-61.296	-2.306
fe+++ /fe++	-0.100	-0.1702E+01	-61.296	-2.306
hs- /so4--	-0.100	-0.1702E+01	-61.296	-2.306
nh4+ /no3-	0.223	0.3790E+01	-39.330	5.136
no2- /no3-	-0.100	-0.1702E+01	-61.296	-2.306

----- summary of aqueous non-equilibrium non-redox reactions -----

couple            affinity, kcal

none

----- summary of stoichiometric mineral saturation states -----

(minerals with affinities .lt. -10 kcal are not listed)

mineral	log q/k	aff, kcal	state	mineral	log q/k	aff, kcal	state
albite	-1.705	-2.311		albite high	-3.037	-4.115	
albite low	-1.705	-2.311		alunite	-5.022	-6.805	
amesite-14a	-0.400	-0.542		amrph.silica	-1.527	-2.070	
anaic-dehydr	-6.407	-8.682		analcime	-1.663	-2.254	
andalusite	-1.524	-2.065		anhydrite	-2.720	-3.686	
annite	-1.350	-1.829		anorthite	-4.830	-6.546	
aragonite	0.082	0.111	satd	artinite	-6.263	-8.487	
ashcroftite	-2.091	-2.833		bassanite	-3.351	-4.541	
beidellit-ca	2.562	3.472	ssatd	beidellit-k	2.110	2.859	ssatd
beidellit-mg	2.604	3.528	ssatd	beidellit-na	2.078	2.816	ssatd
berlinite	-5.033	-6.821		boehmite	0.049	0.066	satd
brewsterite	-0.189	-0.256	satd	brucite	-4.885	-6.620	
cahpo4.2h2o	-3.509	-4.755		calcite	0.247	0.334	satd
casio2o5.2h2o	-6.988	-9.470		caso4.1/2h2o	-3.522	-4.773	
chabazite	0.431	0.584	ssatd	chalcedony	-0.499	-0.676	
chamosite-7a	0.262	0.355	satd	chrysotile	-5.268	-7.139	
clinochl-14a	-4.048	-5.486		clinoptil-ca	-2.399	-3.252	
clinoptil-k	-0.997	-1.351		clinoptil-mg	-6.517	-8.831	
clinoptil-na	-6.236	-8.451		clinozoisite	-4.805	-6.512	
corundum	-2.118	-2.870		cristobalite	-0.781	-1.058	
crist.beta.a	-1.225	-1.661		cronstedt.-7	1.982	2.686	ssatd
dachiardite	-1.729	-2.343		daphnite-14a	0.368	0.498	satd
daphnite-7a	-3.023	-4.096		dawsonite	-0.068	-0.092	satd
diaspore	0.903	1.224	ssatd	diopside	-6.437	-8.723	
dolomite	1.547	2.097	ssatd	dolomite-dis	-0.012	-0.016	satd
dolomite-ord	1.547	2.097	ssatd	enstatite	-4.142	-5.613	

epidote	-1.908	-2.586		epidote-ord	-1.908	-2.586	
epistilbite	-0.189	-0.256	ssatd	epsomite	-4.997	-6.771	
erionite-ca	-0.880	-1.193		faujasite-ca	0.425	0.575	ssatd
faujasite-na	-4.090	-5.543		fayalite	-4.716	-6.391	
fe(oh)2(ppd)	-3.568	-4.835		fe(oh)3(ppd)	-3.041	-4.120	
feo(c)	-2.082	-2.821		ferrite-ca	-6.443	-8.731	
ferrite-mg	-5.865	-7.948		ferrite-zn	0.104	0.140	ssatd
ferrosilite	-2.360	-3.198		fluorapatite	14.610	19.799	ssatd
fluorite	-0.815	-1.105		garronite	-0.311	-0.422	ssatd
gibbsite	1.712	2.321	ssatd	gismondine	1.064	1.441	ssatd
gmelinite-ca	0.431	0.584	ssatd	gmelinite-na	-4.069	-5.514	
goethite	1.372	1.860	ssatd	greenalite	-3.138	-4.252	
gypsum	-2.527	-3.425		halite	-7.058	-9.565	
hedenbergite	-7.197	-9.753		hematite	3.697	5.010	ssatd
hercynite	-0.876	-1.188		heulandite-c	-0.505	-0.685	
heulandite-n	-5.005	-6.783		hexahydrite	-5.248	-7.112	
huntite	-2.522	-3.418		hydroxyapati	4.229	5.731	ssatd
illite	2.635	3.571	ssatd	jadeite	-3.104	-4.206	
k-feldspar	0.420	0.569	ssatd	kalicinite	-6.343	-8.595	
kalsilite	-2.325	-3.151		kaolinite	3.451	4.677	ssatd
kieserite	-6.757	-9.156		kyanite	-1.244	-1.686	
lansfordite	-2.783	-3.771		laumontite	-0.304	-0.412	ssatd
lawsonite	-0.407	-0.551		leonhardtite	-5.994	-8.123	
levyne	0.431	0.584	ssatd	magnesite	-0.340	-0.461	ssatd
magnetite	2.733	3.703	ssatd	margarite	-0.609	-0.825	
maximum micr	0.420	0.569	ssatd	melanterite	-6.733	-9.124	
mesolite	2.811	3.810	ssatd	mesolite-ss	-2.233	-3.026	
mgf2(c)	-3.479	-4.714		minnesotaite	-2.905	-3.937	
mn(oh)2(am)	-6.946	-9.412		mnhpo4(c)	-0.173	-0.234	ssatd
monohydrocal	-0.745	-1.009		montmor-ca	1.877	2.544	ssatd
montmor-mg	1.989	2.695	ssatd	montmor-na	1.460	1.978	ssatd
montmor-k	1.495	2.026	ssatd	mordenite-k	-0.503	-0.682	
mordenite-na	-3.123	-4.232		moscovite	5.268	7.139	ssatd
nahcolite	-4.967	-6.731		natrolite	-3.651	-4.947	
nepheline	-4.311	-5.842		nesquehonite	-3.036	-4.114	
nontronit-ca	4.871	6.600	ssatd	nontronit-k	4.418	5.987	ssatd
nontronit-mg	4.912	6.656	ssatd	nontronit-na	4.386	5.944	ssatd
paragonite	2.242	3.038	ssatd	pd-oxyannite	6.541	8.864	ssatd
pentahydrate	-5.582	-7.564		phengite	-0.089	-0.121	ssatd
phillipsite-	0.973	1.318	ssatd	phillipsite-	-3.998	-5.418	
phillipsite-	-5.781	-7.834		phlogopite	-2.991	-4.053	
prehnite	-3.789	-5.135		pseudowollas	-6.846	-9.277	
pyrophyllite	1.350	1.830	ssatd	quartz	-0.226	-0.306	ssatd
rhodochrosit	-0.852	-1.154		rhodonite	-5.599	-7.588	
ripidolit-14	-2.001	-2.712		ripidolit-7a	-5.391	-7.305	
sanidine hig	-0.792	-1.074		saponite-ca	-2.515	-3.409	
saponite-h	-3.438	-4.659		saponite-k	-2.968	-4.023	
saponite-mg	-2.474	-3.353		saponite-na	-3.000	-4.065	
scolecite	1.580	2.141	ssatd	siderite	0.034	0.046	ssatd
sillimanite	-1.887	-2.557		smectite-hig	-0.922	-1.250	
smectite-low	-0.324	-0.439	ssatd	smectite-rey	2.555	3.463	ssatd
smithsonite	-1.893	-2.565		stilbite-ca	-0.512	-0.694	
stilbite-k	-3.821	-5.177		stilbite-na	-5.012	-6.792	
strengite	-5.553	-7.525		sylvite	-7.332	-9.935	
talc	-3.729	-5.053		tridymite	-0.394	-0.534	
vivianite	-3.717	-5.037		wairakite	-4.778	-6.475	
whitlockite	1.210	1.639	ssatd	wollastonite	-6.448	-8.738	
wustite	-4.397	-5.958		yugawaralite	0.128	0.173	ssatd
zincite	-3.120	-4.228		zoisite	-4.850	-6.573	

19 approx. saturated pure minerals  
0 approx. saturated end-members of specified solid solutions  
0 saturated end-members of hypothetical solid solutions

40 supersaturated pure minerals  
0 supersatd. end-members of specified solid solutions  
0 supersatd. hypothetical solid solution phases

----- summary of gases -----

gas	fugacity	log fugacity
ch4(g)	0.311068E-23	-23.50714
co2(g)	0.184124E-01	-1.73489
h2(g)	0.572260E-11	-11.24241
h2s(g)	0.299976E-21	-21.52291
n2(g)	0.100000E+35	97.29711
o2(g)	0.000000E+00	-61.29581
s2(g)	0.000000E+00	-46.39808
steam	0.277603E-01	-1.55658

----- end of output -----

----- pickup file successfully written -----

--- reading the input file ---

--- no further input found ---

start time = 11:52:46 12-0C89

end time = 11:53:09 12-0C89

-----  
9 completed 11  
normal exit

EQ3NR, version 3245R111

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Run 11:58:45 12-0C89

--- reading the input file ---

input file name= kerr3.31 revised=10/11/89 revisor= rg  
Kerrville, Texas - WTP Project; Charge No.: TEX24486.a1

Basic data for EQ3 modeling of Kerrville project received  
from Dick Glanzman/DEN on October 10, 1989.

This is one of four scenarios.

- 1) Equilibrium for ASR groundwater at a pH of 8.2
- 2) Equilibrium for ASR groundwater at a pH of 7.3
- 3) Equilibrium for ASR water Treatment Plant (WTP) recharge water
- 4) Equilibrium of a 50-50 mixture of one of the above ASR  
groundwaters and the WTP water.

This run is for the third scenario.

endit.

tempc= 0.25000E+02  
rho= 0.10000E+01      tdspsy= 0.00000E+00      tdspl= 0.00000E+00  
fep= -0.10000E+00      uredox=  
tolbt= 0.00000E+00      toldi= 0.00000E+00      tolsat= 0.00000E+00  
itermx= 0

	1	2	3	4	5	6	7	8	9	10
lopt1-10=	-1	0	0	0	0	0	0	0	0	0
lopg1-10=	0	0	0	0	0	0	0	0	0	0
lopr1-10=	0	0	0	0	0	0	0	0	0	0
iopr11-20=	0	0	0	0	0	0	0	0	0	0
iodb1-10=	0	0	0	0	0	0	0	0	0	0

uebal= none  
uacion= cl-  
nxmod= 0  
data file master species= na+  
switch with species=  
jflag= 2    csp= 0.11000E+02

h2(aq) /h2o	-0.100	-0.1690E+01	-59.465	-2.306
fe+++ /fe++	-0.100	-0.1690E+01	-59.465	-2.306
hs- /so4--	-0.100	-0.1690E+01	-59.465	-2.306
nh4+ /no3-	0.203	0.3440E+01	-38.943	4.693
no2- /no3-	-0.100	-0.1690E+01	-59.465	-2.306

----- summary of aqueous non-equilibrium non-redox reactions -----

couple            affinity, kcal

none

----- summary of stoichiometric mineral saturation states -----

(minerals with affinities .lt. -10 kcal are not listed)

mineral	log q/k	aff, kcal	state	mineral	log q/k	aff, kcal	state
albite	-1.529	-2.087		albite high	-2.848	-3.886	
albite low	-1.529	-2.087		amesite-14a	0.371	0.506	ssatd
amrph.silica	-1.377	-1.879		analc-dehydr	-6.329	-8.635	
analcime	-1.621	-2.212		andalusite	-1.467	-2.002	
andradite	-5.763	-7.862		anhydrite	-3.198	-4.363	
annite	-2.377	-3.243		anorthite	-4.179	-5.702	
aragonite	-0.124	-0.169	satd	artinite	-6.164	-8.410	
ashcroftite	-2.312	-3.154		bassanite	-3.828	-5.223	
beidellit-ca	2.988	4.076	ssatd	beidellit-k	2.319	3.163	ssatd
beidellit-mg	3.019	4.119	ssatd	beidellit-na	2.370	3.234	ssatd
berlinite	-6.084	-8.300		boehmite	0.001	0.001	satd
brewsterite-	0.791	1.079	ssatd	brucite	-4.493	-6.129	
cahpo4.2h2o	-4.133	-5.639		calcite	0.041	0.056	satd
cas12o5.2h2o	-6.279	-8.566		caso4.1/2h2o	-3.997	-5.453	
chabazite	1.072	1.462	ssatd	chalcedony	-0.363	-0.495	satd
chamosite-7a	-0.338	-0.461	satd	chrysotile	-3.881	-5.295	
clinochl-14a	-1.895	-2.586		clinochl-7a	-5.269	-7.188	
clinoptil-ca	-0.724	-0.988		clinoptil-k	-0.632	-0.863	
clinoptil-mg	-4.865	-6.638		clinoptil-na	-5.338	-7.282	
clinozoisite	-3.655	-4.986		corundum	-2.190	-2.988	
crystalite	-0.642	-0.876		cris.beta.a	-1.081	-1.475	
cronstedt.-7	1.504	2.052	ssatd	dachiardite-	1.399	1.908	ssatd
daphnite-14a	-0.918	-1.252		daphnite-7a	-4.291	-5.854	
dawsonite	-0.960	-1.309		diaspore	0.845	1.153	ssatd
diopside	-5.331	-7.272		dolomite	1.066	1.455	ssatd
dolomite-dis	-0.478	-0.652		dolomite-ord	1.066	1.455	ssatd
enstatite	-3.610	-4.925		epidote	-0.711	-0.970	
epidote-ord	-0.711	-0.970		epistilbite	0.791	1.079	ssatd
epsomite	-5.589	-7.624		erionite-ca	3.529	4.815	ssatd
faujasite-ca	1.066	1.454	ssatd	faujasite-na	-4.209	-5.742	
fayalite	-5.172	-7.056		fe(oh)2(ppd)	-3.867	-5.275	
fe(oh)3(ppd)	-3.012	-4.109		feo(c)	-2.376	-3.241	
ferrite-ca	-5.919	-8.075		ferrite-mg	-5.405	-7.374	
ferrite-zn	-0.692	-0.944		ferrosilite	-2.523	-3.442	
fluorapatite	13.153	17.945	ssatd	fluorite	-1.121	-1.529	
garronite	0.892	1.218	ssatd	gibbsite	1.637	2.233	ssatd
gismondine	1.365	1.863	ssatd	gmelinite-ca	1.072	1.462	ssatd
gmelinite-na	-4.188	-5.713		goethite	1.380	1.883	ssatd
greenalite	-3.809	-5.197		gypsum	-3.025	-4.127	

hedenbergite	-6.767	-9.232		hematite	3.719	5.073	ssatd
hercynite	-1.267	-1.728		heulandite-c	0.644	0.879	ssatd
heulandite-n	-4.615	-6.297		hexahydrate	-5.823	-7.944	
huntite	-3.503	-4.778		hydroxyapatite	3.205	4.373	ssatd
illite	2.791	3.807	ssatd	jadeite	-3.063	-4.179	
k-feldspar	0.327	0.447	ssatd	kalsilite	-2.665	-3.635	
kaolinite	3.583	4.888	ssatd	kieserite	-7.277	-9.928	
kyanite	-1.192	-1.627		lansfordite	-3.099	-4.228	
laumontite	0.554	0.756	ssatd	lawsonite	0.175	0.239	ssatd
leonhardtite	-6.547	-8.933		levyne	1.072	1.462	ssatd
magnesite	-0.604	-0.823		magnetite	2.452	3.345	ssatd
margarite	-0.094	-0.128	ssatd	maximum micr	0.327	0.447	ssatd
mesolite	3.237	4.416	ssatd	mesolite-ss	-1.578	-2.153	
mgf2(c)	-3.822	-5.215		minnesotaite	-3.301	-4.503	
mnhpo4(c)	-2.313	-3.155		monohydrocal	-0.955	-1.303	
montmor-ca	2.503	3.414	ssatd	montmor-mg	2.604	3.552	ssatd
montmor-na	1.952	2.663	ssatd	montmor-k	1.904	2.597	ssatd
mordenite-k	-0.321	-0.438	ssatd	mordenite-na	-2.674	-3.648	
muscovite	5.040	6.876	ssatd	nahcolite	-5.772	-7.875	
natrolite	-3.722	-5.077		nepheline	-4.384	-5.981	
nesquehonite	-3.309	-4.514		nontronit-ca	5.412	7.384	ssatd
nontronit-k	4.743	6.471	ssatd	nontronit-mg	5.444	7.427	ssatd
nontronit-na	4.795	6.542	ssatd	paragonite	2.287	3.120	ssatd
pd oxyannite	6.469	8.825	ssatd	pentahydrate	-6.161	-8.406	
phengite	0.313	0.427	ssatd	phillipsite-	1.764	2.407	ssatd
phillipsite-	-5.050	-6.890		phillipsite-	-6.129	-8.361	
phlogopite	-1.963	-2.678		prehnite	-2.614	-3.567	
pseudowollas	-6.237	-8.509		pyrophyllite	1.770	2.415	ssatd
quartz	-0.092	-0.125	ssatd	rhodochrosit	-2.577	-3.516	
rhodonite	-6.523	-8.899		ripidolit-14	-1.226	-1.672	
ripidolit-7a	-4.599	-6.274		sanidine hig	-0.872	-1.189	
saponite-ca	-0.860	-1.173		saponite-h	-1.847	-2.520	
saponite-k	-1.529	-2.086		saponite-mg	-0.828	-1.130	
saponite-na	-1.477	-2.015		scolecite	2.290	3.124	ssatd
siderite	-0.909	-1.240		sillimanite	-1.826	-2.492	
smectite-hig	-0.342	-0.467	ssatd	smectite-low	0.245	0.334	ssatd
smectite-rey	3.475	4.741	ssatd	smithsonite	-3.365	-4.591	
spinel	-7.249	-9.890		stilbite-ca	0.637	0.870	ssatd
stilbite-k	-3.901	-5.321		stilbite-na	-4.622	-6.306	
strengite	-6.560	-8.950		talc	-2.077	-2.834	
tridymite	-0.257	-0.351	ssatd	vivianite	-6.796	-9.272	
wairakite	-3.857	-5.262		whitlockite	0.400	0.545	ssatd
wollastonite	-5.844	-7.973		wustite	-4.623	-6.307	
yugawaralite	0.938	1.279	ssatd	zincite	-3.947	-5.385	
zoisite	-3.700	-5.047					

15 approx. saturated pure minerals  
0 approx. saturated end-members of specified solid solutions  
0 saturated end-members of hypothetical solid solutions

48 supersaturated pure minerals  
0 supersatd. end-members of specified solid solutions  
0 supersatd. hypothetical solid solution phases

----- summary of gases -----



gas	fugacity	log fugacity
ch4(g)	0.209994E-26	-26.67779
co2(g)	0.502736E-02	-2.29866
h2(g)	0.151657E-11	-11.81914
h2s(g)	0.106547E-24	-24.97246
n2(g)	0.100000E+35	93.88885
o2(g)	0.000000E+00	-59.46454
s2(g)	0.000000E+00	-51.94284
steam	0.313105E-01	-1.50431

----- end of output -----

----- pickup file successfully written -----

--- reading the input file ---

--- no further input found ---

start time = 11:58:45 12-0C89

end time = 11:59:06 12-0C89

-----  
9 completed 11  
normal exit

EQ3NR, version 3245R111

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Run 09:40:05 19-0C89

--- reading the input file ---

input file name- kerr3.3i revised-10/11/89 revisor- rg  
Kerrville, Texas - WTP Project; Charge No.: TEX24486.a1

Basic data for EQ3 modeling of Kerrville project received  
from Dick Glanzman/DEN on October 10, 1989.

This is one of four scenarios.

- 1) Equilibrium for ASR groundwater at a pH of 8.2
- 2) Equilibrium for ASR groundwater at a pH of 7.3
- 3) Equilibrium for ASR Water Treatment Plant (WTP) recharge water
- 4) Equilibrium of a 50-50 mixture of one of the above ASR  
groundwaters and the WTP water.

This run is for the third scenario.

endit.

tempc-	0.25000E+02									
rho-	0.10002E+01	tdspkg-	0.00000E+00	tdspl-	0.00000E+00					
fep-	0.30000E+00	uredox-								
tolbt-	0.00000E+00	toldl-	0.00000E+00	tolst-	0.00000E+00					
itermx-	0									
	1	2	3	4	5	6	7	8	9	10
iopt1-10-	-1	0	0	0	0	0	0	0	0	0
iopg1-10-	0	0	0	0	0	0	0	0	0	0
iopr1-10-	0	0	0	0	0	0	0	0	0	0
iopr11-20-	0	0	0	0	0	0	0	0	0	0
iodb1-10-	0	0	0	0	0	0	0	0	0	0
uebal-	none									
uacion-	cl-									
nxmod-	0									
data file master species-	na+									
switch with species-										
jflag-	2	csp-	0.11000E+02							

fe++	/fe++	0.300	0.5071E+01	-32.418	6.919
hs-	/so4--	0.300	0.5071E+01	-32.418	6.919
nh4+	/no3-	0.303	0.5130E+01	-32.183	6.999
no2-	/no3-	0.300	0.5071E+01	-32.418	6.919

----- summary of aqueous non-equilibrium non-redox reactions -----

couple            affinity, kcal

none

----- summary of stoichiometric mineral saturation states -----

(minerals with affinities .lt. -10 kcal are not listed)

mineral	log q/k	aff, kcal	state	mineral	log q/k	aff, kcal	state
albite	-1.530	-2.087		albite high	-2.849	-3.886	
albite low	-1.530	-2.087		amesite-14a	0.371	0.506	ssatd
amrph.silica	-1.377	-1.879		analc-dehydr	-6.330	-8.635	
analcime	-1.622	-2.212		andalusite	-1.467	-2.002	
andradite	2.389	3.260	ssatd	anhydrite	-3.198	-4.363	
anorthite	-4.180	-5.703		aragonite	-0.124	-0.169	satd
artinite	-6.164	-8.410		ashcroftite	-2.313	-3.155	
bassanite	-3.828	-5.223		beidellit-ca	2.987	4.076	ssatd
beidellit-k	2.318	3.162	ssatd	beidellit-mg	3.019	4.118	ssatd
beidellit-na	2.370	3.233	ssatd	berlinite	-6.083	-8.299	
boehmite	0.001	0.001	satd	brewsterite-	0.790	1.078	ssatd
brucite	-4.493	-6.129		cahpo4.2h2o	-4.133	-5.639	
calcite	0.041	0.056	satd	casio5.2h2o	-6.279	-8.567	
caso4.1/2h2o	-3.997	-5.453		chabazite	1.071	1.461	ssatd
chalcedony	-0.363	-0.495	satd	chamosite-7a	-5.709	-7.789	
chrysotile	-3.882	-5.296		clinocl-14a	-1.896	-2.587	
clinocl-7a	-5.269	-7.189		clinoptil-ca	-0.725	-0.989	
clinoptil-k	-0.633	-0.864		clinoptil-mg	-4.866	-6.639	
clinoptil-na	-5.339	-7.284		clinozoisite	-3.655	-4.987	
corundum	-2.190	-2.988		crystalite	-0.642	-0.876	
crst.beta.a	-1.081	-1.475		cronstedt.-7	4.286	5.847	ssatd
dachiardite-	1.396	1.905	ssatd	dawsonite	-0.960	-1.310	
diaspore	0.845	1.153	ssatd	diopside	-5.331	-7.273	
dolomite	1.066	1.454	ssatd	dolomite-dis	-0.479	-0.653	
dolomite-ord	1.066	1.454	ssatd	enstatite	-3.610	-4.925	
epidote	3.365	4.591	ssatd	epidote-ord	3.365	4.591	ssatd
epistilbite	0.790	1.078	ssatd	epsomite	-5.589	-7.624	
erionite-ca	3.526	4.810	ssatd	faujasite-ca	1.065	1.453	ssatd
faujasite na	-4.209	-5.743		fe(oh)2(ppd)	-6.552	-8.939	
fe(oh)3(ppd)	1.065	1.453	ssatd	feo(c)	-5.061	-6.905	
ferrite ca	2.234	3.047	ssatd	ferrite-mg	2.748	3.749	ssatd
ferrite-zn	7.461	10.179	ssatd	ferrosilite	-5.209	-7.106	
fluorapatite	13.154	17.946	ssatd	fluorite	-1.121	-1.530	
garronite	0.891	1.215	ssatd	gibbsite	1.637	2.233	ssatd
gismondine	1.365	1.862	ssatd	gmelinite-ca	1.071	1.461	ssatd
gmelinite-na	-4.189	-5.714		goethite	5.456	7.444	ssatd
gypsum	-3.025	-4.127		hematite	11.871	16.196	ssatd
hercynite	-3.952	-5.392		heulandite-c	0.643	0.878	ssatd
heulandite-n	-4.616	-6.298		hexahydrite	-5.823	-7.944	
huntite	-3.504	-4.780		hydroxyapati	3.206	4.274	

illite	2.790	3.806	ssatd	jadeite	-3.063	-4.179	
k-feldspar	0.327	0.446	satd	kalsilite	-2.665	-3.636	
kaolinite	3.583	4.888	ssatd	kieserite	-7.277	-9.928	
kyanite	-1.193	-1.627		lansfordite	-3.099	-4.228	
laumontite	0.554	0.755	ssatd	lawsonite	0.175	0.239	satd
leonhardtite	-6.547	-8.933		levyne	1.071	1.461	ssatd
magnesite	-0.604	-0.824		magnetite	7.919	10.804	ssatd
margarite	-0.094	-0.128	satd	maximum micr	0.327	0.446	satd
mesolite	3.236	4.415	ssatd	mesolite-ss	-1.580	-2.155	
mgf2(c)	-3.823	-5.215		mnlpo4(c)	-2.312	-3.154	
monohydrocal	-0.955	-1.304		montmor-ca	2.502	3.413	ssatd
montmor-mg	2.603	3.551	ssatd	montmor-na	1.951	2.662	ssatd
montmor k	1.903	2.596	ssatd	mordenite k	-0.322	-0.439	satd
mordenite-na	-2.675	-3.649		muscovite	5.040	6.875	ssatd
nahcolite	-5.772	-7.875		natrolite	-3.722	-5.078	
nepheline	-4.384	-5.981		nesquehonite	-3.309	-4.515	
nontronit-ca	13.565	18.506	ssatd	nontronit-k	12.895	17.593	ssatd
nontronit-mg	13.596	18.549	ssatd	nontronit-na	12.947	17.664	ssatd
paragonite	2.286	3.119	ssatd	pd oxyannite	18.697	25.509	ssatd
pentahydrate	-6.161	-8.406		phengite	0.312	0.426	satd
phillipsite-	1.764	2.406	ssatd	phillipsite-	-5.051	-6.891	
phillipsite-	-6.130	-8.363		phlogopite	-1.964	-2.679	
prehnite	-2.615	-3.567		pseudowollas	-6.237	-8.509	
pyrophyllite	1.770	2.415	ssatd	quartz	-0.092	-0.125	satd
rhodochrosit	-2.578	-3.517		rhodonite	-6.523	-8.899	
ripidolit-14	-6.597	-9.000		sanidine hig	-0.872	-1.190	
saponite-ca	-0.860	-1.174		saponite-h	-1.848	-2.521	
saponite-k	-1.530	-2.087		saponite-mg	-0.829	-1.131	
saponite-na	-1.478	-2.016		scolecite	2.289	3.123	ssatd
siderite	-3.595	-4.904		sillimanite	-1.827	-2.492	
smectite-hig	-0.870	-1.187		smectite-low	0.118	0.161	satd
smectite-rey	4.015	5.478	ssatd	smithsonite	-3.365	-4.591	
spinel	-7.249	-9.890		stilbite-ca	0.637	0.869	ssatd
stilbite-k	-3.901	-5.323		stilbite-na	-4.623	-6.307	
strengite	-2.483	-3.388		talc	-2.078	-2.834	
tridymite	-0.257	-0.351	satd	wairakite	-3.858	-5.263	
whitlockite	0.400	0.546	ssatd	wollastonite	-5.844	-7.973	
wustite	-6.449	-8.799		yugawaralite	0.937	1.279	ssatd
zincite	-3.947	-5.385		zoisite	-3.700	-5.048	

13 approx. saturated pure minerals

0 approx. saturated end-members of specified solid solutions

0 saturated end-members of hypothetical solid solutions

55 supersaturated pure minerals

0 supersatd. end-members of specified solid solutions

0 supersatd. hypothetical solid solution phases

----- summary of gases -----

gas	fugacity	log fugacity
ch4(g)	0.000000E+00	-80.77179
co2(g)	0.502497E-02	-2.29887

h2(g)	0.454375E-25	-25.34259
h2s(g)	0.000000E+00	-79.06627
n2(g)	0.100000E+35	53.31442
o2(g)	0.382253E-32	-32.41765
s2(g)	0.000000E+00	-133.08357
steam	0.313105E-01	-1.50431

----- end of output -----

----- pickup file successfully written -----

--- reading the input file ---

--- no further input found ---

start time - 09:40:05 19-0C89  
end time - 09:40:30 19-0C89

-----  
9 completed 01  
normal exit

EQ3HR, version 3245R111

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Run 09:54:19 19-0C89

--- reading the input file ---  
input file name- kerr4.3i revised-10/18/89 revisor- rg  
Kerrville, Texas - ASR Project; Charge No.: TEX24486.a1

Basic data for EQ3 modeling of Kerrville project received  
from Dick Glanzman/DEN on October 10, 1989.

This is one of four scenarios.

- 1) Equilibrium for ASR groundwater at a pH of 8.2
- 2) Equilibrium for ASR groundwater at a pH of 7.3
- 3) Equilibrium for ASR Water Treatment Plant (WTP) recharge water
- 4) Equilibrium of a 50-50 mixture of one of the above ASR  
groundwaters and the WTP water (as an approximation av. value  
of asr and wtp used)

This run is for the fourth scenario.

endit.

```
tempc- 0.24000E+02
rho- 0.10004E+01      tdspkg- 0.00000E+00      tdspl- 0.00000E+00
fep- 0.10000E+00      uredox-
tolbt- 0.00000E+00      toldl- 0.00000E+00      tolsat- 0.00000E+00
itermx- 0
      1      2      3      4      5      6      7      8      9      10
iop1-10- -1      0      0      0      0      0      0      0      0      0
iopg1-10- 0      0      0      0      0      0      0      0      0      0
ioprl-10- 0      0      0      0      0      0      0      0      0      0
ioprl1-20- 0      0      0      0      0      0      0      0      0      0
iodb1-10- 0      0      0      0      0      0      0      0      0      0
uebal- none
uacion- cl-
nxmod- 0
data file master species- na+
switch with species-
jflag- 2      csp- 0.24000E+02
```

couple	eh, volts	pe-	log fo2	ah, kcal
default	0.100	0.1696E+01	-46.810	2.306
o2(aq) /h2o	0.778	0.1319E+02	-0.839	17.933
h2(aq) /h2o	0.100	0.1696E+01	-46.810	2.306
fe+++ /fe++	0.100	0.1696E+01	-46.810	2.306
hs- /so4--	0.100	0.1696E+01	-46.810	2.306
nh4+ /no3-	0.263	0.4462E+01	-35.747	6.067
no2- /no3-	0.100	0.1696E+01	-46.810	2.306

----- summary of aqueous non-equilibrium non-redox reactions -----

couple            affinity, kcal

none

----- summary of stoichiometric mineral saturation states -----

(minerals with affinities .lt. -10 kcal are not listed)

mineral	log q/k	aff, kcal	state	mineral	log q/k	aff, kcal	state
albite	-1.491	-2.028		albite high	-2.817	-3.830	
albite low	-1.491	-2.028		alunite	-6.071	-8.255	
amesite-14a	0.130	0.177	satd	amrph.silica	-1.444	-1.963	
analc-dehydr	-6.250	-8.499		analcime	-1.525	-2.073	
andalusite	-1.434	-1.950		andradite	0.736	1.001	ssatd
anhydrite	-2.960	-4.024		annite	-0.928	-1.261	
anorthite	-4.408	-5.993		aragonite	0.029	0.040	satd
artinite	-6.107	-8.304		ashcroftite	-1.805	-2.454	
bassanite	-3.590	-4.881		beidellit-ca	2.872	3.905	ssatd
beidellit-k	2.355	3.202	ssatd	beidellit-mg	2.911	3.958	ssatd
beidellit-na	2.341	3.183	ssatd	berlinite	-5.449	-7.409	
boehmite	0.051	0.070	satd	brewsterite-	0.431	0.586	ssatd
brucite	-4.647	-6.319		cahpo4.2h2o	-3.711	-5.046	
calcite	0.194	0.264	satd	casio5.2h2o	-6.590	-8.960	
caso4.1/2h2o	-3.760	-5.112		chabazite	0.865	1.176	ssatd
chalcedony	-0.423	-0.575		chamosite-7a	0.515	0.700	ssatd
chrysotile	-4.433	-6.028		clinochl-14a	-2.686	-3.652	
clinochl-7a	-6.067	-8.249		clinoptil-ca	-1.399	-1.902	
clinoptil-k	-0.383	-0.521		clinoptil-mg	-5.513	-7.497	
clinoptil-na	-5.502	-7.482		clinozoisite	-4.071	-5.535	
corundum	-2.100	-2.856		cristobalite	-0.703	-0.956	
crist.beta.a	-1.145	-1.557		cronstedt.-7	9.518	12.942	ssatd
dachiardite-	0.193	0.263	satd	daphnite-14a	1.031	1.402	ssatd
daphnite-7a	-2.351	-3.197		dawsonite	-0.389	-0.530	
diaspore	0.901	1.225	ssatd	diopside	-5.798	-7.884	
dolomite	1.422	1.933	ssatd	dolomite-dis	-0.130	-0.176	satd
dolomite-ord	1.422	1.933	ssatd	enstatite	-3.826	-5.202	
epidote	2.461	3.346	ssatd	epidote-ord	2.461	3.346	ssatd
epistilbite	0.431	0.586	ssatd	epsomite	-5.279	-7.177	
erionite-ca	1.910	2.597	ssatd	faujasite-ca	0.858	1.167	ssatd
faujasite-na	-3.915	-5.323		fayalite	-4.445	-6.044	
fe(oh)2(ppd)	-3.472	-4.721		fe(oh)3(ppd)	0.612	0.832	ssatd
feo(c)	-1.983	-2.697		ferrite-ca	1.122	1.526	ssatd
ferrite-mg	1.682	2.288	ssatd	ferrite-zn	7.500	10.198	ssatd

ferrosilite	-2.188	-2.975		fluorapatite	14.264	19.394	ssatd
fluorite	-0.944	-1.283		garronite	0.674	0.917	ssatd
gibbsite	1.701	2.313	ssatd	gismondine	1.311	1.783	ssatd
gmelinite-ca	0.865	1.176	ssatd	gmelinite-na	-3.894	-5.294	
goethite	5.014	6.818	ssatd	greenalite	-2.720	-3.699	
gypsum	-2.777	-3.775		hedenbergite	-6.693	-9.100	
hematite	10.984	14.935	ssatd	hercynite	-0.773	-1.051	
heulandite-c	0.208	0.283	satd	heulandite-n	-4.550	-6.187	
hexahydrite	-5.521	-7.508		huntite	-2.768	-3.763	
hydroxyapatite	4.100	5.575	ssatd	illite	2.902	3.946	ssatd
jadeite	-2.966	-4.033		k-feldspar	0.573	0.779	ssatd
kalicinite	-6.682	-9.085		kalsilite	-2.312	-3.144	
kaolinite	3.587	4.877	ssatd	kieserite	-7.003	-9.522	
kyanite	-1.157	-1.573		lansfordite	-2.876	-3.911	
laumontite	0.239	0.325	satd	lawsonite	-0.019	-0.025	satd
leonhardtite	-6.257	-8.507		levyne	0.865	1.176	ssatd
magnesite	-0.407	-0.554		magnetite	10.114	13.752	ssatd
margarite	-0.201	-0.273	satd	maximum micr	0.573	0.779	ssatd
melanterite	-7.145	-9.715		mesolite	3.170	4.311	ssatd
mesolite-ss	-1.469	-1.998		mgf2(c)	-3.612	-4.911	
minnesotaite	-2.333	-3.172		mn(oh)2(am)	-6.845	-9.307	
mnhpo4(c)	-0.530	-0.721		monohydrocal	-0.800	-1.087	
montmor-ca	2.286	3.108	ssatd	montmor-mg	2.394	3.255	ssatd
montmor-na	1.822	2.477	ssatd	montmor-k	1.839	2.501	ssatd
mordenite-k	-0.196	-0.267	satd	mordenite-na	-2.756	-3.748	
muscovite	5.407	7.351	ssatd	nahcolite	-5.272	-7.168	
natrolite	-3.459	-4.704		nepheline	-4.238	-5.763	
nesquehonite	-3.108	-4.226		nontronit-ca	12.461	16.943	ssatd
nontronit-k	11.944	16.240	ssatd	nontronit-mg	12.499	16.996	ssatd
nontronit-na	11.930	16.221	ssatd	paragonite	2.443	3.322	ssatd
pd-oxyannite	17.618	23.955	ssatd	pentahydrite	-5.857	-7.964	
phengite	0.361	0.491	satd	phillipsite	1.530	2.080	ssatd
phillipsite	-3.959	-5.384		phillipsite-	-5.611	-7.630	
phlogopite	-2.153	-2.928		prehnite	-3.069	-4.173	
pseudowollas	-6.506	-8.846		pyrophyllite	1.647	2.239	ssatd
quartz	-0.151	-0.205	satd	rhodochrosit	-1.062	-1.444	
rhodonite	-5.423	-7.374		ripidolit-14	-0.919	-1.250	
ripidolit-7a	-4.301	-5.848		sanidine hig	-0.633	-0.860	
saponite-ca	-1.519	-2.066		saponite-h	-2.479	-3.371	
saponite-k	-2.036	-2.769		saponite-mg	-1.480	-2.013	
saponite-na	-2.050	-2.788		scolecite	2.040	2.774	ssatd
siderite	-0.169	-0.230	satd	sillimanite	-1.795	-2.441	
smectite-hig	0.366	0.497	satd	smectite-low	0.757	1.029	ssatd
smectite-rey	4.532	6.162	ssatd	smithsonite	-2.087	-2.838	
spinel	-7.322	-9.956		stilbite-ca	0.201	0.274	satd
stilbite-k	-3.454	-4.696		stilbite-na	-4.557	-6.197	
strengite	-2.336	-3.176		talc	-2.745	-3.732	
tridymite	-0.317	-0.431	satd	vivianite	-4.355	-5.921	
wairakite	-4.204	-5.716		whitlockite	1.051	1.429	ssatd
wollastonite	-6.110	-8.308		wustite	-3.918	-5.327	
yugawaralite	0.654	0.890	ssatd	zincite	-3.015	-4.100	
zoisite	-4.116	-5.596					

17 approx. saturated pure minerals

0 approx. saturated end-members of specified solid solutions

0 saturated end-members of hypothetical solid solutions

55 supersaturated pure minerals



0 supersatd. end-members of specified solid solutions  
0 supersatd. hypothetical solid solution phases

----- summary of gases -----

gas	fugacity	log fugacity
ch4(g)	0.000000E+00	-52.20749
co2(g)	0.101511E-01	-1.99348
h2(g)	0.483926E-18	-18.31522
h2s(g)	0.000000E+00	-50.41362
n2(g)	0.100000E+35	75.23532
o2(g)	0.000000E+00	-46.81012
s2(g)	0.000000E+00	-89.93310
steam	0.294888E-01	-1.53034

----- end of output -----

----- pickup file successfully written -----

--- reading the input file ---

--- no further input found ---

start time - 09:54:19 19-0C89  
end time - 09:54:46 19-0C89

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9 completed 01  
normal exit