PROJECT DRIBBLE
PETROGRAPHIC EXAMINATION AND PHYSICAL TESTS OF CORES, TATUM SALT DOME, MISSISSIPPI

TECHNICAL REPORT NO. 6-614

January 1963

U. S. Army Engineer Waterways Experiment Station
CORPS OF ENGINEERS
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PREFACE

The tests described in this report were authorized in a letter from the U. S. Atomic Energy Commission, Albuquerque Operations Office, to the U. S. Army Engineer Waterways Experiment Station, dated 30 December 1960, subject, "WES Participation in Vela Uniform."

The tests were performed for the Atomic Energy Commission as directed by Holmes and Narver, Inc., architect-engineers for the AEC, and Dr. D. U. Deere, University of Illinois, consultant for Holmes and Narver. They were conducted at the Waterways Experiment Station under the supervision of Mr. Thomas B. Kennedy, Chief, Concrete Division, and Messrs. Bryant Mather, James M. Polatty, E. E. McCoy, Jr., and William O. Tynes and Mrs. Katharine Mather, of the Concrete Division staff. Messrs. Alan D. Buck, W. I. Luke, E. C. Roshore, B. J. Houston, Kenneth L. Saucier, Frank S. Stewart, and SP4 Howard Sugiuchi, also of the Concrete Division staff, actively participated in the work. This report was prepared by Messrs. Saucier and Buck.

Directors of the Waterways Experiment Station during the conduct of the study and the preparation of this report were Col. Edmund H. Lang, CE, and Col. Alex G. Sutton, Jr., CE. Technical Director was Mr. J. B. Tiffany.

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SUMMARY

Two holes (WP-1 and -4) drilled into the Tatum dome, Lamar County, Miss., yielded 95 samples taken from scattered depths between 948 and 2703 ft below ground surface. Eight cores from cap rock in hole WP-1 and six cores from cap rock and 11 cores from salt in hole WP-4 were 2-1/8 in. in diameter; 70 cores from salt in hole WP-1 were 4-15/16 in. in diameter. In addition, 32 core samples, 16 of each of the above-listed diameters, were obtained from the 811-ft depth in the Carey Salt Mine, Winnfield, La. (tests of these cores are described in Appendix A).

All samples were examined petrographically before being subjected to physical tests to develop information on texture, fabric, structure, and composition. Many samples were reexamined after having been subjected to the physical tests. Observations were made at various magnifications; quantity, nature, and particle-size distribution of water-insoluble residues were determined; composition and constitution were determined from optical properties of thin sections and powder mounts, and by X-ray diffraction and X-ray emission; precise determinations of specific gravity were made with a torsion microbalance.

The following physical tests were performed: (a) uniaxial compressive strength tests; (b) uniaxial tensile strength tests; (c) uniaxial tests for compressive strength under cyclic loading; (d) uniaxial compression tests by incremental loading; (e) uniaxial creep tests; (f) triaxial extension tests; (g) nondestructive dynamic (sonic and ultrasonic) tests; and (h) specific gravity, porosity, permeability, and interstitial fluid tests. Strain measurements were made in all strength test specimens using one of three methods: (a) with a compressometer, (b) between embedded inserts with a mechanical gage, or (c) by SR-4 electrical strain gages.

The samples from Winnfield represented three lithologic varieties: (a) alternating bands of pure salt and gray anhydrite-bearing salt, (b) anhydrite-bearing salt, and (c) pure salt. Of the 81 samples of salt from the Tatum dome, 79 were of the banded type and two of pure salt. The salt crystals tended to be aligned parallel to the bands. The average grain size of the salt crystals was 1/4 to 1/2 in. The bands generally dipped at angles from 60 to 90 degrees. The anhydrite content averaged about 9 percent and ranged from 1 to 22 percent. Only traces of other materials (calcite, dolomite, iron oxide) were present. The carbonate cap rock included a strontium-rich zone that was found in both holes at Tatum.

The essential similarity and homogeneity of the core samples from the Tatum salt precluded positive correlation of variation in mechanical properties with variations in texture, fabric, structure, and composition. Of the cores which failed under sustained loads, most are regarded as having done so because the inherent ultimate strength of the material was exceeded; in a few cases failure is believed to have been brought about by undetected abnormal flaws in the specimen.

PROJECT DRIBBLE

PETROGRAPHIC EXAMINATION AND PHYSICAL TESTS OF CORES

TATUM SALT DOME, MISSISSIPPI

PART I: INTRODUCTION

Background

1. Project DRIBBLE is a portion of the Vela Uniform explosion series under the supervision of the U. S. Atomic Energy Commission. The principal purpose of the program is to test the "decoupling" theory. This theory states that if an explosive is placed in a hole just large enough for the critical stress to occur, the radiated seismic waves will be smaller than those from a tamped shot. In order to determine if a large cavity could be constructed and readied in the selected salt medium, a feasibility study was authorized in which the theoretical approach to the stability problem was to be augmented by test data on cores drilled from the cavity area. The physical quantities required to describe the necessary elastic, viscous, and plastic behavior would include the various properties, composition, stress limits, strains, moduli, and condition of the salt.

Purpose and Scope of Investigation

2. The Waterways Experiment Station was authorized to perform petrographic examinations and physical tests on halite, anhydrite, and cap rock cores from the Tatum salt dome, Lamar County, Miss., as part of the cavity durability study for Project DRIBBLE. Ninety-five cores of two sizes, 2-1/8 and 4-15/16 in. in diameter, were taken from two holes (designated WP-1 and WP-4) at the project site and sent to the Waterways Experiment Station. The cores were first examined petrographically, after which the following physical tests were performed: (a) uniaxial compressive strength tests; (b) uniaxial tensile strength tests; (c) uniaxial tests for compressive strength under cyclic loading; (d) uniaxial compression tests by incremental loading; (e) uniaxial creep tests; (f) triaxial extension tests; (g) nondestructive dynamic (sonic and ultrasonic) tests;

and (h) specific gravity, porosity, permeability, and interstitial fluid tests. Specimens were then reexamined petrographically to determine failure characteristics.

Scope of Report

3. Periodic progress reports were made to the sponsoring agency as data became available; this report summarizes the information from the fourteen progress reports. Parts II and III describe and give results of the petrographic examination of the cores from holes WP-1 and WP-4. Part IV discusses in detail the physical tests performed on the cores. Part V gives general conclusions based on the results of all examinations and tests. Appendix A describes tests made on cores from another salt dome in the Gulf Coast area (at Winnfield, La.), and is included for ready comparison of the results of tests on cores from the two salt domes. Appendices B and C are reprints of petrographic reports on the 17 cores from Tatum hole WP-4 submitted in May and November 1961, respectively. They are included as appendices to this report so that the detailed data they contain need not be included in the main text but will be available for reference.

Description of Drill Holes

4. Before the present investigation of the Tatum salt dome, a hole was drilled in the dome during an exploration for oil in 1940.[3*] This hole was located in section 14, Township 2 North, Range 16 West, Lamar County, Miss. It was abandoned as a dry hole at a depth of 2077 ft, after drilling had been carried through 561 ft of salt. The anhydrite cap rock was encountered at 1096 ft near the base of the Catahoula formation; the salt was encountered at 1516 ft.

5. Hole WP-1 is also located in section 14, Lamar County, Miss. The hole coordinates are N10166.85 and E8040.83; ground elevation is

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* Raised numbers refer to similarly numbered items in the list of references at the end of text.

about 270 ft above mean sea level. The top of the anhydrite was found at a depth of 1056 ft, and the top of the salt at a depth of 1509.5 ft (plate 1). The depths at which these materials were found correspond closely to those at which anhydrite and salt were found in the hole drilled in 1940.

6. Hole WP-4 is likewise located in section 14, Lamar County, Miss. The hole coordinates are N9217.06 and E9272.30; ground elevation is about 240 ft above mean sea level. The top of the anhydrite was found at depth of 1016 ft, and the top of the salt at 1484 ft (plate 1). These depths are also similar to those reported for the 1940 hole and hole WP-1.

PART II: PETROGRAPHIC EXAMINATION OF CORES FROM HOLE WP-1 IN TATUM SALT DOME

Identification of Cores

7. Seventy-eight cores taken from hole WP-1 were sent to the Waterways Experiment Station for laboratory tests and petrographic examination. Eight were NX, 2-1/8 in. in diameter, and came from the cap rock; the remaining 70 were 4-15/16 in. in diameter and came from the salt. The cores represented only part of the material taken from hole WP-1.

8. When cores were cut for test a letter designation was added to facilitate identification, the portions being marked A, B, etc., from the top of the core downward. This designation became the last part of the serial number. Locations of saw cuts and letter designations for the resulting portions of cores are shown in plates 2-40 (two cores on each plate, in order listed below). Other information about hole WP-1 cores is as follows:

CD Serial No.	Depth, ft	Date Received	Lithology
	NX Cores from Cap Rock		
TAT-1-NXC-14	1012.0 to 1012.3	7 July 1961	Limestone
-15	1020.0 to 1020.3	7 July 1961	Strontium-rich carbonate rock
-16	1103.5 to 1106.0	7 July 1961	Anhydrite
-17	1116.5 to 1119.0	7 July 1961	Anhydrite
-21	1181.0 to 1183.5	7 July 1961	Anhydrite
-19	1260.5 to 1262.8	7 July 1961	Anhydrite
-20	1345.0 to 1347.0	7 July 1961	Anhydrite
-18	1409.5 to 1412.0	7 July 1961	Anhydrite
	Cores from Salt*		
TAT-1-DC-64	1553.5 to 1555.0	30 Aug 1961	
-13	1657.3 to 1658.5	10 July 1961	
-14	1672.0 to 1673.6	10 July 1961	
-65	1673.5 to 1675.0	30 Aug 1961	
-18	1679.0 to 1680.5	10 July 1961	
-20	1681.0 to 1682.2	10 July 1961	
-17	1708.0 to 1709.5	10 July 1961	
-15	1720.0 to 1721.5	10 July 1961	
-19	1723.2 to 1724.7	10 July 1961	
-68	1725.0 to 1726.6	13 Dec 1961	

(Continued)

* All 70 cores were impure rock salt; DC-5 was almost pure.

CD Serial No.	Depth, ft	Date Received	Lithology
	Cores from Salt* (Continued)		
TAT-1-DC-16	1822.5 to 1824.2	10 July 1961	
-25	1947.2 to 1949.0	10 July 1961	
-24	1990.5 to 1992.3	10 July 1961	
-26	1994.5 to 1995.6	10 July 1961	
-28	2035.0 to 2036.4	10 July 1961	
-22	2097.3 to 2099.0	10 July 1961	
-33	2151.8 to 2153.5	10 July 1961	
-32	2158.8 to 2160.0	10 July 1961	
-69	2161.5 to 2163.0	13 Dec 1961	
-21	2179.3 to 2180.8	10 July 1961	
-23	2196.5 to 2198.0	10 July 1961	
-27	2200.5 to 2201.5	10 July 1961	
-66	2213.0 to 2214.5	30 Aug 1961	
-40	2216.5 to 2218.0	10 July 1961	
-70	2238.0 to 2239.8	27 Dec 1961	
-30	2239.8 to 2241.5	10 July 1961	
-1	2244.0 to 2247.0	6 June 1961	
-2	2249.0 to 2252.0	6 June 1961	
-47	2252.0 to 2253.7	10 July 1961	
-36	2261.0 to 2262.5	10 July 1961	
-35	2262.5 to 2264.2	10 July 1961	
-45	2271.0 to 2272.1	10 July 1961	
-29	2287.2 to 2289.0	10 July 1961	
-34	2290.8 to 2292.5	10 July 1961	
-31	2322.8 to 2324.4	10 July 1961	
-42	2325.0 to 2326.3	10 July 1961	
-5	2333.0 to 2335.0	29 June 1961	
-4	2341.0 to 2344.0	29 June 1961	
-3	2393.0 to 2397.0	29 June 1961	
-44	2398.8 to 2400.5	10 July 1961	
-41	2406.0 to 2407.2	10 July 1961	
-6	2445.0 to 2448.0	29 June 1961	
-37	2453.2 to 2455.0	10 July 1961	
-48	2456.7 to 2458.5	10 July 1961	
-8	2459.5 to 2463.0	29 June 1961	
-38	2463.8 to 2465.5	10 July 1961	
-43	2486.5 to 2488.0	10 July 1961	
-50	2494.8 to 2496.5	10 July 1961	
-49	2496.5 to 2498.3	10 July 1961	
-39	2506.0 to 2507.5	10 July 1961	
-52	2518.5 to 2520.2	10 July 1961	
-51	2522.0 to 2523.5	10 July 1961	
-53	2526.6 to 2528.5	10 July 1961	

(Continued)

* All 70 cores were impure rock salt; DC-5 was almost pure.

CD Serial No.	Depth, ft	Date Received	Lithology
	Cores from Salt* (Continued)		
TAT-1-DC-54	2533.5 to 2535.5	10 July 1961	
-46	2539.5 to 2540.8	10 July 1961	
-7	2545.0 to 2548.0	29 June 1961	
-67	2557.0 to 2559.5	30 Aug 1961	
-9	2559.5 to 2563.0	29 June 1961	
-55	2571.8 to 2573.5	10 July 1961	
-56	2584.0 to 2585.3	10 July 1961	
-58	2598.2 to 2599.0	10 July 1961	
-57	2602.4 to 2604.0	10 July 1961	
-11	2613.0 to 2616.0	29 June 1961	
-59	2629.3 to 2630.5	10 July 1961	
-60	2643.3 to 2645.0	10 July 1961	
-10	2656.0 to 2659.0	29 June 1961	
-63	2659.8 to 2662.5	10 July 1961	
-61	2683.7 to 2685.5	10 July 1961	
-62	2693.1 to 2695.0	10 July 1961	
-12	2700.0 to 2703.0	29 June 1961	

* All 70 cores were impure rock salt; DC-5 was almost pure.

Examinations and Description of Cores

Examinations

9. Each core was measured, and examined visually and with a stereomicroscope as necessary to obtain data for preparation of core logs (plates 1-40). A portion of a typical core was sawed down the middle and etched in water; the recrystallization of very small halite grains at grain boundaries as the surface dried resulted in a thin white line outlining grain boundaries. Photographs 1 and 2 show size and shape of halite grains and the appearance of gray anhydritic bands in a typical salt core. Detailed examinations were made as described in the following paragraphs.

10. Insoluble-residue determinations. The amount of water-insoluble residue was determined for 20 cores representing depths from 1553.5 to 2685.5 ft. Scrap ends of cores, ranging in weight from about 700 to 1900 g, were used. Each sample was weighed and placed in a 4000-ml beaker filled with tap water; the water was alternately stirred and left standing, then it was siphoned off, and the beaker refilled with clean tap water to continually remove the dissolved portions of each sample. The test was

terminated when the water in which the sample was immersed no longer developed a salty taste after adequate stirring and standing. The water-insoluble residues were dried at 100 C and weighed, and the percentages of insoluble residues were calculated (table 1).

Table 1

Insoluble Residues, Absorptions, and Specific Gravities of Selected Cores from Hole WP-1

		Water-Insoluble Residue					
CD Serial No.*	Depth, ft	Original Wt of Core g	Wt of Insoluble Residue g	Amt of Insoluble Residue %**	Calculated Specific Gravity †	Measured Specific Gravity (Apparent) ††	Absorption %††
TAT-1-NXC-15	1020.0 to 1020.3	--	---	--	--	3.25	0.87
-21	1181.0 to 1183.5	--	---	--	--	2.95	0.05
-19	1260.5 to 1262.8	--	---	--	--	2.95	0.05
-18	1409.5 to 1412.0	--	---	--	--	2.95	0.04
TAT-1-DC-64	1553.5 to 1555.0	1414	123.9	8.8	2.23	2.21	--
-13	1657.3 to 1658.5	784	31.2	4.0	2.19	2.19	0.27
-65	1673.5 to 1675.0	1235	91.3	7.4	2.22	2.22	0.16
-20	1681.0 to 1682.2	739	162.4	22.0	2.33	2.23	0.12
-15	1720.0 to 1721.5	901	69.6	7.7	2.20	--	--
-16A	1822.5 to 1824.2	2371	196.2	8.4	2.22	2.22	--
-25	1947.[illegible] to 1949.0	1181	97.7	8.3	2.22	2.21	0.53
-26	1994.5 to 1995.6	1632	153.8	9.4	2.23	2.21	--
-28	2035.0 to 2036.4	1049	183.4	17.5	2.29	2.29	0.35
-23	2196.5 to 2198.0	1843	56.7	3.1	2.18	--	--
-2	2249.0 to 2252.0	1497	129.7	8.7	2.23	2.20	--
-5	2333.0 to 2335.0	1006	11.6	1.2	2.17	--	--
-44A	2398.8 to 2400.5	1238	89.4	7.2	2.21	--	--
-37C	2453.2 to 2455.0	1296	180.1	13.9	2.27	--	--
-39B	2506.0 to 2507.5	1709	43.4	2.5	2.18	--	--
-46A	2539.5 to 2540.8	1019	84.8	8.3	2.22	--	--
-67A	2557.0 to 2559.5	1344	165.5	12.3	2.25	--	--
-56A	2584.0 to 2585.3	1883	129.0	6.9	2.21	--	--
-59A	2629.3 to 2630.5	842	116.0	13.8	2.26	--	--
-61	2683.7 to 2685.5	1155	126.6	11.0	2.24	2.23	0.35
			Average	9.1			

Note: The cavity is expected to be located between depths of 2398.8 and 2630.5 ft.

* The samples without a letter designation consisted of scrap core ends.

** $\frac{\text{Wt of water-insoluble residue}}{\text{Original wt of core}} \times 100$

† Percent halite × sp gr (halite) + percent insoluble residue × sp gr (anhydrite). The sp gr of halite used was that reported in the literature (2.16). The sp gr of anhydrite used was the average obtained by the measurement of 20 grains (2.92) (table 2). All of the insoluble residue was assumed to be anhydrite, and the effects of absorption were ignored as being insignificant.

†† Determined by Method CRD-C 107-60 in Handbook for Concrete and Cement.[7] Kerosene was used instead of water since salt is insoluble in kerosene.

11. Particle-size analysis of insoluble residues. The dried insoluble residue from each of the 20 DC cores listed in table 1 was screened over Nos. 8, 16, 30, 50, 100, and 200 sieves; the splits obtained were weighed, and these values and the grain-size distribution curves are shown in plates 41-60. The average values for all 20 of the cores were used to prepare plate 61.

12. Specific-gravity determinations. Companion samples to 10 of the salt cores used for insoluble-residue determinations were tested for bulk and apparent specific gravities by Method CRD-C 107-60[7] using kerosene instead of water. The theoretical specific gravity was calculated for each of the 20 cores tested for insoluble residue by using the values for the

amount and specific gravity of halite and the amount of insoluble residue with a specially determined value for the specific gravity of anhydrite. This latter value was found as follows. Twenty specific-gravity determinations were made on 20 grains of anhydrite selected from the insoluble residue of core DC-28 in the size passing the No. 8 and retained on the No. 16 sieve (table 2). The average of the 20 values was used in calculating the

Table 2

Specific Gravities of 20 Anhydrite* Grains from the Insoluble Residue of Salt Core TAT-1-DC-28 from Hole WP-1

Anhydrite Grains Selected from the Insoluble Residue Passing No. 8 and Retained on No. 16 Sieve	Specific Gravity**
Grain 1	2.95
2	2.97
3	2.97
4	2.91
5	2.92
6	2.88
7	2.91
8	2.90
9	2.94
10	2.98
11	2.97
12	2.92
13	2.91
14	2.91
15	2.90
16	2.88
17	2.91
18	2.90
19	2.91
20	2.93

* Various mineralogy books report a specific gravity of 2.7 to 3.0. The latest Dana (reference 4) gives a reported value of 2.98 and a calculated value of 3.00.

** Determined with a Berman torsion microbalance; toluene was used as the liquid.

$$\text{sp gr} = \frac{Wt_{air}}{Wt_{air} - Wt_{toluene}} \times \text{sp gr}_{toluene}$$

specific gravity of 20 cores. The specific-gravity determinations were made with a Berman torsion microbalance. The comparison between measured and calculated specific gravities of the cores is shown in table 1.

13. Three of the NX-size cores, NXC-18, -19, and -21, had reported specific gravities that were higher than that of any mineral known or suspected to be present in these cores. These values had been determined by the mercury-displacement method. When X-ray diffraction and emission analyses showed the presence of no constituents having specific gravities such as to account for the reported high values, new specific-gravity values were obtained by Method CRD-C 107-60 using kerosene instead of water. The results are shown in table 1.

14. X-ray examinations. X-ray diffraction and/or X-ray emission spectroscopy was used to examine the cores listed in table 3. The

Table 3

Composition of Selected Cores from Holes WP-1 and WP-4 in Tatum Salt Dome by X-Ray Examination

Hole WP-1		Hole WP-4		Minerals Identified by X-Ray Diffraction					
CD Serial No.	Depth, ft	CD Serial No.	Depth, ft	Anhydrite ($CaSO_4$)	Calcite ($CaCO_3$)	Dolomite ($CaCO_3 \cdot MgCO_3$)	Strontianite ($SrCO_3$)	Celestite ($SrSO_4$)	Amorphous Iron Oxide
--	--	TAT-1-NXC-1	948.0 to 948.5	--	Major	--	--	--	--
--	--	TAT-1-NXC-2 (Piece A)	999.0 to 1000.0	--	Major	--	Major, < calcite	Major, < calcite	--
TAT-1-NXC-14	1012.0 to 1012.3	--	--	--	Major	--	--	--	--
-15	1020.0 to 1020.3	--	--	--	Major	--	Major, < calcite	Major, < calcite	--
-21B	1181.0 to 1183.5	--	--	Major	Trace	Trace	--	--	--
-19	1260.5 to 1262.8	--	--	Major	Trace	Trace	--	--	--
-18C	1409.5 to 1412.0	--	--	Major	Trace	Trace	--	--	--
TAT-1-DC-20*	1681.0 to 1682.2	--	--	Major	Trace	Trace	--	--	Trace
-5*	2333.0 to 2335.0	--	--	Major	--	--	--	--	--
-46A*	2539.5 to 2540.8	--	--	Major	--	--	--	--	--

* Minerals indicated as being present in cores DC-20, -5, and -46A were present in the insoluble residue of these cores.

diffraction patterns were made with an X-ray diffractometer using nickel-filtered copper radiation at 50 kv and 16 ma or 30 kv and 27 ma. The emission patterns were made on a twin unit using a chromium target tube at 50 kv and 40 ma with an ethylene diamine ditartrate analyzing crystal in a helium atmosphere or a lithium fluoride analyzing crystal with an air path. The following five cores from the cap rock were examined by diffraction and emission: NXC-14, -15, -18C, -19, and -21B. The first one and latter three were examined as tightly packed powders which were pulverized in a mechanical mortar. A composite sample of core NXC-15 was pulverized to pass a No. 325 sieve and examined as a tightly packed powder by diffraction and emission. A portion selected from a dark band in core NXC-15 was pulverized and examined as a tightly packed powder by diffraction. A portion of core NXC-15 was digested in dilute hydrochloric acid and both the soluble and insoluble portions were examined by diffraction. Both portions were washed and evaporated to dryness; the dried materials were pulverized and sprinkled on cellophane tape to make X-ray samples.

15. Portions of the Nos. 30, 50, 100, and 200 sieve fractions from the insoluble residue of core DC-20 were pulverized and examined as tightly packed powders by diffraction. Hand-picked samples of brown carbonate grains and of magnetic ferruginous grains from the insoluble residues of 20 cores were pulverized, sprinkled on cellophane tape, and examined by diffraction. Composite samples of the insoluble residue of cores DC-5 and DC-46A were examined as tightly packed powders by diffraction (table 3).

16. Microscope examinations. The splits from the insoluble residues of 20 cores were examined with a stereomicroscope to identify the minerals present and estimate compositions. Selected grains were examined as oil immersion mounts with a petrographic microscope to determine certain desired optical properties. Some anhydrite crystals were cleaved with a dissecting needle while being observed with a stereomicroscope. Thin sections of core NXC-15 were made and examined.

Description of cores

17. Drawings, brief descriptions, and saw-cut locations for the 78 cores from hole WP-1 are included in plates 2-40. Plate 1 shows the position of all the cores from hole WP-1 by depth. Tables 1 and 2 contain results of specific-gravity, absorption, and insoluble-residue determinations on selected cores. The grain-size analyses of the insoluble residue from 20 salt cores are shown in plates 41-60. Plate 61 shows the grain-size distribution obtained by taking the average of the combined insoluble residues. The mineralogical composition of selected cores from hole WP-1 as determined by X-ray examination is shown in table 3. The size and shape of halite grains in a typical salt core are shown in photograph 1 and plate 62. Photograph 2 shows the size, shape, and orientation of the gray anhydritic

bands in a typical salt core. Detailed descriptions of the sample cores before they were subjected to creep, triaxial extension, tensile, and uniaxial compression tests are given in the following paragraphs. Descriptions of the cores after these physical tests are given in paragraphs 22-42.

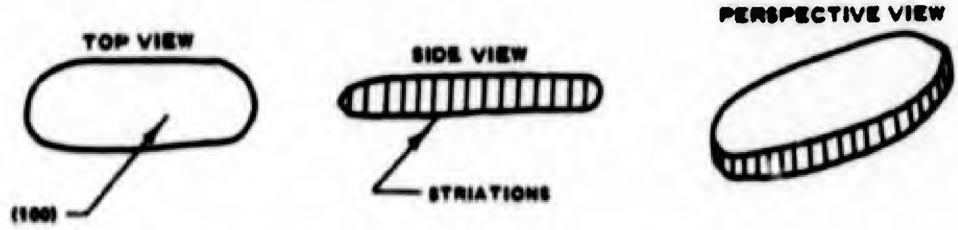
18. Cap rock cores. The eight cap rock cores (NXC-14 through -21), representing scattered depths from 1012.0 to 1412.0 ft, are described in the following subparagraphs.

a. Cores NXC-14 and -15 (1012.0 to 1012.3 ft and 1020.0 to 1020.3 ft). Core NXC-14 was a vuggy piece of carbonate rock with alternating irregular bands of light and dark rock (plate 2). X-ray analysis indicated that this core was all limestone (calcite, see table 3). Core NXC-15 resembled NXC-14 and contained numerous, well-healed fractures (plate 2). However, NXC-15 had a specific gravity of 3.34 as measured by the mercury-displacement method. Since this specific gravity was much higher than that expected for limestone, the specific gravity was remeasured by Method CRD-C 107-60 using kerosene instead of water, and an extensive X-ray examination was made. The new specific gravity was 3.25 (table 1). The rock in core NXC-15 was found to contain calcite ($CaCO_3$, specific gravity 2.71), strontianite ($SrCO_3$, specific gravity 3.76 ± 0.02), and celestite ($SrSO_4$, specific gravity 3.97 ± 0.01) (table 3). The presence of the strontium minerals explains the high specific gravity. The presence of these minerals in salt dome cap rock has been reported before[6] and is fairly common. Consideration of the X-ray data in conjunction with the peak intensities, mass-absorption coefficients, and the specific gravity of the core suggested that the three minerals were probably present as five parts calcite, three parts strontianite, and two parts celestite. The X-ray data also suggested that the strontium carbonate contained some calcium substituting for strontium. The closest available cores above and below NXC-15 (NXC-14 and -16, respectively) were examined in an attempt to determine the thickness of the strontium-carbonate rock present. Core NXC-16 was definitely anhydrite, and core NXC-14, which bore some resemblance to core NXC-15, was all calcite (table 3). Thus, the vertical extent of the minerals found in core NXC-15 could not be determined from the cores and data available. Subsequently it was found that the part of core NXC-2, hole WP-4, from a similar depth was identical with the rock in core NXC-15 (table 3). This indicated a definite lateral extent for the zone of strontium-carbonate rock. Thin sections of core NXC-15 indicated that, like piece A from core NXC-2, the rock was a dense mosaic of anhedral calcite and strontianite crystals with scattered patches of anhedral celestite crystals.

b. Cores NXC-16. -17, -21, -19, -20, and -18 (scattered depths from 1103.9 to 1412.0 ft). These six cores were composed of dense and massive, fine- to medium-grained, bluish-gray anhydrite rock (plates 3-5). The reported specific gravities of NXC-21, -19, and -18, determined by the mercury-displacement method, were considered high for anhydrite, so they were remeasured by Method CRD-C 107-60 (table 1). NXC-21, -19, and -18 were also examined by X-ray diffraction and emission. The composition of these cores as determined by X-ray diffraction was anhydrite with trace amounts of calcite and dolomite (table 3). Traces of iron, silicon, and strontium, in addition to major quantities of calcium, were noted. These trace elements did not show up as other minerals and were probably carried largely as impurities or substitutions in the anhydrite, calcite, and dolomite. The specific-gravity recheck values (table 1) correlated well with the indicated X-ray composition, thus indicating that the original values reported were somewhat too high.

19. Salt cores. Logs of 70 cores from the salt were prepared (plates 6-40). These cores were from scattered depths ranging from 1553.5 to 2703.0 ft. Core DC-5 was the only one reported as pure salt (plate 24). Although it lacked the gray anhydritic bands common to the other cores, it was found to be slightly impure (table 1). Cores DC-44, -37, -39, -46, -67, -56, and -59, representing depths from 2398.8 to 2630.5 ft, were from the region in which it was proposed to make the cavity in which the Project DRIBBLE charges were to be placed and detonated.

a. Composition and appearance. All of the salt cores were from dense, massive, relatively unfractured, impure rock salt, which consisted of halite ($NaCl$) with minor amounts of anhydrite ($CaSO_4$) and trace amounts of calcite ($CaCO_3$) and dolomite ($CaCO_3.MgCO_3$). The halite was colorless (transparent) or white (translucent), and sometimes showed cleavage traces. The areas of purer halite, measured perpendicular to the anhydritic gray bands, were never more than 3 or 4 in. thick in the cores examined. The more anhydritic parts of the salt were gray, steeply dipping, roughly parallel bands (ranging from a fraction of an inch to several inches in thickness) which alternated with zones of less anhydritic salt (see photograph 2); the effect of this alternation in color was to impart a gneissic appearance to the cores. The amounts of water-insoluble residue from portions of 20 of the cores representing depths from 1553.5 to 2685.5 ft are given in table 1. These residues ranged in amounts from slightly more than 1 percent to 22 percent, averaging 9.1 percent. Table 1 shows that there was no detectable pattern of residue content versus depth; thus, residue content was believed to correlate with structure rather than with depth. In other words, the amount of insoluble residue was determined by the position of a core in the hole in relation to the steeply dipping, parallel bands of gray anhydritic salt. The results of the X-ray examination (table 3) of insoluble residues, as sieve fractions from core DC-20, as composite samples from cores DC-5 and -46A, and as hand-picked composite samples from various cores, together with brief examination of all insoluble residues by stereomicroscope, showed the following: (1) the mineral anhydrite made up about 98 percent of all water-insoluble residues; (2) a brown ferroan calcite was present in all insoluble residues as a very minor constituent; it was concentrated in the material retained on the Nos. 30 and 50 sieves as aggregates of anhedral grains; (3) a trace of tan ferroan anhedral dolomite crystals, some of which were zoned, was present largely in the sizes passing the No. 50 sieve; (4) a trace of reddish-brown, slightly magnetic, ferruginous aggregates of anhydrite, calcite, and amorphous iron oxide was found largely in the fractions retained on the Nos. 30 and 50 sieves; (5) trace amounts of transparent yellow sulfur crystals were seen in some residues; they did not show on the X-ray diffraction charts; and (6) trace amounts of other minerals were observed by microscope but not identified by X-ray. The residue from cores DC-20, -5, and -46A represented maximum, minimum, and median values, respectively (table 1). The composition and amounts of insoluble residues are generally in good agreement with other data reported for salt domes in the Gulf Coast area.[6] Most of the anhydrite was in the salt as discrete, subhedral, clear crystals; the various sieve fractions separated from the insoluble residues contained mostly individual grains of anhydrite, but there were occasional aggregates of anhydrite where the grains had grown in contact. The appearance of the usual anhydrite grain from the salt is shown in the sketches below. The



crystals grew mainly on the (100) pinacoid faces;[5] the striations shown on the side pinacoids in the sketches were believed to be vicinal or underdeveloped dome faces formed as the crystals grew from solution. The results of 20 specific-gravity determinations on 20 anhydrite grains selected from the No. 16 sieve fraction of the insoluble residue from core DC-28 are shown in table 2; the averaged specific-gravity value of 2.92 was used, along with the simplifying assumption that all of the insoluble residues were anhydrite, to calculate what the specific gravity of the 20 salt cores listed in table 1 should be. The excellent agreement shown by the calculated and measured specific gravities for 10 cores in table 1 indicates that it should be feasible to calculate (1) the specific gravity of each salt core if the amount of insoluble residue is known, or (2) the composition of the salt core if the specific gravity is known.

b. Structure. The only observable structure in the salt was that indicated by the position of the gray anhydrite-rich bands of salt, and these were often faint or indistinct, especially so since the cores could not be washed when they were logged before testing. The gray zones appeared to represent parallel bands, ranging from a fraction of an inch to several inches in thickness, which generally had a dip of about 60 to 90 degrees in the hole WP-1 cores examined (see photograph 2). The thickness of the areas of colorless purer salt in these cores was usually 3 to 4 in. or less. The bands of light-colored salt (pure) and gray anhydritic salt (impure) appear to represent the "year rings" described by Taylor[6] for other Gulf Coast salt domes, the alternation from band to band representing periodic changes in conditions of deposition. Taylor says that the dark bands usually average 1 to 4 in. in thickness, that the clear bands are usually thicker, and that either type may exceed 12 in. in thickness. The cores examined in hole WP-1 (and hole WP-4 as well) generally conform to this description except that the maximum band thickness observed was less than 12 in. (plates 6-40). In general, the lithologic sequence shown by the cores examined is that expected for a salt dome.

c. Texture. The halite grains were usually anhedral in shape with irregular surfaces; they ranged from 1/16 (or smaller) to 1-1/2 in. in maximum dimension with the usual size being 1/4 to 1/2 in. They tended to be aligned so that their longest axis was parallel to the dip of the gray anhydritic bands. The size and shape of halite grains in a typical salt core are shown in photograph 1 and plate 62. Note the anhedral shape, grain size, and sinuous grain contacts. There were two vertical gray anhydritic bands in core DC-4A, but they do not show well in photograph 1. The grains do not usually have such visible borders; this was induced by the method of sample preparation to make them visible in a picture. Plates 41-60 show the grain size and frequency distribution of the insoluble residues from 20 salt cores from depths ranging from 1553.5 to 2685.5 ft. Plate 61 shows the same information as the average of the 20 individual results shown in plates 41-60. A comparison of plate 61 with any of the others shows that they are all remarkably alike; however, the particles in the cores with small amounts of insoluble residues tended to be somewhat finer than those in the cores with high percentages of insoluble residues. The maximum grain size in the insoluble residues was about 5 by 2 by 1 mm; most of the grains would pass a No. 16 sieve, which has openings of 1.19 mm. The maximum size of most of the grains in the insoluble residues was less than 1 mm.

Examination of Cores After Physical Tests

Physical test conditions

20. Only the 4-15/16-in.-diameter cores were subjected to physical tests. All of the cores tested were examined after the tests to determine the mode and cause of failure, the effect of lithologic variables, or other features of interest which might be apparent. The cores examined and the testing conditions and results follow:

Creep Test

Core CD Serial No.	Load and Temperature Conditions	Remarks
TAT-1-DC-30B	750 psi, 150 F	Tested 2000 hr
-18B	1750 psi, 150 F	Tested 2000 hr
-19B	2250 psi, 150 F	Tested 2000 hr
-40A	3000 psi, 150 F	Specimen failed by diagonal fracture after 11 min
-70B	750 psi, 150 F	Retest of 30B conditions, tested 2000 hr
-68B	1750 psi, 150 F	Retest of 18B conditions, tested 2000 hr
-15B	525 psi, 73 F	Tested 2000 hr
-33B	1750 psi, 73 F	Tested 2000 hr
-23B	2250 psi, 73 F	Specimen failed by general rupture after 4 to 5 days
-14C	3000 psi, 73 F	Specimen failed by diagonal fracture after 5 hr 50 min
-69B	2250 psi, 73 F	Retest of 23B conditions, tested 2000 hr

Triaxial Extension Test

Core	Applied Loads	Remarks
TAT-1-DC-48A	2000-psi lateral load 1000-psi axial load	Tested 1000 hr
-67B	2500-psi lateral load 1000-psi axial load	Tested 1000 hr

(Continued)

Triaxial Extension Test

Core	Applied Loads	Remarks
TAT-1-DC-51B	3000-psi lateral load 500-psi axial load	Tested 1000 hr
-16B	3425-psi lateral load 300-psi axial load	Failed after 213 hr by breaking
-49A	3850-psi lateral load 100-psi axial load	Failed after 1 day by breaking

Tensile Test

Core	Ultimate Strength psi	Remarks
TAT-1-DC-10B	147	Specimen parted
-10C	144	Specimen parted
-10D	123	Specimen parted
-2B	115	Specimen parted
-21B	85	Specimen parted
-32B	106	Specimen parted

Uniaxial Compression Test by Incremental Loading

Core	Load Applied to Break Core in	Remarks
TAT-1-DC-45B	1 day	Cores tended to break into double cones
-29A	5 days	
-29B	30 days	
-37B	1 day	
-43B	5 days	
-46B	30 days	
-62A	1 day	
-63B	5 days	
-62B	30 days	

Uniaxial Compression Standard and Cyclic Tests

Core	Conditions	Ultimate Strength psi	Remarks
TAT-1-DC-4B	Continuous loading	3590	Core remained intact
-4D	1 unloading cycle	3550	Core remained intact
-44B	Continuous loading	3700	Core remained intact
-41B	1 unloading cycle	3660	Core remained intact
-8C	Continuous loading	3200	Core remained intact
-8B	1 unloading cycle	3230	Core remained intact
-11C	Continuous loading	3050	Core remained intact
-11D	1 unloading cycle	3120	Core remained intact
-12B	Continuous loading	3110	Core remained intact
-12C	1 unloading cycle	3300	Core remained intact

Uniaxial Compression Length-to-Diameter Test

Core	Ratio of Length to Diameter, L/D	Ultimate Strength psi	Remarks
TAT-1-DC-7B	1/1	4140	All 18 cores were intact after test was completed
-7C	1/1	4160	
-37A	1/1	4450	
-6B	1.5/1	3220	
-6D	1.5/1	3270	
-6E	1.5/1	3380	
-7D	2/1	3350	
-7E	2/1	3350	
-3B	2/1	3260	
-3C	2/1	3410	
-5B	2/1	2750	
-5C	2/1	3000	
-31B	2.5/1	3500	
-34B	2.5/1	3515	
-36B	2.5/1	3810	
-9B	3/1	3450	
-9D	3/1	3400	
-57B	3/1	3240	

Uniaxial Tests for Compressive Strength Under Cyclic Loading

Core	Conditions*	Ultimate Strength psi	Remarks
TAT-1-DC-13B	Fast at 73 F	4190	Core broke into pieces
-26B	Fast at 73 F	3665	Core remained intact; most of core surface lost
-20B	Fast at 150 F	3770	Core remained intact; most of core surface lost
-28B	Fast at 150 F	3490	Core remained intact; minor surface loss
-35B	Slow at 73 F	3770	Core remained intact; moderate surface loss
-56B	Slow at 73 F	3330	Core remained intact; moderate surface loss
-35A	Slow at 150 F	3770	Core remained intact; no surface loss
-59B	Slow at 150 F	3710	Core remained intact; no surface loss

* 'Fast" consisted of loading and unloading cores to an estimated 75 percent of ultimate strength five times before loading to failure. "Slow" consisted of loading and unloading cores to an estimated 75 percent of ultimate strength two times before loading to failure.

Examination procedures

21. The groups of cores from each type of test were arranged to separate such variables of the test as temperature, pressure, etc. The cores were examined, using a stereomicroscope as needed, to determine mode of failure and other pertinent features. The petrographic data developed in the pretest examination of cores and such other available information as specific gravity and the dynamic modulus of elasticity were considered in an effort to relate them to differences shown by the physical test results. Photographs 3-9 and plates 62-66 illustrate salient features or general appearance of the cores. Several thin sections were prepared from core DC-19B, which was tested for creep for 2000 hr at 2250 psi and 150 F, and these sections were examined with a petrographic microscope (plate 63).

Description of cores

22. Creep test specimens. Eleven cores were tested for creep, five at 73 F and six at 150 F. In each group, one core was to be tested at 750 psi, one at 1750 psi, one at 2250 psi, and one at 3000 psi. In the 73 F group, the low-pressure core was tested at 525 psi instead of 750 psi by accident. The other three cores were retests of the 73 F core at 2250 psi (DC-23B) and the 150 F cores at 750 and 1750 psi (DC-30B and -18B). These additional tests were made because DC-23B had failed early in the test with unequal strain on opposite gage lines, DC-30B had been overloaded for a short time during test, and DC-18B had shown extremely unequal deformation from side to side (i.e. had deformed faster on one side than on the other).

23. The two cores tested at 3000 psi (DC-40A and -14C) failed by breaking diagonally along the length; one broke after 11 min and the other after 5 hr 50 min. Core DC-23B, tested at 2250 psi, failed by general rupture, but remained intact for 4 to 5 days of testing. The other eight cores completed the test to 2000 hr without failure. The appearance of the original eight cores after creep testing is illustrated in plate 64 and photograph 3, which show the core deformation that occurred under the different pressures and the relation of the fracture surface of the failed cores to the core and to the gray anhydritic bands. The following paragraphs summarize results of the posttest examination of the creep test specimens.

24. The specimens tended to deform, in proportion to the pressure applied, by becoming barrel-shaped. No deformation of the three cores tested at the lowest pressures (DC-15B, -30B, and -70B) was apparent. Those tested at 1750 psi (DC-33B, -18B, and -68B) shortened about 1/2 in. The cores which did not fail at 2250 psi (DC-19B and -69B) shortened about 1 in.

25. A series of short, open or closed, shallow cracks parallel to the long axis of the cores was seen. The cracks tended to be straight rather than to follow grain boundaries. In addition to the overall lateral bulging of the cores, a roughening of the surfaces was noted in scattered areas. These were points of movement resulting in an outward buckling of the surface. The core surface was easily pried away at these points. The cores whitened as they deformed. This was due to refraction effects where air gaps were created at grain boundaries, cleavages, and fractures.

26. Microscopic examination of thin sections from a core tested for creep (DC-19B) and from a portion of an untested core (NXC-11 from hole WP-4) showed several differences (plates 62 and 63). Core DC-19B often showed air gaps at halite grain boundaries where the grains were no longer in contact; short vertical fractures (pressure-release fractures) tended to develop in the compressed halite grains, and cleavage traces were seen in many of the compressed halite grains. The cleavage traces probably represented glide translations within the grains parallel to the {110} planes.[2] The grain size was greatly reduced as the cores deformed under pressure. It was possible to find all of the above-mentioned features in thin sections of untested cores, but their number and effect on grain size were greatly enhanced by compression.

27. No effects of the difference in temperature used in the tests were apparent.

28. The two cores that failed at 3000 psi (DC-40A and -14C) behaved like the other creep test cores before failing. Core DC-14C, which broke after 5 hr 50 min, shortened about 1 in., turned white, developed short vertical cracks, and failed with a loud noise. It remained intact, but the pieces could be lifted apart. Core DC-40A, which failed after 11 min, showed the same effects but to a lesser degree due to the lack of time for distortion. It essentially fractured before much distortion occurred. The

plane of fracture dipped about 60 degrees from horizontal in each core. The fracture surface was fairly plane in DC-40A and curved in DC-14B. The fracture surface was parallel to the plane of the gray anhydritic bands in core DC-40A and perpendicular thereto in DC-14C (plate 64). This indicates that the direction of fracture was determined by the magnitude of the pressure and not by the position of the gray anhydritic bands.

29. Core DC-23B shortened about 3/4 in., developed extreme lateral bulging, and failed by general rupture. It resembled many of the other salt cores that failed in some form of compression test. The core was intact but fragile. Its condition precluded much examination. No reason for its failure was noted or deduced from other data. Two other cores (DC-19B and -69B) were tested 2000 hr at 2250 psi without failure. Also, four 4-15/16-in.-diameter salt cores from the Carey Salt Mine, Winnfield, La.,* were creep-tested at 2250 psi, two at 73 F and two at 150 F, for 1006 to 1030 hr without failure. The successful testing of six out of seven cores at this pressure suggests that the failure of DC-23B was probably due to a hidden defect. The reported dynamic modulus of elasticity for core DC-23 was 4.82×10^6 psi. This value is in the usual range for most of the salt cores from this hole, so there is no clear indication of such a flaw.

30. It was concluded that the behavior and appearance of the cores were influenced solely by the testing conditions, and that no lithologic explanation existed or was needed. It seemed probable that any similar-sized core of salt dome rock salt would fail under conditions of test (i.e. sustained load of 3000 psi) similar to those that resulted in failure of cores DC-40A and -14C.

31. Triaxial extension test specimens. Five cores were subjected to triaxial extension tests. Cores DC-48A, -67B, and -51B withstood the prescribed 1000 hr of test; core DC-49A failed by breaking after 1 day of test; core DC-16B failed by breaking after 213 hr of test. Plate 65 shows sketches of the cores, depicting the approximate deformation, and the appearance and location of cracks and complete breaks. The following paragraphs summarize the results of the posttest examination of the triaxial extension test specimens.

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* Tests of the Winnfield cores are described in Appendix A.

32. The cores deformed by lengthening in proportion to the effective lateral pressure applied, the elongation ranging from about 1/8 to 1/2 in. No other dimensional changes were evident. It is pointed out, however, that the initial lengths for the five samples were not the same.

33. The cores tended to develop short, straight, open or closed cracks parallel to the core ends. The number and severity of these cracks increased with increasing effective lateral pressure. These were pressure-release cracks similar to those that formed in the creep test specimens, and were considered normal.

34. Core DC-16B failed by breaking about 1 in. from and parallel to the top of the specimen. The break went both through and around grains; this resulted in an irregular surface like those observed on untested cores or on cores broken in tension (photographs 8 and 9).

35. Core DC-49A failed test by breaking about 3 in. from and parallel to the bottom surface of the core. The fracture surface was quite smooth in comparison to that of core DC-16B and all others seen on untested cores or cores broken in tension. This smoothness was due to the break generally progressing through grains rather than around them.

36. The following possibly explains the difference in the types of broken surfaces which developed in these salt cores. Every broken surface was a composite of partings that occurred between grains at their boundaries, and within grains by fracture or cleavage or both; this results in an irregular surface. The irregular fracture surface of core DC-16B is evidence that grain boundary separation was a major factor in its formation. The smoothness of the fracture surface of core DC-49A is evidence that grain boundary separation was much less a factor. This means that the differences in effective lateral pressure resulted in different response times available for failure to occur. The force on core DC-16B, although it demanded failure, allowed time for the separation to follow the line of least resistance. The line of least resistance would be between grains rather than through them. The overwhelming force on core DC-49A demanded a faster response, and consequently the fracture occurred through more grains than around them.

37. Plate 65 shows the presence of continuous cracks near the ends of core DC-49A and near the bottom of core DC-51B. These cracks were

potential core failures. They were as deep as 1/2 in. in some spots and perhaps deeper, although they were generally much shallower. (Their location was at the point where the protective cap ended. This cap was placed over the core ends to prevent entry of the membrane at the piston-core end interface under pressure.) These continuous cracks were not found in the two cores tested at the lowest lateral pressures nor on DC-16B. However, core DC-16B failed near the point where the cap ended. The fact that continuous cracks tended to form at the points where the cores were being "held" as they elongated was not surprising.

38. It was concluded that the cores were essentially homogeneous and that no lithologic variables were involved in the triaxial extension test results. It also seemed probable that any similar-sized salt core from a salt dome would fail under conditions similar to those which resulted in failure of cores DC-16B and -49A.

39. Tensile test specimens. Six cores were tested to failure in tension. During removal of the cores from the test rig after test, some of the capping compound melted and covered much of the surfaces of the test specimens. For this reason it was only feasible to examine the broken surfaces produced during the test. Each core developed breaks 2 to 3 in. from and approximately parallel to the core ends. The broken surfaces were irregular like those seen on untested cores. This indicated that the surfaces resulted from partings within grains by fractures or cleavages or both, and between grains by separation at their boundaries. A typical broken surface is shown in photographs 8 and 9. The cores were lithologically similar, and the variation in test results was considered normal.

40. Uniaxial compression test specimens. Cores were tested to failure in four kinds of uniaxial compression tests. The cores ranged from intact to fragmented; all exhibited the same characteristics in varying degrees. Photographs 4-7 illustrate six salt cores after failure in the uniaxial compression cyclic test; they show the range in appearance of all the salt cores tested in compression. In general, the cores tended to fracture into double cones at an angle of about 60 degrees from the core ends. When pieces of the surface of cores tested in compression broke loose, they characteristically were elongated parallel to the long axis of the core and their inner surface was parallel to the curved outer surface.

Plate 66 is a sketch made to illustrate these features on a typical core that broke into pieces.

a. Uniaxial compression test by incremental loading. Nine cores were subjected to this test. It consisted of estimating their ultimate strength in compression (a value of 3400 psi was used) and loading the cores in increments designed to produce failure after 1, 5, and 30 days. Three cores were tested at each of the three conditions. Since all of the cores broke into pieces and much of the surfaces was thereby lost, the posttest examination of the cores yielded little information. The fracture surfaces tended to be curved rather than plane, and the cores tended to break into double cones (plate 66). The core fragments were similar to those of core DC-13B which was broken in the uniaxial compression cyclic test (photograph 4).

b. Uniaxial compression standard and cyclic tests. Ten cores were tested as follows. Five were loaded to failure in compression (standard test as for a 6- by 12-in. concrete cylinder). Five companion cores were loaded to 1660 psi at 20 psi per sec, unloaded at the same rate, and then loaded to failure (cyclic test). Posttest examination revealed that all cores were intact. They showed a slight bulging in the middle, occasional grain loss from the surfaces, and development of scattered, short, vertical, open fractures. These fractures tended to wander a bit and tried to follow grain boundaries. This was in contrast to the vertical cracks which developed in the creep-tested cores and cut across grain boundaries. There was no appreciable difference in the appearance of the 10 cores nor in the results of the two types of tests (i.e. standard and cyclic). No appreciable variation in lithology existed, and it was concluded that the cores exhibited features generally associated with compression test specimens. No significance was seen in the range in ultimate strengths.

c. Uniaxial compression length-to-diameter test. Eighteen cores were cut to length-to-diameter ratios of 1 to 1, 1.5 to 1, 2 to 1, 2.5 to 1, and 3 to 1. Six cores were tested at the 2-to-1 ratio, and three at each of the others. After testing, all 18 cores were intact and exhibited the same features of bulging, surface grain loss, and open vertical cracks as described for the 10 cores tested by the compression standard and cyclic tests. The two specimens from core DC-5 were known to be unusual for the following reasons: Core DC-5 contained only 1.2 percent insoluble residue (table 1) and had been logged as pure halite. It was the only 4-15/16-in.-diameter core received (plate 24) and tested from Tatum which represented a real lithologic variant of the standard pure and impure salt mixtures of the other cores. Its dynamic modulus of elasticity for the 20-in. length from which core specimens DC-5B and -5C were cut was 1.28×10^6 psi; this was much lower than the usual values recorded for the other cores (4 to 5×10^6 psi). The ultimate strengths of 2750 and 3000 psi for DC-5B and -5C were the lowest recorded for the 18 length-to-diameter cores tested. Cores DC-5B and -5C were compared carefully with other cores, after which cores DC-5B, -3C, and -7E were selected as representing the extremes of lithology and test results, and were sawed down the middle in brine and examined carefully. The only real difference noted in the appearance of the length-to-diameter cores was the lithology of DC-5. Two other salt cores lithologically similar to DC-5 were tested in the entire program. Core 15, 4-15/16 in. in diameter and obtained from the salt dome at Winnfield, was tested for creep, but dynamic modulus of elasticity was not determined; it had intermediate total strain but lower creep strain than the three cores of impure salt tested under similar conditions with it. The portion of core NXC-10 from Tatum hole WP-4 that was sawed for testing was almost pure salt. This portion was tested for creep, and its dynamic modulus of elasticity was determined as 4.97×10^6 psi. This indicated that the low modulus of elasticity value reported for core DC-5 was probably due to a hidden flaw and did not represent a true difference between modulus of elasticity for pure and impure salt. With this in mind the lower compression test results for DC-5B and -5C were probably due to flawed specimens. The range of test results for the other 16 specimens seemed reasonable.

d. Uniaxial compression cyclic test. Eight cores were tested. Four cores, two at 73 F and two at 150 F, were loaded to an estimated 75 percent of ultimate compressive strength (2500 psi) at 20 psi per sec five times, and unloaded at the same rate; they were then loaded to failure. This was called the fast method. The same number of cores at the same temperatures were treated similarly except that there were only two loading and unloading cycles. This was the slow method. The cores showed the lateral bulging, vertical cracking, and grain loss common to all of the salt cores tested to failure in compression (photographs 4-7). Some were intact, and others had lost considerable amounts of their surfaces; core DC-13B broke into two large and many smaller pieces (photograph 4).

41. The core fragments resulting from testing to failure in the incremental-loading compression test and the 18 intact but failed cores from the uniaxial compression length-to-diameter tests represented the extremes in appearance shown by all of the salt cores tested to failure in compression. The eight cyclic test cores generally varied in appearance between these extremes.

42. Neither temperature variation nor number of loading cycles had

any apparent effect on the test results. The amount of insoluble residue had been determined for six of the cyclic test cores (table 1); it was noticed that core DC-13B which had the lowest residue, 4.0 percent, had the highest compressive strength of the eight cores subjected to the uniaxial compression cyclic test. Consideration of the insoluble residues shown in table 1 revealed the following. The other two of the three cores with the low insoluble residues (cores DC-5B and -5C with 1.2 percent residue) had the lowest compressive strength of the 18 cores tested in the length-to-diameter test. Core DC-23B, 3.1 percent insoluble residue, failed by rupture in the creep test after 4 to 5 days. It was not possible to draw conclusions from these three comparisons since both DC-5 and -23B were suspected of being flawed specimens.

Summary of Results

Examinations of cores before physical tests

43. Of the 78 cores from hole WP-1 in the Tatum salt dome examined (plates 2-40), eight were from the cap rock, and represented scattered depths ranging from 1012.0 to 1412.0 ft. The remaining 70 cores were from the salt and represented scattered depths from 1553.5 to 2703.0 ft. The information developed from this examination was in good agreement with that available in the literature for other salt domes in the Gulf Coast area.[1,6]

44. Plate 1 shows that the cores from holes WP-1 and WP-4 were very similar when comparisons at equivalent depths could be made. Quartz was a possible trace constituent in some of the cap rock cores but was not identified in any of the salt cores. In general, it could be said that there was essentially no quartz in the samples examined representing depths from 1012.0 to 2703.0 ft.

45. Cap rock cores. Core NXC-14 from 1012.0 to 1012.3 ft was vuggy limestone with alternating bands of light and dark rock (plate 2, table 3). Core NXC-15 from 1020.0 to 1020.3 ft consisted of dense, somewhat vuggy rock that resembled core NXC-14 (plate 2). However, NXC-15 contained the strontium minerals, strontianite ($SrCO_3$) and celestite ($SrSO_4$), in addition to calcite (table 3). The minerals were estimated to be present as five

parts calcite, three parts strontianite, and two parts celestite. Due to the presence of the heavy strontium minerals, this core had a specific gravity of 3.25 (table 1). Part of core NXC-2 from a depth of 999.0 to 1000.0 ft in the other hole, WP-4, was found to have the same composition (table 3). The vertical extent of the zone of strontium-rich carbonate rock could not be determined from the few cores available for examination.

46. The other six cap rock cores (NXC-16, -17, -21, -19, -20, and -18) were composed of dense and massive, fine- to medium-grained anhydrite which contained traces of calcite and dolomite (table 3).

47. Salt cores. Sixty-nine of the salt cores (plates 6-40) were logged as impure salt while one (plate 24) was called pure salt. A typical core of impure salt consisted of clear or translucent halite with one or more thin longitudinal bands of gray anhydritic halite in it (photograph 2); these bands had dips ranging from about 60 to 90 degrees. The areas of purer salt contained anhedral halite grains with sinuous grain boundaries (photograph 1 and plate 62); the average halite grain size was about 1/4 to 1/2 in. in maximum dimension, and the major axis of the grains tended to follow the dip, although not so steeply, of the gray anhydritic bands. The gray bands contained halite grains, concentrations of anhydrite grains, and trace amounts of carbonates. The halite grains tended to be smaller than those in the areas of purer salt. The anhydrite occurred as small, clear, subhedral to euhedral, blocky grains less than 1 mm in maximum dimension; most anhydrite grains were discrete particles, but some aggregates of grains did occur. While the anhydrite was concentrated in the gray bands, no portions of the cores were ever truly free of it. Grain-size distribution is shown in plates 41-61 for the insoluble residues from portions of 20 cores and for the average of the 20.

a. Composition. Table 1 shows the amounts of insoluble residue present in portions of 20 salt cores representing depths from 1553.5 to 2685.5 ft. The amounts ranged from 1.2 to 22.0 percent; the average insoluble residue of the 20 cores was 9.1 percent. The variation in amount of residue with depth was random rather than regular. The insoluble residue was essentially anhydrite, but also contained trace amounts of calcite, dolomite, and amorphous iron oxide (table 3). The remainder of each core was halite. Thus the indicated range of composition for all of the cores was about 80 to 99 percent halite with the remainder being essentially anhydrite. Twenty anhydrite grains were selected from the insoluble residues, and the specific gravity of each was determined (table 2). These values ranged from 2.88 to 2.98 and averaged 2.92. This average value was used with the amount of insoluble residue and the amount and specific gravity of salt to calculate the specific gravities for the cores shown in table 1. The generally excellent agreement between calculated and measured specific gravities for the 10 cores (table 1) where comparison was possible suggests that it should be possible to calculate core composition if its specific gravity is known, or to calculate the specific gravity of a core if the amount of insoluble residue is known. Such a calculation should provide a close approximation of the true value for all of the salt cores from Tatum hole WP-1. Corrections for absorption were ignored with little apparent effect since the absorptions were generally small.

b. Cavity area (2350.0 to 2650.0 ft). The cores from these depths were similar to the typical salt core just described.

c. Comparison with salt from Winnfield. The cores from Winnfield were easily divisible into three lithologic varieties on the basis of appearance (see Appendix A). The salt cores from the Tatum dome tended to be of one lithologic type, and were composed of nearly vertical, alternating zones of pure and impure salt. This type was most like the Group I type of the Winnfield cores. The anhydrite grains were closely packed in the impure portions of the Winnfield salt, and they were somewhat opaque on exposed surfaces due to discoloration by what was believed to have been alteration of iron-bearing dolomite grains to iron halides. The impure zones of the Winnfield salt showed offsets and discontinuities due to movement after solidification. In the Tatum salt, the anhydrite grains were less closely packed in the impure areas, they were clear, and there was no apparent alteration of carbonates and subsequent discoloration. No distortion of the impure gray bands was noticed. The dip of impure bands in the Winnfield salt was generally near 60 degrees and ranged from about 30 to 60 degrees, whereas it ranged from about 60 to 90 degrees in the Tatum salt (photograph 2).

Examination of cores after physical tests

48. Creep test specimens. In general, the cores deformed in the creep tests in proportion to the pressure applied by tending to become barrel-shaped. Other visible signs of change were the presence of short, open or closed cracks parallel to the long axis of the cores; small, raised areas on the surfaces where material had broken loose; and a whitening of

the cores. The whitening was due to refraction effects at newly developed air gaps inside the cores. The cracks tended to be straight and independent of grain boundaries. In contrast, the vertical cracks developed in cores tested to failure in compression tended to wander in an effort to follow grain boundaries.

49. Thin-section study of untested and deformed cores revealed that deformation took place by separation of grains at their boundaries, by the development of fractures that were generally vertical, and by translation gliding along cleavage planes that were probably parallel to the {110} directions in the grains[2] (plates 62 and 63). The cores tested at the lowest pressures (525 and 750 psi) did not deform visibly, and those tested at the highest stress of 3000 psi (DC-14C and -40A) failed by breaking on a lengthwise diagonal which had a dip of about 60 degrees. The fracture surface appeared to be independent of the gray anhydritic bands (plate 64). The reason for the failure of core DC-23B at 2250 psi after 4 to 5 days of testing was not apparent after examination. However, since six of seven specimens from the Winnfield and Tatum salt were tested successfully at this pressure, it seemed likely that DC-23B failed because of a hidden flaw.

50. It was concluded that the creep specimens showed the types of deformation to be expected, that the visible effects of testing at different temperatures were negligible, and that any salt dome salt core of equivalent size would probably fail at a sustained load of 3000 psi before 2000 hr.

51. Triaxial extension test specimens. Five cores were tested, three completing 1000 hr of test and the other two failing by breaking. Core DC-16B failed after 213 hr, and DC-49A failed after 1 day. The observed response of the specimens to the test was somewhat similar to that listed for the creep test specimens. The cores elongated in response to the effective lateral pressure applied, and short, straight cracks formed to accommodate this deformation. The number and severity of the cracks increased with increasing effective lateral pressure. Shallow continuous cracks tended to form near the ends of cores DC-51B and -49A where they were covered by a protective cap. Core DC-16B broke about 1 in. from and parallel to the top surface of the core; core DC-49A broke about 3 in. from and parallel to the bottom surface. The broken surface of DC-16B was the

usual irregular one similar to those seen on other failed cores. The broken surface of DC-49A was relatively smooth. The nature of the broken surface was believed to be due to the time the core had for breaking. The core subjected to lower effective lateral pressure (DC-16B) failed more slowly, and the break had time to follow the line of least resistance. In a salt core, this would mean parting at grain boundaries, and the broken surface would be irregular. The break in the core subjected to the higher pressure did not have time to follow grain boundaries. This resulted in the smoother broken surface on core DC-49A. This concept does not hold for the broken surfaces developed on cores DC-14C and -40A in creep testing. They failed after about 6 hr and 11 min, respectively, along diagonal surfaces which were irregular.

52. It was concluded that the test conditions which caused failure of cores DC-16B and -49A would probably cause failure of most or all salt dome salt cores of this size.

53. Tensile test specimens. Six cores were tested and examined. During removal of the fractured cores from the test apparatus the capping compound melted and covered the outer surfaces of specimens. Therefore these surfaces could not be examined. The broken surfaces resulting from the tensile tests were the usual irregular ones. Photographs 8 and 9 show a typical surface.

54. Compression test specimens. A total of 45 cores were tested for ultimate compressive strength by means of four different kinds of uniaxial compression tests. Such variables as loading rate, number of loading cycles, length-to-diameter ratio, and temperature were involved.

55. Some of the cores remained intact and others disintegrated. The common signs of distortion were a lateral bulging, popouts where bits of the surface had loosened, and development of scattered, short, vertical cracks. These cracks tended to wander in an effort to follow grain boundaries. This was in contrast to the vertical cracks developed in creep-tested cores which tended to ignore grain boundaries. Photographs 4-7 show examples of varying degrees of core deformation. All of the cores were apparently trying to fracture into double cones with the fracture angles dipping about 60 degrees from the horizontal. When cores actually broke, elongated pieces of surface came loose. Plate 66 shows an idealized sketch

of core failure and the kind of curved surface fragments which normally accompanied core failure.

56. Comparison of test results of pure and impure salt cores. Core 15 from Winnfield and core DC-5 from hole WP-1 in the Tatum salt dome were pure salt. Cores DC-13, -23, and -39 from hole WP-1 in the Tatum dome had small amounts of insoluble residues (table 1). Core DC-39 was not subjected to physical tests.

a. Winnfield cores. Cores 15 and 19 (4-15/16 in. in diameter) were creep-tested at 2250 psi and 150 F for 1030 hr; cores 2 and 3 were creep-tested at 2250 psi and 73 F for 1006 hr. Cores 19, 2, and 3 were impure salt. Core 15 had a total deformation that was intermediate and a creep deformation that was low for this group of four cores.

b. Tatum hole WP-1 cores. Core DC-5 had a dynamic modulus of elasticity of 1.28×10^6 psi. Pieces B and C were tested for ultimate strength at a length-to-diameter ratio of 2 to 1 in the uniaxial compression length-to-diameter tests. These pieces had the lowest strengths of the six cores in these ratios and the lowest of the 18 tested in this manner. It is believed that this core contained a hidden flaw which caused the low test values. This is based on the fact that the pure salt portion of core NXC-10 from hole WP-4 had a dynamic modulus of elasticity of 4.97×10^6 psi. Core DC-13 had 4.0 percent insoluble residue (table 1); piece B was tested for ultimate strength in the uniaxial compression cyclic test and had the highest strength of the eight cores tested. Its insoluble residue was known to be lower than that of five of the other cores (table 1) tested in this fashion. Core DC-23 had 3.1 percent insoluble residue (table 1) and a dynamic modulus of elasticity of 4.82×10^6 psi. Piece B failed after 4 to 5 days when tested for creep at 2250 psi and 73 F. Six of the seven 4-15/16-in.-diameter salt cores from Winnfield and Tatum were successfully tested at the same pressure. It seems probable, but is not certain that DC-23B failed because of a hidden flaw.

PART III: PETROGRAPHIC EXAMINATION OF CORES FROM HOLE WP-4 IN TATUM SALT DOME

Identification of Cores

57. Seventeen NX cores representing part of the material taken from hole WP-4 in the Tatum salt dome were received at the Waterways Experiment Station for laboratory tests and petrographic examination.

58. A petrographic report of 13 cores from hole WP-4, dated 18 May 1961, and Report No. 5 of Test Data for Project DRIBBLE, dated 14 November 1961, are included herein as Appendix B and Appendix C, respectively. A summary log of all 17 cores from hole WP-4 is shown in plate 1. Information concerning the positions of saw cuts made on the cores was available only for core NXC-2. Hole WP-4 core data are shown below:

CD Serial No.	Depth, ft	Date Received	Lithology
TAT-1-NXC-1	948.0 to 948.5	12 May 1961	Limestone
-2	999.0 to 1000.0	12 May 1961	Limestone and strontium-rich carbonate rock
-3	1107.0 to 1108.0	12 May 1961	Anhydrite
-4	1199.5 to 1200.5	12 May 1961	Anhydrite
-5	1299.0 to 1300.0	12 May 1961	Anhydrite
-6	1392.5 to 1393.5	12 May 1961	Anhydrite
-7	1491.5 to 1492.5	12 May 1961	Pure rock salt
-8	2317.0 to 2318.0	12 May 1961	Impure rock salt
-9	2402.0 to 2403.0	12 May 1961	Impure rock salt
-22	2462.5 to 2463.5	27 Sept 1961	Impure rock salt
-23	2476.0 to 2477.4	27 Sept 1961	Impure rock salt
-11	2495.5 to 2496.5	12 May 1961	Impure rock salt
-24	2522.0 to 2522.9	27 Sept 1961	Impure rock salt
-25	2533.0 to 2534.0	27 Sept 1961	Impure rock salt
-10	2603.5 to 2604.5	12 May 1961	Impure rock salt
-12	2647.5 to 2648.6	18 May 1961	Impure rock salt
-13	2698.5 to 2699.5	18 May 1961	Impure rock salt

Examination and Description of Cores

Examination

59. Each core was measured, and examined visually and with a stereomicroscope as needed to prepare core logs; some cores were tested with dilute hydrochloric acid. Thin-section examinations were made on pieces of seven of the cores (four salt, one carbonate rock, and two anhydrite).

Sketches and photographs were made to show typical features.

60. In addition, the following examination of cores NXC-1 and -2 (948.0 to 948.5 ft and 999.0 to 1000.0 ft) was made, supplementing that given in Appendix B. Core NXC-2 was available in three pieces after it had been sawed and tested for specific gravity (see log of NXC-2, fig. B1 of Appendix B). A portion of one end piece from NXC-2 and part of NXC-1 were pulverized and examined by X-ray diffraction as a tightly packed powder. The specific gravity of each piece of NXC-2 was determined, and a thin section of each piece was made and examined. Table 4 shows the specific-gravity and X-ray results for both cores. The X-ray analysis was made using an X-ray diffractometer with nickel-filtered copper radiation at 49 kv and 16 ma.

Table 4

Composition and Specific Gravities of Cores NXC-1 and -2 from Hole WP-4

CD Serial No.*	Depth, ft	Bulk Specific Gravity: Mercury Displacement**	Bulk Specific Gravity: Kerosene Displacement	†	Minerals Identified by X-Ray Diffraction: Calcite	Strontianite	Celestite	Feldspar
TAT-1-NXC-1	948.0 to 948.5			--	Major	--	--	Trace
TAT-1-NXC-2	999.0 to 1000.0	2.79	2.83					
Piece A				3.35	Major	Major, < calcite	Major, < calcite	--
Piece B				2.89	Not examined			
Piece C				2.73	Not examined			
				Avg 3.01				

* Pieces A, B, and C are from core NXC-2; their location in the core is shown in the log of that core (see fig. B1, Appendix B).

** Core NXC-2 was received in two pieces; the two values were obtained from the same piece. The first value was determined by the mercury-displacement method and lies between bulk and apparent specific gravities since the core was weighed as received. The second value was determined by Method CRD-C 107-60 in Handbook for Concrete and Cement;[7] keresone was used instead of water.

† These values are for a different piece of core than those under **. They were determined by Method CRD-C 107-60; the samples were neither soaked nor oven-dried first. Therefore, the reported values are somewhere between those for bulk and apparent specific gravities. Kerosene was used instead of water.

Description of cores

61. The log of core NXC-2 (Appendix B) was modified to include the results of later work described below.

62. Cap rock carbonate cores NXC-1 and -2. The X-ray examination of NXC-1 (table 4) showed it to be limestone as had previously been indicated on its log. Core NXC-2 was examined in detail because it

resembled, and came from about the same depth as core NXC-15 of hole WP-1 which contained strontium minerals (see paragraph 18a). Part of core NXC-2 was found to contain the same minerals in about the same proportions as core NXC-15. However, NXC-2 graded within its own length into limestone without strontium minerals. This was the reason for the range of specific-gravity values shown in table 4 for pieces A, B, and C. Study of thin sections of the strontium-carbonate rock showed it to consist of a dense mosaic of anhedral calcite and strontianite crystals with scattered patches of anhedral celestite crystals. It was not possible to determine the thickness of the strontium-carbonate rock since adjacent cores were lacking. It did not extend to the next higher or lower core (NXC-1 and -3).

63. Cap rock anhydrite cores NXC-3, -4, -5, and -6. These cores, representing depths of 1107.0 to 1393.5 ft, were composed of dense and massive, fine- to medium-grained, bluish-gray anhydrite rock. Thin-section study of portions of cores NXC-4 and -5 showed the rock to be a mass of subhedral blocky anhydrite grains; smaller grains of anhedral anhydrite filled the interstices and gave it a tightly packed, dense texture.

64. Salt cores NXC-7 to -13 and -22 to -25 (scattered depths from 1491.5 to 2699.5 ft). Cores NXC-9 to -12 and -22 to -25, representing depths from 2402.0 to 2648.6 ft, were from the region proposed for the cavity.

a. Composition and appearance. The cores consisted of dense, massive rock salt (halite) which contained a small amount of anhydrite; the latter was usually estimated to be around 5 percent, never more than 10 percent, and less than 1 percent for cores NXC-7 and -13. The halite was colorless (transparent) or white (translucent) and sometimes showed cleavage traces. The anhydrite crystals were usually discrete particles; the individual anhydrite crystals were clear, but in the cores they tended to occur together; this resulted in a grayish color for those parts of the cores which contained concentrations of anhydrite. Because of these color differences, the cores had a banded or gneissic appearance wherein areas of white or transparent halite alternated with patchy, steeply dipping bands of gray anhydrite-rich salt (photograph 2).

b. Structure. The remarks concerning structure of the cores obtained from hole WP-1 (paragraph 19b) also apply here, the only difference being that the dip of the gray anhydritic bands was less in hole WP-4. In the salt, roughly parallel gray bands of anhydritic salt, ranging from a fraction of an inch to several inches thick, were found to dip generally from about 50 to 60 degrees in the cores examined. Core NXC-13 was an exception to this in that the dip of the anhydrite zones was only 25 to 30 degrees. The distance between the gray bands was always a matter of inches, i.e. never more than 1 ft.

c. Texture. The halite grains were usually anhedral in shape with irregular surfaces; they ranged from 1/16 (or smaller) to 1-1/2 in. in maximum dimension with the usual size being 1/4 to 1/2 in. The halite grains tended to be aligned so that their longest axis was parallel to the dip of the gray anhydritic bands. The size and shape of halite grains in a typical salt core are shown in photograph 1 and plate 62. The anhydrite was usually euhedral to subhedral blocky grains less than 1 mm in maximum dimension. This size observation agrees with the insoluble-residue grain-size data given for the 20 salt cores from hole WP-1.

Examination of Cores After Physical Tests

Physical test conditions

65. One NX salt core was tested to failure in compression to provide material for thin-section study. Two other NX salt cores were examined after creep testing; one of these failed, one did not. The two cores that failed behaved like similar larger cores from hole WP-1; the core that did not fail was unlike larger cores tested in similar fashion from hole WP-1. However, the differences in behavior were considered normal.

66. The testing conditions for the three NX cores were as follows:

CD Serial No.	Conditions	Remarks
		Creep Test
TAT-1-NXC-10	2500 psi at 73 F and 45 to 55 percent relative humidity	Tested in tandem with NXC-12; test was stopped when NXC-12 failed
-12	2500 psi at 73 F and 45 to 55 percent relative humidity	Specimen failed by rupture after 1705 hr
		Uniaxial Compression Test
-11	2500 psi for 6 min	No test results reported; this sample was tested to failure for petrographic study

Examination procedures

67. Cores NXC-10 and -12 were examined visually. Core NXC-11 was vacuum-impregnated with epoxy resin after failure; this procedure essentially glued the core back together so that thin sections could be made. Eight thin sections were made from the failed core and examined with a petrographic microscope. Thin sections from untested portions of cores NXC-7, -10, -11, and -12 were examined for comparison.

Description of cores

68. Creep test specimens. The portion of NXC-12 which was tested was a mixture of pure and impure salt; it was like the great majority of salt cores from holes WP-1 and WP-4. It failed on a diagonal fracture from end to end; the plane of this fracture dipped about 60 degrees and cut across the anhydritic zone. This failure was similar to those of cores DC-14C and -40A from hole WP-1 in their creep test (plate 64 and photograph 3).

69. The portion of core NXC-10 subjected to the creep test was almost pure salt like the Group III material from Winnfield (Appendix A). This core showed none of the features common to the specimens from hole WP-1 creep-tested at similar pressures. It had neither shortened (the length was still 5-1/2 in.) nor bulged laterally; there were no roughened surface areas where bits of surface had broken loose, and no open vertical cracks were observed.

70. The dynamic modulus of elasticity was 4.97×10^6 psi for NXC-10 and 4.55×10^6 psi for NXC-12. Neither the petrographic nor the dynamic modulus data would lead one to expect great differences in the results of creep tests of the two cores under similar conditions. However, such a difference did exist since NXC-12 failed in the creep test while NXC-10 did not.

71. The scanty test data developed for pure versus impure salt in this program do not indicate a clear difference between the types. The pure salt core, No. 15, from Winnfield gave intermediate results for total deformation in creep testing; the portions of the pure salt core, DC-5, from hole WP-1 gave low compressive strength results and had a very low dynamic modulus of elasticity. The most plausible explanation for failure of core NXC-12 is that this core had a hidden flaw or flaws that were not

detected in the pretest examination and that the flaw or flaws caused its failure. The lack of deformation of core NXC-10 as compared with larger cores (from hole WP-1) tested similarly was considered explained by flaw theory which states that smaller specimens should be stronger. In other words, higher pressures would be needed before NX cores would show deformation like that observed for the larger cores.

72. Uniaxial compression test specimen. The appearance of core NXC-11 was like that of the cores from hole WP-1 tested in compression which remained intact after failure. Thin sections made from NXC-11 showed the same features of grain-size reduction, failure by gliding on cleavage planes, open fractures, and open grain boundaries as the sections made from core DC-19B from hole WP-1 had shown. Plates 62 and 63 illustrate the changes that developed as a result of compressive forces.

Summary of Results

Examinations of cores before physical tests

73. Of the 17 NX cores from hole WP-4 in the Tatum salt dome examined (see core sketches in Appendices B and C), six were from the cap rock; they represented scattered depths from 948.0 to 1393.5 ft. The remaining 11 cores were from the salt and represented scattered depths from 1491.5 to 2699.5 ft. Plate 1 shows that the cores from this hole and from hole WP-1 were alike where depth comparisons could be made. Only the limestone core NXC-1 from 948.0 to 948.5 ft showed any quartz. It contained a small amount as mentioned in Appendix B. The position of this core in the hole was about 50 ft higher than that of any of the cores from hole WP-1.

74. The detailed descriptions of cap rock and salt cores in the summary of the results of the petrographic examination for the cores obtained from hole WP-1 apply equally well to the cores from this hole. Therefore, only brief descriptions are given below.

75. Cap rock cores. Core NXC-1 was limestone. Core NXC-2, representing depths from 999.0 to 1000.0 ft, ranged from limestone as in core NXC-1 to strontium-rich carbonate rock as in core NXC-15 from hole WP-1. Cores NXC-3, -4, -5, and -6 were dense, massive anhydrite rock.

76. Salt cores. Core NXC-7 was pure rock salt; no core from a

comparable depth in hole WP-1 was available. The remaining salt cores were impure rock salt consisting of halite containing nearly vertical bands of gray anhydritic salt (photograph 2). The halite grains were anhedral with sinuous boundaries (photograph 1 and plate 62); they averaged about 1/4 to 1/2 in. in maximum dimension, and they tended to be oriented with their longest axis roughly parallel to the gray anhydritic bands. The gray bands contained halite, anhydrite, and traces of carbonates. The average amount of insoluble residue was probably about 9 percent, and most of this was anhydrite. The anhydrite was present as small (less than 1 mm), clear, subhedral to euhedral, blocky grains. It should be possible to calculate the composition of these salt cores if the specific gravity is known, and vice versa, using data developed and presented earlier herein.

77. Cores from cavity area (depths of 2350.0 to 2650.0 ft). The eight salt cores from these depths were like the salt cores from hole WP-4 that were examined.

Examination of cores
after physical tests

78. Creep test specimens. Cores NXC-10 and -12 were tested in tandem, and core NXC-12 failed along a diagonal fracture which extended from end to end. This failure was like those which occurred in cores DC-14C and -40A from hole WP-1 during their creep test.

79. Core NXC-12 was a mixture of pure and impure anhydritic salt. Core NXC-10 as received was a mixture of pure and impure salt, but the portion sawed from it for the creep test was pure salt; the dynamic modulus of elasticity of the pure salt portion was 4.97×10^6 psi. The deformation recorded for this core was about half that for NXC-12 throughout the test. In addition, core NXC-10 did not show the visible signs of deformation common to the larger cores from hole WP-1 tested at similar pressures. This lack of deformation was considered normal since by flaw theory smaller specimens should be stronger. Apparently NX salt cores require higher pressures before they will exhibit the type of deformation shown by the larger salt cores. The conclusion is that core NXC-10 was stronger than core NXC-12 in this test. However, the test data developed for pure salt are too scanty to show a clear-cut superiority for either the pure or impure salt cores. Therefore, the most reasonable explanation for the

test differences in cores NXC-10 and -12 appeared to be that NXC-12 contained a hidden flaw which lowered its strength.

80. <u>Compression test specimen.</u> Core NXC-11 was broken in compression, and thin sections were then made from it for examination. Thin sections from untested cores were also examined for comparison. Plates 62 and 63 illustrate the typical changes that developed during deformation under compression. The core deformed by separation along grain boundaries, development of nearly vertical fractures, and translation gliding along cleavages parallel to the {110} direction.[2] These were the same features observed in cores from hole WP-1 that had been subjected to uniaxial compression.

PART IV: PHYSICAL TESTS ON TATUM CORES

Tests for Uniaxial Compressive Strength

81. Uniaxial compression testing was performed by two methods: (a) standard and cyclic tests, and (b) length-to-diameter tests. All test specimens were obtained from nominal 4-15/16-in.-diameter cores from hole WP-1. Testing was done on a 440,000-lb-capacity Baldwin testing machine.

Standard and cyclic tests

82. Five pairs of specimens were tested in this series. In the standard tests, one specimen of each pair was tested to failure by the standard unconfined method, i.e. loaded at a specified rate to failure similar to the way a 6- by 12-in. concrete cylinder would be tested. In the cyclic tests, the other specimen of each pair was loaded to 1660 psi, unloaded, and then loaded to failure. Strain was measured with a compressometer with two diametrically opposed 6-in. gage lines. Fig. 1 shows a specimen in the compression machine with a compressometer attached. The

Fig. 1. Testing a core specimen in compression

numbers of the core specimens tested and the depths from which they were obtained are shown below. Stress-strain curves obtained in tests of the 10 specimens are shown in plates 67-76.

Core	Test	Depth of Core, ft From	To
4B	Standard	2341.0	2344.0
4D	Single cyclic	2341.0	2344.0
44B	Standard	2398.8	2400.5
41B	Single cyclic	2406.0	2407.2
8C	Standard	2459.5	2463.0
8B	Single cyclic	2459.5	2463.0
11C	Standard	2613.0	2616.0
11D	Single cyclic	2613.0	2616.0
12B	Standard	2700.0	2703.0
12C	Single cyclic	2700.0	2703.0

Length-to-diameter tests

83. Five groups of specimens with various length-to-diameter ratios as shown below were tested in this series. Strain measurements were made

Core	L/D	Depth of Core, ft From	To
37A	1/1	2453.2	2455.0
7B	1/1	2545.0	2548.0
7C	1/1	2545.0	2548.0
6B	1.5/1	2445.0	2448.0
6D	1.5/1	2445.0	2448.0
6E	1.5/1	2445.0	2448.0
5B	2/1	2333.0	2335.0
5C*	2/1	2333.0	2335.0
3C	2/1	2393.0	2397.0
3B*	2/1	2393.0	2397.0
7D	2/1	2545.0	2548.0
7E	2/1	2545.0	2548.0
36B*	2.5/1	2261.0	2262.5
34B	2.5/1	2290.8	2292.5
31B	2.5/1	2322.8	2324.4
9B	3/1	2559.5	2563.0
9D*	3/1	2559.5	2563.0
57B	3/1	2602.4	2604.0

* Poisson's ratio determinations made on these cores.

with SR-4 strain gages on the specimens of L/D less than 2 as the compressometer used in the standard and cyclic tests could not be used on these specimens. Therefore, some of the strain measurements at high stress were missed because of the rapid movements of the strain indicator dial.

84. Poisson's ratio determinations were made on four specimens with a mechanical yoke similar to that shown in fig. 4, page 44.

85. Stress-strain data for each of the 18 specimens are given in plates 77-94. Specimen 6B was accidentally loaded to an undetermined magnitude, unloaded, and then reloaded to failure. This is probably the reason for the unusual shape of the stress-strain curve for that specimen (see plate 80).

Uniaxial Tensile Strength Tests

86. Six 4-15/16-in.-diameter core specimens (see tabulation below) from hole WP-1 were tested with a self-aligning direct tension apparatus. The ends of each specimen were anchored in the apparatus with a sulfur-silica compound.

Core	Depth of Core, ft From	To
32B	2158.8	2160.0
21B	2179.3	2180.8
2B	2249.0	2252.0
10B	2656.0	2659.0
10C	2656.0	2659.0
10D	2656.0	2659.0

Stress was applied at a constant rate with a Riehle testing machine, 30,000-lb capacity, and strain was measured with SR-4 strain gages. Fig. 2 shows the test setup. Stress-strain curves obtained are presented in plates 95-100.

Fig. 2. Tensile test setup

Uniaxial Tests for Compressive Strength Under Multiple Cyclic Loading

87. Selected specimens were tested in compression under the following conditions:

- a. Five cycles of stressing to 2500 psi and unloading to 0 at rate of 20 psi per sec and temperature of 73 F; loaded to failure on sixth cycle. This was termed "fast" loading.
- b. Same as a except that core was tested at temperature of 150 F.
- c. Two cycles of stressing to 2500 psi and unloading to 0 at rate of 105 psi per hr and temperature of 73 F; loaded to failure on third cycle. This was termed "slow" loading.
- d. Same as c except that core was tested at temperature of 150 F.

Two specimens were tested for each condition. A Baldwin universal testing machine (440,000-lb capacity) was used for conditions a and b, and a spring-loaded frame for conditions c and d. Strain was measured with a compressometer with two diametrically opposed 6-in. gage lines. A commercial heating pad was used to maintain the test temperature for b. For d, the rigs were placed in a heated room and maintained at 150 F throughout the test. Fig. 3 shows the test setup for conditions c and d. The specimens, depths at which the cores were obtained, and test conditions are listed below:

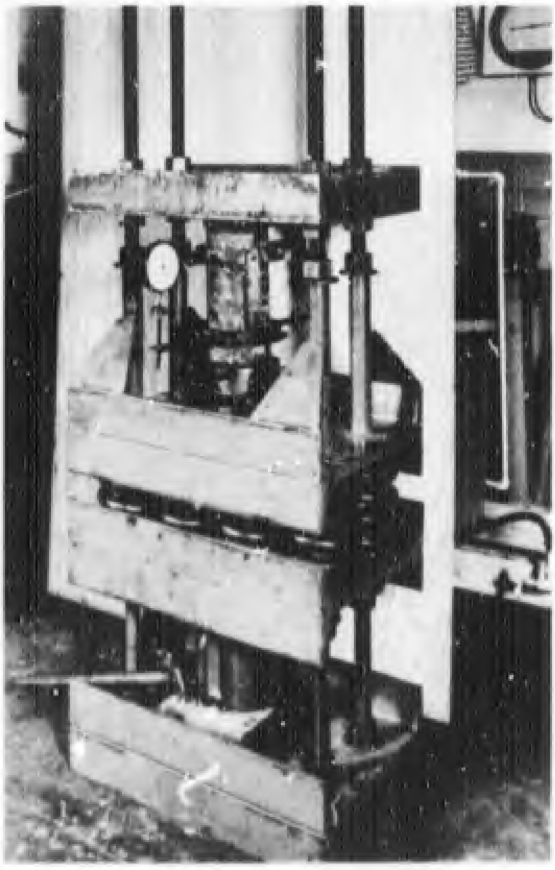

Fig. 3. Spring-loaded frame used in compression tests

Core	Loading Condition	Depth of Core, ft From	Depth of Core, ft To
13B	Fast at 73 F	1657.3	1658.5
20B	Fast at 150 F	1681.0	1682.2
26B	Fast at 73 F	1994.5	1995.6
28B	Fast at 150 F	2035.0	2036.4
35B	Slow at 73 F	2262.5	2264.2
35A	Slow at 150 F	2262.5	2264.2
56B	Slow at 73 F	2584.0	2585.3
59B	Slow at 150 F	2629.3	2630.5

Plates 101-108 present the stress-strain curves obtained for the eight test specimens.

Uniaxial Compression Tests by Incremental Loading

88. Three groups of three specimens each were loaded in compression to failure at periods of 1 day, 5 days, and 30 days (see tabulation below).

Core	Time to Failure, days	Depth of Core, ft From	To
45B	1	2271.0	2272.1
29A	5	2287.2	2289.0
29B	30	2287.2	2289.0
37B	1	2453.2	2455.0
43B	5	2486.5	2488.0
46B	30	2539.5	2540.8
62A	1	2693.1	2695.0
63B	5	2659.8	2662.5
62B	30	2693.1	2695.0

Load was applied in increments of 420 psi per hr for the 1-day specimens, 350 psi per 12 hr for the 5-day specimens, and 200 psi per 48 hr for the 30-day specimens. A spring-loaded frame (see fig. 3) was used, and strain was measured with a compressometer with two diametrically opposed 6-in. gage lines. Since it would have been difficult to obtain a final (ultimate) strain reading and because of the damage that would have been sustained by the gages if they had been left attached to the core specimen until failure of the specimen, the gages were removed when failure of the specimen appeared imminent. Specimen failure was considered imminent when any or all of the following were noted: (a) unusually large increase in strain; (b) cracking sound; and (c) spalling of crystals from the test specimen. The stress-strain data obtained in these tests are presented in plates 109-117.

Uniaxial Creep Tests

89. Eight cores from hole WP-1 were subjected to uniaxial creep tests at two temperatures and four stress conditions as shown below:

Core	Temp, °F	Stress, psi	Depth of Core, ft From	To
15B	73	525	1720.0	1721.5
33B	73	1750	2151.8	2153.5
23B*	73	2250	2196.5	2198.0
14C	73	3000	1672.0	1673.6
30B	150	750	2239.8	2241.5
18B	150	1750	1679.0	1680.5
19B*	150	2250	1723.2	1724.7
40A	150	3000	2216.5	2218.0

* Poisson's ratio determinations made on these cores.

Fig. 4. Creep test setup

Load was maintained by means of a spring-loaded frame (see fig. 4) for 2000 hr. The creep load was maintained within ±5 percent of that specified. Vertical strain was measured, by means of a mechanical strain gage, on two diametrically opposite 6-in. gage lines between small brass inserts embedded in the specimen. Readings were taken as necessary to fully define the creep curve. Lateral strain was determined on several specimens by a dial gage and yoke as shown in fig. 4. Poisson's ratio was determined from the two strain measurements on two of the creep test specimens. A ratio greater than 0.50 indicates that the volume increased under load. This is probably what happened, since the specimens loaded to a high degree of stress attained a "puffy" appearance. Apparently there was a vertical splitting along the crystal boundaries which resulted in the high Poisson's ratio values.

90. Specimens 18B and 23B tilted in the loading frame, and specimen 30B, scheduled to be tested at 750 psi, was accidentally overloaded.* Three additional specimens were selected and tested as replacements as shown below:

Core	Temp, °F	Stress, psi	Depth of Core, ft From	To
68B	150	1750	1725.0	1726.6
69B*	73	2250	2161.5	2163.0
70B	150	750	2238.0	2239.8

* Poisson's ratio determination made on this core.

91. Two 2-1/8-in.-diameter specimens (NXC-10 and -12) from hole WP-4 were tested together, one on top of the other, in one frame at 2500-psi creep load. Core NXC-12 failed after approximately 1700 hr. Although core NXC-10 had not failed, testing thereof was discontinued because of the failure of core NXC-12. These tests were the only destructive physical tests made on cores from hole WP-4.

92. Strain-time data obtained on the 11 creep test specimens are presented in plates 118-130.

Triaxial Extension Tests

93. Triaxial tests are performed to determine the strength of materials and the manner, rate, and amount of strain that materials undergo when stress is applied in all directions. In the usual triaxial tests, a constant lateral minor stress is applied to the cylindrical surface of a right cylindrical specimen and the major stress is applied along the

† During adjustment of the load on specimen 30B at test age of 3 hr, the load was inadvertently increased to 1500 psi. It remained at this level for an undetermined period of time (but less than 1 hr). When it was realized that the load was too high, it was decreased to 750 psi. No reading was made of the strain while the load was at 1500 psi. The next reading taken was the scheduled one at 5 hr. A large increase in strain resulted from the short-time overload. This strain was not wholly elastic, since full recovery did not occur on release of load. In fact, the strain appeared to increase, but at a diminishing rate, until an age of about 24 hr, after which it seemed to fall off very gradually and very slightly for the remainder of the test.

longitudinal axis. In the triaxial extension test, the axial stress is the minor stress and the lateral stress is the major stress. Such a test is, in effect, a tension test. Either type of test can be a quick test, i.e. completed in a few minutes, or a creep test in which the stresses are maintained for a long period of time. All tests performed in this study were triaxial extension tests in which the stresses were maintained on the specimens for a period of 1000 hr or to failure, whichever occurred first.

94. The specimens were tested in a high-pressure triaxial test chamber, and a spring-loaded frame was utilized for axial-load maintenance. Since the lateral stresses exceeded the axial stresses, special equipment which permitted these stresses to be applied independently was constructed. The diameter of the axial-loading piston was identical with that of the test specimens, and the swivel head, which allowed for minor nonperpendicularity of the top surface of the specimen to the longitudinal axis, was placed on the outside of the chamber. In addition, it was necessary to machine the flat surfaces of each specimen on a lathe since the sulfur-silica capping material used for all other tests tended to permit failure to occur where the cap joined the core under the differential stresses applied in the triaxial extension tests. A 1/8-in.-thick neoprene rubber membrane, used to insulate the specimen from the confining fluid (castor oil), was fastened to the lower baseplate and piston by means of hose clamps. A steel shim, approximately 1 in. wide by 0.009 in. thick, was required under the membrane and over the joints between the specimen and the baseplate and piston to prevent the pressurized fluid from puncturing the membrane.

95. Strain was measured mechanically with diametrically opposed dial gages mounted on the loading piston, and electrically with diametrically opposed SR-4 strain gages mounted on the test specimen. The strain gages had the capacity to measure up to 10 percent strain. Epoxy resin was used to bond the strain gages to the test specimens after other types of glue and gages proved unsuccessful for use under the applied pressures (up to 3850 psi). The epoxy was applied over as well as under the gage, and allowed to cure at 150 F for 20 hr immediately after application.

96. Five triaxial extension tests were performed on large cores from hole WP-1. Axial and lateral loads were maintained within ±5 percent of

that specified. Fig. 5 shows the test setup. The specimens, test conditions, and depths were as follows:

Core	Axial Load, psi	Lateral Load, psi	Depth of Core, ft From	To
48A	1000	2000	2456.7	2458.5
67B	1000	2500	2557.0	2559.5
51B	500	3000	2522.0	2523.5
16B	300	3425	1822.5	1824.2
49A	100	3850	2496.5	2498.3

97. Plates 131-135 show the data obtained for each specimen tested. It will be noted that there is a divergence of strain readings for all specimens except that subjected to the severest test condition (core 49A, plate 135). In order to determine if the difference in strain readings was due to creep of the bonding agent for the strain gages, a steel cylinder was instrumented and loaded in a similar manner to the salt specimens. The results obtained are shown in plate 136.

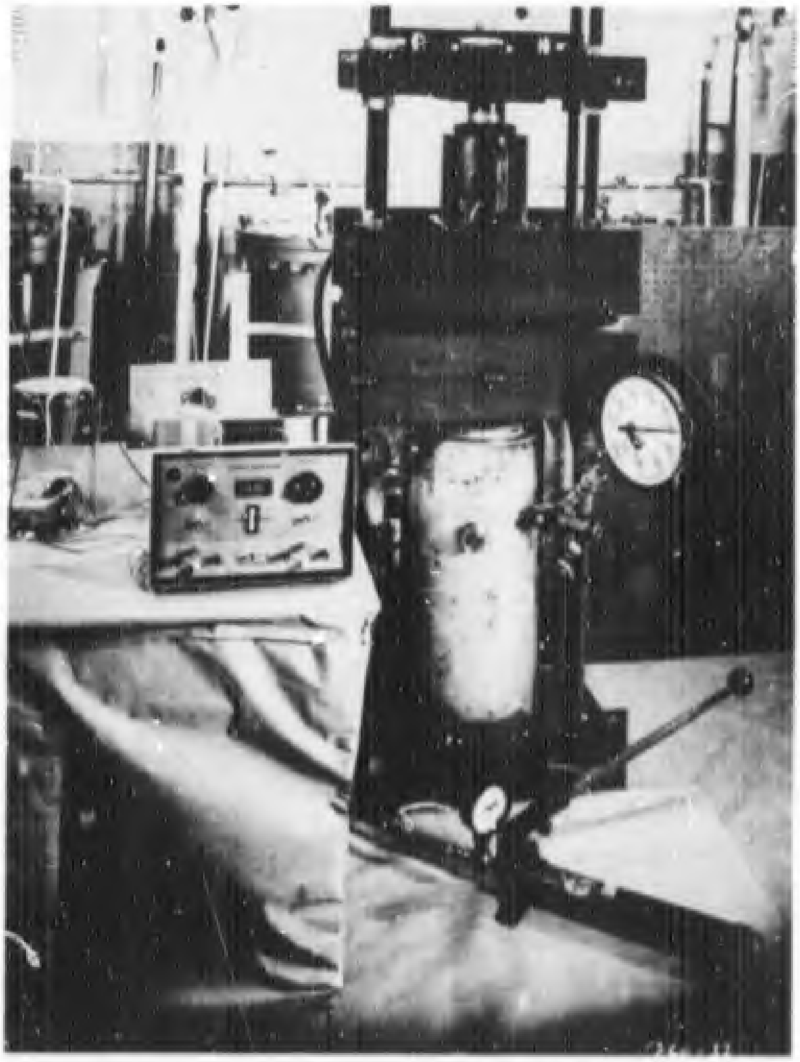

Fig. 5. Triaxial extension test setup

Strain measurements, compared with theoretical calculations, indicated very little creep of the epoxy glue. Apparently the difference in strain measurements on the Tatum cores was actual; more strain is experienced in the center of the specimen than on the overall length. Recovery readings indicated a permanent set in the specimens, since little recovery was noted on the dial or the strain gages.

98. It can be seen in plate 131 that for the first 12 hr of test the mechanical measurements on specimen 48A were negative, indicating compression. Occurrence of compression in this test is very unlikely. Instead of compression of the test specimen, the measurements are probably the result of compression of a new gasket that had been recently installed in the base pedestal of the test chamber. If the mechanical strain were replotted starting after the loading cycle was completed (at 0.17 hr), agreement between methods of strain measurement would be very good.

Nondestructive Dynamic Tests

99. The dynamic testing consisted of sonic and ultrasonic tests on selected cores from holes WP-1 and WP-4. The ultrasonic pulse velocity of propagation of compressional waves was measured by means of a soniscope according to the method described in CRD-C 51 of the Handbook for Concrete and Cement.[7] Sonic work consisted of determining the transverse and longitudinal frequencies of vibration according to CRD-C 18. From these were calculated the sonic pulse velocity, Young's modulus of elasticity (E), the modulus of rigidity, and Poisson's ratio. Satisfactory results were not obtained on all specimens due to unusual size, length, or condition of the specimen. Young's E, calculated from the transverse frequency, was obtained on all triaxial and creep specimens for use in analyzing the data. All data are given in table 5.

Specific Gravity, Porosity, Permeability, and Interstitial Fluid

100. Eighteen specific-gravity determinations were made on cores from hole WP-1 and 11 on cores from hole WP-4 by weighing the core in air as received and dividing this weight by the volume of the specimen determined

Table 5

Results of Nondestructive Dynamic Tests

Core No.	Core Depth, ft From	Core Depth, ft To	Specimen Diameter in.*	Specimen Length in.*	Pulse Velocity, fps Ultrasonic V_p**	Pulse Velocity, fps Sonic V_s†	Young's E × 10^{-6}, psi, Calculated from Transverse Frequency	Young's E × 10^{-6}, psi, Calculated from Longitudinal Frequency	Modulus of Rigidity G × 10^{-6} psi	Poisson's Ratio Calculated from Moduli††	Poisson's Ratio Calculated from Pulse Velocity‡
					Hole WP-1; Coordinates N10166.85, E8040.83						
NXC-18A	1409.5	1412.0	2.12	18.00	18,315	17,045	12.44	13.27	5.05	0.230	0.225
NXC-19B	1260.5	1262.8	2.12	20.00	18,945	17,890	12.03	12.49	4.81	0.250	0.205
NXC-20B	1345.0	1347.0	2.12	20.00	18,555	16,760	9.91	10.84	4.20	0.180	0.260
NXC-21B	1181.0	1183.5	2.12	20.00	a	--	11.93	12.43	4.92	0.210	---
DC-1	2244.0	2247.0	5.00	30.00	--	12,965	4.95	5.01	2.33[b]	0.062[b]	---
DC-1C[c]	2244.0	2247.0	5.00	12.50	13,390	--	--	--	--	---	---
DC-1D[c]	2244.0	2247.0	5.00	12.50	13,355	--	--	--	--	---	---
DC-2	2249.0	2252.0	5.00	30.00	--	12,710	4.61	4.76	2.24[b]	0.030[b]	---
DC-2'[d]	2249.0	2252.0	5.00	20.00	--	10,050	3.90	2.98	1.64	0.189[e]	---
DC-2B[d]	2249.0	2252.0	5.00	10.00	12,220	--	--	--	--	---	---
DC-2C[d]	2249.0	2252.0	5.00	10.00	12,705	--	--	--	--	---	---
DC-3	2393.0	2397.0	5.00	20.00	13,380	11,585	4.14	3.92	a	a	0.295
DC-5	2333.0	2335.0	5.00	20.00	8,455[b]	6,025	1.28	1.03	a	a	0.385[b]
DC-7	2545.0	2548.0	5.00	20.00	13,845	12,695	4.62	4.63	a	a	0.250
DC-11	2613.0	2616.0	5.00	20.00	13,735	12,600	4.55	4.61	a	a	0.250
DC-12	2700.0	2703.0	5.00	20.00	13,690	12,745	4.79	4.81	a	a	0.225
DC-14	1672.0	1673.6	5.00	20.00	14,860	13,195	4.86	4.97	2.04	0.190	0.280
DC-14C[g]	1672.0	1673.6	5.00	12.88	--	--	4.47	--	--	---	---
DC-15B	1720.0	1721.5	5.00	12.62	--	--	4.96	--	--	---	---
DC-16	1822.5	1824.2	5.00	20.00	14,955	12,910	4.80	4.90	2.01	0.190	0.300
DC-18B	1679.0	1680.5	5.00	12.38	--	--	4.82	--	--	---	---
DC-19B	1723.[illegible]	1724.7	5.00	12.31	--	--	4.99	--	--	---	---
DC-22	2097.3	2099.0	5.00	20.00	14,505	13,055	4.93	4.93	2.02	0.220	0.265
DC-23B	2196.5	2198.0	5.00	12.50	--	--	4.82	--	--	---	---
DC-24	1990.5	1992.3	5.00	20.00	15,000	12,930	4.82	4.84	1.93	0.250	0.285
DC-25	1947.2	1949.0	5.00	20.00	14,910	12,700	4.69	4.74	1.96	0.200	0.315
DC-30B	2239.8	2241.5	5.00	12.38	--	--	4.75	--	-	---	---
DC-33B	2151.8	2153.5	5.00	12.50	--	--	4.95	--	--	---	---
DC-4[illegible]A	2216.5	2218.0	5.00	12.59	--	--	5.33	--	--	---	---
DC-64	1553.5	1555.0	4.88	19.00	14,820	13,080	5.01	5.07	2.10	0.193	0.285
Box 116	Unknown		5.00	18.25	13,945	12,390	5.03	4.55	2.04	0.233	0.275
Box 225	Unknown		5.00	16.50	13,195	10,865	4.33	3.47	1.81	0.196	0.325
DC-38B	2463.8	2465.5	4.90	10.00	--	--	5.39	--	--	---	---
DC-49A	2496.5	2498.3	4.90	10.00	--	--	5.32	--	--	---	---
DC-48A	2456.7	2458.5	4.90	10.00	--	--	5.13	--	--	---	---
DC-51B	2522.0	2523.5	4.88	10.00	--	--	4.25	--	--	---	---
DC-68B	1725.0	1726.0	5.00	13.00	--	--	4.36	--	--	---	---
DC-69B	2161.5	2163.0	5.00	13.00	--	--	4.84	--	--	---	---
DC-70B	2238.0	2239.8	5.00	13.00	--	--	3.54	--	--	---	---
DC-67B	2557.0	2559.5	4.88	9.88	--	--	4.55	--	--	---	---
					Hole WP-4; Coordinates N9217.06, E9272.30						
NXC-2	999.0	1000.0	2.12	6.06	15,910	--	--	--	--	---	---
NXC-3	1107.0	1108.0	2.06	10.56	19,755	--	12.85	--	--	---	---
NXC-4	1199.5	1200.5	2.06	10.50	19,230	--	14.03	--	--	---	---
NXC-5	1299.0	1300.0	2.12	10.50	--	--	13.07	12.96	5.01	0.300	---
NXC-6	1392.5	1393.5	2.12	10.62	--	--	12.61	12.46	4.98	0.270	---
NXC-7	1491.5	1492.5	2.06	10.50	14,405	--	5.23	--	--	---	---
NXC-8	2317.0	2318.0	2.06	10.50	14,035	--	5.11	--	--	---	---
NXC-9	2402.0	2403.0	2.06	10.56	13,510	--	5.37	--	--	---	---
NXC-10	2603.5	2604.5	2.06	10.56	13,810	--	4.97	--	--	---	---
NXC-11	2495.5	2496.5	2.06	10.56	13,270	--	4.49	--	--	---	---
NXC-12	2647.5	2648.6	2.06	10.56	12,805	--	4.55	--	--	---	---
NXC-13	2698.5	2699.5	2.06	10.56	12,645	--	2.56	--	--	---	---
Box 44	Unknown		2.06	20.00	a	18,215	14.47	13.77	5.32[b]	---	---
Box 74	Unknown		2.06	18.00	14,020	12,980	4.91	5.06	2.08	0.180	[illegible]

* Dimensions used in calculations.
** Determined on soniscope (CRD-C 51-55).
† Calculated from $2lf_n$.
†† Calculated from $\frac{E}{2G} - 1$.
‡ Calculated from $(V_p/V_s)^2$.
a Unable to obtain satisfactory results.
b No confidence.
c Sawed from core 1.
d Sawed from core 2.
e This value previously reported informally as 0.180.
f Sawed from core 2'.
g Capped, sawed from core 14.

by the mercury-displacement method described in American Petroleum Institute Recommended Practice No. 4 (API RP40).

101. Seven porosity, permeability, and interstitial fluid tests were made on specimens from hole WP-1 and four on specimens from hole WP-4. The porosity was determined by the Washburn-Bunting Method (as shown in paragraph 3.5.12 on page 30 of above-mentioned API RP40) which involves the determination of the true effective pore volume of the core and the dividing of this volume by the bulk volume of the core. The permeability was determined by the gas-permeability method (as shown in section 3.4 of API RP40) which involves the measurement of the volume of air that will pass, under a known pressure, through a specimen of known volume in a certain period of time. The interstitial fluid was determined using the oven retort-atmospheric pressure equipment shown in fig. 3.53F1 on page 20 of API RP40 and the procedure described in section 4.3 of the same publication, and involves the vaporization and condensation for measurement of any fluid in the sample.

102. The bulk specific gravity by kerosene displacement and the apparent specific gravity were determined after some differences were noted between the specific gravities obtained by mercury displacement and those calculated from insoluble residue. The bulk specific gravity by kerosene displacement is determined by dividing the oven-dried specimen weight in air by the volume of the specimen including air voids. The apparent specific gravity is obtained by dividing the weight in air of the specimen with the voids filled with kerosene by the volume of the specimen excluding voids. The apparent specific gravity and the bulk specific gravity determined by kerosene displacement probably more nearly approach the correct value than the specific gravities determined by mercury displacement or those calculated from insoluble residue.

103. Results of the specific gravity, porosity, permeability, and interstitial fluid tests are presented in table 6.

Table 6

Results of Specific Gravity, Porosity, Permeability, and Interstitial Fluid Tests

Core No.	Depth of Core, ft	Diameter of Core in.	Specific Gravity: Bulk Mercury Displacement	Specific Gravity: Bulk Kerosene Displacement	Specific Gravity: Apparent	Permeability Millidarcys Horizontal	Porosity %	Residual Liquid Saturations % of Pore Space: Oil	Residual Liquid Saturations % of Pore Space: Total Water
				Hole WP-1					
NXC-14	1012.0-1012.3	2.125	2.634	2.656	2.688	--	--	-	-
NXC-15	1020.0-1020.3	2.125	3.336	3.164	3.246	--	--	-	-
NXC-21	1181.0-1183.5	2.125	3.079	2.945	2.950	--	--	-	-
NXC-19	1260.5-1262.8	2.125	3.119	2.940	2.954	--	--	-	-
NXC-20	1345.0-1347.0	2.125	2.927	2.953	2.977	--	--	-	-
NXC-18	1409.5-1412.0	2.125	3.109	2.948	2.952	--	--	-	-
DC-64	1553.5-1555.0	5.0	2.167	2.205	2.207	6.01	3.00	0	1.7
DC-14	1672.0-1673.6	5.0	2.298	2.194	2.195	Trace	5.30	0	1.1
DC-16	1822.5-1824.2	5.0	2.317	2.207	2.218	Trace	3.30	0	1.5
DC-25	1947.2-1949.0	5.0	2.297	2.205	2.206	--	--	-	-
DC-26	1994.5-1995.6	5.0	2.322	2.211	2.206	--	--	-	-
DC-22	2097.3-2099.0	5.0	2.291	2.200	2.198	--	--	-	-
DC-2	2249.0-2252.0	5.0	2.221	2.198	2.203	--	--	-	-
DC-4	2341.0-2344.0	5.0	2.206	2.196	2.199	2.32	2.64	0	0
DC-6	2445.0-2448.0	5.0	2.200	2.181	2.186	--	--	-	-
DC-8	2459.5-2463.0	5.0	2.210	2.186	2.207	1.26	4.71	0	0
DC-11	2613.0-2616.0	5.0	2.215	2.206	2.222	0.39	3.36	0	0
DC-10	2656.0-2659.0	5.0	2.230	2.223	2.228	0.00	2.76	0	0
				Hole WP-4					
NXC-2	999.0-1000.0	2.125	2.785	2.828	2.839	--	--	-	-
NXC-3	1107.0-1108.0	2.125	2.923	2.953	2.983	--	--	-	-
NXC-4	1199.5-1200.5	2.125	2.932	2.958	2.962	--	--	-	-
NXC-5	1299.0-1300.0	2.125	2.948	2.946	2.961	--	--	-	-
NXC-6	1392.5-1393.5	2.125	2.947	2.946	2.961	--	--	-	-
NXC-7	1491.5-1492.5	2.125	2.158	2.168	2.161	0.00	2.75	0	0
NXC-8	2317.0-2318.0	2.125	2.207	2.219	2.219	0.00	2.05	0	0
NXC-9	2402.0-2403.0	2.125	2.186	2.189	2.208	0.00	1.53	0	0
NXC-23	2476.0-2477.4	2.125	---	2.212	2.212	--	--	-	-
NXC-25	2533.0-2534.0	2.125	---	2.204	2.202	--	--	-	-
NXC-13*	2698.5-2699.5	2.125	2.141	2.1[illegible]3	2.183	Trace	8.59	0	0

Note: All procedures except those for determining bulk kerosene specific gravity and apparent specific gravity were taken from American Petroleum Institute Recommended Practice for Core-Analysis Procedure. Kerosene bulk and apparent specific gravities were determined using the method described in CRD-C 107-60, Handbook for Concrete and Cement.[7]

* Core 13 was fractured, causing permeability and porosity to be unusually high.

PART V: CONCLUSIONS

104. It was not possible to determine from the test results if real differences existed between pure and impure salt, due to the limited number of possible comparisons. However, since the literature[6] on salt domes indicates that impure salt is the rule and since the petrographic results obtained in this study verify this, the question probably is not of very great importance since the amount of pure salt is negligible.

105. From consideration of the petrographic data developed on the cores both before and after the physical tests and the physical test data, it is concluded that the salt cores from holes WP-1 and WP-4 can be considered homogeneous material, and that the variations in test results were those normally to be expected in testing subsamples of a homogeneous material. (The variations were probably due to the testing and not to the samples.) Aside from a few cores that failed or exhibited low compressive strengths (DC-23B, -5B, and -5C) probably due to hidden flaws, the other cores that failed probably behaved like all or most salt dome salt cores of similar size under equivalent conditions.

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2. Gilman, J. J., "Deformation and fracture of ionic crystals," in J. E. Burke, Ed., Progress in Ceramic Science, Volume 1 (Pergamon Press, New York, N. Y., 1961), Chap. 4.

3. Morgan, C. L., "Tatum Salt Dome, Lamar County, Mississippi." Bulletin, American Association of Petroleum Geologists, vol 25, No. 3 (3 March 1941), p 424.

4. Palache, C., Berman, H., and Frondel, C., The System of Mineralogy of James Dwight Dana and Edward Salisbury Dana, Volume II, 7th ed. John Wiley and Sons, Inc., New York, N. Y., 1951.

5. Rogers, A. F., and Kerr, Paul F., Optical Mineralogy, 3rd ed. McGraw-Hill Book Co., Inc., New York, N. Y., 1959.

6. Taylor, Ralph E., Origin of the Cap Rock of Louisiana Salt Domes. Geological Bulletin No. 11, Department of Conservation, Louisiana Geological Survey, New Orleans, La., August 1938.

7. U. S. Army Engineer Waterways Experiment Station, CE, Handbook for Concrete and Cement, with quarterly supplements. Vicksburg, Miss., August 1949.

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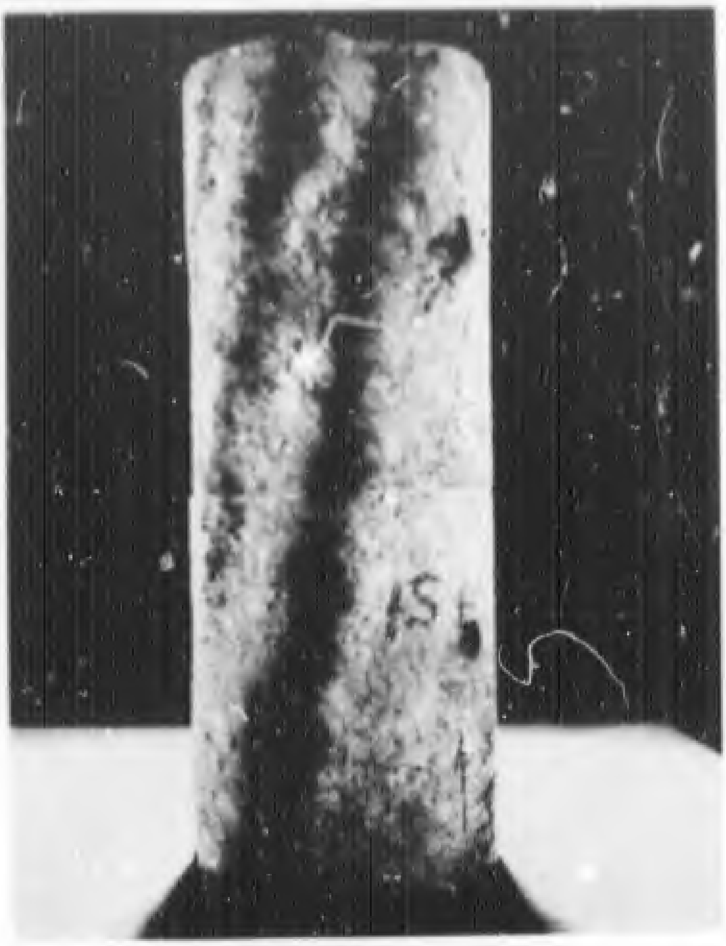
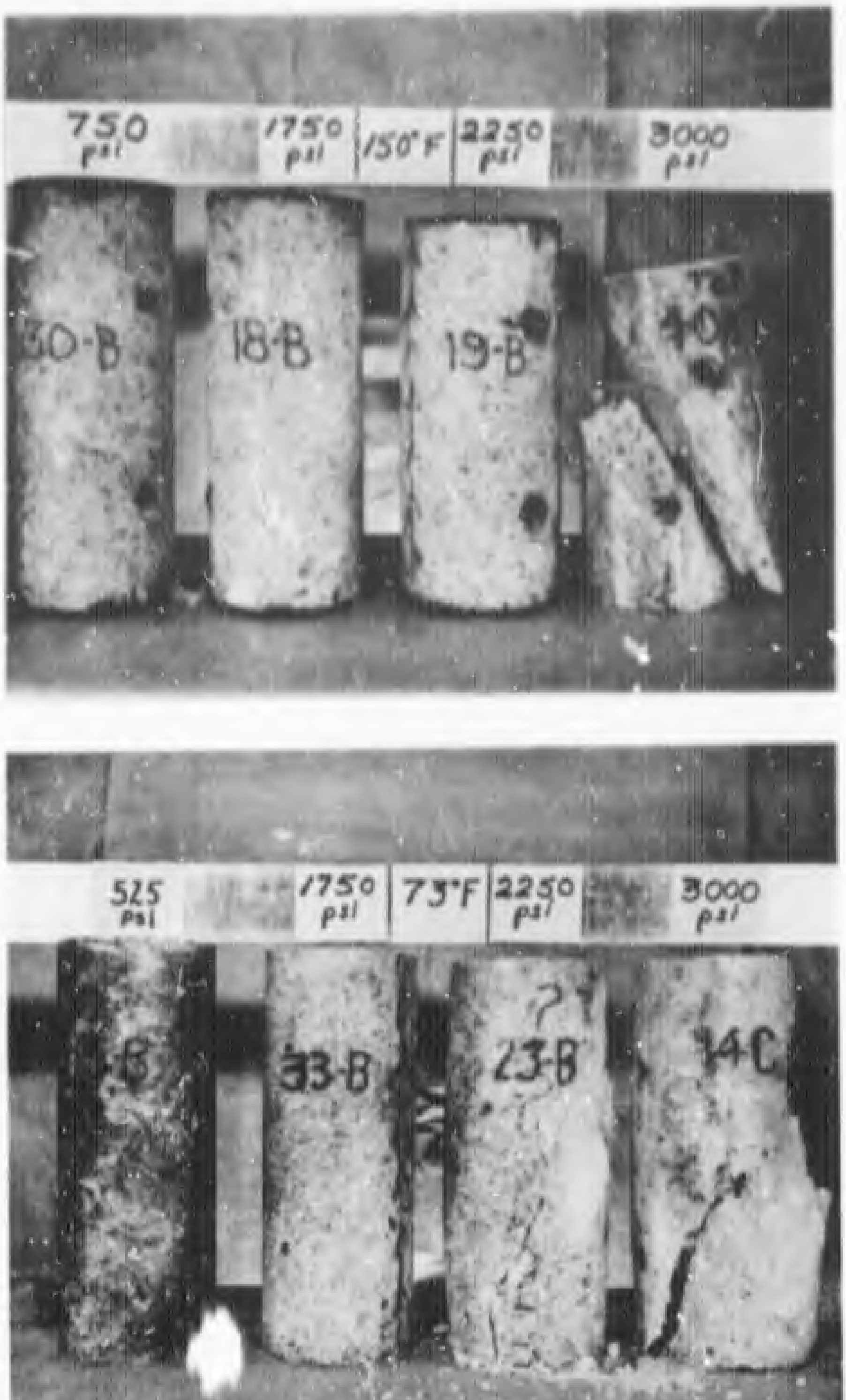
Untested portion of salt core DC-4A from hole WP-1. Sawed down the middle and etched in water. Halite grains are outlined by thin white lines of recrystallized halite. Small clear or white grains are anhydrite or recrystallized halite. Natural size.

Photograph 1. Typical salt core from Tatum salt dome



Transmitted light view of core DC-15B from hole WP-1 after creep test. The two diagonal black streaks are the gray bands of anhydritic salt. The sketch shows the position of the bands as seen from above.

Photograph 2. Typical gray anhydritic bands in salt core from Tatum salt dome



Cores DC-14, -23, and -40 failed; others withstood 2000 hr without failure. Note progressive shortening and lateral bulging of cores with increasing pressure.

Photograph 3. Appearance of salt cores after creep testing

a. Immediately after removal of compressometer

b. Separated by hand to show cones

Photograph 4. Salt core DC-13B after failure in uniaxial compression cyclic test

a. Core in compressometer

b. After removal of compressometer

Photograph 5. Salt core DC-26B after failure in uniaxial compression cyclic test

a. Core DC-20B, compressometer removed

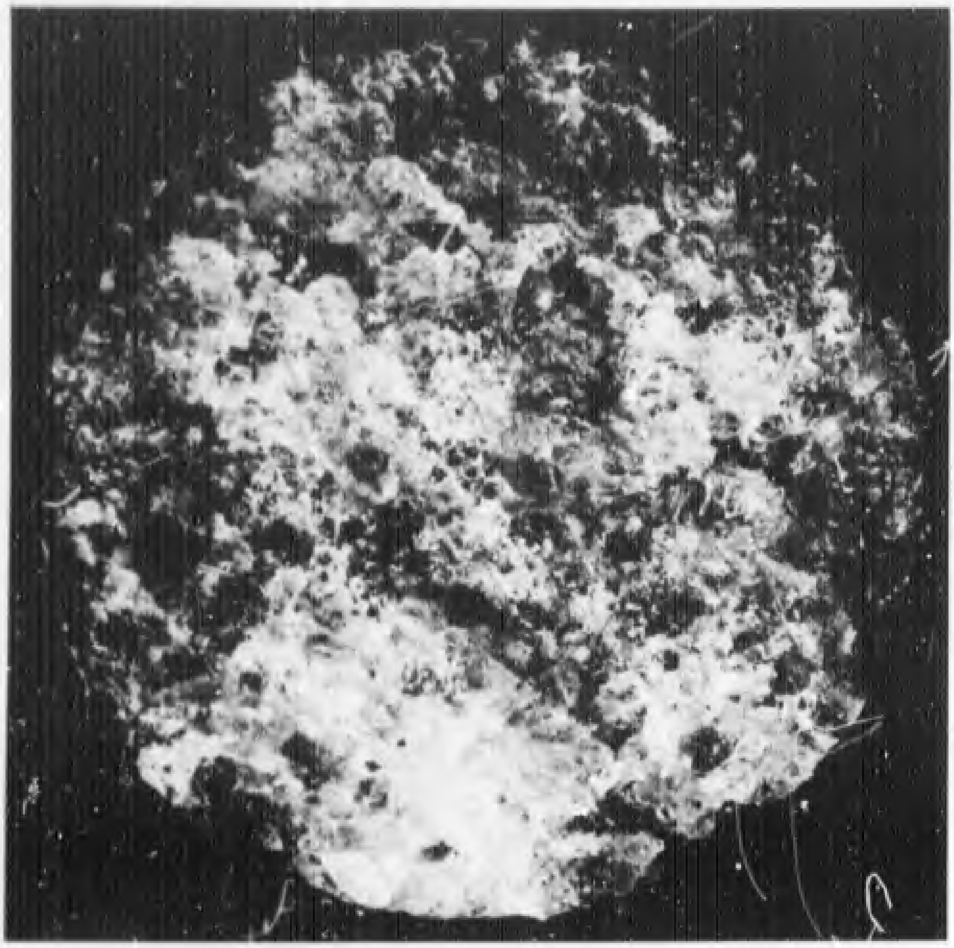
b. Core DC-56B, compressometer removed

Photograph 6. Salt cores DC-20B and -56B after failure in uniaxial compression cyclic test

a. Core DC-28B, compressometer removed

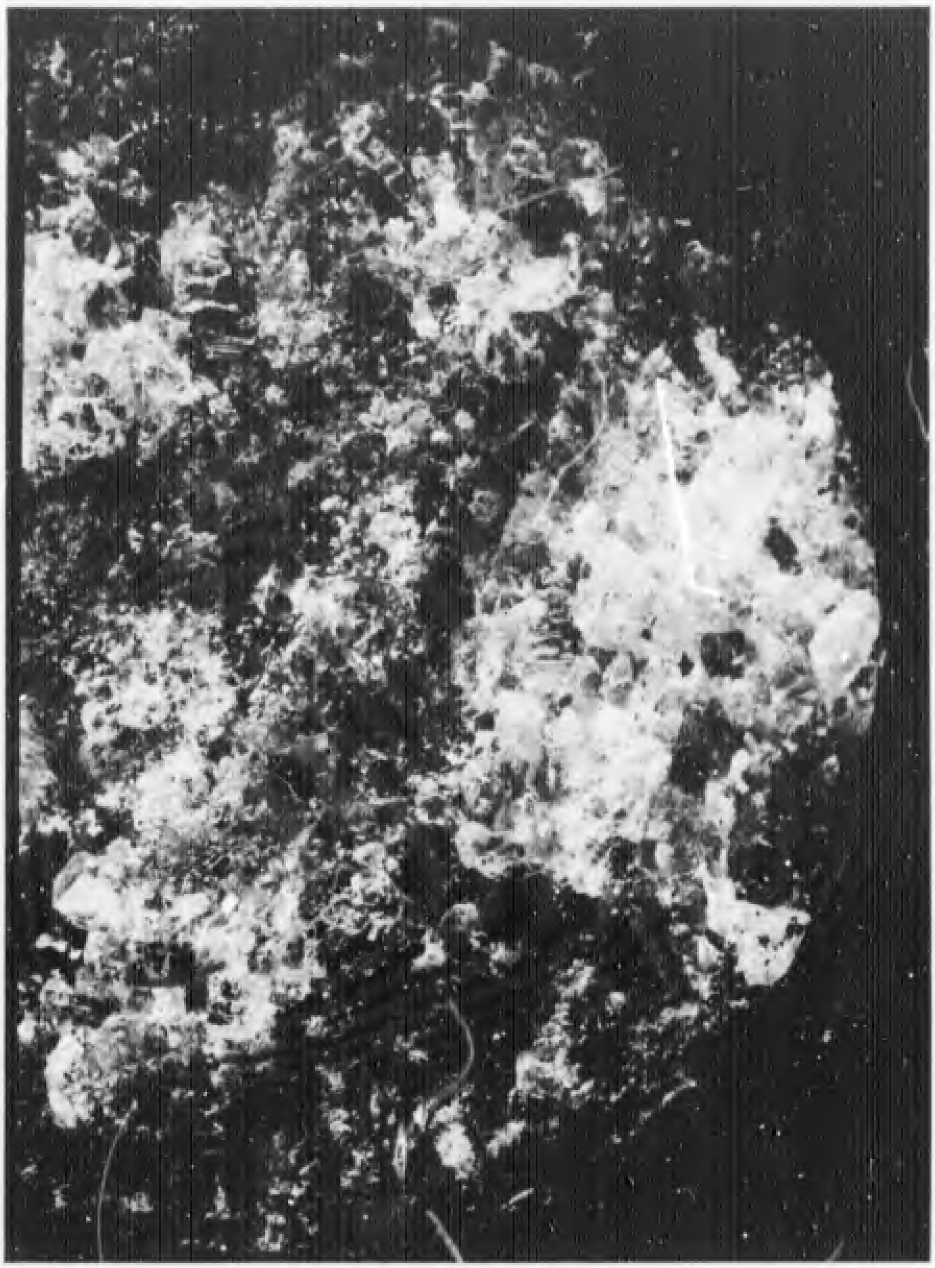
b. Core DC-35B, compressometer removed

Photograph 7. Salt cores DC-28B and -35B after failure in uniaxial compression cyclic test



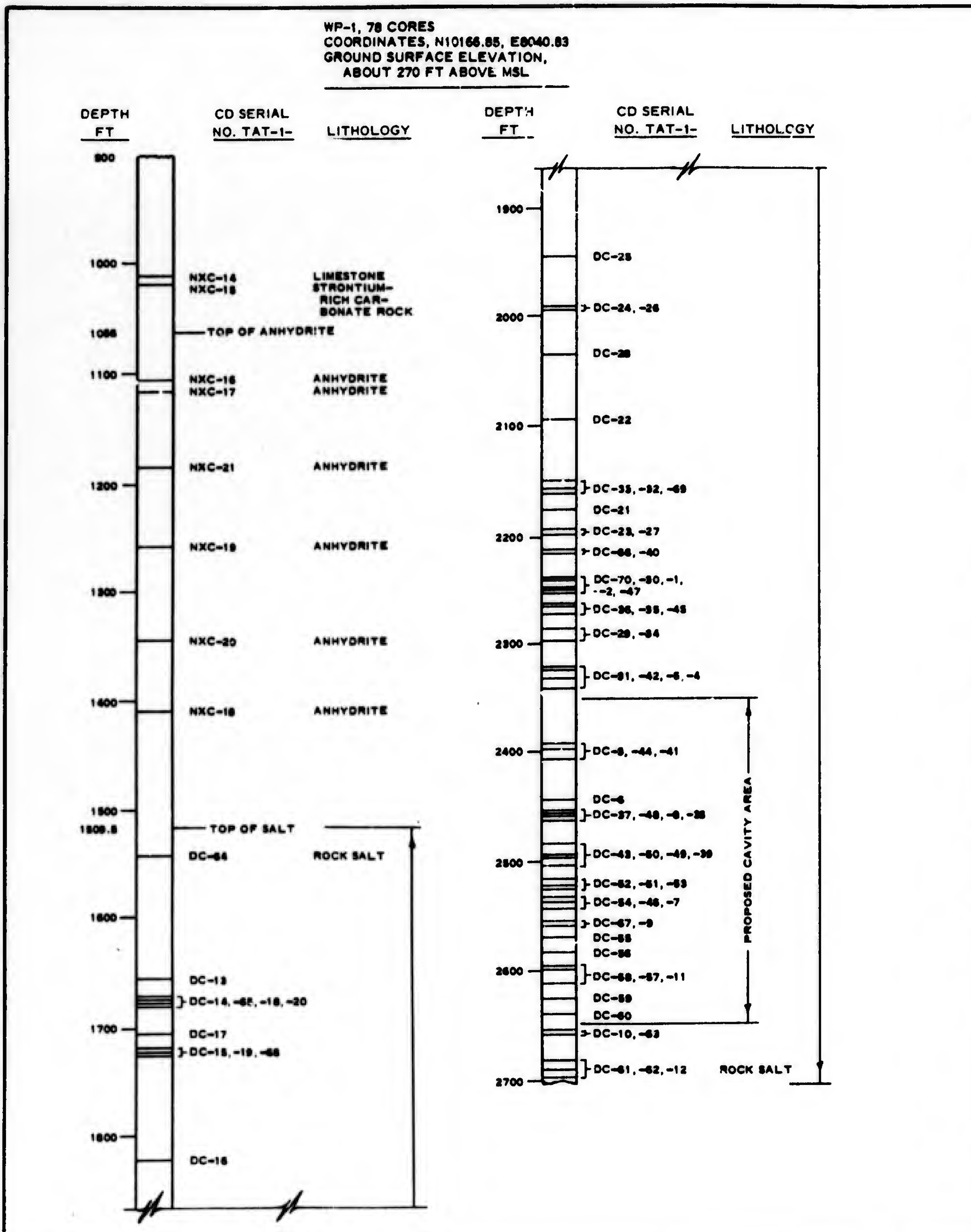
Core DC-10B. Fracture surface through core axis. Surface dips down about 20 to 30 degrees from right edge of core. The surface is very irregular since the break goes through and around grains. Broken ends of untested cores are also like this. Core is slightly reduced in size. Photograph 9 is a slightly magnified view of the left portion of the fracture surface.

Photograph 8. Typical fracture surface developed in salt core by failure in tension



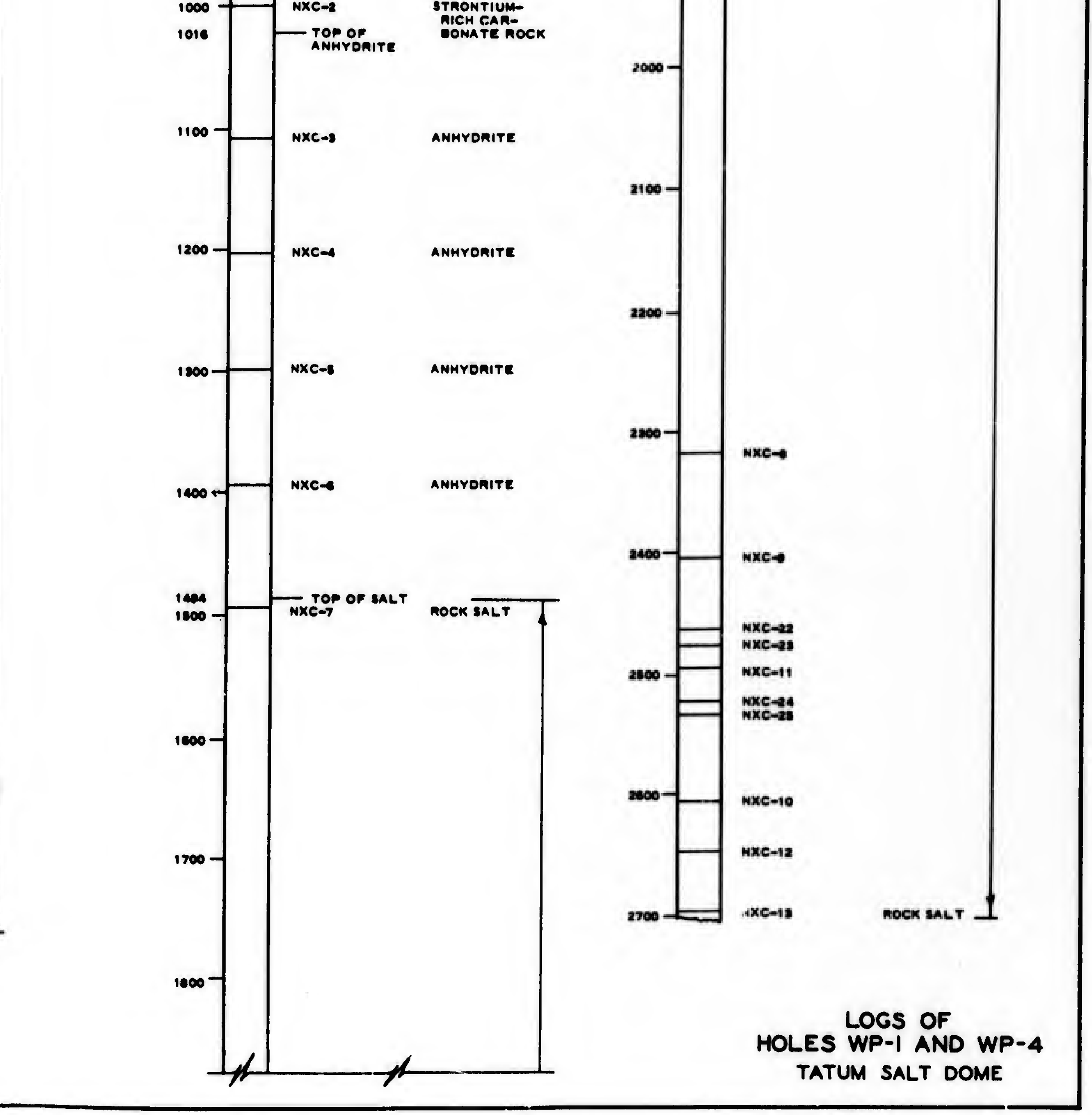
Core DC-10B. Enlarged view of left portion of fracture surface seen in photograph 8. Note the salt cube in the upper right and the striated grain surfaces in lower right and left center of picture. Aside from scattered specks of leadite (capping material), the dark areas of salt are due to lighting conditions. Magnification, × 1.3.

Photograph 9. Portion of typical fracture surface developed in salt core by failure in tension



WP-1, 78 CORES
COORDINATES, N10166.85, E8040.83
GROUND SURFACE ELEVATION,
ABOUT 270 FT ABOVE MSL
DEPTH FT
CD SERIAL NO. TAT-1-
LITHOLOGY
900
1000
NXC-14
NXC-15
LIMESTONE
STRONTIUM-RICH CAR-BONATE ROCK
1066
TOP OF ANHYDRITE
1100
NXC-16
NXC-17
ANHYDRITE
ANHYDRITE
NXC-21
ANHYDRITE
1200
NXC-19
ANHYDRITE
1300
NXC-20
ANHYDRITE
1400
NXC-18
ANHYDRITE
1500
1508.5
TOP OF SALT
DC-64
ROCK SALT
1600
DC-13
DC-14, -65, -18, -20
1700
DC-17
DC-15, -19, -66
1800
DC-16
DEPTH FT
CD SERIAL NO. TAT-1-
LITHOLOGY
1900
DC-25
DC-24, -26
2000
DC-28
DC-22
2100
DC-35, -32, -69
DC-21
DC-23, -27
2200
DC-66, -40
DC-70, -30, -1, -2, -47
DC-36, -38, -45
DC-29, -34
2300
DC-31, -42, -5, -4
2400
DC-8, -44, -41
DC-6
DC-37, -48, -8, -38
DC-43, -50, -49, -39
2500
DC-52, -51, -53
DC-54, -46, -7
DC-57, -9
DC-55
DC-56
2600
DC-58, -57, -11
DC-59
DC-60
DC-10, -63
DC-61, -62, -12
ROCK SALT
2700
PROPOSED CAVITY AREA

A



LOGS OF
HOLES WP-I AND WP-4
TATUM SALT DOME

PLATE I

B

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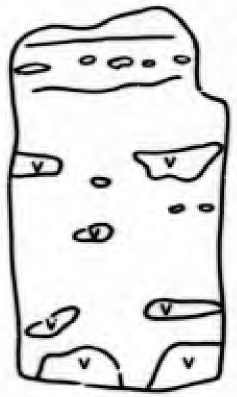
DEPTH
IN FT
1012.0



1012.3

CORE DIAMETER:
2-1/8 IN.

CORE LENGTH:
0.3 FT

COMPOSITION:
VUGGY, IRREGULARLY BEDDED CAP ROCK LIMESTONE WITH ALTERNATING HORIZONTAL BANDS (1/8 TO 1/4 IN. WIDE) OF WHITE AND BLACKISH CALCITE. VUGS ARE LINED WITH CALCITE CRYSTALS. THERE ARE NO STRONTIUM MINERALS IN THIS CORE (TABLE 3).

REMARKS:
TOP AND BOTTOM OF CORE NOT MARKED. NO SAW CUTS MADE.

TAT-1-NXC-14

DEPTH
IN FT
1020.0

1020.3

CORE DIAMETER:
2-5/8 IN. (NOT NX)

CORE LENGTH:
0.3 FT

COMPOSITION:
BUFF-COLORED, SOMEWHAT VUGGY, DENSE CARBONATE CAP ROCK WITH SCATTERED, GENERALLY HORIZONTAL BLACKISH BANDS ABOUT 1/2 IN. WIDE. X-RAY ANALYSIS SHOWS THIS CORE TO CONSIST OF CALCITE ($CaCO_3$), STRONTIANITE ($SrCO_3$), AND CELESTITE ($SrSO_4$) (TABLE 3).

REMARKS:
TOP AND BOTTOM OF CORE NOT MARKED. NO SAW CUTS MADE.

TAT-1-NXC-15

LEGEND

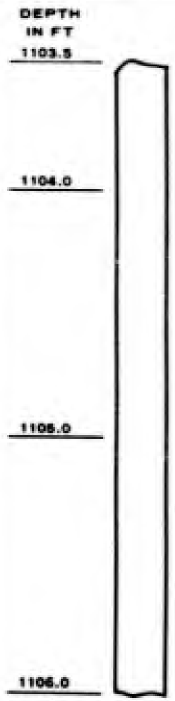
V VUGS

B DARK BANDS

PETROGRAPHIC EXAMINATION OF TATUM CORES
HOLE WP-1
CORES TAT-1-NXC-14 AND -15

PLATE 2

PLATE 3



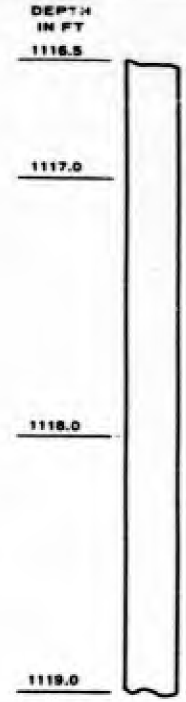
CORE DIAMETER:
2-1/8 IN.

CORE LENGTH:
2.5 FT

COMPOSITION:
FINE- TO MEDIUM-GRAINED, DENSE, MASSIVE (STRUCTURELESS), DARK GRAY TO BLUE-GRAY ANHYDRITE CAP ROCK.

REMARKS:
CORES NXC-17, -21, -19, -20, AND -18 ARE COMPOSED OF THE SAME ROCK. NO SAW CUTS MADE.

<u>TAT-I-NXC-16</u>



CORE DIAMETER:
2-1/8 IN.

CORE LENGTH:
2.5 FT

COMPOSITION:
AN ANHYDRITE CAP ROCK LIKE CORE NXC-16.

REMARKS:
NO SAW CUTS MADE.

<u>TAT-I-NXC-17</u>

PETROGRAPHIC EXAMINATION
OF TATUM CORES
HOLE WP-I
CORES TAT-I-NXC-16 AND -17

CORE DIAMETER:
2-1/8 IN.

CORE LENGTH:
2.5 FT

COMPOSITION:
FINE- TO MEDIUM-GRAINED, DENSE, MASSIVE (STRUCTURELESS), DARK GRAY TO BLUE-GRAY ANHYDRITE CAP ROCK LIKE CORE NXC-16.

REMARKS:
X-RAY ANALYSIS SHOWS THE CORE TO BE COMPOSED OF ANHYDRITE WITH TRACE AMOUNTS OF CALCITE AND DOLOMITE (TABLE 3).

TAT-I-NXC-21

CORE DIAMETER:
2-1/8 IN.

CORE LENGTH:
2.3 FT

COMPOSITION:
ANHYDRITE CAP ROCK LIKE CORE NXC-16. X-RAY ANALYSIS SHOWS THIS CORE TO BE COMPOSED OF ANHYDRITE WITH TRACE AMOUNTS OF CALCITE AND DOLOMITE (TABLE 3).

TAT-I-NXC-19

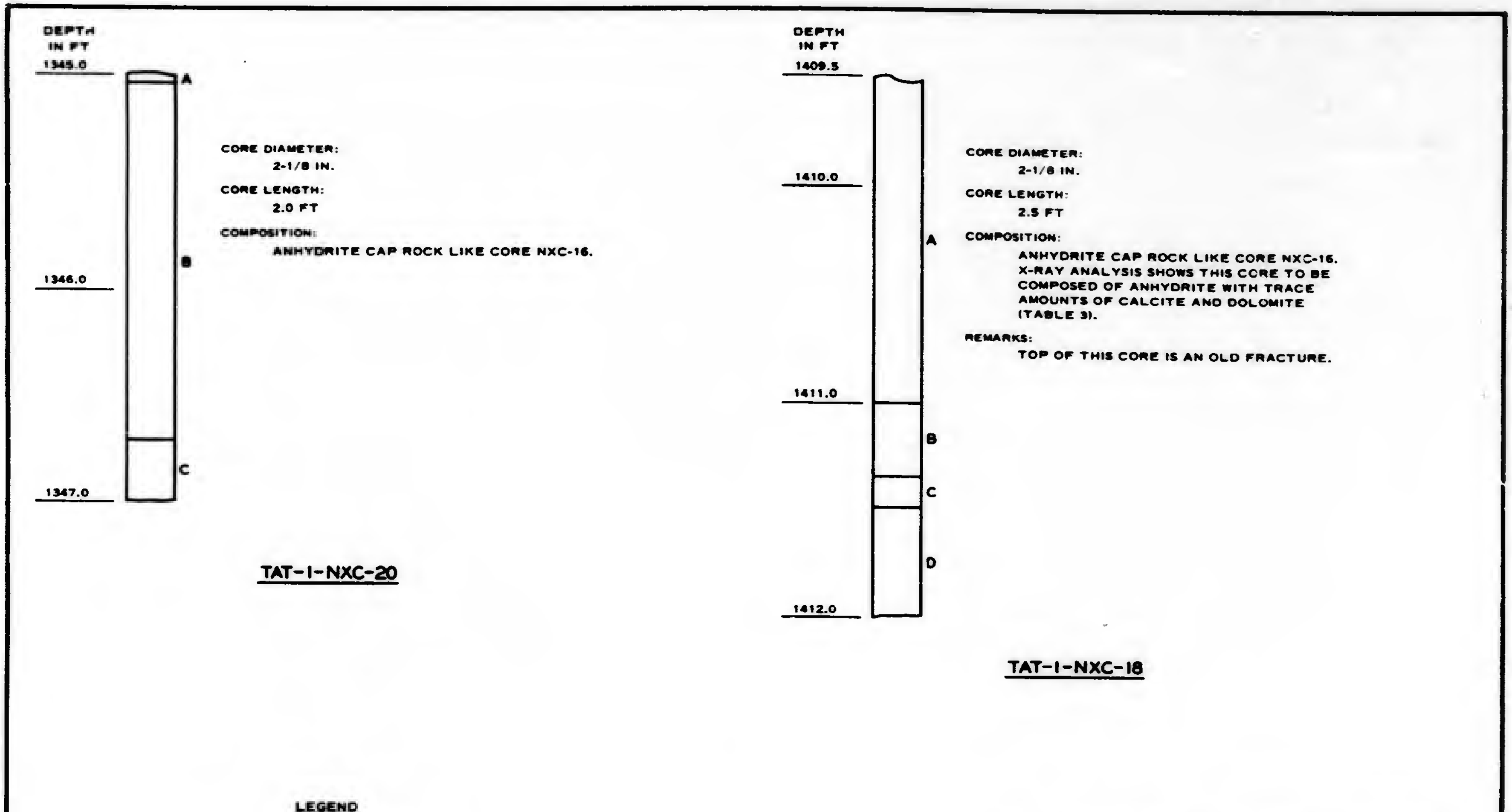
LEGEND

——— SAW CUT

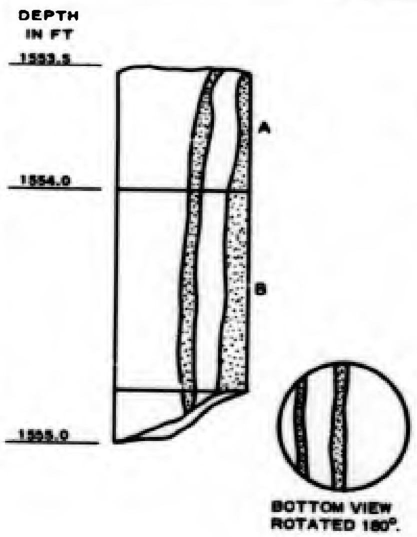
PETROGRAPHIC EXAMINATION OF TATUM CORES
HOLE WP-I
CORES TAT-I-NXC-21 AND -19

PLATE 4

PLATE 5



PETROGRAPHIC EXAMINATION OF TATUM CORES
HOLE WP-1
CORES TAT-1-NXC-20 AND -18



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.96 FT

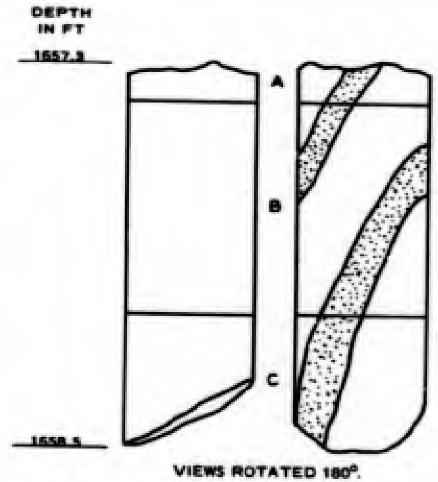
COMPOSITION:
MASSIVE ROCK SALT CONSISTING OF HALITE WITH ANHYDRITE AS IMPURITY. 8.76 PERCENT INSOLUBLE RESIDUE (TABLE 1). THE PURE SALT (HALITE) IS TRANSPARENT OR TRANSLUCENT (WHITE). THE IMPURE SALT OCCURS AS THIN, STEEPLY DIPPING, GRAY BANDS COMPOSED OF HALITE AND ANHYDRITE. THE BANDS RANGE IN THICKNESS FROM A FRACTION OF AN INCH UP TO SEVERAL INCHES. MOST OF THE ANHYDRITE OCCURS IN THESE GRAY BANDS AS TINY (<1 MM) DISCRETE CRYSTALS.

TEXTURE:
HALITE GRAINS UP TO 1 IN. IN MAXIMUM DIMENSION; GRAIN BOUNDARIES ARE TIGHT.

STRUCTURE:
GRAY ANHYDRITIC STREAKS ARE VERTICAL.

REMARKS:
HEAVILY ETCHED OUTER SURFACE. CANNOT TELL GRAIN SIZE ON CORE SURFACE OR MUCH ABOUT GRAIN DIP. TOP AND BOTTOM SAWED, FRACTURED.

TAT-1-DC-64



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.3 FT

COMPOSITION:
DENSE, MASSIVE ROCK SALT WITH ANHYDRITE IMPURITY. INSOLUBLE RESIDUE, 3.97 PERCENT (TABLE 1). APPEARANCE LIKE CORE DC-64 (PRECEDING ONE).

TEXTURE:
MAXIMUM GRAIN DIMENSION IN HALITE 1 IN. AVERAGE 1/4 TO 1/2 IN.

REMARKS:
TOP AND BOTTOM HAVE FRESH BUT DIRTY FRACTURES.

TAT-1-DC-13

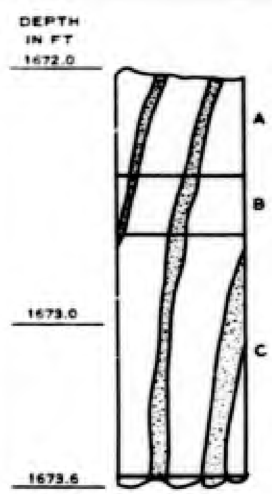
LEGEND

PURE SALT
IMPURE SALT
SAW CUT

PETROGRAPHIC EXAMINATION OF TATUM CORES
HOLE WP-1
CORES TAT-1-DC-64 AND -13

PLATE 6

PLATE 7



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.6 FT

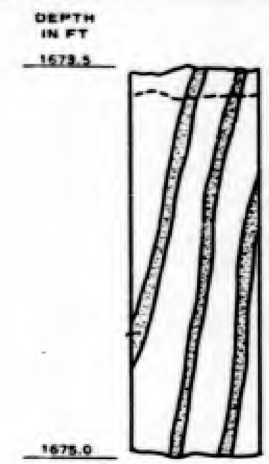
COMPOSITION:
MASSIVE ROCK SALT WITH A SMALL AMOUNT OF ANHYDRITE AS IMPURITY. THE HALITE IS CLEAR OR TRANSLUCENT (WHITE). THE ANHYDRITE IS CONCENTRATED IN NARROW, GRAY, STEEPLY DIPPING STREAKS.

TEXTURE:
HALITE GRAINS UP TO 1 IN. IN MAXIMUM DIMENSION; THE AVERAGE SIZE IS 1/4 TO 1/2 IN.

STRUCTURE:
THE GRAY ANHYDRITIC STREAKS ARE ALMOST VERTICAL.

REMARKS:
TOP AND BOTTOM OF CORE ARE FRESH FRACTURES.

TAT-1-DC-14



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.67 FT

COMPOSITION:
MASSIVE ROCK SALT, CONTAINING ANHYDRITE IMPURITY; INSOLUBLE RESIDUE OF 7.39 PERCENT (TABLE 1). ROCK LIKE THAT OF OTHER SALT CORES FROM HOLE IN APPEARANCE.

STRUCTURE:
GRAY ANHYDRITIC STREAKS DIP STEEPLY.

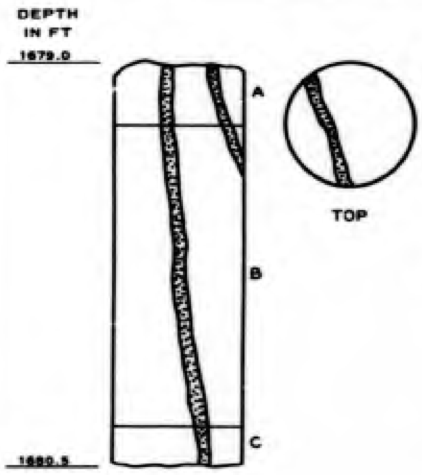
REMARKS:
TOP FRACTURED OR ROTATED, THEN HEAVILY ETCHED. ETCHED GROOVE INDICATED NEAR TOP. BOTTOM HAS A FRESHER FRACTURE BUT ETCHED SOMEWHAT. OUTER SURFACE OF CORE HEAVILY ETCHED. NO SAW CUTS MADE.

TAT-1-DC-65

LEGEND

- PURE SALT
- IMPURE SALT
- SAW CUT
- ETCHED GROOVE

PETROGRAPHIC EXAMINATION OF TATUM CORES
HOLE WP-1
CORES TAT-1-DC-14 AND -65



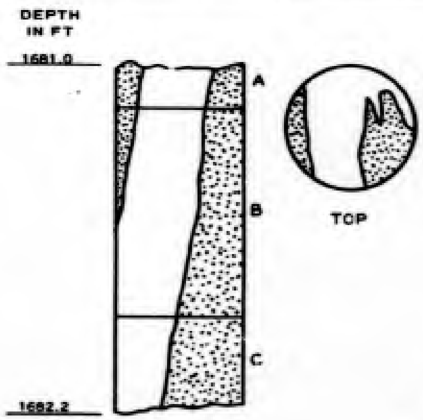
CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.5 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES FROM HOLE.

TEXTURE:
MAXIMUM GRAIN SIZE OF HALITE UP TO 1-1/8 IN.; MEAN 1/4 TO 1/2 IN.

TAT-I-DC-18



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.2 FT

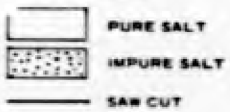
COMPOSITION:
MASSIVE ROCK SALT WITH ANHYDRITE IMPURITY. INSOLUBLE RESIDUE OF 21.98 PERCENT (TABLE 1). COMPOSITION OF INSOLUBLE RESIDUE BY X-RAY ANALYSIS WAS ANHYDRITE WITH TRACE AMOUNTS OF CALCITE, DOLOMITE, AND AMORPHOUS IRON OXIDE (TABLE 3). ROCK LIKE THAT OF OTHER SALT CORES FROM HOLE IN APPEARANCE.

TEXTURE:
MAXIMUM GRAIN SIZE OF HALITE WAS 1 IN.; AVERAGE WAS 1/4 TO 1/2 IN.

STRUCTURE:
THE GRAY BANDS OF ANHYDRITE SALT WERE DIPPING ALMOST VERTICALLY.

TAT-I-DC-20

LEGEND



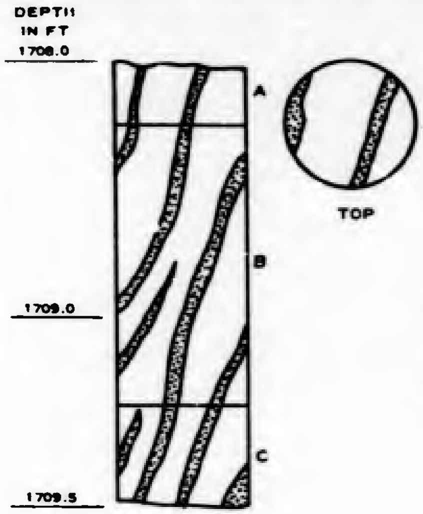
PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-I

CORES TAT-I-DC-18 AND -20

PLATE 8

PLATE 9



CORE DIAMETER:
4-15/16 IN.

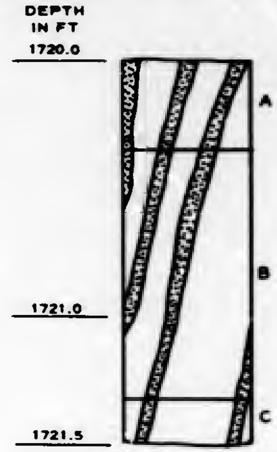
CORE LENGTH:
1.5 FT

COMPOSITION:
MASSIVE ROCK SALT WITH A FEW PERCENT OF ANHYDRITE. THE ANHYDRITE IS CONCENTRATED IN THIN, GRAY STEEPLY DIPPING STREAKS. THE HALITE IS CLEAR OR TRANSLUCENT (WHITE).

TEXTURE:
HALITE GRAINS UP TO 1-IN. MAXIMUM DIMENSION; AVERAGE SIZE WAS 1/4 TO 1/2 IN.

STRUCTURE:
THE GRAY ANHYDRITIC STREAKS DIP STEEPLY AND WITH SOME VARIATION.

TAT-1-DC-17



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.5 FT

COMPOSITION:
MASSIVE ROCK SALT WITH ANHYDRITE IMPURITY; INSOLUBLE RESIDUE OF 7.72 PERCENT (TABLE 1). APPEARANCE OF ROCK LIKE CORE DC-17

TEXTURE:
MAXIMUM GRAIN SIZE OF HALITE WAS 1 IN.; THE AVERAGE SIZE WAS 1/4 TO 1/2 IN.

STRUCTURE:
VERY STEEP DIP TO GRAY ANHYDRITIC BANDS.

REMARKS:
TOP AND BOTTOM SAWED WHEN RECEIVED. CANNOT TELL TOP FROM BOTTOM.

TAT-1-DC-15

LEGEND

PURE SALT

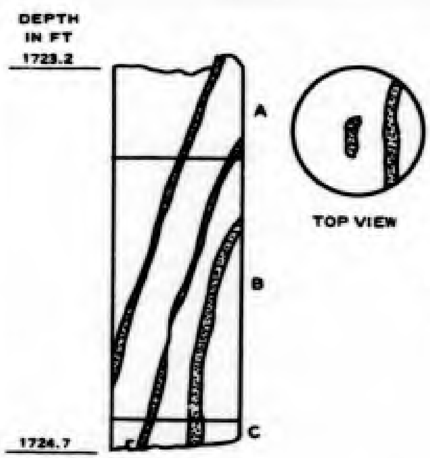
IMPURE SALT

SAW CUT

PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-1

CORES TAT-1-DC-17 AND -15



CORE DIAMETER:
4-15/16 IN.

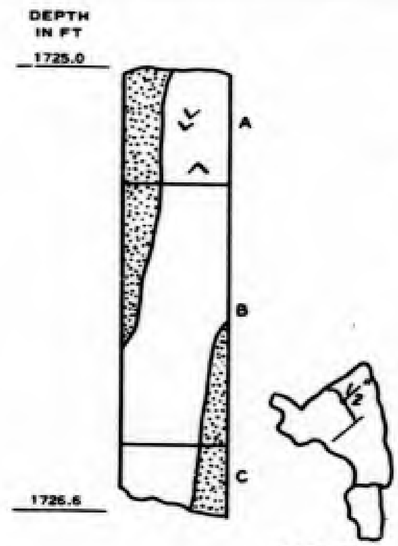
CORE LENGTH:
1.5 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES FROM HOLE.

TEXTURE:
FINER GRAINED THAN DC-15.

STRUCTURE:
STEEPLY DIPPING GRAY ANHYDRITE BANDS.

TAT-I-DC-19



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.7 FT

COMPOSITION:
MASSIVE ROCK SALT WITH ESTIMATED 3 PERCENT OF ANHYDRITE. APPEARANCE OF ROCK LIKE DC-19.

TEXTURE:
RANGE OF GRAIN SIZE OF HALITE ABOUT 1/4 TO 3/4 IN.; AVERAGE SIZE ABOUT 1/4 TO 3/8 IN.

STRUCTURE:
STEEP DIP OF GRAY ANHYDRITIC SALT IS VISIBLE.

REMARKS:
A LOT OF DEVELOPMENT OF CUBE FACE DIRECTIONS AT 45° TO 60° TO LONG AXIS OF CORE IN THE HALITE.

TAT-I-DC-68

LEGEND

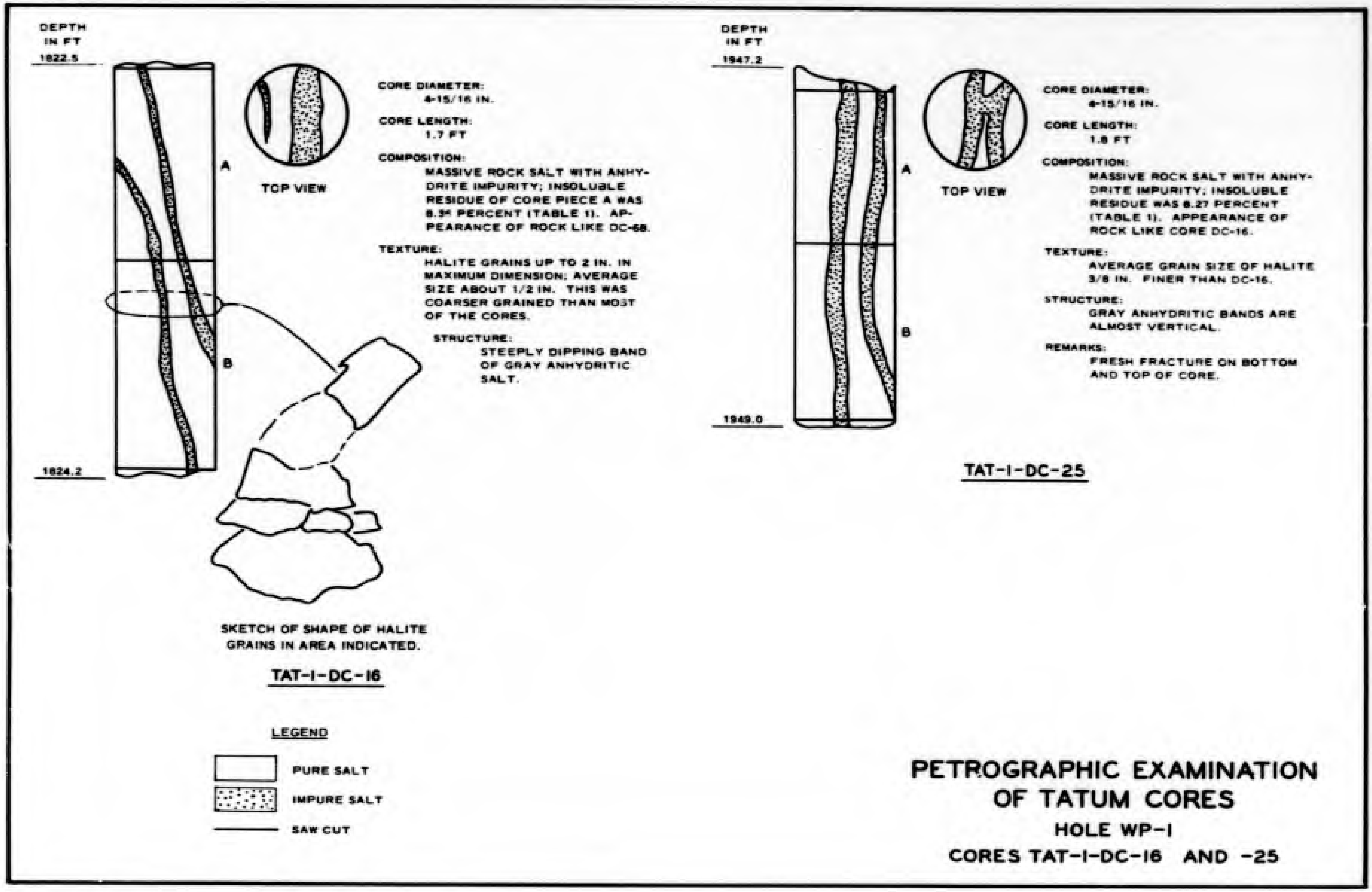
- PURE SALT
- IMPURE SALT
- SAW CUT
- ^ v FRACTURE

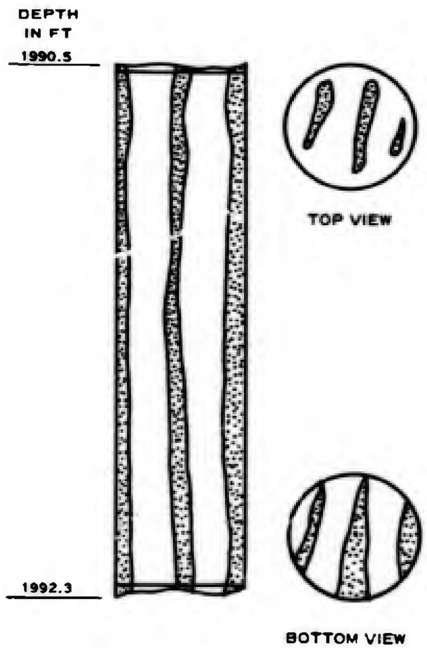
PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-I

CORES TAT-I-DC-19 AND -68

PLATE II


DEPTH
IN FT
1822.5
1824.2
A
B
TOP VIEW
CORE DIAMETER:
4-15/16 IN.
CORE LENGTH:
1.7 FT
COMPOSITION:
MASSIVE ROCK SALT WITH ANHYDRITE IMPURITY; INSOLUBLE RESIDUE OF CORE PIECE A WAS 8.34 PERCENT (TABLE 1). APPEARANCE OF ROCK LIKE DC-68.
TEXTURE:
HALITE GRAINS UP TO 2 IN. IN MAXIMUM DIMENSION; AVERAGE SIZE ABOUT 1/2 IN. THIS WAS COARSER GRAINED THAN MOST OF THE CORES.
STRUCTURE:
STEEPLY DIPPING BAND OF GRAY ANHYDRITIC SALT.
SKETCH OF SHAPE OF HALITE GRAINS IN AREA INDICATED.
TAT-1-DC-16
DEPTH
IN FT
1947.2
1949.0
A
B
TOP VIEW
CORE DIAMETER:
4-15/16 IN.
CORE LENGTH:
1.8 FT
COMPOSITION:
MASSIVE ROCK SALT WITH ANHYDRITE IMPURITY; INSOLUBLE RESIDUE WAS 8.27 PERCENT (TABLE 1). APPEARANCE OF ROCK LIKE CORE DC-16.
TEXTURE:
AVERAGE GRAIN SIZE OF HALITE 3/8 IN. FINER THAN DC-16.
STRUCTURE:
GRAY ANHYDRITIC BANDS ARE ALMOST VERTICAL.
REMARKS:
FRESH FRACTURE ON BOTTOM AND TOP OF CORE.
TAT-1-DC-25
LEGEND
PURE SALT
IMPURE SALT
SAW CUT
PETROGRAPHIC EXAMINATION OF TATUM CORES
HOLE WP-1
CORES TAT-1-DC-16 AND -25



CORE DIAMETER:
4-15/16 IN.

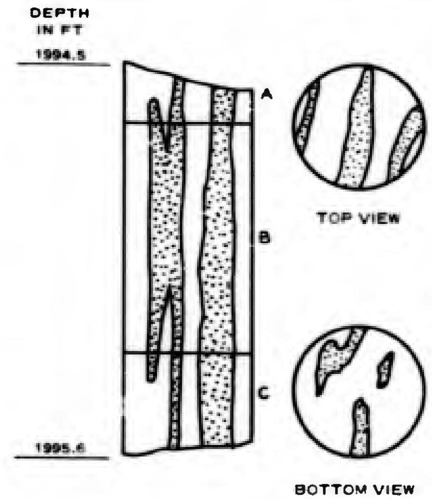
CORE LENGTH:
1.8 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES FROM HOLE.

TEXTURE:
HALITE GRAIN SIZE RANGED FROM 1/8 TO 1/2 IN.; AVERAGE WAS ABOUT 3/16 IN.

STRUCTURE:
GRAY ANHYDRITIC BANDS ARE VERTICAL.

TAT-1-DC-24



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.35 FT

COMPOSITION:
MASSIVE ROCK SALT WITH ANHYDRITE IMPURITY; INSOLUBLE RESIDUE WAS 9.42 PERCENT (TABLE 1). APPEARANCE OF ROCK LIKE CORE DC-24.

REMARKS:
SIMILAR TO PREVIOUS CORES.

TAT-1-DC-26

LEGEND

PURE SALT
IMPURE SALT
SAW CUT

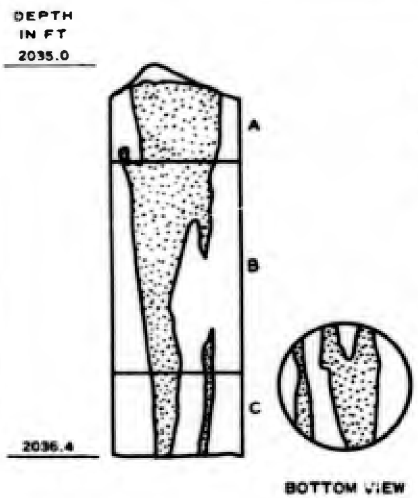
PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-1

CORES TAT-1-DC-24 AND -26

PLATE 12

PLATE 13



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.4 FT

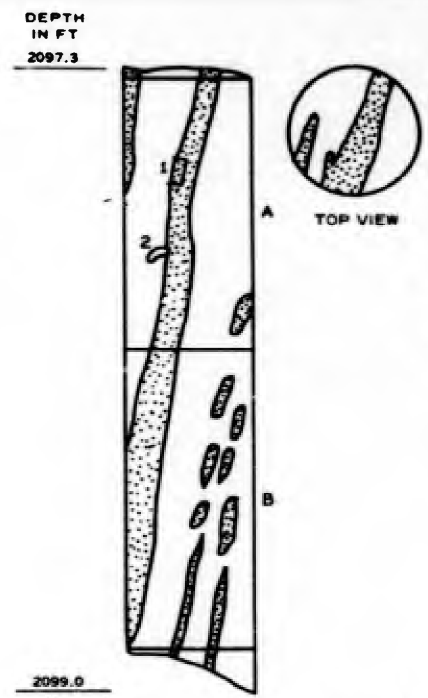
COMPOSITION:
MASSIVE ROCK SALT WITH ANHYDRITE IMPURITY. INSOLUBLE RESIDUE WAS 17.48 PERCENT (TABLE 1). APPEARANCE OF ROCK LIKE THAT OF OTHER SALT CORES FROM HOLE.

TEXTURE:
HALITE GRAINS UP TO 1-1/4 IN. IN SIZE; AVERAGE SIZE WAS 3/8 IN.

STRUCTURE:
RAGGED GRAY ANHYDRITIC BANDS DIPPING VERTICALLY.

REMARKS:
TOP WAS WORN ON FRACTURE.

TAT-I-DC-28



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.7 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES FROM HOLE.

STRUCTURE:
NEAR VERTICAL DIP OF GRAY ANHYDRITIC BANDS.

REMARKS:
1 AND 2 ARE LARGE CRYSTALS. IMPURE ANHYDRITIC SPOTS ON RIGHT SIDE OF CORE ARE ABOUT 1/2 IN. IN MAXIMUM DIMENSION.

TAT-I-DC-22

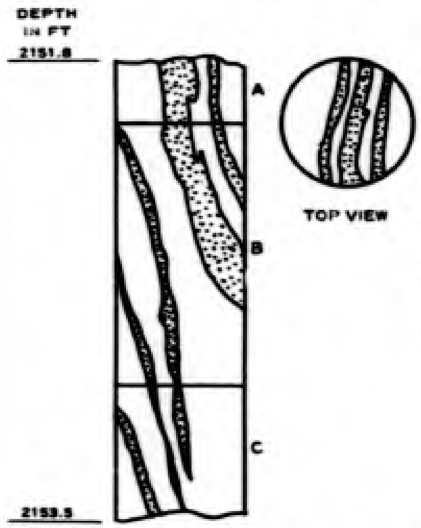
LEGEND

PURE SALT
IMPURE SALT
SAW CUT

PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-I

CORES TAT-I-DC-28 AND -22



CORE DIAMETER:
4-15/16 IN.

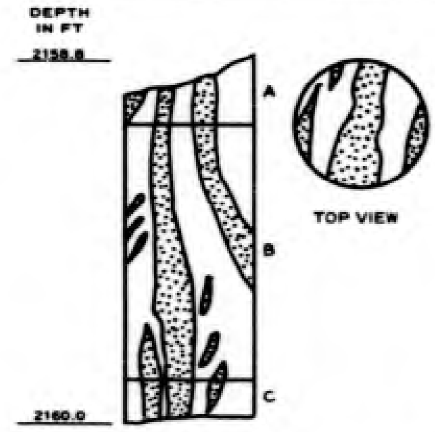
CORE LENGTH:
1.4 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES FROM HOLE.

TEXTURE:
HALITE GRAINS UP TO 1 IN. IN SIZE; USUAL SIZE 1/4 TO 1/2 IN.

STRUCTURE:
GRAY ANHYDRITIC BANDS ARE DIPPING STEEPLY.

<u>TAT-I-DC-33</u>



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.2 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES FROM HOLE.

<u>TAT-I-DC-32</u>

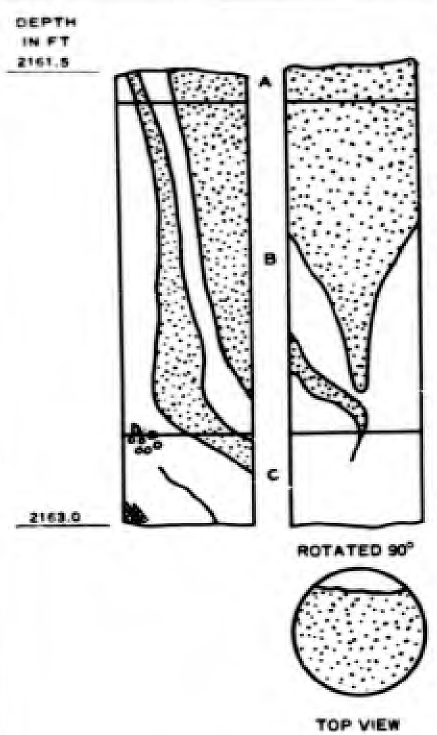
<u>LEGEND</u>

PURE SALT
IMPURE SALT
SAW CUT

PETROGRAPHIC EXAMINATION
OF TATUM CORES
HOLE WP-I
CORES TAT-I-DC-33 AND -32

PLATE 14

PLATE 15



TAT-1-DC-69

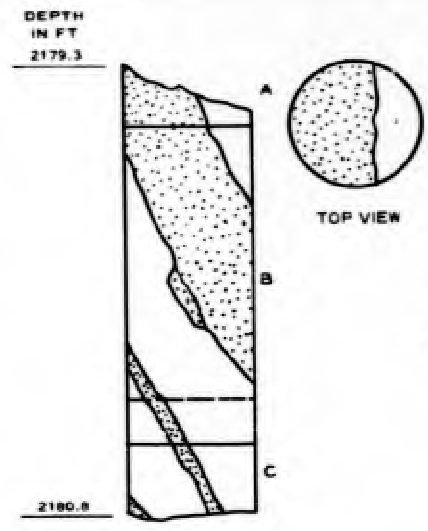
CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.5 FT

COMPOSITION:
MASSIVE ROCK SALT WITH ESTIMATED 5 PERCENT ANHYDRITE. APPEARANCE OF ROCK LIKE THAT IN OTHER SALT CORES FROM THIS HOLE.

TEXTURE:
HALITE GRAINS RANGE FROM 1/16 TO 1-1/2 IN. IN SIZE; MOST GRAINS IN THE PURE SALT ARE 3/8 BY 1/2 IN., OR 1/4 BY 3/8 IN. IN SIZE; THEIR MAJOR AXIS TENDS TO DIP LESS THAN THE DIP OF THE GRAY ANHYDRITIC BANDS. THE SIZE OF MOST HALITE GRAINS IN THE GRAY ANHYDRITIC BANDS IS ABOUT 1/8 IN.

REMARKS:
EXTERIOR OF CORE ETCHED. CRACK SHOWN AT BOTTOM WITH BRUISE AT LEFT BOTTOM OF LEFT VIEW.



TAT-1-DC-21

CORE DIAMETER:
4-15/16 IN.

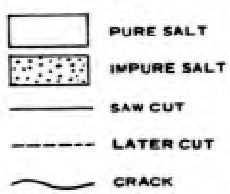
CORE LENGTH:
1.5 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.

TEXTURE:
MAXIMUM GRAIN SIZE OF HALITE UP TO 3/4 IN.

STRUCTURE:
SHOWN BY DIP OF GRAY ANHYDRITIC BANDS.

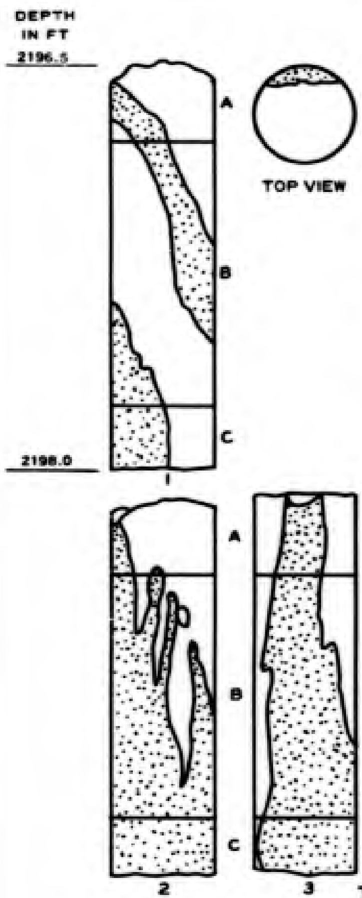
LEGEND



PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-1

CORES TAT-1-DC-69 AND -21



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.55 FT MAX

COMPOSITION:
MASSIVE ROCK SALT WITH ANHYDRITE IMPURITY; INSOLUBLE RESIDUE OF 3.08 PERCENT (TABLE 1). ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.

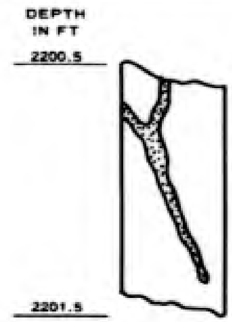
STRUCTURE:
GRAY ANHYDRITIC BANDS DIPPING ABOUT 60°.

REMARKS:
2 IS A 90° ROTATION TO THE RIGHT. 3 IS ANOTHER 90° ROTATION TO THE RIGHT.

TAT-I-DC-23

LEGEND

PURE SALT
IMPURE SALT
SAW CUT



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.3 FT

COMPOSITION:
QUITE PURE, CLEAR, MASSIVE ROCK SALT; THERE IS SOME ANHYDRITE IN ONE GRAY STREAK IN CORE.

TEXTURE:
MAXIMUM DIAMETER OF HALITE GRAINS IS MORE THAN 3 IN.; THE AVERAGE MAXIMUM GRAIN SIZE IS ABOUT 1/4 IN. HALITE GRAINS ARE ANHEDRAL WITH IRREGULAR BOUNDARIES. THE HALITE GRAIN SIZE IS MORE LIKE THAT IN CORE DC-16 THAN ANY OF THE OTHER CORES FROM HIGHER IN THE HOLE.

STRUCTURE:
THE FAINT GRAY BAND OF ANHYDRITIC SALT DIPS ABOUT 60°.

REMARKS:
NO SAW CUTS MADE. THE AREAS CONTAINING THE LARGEST HALITE GRAINS SHOW SOME CLEAVAGE TRACES OR ROWS PARALLEL TO CORE AXIS.

TAT-I-DC-27

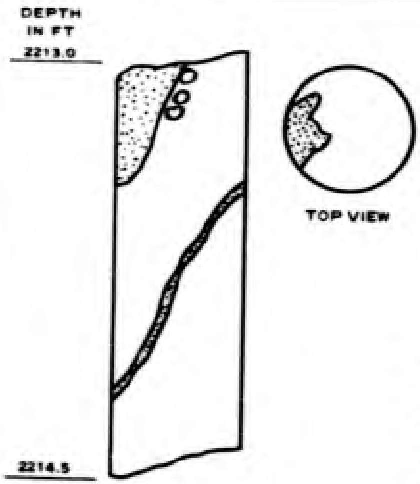
PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-I

CORES TAT-I-DC-23 AND -27

PLATE 16

PLATE 17



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.60 TO 1.62 FT

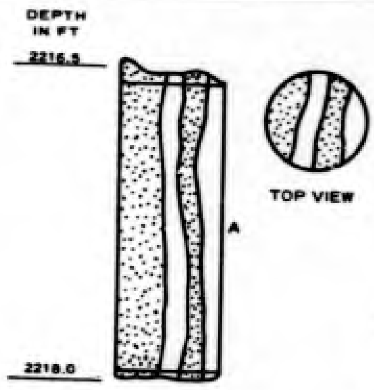
COMPOSITION:
MASSIVE ROCK SALT WITH SMALL AMOUNT OF ANHYDRITE IMPURITY. THE CLEAR HALITE WAS ESTIMATED TO CONTAIN 1 PERCENT ANHYDRITE. THE GRAY ANHYDRITIC SALT STREAKS WERE ESTIMATED TO CONTAIN ABOUT 2 PERCENT ANHYDRITE.

TEXTURE:
MAXIMUM GRAIN SIZE OF HALITE WAS ABOUT 1-1/2 IN.

STRUCTURE:
GRAY ANHYDRITIC STREAKS DIP ABOUT 60°.

REMARKS:
CORE IS GENERALLY VERY WHITE AND TRANSPARENT. FRES- RACTURE ON TOP; HACKED AND BROKEN ON BOTTOM. NO SAW CUTS MADE.

TAT-I-DC-66



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.25 FT

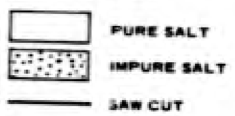
COMPOSITION:
MASSIVE ROCK SALT WITH SMALL AMOUNT OF ANHYDRITE IMPURITY. THE HALITE WAS CLEAR OR TRANSLUCENT (WHITE); THE ANHYDRITE WAS CONCENTRATED IN THIN, GRAY, STEEPLY DIPPING BANDS.

TEXTURE:
AVERAGE GRAIN SIZE OF HALITE WAS 3/16 IN.; MAXIMUM SIZE WAS 3/8 IN.

STRUCTURE:
VERTICAL DIP SHOWN BY GRAY ANHYDRITIC STREAKS.

TAT-I-DC-40

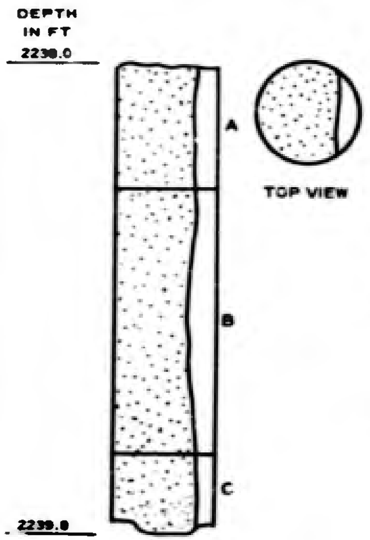
LEGEND



PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-I

CORES TAT-I-DC-66 AND -40



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.83 FT

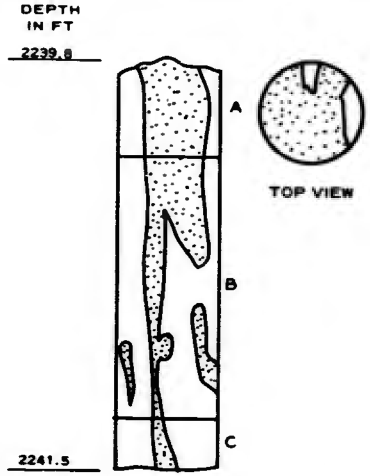
COMPOSITION:
MASSIVE ROCK SALT WITH ESTIMATED 10 PERCENT ANHYDRITE.

TEXTURE:
ANHEDRAL HALITE GRAINS UP TO 1/2 IN. MOST ARE 1/4 IN.

STRUCTURE:
VERTICAL CONTACT BETWEEN PURE AND IMPURE SALT. CORE IS DENSE AND DIRTY SO THAT STRUCTURE IS DIFFICULT TO SEE.

REMARKS:
UNBROKEN CORE COMPOSED OF PURE AND IMPURE ROCK SALT. THE PURE ZONE IS WHITE AND TRANSLUCENT. THE IMPURE ZONE IS LIGHT GRAY AND MORE OPAQUE; THE ANHYDRITE GRAINS ARE THOROUGHLY DISSEMINATED THROUGH IT. DENSE, MASSIVE, UNFRACTURED MATERIAL. CORE ENDS MARKED.

TAT-I-DC-70



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.77 FT MAX

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES.

TEXTURE:
AVERAGE HALITE GRAIN SIZE 3/16 IN.; MAXIMUM SIZE 3/8 IN.

TAT-I-DC-30

LEGEND

PURE SALT

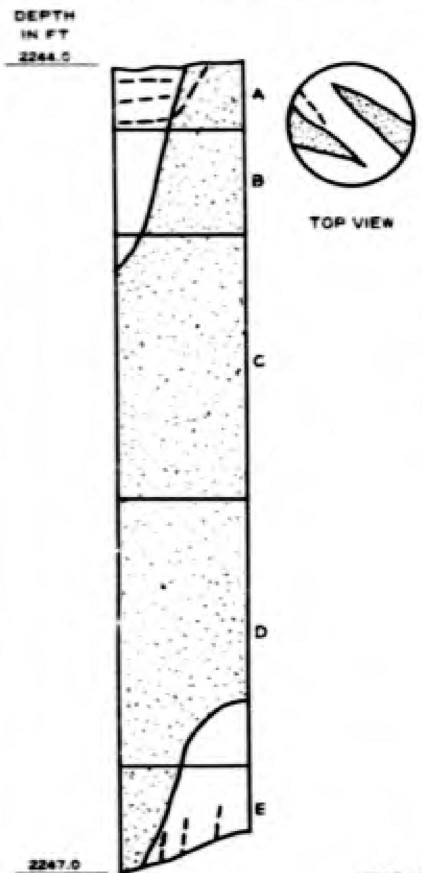
IMPURE SALT

SAW CUT

PETROGRAPHIC EXAMINATION
OF TATUM CORES
HOLE WP-I
CORES TAT-I-DC-70 AND -30

PLATE 18

PLATE 19



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
3.15 FT

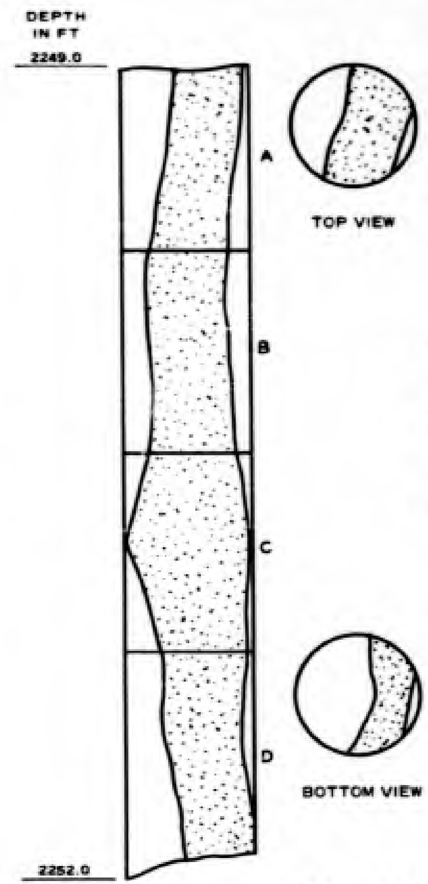
COMPOSITION:
MASSIVE ROCK SALT WITH SMALL AMOUNT OF ANHYDRITE IMPURITY. ROCK LIKE CORE DC-2.

TEXTURE:
HALITE GRAIN SIZE RANGING FROM 1/8 TO 3/4 IN.

STRUCTURE:
NO STRUCTURE SHOWS THROUGH MUD COATING EXCEPT AS SHOWN.

REMARKS:
HALITE AND ANHYDRITE DENSE, MASSIVE, AND UNFRACTURED EXCEPT AS SHOWN ON TOP AND BOTTOM. BOTTOM IS FRACTURED, SMOOTHED, AND ABRADED BY ROTATING ON CORE BELOW; BOTTOM OF A PULL PROBABLY. SOME ETCHING, POSSIBLY BY MUD IN HALITE.

TAT-I-DC-I



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
3.15 FT

COMPOSITION:
MASSIVE ROCK SALT WITH ANHYDRITE IMPURITY. THE HALITE IS CLEAR OR TRANSLUCENT. THE AREAS OF IMPURE SALT (ANHYDRITIC) ARE GRAY AND SOMEWHAT OPAQUE. INSOLUBLE RESIDUE OF CORE WAS 8.66 PERCENT (TABLE 1).

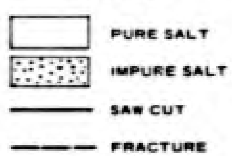
TEXTURE:
GRAIN SIZE, JUDGED FROM ENDS, IS 1/8-IN. TO 5/8-IN. MAXIMUM DIMENSION OF HALITE.

STRUCTURE:
NO STRUCTURE SHOWS THROUGH MUD COATING EXCEPT AS INDICATED.

REMARKS:
BOTH HALITE AND ANHYDRITE ARE DENSE, MASSIVE, AND UNFRACTURED EXCEPT AS SHOWN. TOP AND BOTTOM HAVE FRESH FRACTURES. CORE ENDS MARKED.

TAT-I-DC-2

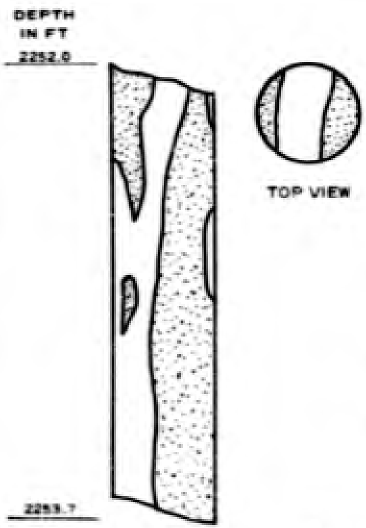
LEGEND



PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-I

CORES TAT-I-DC-I AND -2



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.7 FT

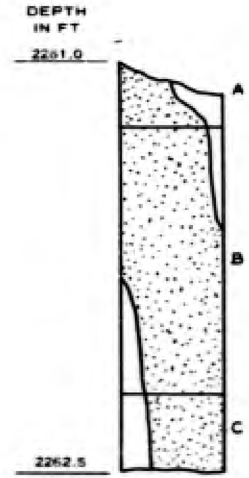
COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.

TEXTURE:
HALITE GRAIN SIZE UP TO 3/4 IN. AND AVERAGE IS ABOUT 3/8 IN. IN PURE SALT AREAS.

STRUCTURE:
NEAR VERTICAL, GRAY ANHYDRITIC BANDS.

REMARKS:
NO SAW CUTS MADE.

TAT-I-DC-47



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.6 FT MAX

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE, BUT WITH MORE ANHYDRITE (INDICATED BY COPE BEING MORE OPAQUE).

TEXTURE:
AVERAGE HALITE GRAIN SIZE (MAX DIMENSION) WAS ABOUT 1/4 IN.

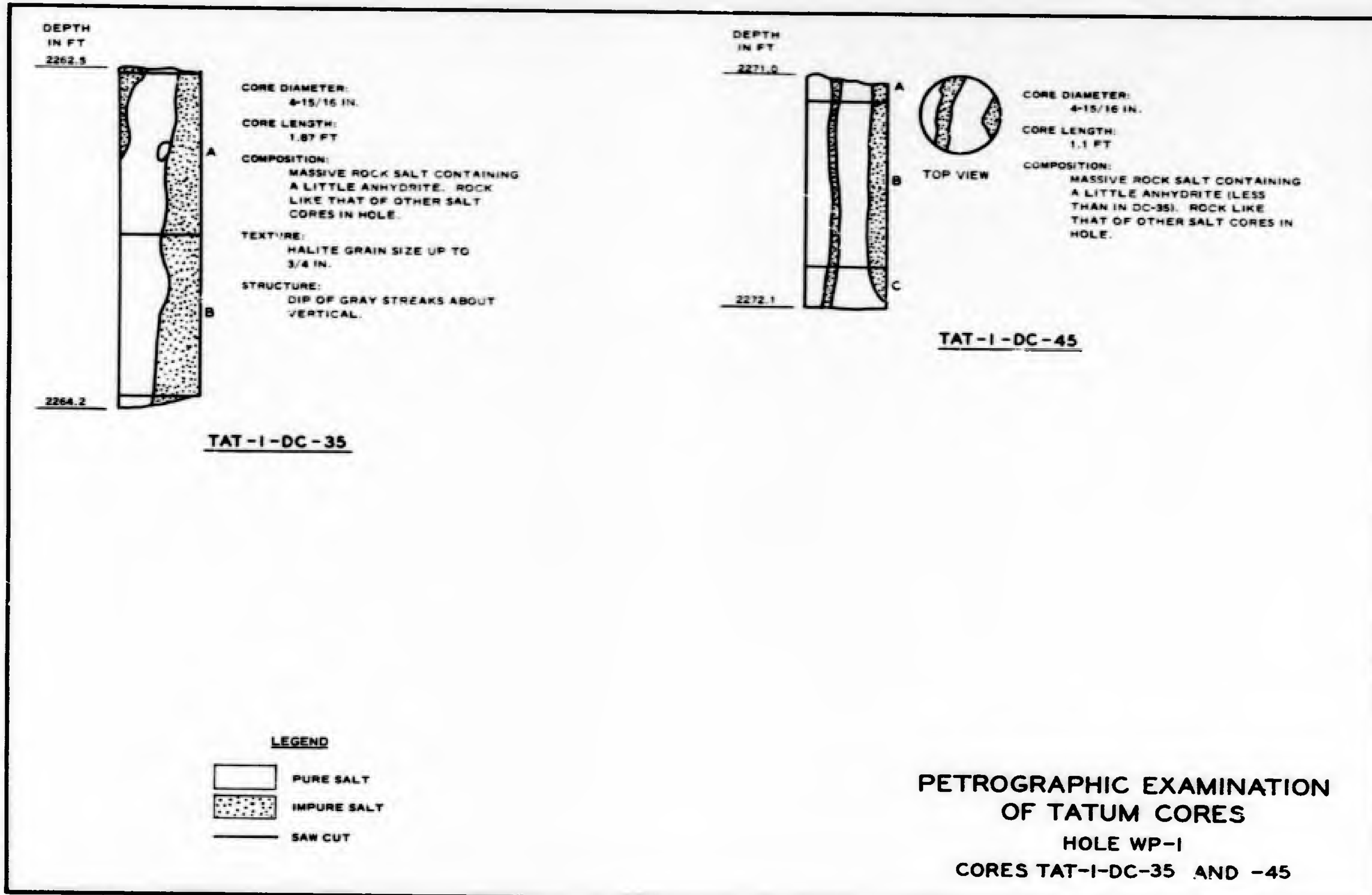
TAT-I-DC-36

PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-I

CORES TAT-I-DC-47 AND -36

PLATE 21


DEPTH
IN FT
2262.5
2264.2
A
B
CORE DIAMETER:
4-15/16 IN.
CORE LENGTH:
1.87 FT
COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.
TEXTURE:
HALITE GRAIN SIZE UP TO 3/4 IN.
STRUCTURE:
DIP OF GRAY STREAKS ABOUT VERTICAL.
TAT-1-DC-35
DEPTH
IN FT
2271.0
2272.1
A
B
C
TOP VIEW
CORE DIAMETER:
4-15/16 IN.
CORE LENGTH:
1.1 FT
COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE (LESS THAN IN DC-35). ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.
TAT-1-DC-45
LEGEND
PURE SALT
IMPURE SALT
SAW CUT
PETROGRAPHIC EXAMINATION
OF TATUM CORES
HOLE WP-1
CORES TAT-1-DC-35 AND -45

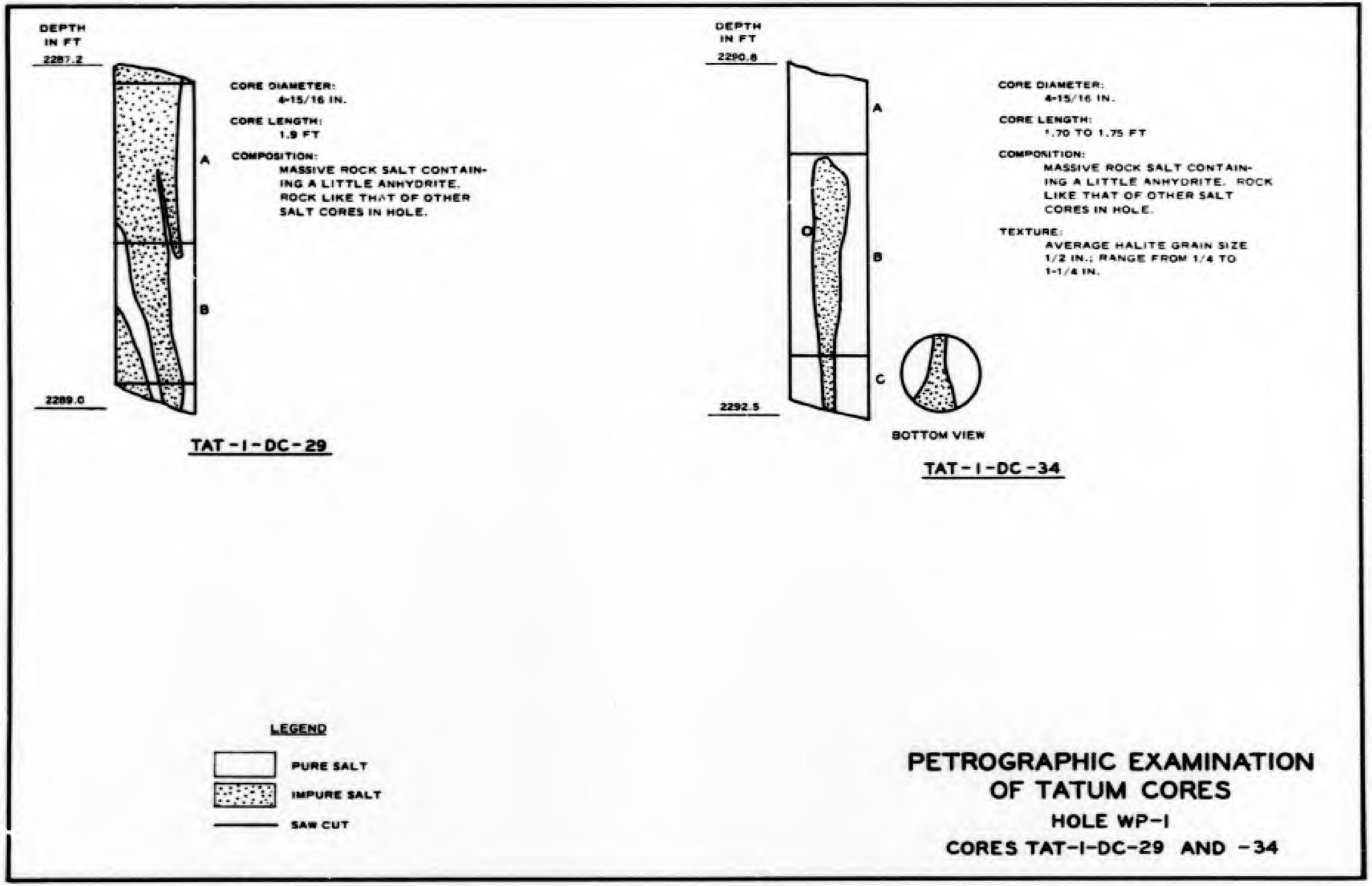
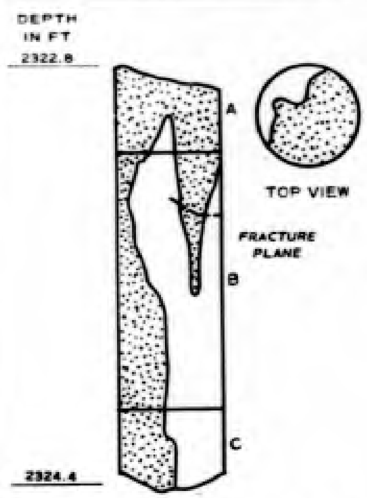

DEPTH
IN FT
2287.2
2289.0
A
B
CORE DIAMETER:
4-15/16 IN.
CORE LENGTH:
1.9 FT
COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.
TAT-I-DC-29
DEPTH
IN FT
2290.8
2292.5
A
B
C
D
BOTTOM VIEW
CORE DIAMETER:
4-15/16 IN.
CORE LENGTH:
1.70 TO 1.75 FT
COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.
TEXTURE:
AVERAGE HALITE GRAIN SIZE 1/2 IN.; RANGE FROM 1/4 TO 1-1/4 IN.
TAT-I-DC-34
LEGEND
PURE SALT
IMPURE SALT
SAW CUT
PETROGRAPHIC EXAMINATION
OF TATUM CORES
HOLE WP-I
CORES TAT-I-DC-29 AND -34

PLATE 22

PLATE 23



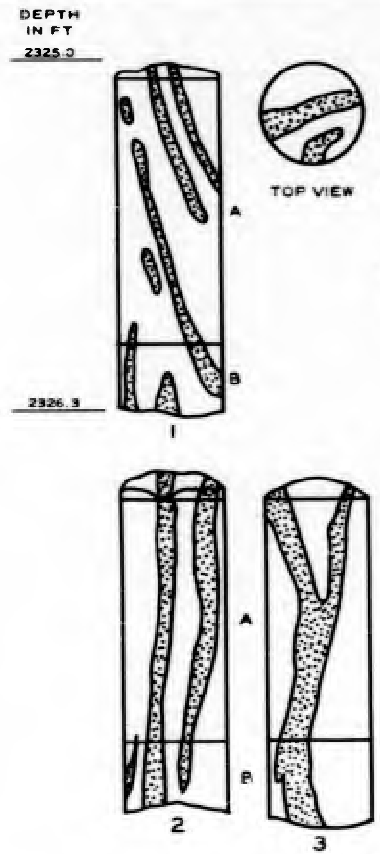
CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.54 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A FEW PERCENT ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.

TEXTURE:
AVERAGE HALITE GRAIN SIZE 1/2 IN. LONG AXIS OF HALITE GRAINS DIPS ABOUT 60°.

TAT-1-DC-31



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.3 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A FEW PERCENT ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.

REMARKS:
VIEW 2 IS A ROTATION OF 90° TO THE RIGHT OF VIEW 1. VIEW 3 IS ANOTHER 90° ROTATION.

TAT-1-DC-42

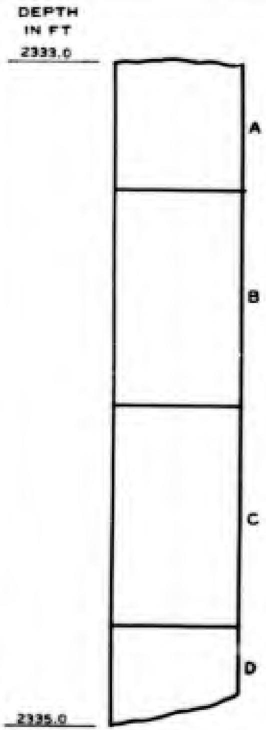
LEGEND

- PURE SALT
- IMPURE SALT
- SAW CUT
- FRACTURE

PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-1

CORES TAT-1-DC-31 AND -42



TAT-I-DC-5

CORE DIAMETER:
4-15/16 IN.

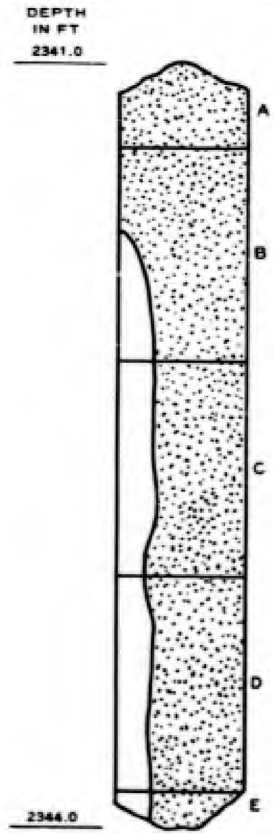
CORE LENGTH:
2.35 FT

COMPOSITION:
PURE MASSIVE ROCK SALT. INSOLUBLE RESIDUE OF 1.15 PERCENT (TABLE 1). X-RAY ANALYSIS OF INSOLUBLE RESIDUE SHOWS ANHYDRITE (TABLE 3). HALITE IS TRANSPARENT TO TRANSLUCENT (WHITE).

TEXTURE:
HALITE GRAIN SIZE ABOUT 1/8 TO 1/2 IN. THE GRAINS ARE ANHEDRAL WITH FAIRLY STRAIGHT SIDES. THE LONG AXIS OF THE GRAINS TENDS TO DIP ABOUT 20°.

STRUCTURE:
DIP OF 20 PERCENT SEEN AFTER WASHING.

REMARKS:
PURE MASSIVE ROCK SALT. TRANSPARENT TO TRANSLUCENT. CORE FAIRLY CLEAN AS RECEIVED AND UNBROKEN.



TAT-I-DC-4

CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
3.2 FT

COMPOSITION:
MASSIVE ROCK SALT WITH ESTIMATED 5 TO 10 PERCENT ANHYDRITE. ROCK LIKE CORE DC-70.

TEXTURE:
HALITE GRAIN SIZE 1/8 TO 1/2 IN.; AVERAGE 1/4 IN.

STRUCTURE:
NO STRUCTURE SEEN BEFORE OR AFTER WASHING.

REMARKS:
UNBROKEN CORE OF VARIOUS SHADES OF LIGHT GRAY COLOR INDICATING IMPURITY. THREE SUPERFICIAL SCRATCHES LONGITUDINALLY ON CORE.

LEGEND

- PURE SALT
- IMPURE SALT
- SAW CUT

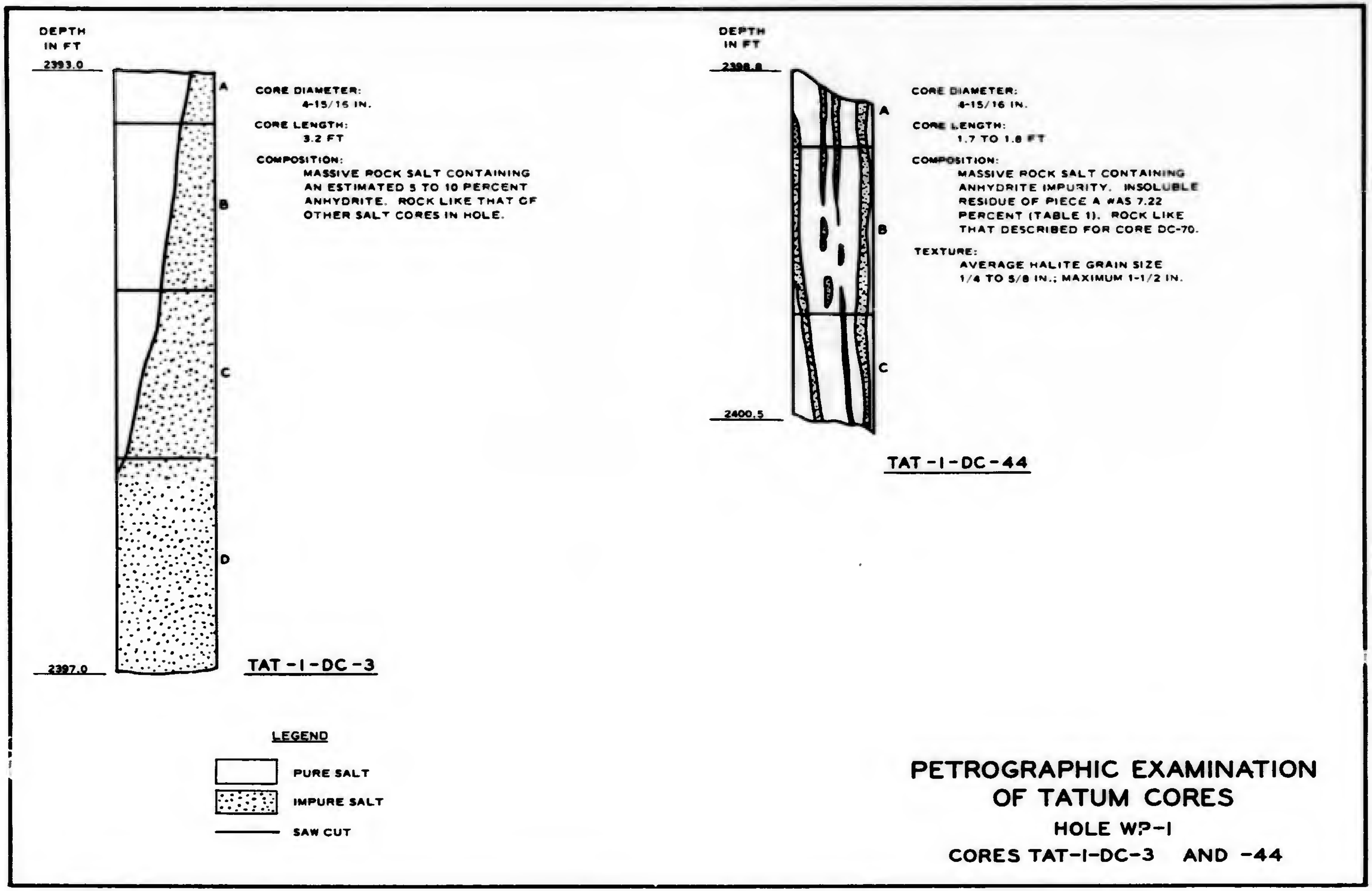
PETROGRAPHIC EXAMINATION OF TATUM CORES

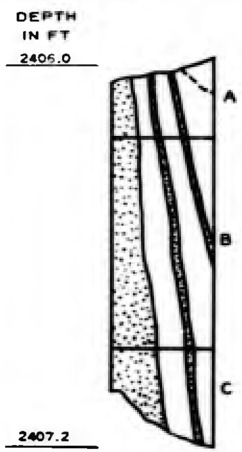
HOLE WP-I

CORES TAT-I-DC-5 AND -4

PLATE 24

PLATE 25


DEPTH IN FT
2393.0
2397.0
A
B
C
D
CORE DIAMETER: 4-15/16 IN.
CORE LENGTH: 3.2 FT
COMPOSITION: MASSIVE ROCK SALT CONTAINING AN ESTIMATED 5 TO 10 PERCENT ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.
TAT-I-DC-3
DEPTH IN FT
2398.8
2400.5
A
B
C
CORE DIAMETER: 4-15/16 IN.
CORE LENGTH: 1.7 TO 1.8 FT
COMPOSITION: MASSIVE ROCK SALT CONTAINING ANHYDRITE IMPURITY. INSOLUBLE RESIDUE OF PIECE A WAS 7.22 PERCENT (TABLE 1). ROCK LIKE THAT DESCRIBED FOR CORE DC-70.
TEXTURE: AVERAGE HALITE GRAIN SIZE 1/4 TO 5/8 IN.; MAXIMUM 1-1/2 IN.
TAT-I-DC-44
LEGEND
PURE SALT
IMPURE SALT
SAW CUT
PETROGRAPHIC EXAMINATION OF TATUM CORES
HOLE WP-I
CORES TAT-I-DC-3 AND -44



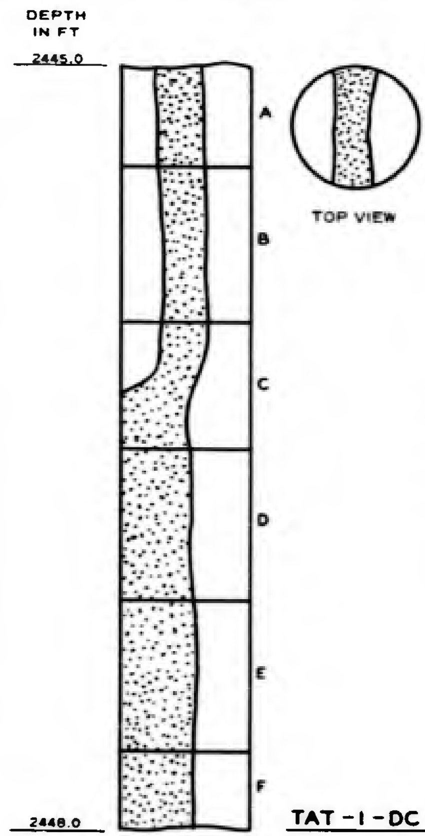
TAT-1-DC-41

CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.3 TO 1.5 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.

TEXTURE:
AVERAGE GRAIN SIZE OF HALITE 1/4 TO 5/8 IN.



TAT-1-DC-6

CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
3.2 FT

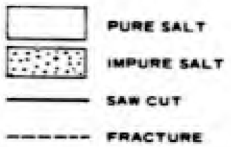
COMPOSITION:
MASSIVE ROCK SALT WITH ESTIMATED 5 TO 10 PERCENT OF ANHYDRITE. THE HALITE IN THE PURE AREAS IS TRANSPARENT OR TRANSLUCENT (WHITE). THE ANHYDRITE OCCURS MAINLY AS DISCRETE CRYSTALS IN THIN, GRAY, STEEPLY DIPPING STREAKS. THE GRAY COLOR OF THE IMPURE SALT IS DUE TO THE ANHYDRITE.

TEXTURE:
HALITE GRAIN SIZE FROM 1/8 TO 1/2 IN.; THE AVERAGE IS 1/4 IN.

STRUCTURE:
GRAY BANDS OF IMPURE SALT ARE VERTICAL.

REMARKS:
UNBROKEN CORE.

LEGEND



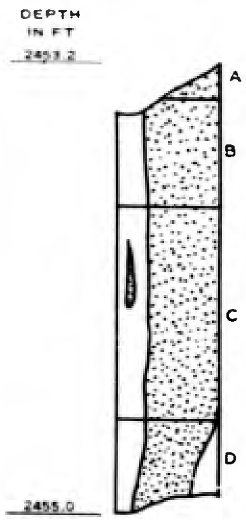
PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-1

CORES TAT-1-DC-41 AND -6

PLATE 26

PLATE 27



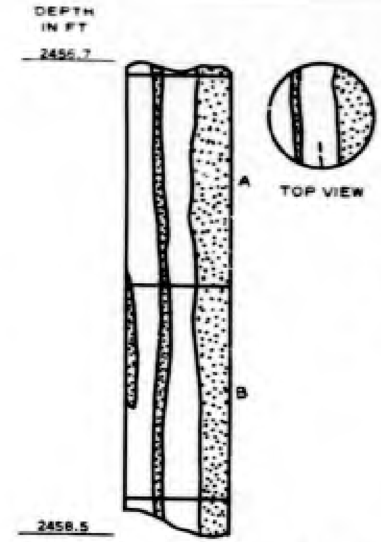
CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.65 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING ANHYDRITE. INSOLUBLE RESIDUE OF PIECE C WAS 13.90 PERCENT (TABLE 1). ROCK LIKE THAT OF OTHER SALT CORES IN HOLE (DC-6 FOR EXAMPLE).

TEXTURE:
MAXIMUM GRAIN SIZE OF IMPURE SALT 1 IN., AND RANGE OF GRAIN SIZE IN PURE SALT 1/16 IN. TO 3/8 IN.

TAT-I-DC-37



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.8 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.

TEXTURE:
HALITE GRAIN SIZE UP TO 1/2-IN. MAXIMUM DIMENSION.

STRUCTURE:
GRAY STREAKS ARE VERTICAL.

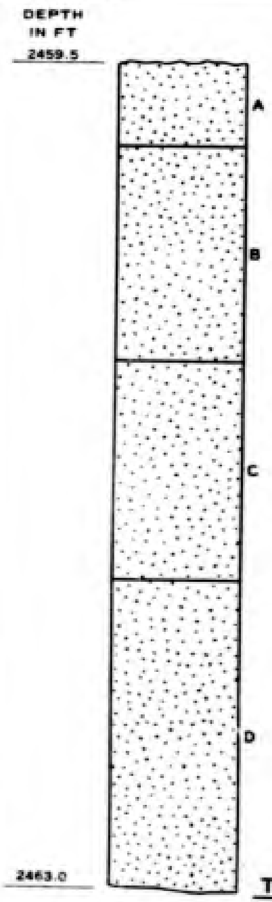
TAT-I-DC-48

LEGEND

PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-I

CORES TAT-I-DC-37 AND -48



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
3.2 FT

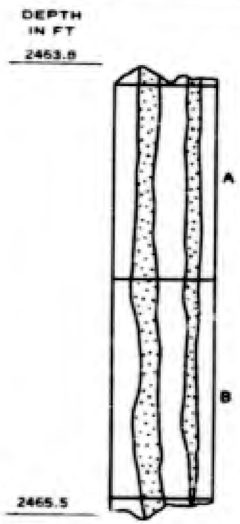
COMPOSITION:
MASSIVE ROCK SALT WITH ESTIMATED 5 TO 10 PERCENT ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.

TEXTURE:
HALITE GRAIN SIZE 1/8 TO 1/2 IN.; AVERAGE 1/4 IN.

STRUCTURE:
NO STRUCTURE SEEN.

REMARKS:
LIGHT GRAY IMPURE SALT; FAIRLY HOMOGENEOUS WITH NO PRONOUNCED ZONES OF PURE SALT EXCEPT IN PATCHES. NUMEROUS SHORT LONGITUDINAL SCRATCHES ON CORE SURFACE. WASHING NOT ADEQUATE TO REMOVE DRILLING MARKS. THIS CORE WAS UNUSUAL IN THAT IT LACKED ANY AREAS OF PURE SALT.

TAT-I-DC-8



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.75 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.

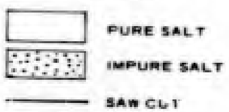
TEXTURE:
MAXIMUM HALITE GRAIN SIZE 1/2 IN.; AVERAGE 1/4 IN.

STRUCTURE:
VERTICAL DIP OF GRAY BANDS OF IMPURE SALT.

REMARKS:
OPAQUE AS DC-8.

TAT-I-DC-38

LEGEND

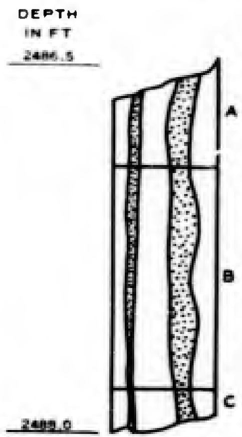


PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-I

CORES TAT-I-DC-8 AND -38

PLATE 29



CORE DIAMETER:
4-15/16 IN.

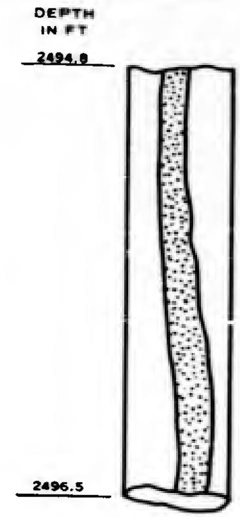
CORE LENGTH:
1.5 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT IN OTHER SALT CORES IN HOLE.

TEXTURE:
MAXIMUM HALITE GRAIN SIZE 1 IN.; AVERAGE 1/2 IN.

REMARKS:
CLEARER AND MORE TRANSLUCENT THAN DC-48 AND DC-38.

TAT-1-DC-43



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.7 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE. THIS CORE MUCH LIKE CORE DC-6.

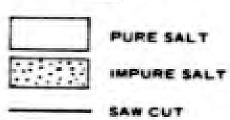
TEXTURE:
MAXIMUM GRAIN DIMENSION IN PURE SALT UP TO 1-1/4 IN. AVERAGE, 1/2 IN. MAXIMUM HALITE GRAIN SIZE IN IMPURE SALT, 3/8 IN.

STRUCTURE:
VERTICAL DIP TO GRAY BANDS OF IMPURE SALT.

REMARKS:
NO SAW CUTS MADE.

TAT-1-DC-50

LEGEND

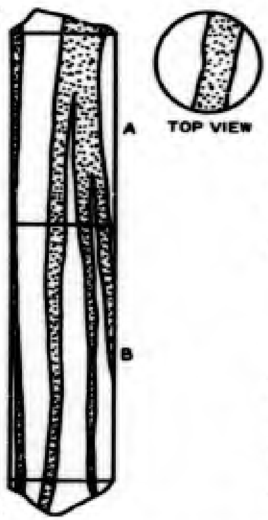


PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-1

CORES TAT-1-DC-43 AND -50

DEPTH
IN FT
2496.5



2498.3

CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.8 FT

COMPOSITION:
MASSIVE ROCK SALT CONTAINING A LITTLE ANHYDRITE. ROCK LIKE THAT IN OTHER SALT CORES IN HOLE. THIS CORE VERY SIMILAR TO CORE DC-6.

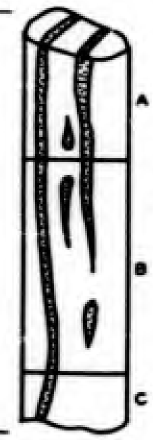
TEXTURE:
SLIGHTLY FINER GRAIN SIZE THAN CORE DC-50.

STRUCTURE:
LIKE DC-50

REMARKS:
THIS CORE IS CONTINUOUS IN FOOTAGE WITH CORE DC-50

TAT-I-DC-49

DEPTH
IN FT
2506.0



2507.5

CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.5 FT

COMPOSITION:
MASSIVE ROCK SALT WITH ANHYDRITE IMPURITY. THE PURE SALT AREAS ARE TRANSPARENT TO TRANSLUCENT (WHITE). THE IMPURE SALT (ANHYDRITIC) OCCURS AS STEEPLY DIPPING THIN GRAY BANDS. INSOLUBLE RESIDUE OF PIECE B WAS 2.54 PERCENT (TABLE 1).

TEXTURE:
MAXIMUM HALITE GRAIN DIMENSION 1/2 IN.; AVERAGE 1/4 IN.

REMARKS:
ALMOST CLEAR AND PURE ALL THROUGH CORE.

TAT-I-DC-39

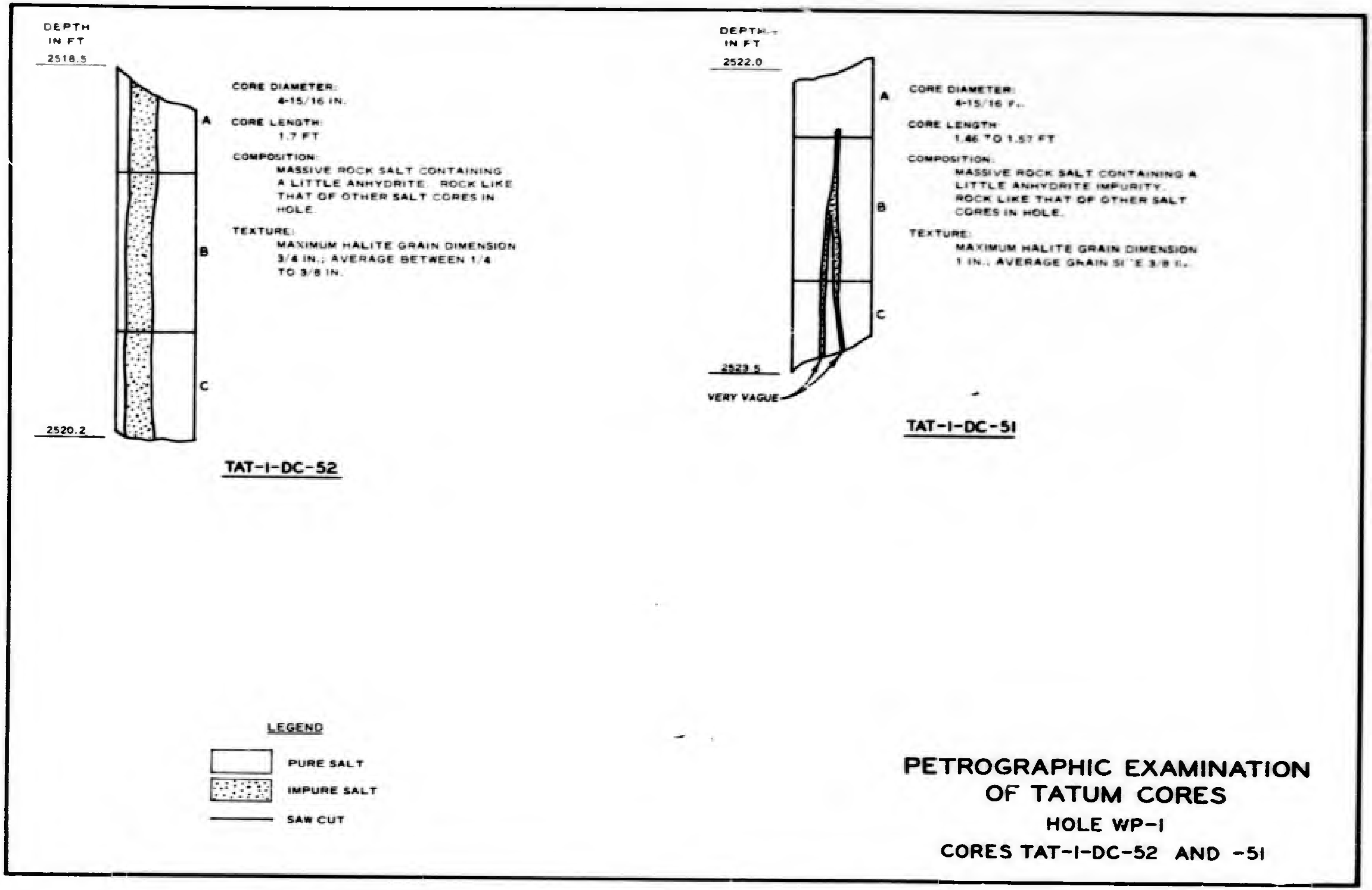
LEGEND

PURE SALT
IMPURE SALT
SAW CUT

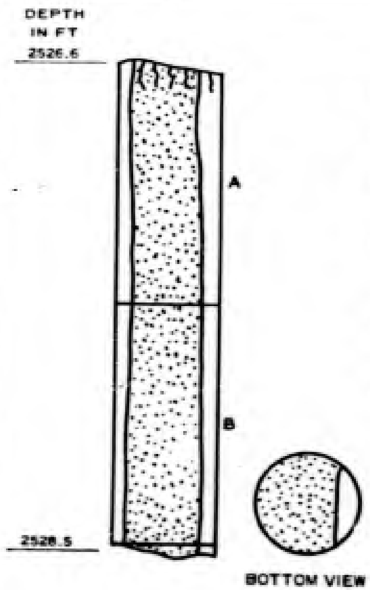
PETROGRAPHIC EXAMINATION OF TATUM CORES
HOLE WP-I
CORES TAT-I-DC-49 AND -39

PLATE 30

PLATE 31



PETROGRAPHIC EXAMINATION OF TATUM CORES
HOLE WP-1
CORES TAT-1-DC-52 AND -51



TAT-I-DC-53

CORE DIAMETER:
4-15/16 IN.

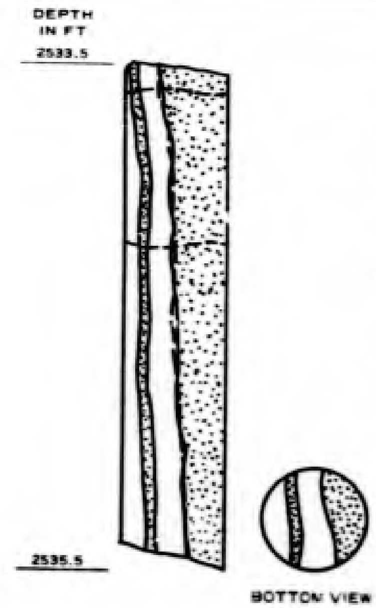
CORE LENGTH:
1.9 FT

COMPOSITION:
MASSIVE ROCK SALT WITH FEW PERCENT ANHYDRITE IMPURITY.

TEXTURE:
SMALLER HALITE GRAIN SIZE THAN CORE DC-51; AVERAGE GRAIN SIZE ABOUT 1/4 IN.

STRUCTURE:
GRAY ANHYDRITIC BANDS HAVE VERTICAL DIP.

REMARKS:
MUCH LESS PURE THAN CORE DC-51, GRAY BUT TRANSPARENT. ROTATION ON TOP OF CORE WITH FRACTURING AND SHATTERING.



TAT-I-DC-54

CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.87 TO 2.0 FT

COMPOSITION:
MASSIVE ROCK SALT WITH A FEW PERCENT ANHYDRITE IMPURITY. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.

TEXTURE:
HALITE GRAIN SIZE IN IMPURE SALT ABOUT 1/4 IN.; IN PURER PORTIONS ABOUT 3/8 IN.

STRUCTURE:
VERTICAL DIP OF GRAY STREAKS.

REMARKS:
DARK BUT TRANSLUCENT CORE WITH INCIPIENT FRACTURES SHOWN BY DASHED LINES. NO SAW CUTS MADE.

LEGEND

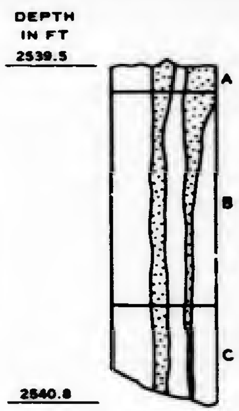
- PURE SALT
- IMPURE SALT
- SAW CUT
- FRACTURE
- FRACTURE (INCIPIENT)

PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-I

CORES TAT-I-DC-53 AND -54

PLATE 32



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.3 FT

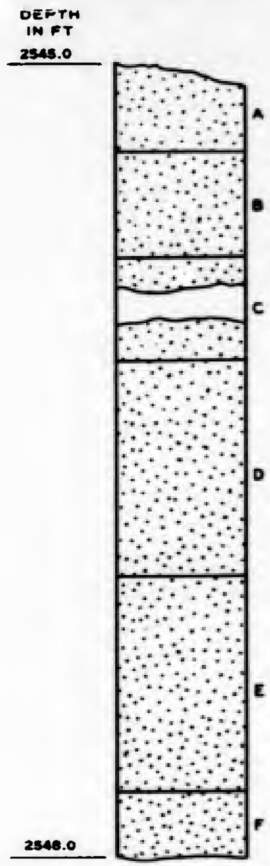
COMPOSITION:
MASSIVE ROCK SALT WITH ANHYDRITE IMPURITY. THE ROCK IS LIKE THAT IN PREVIOUS SALT CORES. INSOLUBLE RESIDUE OF PIECE A WAS 8.32 PERCENT (TABLE 1). ANHYDRITE WAS THE ONLY MINERAL IDENTIFIED IN THE INSOLUBLE RESIDUE BY X-RAY ANALYSIS.

TEXTURE:
MAXIMUM HALITE GRAIN DIMENSION 3/4 IN.; AVERAGE 1/4 IN.

STRUCTURE:
VERTICAL DIP TO GRAY STREAKS.

REMARKS:
PALER THAN DC-84. TOP SAWED AND BROKEN.

TAT-1-DC-46



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
3.15 FT

COMPOSITION:
MASSIVE ROCK SALT WITH VERY LITTLE PURE SALT. ESTIMATED 10 PERCENT ANHYDRITE.

TEXTURE:
HALITE GRAIN SIZE 1/8 TO 1/2 IN.; AVERAGE 1/4 IN.

STRUCTURE:
NO STRUCTURE SEEN.

REMARKS:
SMALL AREAS OF PURE AND IMPURE SALT FAIRLY EVENLY DISTRIBUTED. PURE SALT LAYER SHOWN MAY BE POTENTIAL FRACTURE. NO TOP OR BOTTOM MARKS ON CORE.

TAT-1-DC-7

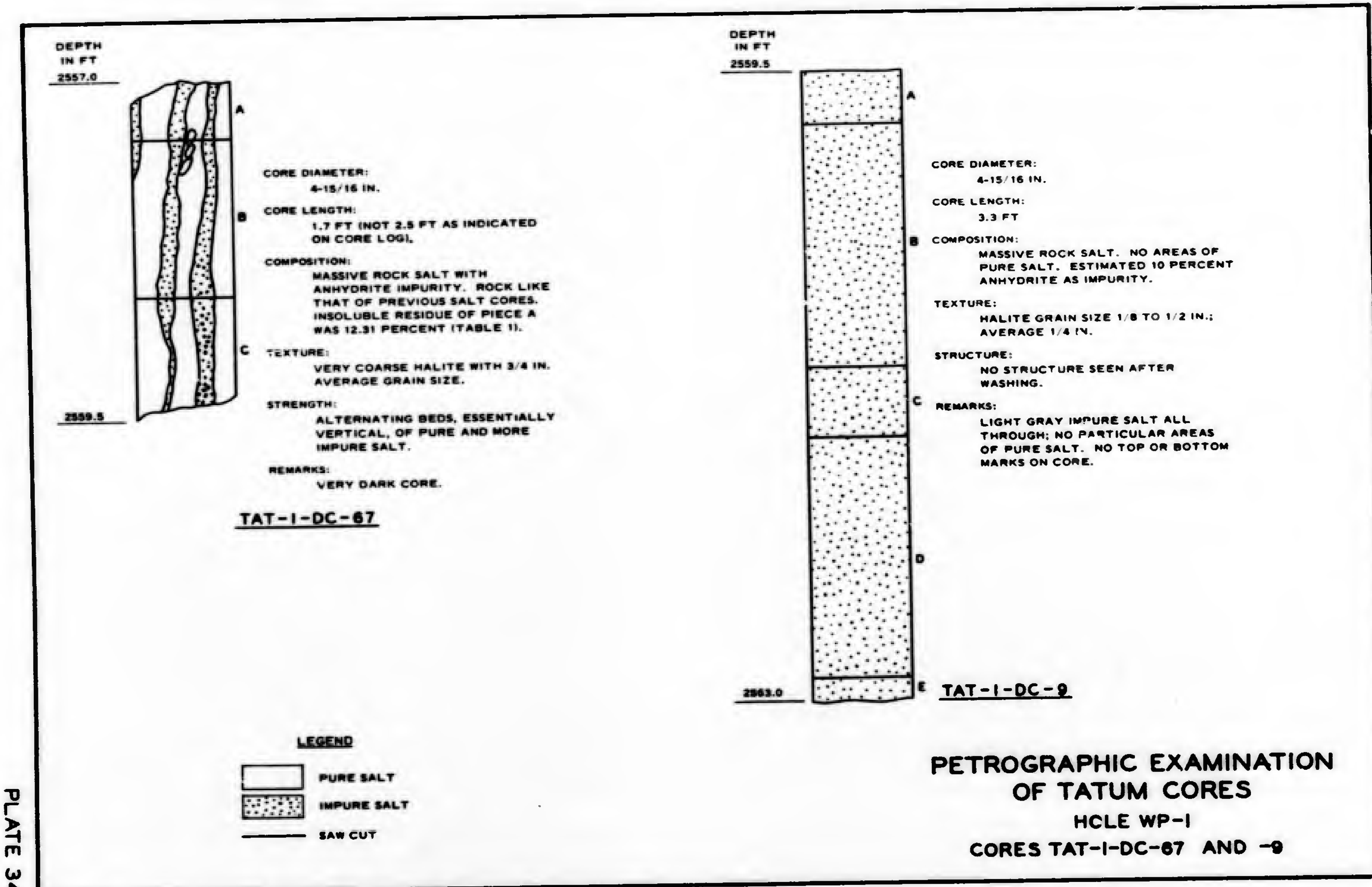
LEGEND

- PURE SALT (blank box)
- IMPURE SALT (stippled box)
- SAW CUT (line)

PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-1

CORES TAT-1-DC-46 AND -7

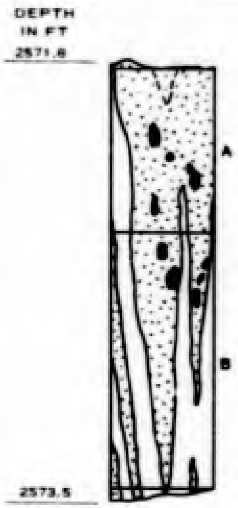


PETROGRAPHIC EXAMINATION OF TATUM CORES

HCLE WP-1

CORES TAT-1-DC-67 AND -9

PLATE 34



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.8 FT

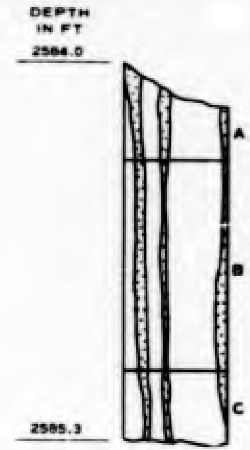
COMPOSITION:
MASSIVE ROCK SALT WITH ANHYDRITE IMPURITY. ROCK LIKE PREVIOUS SALT CORES IN THIS HOLE. ESTIMATED 5 TO 10 PERCENT ANHYDRITE.

TEXTURE:
MAXIMUM HALITE GRAIN SIZE WAS 1/4 IN.

STRUCTURE:
NEAR VERTICAL ALTERNATION OF PURE AND IMPURE SALT ZONES.

REMARKS:
CORE SURFACES ARE HIGHLY ETCHED. SOLUTION CHANNEL DOWN BACK OF UPPER TWO-THIRDS OF VIEW AS SHOWN. DARK AREAS INDICATE HIGH ANHYDRITIC CONCENTRATIONS.

TAT-I-DC-55



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.5 FT

COMPOSITION:
MASSIVE ROCK SALT WITH ANHYDRITE IMPURITY. ROCKS LIKE THAT OF PREVIOUS SALT CORES IN THIS HOLE. INSOLUBLE RESIDUE OF PIECE A WAS 6.85 PERCENT (TABLE 1).

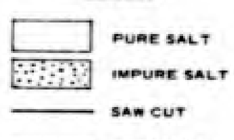
TEXTURE:
AVERAGE HALITE GRAIN SIZE 1/4 IN.; RANGE FROM 1/16 TO 3/4 IN.

STRUCTURE:
VERTICAL BANDS OF PURE AND IMPURE SALT.

REMARKS:
MORE OPAQUE THAN DC-55.

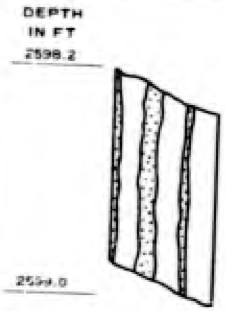
TAT-I-DC-56

LEGEND



PETROGRAPHIC EXAMINATION OF TATUM CORES
HOLE WP-I
CORES TAT-I-DC-55 AND -56

PLATE 35



TAT-I-DC-58

CORE DIAMETER:
4-15/16 IN.

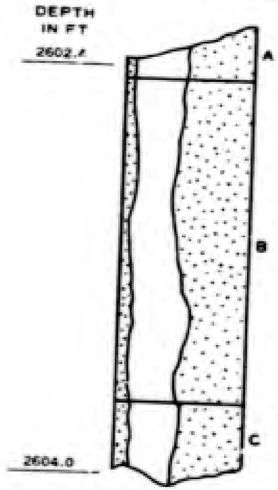
CORE LENGTH:
0.8 FT

COMPOSITION:
MASSIVE ROCK SALT WITH ESTIMATED 5 TO 10 PERCENT ANHYDRITE IMPURITY. ROCK LIKE THAT IN PREVIOUS SALT CORES IN THIS HOLE.

TEXTURE:
MAXIMUM HALITE GRAIN SIZE 1-1/4 IN. THE AVERAGE MAXIMUM DIMENSION OF GRAINS WAS 3/8 TO 1/2 IN.

STRUCTURE:
GRAY ANHYDRITIC BANDS ARE VERTICAL.

REMARKS:
NO SAW CUTS MADE.



TAT-I-DC-57

CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.60 TO 1.75 FT

COMPOSITION:
MASSIVE ROCK SALT WITH ESTIMATED 5 TO 10 PERCENT ANHYDRITE IMPURITY. ROCK LIKE THAT OF PREVIOUS SALT CORES IN THIS HOLE.

TEXTURE:
MAXIMUM HALITE GRAIN SIZE 3/4 IN.; AVERAGE GRAIN SIZE 1/4 IN.

STRUCTURE:
GRAY ANHYDRITIC BANDS HAVE VERTICAL DIP.

LEGEND

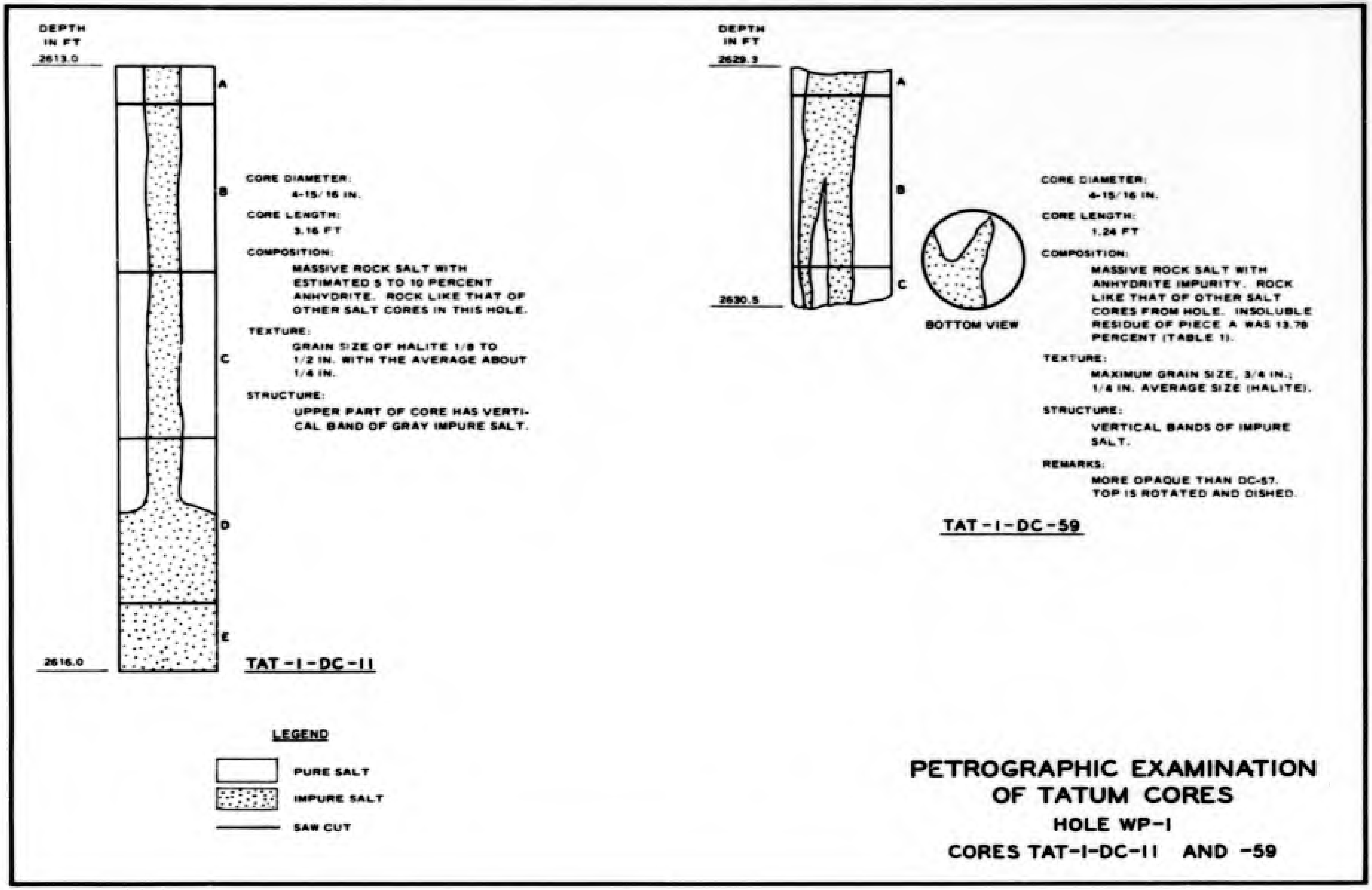
- PURE SALT
- IMPURE SALT
- SAW CUT

PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-I

CORES TAT-I-DC-58 AND -57

PLATE 37


DEPTH IN FT
2613.0
2616.0
A
B
C
D
E
CORE DIAMETER:
4-15/16 IN.
CORE LENGTH:
3.16 FT
COMPOSITION:
MASSIVE ROCK SALT WITH ESTIMATED 5 TO 10 PERCENT ANHYDRITE. ROCK LIKE THAT OF OTHER SALT CORES IN THIS HOLE.
TEXTURE:
GRAIN SIZE OF HALITE 1/8 TO 1/2 IN. WITH THE AVERAGE ABOUT 1/4 IN.
STRUCTURE:
UPPER PART OF CORE HAS VERTICAL BAND OF GRAY IMPURE SALT.
TAT-I-DC-II
DEPTH IN FT
2629.3
2630.5
A
B
C
BOTTOM VIEW
CORE DIAMETER:
4-15/16 IN.
CORE LENGTH:
1.24 FT
COMPOSITION:
MASSIVE ROCK SALT WITH ANHYDRITE IMPURITY. ROCK LIKE THAT OF OTHER SALT CORES FROM HOLE. INSOLUBLE RESIDUE OF PIECE A WAS 13.78 PERCENT (TABLE 1).
TEXTURE:
MAXIMUM GRAIN SIZE, 3/4 IN.; 1/4 IN. AVERAGE SIZE (HALITE).
STRUCTURE:
VERTICAL BANDS OF IMPURE SALT.
REMARKS:
MORE OPAQUE THAN DC-57. TOP IS ROTATED AND DISHED.
TAT-I-DC-59
LEGEND
PURE SALT
IMPURE SALT
SAW CUT
PETROGRAPHIC EXAMINATION OF TATUM CORES
HOLE WP-I
CORES TAT-I-DC-II AND -59

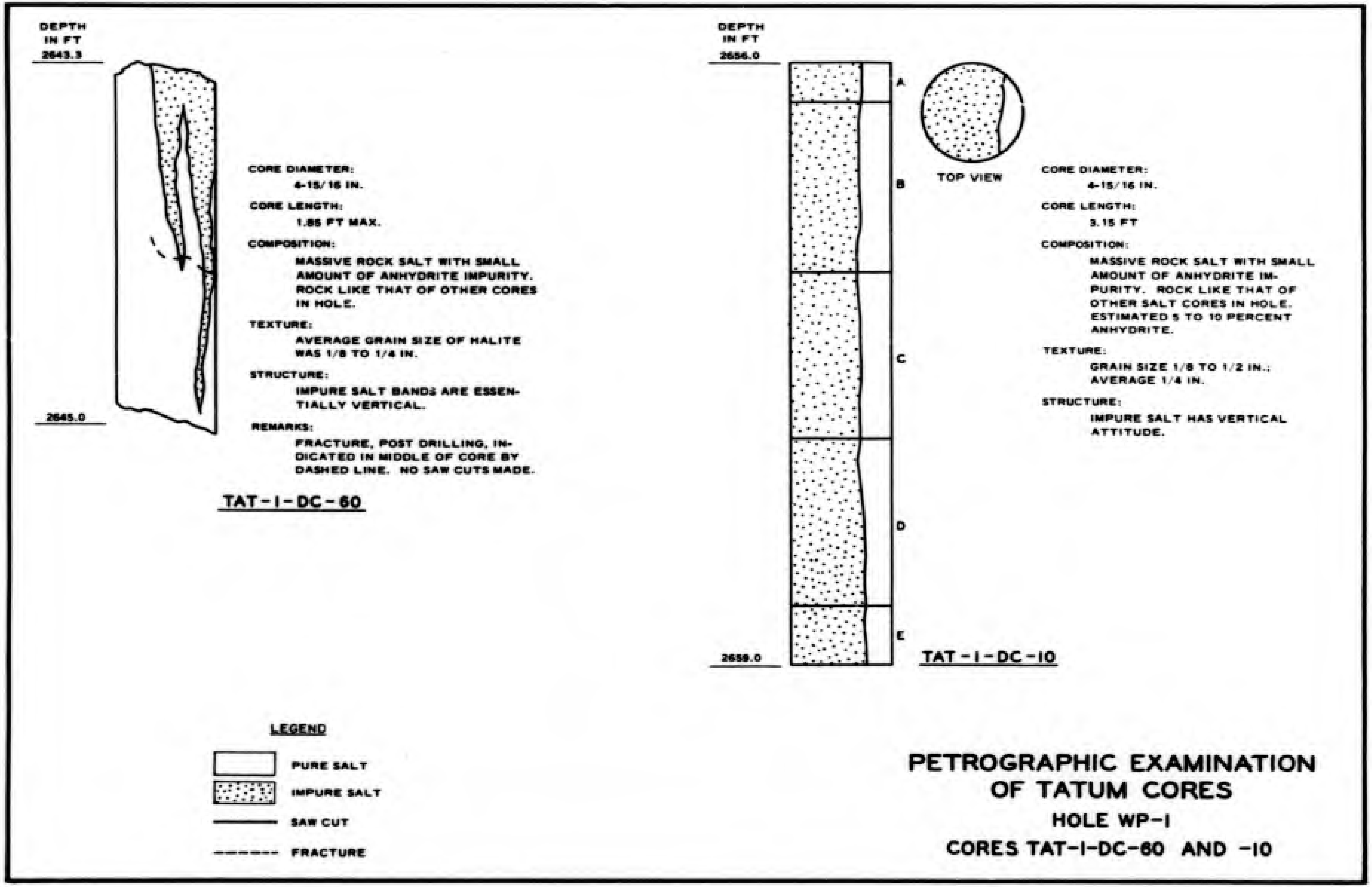
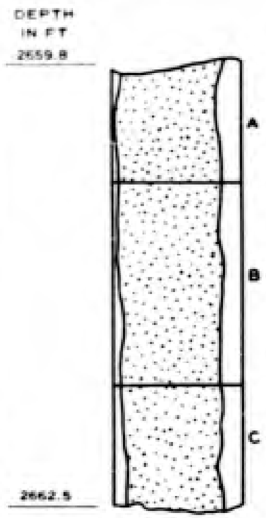

DEPTH IN FT
2643.3
2645.0
CORE DIAMETER:
4-15/16 IN.
CORE LENGTH:
1.85 FT MAX.
COMPOSITION:
MASSIVE ROCK SALT WITH SMALL AMOUNT OF ANHYDRITE IMPURITY. ROCK LIKE THAT OF OTHER CORES IN HOLE.
TEXTURE:
AVERAGE GRAIN SIZE OF HALITE WAS 1/8 TO 1/4 IN.
STRUCTURE:
IMPURE SALT BANDS ARE ESSENTIALLY VERTICAL.
REMARKS:
FRACTURE, POST DRILLING, INDICATED IN MIDDLE OF CORE BY DASHED LINE. NO SAW CUTS MADE.
TAT-1-DC-60
DEPTH IN FT
2656.0
2659.0
A
B
C
D
E
TOP VIEW
CORE DIAMETER:
4-15/16 IN.
CORE LENGTH:
3.15 FT
COMPOSITION:
MASSIVE ROCK SALT WITH SMALL AMOUNT OF ANHYDRITE IMPURITY. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE. ESTIMATED 5 TO 10 PERCENT ANHYDRITE.
TEXTURE:
GRAIN SIZE 1/8 TO 1/2 IN.; AVERAGE 1/4 IN.
STRUCTURE:
IMPURE SALT HAS VERTICAL ATTITUDE.
TAT-1-DC-10
LEGEND
PURE SALT
IMPURE SALT
SAW CUT
FRACTURE
PETROGRAPHIC EXAMINATION OF TATUM CORES
HOLE WP-1
CORES TAT-1-DC-60 AND -10

PLATE 38



CORE DIAMETER:
4-15/16 IN.

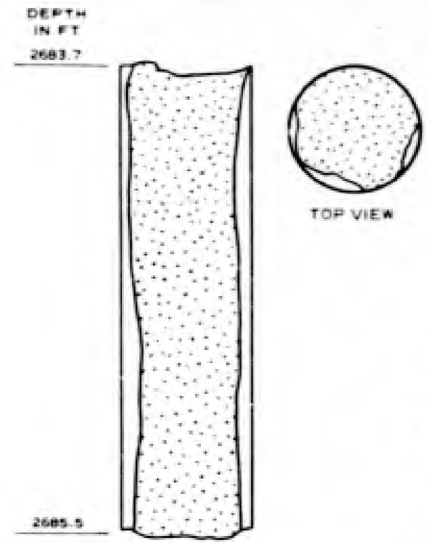
CORE LENGTH:
1.75 FT (NOT 2.7 FT AS INDICATED ON CORE LOG).

COMPOSITION:
MASSIVE ROCK SALT WITH SMALL AMOUNT OF ANHYDRITE IMPURITY. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.

TEXTURE:
MAXIMUM HALITE GRAIN SIZE 1/4 IN. IN IMPURE SALT AND 3/8 IN. IN PURE SALT.

STRUCTURE:
IMPURE SALT BAND IS VERTICAL.

TAT-1-DC-63



CORE DIAMETER:
4-15/16 IN.

CORE LENGTH:
1.85 FT

COMPOSITION:
MASSIVE ROCK SALT WITH ANHYDRITE IMPURITY. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE. THE INSOLUBLE RESIDUE OF CORE WAS 10.96 PERCENT (TABLE 1).

TEXTURE:
AVERAGE HALITE GRAIN SIZE WAS 1/4 IN. IN IMPURE SALT.

STRUCTURE:
ESSENTIALLY VERTICAL CONTACT BETWEEN PURE AND IMPURE SALT.

REMARKS:
ALMOST ALL ANHYDRITIC SALT. NO SAW CUTS MADE.

TAT-1-DC-61

LEGEND

PURE SALT
IMPURE SALT
SAW CUT

PETROGRAPHIC EXAMINATION OF TATUM CORES

HOLE WP-1

CORES TAT-1-DC-63 AND -61

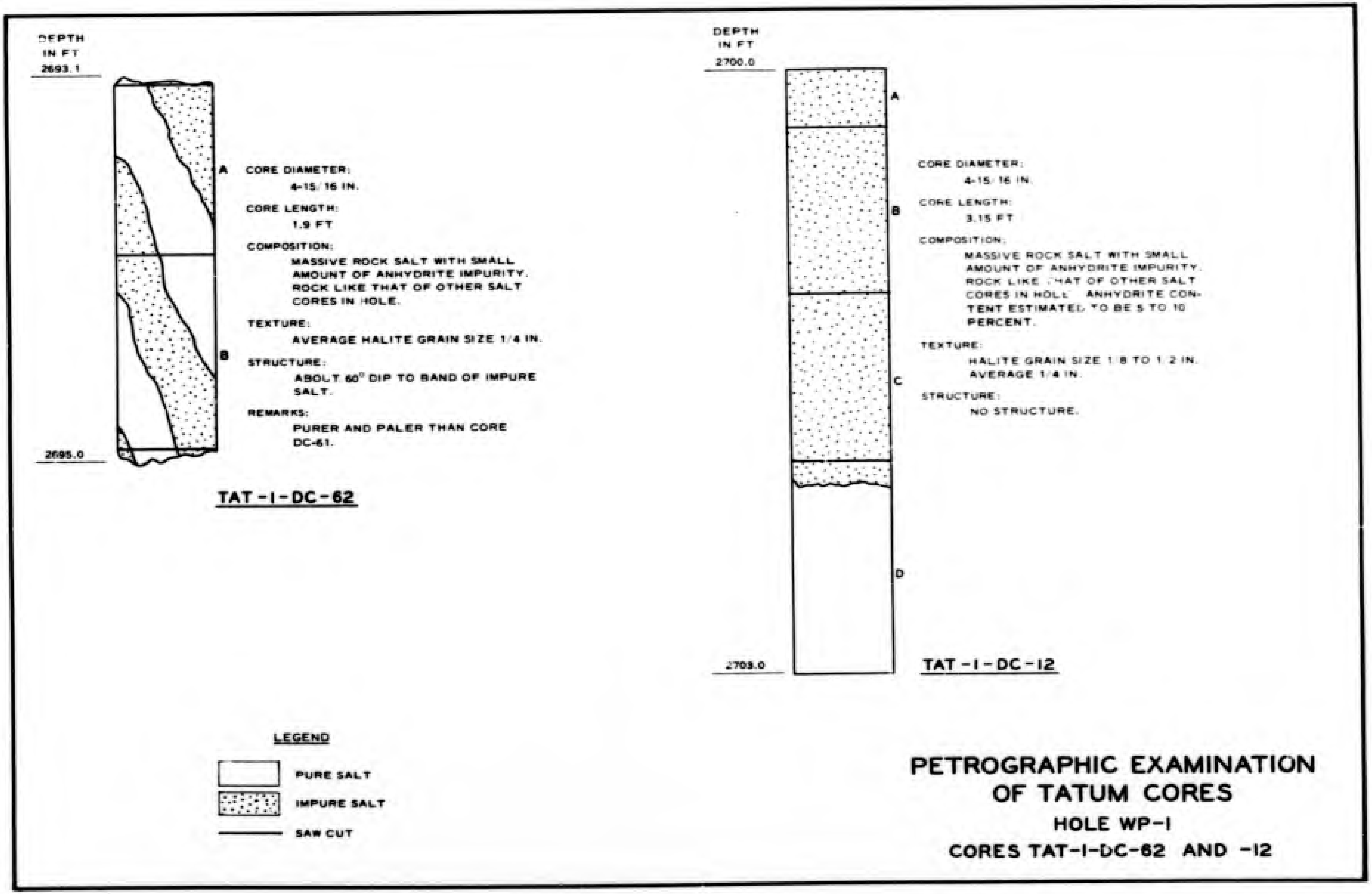
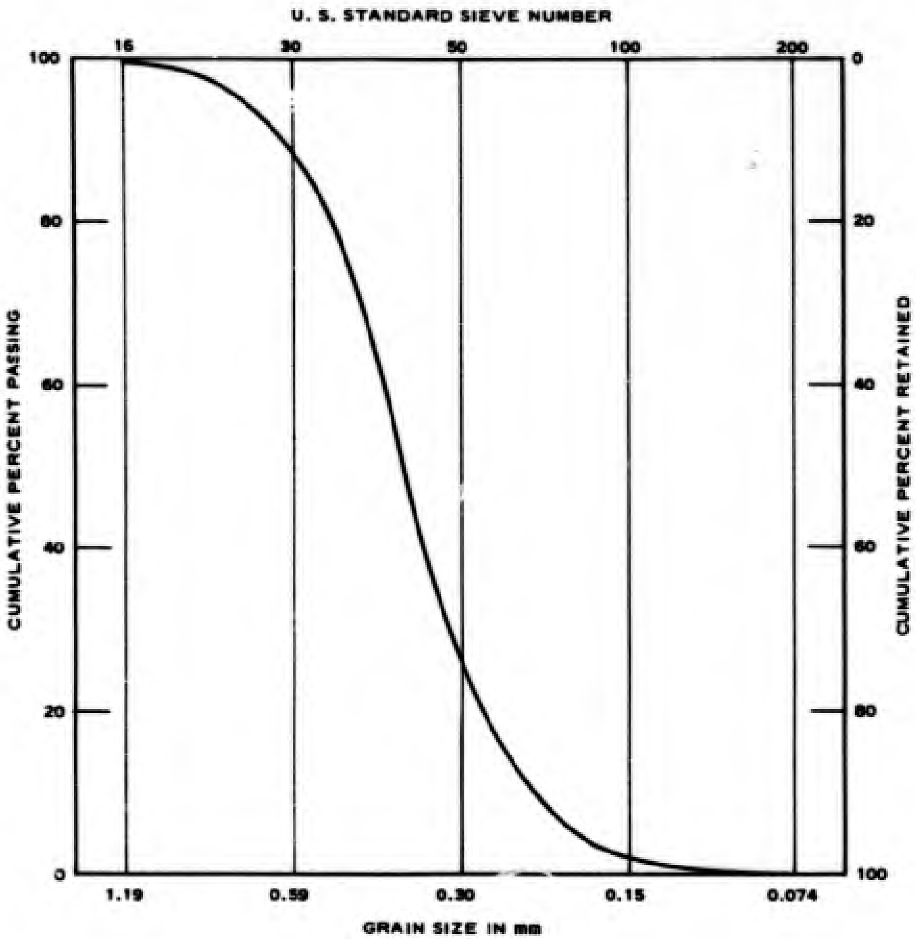

DEPTH
IN FT
2693.1
2695.0
A
B
CORE DIAMETER:
4-15/16 IN.
CORE LENGTH:
1.9 FT
COMPOSITION:
MASSIVE ROCK SALT WITH SMALL AMOUNT OF ANHYDRITE IMPURITY. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE.
TEXTURE:
AVERAGE HALITE GRAIN SIZE 1/4 IN.
STRUCTURE:
ABOUT 60° DIP TO BAND OF IMPURE SALT.
REMARKS:
PURER AND PALER THAN CORE DC-61.
TAT-1-DC-62
DEPTH
IN FT
2700.0
2703.0
A
B
C
D
CORE DIAMETER:
4-15/16 IN.
CORE LENGTH:
3.15 FT
COMPOSITION:
MASSIVE ROCK SALT WITH SMALL AMOUNT OF ANHYDRITE IMPURITY. ROCK LIKE THAT OF OTHER SALT CORES IN HOLE. ANHYDRITE CONTENT ESTIMATED TO BE 5 TO 10 PERCENT.
TEXTURE:
HALITE GRAIN SIZE 1/8 TO 1/2 IN. AVERAGE 1/4 IN.
STRUCTURE:
NO STRUCTURE.
TAT-1-DC-12
LEGEND
PURE SALT
IMPURE SALT
SAW CUT
PETROGRAPHIC EXAMINATION
OF TATUM CORES
HOLE WP-1
CORES TAT-1-DC-62 AND -12

PLATE 40



GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.02	0.02	99.98
30	14.82	11.99	88.01
50	76.23	73.55	26.45
100	29.56	97.41	2.59
200	2.87	99.73	0.27
PAN	0.33	100.00	0.00
TOTAL	123.82	——	——

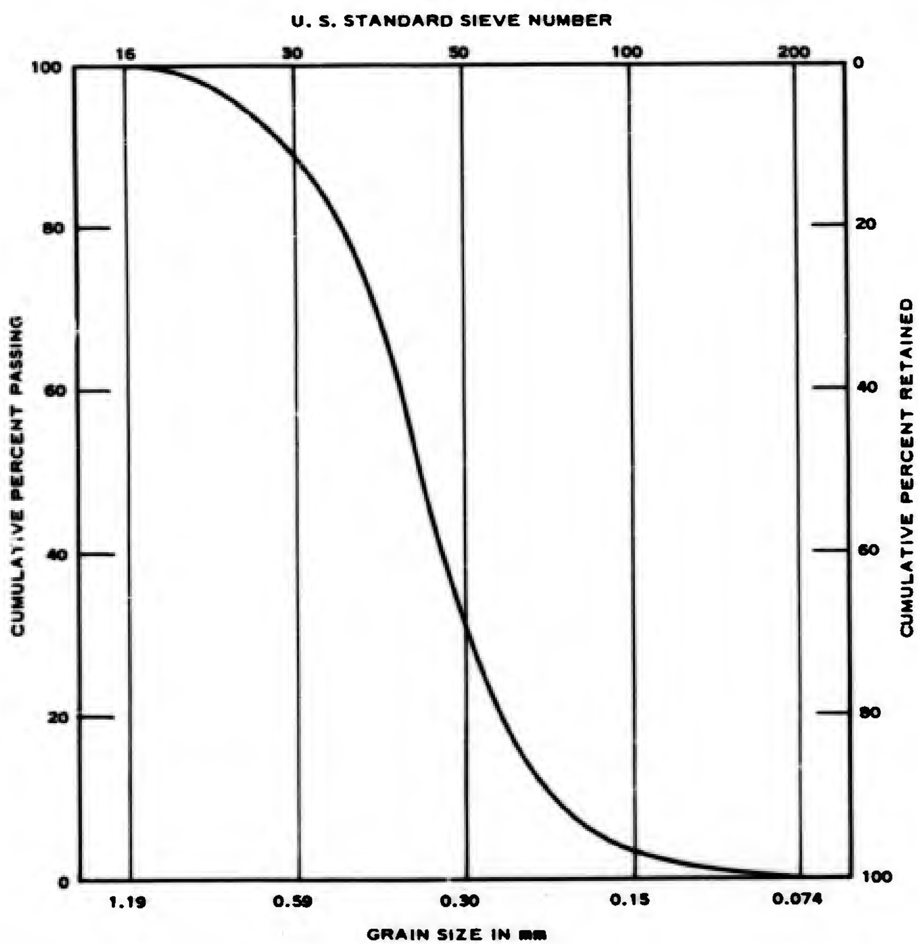
REPORTED DEPTH IN FT

1553.5 – 1555.0

GRADATION OF INSOLUBLE RESIDUE

HOLE WP-1

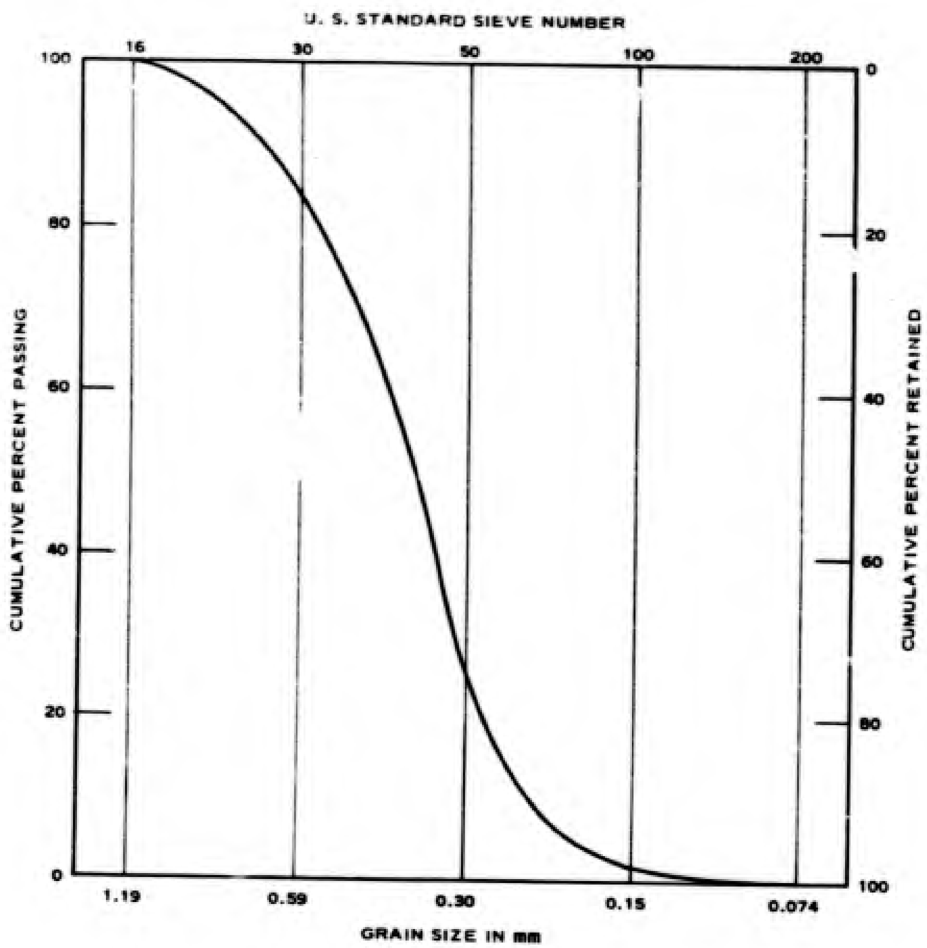
CORE TAT-1-DC-64



GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.02	0.06	99.94
30	3.38	10.94	89.06
50	18.77	71.36	28.64
100	7.99	97.08	2.92
200	0.84	99.78	0.22
PAN	0.07	100.00	0.00
TOTAL	31.07	—	—

REPORTED DEPTH IN FT
1657.3–1658.5

GRADATION OF
INSOLUBLE RESIDUE
HOLE WP-1
CORE TAT-1-DC-13



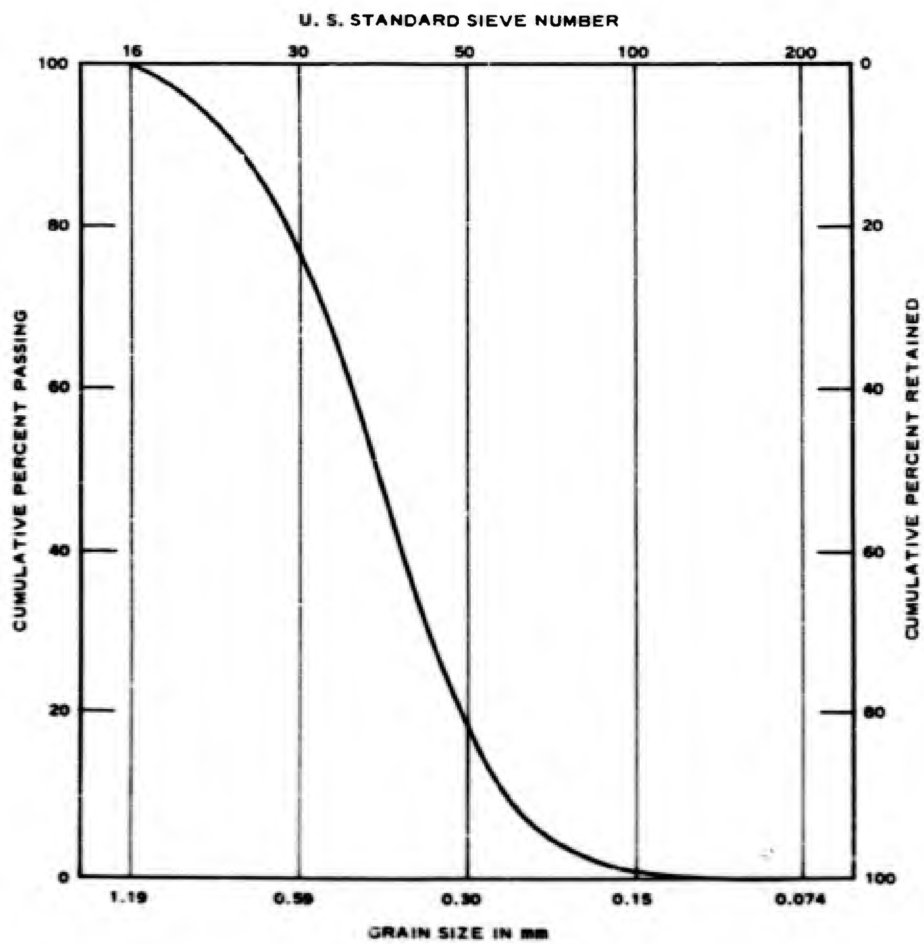
GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.18	0.20	99.80
30	15.62	17.19	82.81
50	53.53	76.29	23.71
100	19.39	97.62	2.38
200	1.94	99.75	0.25
PAN	0.23	100.00	0.00
TOTAL	90.89	——	——

REPORTED DEPTH IN FT

1673.5–1675.0

GRADATION OF INSOLUBLE RESIDUE
HOLE WP-1

CORE TAT-1-DC-65

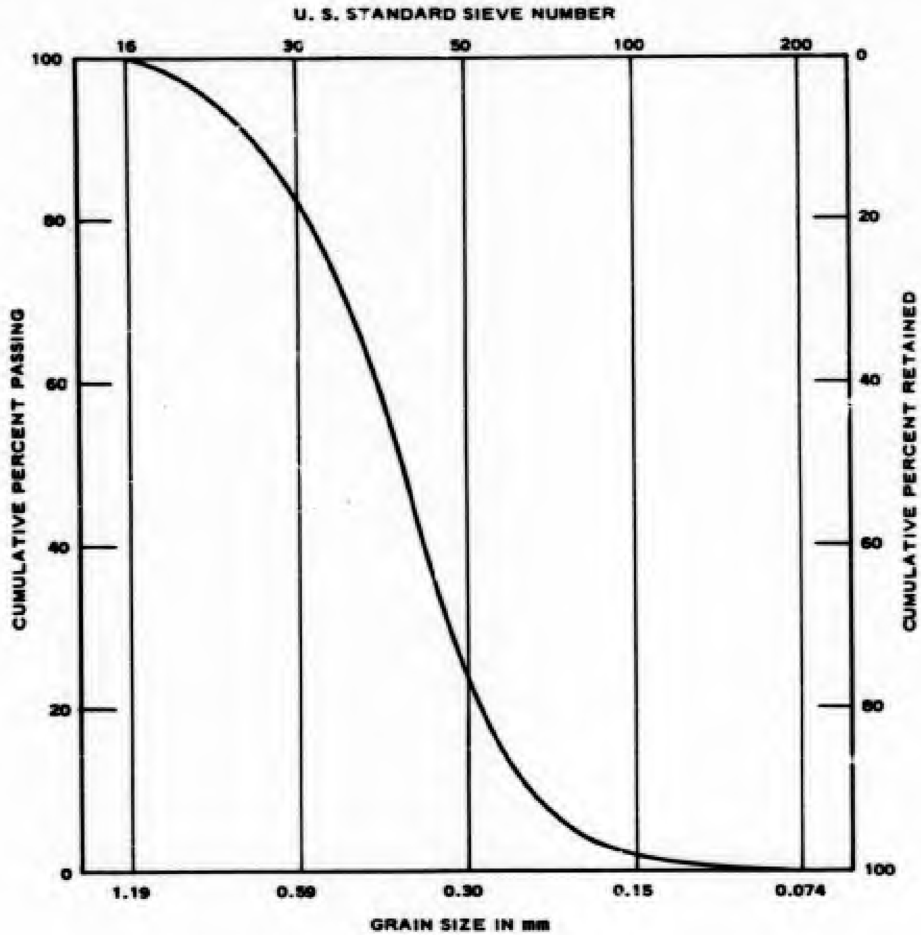


GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.62	0.38	99.62
30	39.80	24.84	75.16
50	95.05	83.24	16.76
100	25.30	98.79	1.21
200	1.83	99.91	0.09
PAN	0.14	100.00	0.00
TOTAL	162.74	——	——

REPORTED DEPTH IN FT

1681.0 – 1682.2

GRADATION OF INSOLUBLE RESIDUE
HOLE WP-1
CORE TAT-1-DC-20



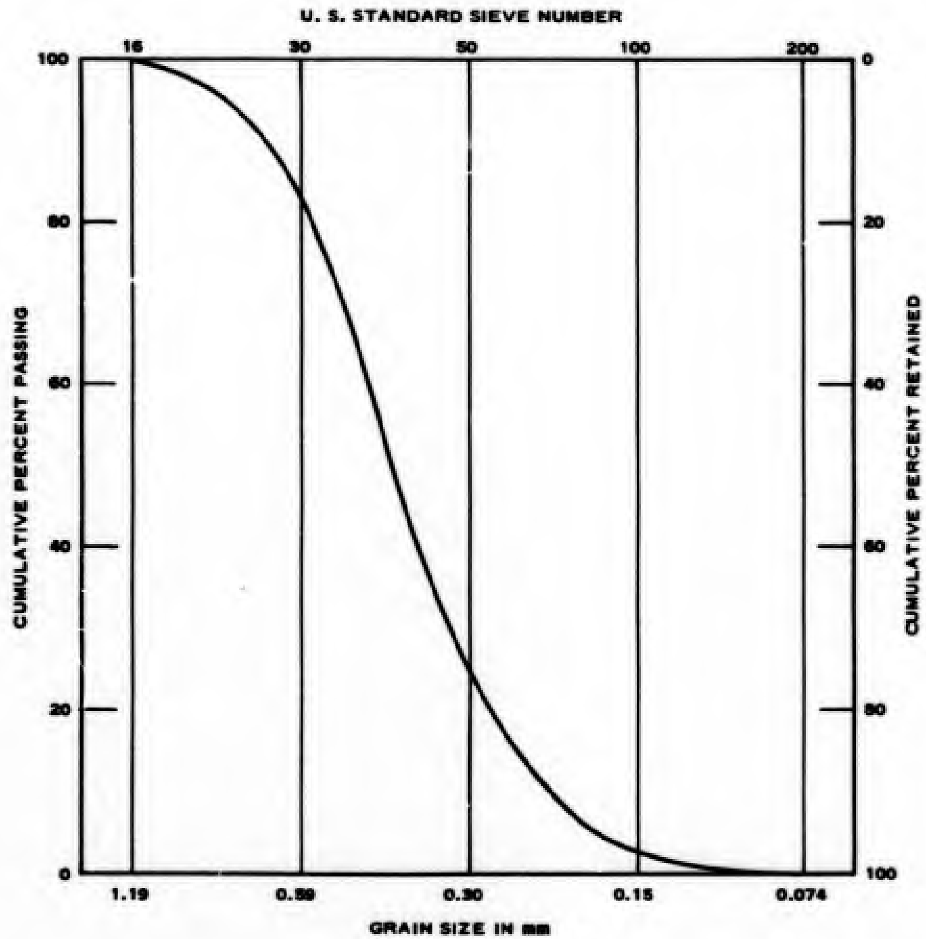
GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.20	0.29	99.71
30	12.43	18.16	81.84
50	40.33	76.11	23.89
100	15.00	97.67	2.33
200	1.50	99.83	0.17
PAN	0.12	100.00	0.00
TOTAL	69.58	——	——

REPORTED DEPTH IN FT

1720.0 – 1721.5

GRADATION OF INSOLUBLE RESIDUE
HOLE WP-1
CORE TAT-1-DC-15

PLATE 45



GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.06	0.02	99.98
30	32.85	16.61	83.39
50	118.24	76.31	23.69
100	42.14	97.59	2.41
200	4.23	99.73	0.27
PAN	0.54	100.00	0.00
TOTAL	198.06	——	——

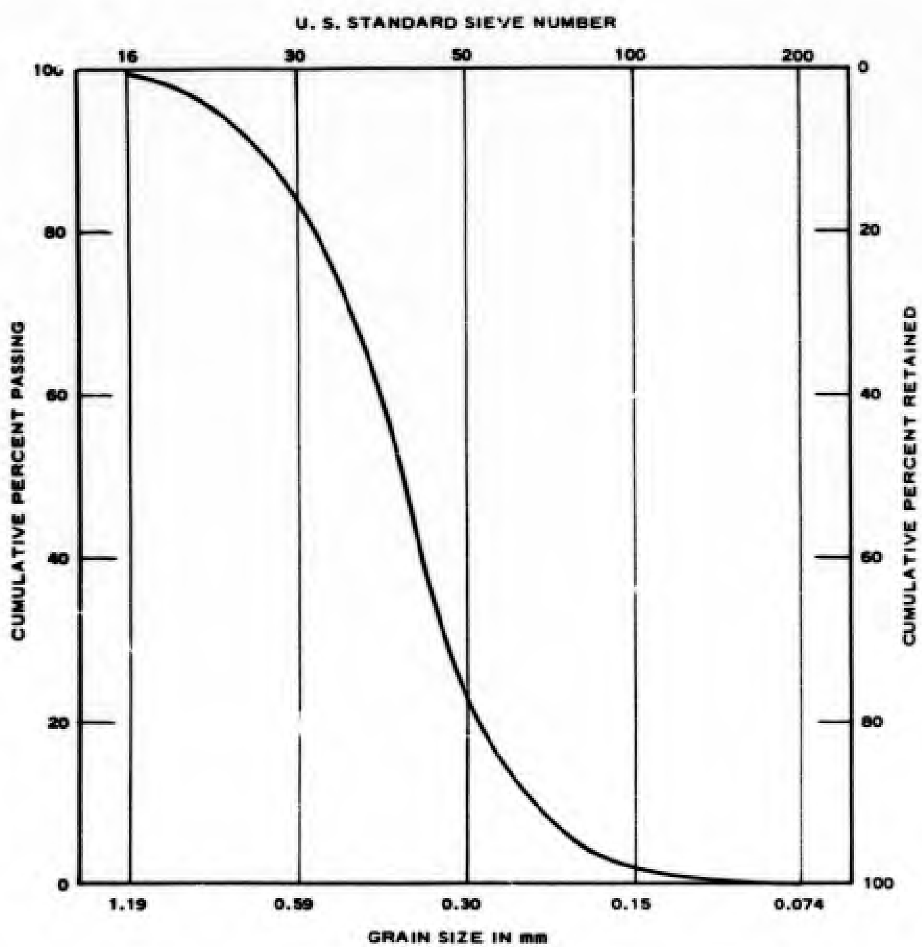
REPORTED DEPTH IN FT

1822.5–1824.2

GRADATION OF INSOLUBLE RESIDUE

HOLE WP-1

CORE TAT-1-DC-16A



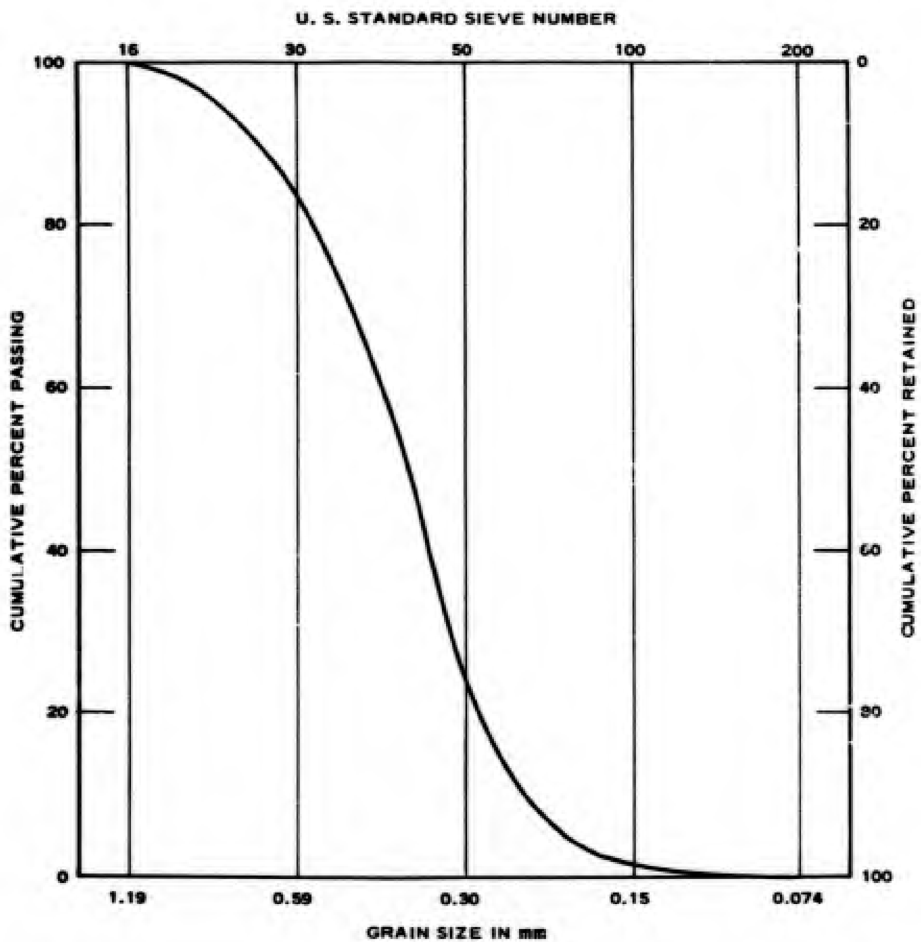
GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.11	0.11	99.89
30	14.45	14.92	85.08
50	60.16	76.88	23.42
100	20.86	97.96	2.04
200	1.80	99.81	0.19
PAN	0.18	100.00	0.00
TOTAL	97.56	——	——

REPORTED DEPTH IN FT

1947.2 - 1949.0

GRADATION OF
INSOLUBLE RESIDUE
HOLE WP-1
CORE TAT-1-DC-25

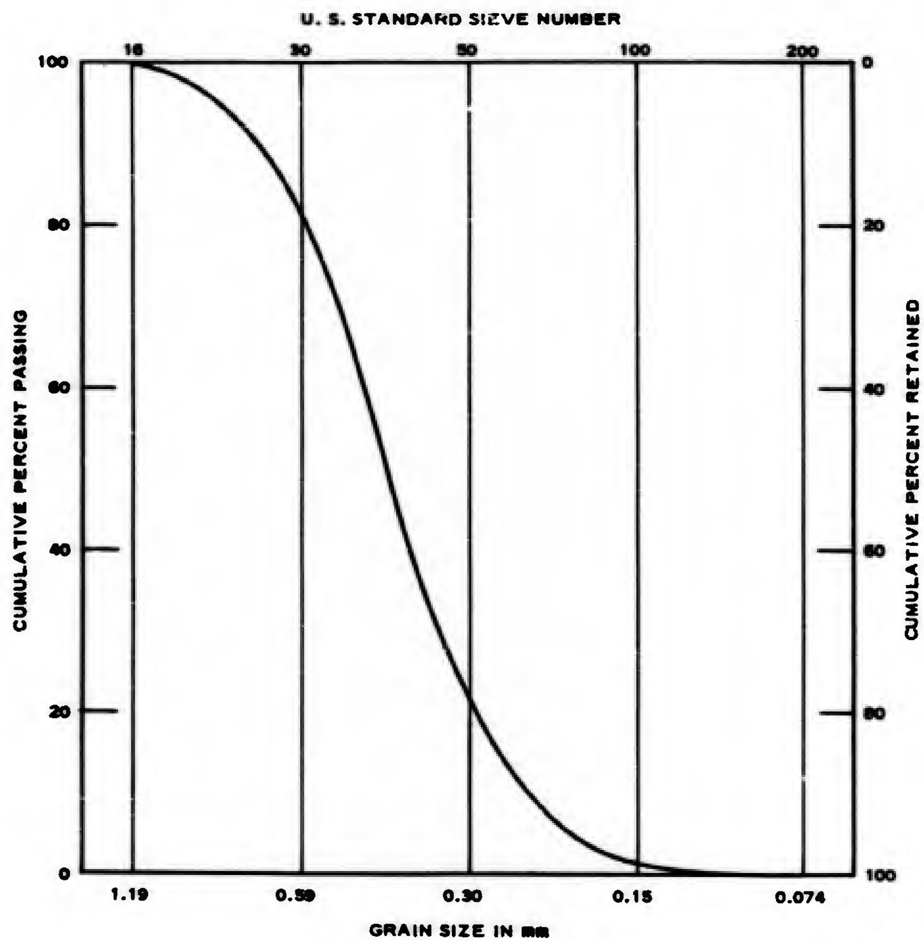
PLATE 47



GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT RETAINED	CUMULATIVE PERCENT PASSING
8	0.00	0.00	100.00
16	0.17	0.11	99.89
30	24.01	15.72	84.28
50	94.48	77.16	22.84
100	32.18	98.08	1.92
200	2.67	99.82	0.18
PAN	0.28	100.00	0.00
TOTAL	153.79	——	——

REPORTED DEPTH IN FT
1994.5 – 1995.6

GRADATION OF INSOLUBLE RESIDUE
HOLE WP-1
CORE TAT-1-DC-26

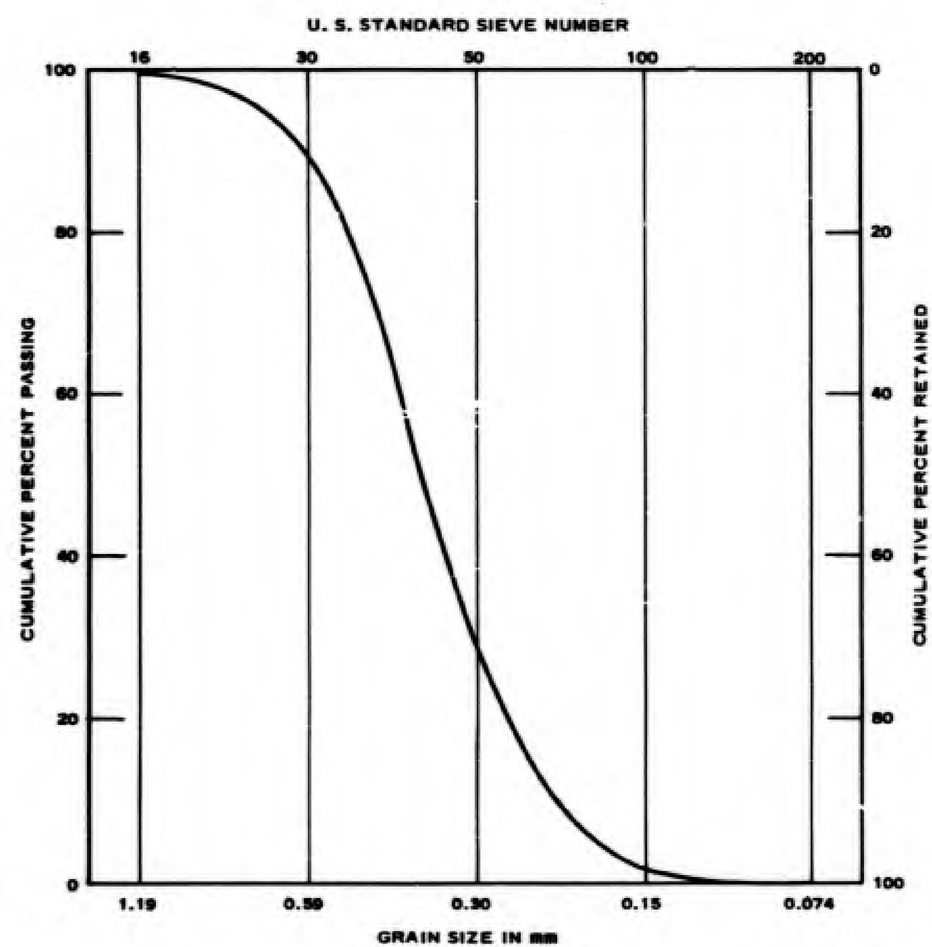


GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.22	0.12	99.88
30	33.03	18.11	81.89
50	112.68	79.48	20.52
100	34.52	98.28	1.72
200	2.73	99.77	0.23
PAN	0.43	100.00	0.00
TOTAL	183.61	——	——

REPORTED DEPTH IN FT

2035.0 – 2036.4

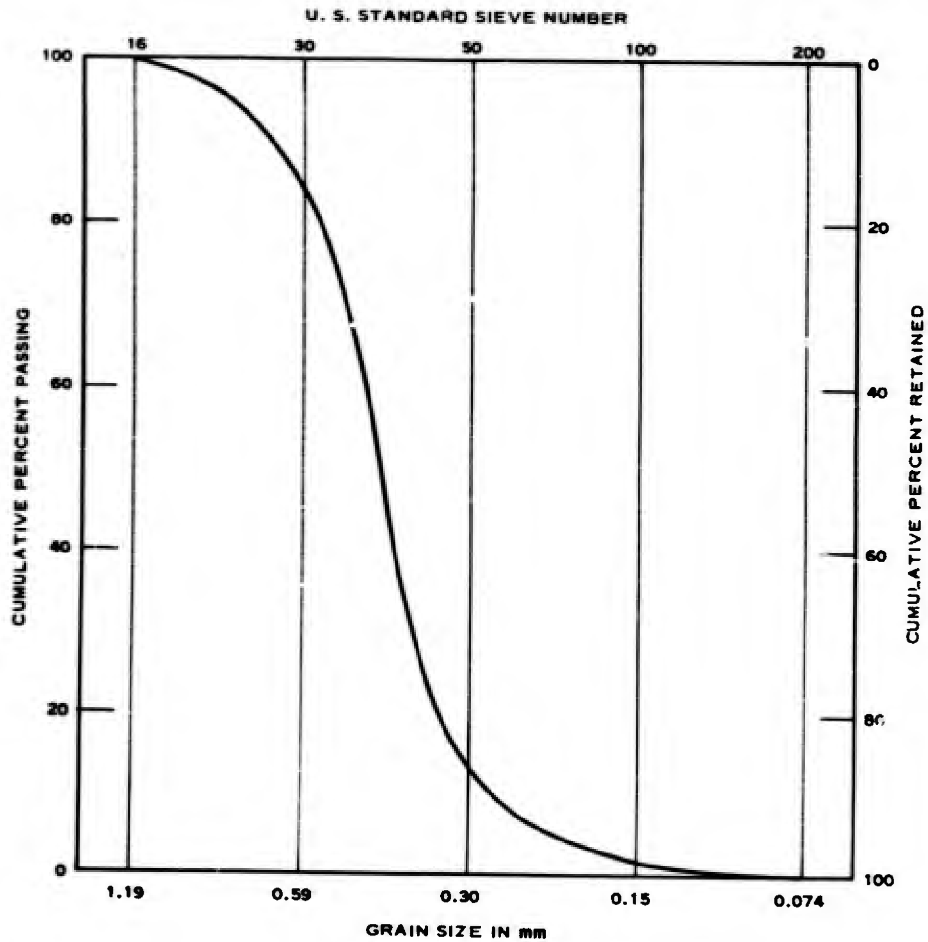
GRADATION OF
INSOLUBLE RESIDUE
HOLE WP-1
CORE TAT-1-DC-28



GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.02	0.03	99.97
30	5.28	9.44	90.56
50	34.90	71.64	28.36
100	14.42	97.33	2.67
200	1.34	99.72	0.28
PAN	0.16	100.00	0.00
TOTAL	56.12	——	——

REPORTED DEPTH IN FT
2196.5–2198.0

GRADATION OF
INSOLUBLE RESIDUE
HOLE WP-1
CORE TAT-1-DC-23



GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.18	0.14	99.86
30	21.84	16.98	83.02
50	77.78	76.96	23.04
100	27.33	98.03	1.97
200	2.32	99.82	0.18
PAN	0.23	100.00	0.00
TOTAL	129.88	——	——

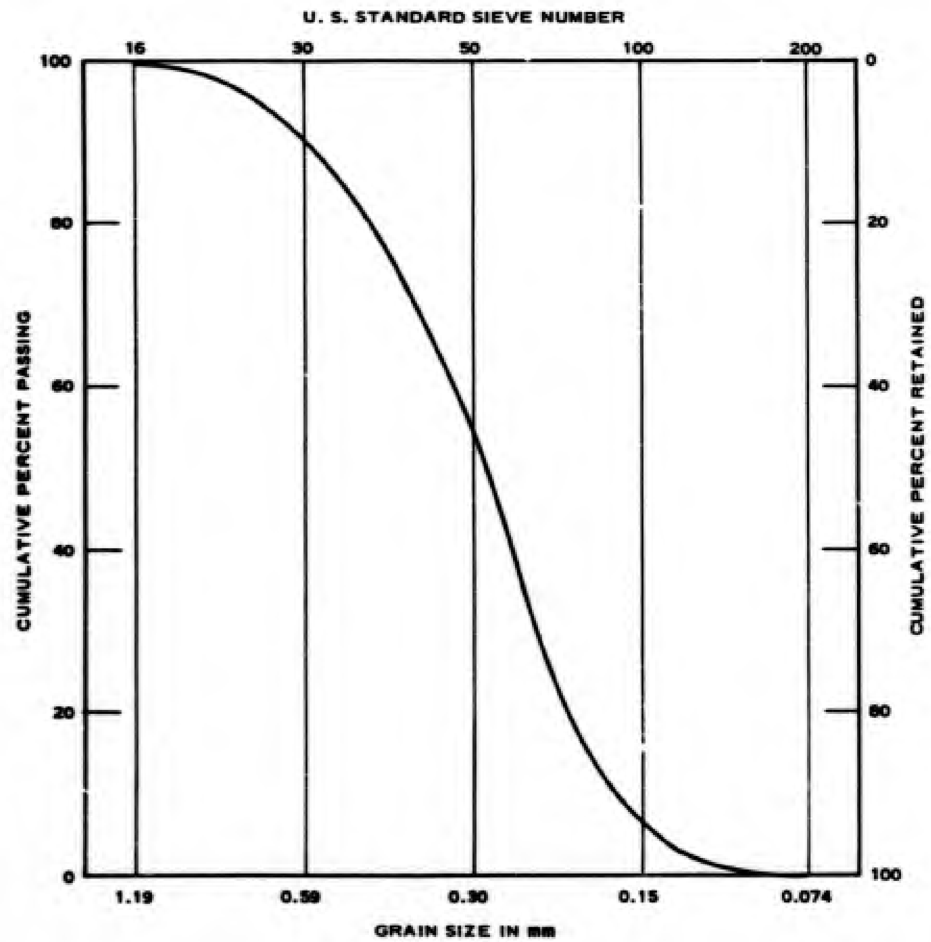
REPORTED DEPTH IN FT

2249.0 – 2252.0

GRADATION OF INSOLUBLE RESIDUE

HOLE WP-1

CORE TAT-1-DC-2

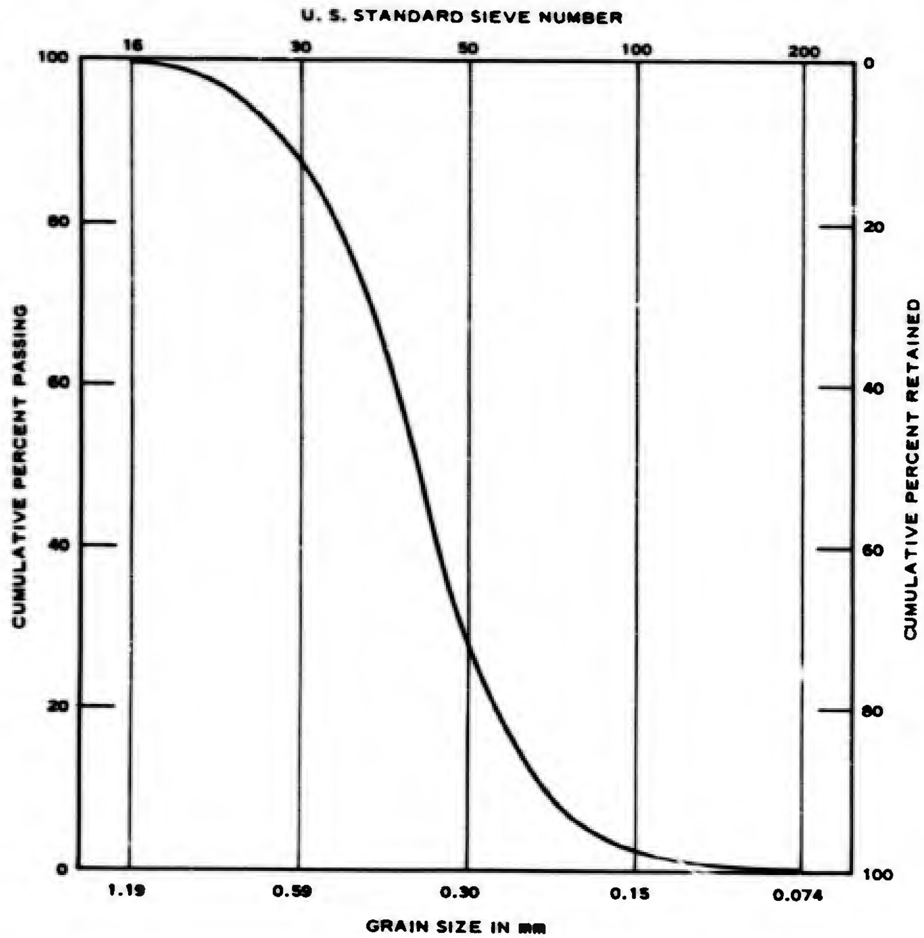


GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.00	0.00	100.00
30	0.50	4.33	95.67
50	6.18	57.83	42.17
100	4.25	94.63	5.37
200	0.56	99.48	0.52
PAN	0.06	100.00	0.00
TOTAL	11.55	——	——

REPORTED DEPTH IN FT

2333.0 – 2335.0

GRADATION OF INSOLUBLE RESIDUE
HOLE WP-1
CORE TAT-1-DC-5

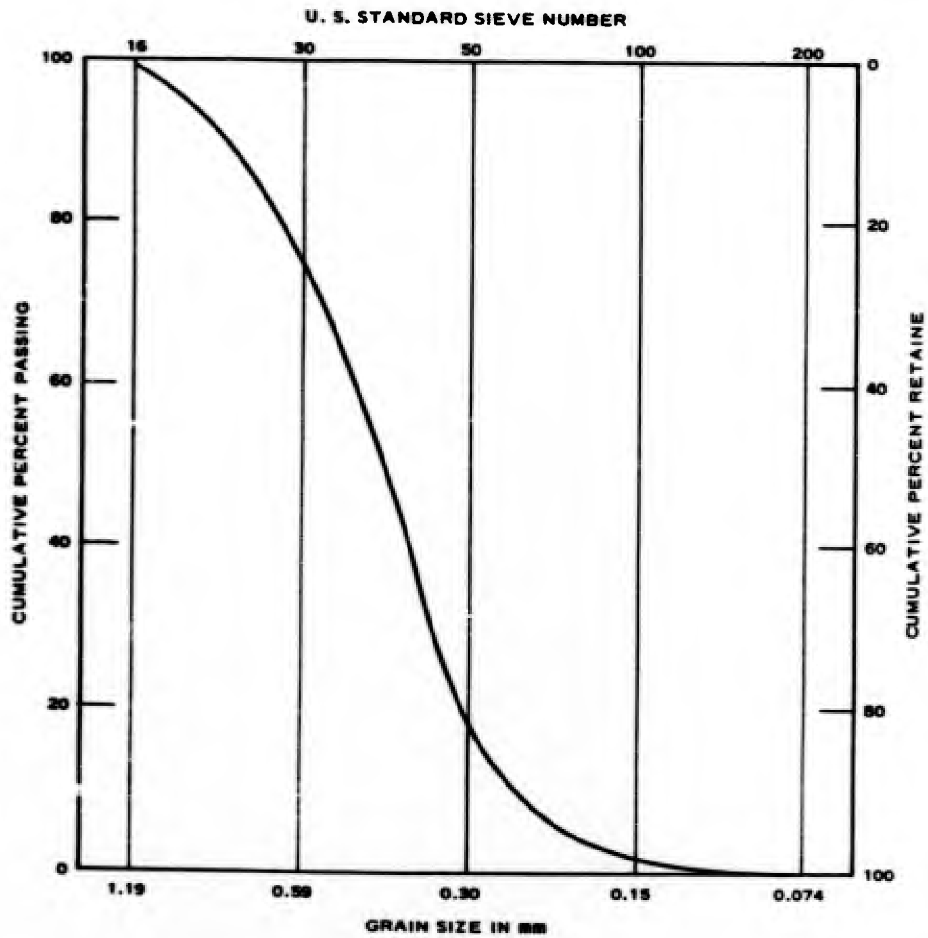


GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.10	0.11	99.89
30	11.74	13.26	86.74
50	53.56	73.27	26.73
100	21.27	97.10	2.90
200	2.26	99.63	0.37
PAN	0.33	100.00	0.00
TOTAL	89.25	—	—

REPORTED DEPTH IN FT

2398.8 – 2400.5

GRADATION OF
INSOLUBLE RESIDUE
HOLE WP-1
CORE TAT-1-DC-44A

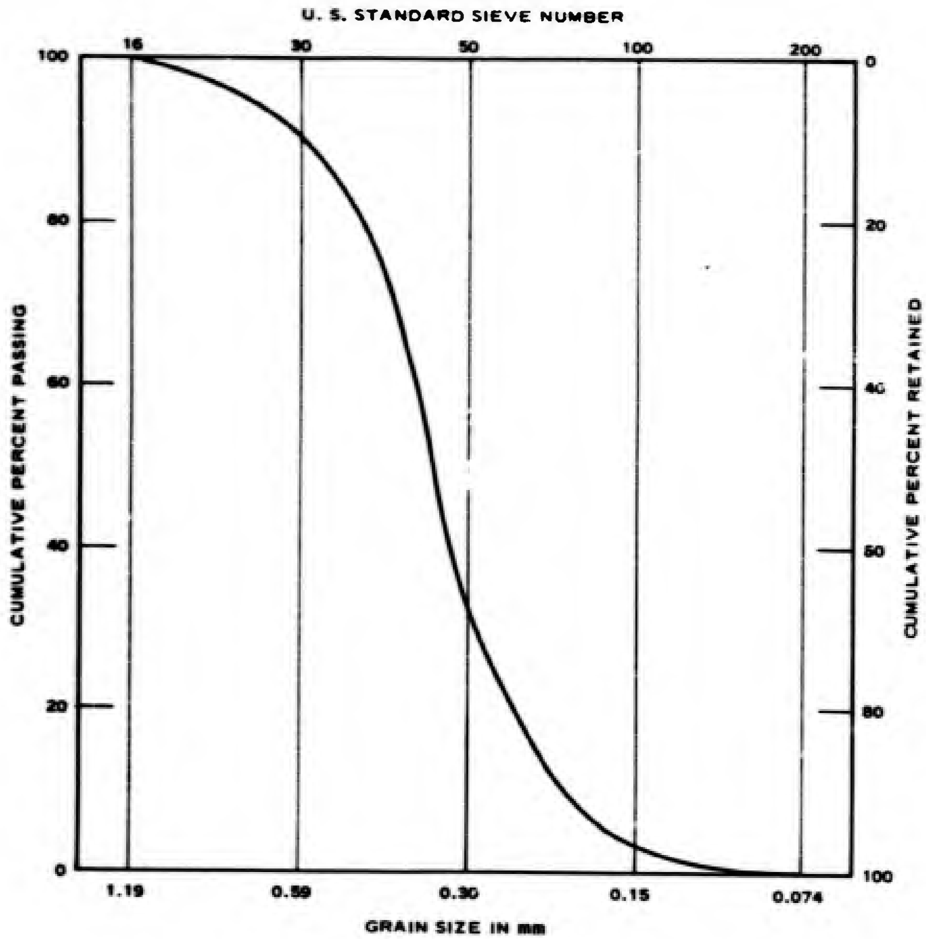


GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.78	0.43	99.57
30	44.31	25.10	74.50
50	101.80	81.61	18.39
100	29.91	98.26	1.74
200	2.79	99.81	0.19
PAN	0.34	100.00	0.00
TOTAL	179.63	——	——

REPORTED DEPTH IN FT
2453.2 - 2455.0

GRADATION OF INSOLUBLE RESIDUE

HOLE WP-1
CORE TAT-1-DC-37C



GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.00	0.00	100.00
30	3.49	8.07	91.93
50	25.62	67.28	32.72
100	12.56	96.31	3.69
200	1.43	99.61	0.39
PAN	0.17	100.00	0.00
TOTAL	43.27	——	——

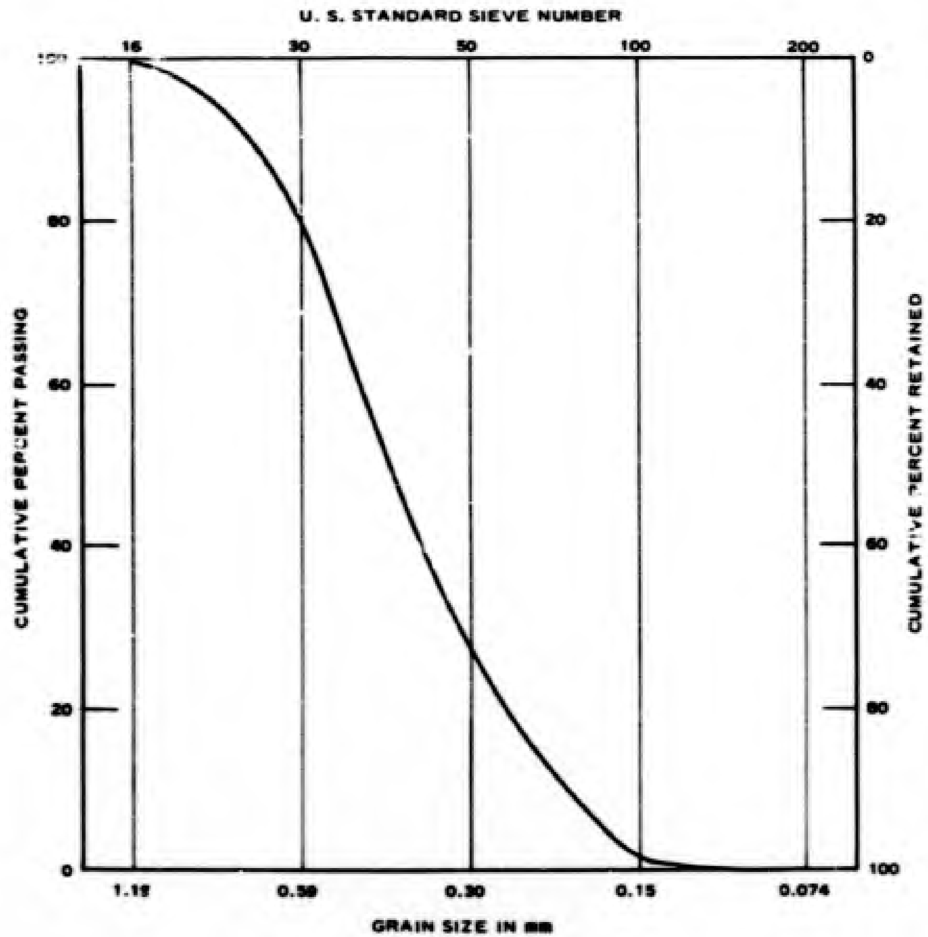
REPORTED DEPTH IN FT

2506.0 – 2507.5

GRADATION OF INSOLUBLE RESIDUE

HOLE WP-1

CORE TAT-1-DC-39B

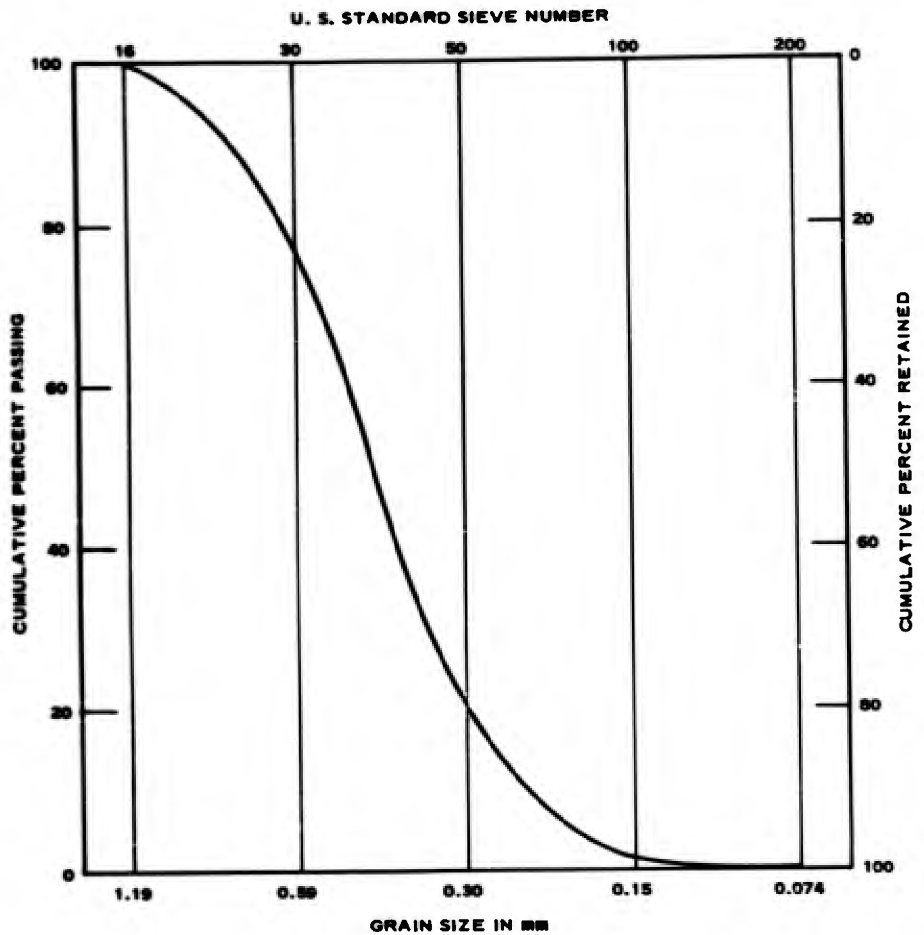


GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.20	0.24	99.76
30	16.73	20.03	79.97
50	50.03	79.20	20.80
100	15.91	98.02	1.98
200	1.48	99.77	0.23
PAN	0.19	100.00	0.00
TOTAL	84.84	——	——

REPORTED DEPTH IN FT

2539.5 – 2540.8

GRADATION OF INSOLUBLE RESIDUE
HOLE WP-1
CORE TAT-1-DC-46A



GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.62	0.38	99.62
30	38.98	23.95	76.05
50	94.00	80.79	19.21
100	28.46	98.00	2.00
200	2.87	99.74	0.26
PAN	0.43	100.00	0.00
TOTAL	165.36	——	——

REPORTED DEPTH IN FT

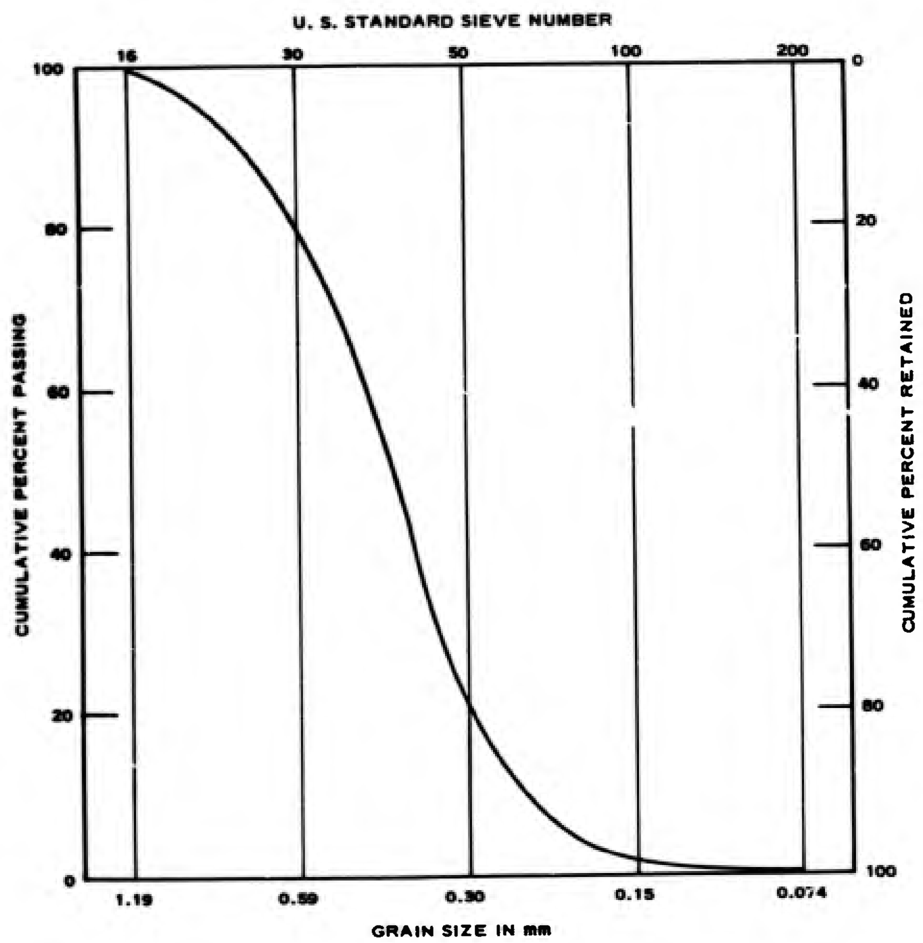
2557.0 – 2559.5

GRADATION OF INSOLUBLE RESIDUE

HOLE WP-1

CORE TAT-1-DC-67A

PLATE 57



GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.38	0.30	99.70
30	26.61	20.95	79.05
50	75.00	79.15	20.85
100	24.27	97.98	2.02
200	2.31	99.77	0.23
PAN	0.29	100.00	0.00
TOTAL	128.86	——	——

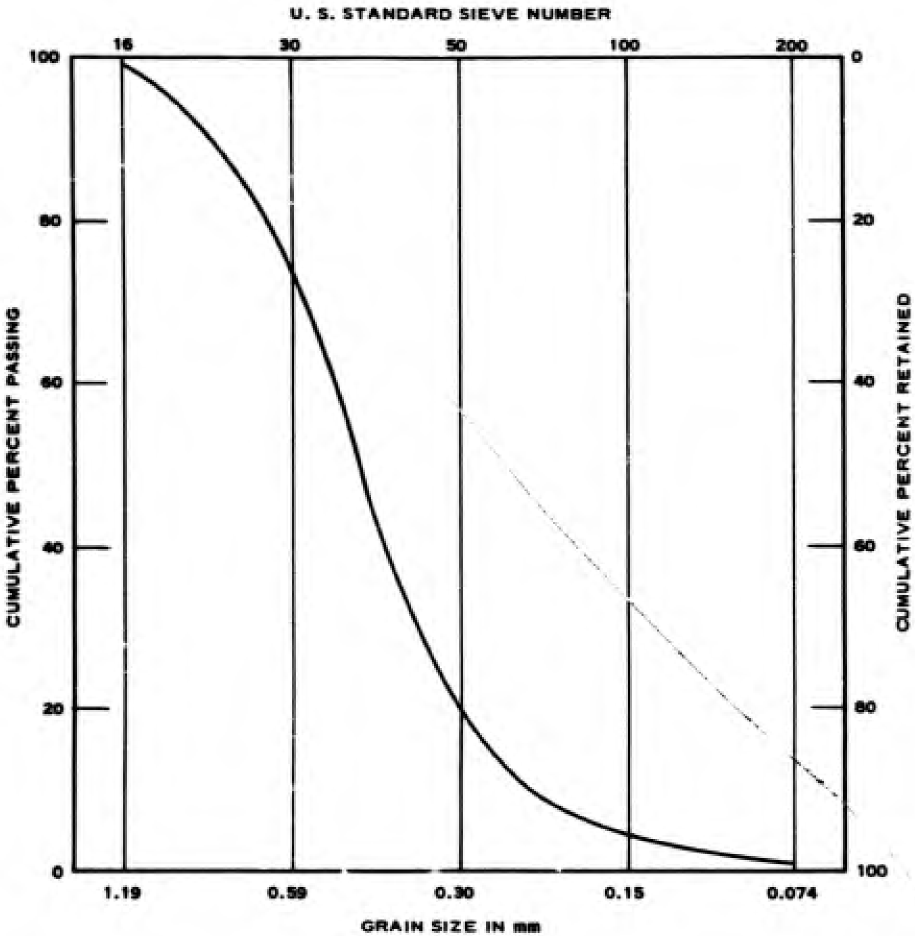
REPORTED DEPTH IN FT

2584.0 – 2585.3

GRADATION OF INSOLUBLE RESIDUE

HOLE WP-1

CORE TAT-1-DC-56A

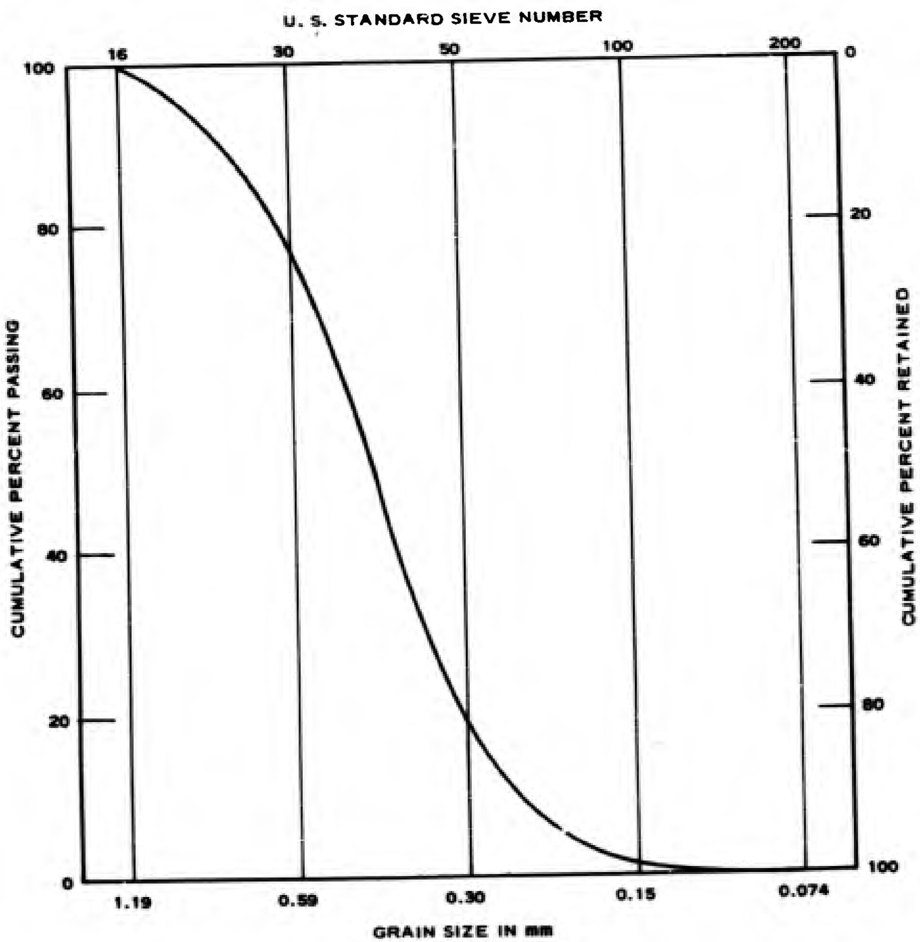


GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.80	0.69	99.31
30	30.04	26.61	73.39
50	62.16	80.25	19.75
100	20.25	97.73	2.27
200	2.28	99.70	0.30
PAN	0.35	100.00	0.00
TOTAL	115.88	——	——

REPORTED DEPTH IN FT

2629.3-2630.5

GRADATION OF INSOLUBLE RESIDUE
HOLE WP-1
CORE TAT-1-DC-59A

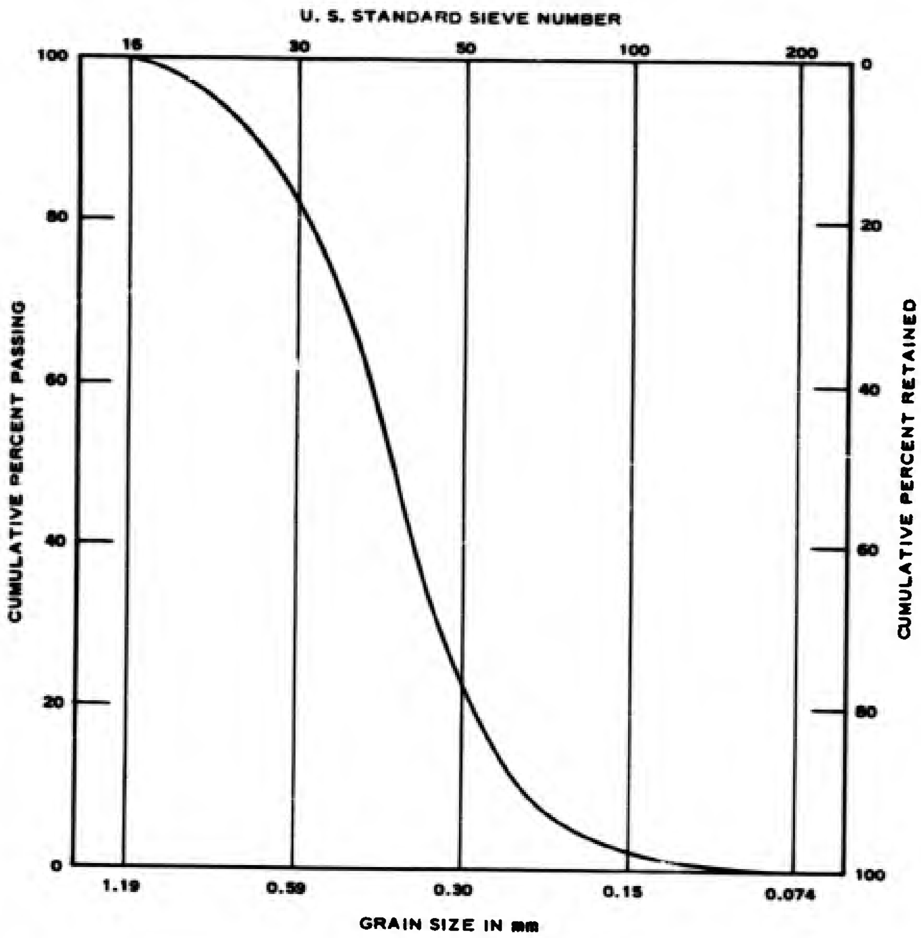


GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.45	0.35	99.65
30	31.02	24.89	75.11
50	72.47	82.22	17.78
100	20.46	98.41	1.59
200	1.75	99.79	0.21
PAN	0.26	100.00	0.00
TOTAL	126.41	——	——

REPORTED DEPTH IN FT

2683.7-2685.5

GRADATION OF INSOLUBLE RESIDUE
HOLE WP-1
CORE TAT-1-DC-61



GRADING			
SIEVE NO.	WEIGHT g	CUMULATIVE PERCENT	
		RETAINED	PASSING
8	0.00	0.00	100.00
16	0.26	0.23	99.77
30	21.05	19.01	80.99
50	66.13	78.01	21.99
100	22.30	97.91	2.09
200	2.09	99.77	0.23
PAN	0.26	100.00	0.00
TOTAL	112.09	——	——

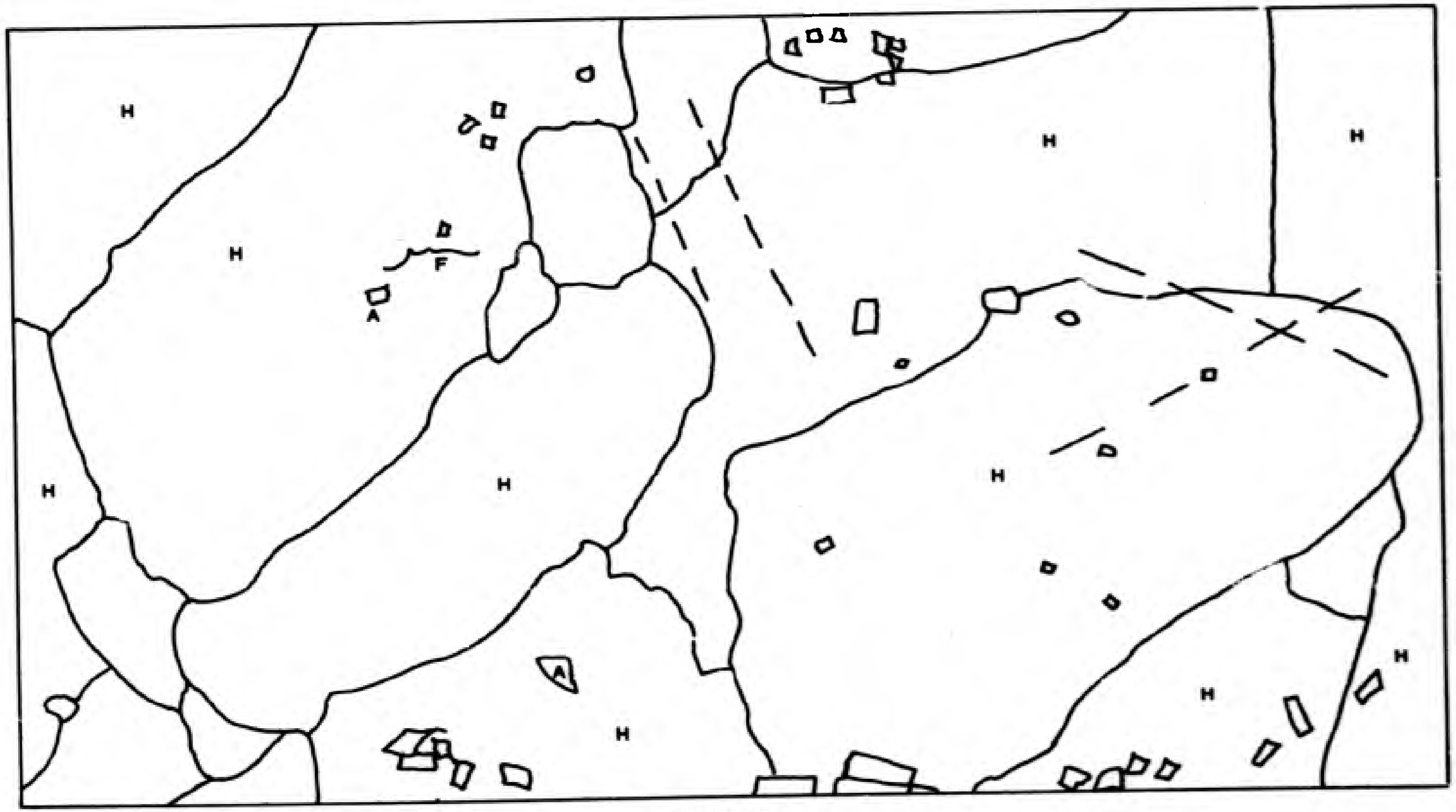
REPORTED DEPTH IN FT

1553.5-2685.5

GRADATION OF INSOLUBLE RESIDUES

COMPOSITE OF 20 CORES

HOLE WP-1



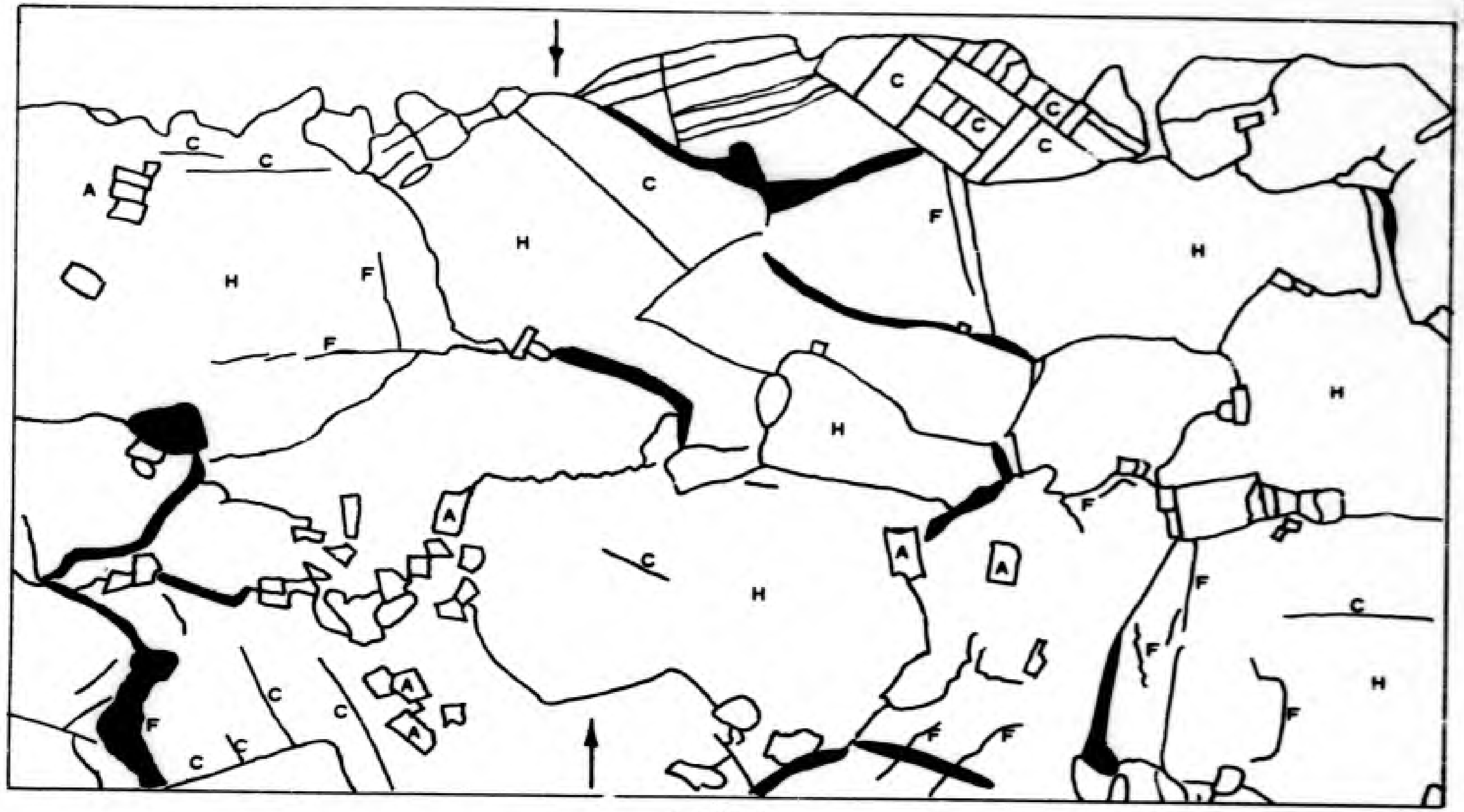
LEGEND

A = ANHYDRITE, H = HALITE, DASHED LINES = GHOSTS OF ORIGINAL GRAIN BOUNDARIES.

NOTE: CORE NXC-11 WAS AN UNTESTED CORE FROM HOLE WP-4.

MAGNIFICATION, × 10.

TRACING OF PORTION OF THIN SECTION FROM TOP OF CORE NXC-11



LEGEND

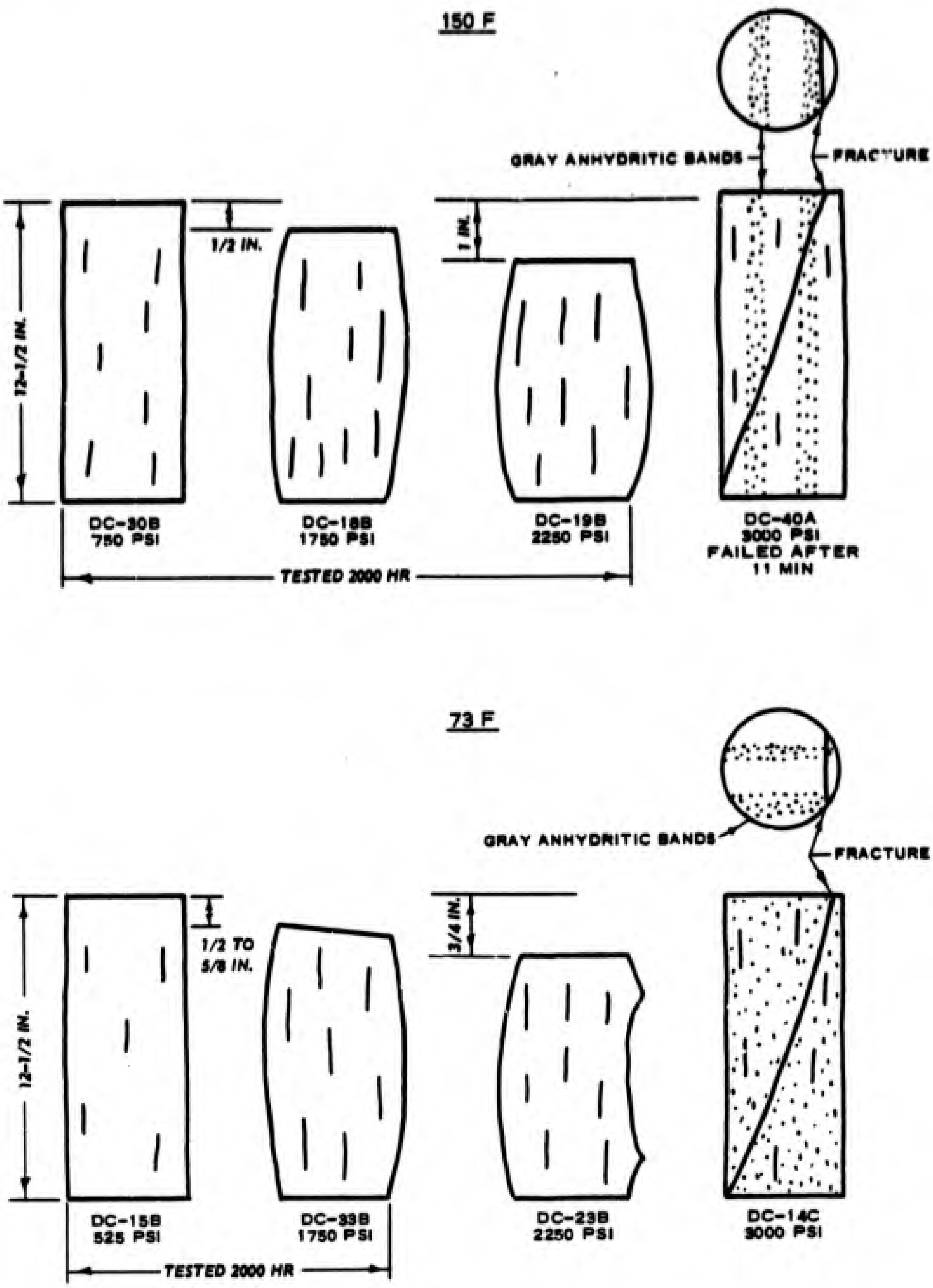
A = ANHYDRITE, C = CLEAVAGE TRACE, F = FRACTURE, H = HALITE, HEAVY LINES = OPEN GRAIN BOUNDARIES OR LOST GRAINS. ARROWS INDICATE COMPRESSIVE FORCE.

NOTE: CORE DC-19B (FROM HOLE WP-1) WAS TESTED 2000 HR FOR CREEP AT 2250 PSI AND 150 F.

MAGNIFICATION, × 10.

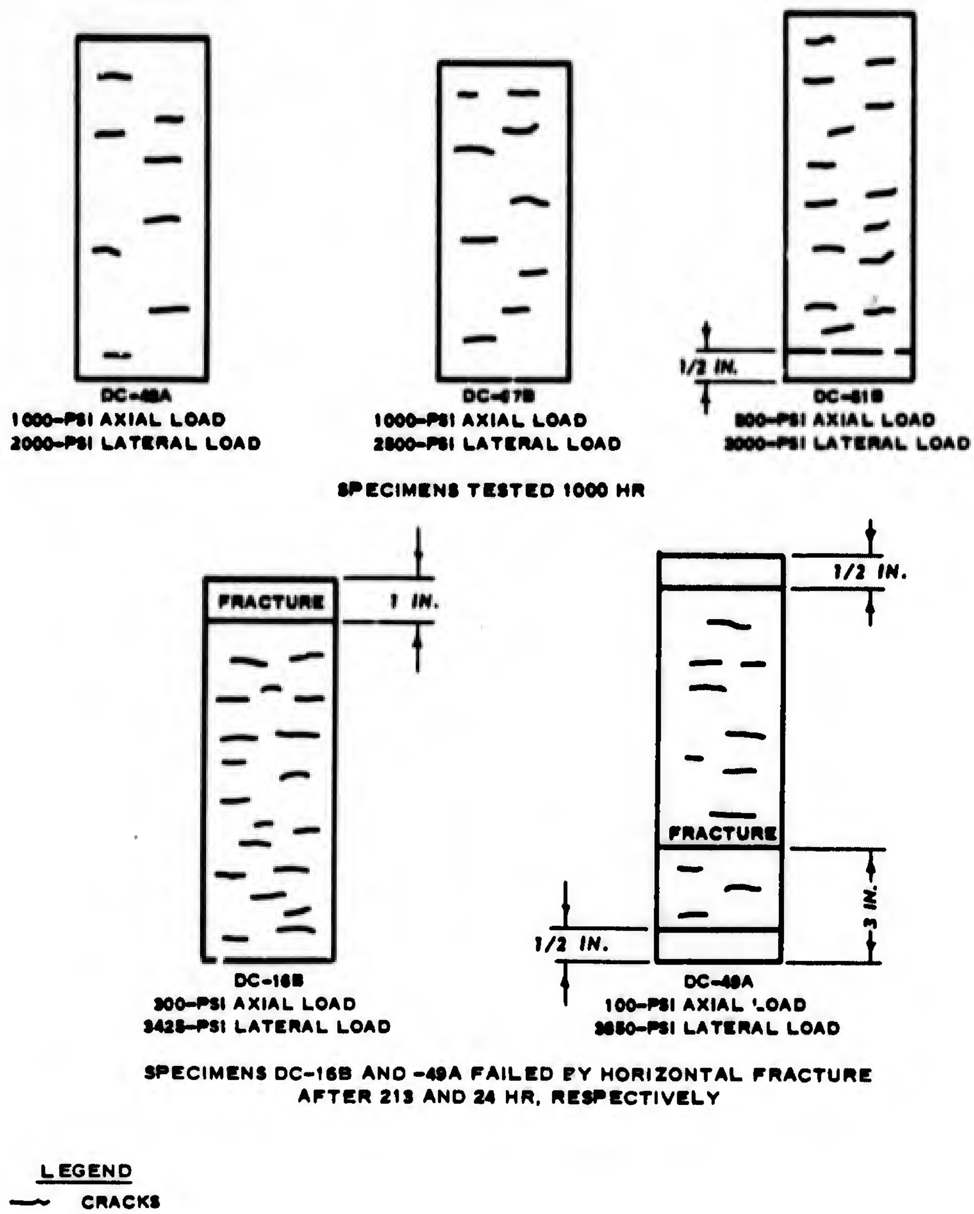
TRACING OF PORTION OF THIN SECTION FROM CORE DC-19B

PLATE 63

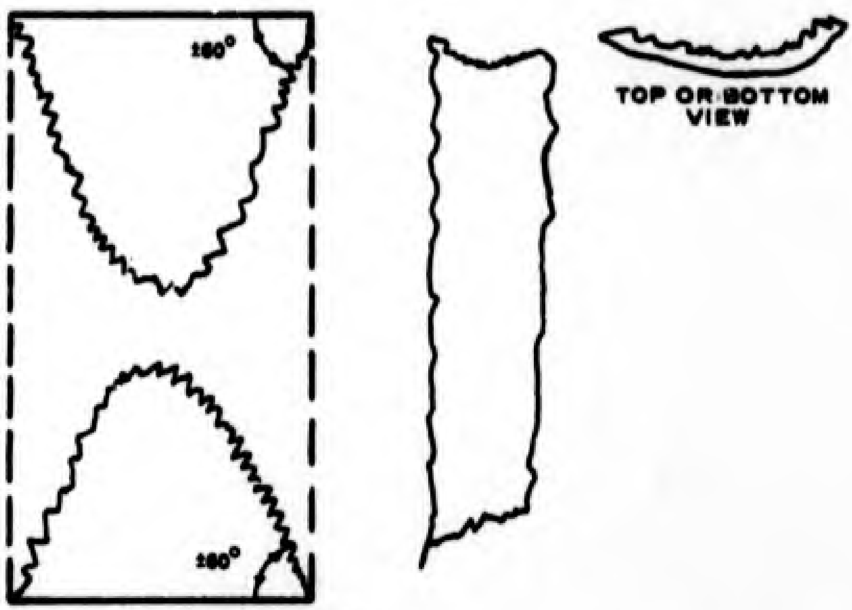


NOTE: FRACTURES SHOWN AS SHORT VERTICAL LINES.

SKETCHES OF SALT CORES
AFTER CREEP TESTING



SKETCHES OF
SALT CORES AFTER
TRIAXIAL EXTENSION TEST



FRONT VIEW

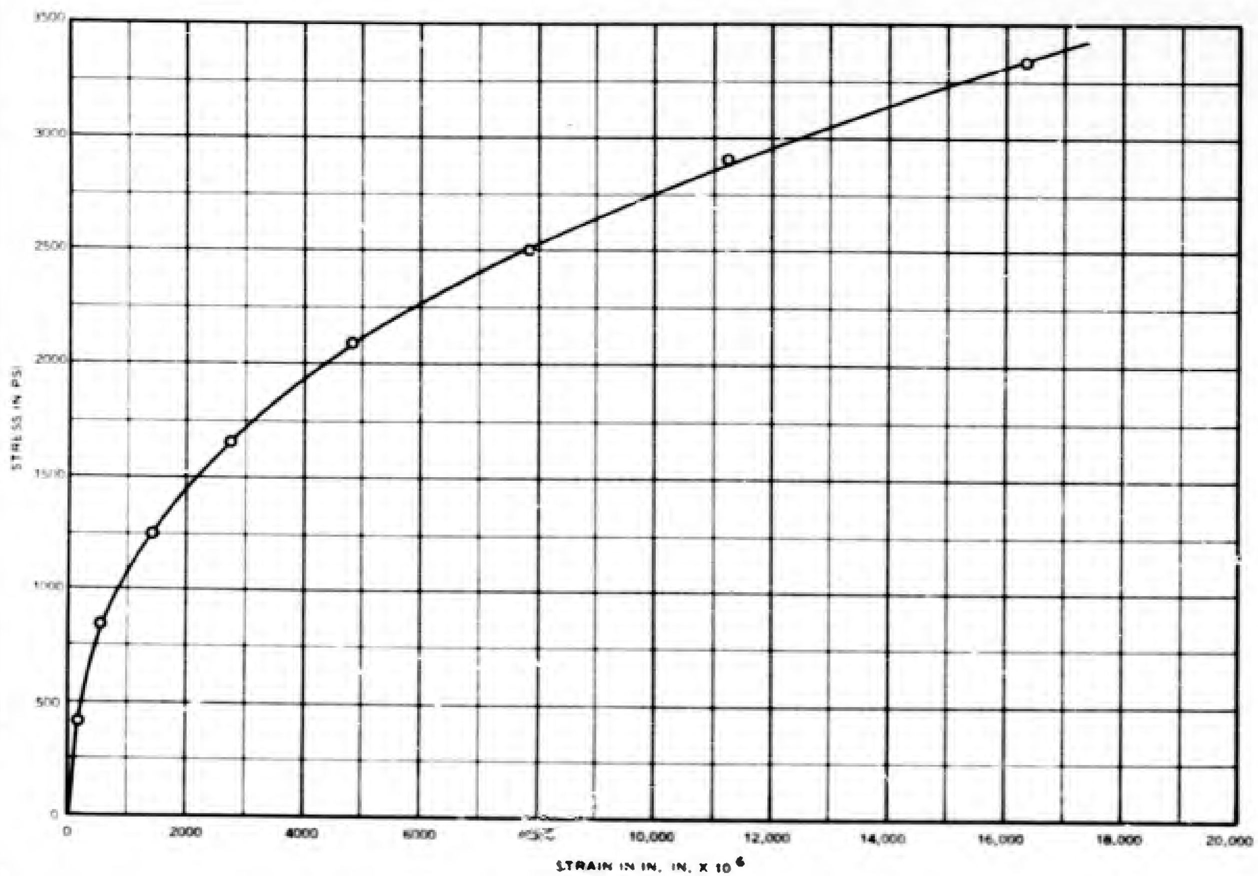
NOTE: THE ABOVE VIEWS ILLUSTRATE THE TYPE OF FAILURE WHICH CORES HAD OR TENDED TO HAVE.

LEGEND

— — PRETEST CORE

——— POSTTEST CORE

SKETCHES OF SALT CORE AND SURFACE FRAGMENT THEREFROM AFTER FAILURE IN COMPRESSION TEST



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 15 SEPT 1961

CORE DEPTH: 2341.0 FT TO 2344.0 FT

DIAMETER: 4.94 IN.

SPECIMEN LENGTH: 10.60 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

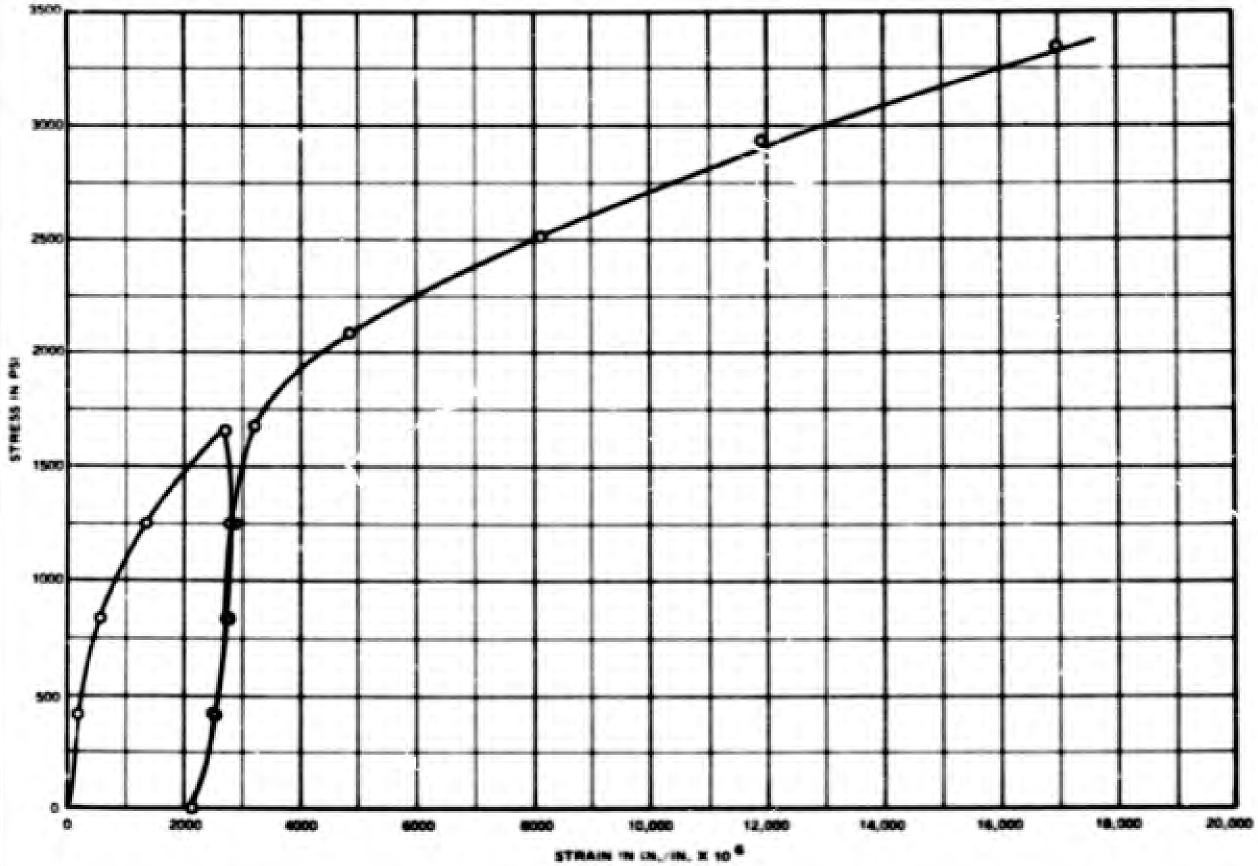
METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

STRESS, PSI	AVG STRAIN, IN./IN. X 10^6
0	0
420	183
840	500
1,250	1,300
1,670	2,767
2,090	4,833
2,500	7,850
2,920	11,250
3,340	16,333
3,590 ULTIMATE STRENGTH	

STRESS-STRAIN CURVE

STANDARD UNIAXIAL COMPRESSIVE STRENGTH TEST

HOLE WP-1 - SPECIMEN 4B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 15 SEPT 1961

CORE DEPTH: 2341.0 FT TO 2344.0 FT

DIAMETER: 4.94 IN.

SPECIMEN LENGTH: 10.50 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

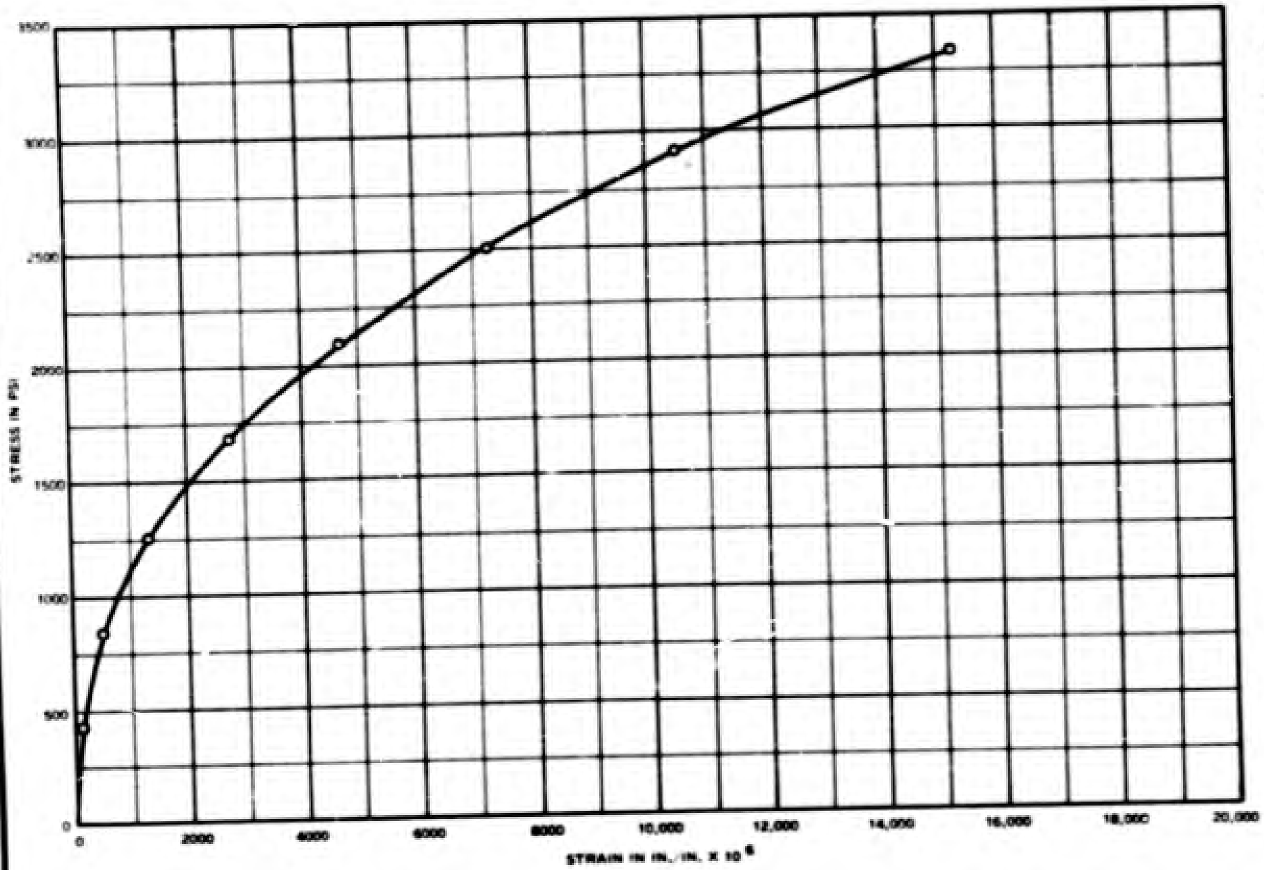
METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

STRESS, PSI	AVG STRAIN, IN./IN. x 10^6
0	0
420	192
840	550
1,250	1,308
1,670	2,683
1,250	2,808
840	2,717
420	2,592
0	2,125
420	2,533
840	2,692
1,250	2,825
1,670	3,225
2,090	4,842
2,500	8,125
2,920	11,892
3,340	16,975
3,550 ULTIMATE STRENGTH	

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSIVE STRENGTH TEST WITH ONE UNLOADING CYCLE

HOLE WP-1 - SPECIMEN 4D



HOLE COORDINATES:
N 10166.85, E 8040.83

DATE: 15 SEPT 1981

CORE DEPTH:
2398.8 FT TO 2400.5 FT

DIAMETER:
4.94 IN.

SPECIMEN LENGTH:
10.59 IN. (INCLUDING CAP)

RATE OF LOAD:
20 PSI/SEC

METHOD OF SAWING TO LENGTH:
BRINE SOLUTION (DIAMOND SAW)

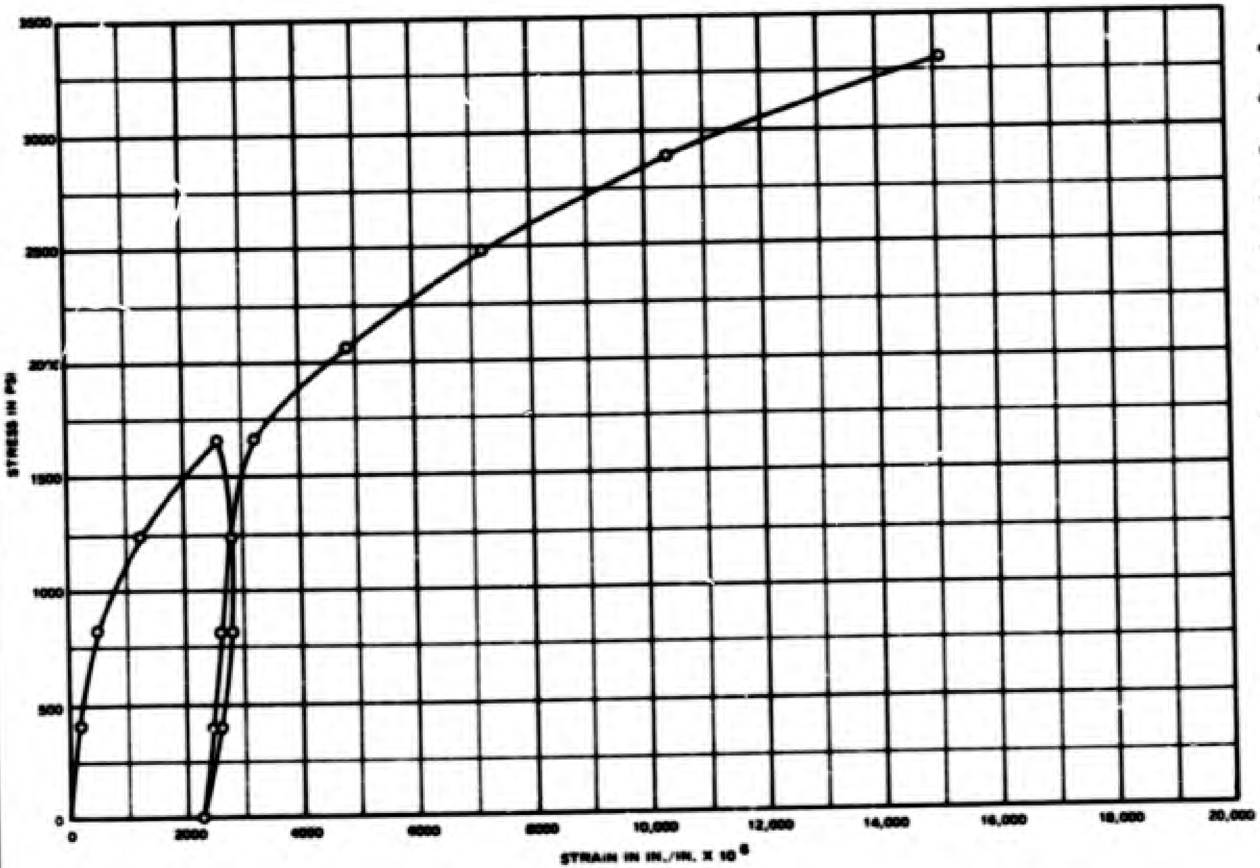
METHOD OF END PREPARATION:
CAPPED WITH SULFUR-SILICA COMPOUND

STRESS, PSI	AVG STRAIN, IN./IN. X 10^6
0	0
420	190
840	509
1,250	1,333
1,670	2,758
2,100	4,687
2,500	7,217
2,920	10,525
3,340	15,275
3,700 ULTIMATE STRENGTH	

STRESS-STRAIN CURVE

STANDARD UNIAXIAL COMPRESSIVE STRENGTH TEST

HOLE WP-1 - SPECIMEN 44B



HOLE COORDINATES:
N 10166.85, E 8040.83

DATE: 15 SEPT 1961

CORE DEPTH:
2406.0 FT TO 2407.2 FT

DIAMETER:
4.96 IN.

SPECIMEN LENGTH:
10.65 IN. (INCLUDING CAP)

RATE OF LOAD:
20 PSI/SEC

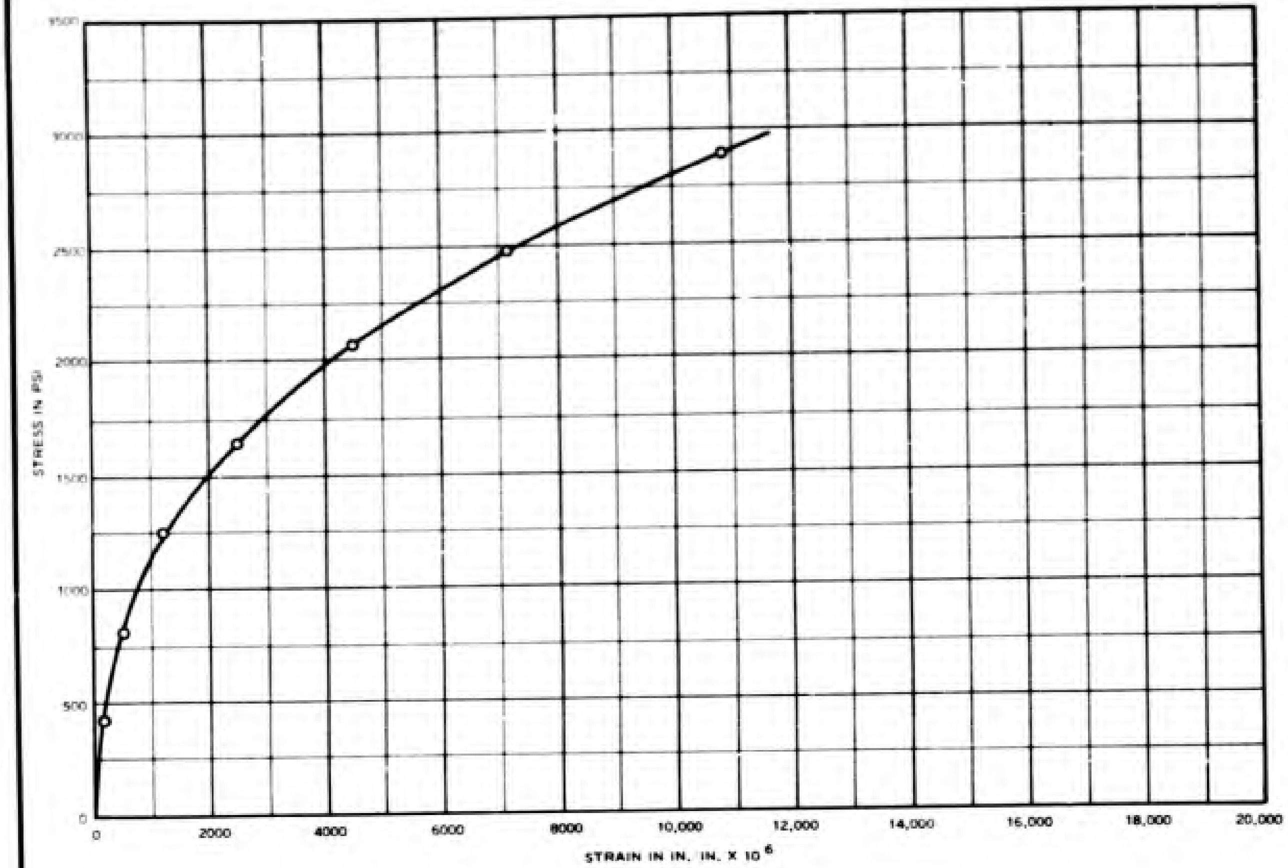
METHOD OF SAWING TO LENGTH:
BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION:
CAPPED WITH SULFUR-SILICA COMPOUND

STRESS, PSI	AVG STRAIN, IN./IN. X 10^{-6}
0	0
410	175
830	475
1,240	1,233
1,660	2,592
1,240	2,775
830	2,700
410	2,600
0	2,250
410	2,475
830	2,633
1,240	2,792
1,660	3,233
2,070	4,858
2,480	7,175
2,900	10,400
3,310	15,142
3,680 ULTIMATE STRENGTH	

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSIVE STRENGTH TEST WITH ONE UNLOADING CYCLE
HOLE WP-1 - SPECIMEN 41B



HOLE COORDINATES: DATE: 15 SEPT 1961
N 10166.65, E 0040.83

CORE DEPTH:
2459.5 FT TO 2463.0 FT

DIAMETER:
4.97 IN.

SPECIMEN LENGTH:
10.46 IN. (INCLUDING CAP)

RATE OF LOAD:
20 PSI/SEC

METHOD OF SAWING TO LENGTH:
DRY (DIAMOND SAW)

METHOD OF END PREPARATION:
CAPPED WITH SULFUR-SILICA COMPOUND

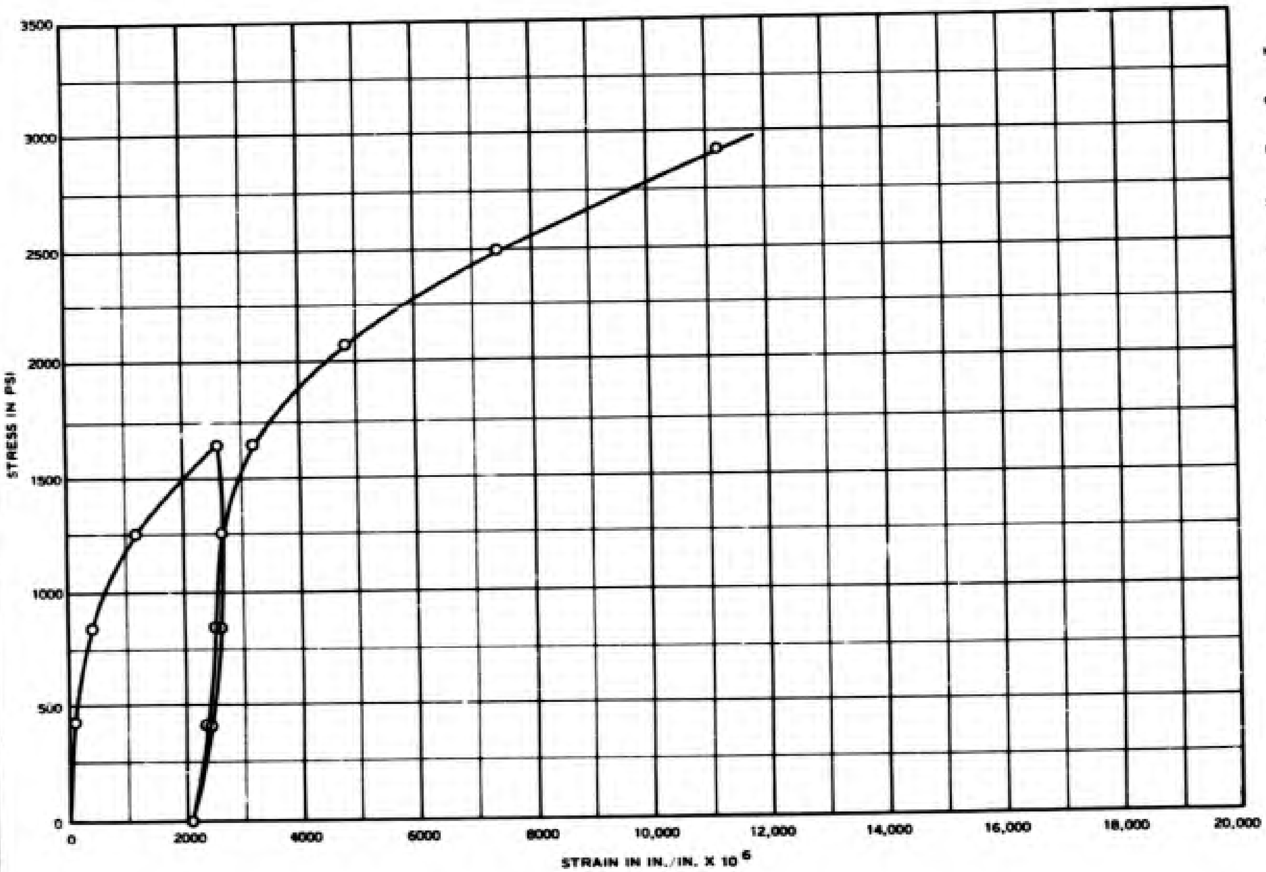
STRESS, PSI	AVG STRAIN, IN./IN. X 10 6
0	0
410	183
820	517
1,240	1,225
1,650	2,525
2,060	4,467
2,470	7,142
2,890	10,858
3,200 ULTIMATE STRENGTH	

STRESS-STRAIN CURVE

STANDARD UNIAXIAL COMPRESSIVE STRENGTH TEST

HOLE WP-1 - SPECIMEN 8C

PLATE 71



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 15 SEPT 1961

CORE DEPTH: 2459.5 FT TO 2463.0 FT

DIAMETER: 4.96 IN.

SPECIMEN LENGTH: 10.63 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

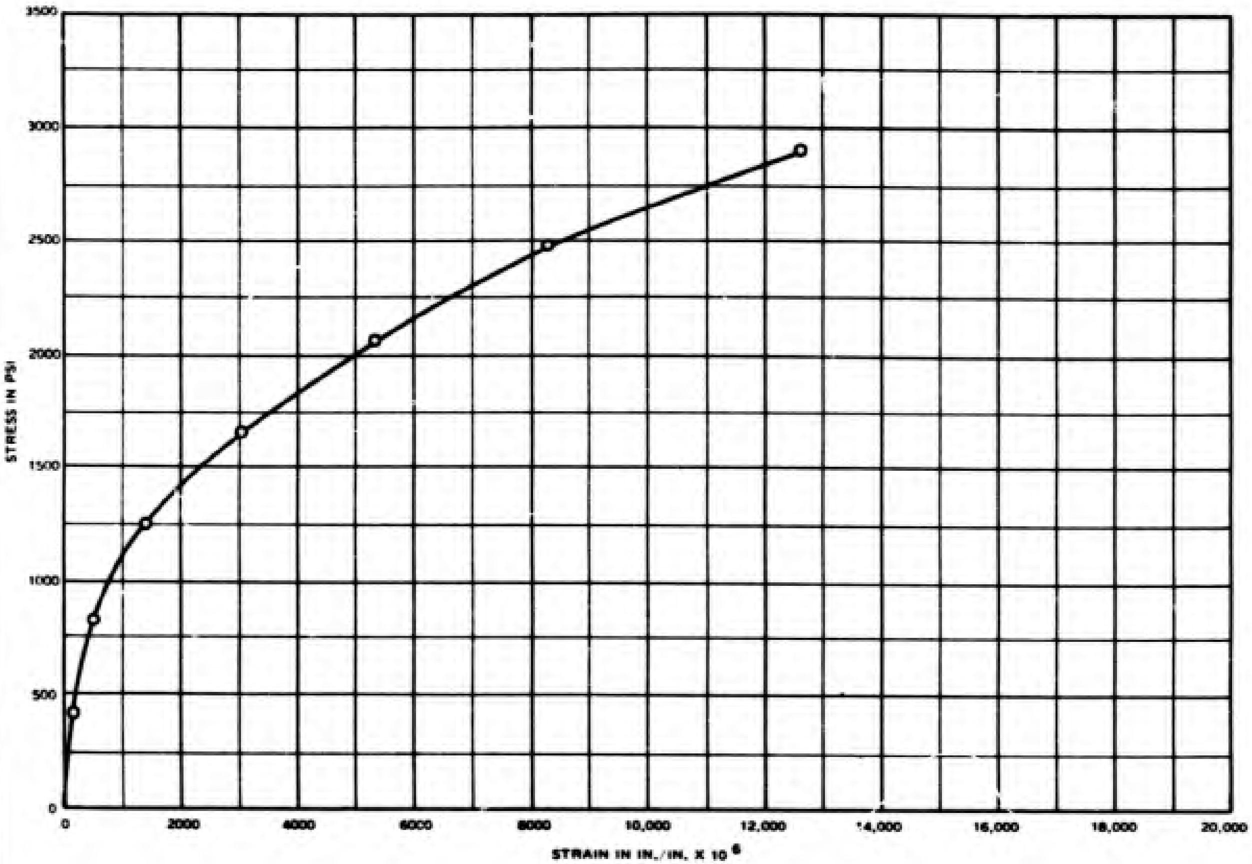
METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

STRESS, PSI	AVG STRAIN, IN./IN. X 10^6
0	0
410	150
830	450
1,240	1,200
1,660	2,658
1,240	2,750
830	2,658
410	2,525
0	2,100
410	2,475
830	2,625
1,240	2,775
1,660	3,233
2,070	4,808
2,480	7,425
2,900	11,208
3,230 ULTIMATE STRENGTH	

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSIVE STRENGTH TEST WITH ONE UNLOADING CYCLE HOLE WP-1 - SPECIMEN 8B



HOLE COORDINATES: N 10166.85, E 8040.83 — DATE: 15 SEPT 1961

CORE DEPTH: 2613.0 FT TO 2616.0 FT

DIAMETER: 4.96 IN.

SPECIMEN LENGTH: 10.48 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

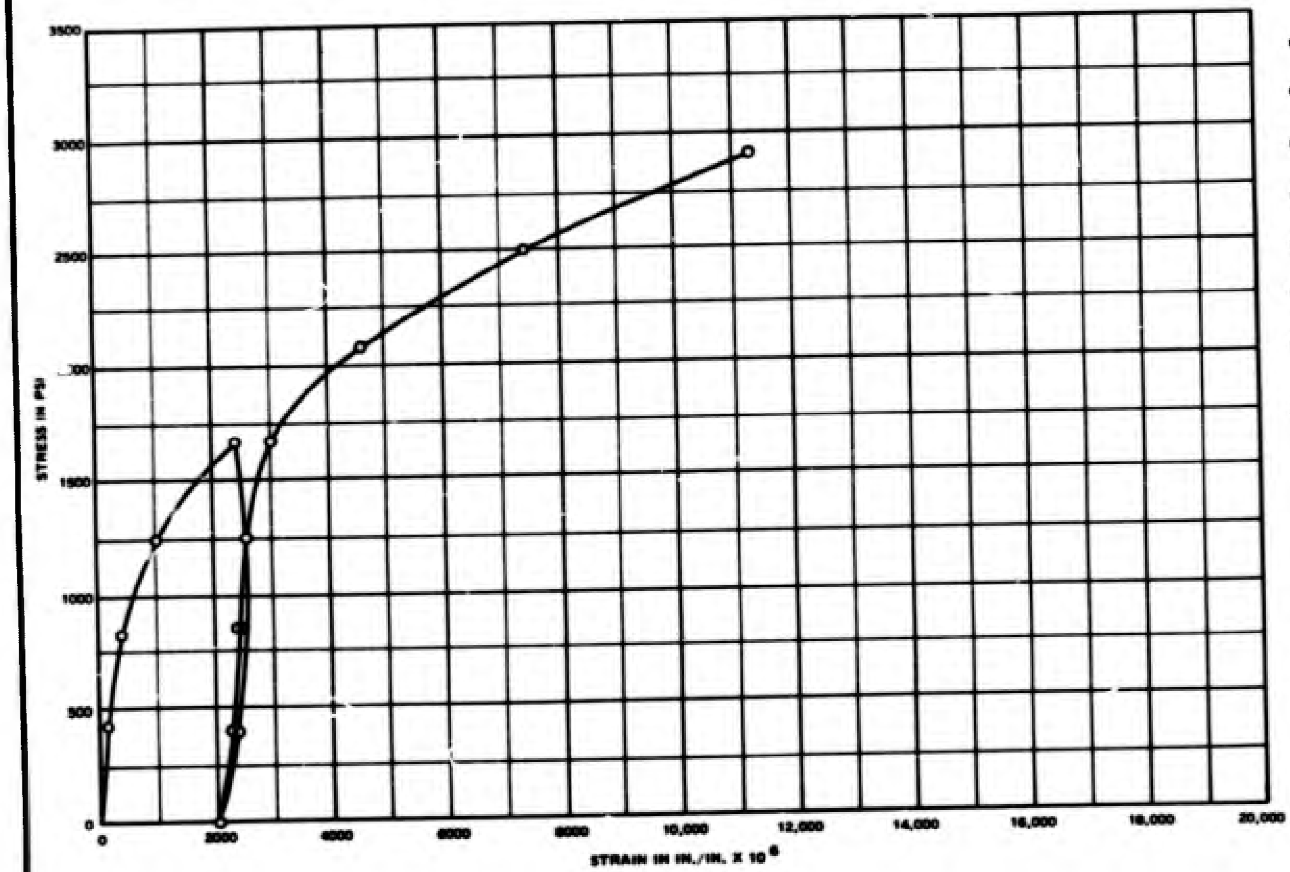
METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

STRESS, PSI	AVG STRAIN, IN./IN. X 10^6
0	0
410	167
830	483
1,240	1 [illegible]
1,660	3,033
2,070	5,325
2,480	8,283
2,900	12,650
3,050 ULTIMATE STRENGTH	

STRESS-STRAIN CURVE

STANDARD UNIAXIAL COMPRESSIVE STRENGTH TEST

HOLE WP-1 - SPECIMEN 11C



HOLE COORDINATES: N 10155.85, E 8040.83

DATE: 15 SEPT 1961

CORE DEPTH: 2613.0 FT TO 2616.0 FT

DIAMETER: 4.96 IN.

SPECIMEN LENGTH: 10.52 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

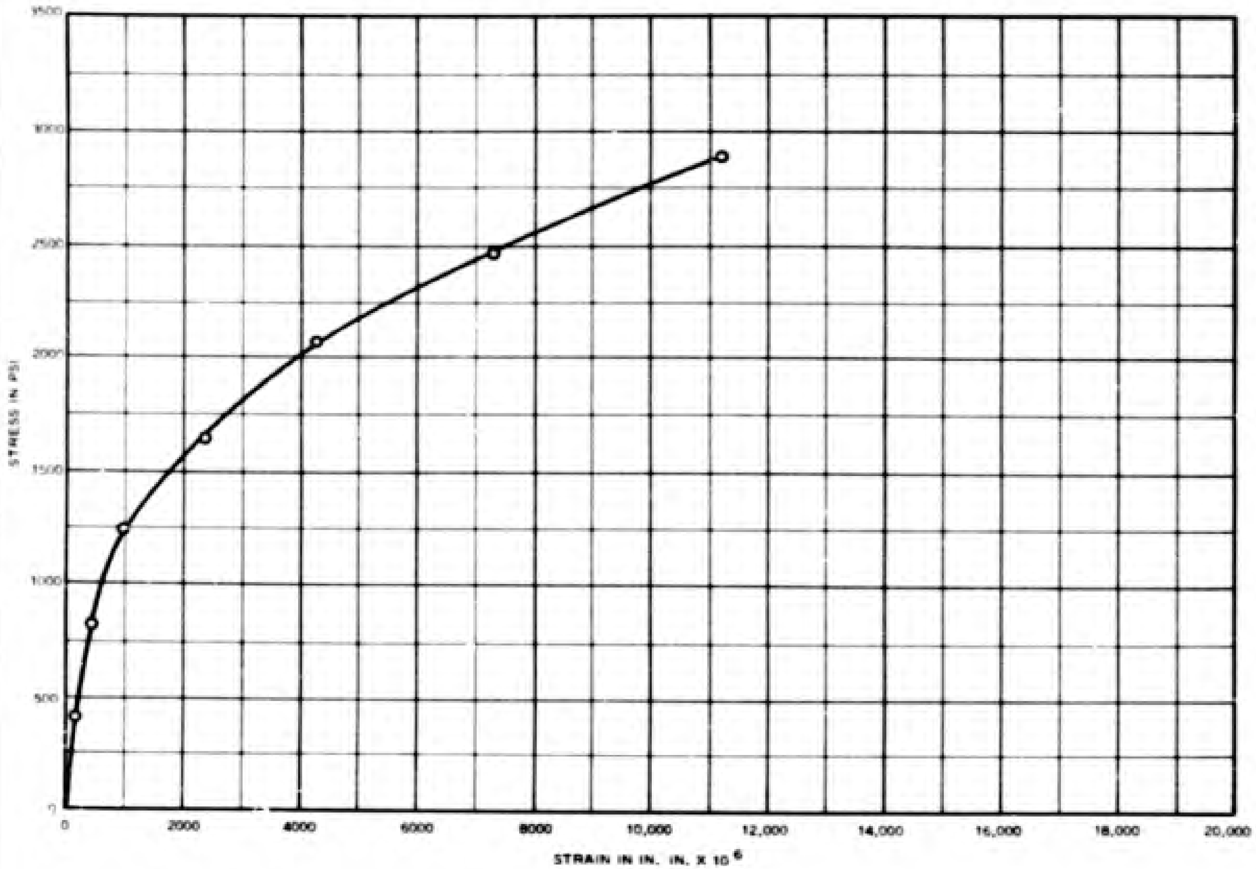
METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

STRESS, PSI	AVG STRAIN, IN./IN. X 10^6
0	0
410	150
830	408
1,240	1,075
1,660	2,475
1,240	2,600
830	2,508
410	2,392
0	2,017
410	2,317
830	2,475
1,240	2,633
1,660	3,083
2,070	4,633
2,480	7,417
2,900	11,375
3,120 ULTIMATE STRENGTH	

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSIVE STRENGTH TEST WITH ONE UNLOADING CYCLE
HOLE WP-1 - SPECIMEN 11D



HOLE COORDINATES: DATE: 15 SEPT 1961
N 10166.85, E 8040.83

CORE DEPTH:
2700.0 FT TO 2703.0 FT

DIAMETER:
4.96 IN.

SPECIMEN LENGTH:
10.50 IN. (INCLUDING CAP)

RATE OF LOAD:
20 PSI/SEC

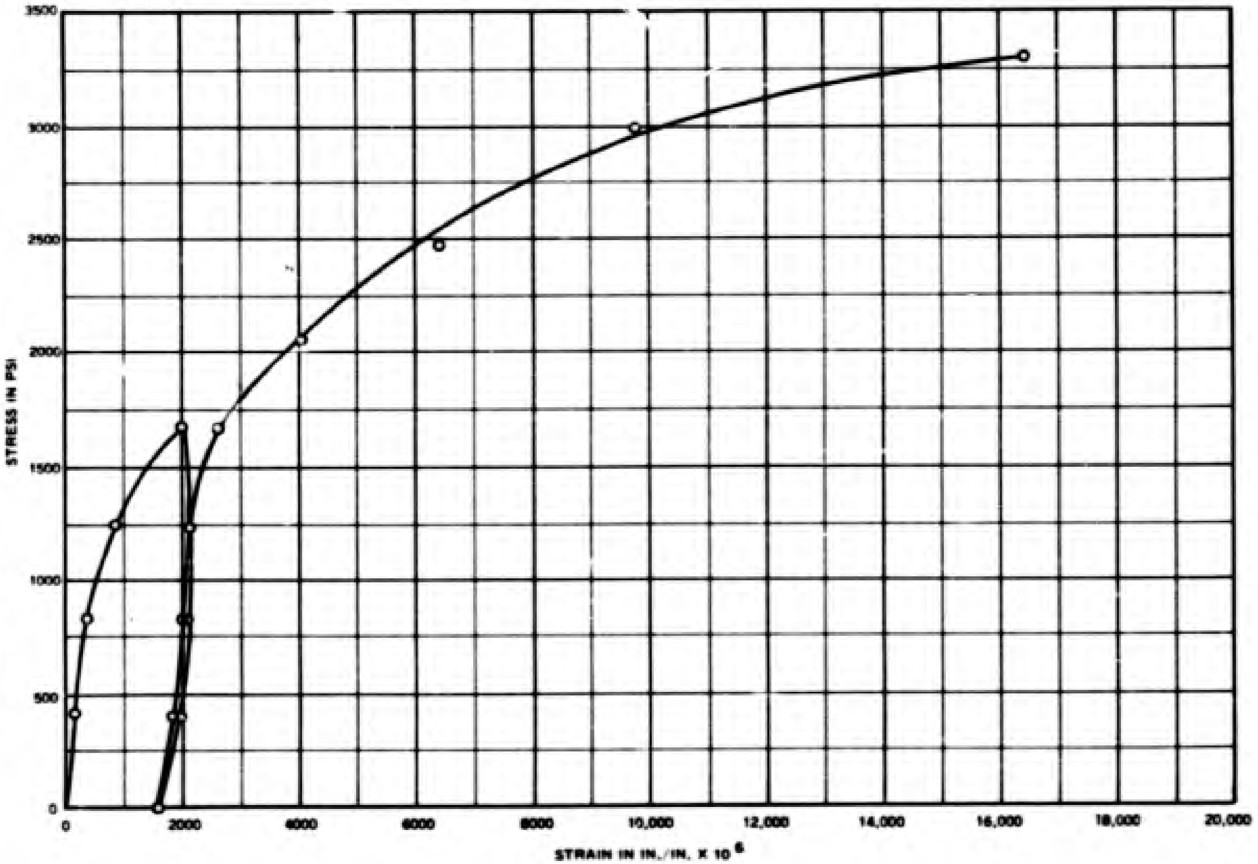
METHOD OF SAWING TO LENGTH:
DRY (DIAMOND SAW)

METHOD OF END PREPARATION:
CAPPED WITH SULFUR-SILICA COMPOUND

STRESS, PSI	AVG STRAIN, IN./IN. X 10^6
0	0
410	142
830	392
1,240	983
1,660	2,350
2,070	4,258
2,480	7,283
2,900	11,225
3,110 ULTIMATE STRENGTH	

STRESS-STRAIN CURVE
STANDARD UNIAXIAL COMPRESSIVE STRENGTH TEST
HOLE WP-1 - SPECIMEN 12B

PLATE 75



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 15 SEPT 1961

CORE DEPTH: 2700.0 FT TO 2703.0 FT

DIAMETER: 4.97 IN.

SPECIMEN LENGTH: 10.47 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

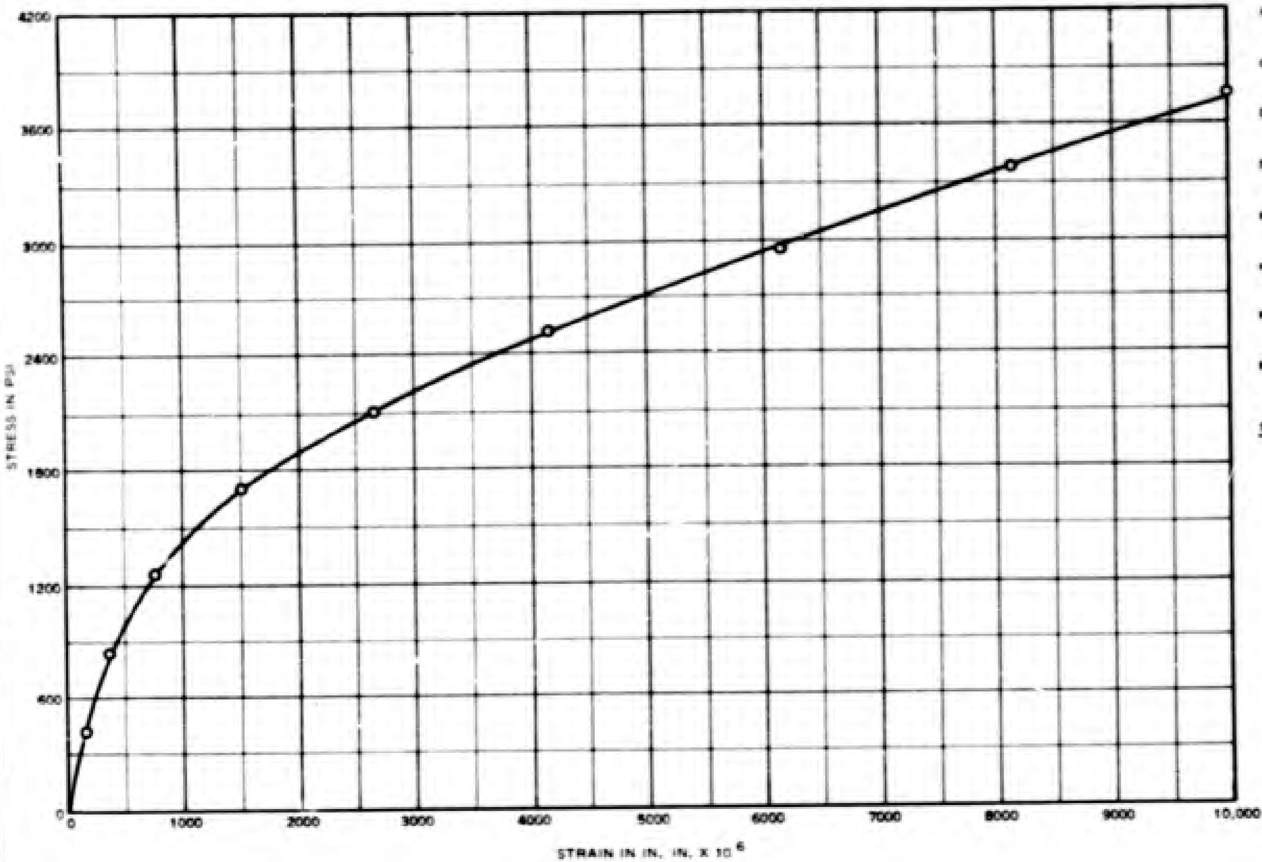
METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

STRESS, PSI	AVG STRAIN, IN./IN. X 10^6
0	0
410	150
820	367
1,240	883
1,650	2,033
1,240	2,158
820	2,067
410	1,942
0	1,625
410	1,842
820	2,008
1,240	2,150
1,650	2,567
2,060	4,042
2,470	6,417
2,890	9,783
3,300 ULTIMATE STRENGTH	16,475

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSIVE STRENGTH TEST WITH ONE UNLOADING CYCLE HOLE WP-1 - SPECIMEN 12C



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 15 SEPT 1961

CORE DEPTH: 2453.2 FT TO 2455.0 FT

DIAMETER: 4.93 IN.

SPECIMEN LENGTH: 5.50 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

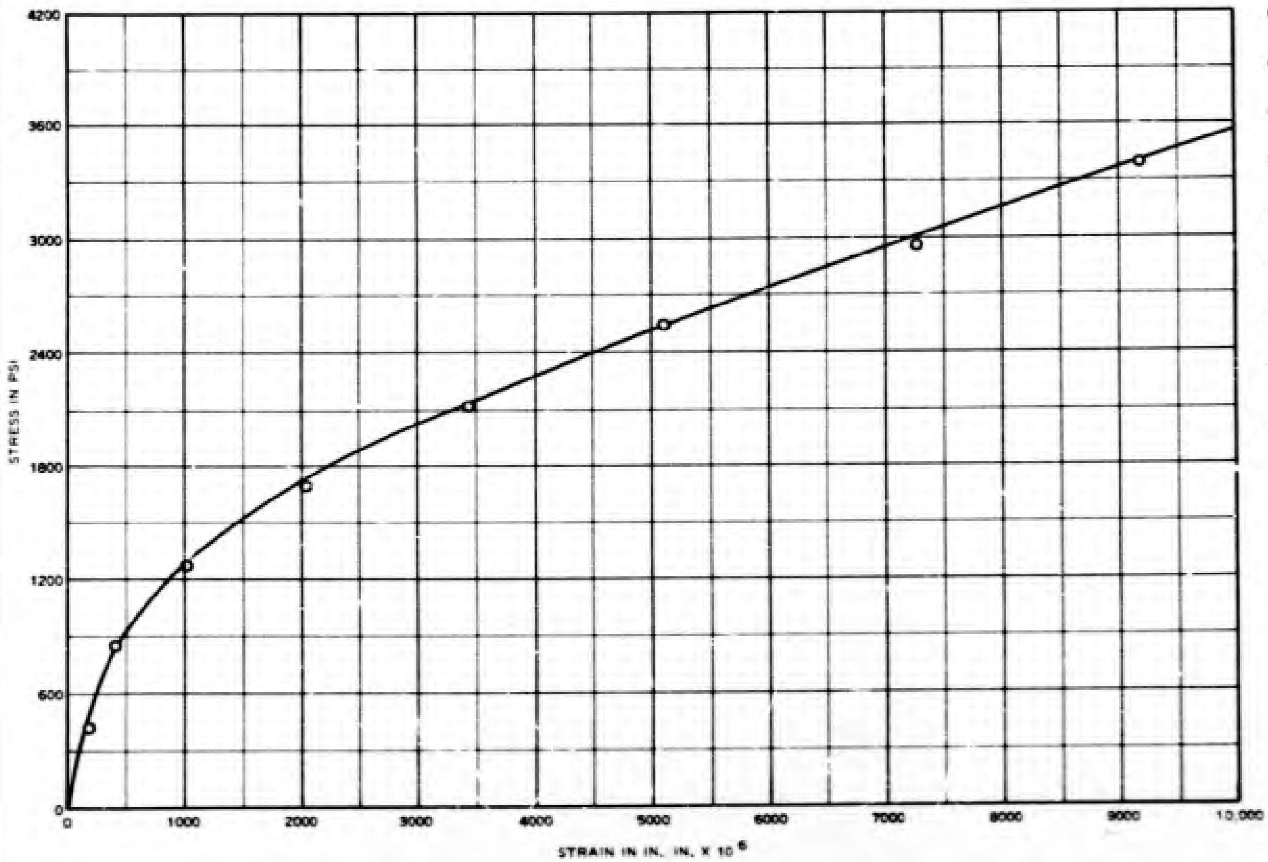
METHOD OF STRAIN MEASUREMENT: SR-4 STRAIN GAGES

STRESS, PSI	AVG STRAIN, IN./IN. × 10^{6}
0	0
420	160
840	350
1,260	750
1,680	1,510
2,100	2,660
2,510	4,160
2,930	6,160
3,350	8,180
3,770	9,990
4,450 ULTIMATE STRENGTH	

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 37A

PLATE 77



HOLE COORDINATES:
N 10166.85, E 8040.83

DATE: 15 SEPT 1961

CORE DEPTH:
2545.0 FT TO 2548.0 FT

DIAMETER:
4.90 IN.

SPECIMEN LENGTH:
5.50 IN. (INCLUDING CAP)

RATE OF LOAD:
20 PSI/SEC

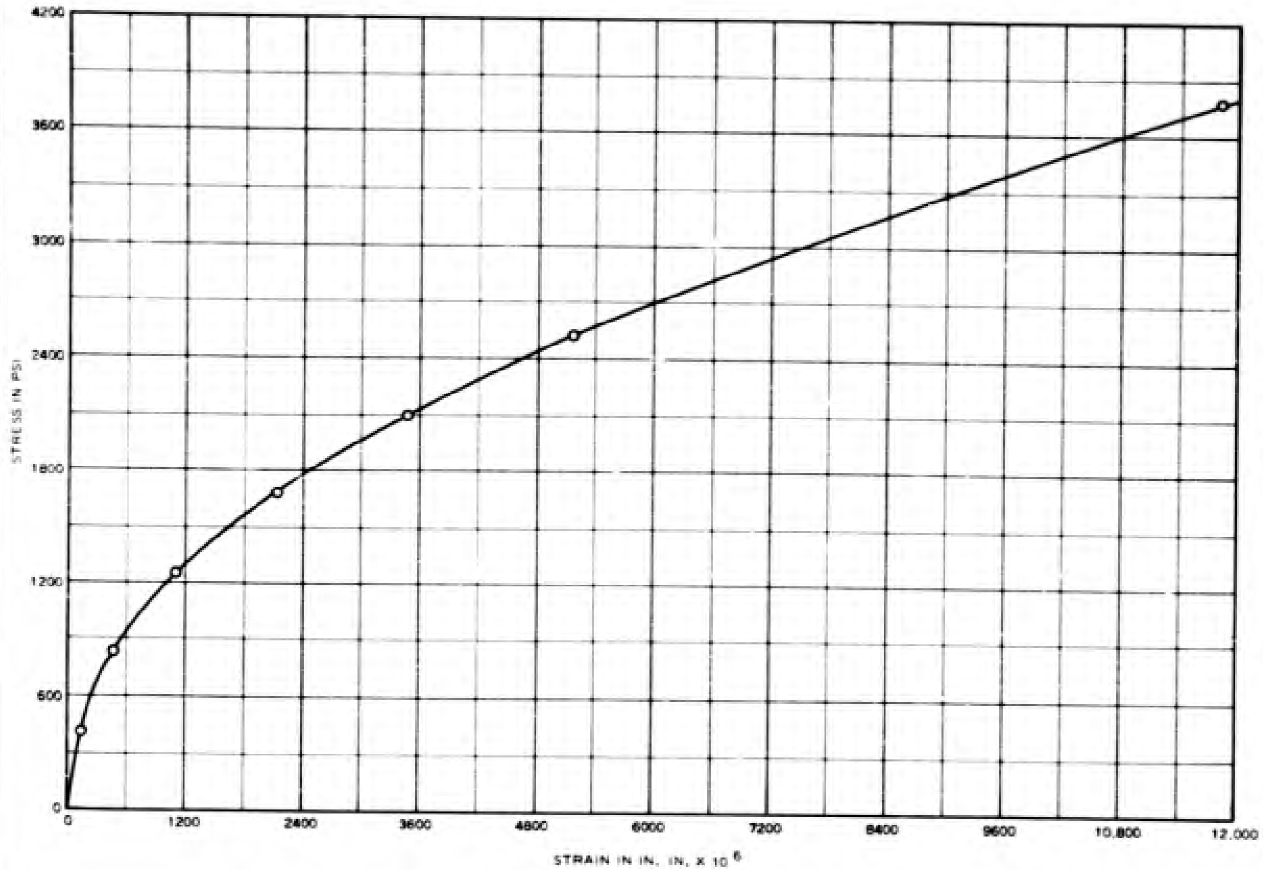
METHOD OF SAWING TO LENGTH:
DRY (DIAMOND SAW)

METHOD OF END PREPARATION:
CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT:
SR-4 STRAIN GAGES

STRESS, PSI	AVG STRAIN, IN./IN. × 10^6
0	0
420	170
850	420
1,270	1,010
1,700	2,050
2,120	3,470
2,540	5,110
2,970	7,290
3,390	9,200
4,140 ULTIMATE STRENGTH	

STRESS-STRAIN CURVE
UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 7B



HOLE COORDINATES: N 10166.85, E 8040.83 DATE: 15 SEPT 1961

CORE DEPTH: 2545.0 FT TO 2548.0 FT

DIAMETER: 4.93 IN.

SPECIMEN LENGTH: 5.50 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

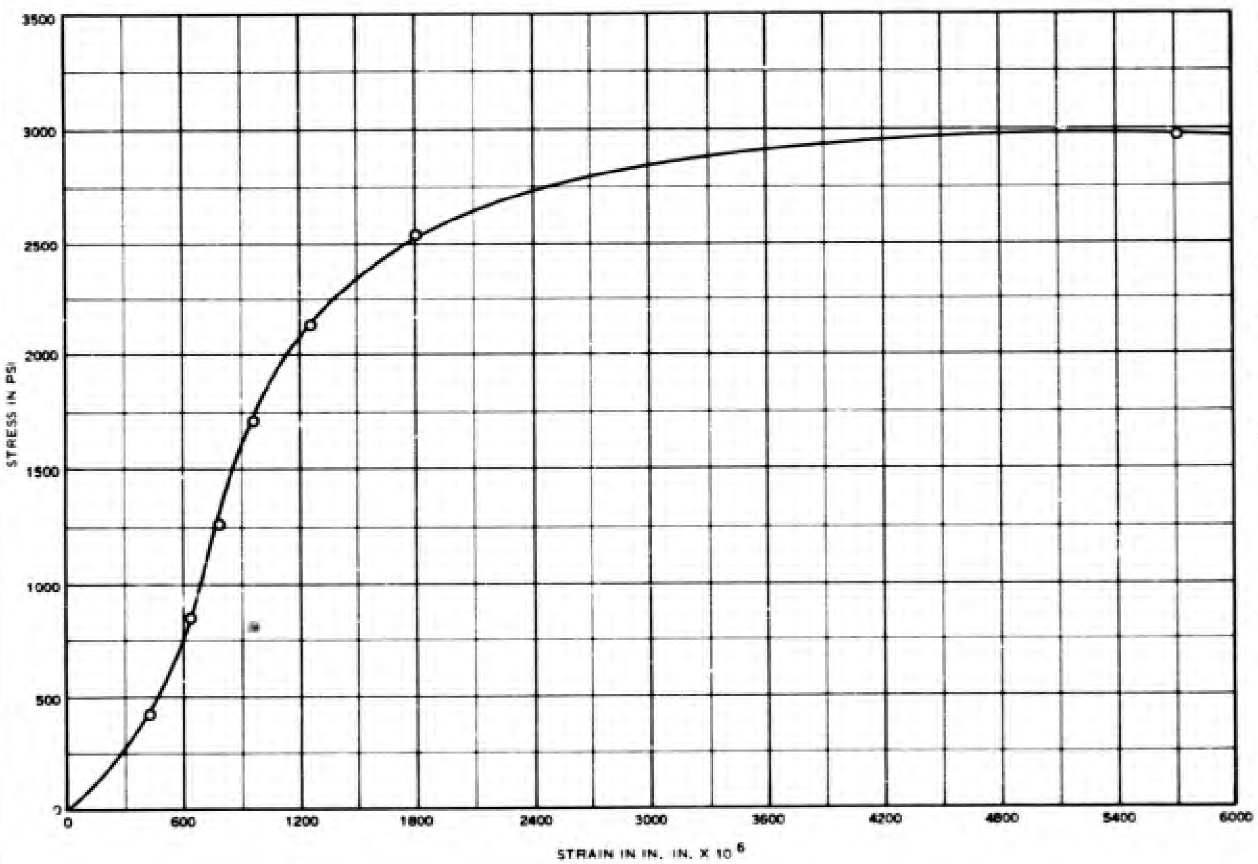
METHOD OF STRAIN MEASUREMENT: SR-4 STRAIN GAGES

STRESS, PSI	AVG STRAIN, IN./IN. × 10^{6}
0	0
420	190
840	510
1,260	1,120
1,680	2,140
2,100	3,460
2,510	5,140
2,930	*
3,350	*
3,770	11,800
4,160 ULTIMATE STRENGTH	

* MISSED READINGS

STRESS-STRAIN CURVE
UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 7C

PLATE 79



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 15 SEPT 1961

CORE DEPTH: 2445.0 FT TO 2448.0 FT

DIAMETER: 4.90 IN.

SPECIMEN LENGTH: 8.00 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

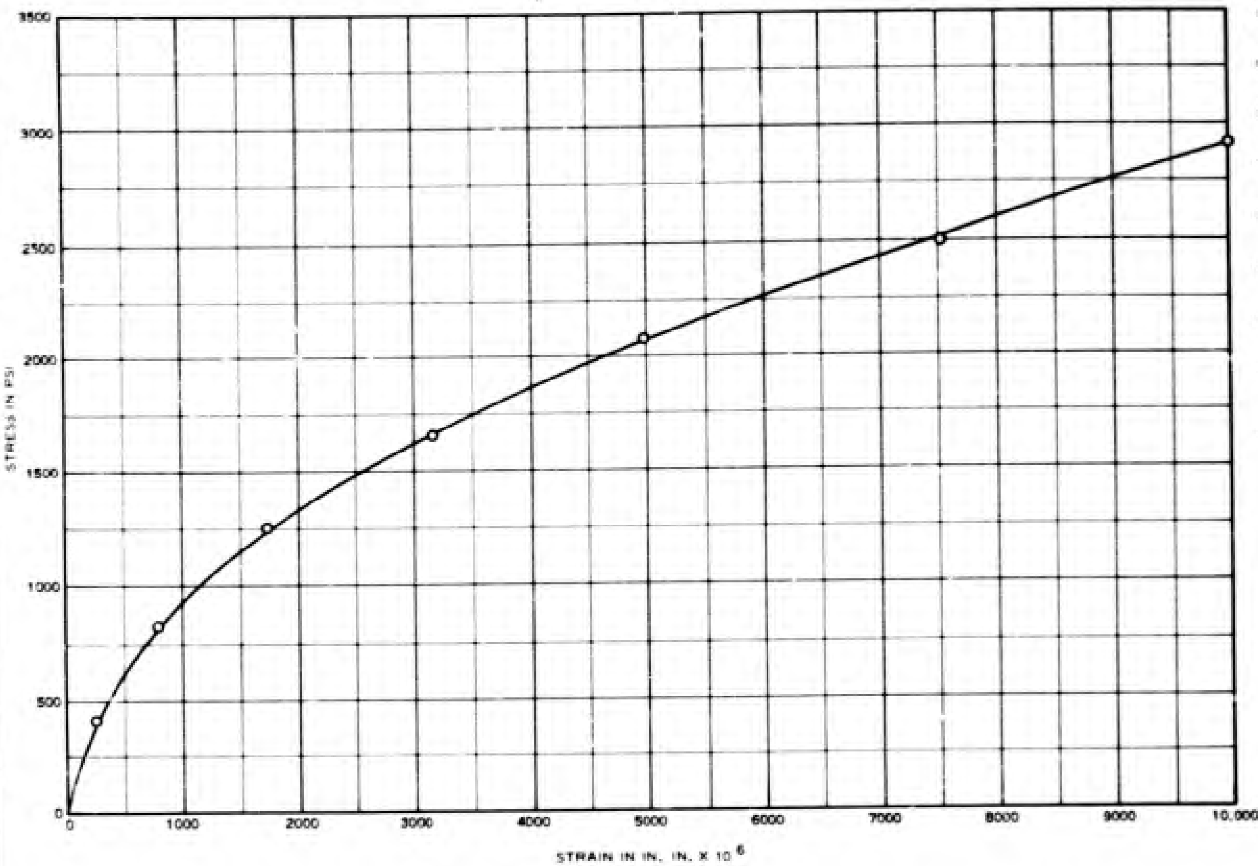
METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT: SR-4 STRAIN GAGES

STRESS, PSI	AVG STRAIN, IN./IN. × 10^6
0	0
420	430
850	630
1,270	800
1,700	970
2,120	1,260
2,540	1,810
2,970	5,720
3,220 ULTIMATE STRENGTH	

NOTE: SPECIMEN WAS LOADED BY MISTAKE TO UNDETERMINED MAGNITUDE, UNLOADED, THEN RELOADED AS SHOWN ABOVE.

STRESS-STRAIN CURVE
UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 6B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 15 SEPT 1961

CORE DEPTH: 2445.0 FT TO 2448.0 FT

DIAMETER: 4.95 IN.

SPECIMEN LENGTH: 8.00 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

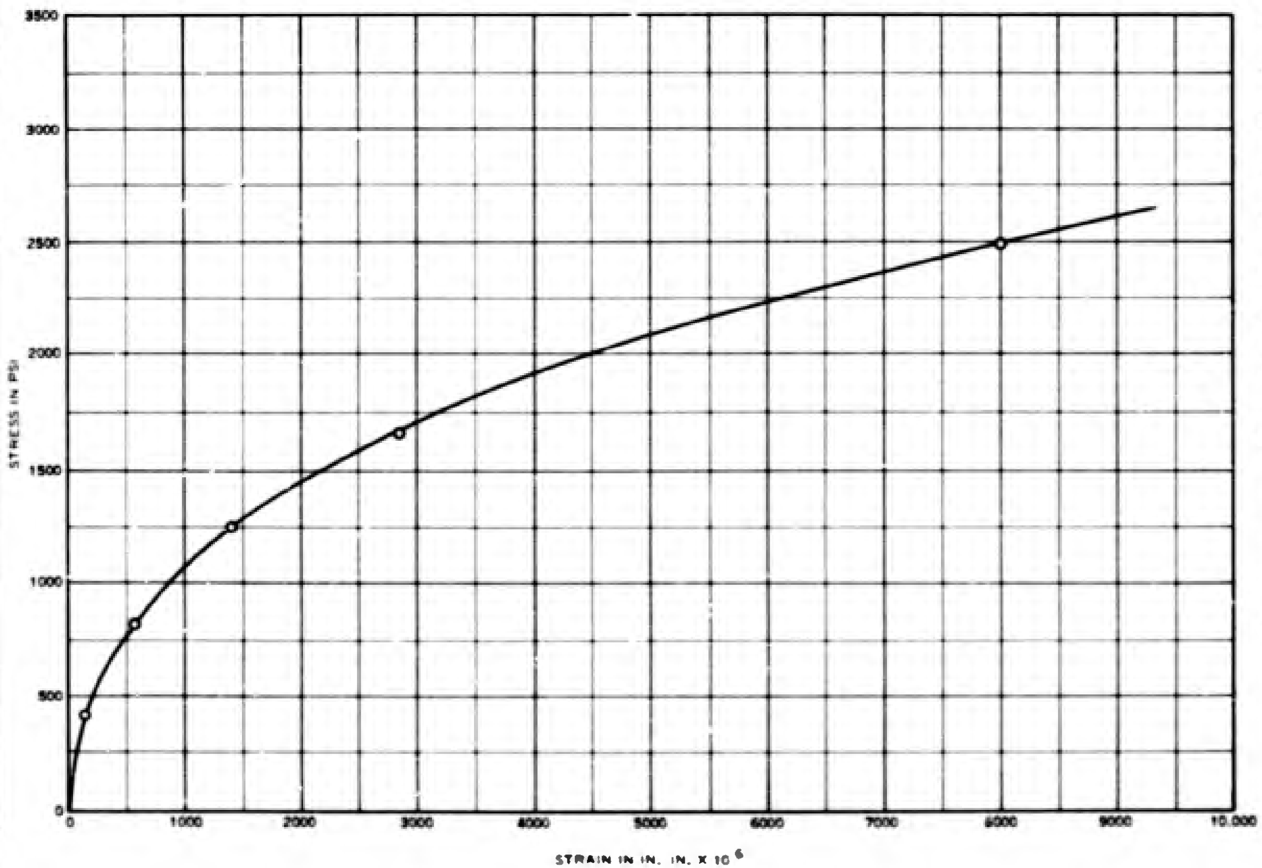
METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT: SR-4 STRAIN GAGES

STRESS, PSI	AVG STRAIN, IN./IN. × 10^{6}
0	0
420	250
830	790
1,250	1,730
1,660	3,170
2,080	4,950
2,490	7,520
2,910	10,020
3,270 ULTIMATE STRENGTH	

STRESS-STRAIN CURVE
UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 6D



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 15 SEPT 1961

CORE DEPTH: 2445.0 FT TO 2448.0 FT

DIAMETER: 4.95 IN.

SPECIMEN LENGTH: 6.00 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

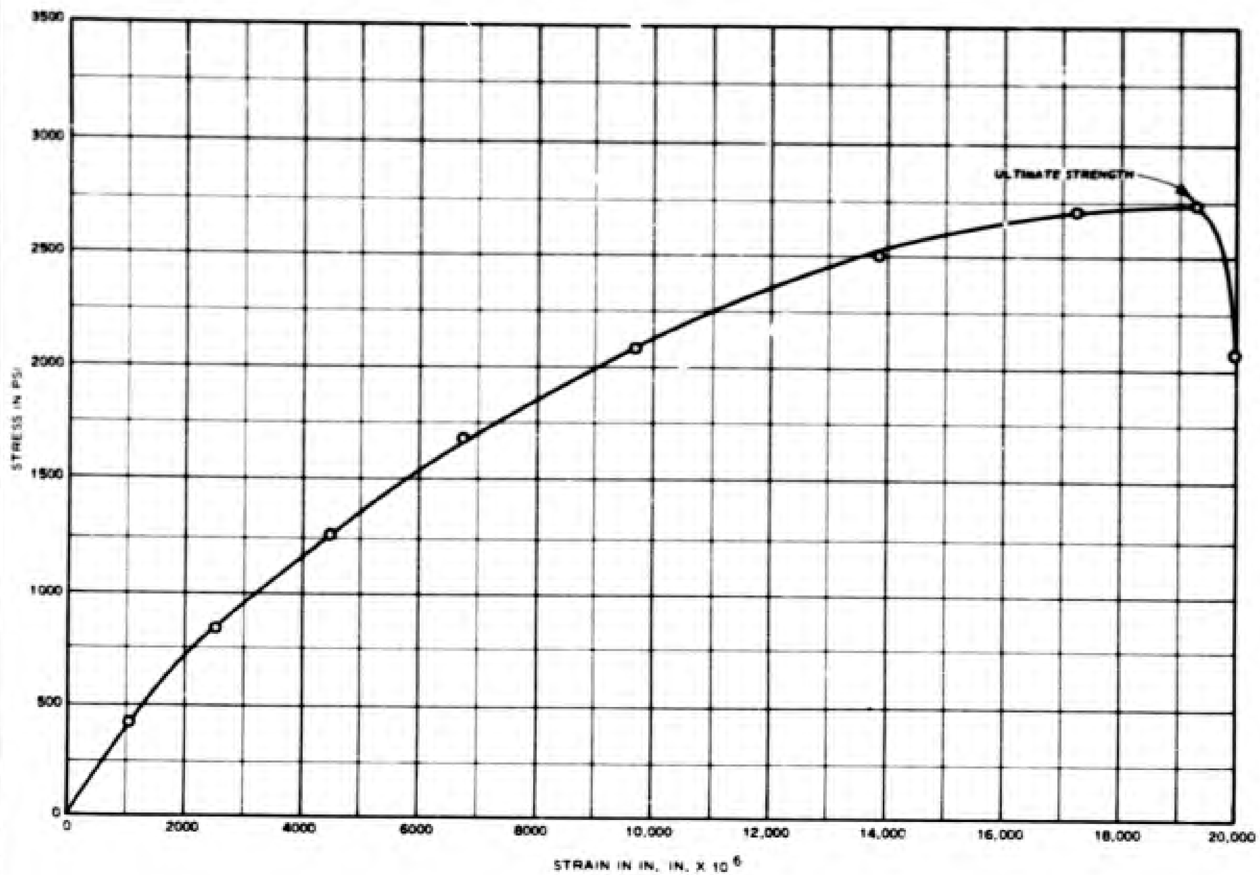
METHOD OF STRAIN MEASUREMENT: SR-4 STRAIN GAGES

STRESS, PSI	AVG STRAIN, IN./IN. × 10^6
0	0
420	150
830	550
1,250	1,410
1,660	2,870
2,080	*
2,490	8,070
2,910	*
3,330	*
3,380 ULTIMATE STRENGTH	

* MISSED READINGS

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 6E



HOLE COORDINATES: N 10166.85, E 8040.83 DATE: 16 MAR 1962

CORE DEPTH: 2333.0 FT TO 2335.0 FT

DIAMETER: 4.93 IN.

SPECIMEN LENGTH: 10.45 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

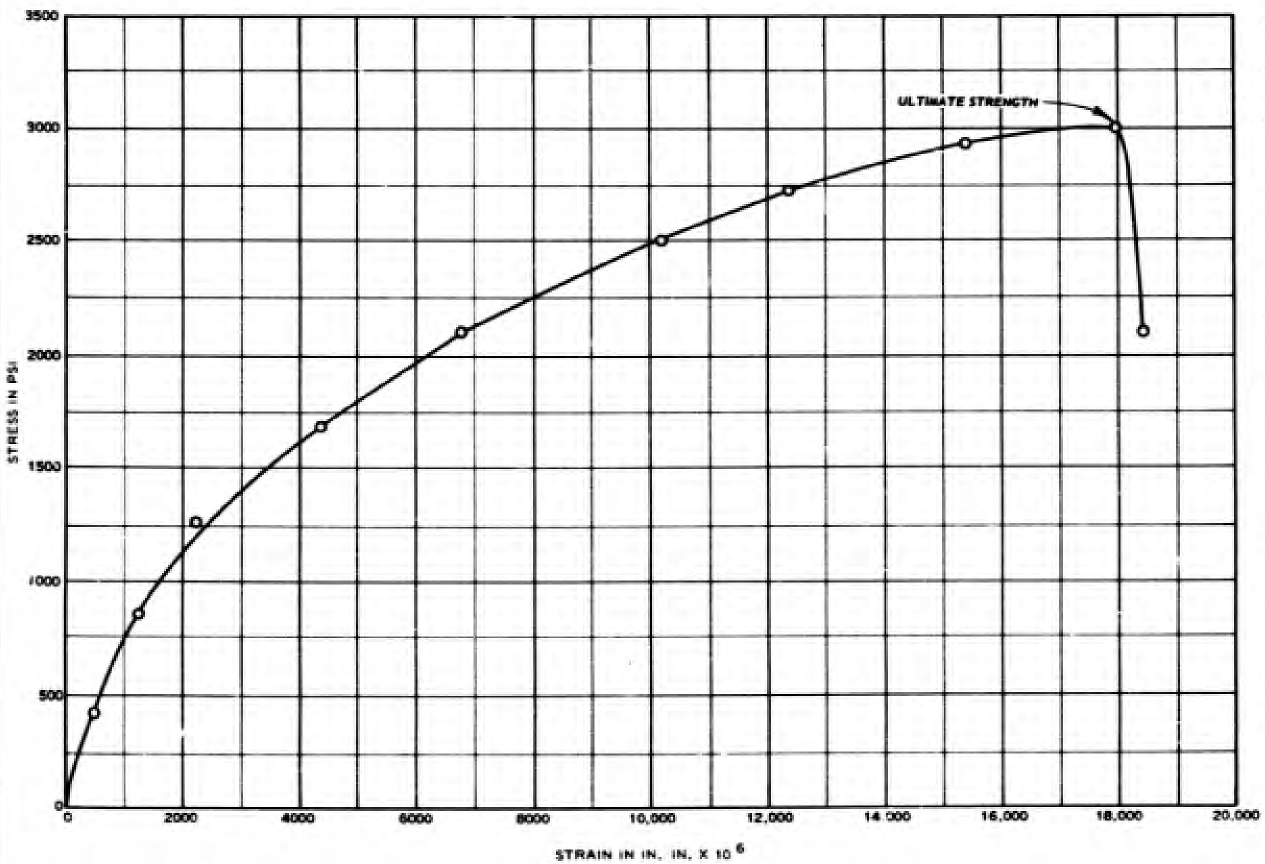
METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT: COMPRESSOMETER WITH TWO DIAMETRICALLY OPPOSED 6-IN. GAGE LINES

STRESS, PSI		AVG STRAIN, IN./IN. × 10^{6}
0		0
420		1,067
840		2,558
1,260		4,492
1,680		6,742
2,100		9,675
2,510		13,842
2,720		17,233
2,750	ULTIMATE STRENGTH	19,292
2,100		19,983

STRESS-STRAIN CURVE
UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 5B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 16 MAR 1962

CORE DEPTH: 2333.0 FT TO 2335.0 FT

DIAMETER: 4.93 IN.

SPECIMEN LENGTH: 10.50 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

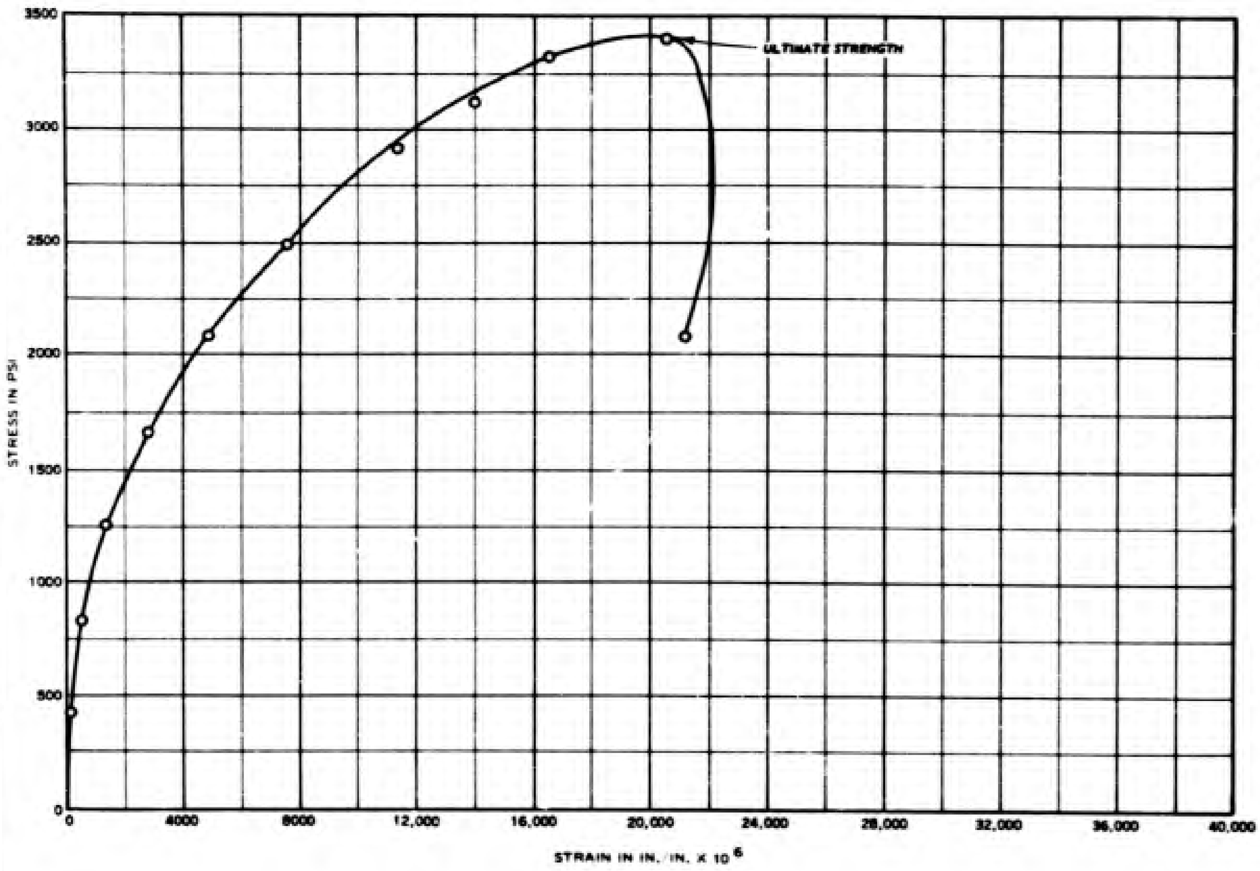
METHOD OF STRAIN MEASUREMENT: UNIAXIAL-COMPRESSOMETER WITH TWO DIAMETRICALLY OPPOSED 6-IN. GAGE LINES. LATERAL-METAL YOKE WITH DIAL GAGE.

STRESS PSI	AVG STRAIN IN./IN. × 10^6 UNIAXIAL	LATERAL	POISSON'S RATIO
0	0	0	0
420	508	0	0
840	1,233	433	0.351
1,260	2,525	1,433	0.568
1,680	4,350	3,100	0.713
2,100	6,792	5,900	0.869
2,510	10,200		
2,720	12,350		
2,930	15,367		
3,000*	17,925		
2,100	18,408		

* ULTIMATE STRENGTH

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 5C



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 16 MAR 1982

CORE DEPTH: 2393.0 FT TO 2397.0 FT

DIAMETER: 4.95 IN.

SPECIMEN LENGTH: 10.39 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

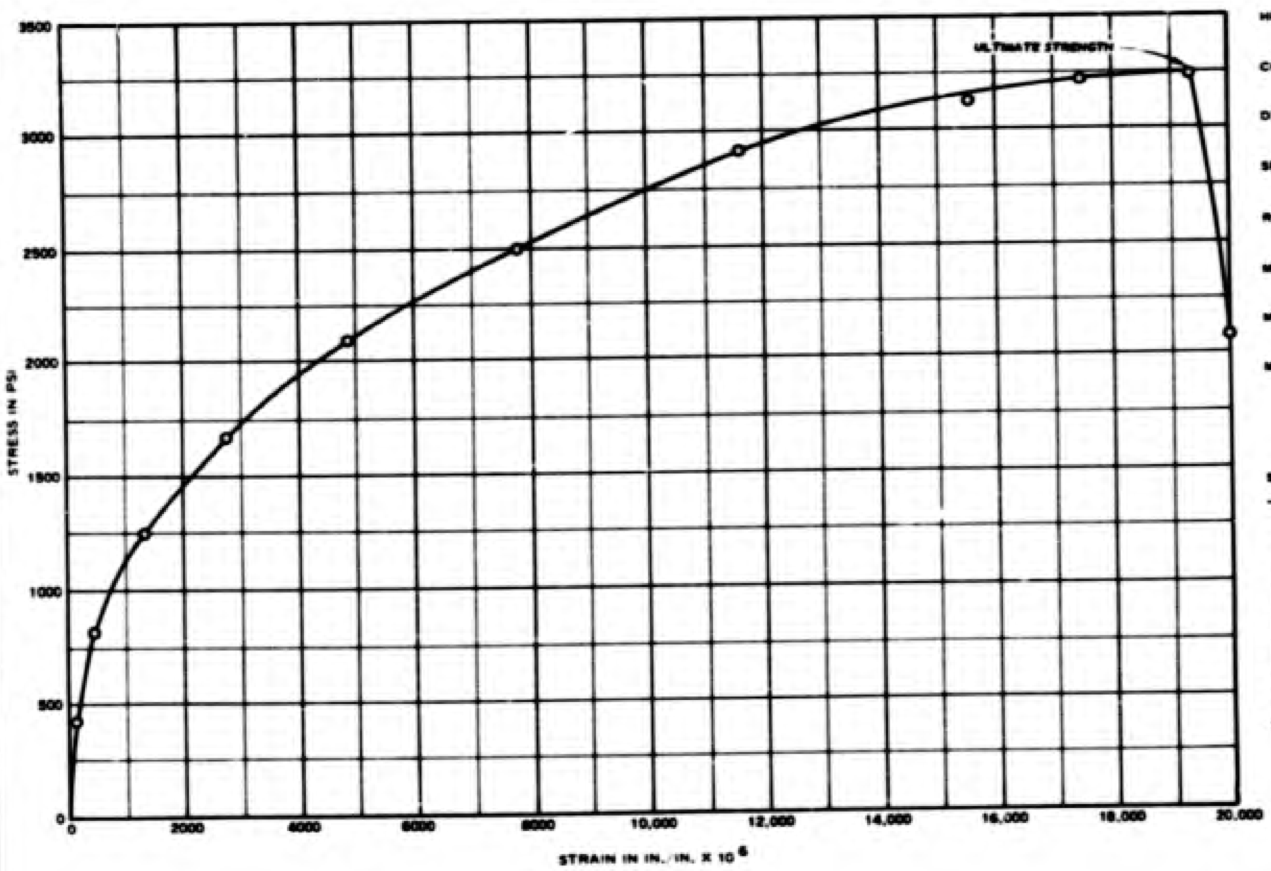
METHOD OF STRAIN MEASUREMENT: COMPRESSOMETER WITH TWO DIAMETRICALLY OPPOSED 6-IN. GAGE LINES.

STRESS, PSI		AVG STRAIN, IN./IN. × 10^6
0		0
420		175
830		508
1,250		1,383
1,660		2,817
2,080		4,850
2,490		7,600
2,910		11,342
3,120		13,998
3,330		16,508
3,410	ULTIMATE STRENGTH	20,567
2,080		21,183

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 3 C

PLATE 85



HOLE COORDINATES:
N 10166.85, E 8040.83

DATE: 16 MAR 1962

CORE DEPTH:
2393.0 FT TO 2397.0 FT

DIAMETER:
4.94 IN.

SPECIMEN LENGTH:
10.40 IN. (INCLUDING CAP)

RATE OF LOAD:
20 PSI/SEC

METHOD OF SAWING TO LENGTH:
DRY (DIAMOND SAW)

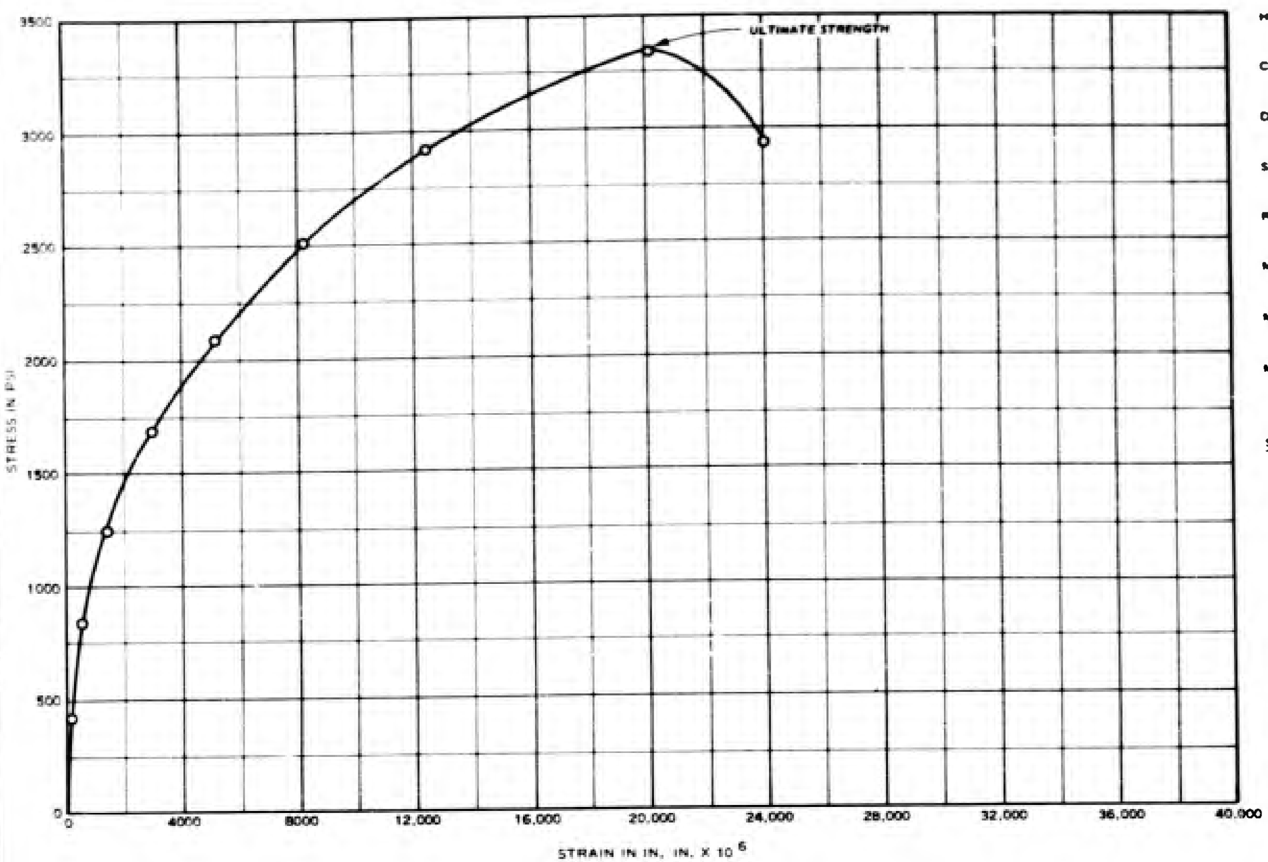
METHOD OF END PREPARATION:
CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT:
UNIAXIAL-COMPRESSOMETER WITH TWO DIAMETRICALLY OPPOSED 6-IN. GAGE LINES.
LATERAL-METAL YOKE WITH DIAL GAGE.

STRESS PSI	AVG STRAIN IN./IN. × 10^6 UNIAXIAL	LATERAL	POISSON'S RATIO
0	0	0	0
420	133	0	0
840	483	53	0.110
1,250	1,308	600	0.459
1,670	2,750	1,667	0.606
2,090	4,875	3,367	0.691
2,500	7,742	5,800	0.749
2,920	11,600		
3,130	15,533		
3,230	17,425		
3,280*	19,317		
2,090	20,000		

* ULTIMATE STRENGTH

STRESS-STRAIN CURVE
UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 3B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 15 SEPT 1961

CORE DEPTH: 2545.0 FT TO 2548.0 FT

DIAMETER: 4.93 IN.

SPECIMEN LENGTH: 10.35 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

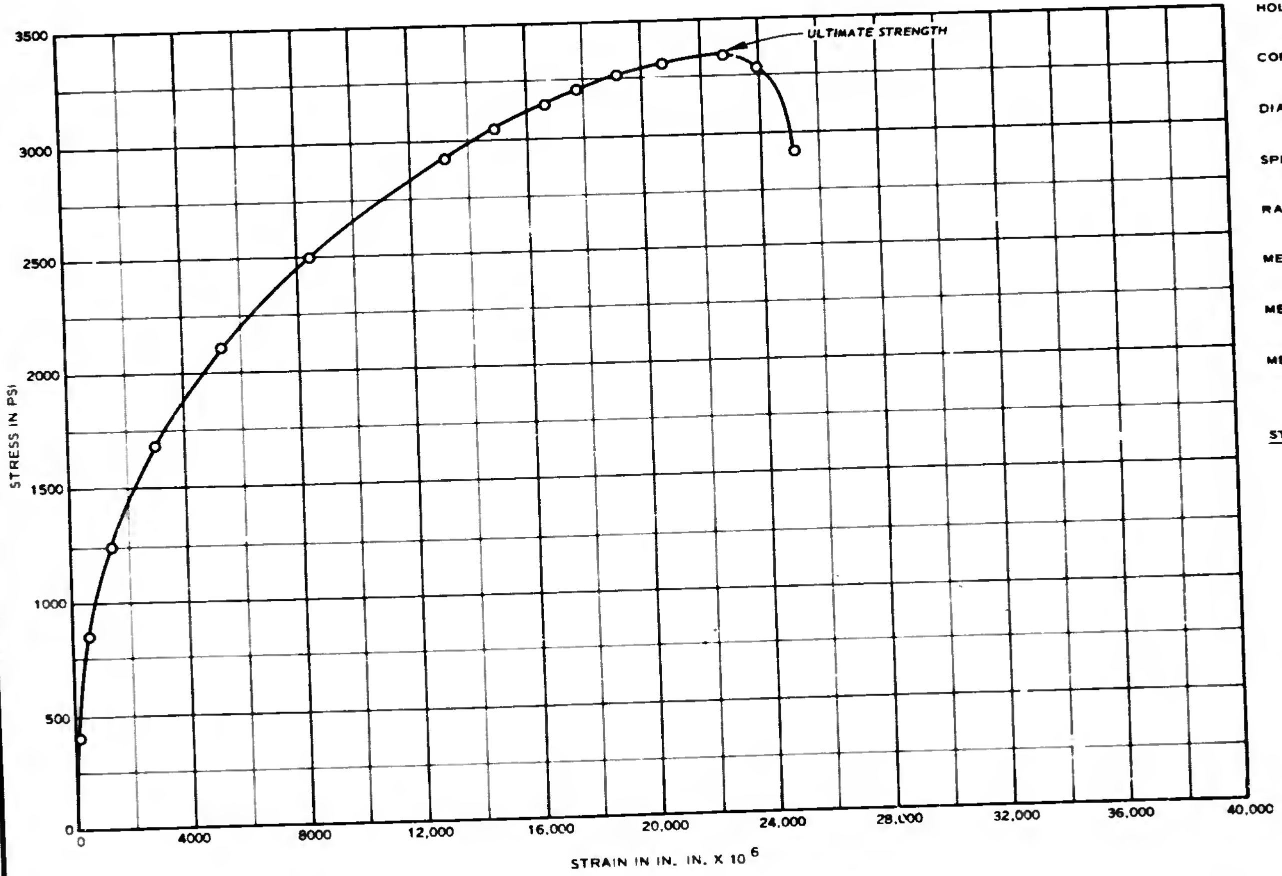
METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT: COMPRESSOMETER WITH TWO DIAMETRICALLY OPPOSED 6-IN. GAGE LINES

STRESS, PSI		AVG STRAIN, IN./IN. × 10^6
0		0
420		133
840		467
1,260		1,425
1,680		3,025
2,100		5,192
2,510		8,200
2,930		12,542
3,350	ULTIMATE STRENGTH	20,225
2,930		24,167

STRESS-STRAIN CURVE
UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 7D



HOLE COORDINATES:
N 10166.85, E 8040.83

DATE: 15 SEPT 1961

CORE DEPTH:
2545.0 FT TO 2548.0 FT

DIAMETER:
4.93 IN.

SPECIMEN LENGTH:
10.42 IN. (INCLUDING CAP)

RATE OF LOAD:
20 PSI SEC

METHOD OF SAWING TO LENGTH:
DRY (DIAMOND SAW)

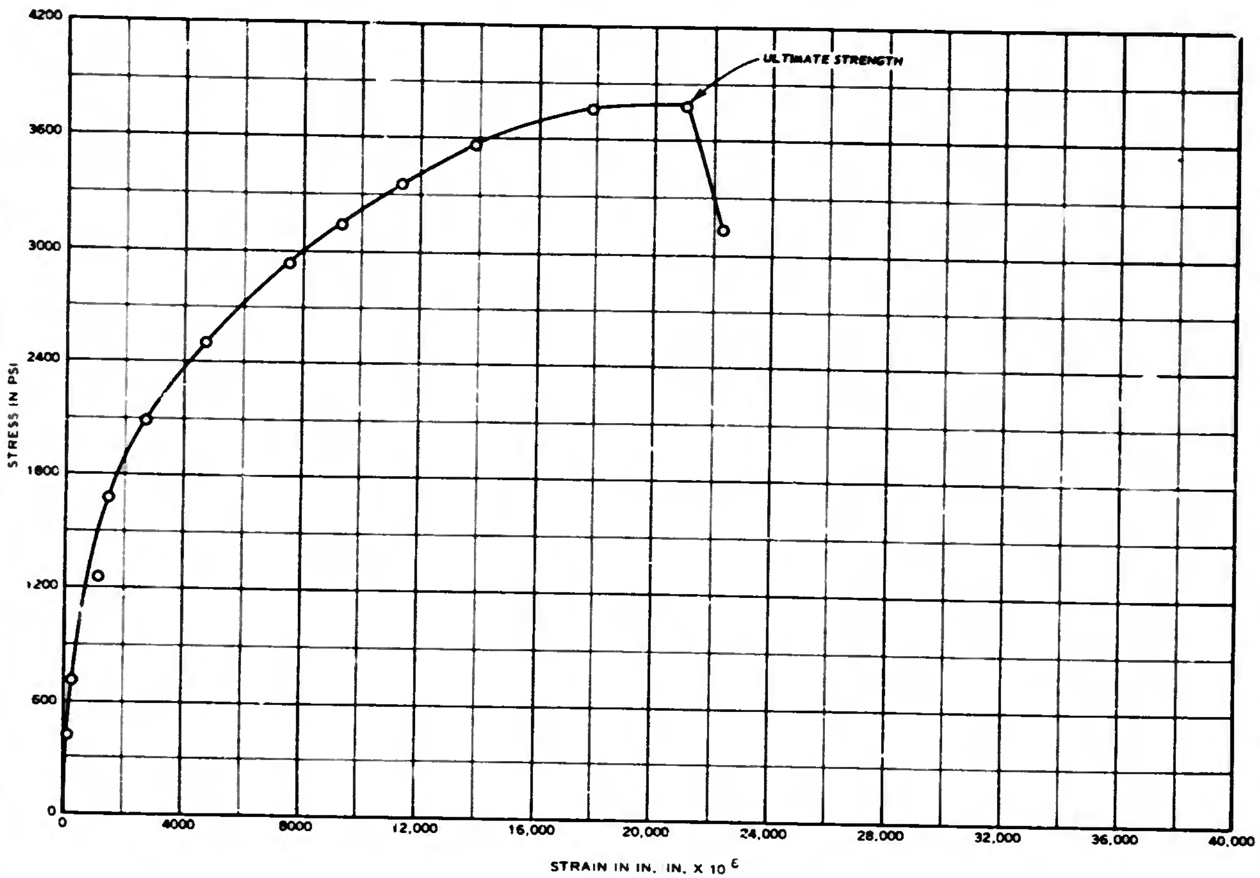
METHOD OF END PREPARATION:
CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT:
COMPRESSOMETER WITH TWO DIAMETRICALLY OPPOSED 6-IN. GAGE LINES

STRESS, PSI		AVG STRAIN, IN. IN. × 10 6
0		0
420		133
840		500
1,260		1,517
1,680		3,058
2,100		5,[illegible]
2,510		8,533
2,930		13,233
3,040		14,842
3,140		16,675
3,200		17,667
3,250		19,058
3,300		20,717
3,350	ULTIMATE STRENGTH	22,792
2,930		25,150

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 7E



HOLE COORDINATES: DATE: 16 MAR 1982

N 10166.85, E 8040.83

CORE DEPTH:

2261.0 FT TO 2262.5 FT

DIAMETER:

4.93 IN.

SPECIMEN LENGTH:

13.00 IN. (INCLUDING CAP)

RATE OF LOAD:

20 PSI/SEC

METHOD OF SAWING TO LENGTH:

BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION:

CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT:

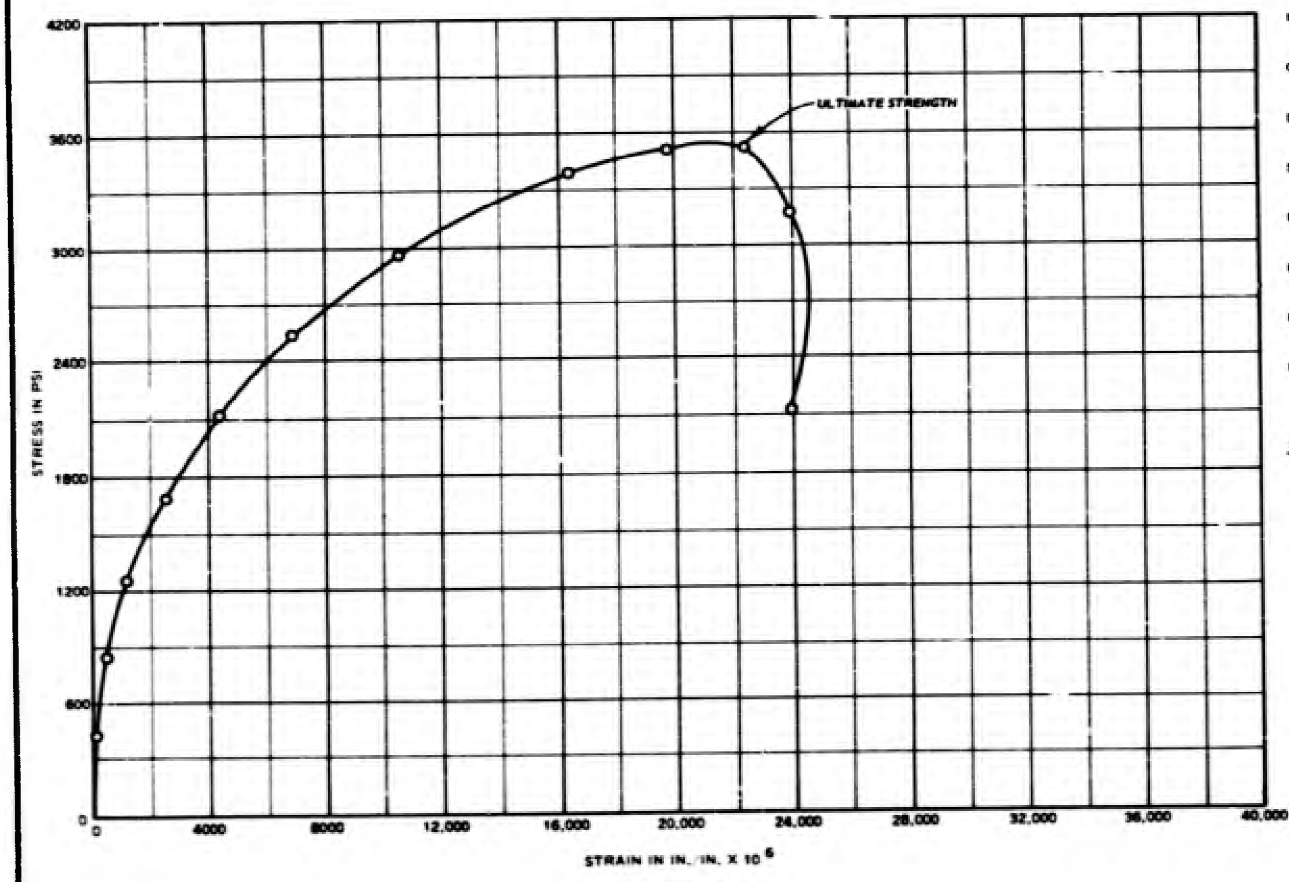
UNIAXIAL-COMPRESSOMETER WITH TWO DIAMETRICALLY OPPOSED 6-IN. GAGE LINES. LATERAL-METAL YOKE WITH DIAL GAGE.

STRESS PSI	AVG STRAIN IN./IN. × 10^6 UNIAXIAL	LATERAL	POISSON'S RATIO
0	0	0	0
125	100	0	0
[illegible]	258	0	0
1,260	600	7	0.012
1,680	1,408	480	0.341
2,100	2,767	1,500	0.542
2,510	4,750	3,160	0.665
2,930	7,525	5,680	0.755
3,140	7,333	7,467	0.802
3,350	11,308	9,820	0.868
3,560	13,850	13,100	0.946
3,770	17,850		
3,810*	20,983		
3,140	22,275		

* ULTIMATE STRENGTH

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 36B



HOLE COORDINATES: N 10166.85, E 5040.83

DATE: 16 MAR 1962

CORE DEPTH: 2290.8 FT TO 2292.5 FT

DIAMETER: 4.90 IN.

SPECIMEN LENGTH: 12.92 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

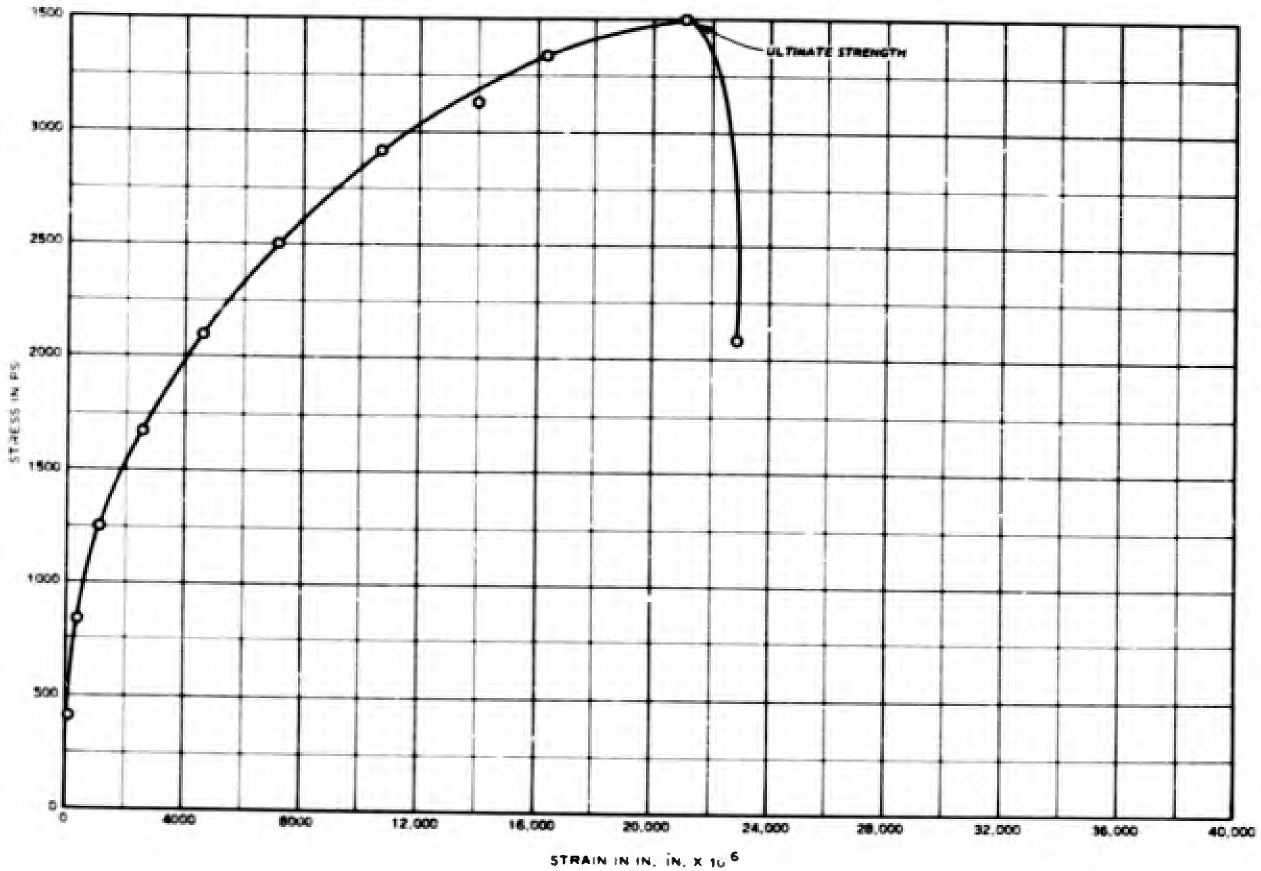
METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT: COMPRESSOMETER WITH TWO DIAMETRICALLY OPPOSED 6-IN. GAGE LINES

STRESS, PSI		AVG STRAIN, IN./IN. × 10^6
0		0
420		133
850		433
1,270		1,158
1,700		2,525
2,120		4,317
2,540		6,933
2,970		10,467
3,390		15,358
3,500		19,617
3,515	ULTIMATE STRENGTH	22,383
3,180		23,983
2,120		23,875

STRESS-STRAIN CURVE
UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 34B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 16 MAR 1962

CORE DEPTH: 2322.8 FT TO 2324.4 FT

DIAMETER: 4.94 IN.

SPECIMEN LENGTH: 12.92 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

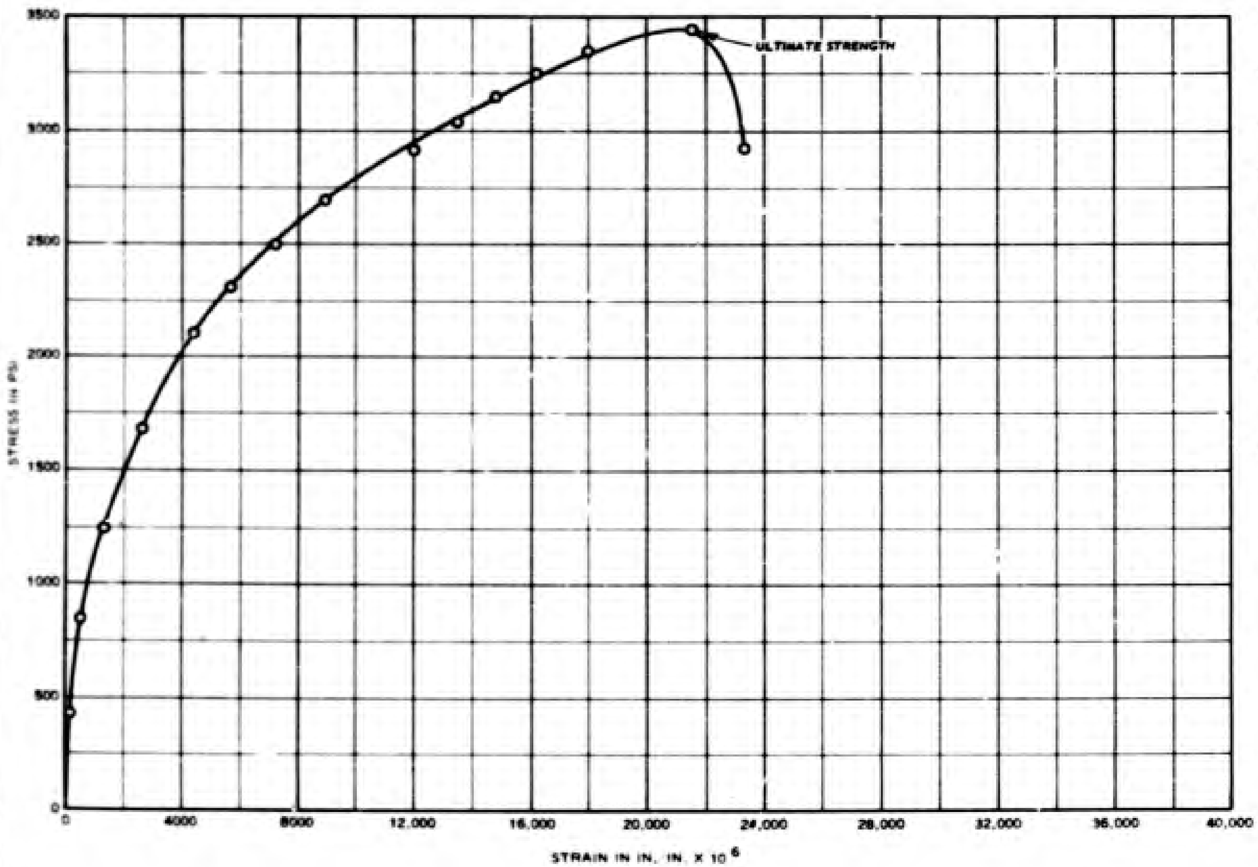
METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT: COMPRESSOMETER WITH TWO DIAMETRICALLY OPPOSED 6-IN. GAGE LINES

STRESS, PSI		AVG STRAIN, IN./IN. × 10^6
0		0
420		133
840		400
1,250		1,150
1,670		2,542
2,090		4,583
2,500		7,167
2,920		10,733
3,130		13,958
3,340		16,250
3,500	ULTIMATE STRENGTH	21,100
2,090		22,983

STRESS-STRAIN CURVE
UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 31B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 16 MAR 1962

CORE DEPTH: 2559.5 FT TO 2563.0 FT

DIAMETER: 4.93 IN.

SPECIMEN LENGTH: 15.60 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

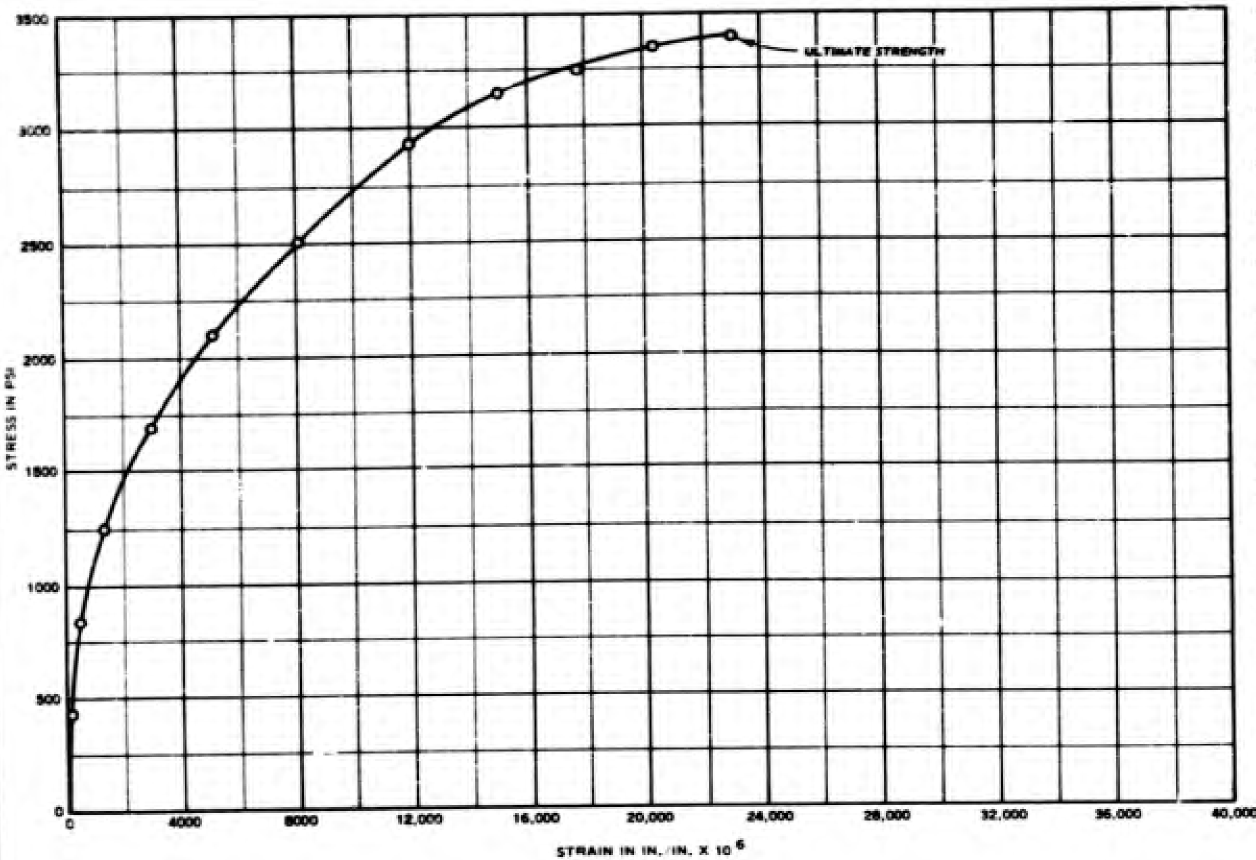
METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT: COMPRESSOMETER WITH TWO DIAMETRICALLY OPPOSED 6-IN. GAGE LINES

STRESS, PSI		AVG STRAIN, IN./IN. $\times 10^6$
0		0
420		117
840		417
1,260		1,158
1,680		2,533
2,100		4,417
2,300		5,717
2,510		7,208
2,720		8,983
2,930		12,042
3,040		13,508
3,140		14,808
3,250		16,192
3,350		18,025
3,450	ULTIMATE STRENGTH	21,642
2,930		23,392

STRESS-STRAIN CURVE
UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 9B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 16 MAR 1962

CORE DEPTH: 2559.5 FT TO 2563.0 FT

DIAMETER: 4.93 IN.

SPECIMEN LENGTH: 15.45 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

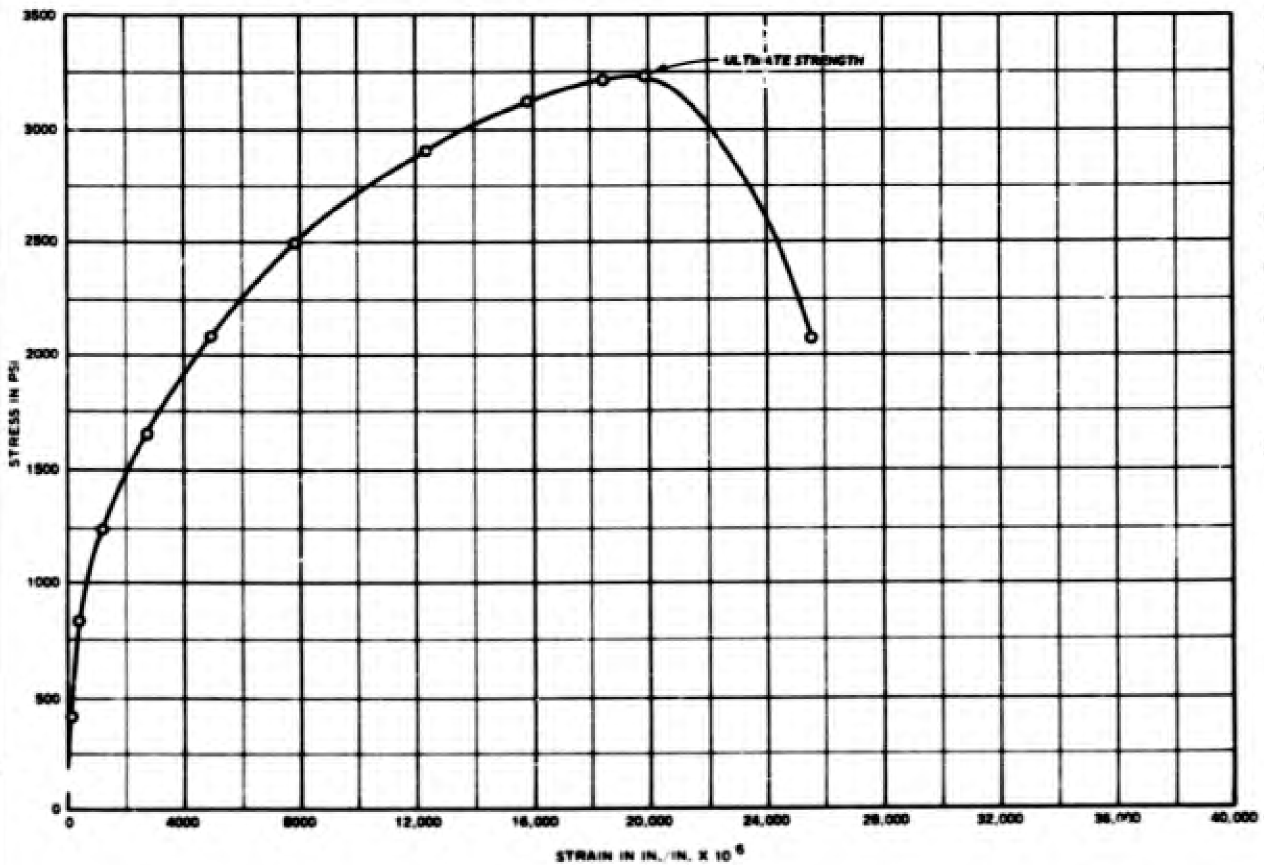
METHOD OF STRAIN MEASUREMENT: UNIAXIAL-COMPRESSOMETER WITH TWO DIAMETRICALLY OPPOSED 6-IN. GAGE LINES. LATERAL-METAL YOKE WITH DIAL GAGE.

STRESS PSI	AVG STRAIN IN./IN. × 10^6 UNIAXIAL	LATERAL	POISSON'S RATIO
0	0	0	0
420	125	7	0.056
840	475	87	0.183
1,260	1,392	787	0.565
1,680	3,056	2,153	0.704
2,100	5,217	4,153	0.796
2,510	8,133	6,953	0.855
2,930	12,017	11,020	0.917
3,140	15,017		
3,250	17,700		
3,350	20,333		
3,400*	23,000		

* ULTIMATE STRENGTH

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 9D



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 16 MAR 1962

CORE DEPTH: 2602.4 FT TO 2604.0 FT

DIAMETER: 4.95 IN.

SPECIMEN LENGTH: 15.55 IN. (INCLUDING CAP)

RATE OF LOAD: 20 PSI/SEC

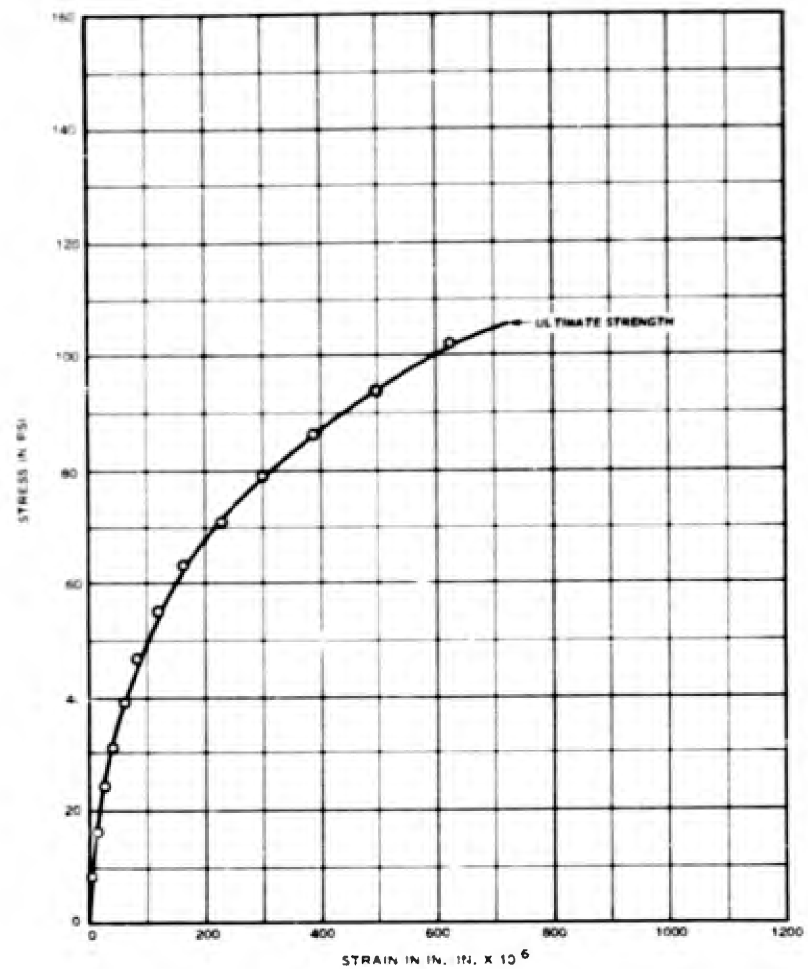
METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT: COMPRESSOMETER WITH TWO DIAMETRICALLY OPPOSED 6-IN. GAGE LINES

STRESS, PSI		AVG STRAIN, IN./IN. × 10^6
0		0
420		133
830		408
1,250		1,175
1,660		2,625
2,080		4,925
2,490		7,750
2,910		12,217
3,120		15,725
3,220		18,408
3,240	ULTIMATE STRENGTH	19,833
2,080		25,558

STRESS-STRAIN CURVE
UNIAXIAL COMPRESSIVE STRENGTH TEST
LENGTH/DIAMETER STUDY
HOLE WP-1 - SPECIMEN 57B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 29 SEPT 1961

CORE DEPTH: 2158.8 FT TO 2160.0 FT

DIAMETER: 4.93 IN.

SPECIMEN LENGTH: 10.00 IN.

RATE OF LOAD: 1 PSI/SEC

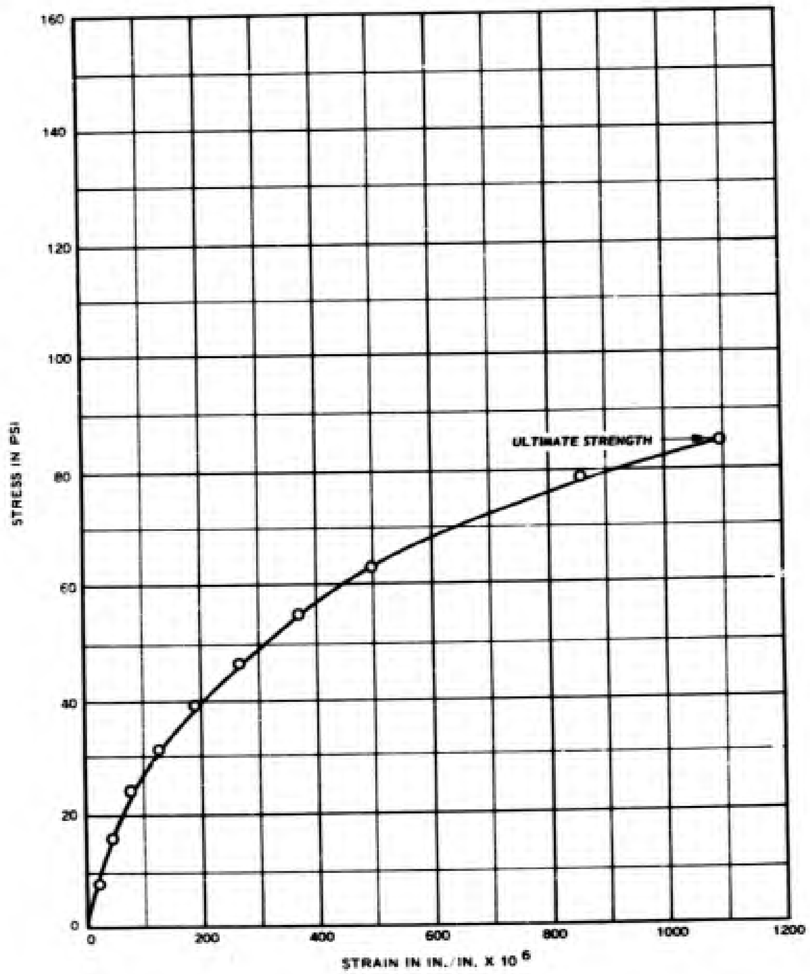
METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION: EMBEDDED IN SULFUR-SILICA COMPOUND

STRESS, PSI	AVG STRAIN, IN./IN. X 10^6
0	0
8	0
16	10
24	25
31	40
39	60
47	85
55	120
63	165
71	225
79	300
86	390
94	495
102	625
106 ULTIMATE STRENGTH	

STRESS-STRAIN CURVE
UNIAXIAL TENSILE STRENGTH TEST
HOLE WP-1 - SPECIMEN 32B

PLATE 95



HOLE COORDINATES:
N 10166.85, E 8040.83

DATE: 29 SEPT 1961

CORE DEPTH:
2179.3 FT TO 2180.8 FT

DIAMETER:
4.93 IN.

SPECIMEN LENGTH:
10.00 IN.

RATE OF LOAD:
1 PSI/ SEC

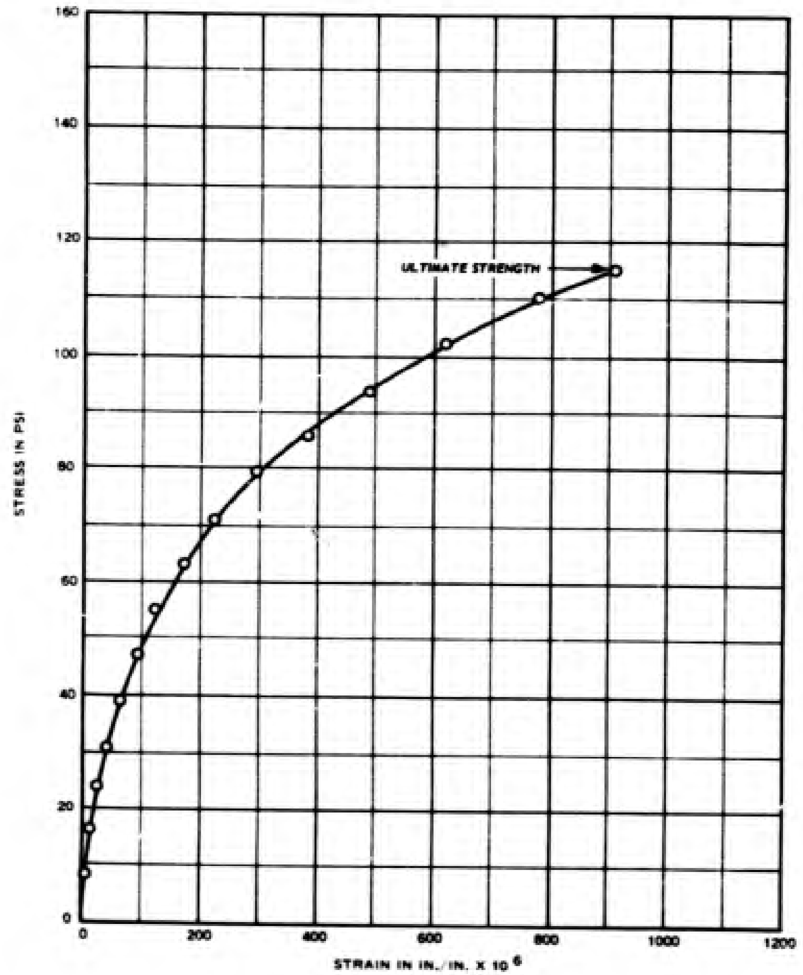
METHOD OF SAWING TO LENGTH:
DRY (DIAMOND SAW)

METHOD OF END PREPARATION:
EMBEDDED IN SULFUR-SILICA COMPOUND

STRESS, PSI	AVG STRAIN, IN./IN. X 10 6
0	0
8	20
16	45
24	80
31	125
39	190
47	265
55	370
63	495
71	*
79	855
85 ULTIMATE STRENGTH	1,095

* MISSED READING

STRESS-STRAIN CURVE
UNIAXIAL TENSILE STRENGTH TEST
HOLE WP-1 - SPECIMEN 21B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 29 SEPT 1961

CORE DEPTH: 2249.0 FT TO 2252.0 FT

DIAMETER: 4.93 IN.

SPECIMEN LENGTH: 10.00 IN.

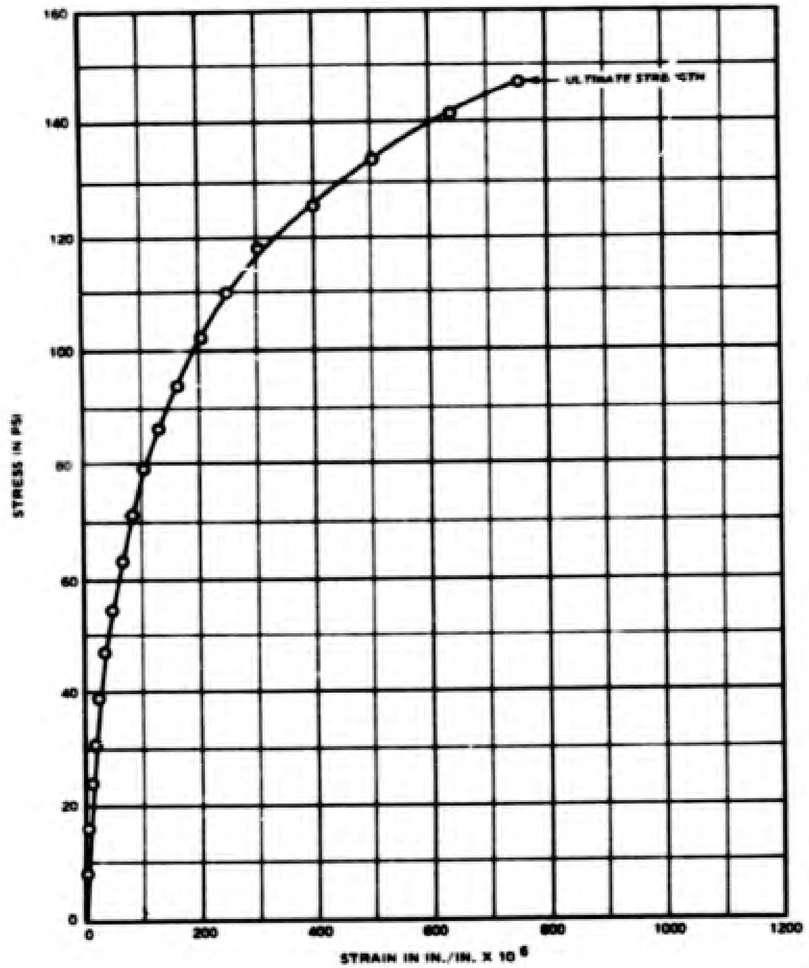
RATE OF LOAD: 1 PSI/SEC

METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

METHOD OF END PREPARATION: EMBEDDED IN SULFUR-SILICA COMPOUND

STRESS, PSI	AVG STRAIN, IN./IN. X 10^6
0	0
8	5
16	15
24	25
31	45
39	65
47	95
55	125
63	175
71	225
79	295
86	380
94	485
102	615
110	775
115 ULTIMATE STRENGTH	905

STRESS-STRAIN CURVE
UNIAXIAL TENSILE STRENGTH TEST
HOLE WP-1 - SPECIMEN 2B



HOLE COORDINATES:
N 10168.85, E 8040.63

DATE: 29 SEPT 1961

CORE DEPTH:
2656.0 FT TO 2659.0 FT

DIAMETER:
4.93 IN.

SPECIMEN LENGTH:
10.00 IN.

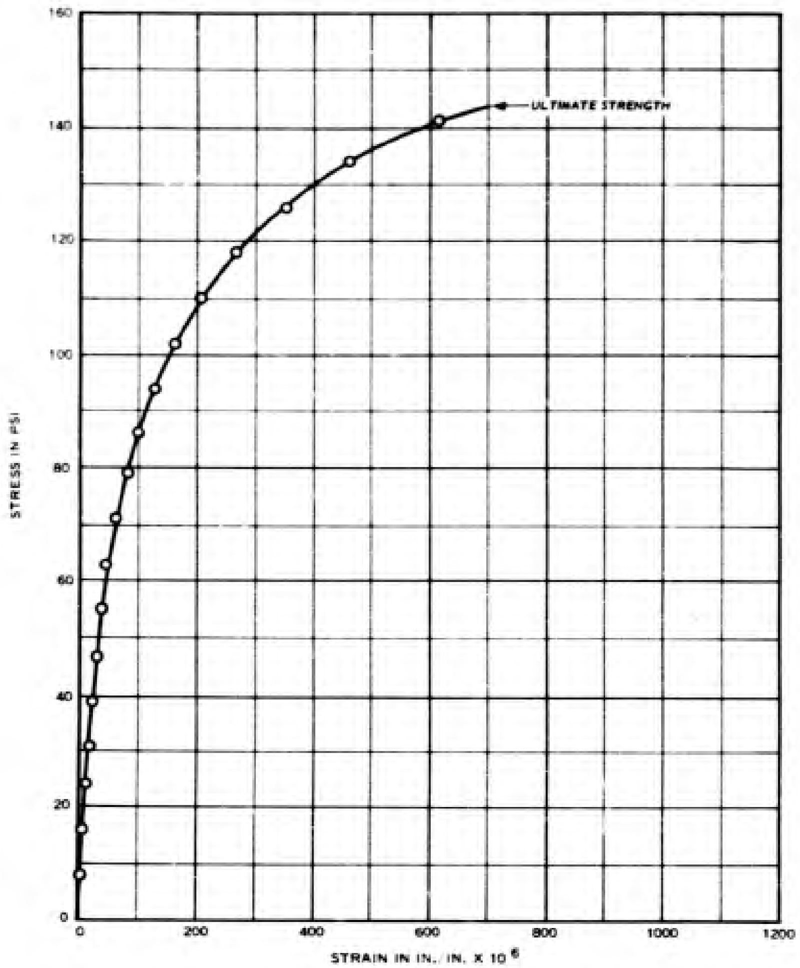
RATE OF LOAD:
1 PSI/SEC

METHOD OF SAWING TO LENGTH:
DRY (DIAMOND SAW)

METHOD OF END PREPARATION:
EMBEDDED IN SULFUR-SILICA COMPOUND

STRESS, PSI	AVG STRAIN, IN./IN. X 10^6
0	0
8	0
16	5
24	10
31	20
39	25
47	35
55	50
63	65
71	85
79	105
86	130
94	165
102	205
110	250
118	305
126	400
134	505
141	635
147 ULTIMATE STRENGTH	755

STRESS-STRAIN CURVE
UNIAXIAL TENSILE STRENGTH TEST
HOLE WP-1 - SPECIMEN 10B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 29 SEPT 1961

CORE DEPTH: 2656.0 FT TO 2669.0 FT

DIAMETER: 4.93 IN.

SPECIMEN LENGTH: 10.00 IN.

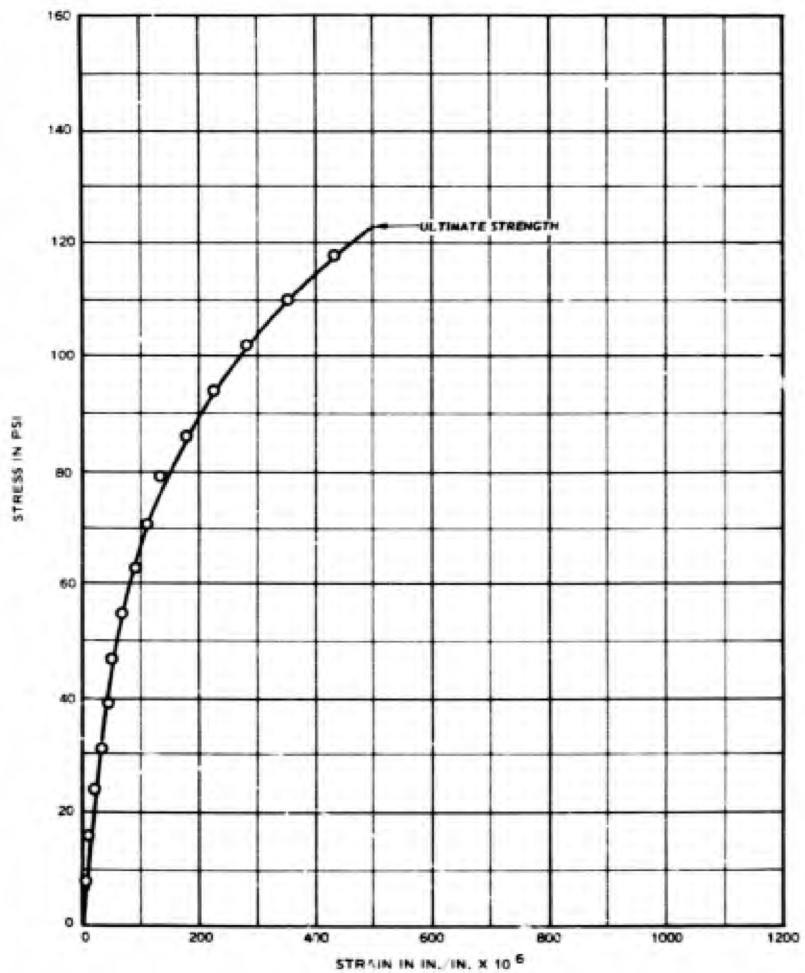
RATE OF LOAD: 1 PSI/SEC

METHOD OF SAWING TO LENGTH: DRY (DIAMOND SAW)

METHOD OF END PREPARATION: EMBEDDED IN SULFUR-SILICA COMPOUND

STRESS, PSI	AVG STRAIN, IN./IN. X 10^6
0	0
8	0
16	5
24	10
31	15
39	20
47	25
55	35
63	45
71	60
79	80
86	100
94	125
102	160
110	205
118	265
126	350
134	460
141	615
144 ULTIMATE STRENGTH	

STRESS-STRAIN CURVE
UNIAXIAL TENSILE STRENGTH TEST
HOLE WP-1 - SPECIMEN 10C



HOLE COORDINATES: DATE: 29 SEPT 1961
N 10166.85, E 8040.83

CORE DEPTH:
2656.0 FT TO 2659.0 FT

DIAMETER:
4.93 IN.

SPECIMEN LENGTH:
10.00 IN.

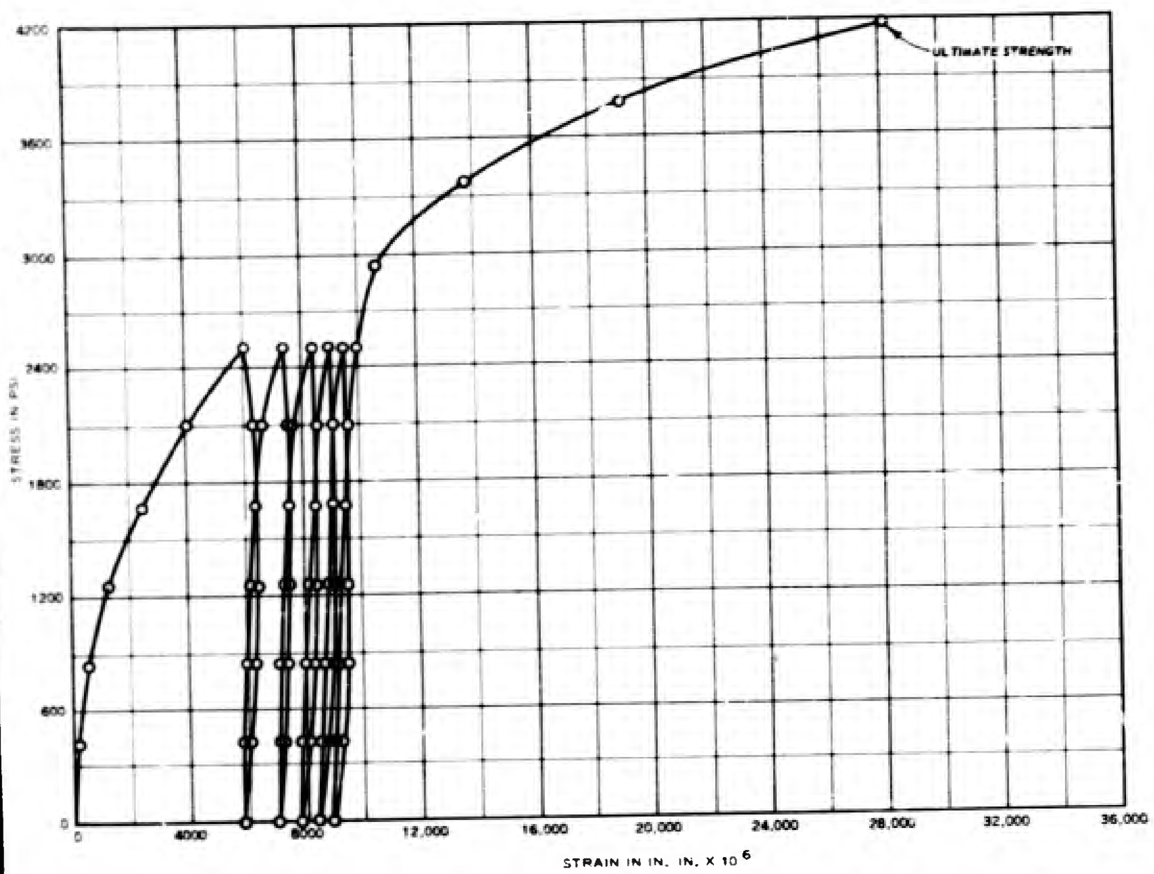
RATE OF LOAD:
1 PSI/SEC

METHOD OF SAWING TO LENGTH:
DRY (DIAMOND SAW)

METHOD OF END PREPARATION:
EMBEDDED IN SULFUR-SILICA COMPOUND

STRESS, PSI	AVG STRAIN, IN./IN. X 10^6
0	0
8	5
16	10
24	20
31	30
39	45
47	55
55	70
63	90
71	110
79	135
86	175
94	225
102	285
110	355
118	435
123 ULTIMATE STRENGTH	

STRESS-STRAIN CURVE
UNIAXIAL TENSILE STRENGTH TEST
HOLE WP-1 - SPECIMEN 10D



HOLE COORDINATES:
N 10166.85, E 8040.83

DATE: 29 SEPT 1961

CORE DEPTH:
1657.3 FT TO 1658.5 FT

DIAMETER:
4.93 IN.

SPECIMEN LENGTH:
10.65 IN.

RATE OF LOAD:
20 PSI/SEC

METHOD OF SAWING TO LENGTH:
BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION:
CAPPED WITH SULFUR-SILICA COMPOUND

TESTING APPARATUS:
BALDWIN UNIVERSAL TESTING MACHINE

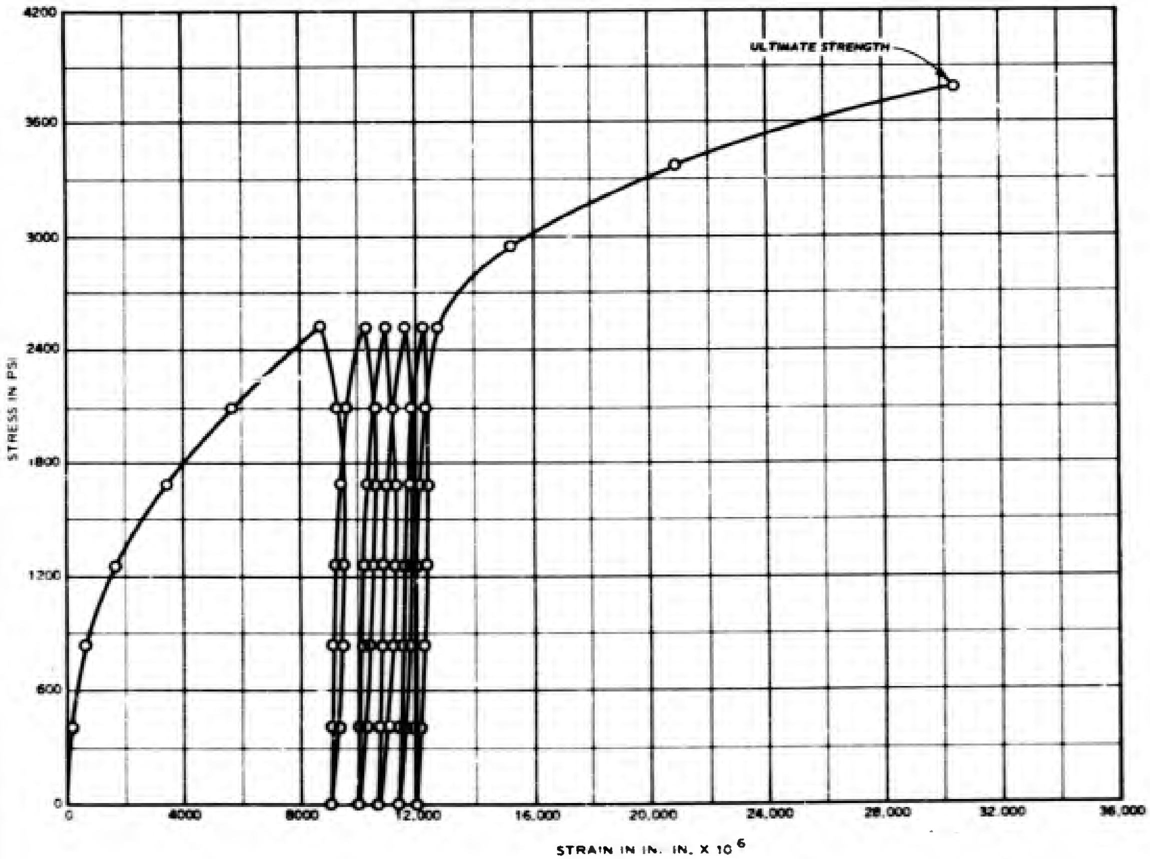
TESTING TEMPERATURE:
73 F

STRESS PSI	AVG STRAIN, IN./IN. × 10^6 LOADING CYCLES 1	2	3	4	5	DESTRUCTIVE TEST STRESS PSI	DESTRUCTIVE TEST STRAIN IN./IN. × 10^6
0	0	5,671	6,887	7,694	8,329	0	8,792
420	94	5,820	6,996	7,835	8,494	420	8,957
840	384	6,016	7,161	8,024	8,675	840	9,129
1,260	1,122	6,157	7,310	8,157	8,800	1,260	9,255
1,680	2,329	6,290	7,459	8,306	8,933	1,680	9,380
2,100	4,024	6,525	7,647	8,447	9,067	2,100	9,514
2,510	6,008	7,365	8,251	8,933	9,420	2,510	9,843
2,100	6,376	7,592	8,416	9,051	9,506	2,930	10,533
1,680	6,376	7,553	8,376	9,020	9,467	3,350	13,655
1,260	6,274	7,482	8,314	8,957	9,396	3,770	19,059
840	6,196	7,380	[illegible]	3,855	9,302	4,190*	28,118
420	6,071	7,263	8,086	8,722	9,169		
0	5,765	6,965	7,757	8,361	8,855		

* ULTIMATE STRENGTH

STRESS-STRAIN CURVE

UNIAXIAL CYCLIC LOADING TEST WITH FIVE UNLOADING CYCLES HOLE WP-1 - SPECIMEN 13B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 29 SEPT 1961

CORE DEPTH: 1681.0 FT TO 1682.2 FT

DIAMETER: 4.94 IN.

SPECIMEN LENGTH: 10.65 IN.

RATE OF LOAD: 20 PSI/SEC

METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

TESTING APPARATUS: BALDWIN UNIVERSAL TESTING MACHINE

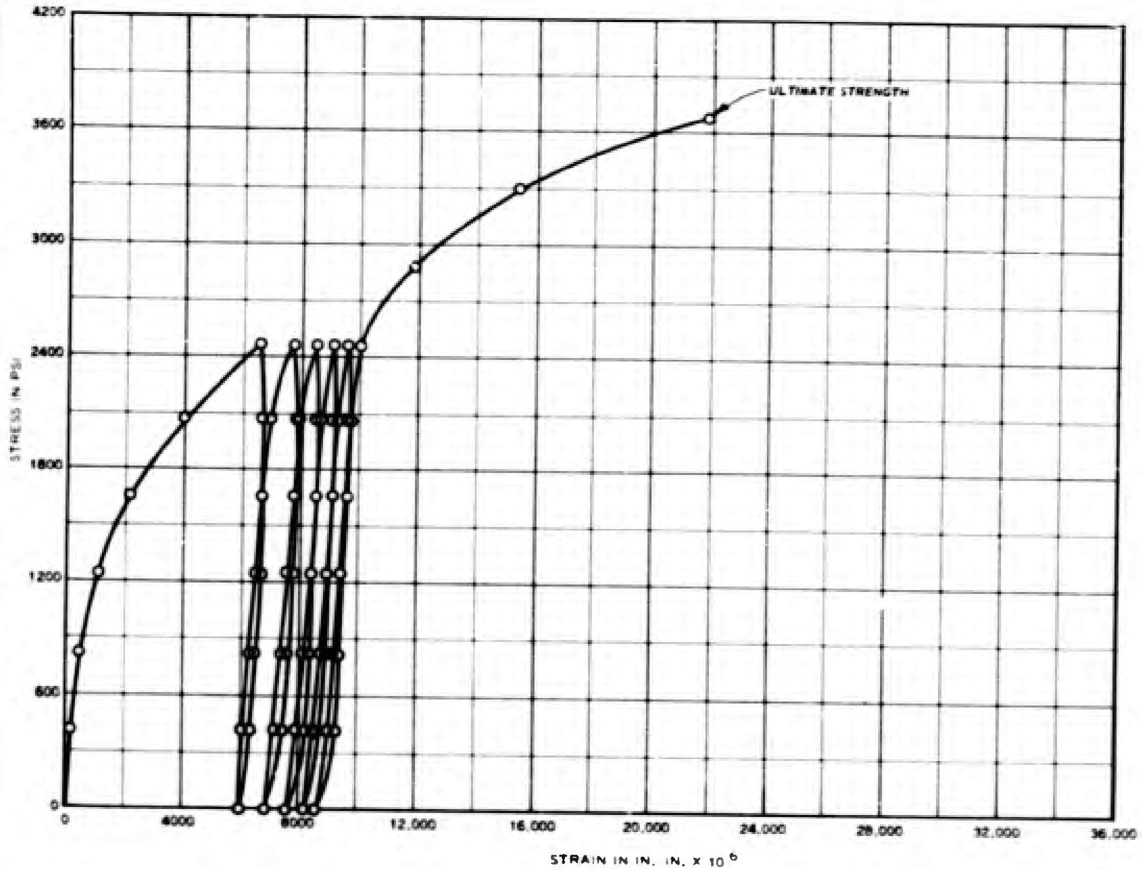
TESTING TEMPERATURE: 150 F

STRESS PSI	AVG STRAIN, IN./IN. × 10^6 LOADING CYCLES 1	2	3	4	5	DESTRUCTIVE TEST STRESS PSI	DESTRUCTIVE TEST STRAIN IN./IN. × 10^6
0	0	9,020	10 031	10,737	11,333	0	11,678
420	133	9,098	10,086	10,808	11,475	420	11,835
840	518	9,224	10,220	10,949	11,569	840	11,976
1,250	1,608	9,349	10,337	11,075	11,678	1,250	12,094
1,670	3,467	9,467	10,439	11,184	11,788	1,670	12,227
2,090	5,725	9,624	10,573	11,333	11,922	2,090	12,345
2,500	8,784	10,290	11,020	11,725	12,259	2,500	12,667
2,090	9,482	10,518	11,263	11,890	12,369	2,930	15,255
1,670	9,482	10,518	11,263	11,982	12,345	3,350	[illegible],933
1,250	9,451	10,471	11,200	11,812	12,259	3,770*	30,470
840	9,373	10,384	11,114	11,725	12,173		
420	9,270	10,282	10,996	11,616	12,063		
0	9,027	10,039	10,745	11,365	11,812		

* ULTIMATE STRENGTH

STRESS-STRAIN CURVE

UNIAXIAL CYCLIC LOADING TEST
WITH FIVE UNLOADING CYCLES
HOLE WP-1 - SPECIMEN 20B



HOLE COORDINATES:
N 10156.85, E 8040.83

DATE: 29 SEPT 1961

CORE DEPTH:
1994.5 FT TO 1995.6 FT

DIAMETER:
4.98 IN.

SPECIMEN LENGTH:
10.65 IN.

RATE OF LOAD:
20 PSI/SEC

METHOD OF SAWING TO LENGTH:
BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION:
CAPPED WITH SULFUR-SILICA COMPOUND

TESTING APPARATUS:
BALDWIN UNIVERSAL TESTING MACHINE

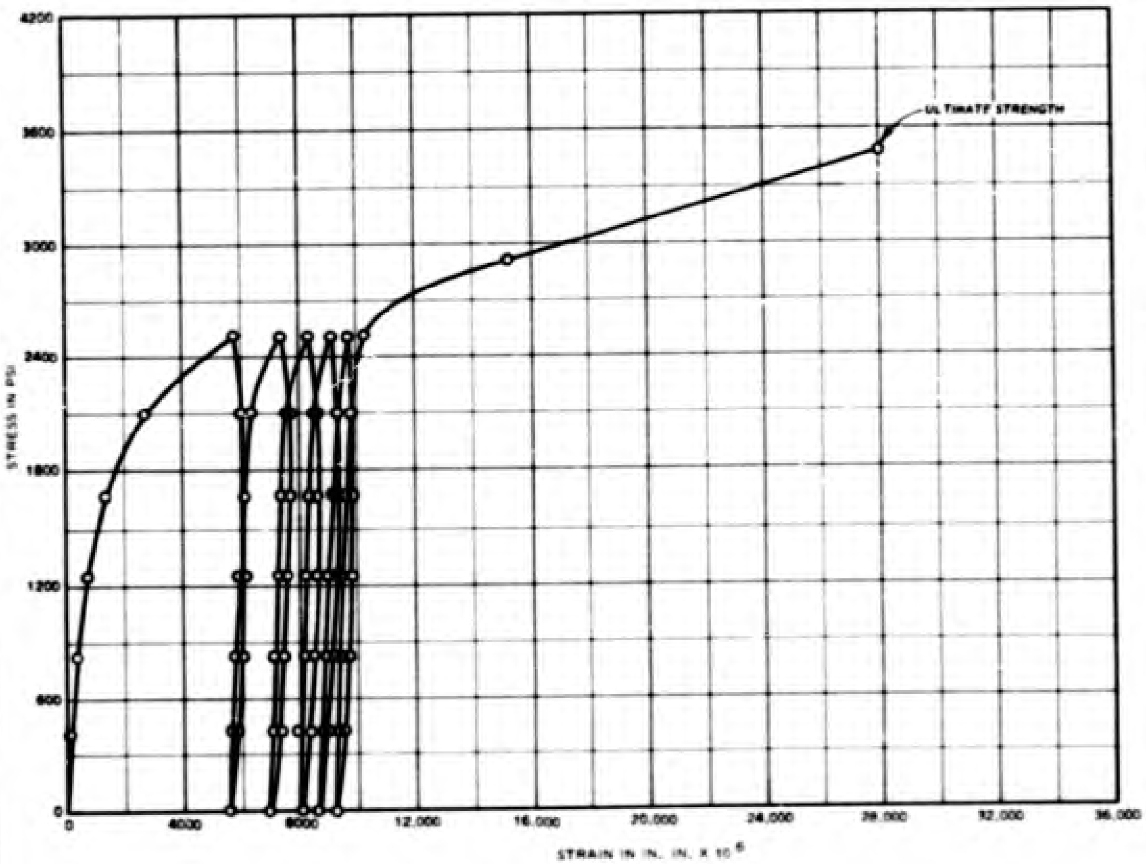
TESTING TEMPERATURE:
73 F

STRESS	AVG STRAIN, IN./IN. × 10^6					DESTRUCTIVE TEST	
	LOADING CYCLES					STRESS	STRAIN
PSI	1	2	3	4	5	PSI	IN./IN. × 10^6
0	0	5,796	6,878	7,655	8,220	0	8,620
410	204	6,259	7,333	8,110	8,682	410	9,114
820	463	6,431	7,522	8,267	8,878	820	9,286
1,230	1,027	6,572	7,655	8,400	9,020	1,230	9,420
1,640	2,243	6,706	7,772	8,518	9,137	1,640	9,561
2,050	4,047	6,925	7,953	8,674	9,278	2,050	9,702
2,460	6,659	7,812	8,596	9,176	9,639	2,460	10,070
2,050	6,737	7,859	8,627	9,247	9,655	2,875	11,874
1,640	6,690	7,796	8,541	9,145	9,569	3,285	15,451
1,230	6,596	7,686	8,439	9,051	9,467	3,665*	21,882
820	6,494	7,584	8,329	8,933	9,349		
410	6,345	7,435	8,188	8,784	9,208		
0	5,820	6,925	7,670	8,235	8,651		

* ULTIMATE STRENGTH

STRESS-STRAIN CURVE
UNIAXIAL CYCLIC LOADING TEST WITH FIVE UNLOADING CYCLES HOLE WP-1 - SPECIMEN 26B

PLATE 103



HOLE COORDINATES: DATE: 29 SEPT 1961

N 10166.85, E 8040.83

CORE DEPTH:

2035.0 FT TO 2036.4 FT

DIAMETER:

4.94 IN.

SPECIMEN LENGTH:

10.65 IN.

RATE OF LOAD:

20 PSI/SEC

METHOD OF SAWING TO LENGTH:

BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION:

CAPPED WITH SULFUR-SILICA COMPOUND

TESTING APPARATUS:

BALDWIN UNIVERSAL TESTING MACHINE

TESTING TEMPERATURE:

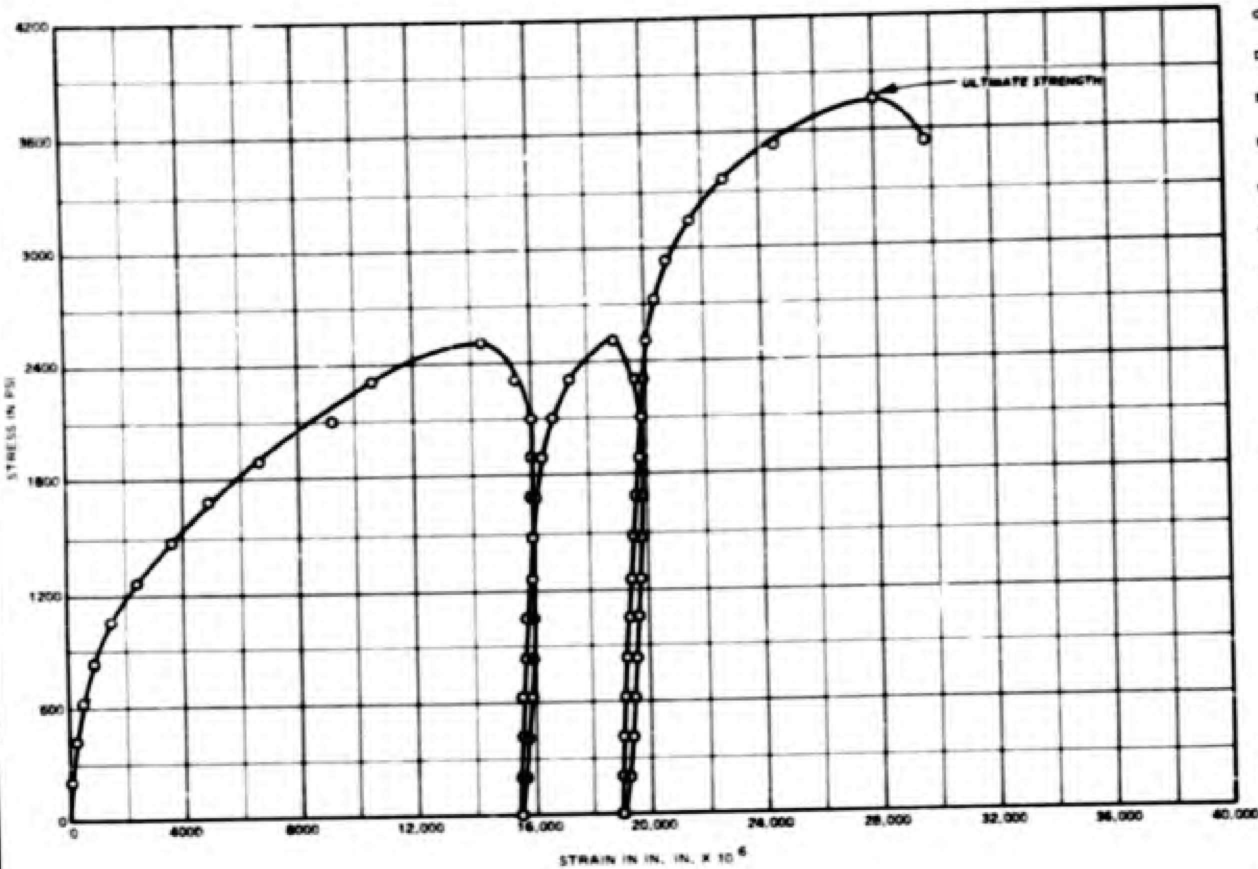
150 F

STRESS	AVG STRAIN, IN./IN. × 10^6					DESTRUCTIVE TEST	
	LOADING CYCLES					STRESS	STRAIN
PSI	1	2	3	4	5	PSI	IN./IN. × 10^6
0	0	5.443	6.919	7.843	8.557	0	9.176
420	94	5.631	7.082	8.008	8.745	420	9.302
840	267	5.804	7.231	8.157	8.866	840	9.459
1,250	612	5.937	7.357	8.282	9.004	1,250	9.592
1,670	1,247	6.070	7.475	8.408	9.137	1,670	9.702
2,090	2,722	6.235	7.624	8.541	9.263	2,090	9.827
2,500	5,788	7.365	8.376	9.129	9.718	2,500	10.266
2,090	6,102	7.569	8.518	9.255	9.820	2,930	15.262
1,670	6,102	7.583	8.502	9.224	9.780	3,490*	28.000
1,250	6,055	7.450	8.416	9.176	9.702		
840	5,937	7.365	8.314	9.043	9.608		
420	5,812	7.247	8.196	8.894	9.459		
0	5,490	6.941	7.859	8.573	9.122		

* ULTIMATE STRENGTH

STRESS-STRAIN CURVE

UNIAXIAL CYCLIC LOADING TEST WITH FIVE UNLOADING CYCLES HOLE WP-1 - SPECIMEN 28B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 29 SEPT 1961

CORE DEPTH: 2262.5 FT TO 2264.2 FT

DIAMETER: 4.93 IN.

SPECIMEN LENGTH: 10.65 IN.

RATE OF LOAD: 105 PSI/HR

METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

TESTING APPARATUS: SPRING-LOADED FRAME

TESTING TEMPERATURE: 73 F

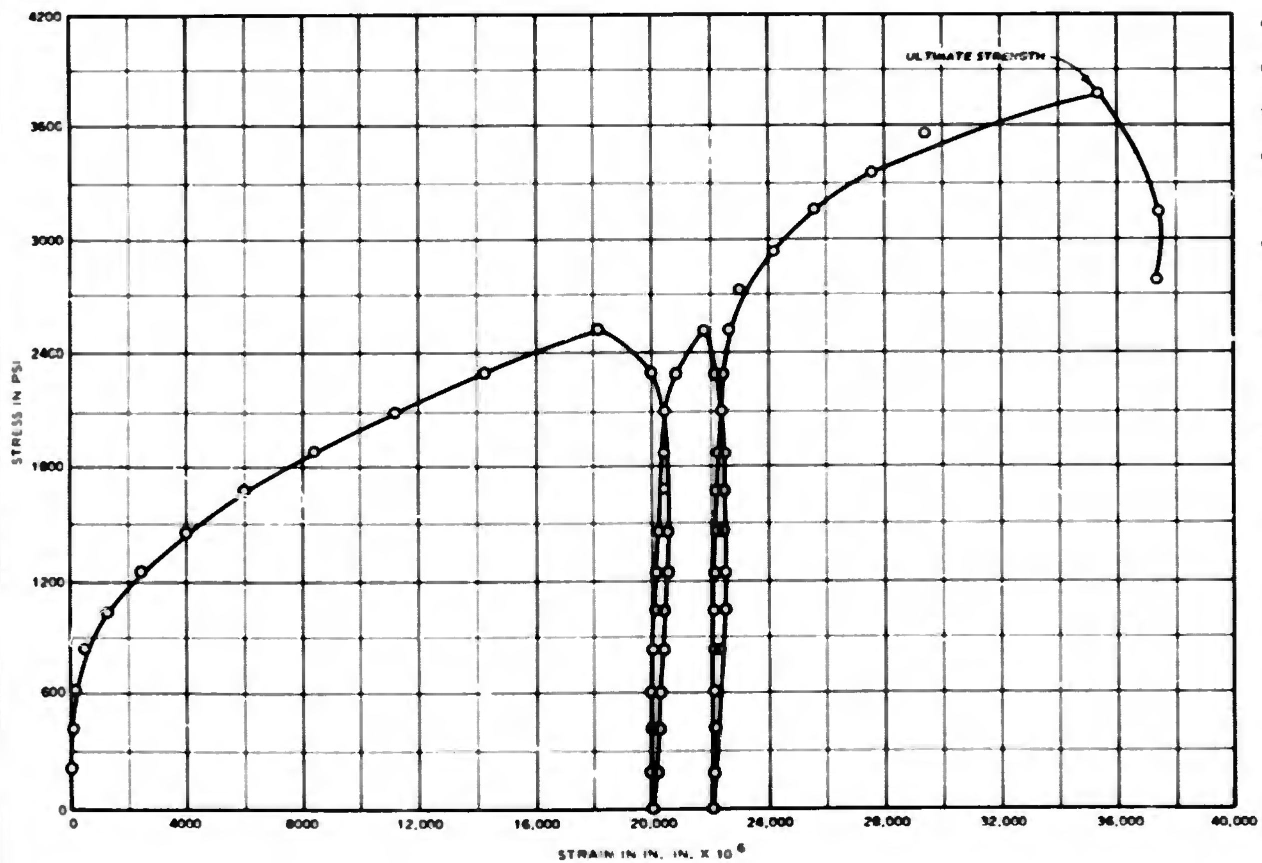
STRESS PSI	AVG STRAIN IN./IN. x 10^{-6} LOADING CYCLES 1	AVG STRAIN IN./IN. x 10^{-6} LOADING CYCLES 2	DESTRUCTIVE TEST STRESS PSI	DESTRUCTIVE TEST STRAIN IN./IN. x 10^{-6}
0	0	15,427	0	19,004
210	78	15,514	210	19,098
420	212	15,725	420	19,153
630	424	15,812	630	19,192
840	855	15,859	840	19,255
1,050	1,459	15,890	1,050	19,333
1,260	2,431	15,992	1,260	19,398
1,465	3,647	16,047	1,465	19,467
1,680	4,876	16,157	1,680	19,522
1,885	6,690	16,322	1,885	19,608
2,100	9,152	16,635	2,100	19,694
2,305	10,588	17,380	2,305	19,804
2,510	14,384	18,941	2,510	19,976
2,305	15,522	19,631	2,725	20,238
2,100	16,055	19,725	2,935	20,729
1,885	16,086	19,694	3,145	21,569
1,680	16,047	19,647	3,355	22,769
1,465	16,024	19,592	3,560	24,588
1,260	15,984	19,529	3,770*	27,804
1,050	15,937	19,490		
840	15,890	19,443		
630	15,773	19,380		
420	15,718	19,318		
210	15,647	19,208		
0	15,529	18,980		

* ULTIMATE STRENGTH

STRESS-STRAIN CURVE

UNIAXIAL CYCLIC LOADING TEST WITH TWO UNLOADING CYCLES HOLE WP-1 - SPECIMEN 35B

PLATE 105



HOLE COORDINATES: N 10166.85, E 8040.83

DATE. 29 SEPT 1961

CORE DEPTH: 2262.5 FT TO 2264.2 FT

DIAMETER: 4.93 IN.

SPECIMEN LENGTH: 10.65 IN.

RATE OF LOAD: 105 PSI/HR

METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

TESTING APPARATUS: SPRING-LOADED FRAME

TESTING TEMPERATURE: 150 F

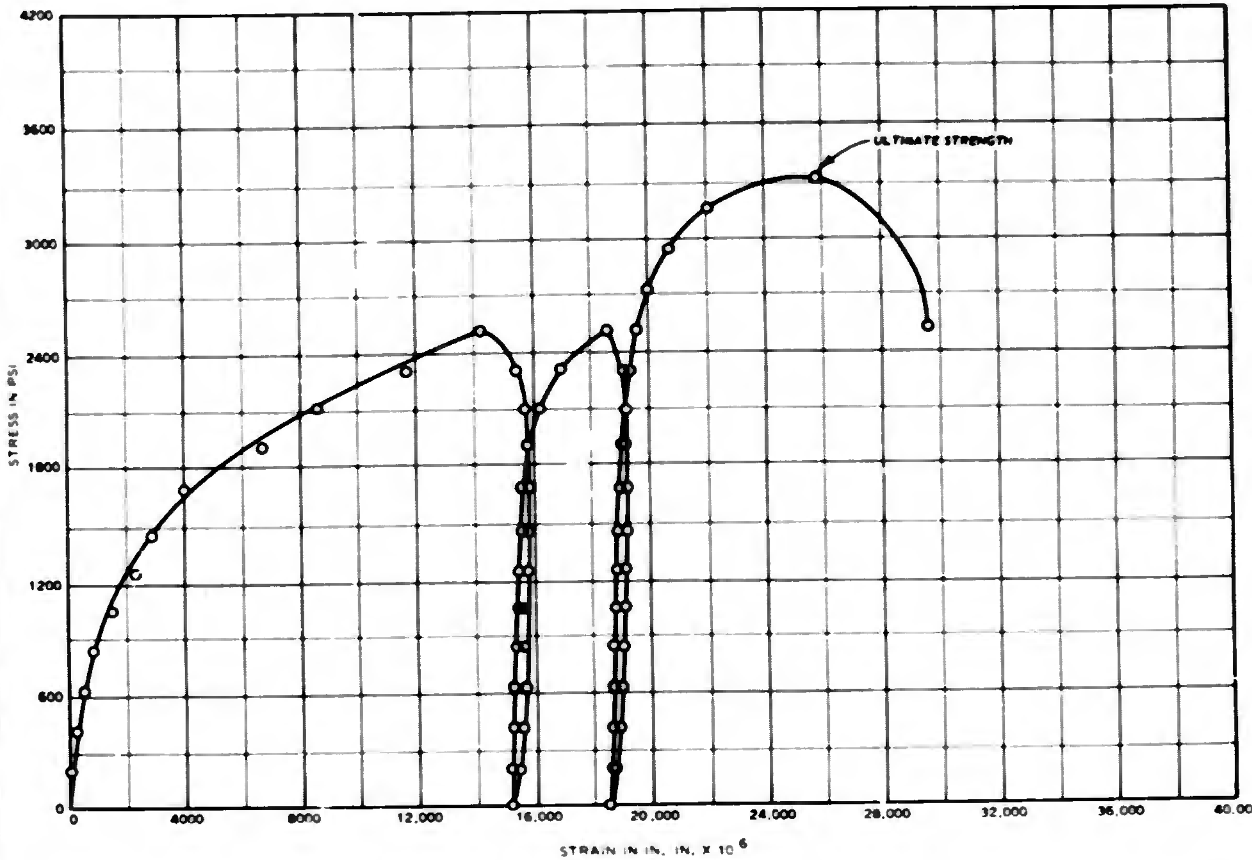
STRESS PSI	AVG STRAIN IN./IN. × 10^6 LOADING CYCLES 1	2	DESTRUCTIVE TEST STRESS PSI	STRAIN IN./IN. × 10^6
0	0	20,000	0	22,016
210	31	20,016	210	22,055
420	71	20,063	420	22,095
630	196	20,118	630	22,140
840	533	20,133	840	22,155
1,050	1,239	20,180	1,050	22,195
1,260	2,400	20,227	1,260	22,225
1,465	3,969	20,282	1,465	22,275
1,680	5,929	20,353	1,680	22,305
1,885	8,400	20,416	1,885	22,360
2,100	11,082	20,518	2,095	22,415
2,305	14,211	20,831	2,305	22,500
2,510	18,117	21,843	2,510	22,645
2,305	20,054	22,369	2,725	23,050
2,100	20,462	22,494	2,935	24,015
1,885	20,494	22,455	3,145	25,450
1,680	20,392	22,400	3,350	27,425
1,465	20,352	22,369	3,560	29,260
1,260	20,298	22,329	3,770*	35,310
1,050	20,251	22,290	3,145	37,365
840	20,235	22,243	2,095	37,240
630	20,165	22,196		
420	20,125	22,157		
210	20,110	22,094		
0	20,000	22,016		

* ULTIMATE STRENGTH

STRESS-STRAIN CURVE

UNIAXIAL CYCLIC LOADING TEST WITH TWO UNLOADING CYCLES HOLE WP-1 - SPECIMEN 35A

PLATE 107



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 29 SEPT 1961

CORE DEPTH: 2584.0 FT TO 2585.3 FT

DIAMETER: 4.92 IN.

SPECIMEN LENGTH: 10.65 IN.

RATE OF LOAD: 105 PSI/HR

METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

TESTING APPARATUS: SPRING-LOADED FRAME

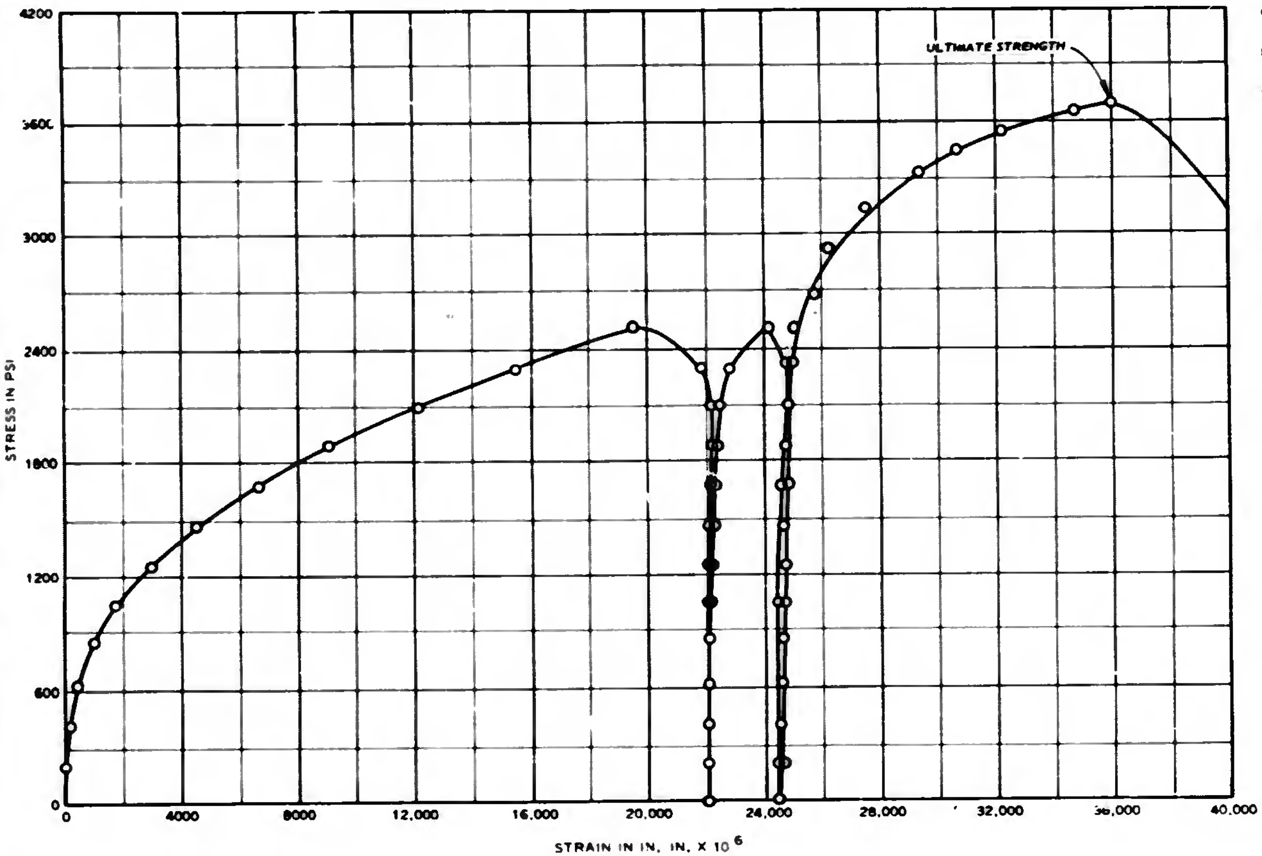
TESTING TEMPERATURE: 73 F

STRESS PSI	AVG STRAIN IN./IN. × 10^6 LOADING CYCLES 1	2	DESTRUCTIVE TEST STRESS PSI	STRAIN IN./IN. × 10^6
0	0	15,231	0	18,690
210	149	15,357	210	18,792
420	252	15,420	420	18,894
630	464	15,506	630	18,941
840	894	15,561	840	18,973
1,050	1,498	15,616	1,050	19,027
1,260	2,361	15,686	1,260	19,082
1,470	2,847	15,686	1,470	19,153
1,680	3,961	15,835	1,680	19,224
1,890	6,682	15,922	1,890	19,278
2,100	8,659	16,235	2,100	19,357
2,310	11,780	17,035	2,310	19,475
2,520	14,282	18,612	2,520	19,647
2,310	15,506	19,216	2,735	20,000
2,100	15,835	19,263	2,950	20,729
1,890	15,843	19,224	3,155	22,149
1,680	15,804	19,200	3,330*	25,725
1,470	15,765	19,145	2,520	29,608
1,260	15,725	19,090		
1,050	15,671	19,059		
840	15,624	19,020		
630	15,569	18,960		
420	15,545	18,918		
210	15,388	18,808		
0	15,231	18,698		

* ULTIMATE STRENGTH

STRESS-STRAIN CURVE

UNIAXIAL CYCLIC LOADING TEST WITH TWO UNLOADING CYCLES HOLE WP-1 - SPECIMEN 56B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 29 SEPT 1961

CORE DEPTH: 2629.3 FT TO 2630.5 FT

DIAMETER: 4.93 IN.

SPECIMEN LENGTH: 10.65 IN.

RATE OF LOAD: 105 PSI/HR

METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

TESTING APPARATUS: SPRING-LOADED FRAME

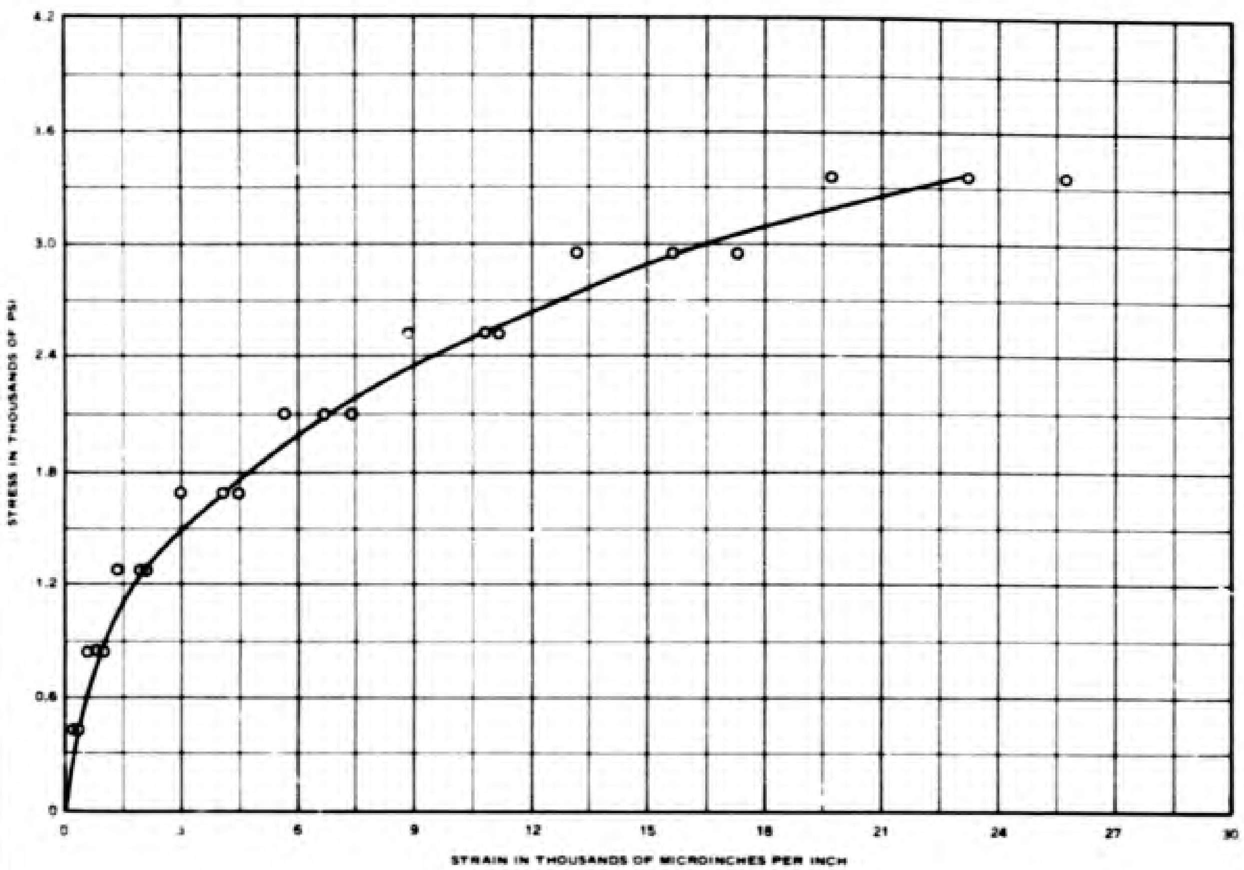
TESTING TEMPERATURE: 150 F

STRESS PSI	AVG STRAIN IN./IN. × 10^6 LOADING CYCLES 1	2	DESTRUCTIVE TEST STRESS PSI	STRAIN IN./IN. × 10^6
0	0	22,000	0	24,510
210	0	22,055	210	24,540
420	173	22,125	420	24,570
630	416	22,196	630	24,625
840	941	22,196	840	24,660
1,050	1,678	22,251	1,050	24,675
1,260	2,973	22,290	1,260	24,720
1,465	4,588	22,384	1,465	24,750
1,680	6,722	22,431	1,680	24,810
1,885	9,137	22,471	1,885	24,845
2,100	12,250	22,549	2,100	24,885
2,305	15,584	22,823	2,305	24,965
2,510	19,662	24,165	2,510	25,100
2,305	21,929	24,761	2,725	25,750
2,100	22,321	24,871	2,935	26,300
1,885	22,345	24,831	3,145	27,550
1,680	22,306	24,792	3,350	29,465
1,465	22,275	24,769	3,455	30,665
1,260	22,196	24,745	3,560	32,290
1,050	22,173	24,715	3,665	34,845
840	22,165	24,690	3,710*	36,065
630	22,118	24,625	3,145	40,885
420	22,102	24,590	2,095	40,760
210	22,016	24,540		
0	22,000	24,510		

* ULTIMATE STRENGTH

STRESS-STRAIN CURVE

UNIAXIAL CYCLIC LOADING TEST WITH TWO UNLOADING CYCLES HOLE WP-1 - SPECIMEN 59B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 20 APR 1962

CORE DEPTH: 2271.0 FT TO 2272.1 FT

DIAMETER: 4.95 IN.

SPECIMEN LENGTH: 10.0 IN.

RATE OF LOAD: 420 PSI/HR

METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

TESTING TEMPERATURE: 73 ± 3F

STRESS PSI		TIME HOURS	AVG STRAIN IN./IN. × 10^6
0		0	0
420		0.1	251
420		0.5	322
420		1.0	369
840		1.1	667
840		1.5	886
840		2.0	989
1,260		2.1	1,396
1,260		2.5	1,969
1,260		3.0	2,094
1,680		3.1	2,949
1,680		3.5	4,094
1,680		4.0	4,447
2,100		4.1	5,624
2,100		4.5	6,698
2,100		5.0	7,349
2,520		5.1	8,624
2,520		5.5	10,816
2,520		6.0	11,186
2,940		6.1	13,137
2,940		6.5	15,647
2,940		7.0	16,949
3,360		7.1	19,718
3,360		7.5	23,176
3,360		8.0	25,639
3,780	ULTIMATE STRENGTH	8.1	

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSION TESTS BY INCREMENTAL LOADING HOLE WP-1 - SPECIMEN 45 B

PLATE 109

HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 19 JULY 1962

CORE DEPTH: 2287.2 FT TO 2289.0 FT

DIAMETER: 4.93 IN.

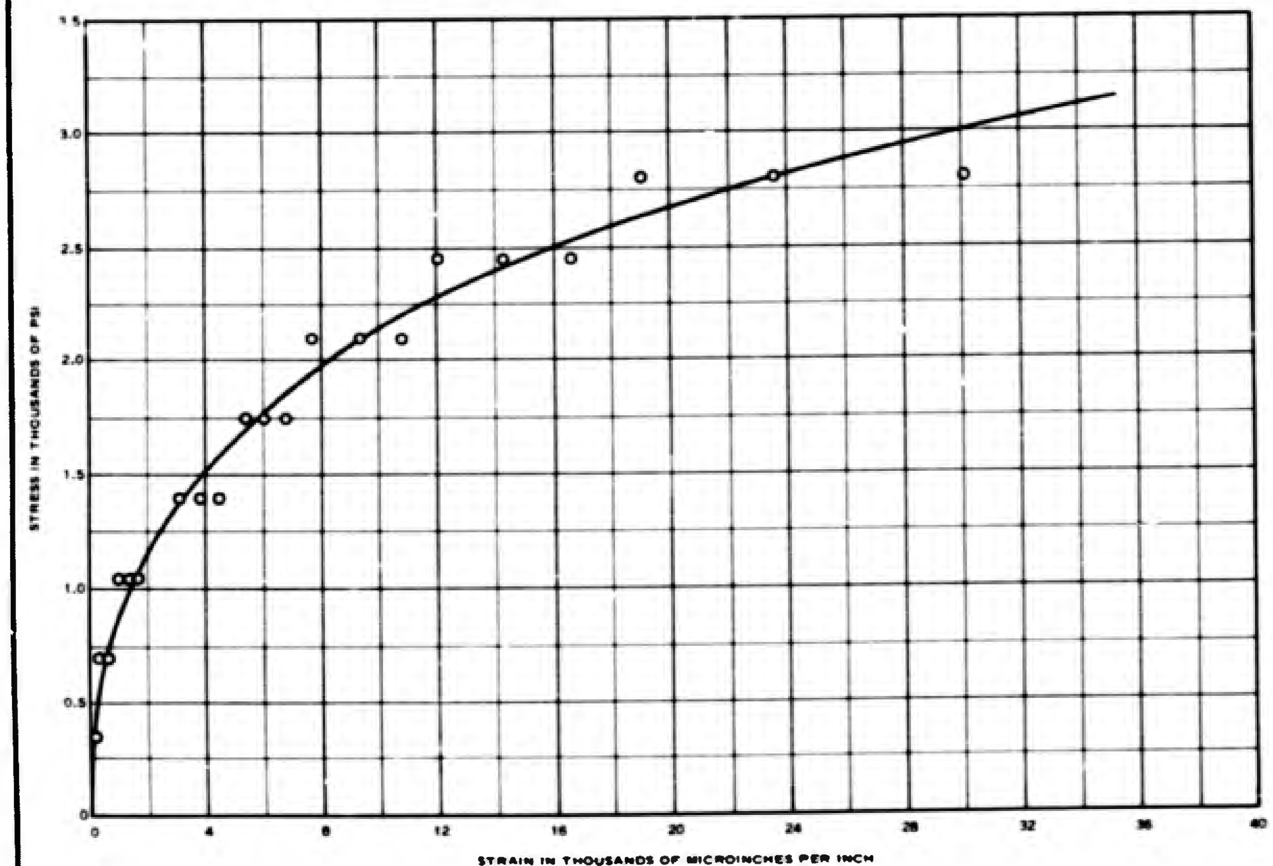
SPECIMEN LENGTH: 9.82 IN.

RATE OF LOAD: 350 PSI/12 HR

METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

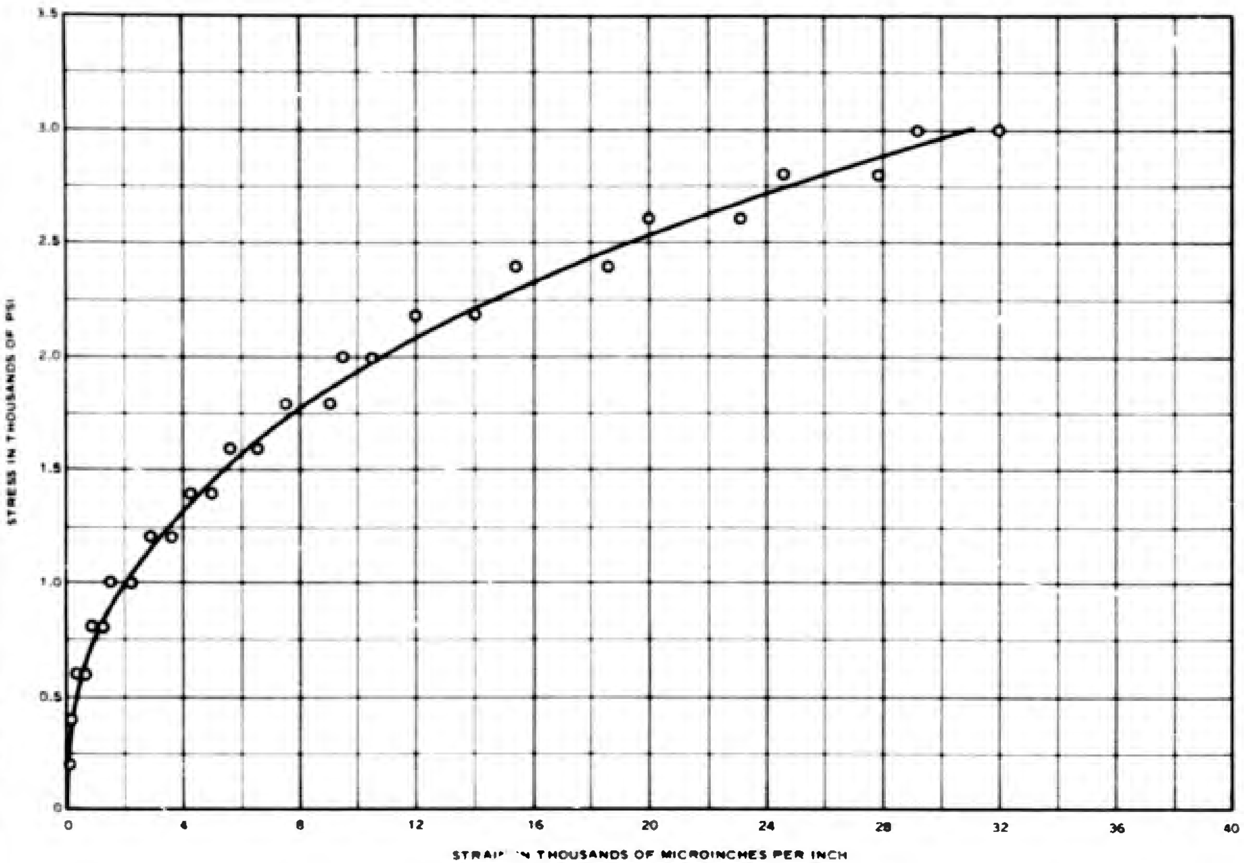
TESTING TEMPERATURE: 73 ± 3 F



STRESS PSI	TIME HOURS	AVG STRAIN IN./IN. × 10^6
0	0	0
350	0.2	71
350	4.0	86
350	12.0	125
700	12.2	290
700	16.0	447
700	24.0	572
1,050	24.2	1,051
1,050	28.0	1,294
1,050	36.0	1,616
1,400	36.2	3,098
1,400	40.0	3,851
1,400	48.0	4,470
1,750	48.2	5,451
1,750	52.0	5,859
1,750	60.0	6,792
2,100	60.2	7,639
2,100	64.0	9,380
2,100	72.0	10,824
2,450	72.2	12,118
2,450	76.0	14,282
2,450	84.0	16,620
2,800	84.2	19,082
2,800	88.0	23,624
2,800	96.0	30,118
3,150	96.2	
3,150 ULTIMATE STRENGTH	98.0	

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSION TESTS
BY INCREMENTAL LOADING
HOLE WP-1 - SPECIMEN 29A



HOLE COORDINATES: N 10166.85, E 8040.83

DATE 19 JULY 1962

CORE DEPTH: 2287.2 FT TO 2289.0 FT

DIAMETER: 4.92 IN.

SPECIMEN LENGTH: 9.89 IN.

RATE OF LOAD: 200 PSI 48 HR

METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

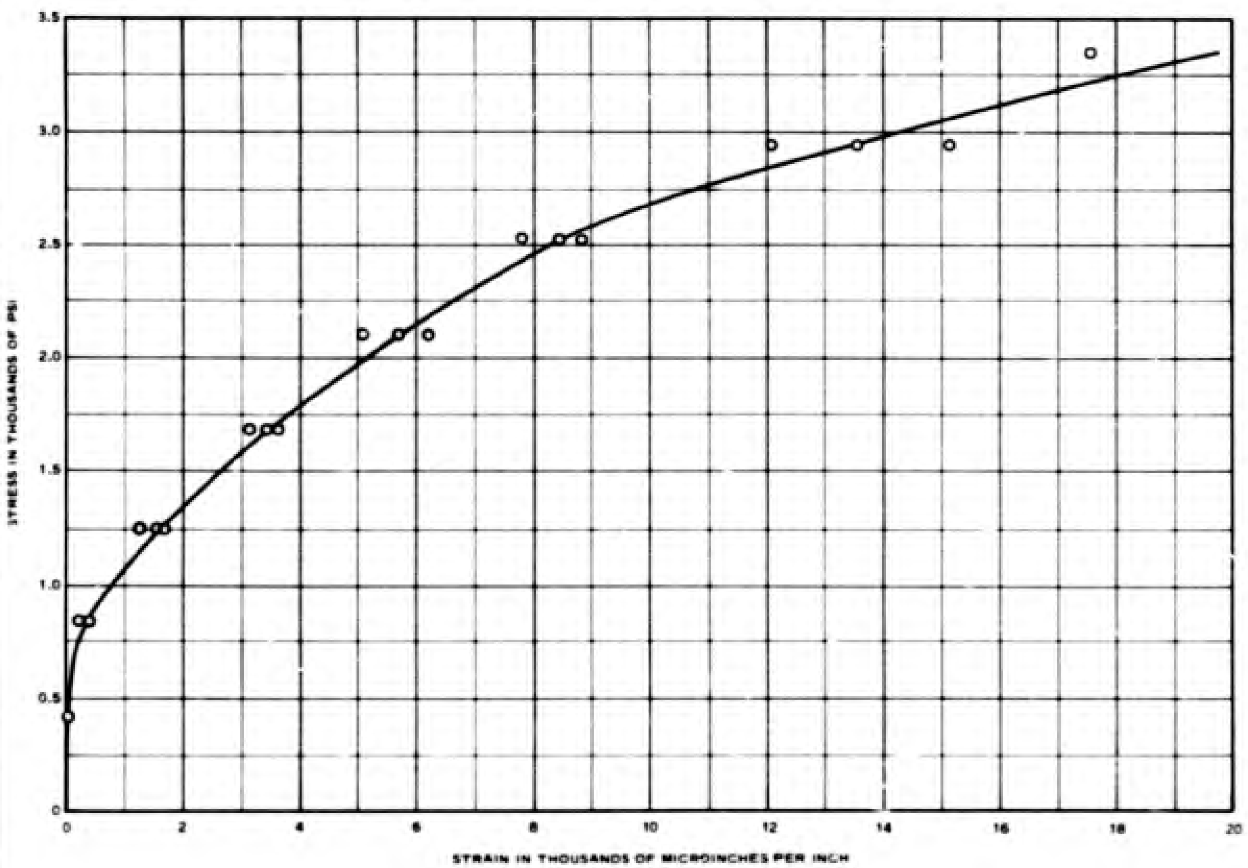
TESTING TEMPERATURE: 73 ± 3 F

STRESS PSI	TIME HOURS	AVG STRAIN IN./IN. × 10^{-6}
0	0	0
200	1	39
200	48	110
400	49	133
400	96	235
600	97	369
600	144	510
800	145	831
800	192	1,208
1,000	193	1,584
1,000	240	2,220
1,200	241	2,863
1,200	288	3,694
1,400	289	4,298
1,400	336	5,043
1,600	337	5,631
1,600	384	6,729
1,800	385	7,576
1,800	432	9,106
2,000	433	9,569
2,000	480•	10,549
2,200	481	11,882
2,200	528	14,133
2,400	529	15,435
2,400	576	18,596
2,600	577	19,984
2,600	624	23,123
2,800	625	24,627
2,800	672	27,780
3,000	673	29,239
3,000	720	32,000
3,520 ULTIMATE STRENGTH	720	

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSION TESTS
BY INCREMENTAL LOADING
HOLE WP-1 - SPECIMEN 29B

PLATE III



HOLE COORDINATES:
N 10166.85, E 8040.83

DATE: 20 APR 1962

CORE DEPTH:
2453.2 FT TO 2455.0 FT

DIAMETER:
4.95 IN.

SPECIMEN LENGTH:
10.0 IN.

RATE OF LOAD:
420 PSI/HR

METHOD OF SAWING TO LENGTH:
BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION:
CAPPED WITH SULFUR-SILICA COMPOUND

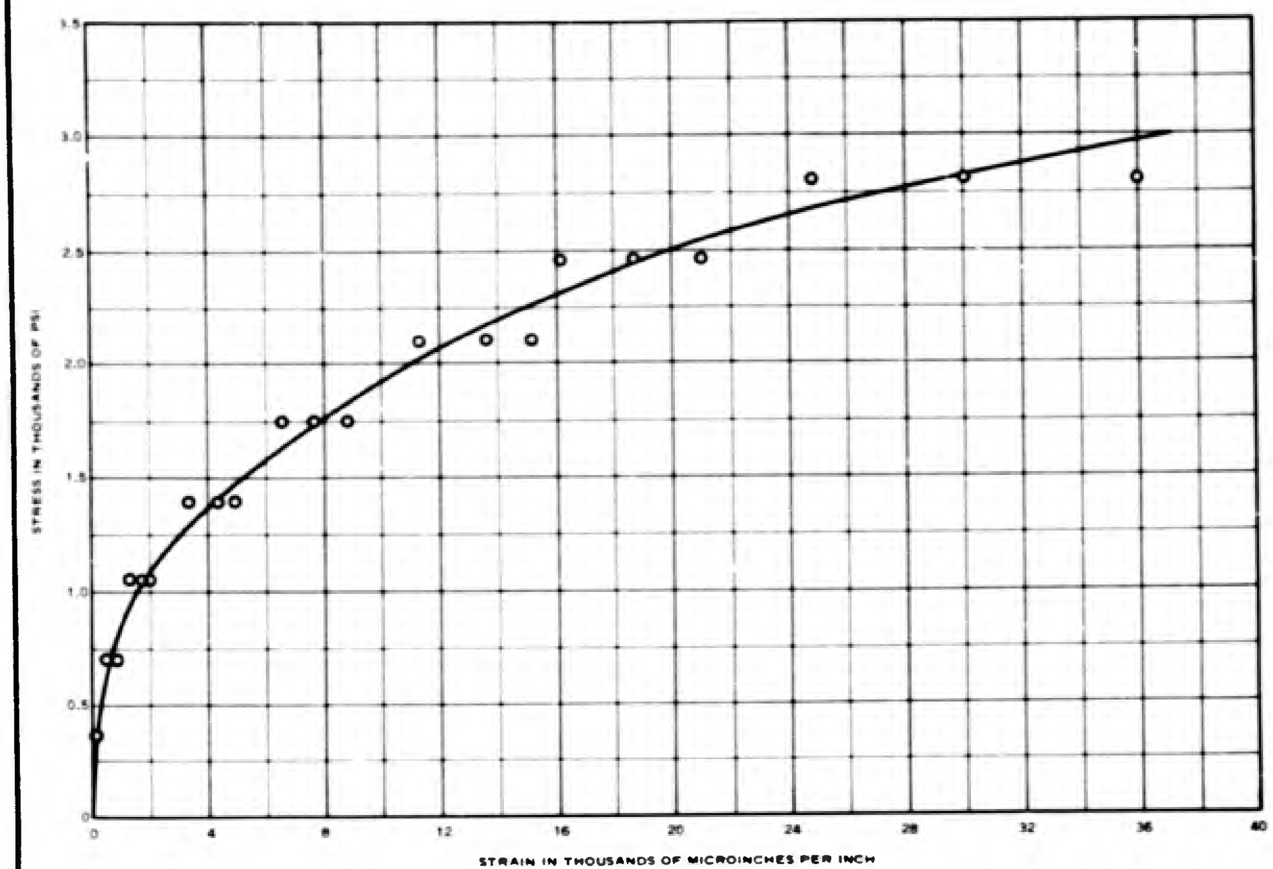
TESTING TEMPERATURE:
73 ± 3F

STRESS PSI		TIME HOURS	AVG STRAIN IN./IN. × 10^{-6}
0		0	0
420		0.1	78
420		0.5	78
420		1.0	78
840		1.1	290
840		1.5	353
840		2.0	376
1,260		2.1	1,286
1,260		2.5	1,584
1,260		3.0	1,670
1,680		3.1	3,145
1,680		3.5	3,441
1,680		4.0	3,624
2,100		4.1	5,106
2,100		4.5	5,725
2,100		5.0	6,196
2,520		5.1	7,827
2,520		5.5	8,463
2,520		6.0	8,863
2,940		6.1	12,119
2,940		6.5	13,584
2,940		7.0	15,153
3,360		7.1	17,616
3,360		7.5	19,804
3,360		8.0	21,098
3,780	ULTIMATE STRENGTH	8.1	

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSION TESTS BY INCREMENTAL LOADING HOLE WP-1 - SPECIMEN 37B

PLATE 112



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 19 JULY 1962

CORE DEPTH: 2486.5 FT TO 2488.0 FT

DIAMETER: 4.94 IN.

SPECIMEN LENGTH: 9.80 IN.

RATE OF LOAD: 350 PSI/12 HR

METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

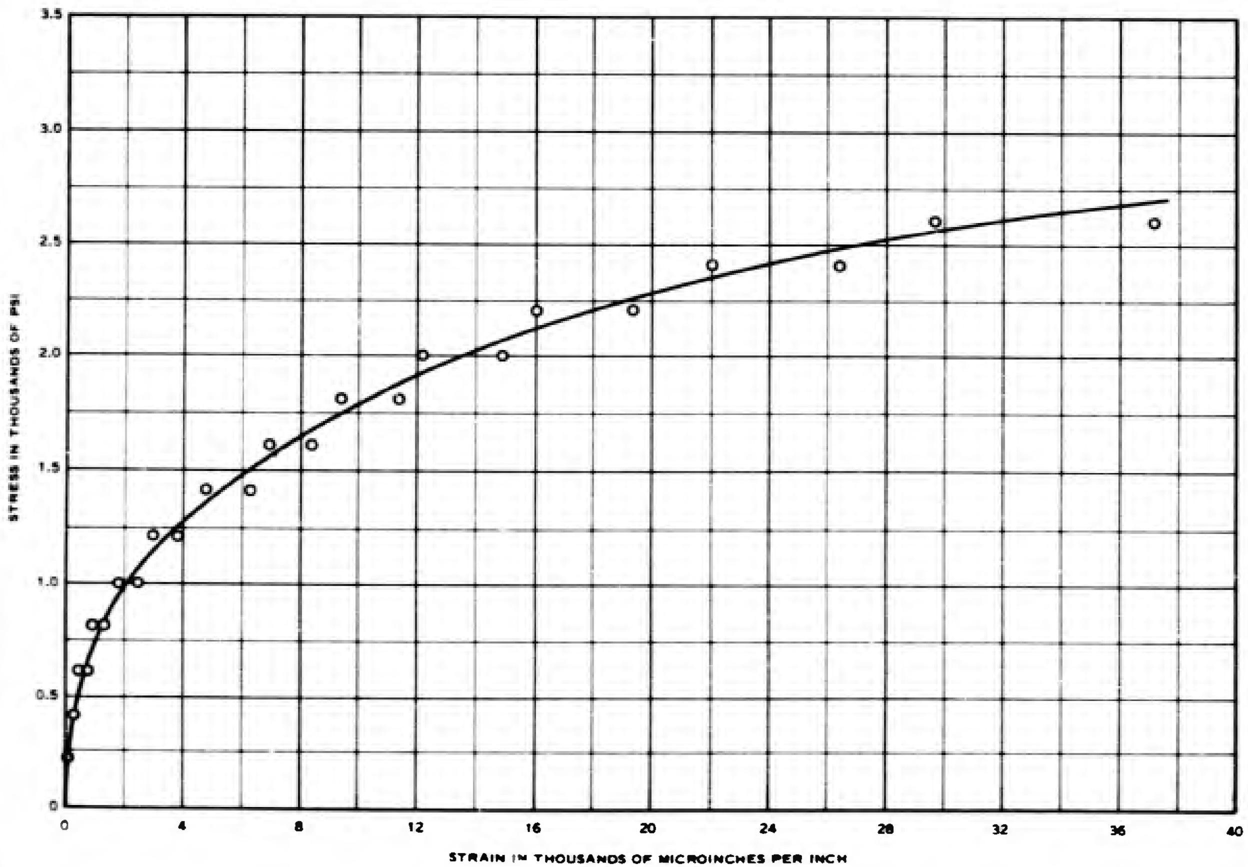
METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

TESTING TEMPERATURE: 73 ± 3F

STRESS PSI	TIME HOURS	AVG STRAIN IN./IN. × 10^{6}
0	0	0
350	0.2	94
350	4.0	141
350	12.0	172
700	12.2	478
700	16.0	682
700	24.0	831
1,050	24.2	1,349
1,050	28.0	1,709
1,050	36.0	2,039
1,400	36.2	3,443
1,400	40.0	4,447
1,400	48.0	4,972
1,750	48.2	6,596
1,750	52.0	[illegible]
1,750	60.0	[illegible]
2,100	60.2	11,341
2,100	64.0	13,576
2,100	72.0	15,169
2,450	72.2	16,157
2,450	76.0	18,651
2,450	84.0	21,051
2,800	84.2	24,941
2,800	88.0	29,960
2,800	96.0	35,882
3,000 ULTIMATE STRENGTH	96.1	

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSION TESTS BY INCREMENTAL LOADING HOLE WP-1 - SPECIMEN 43B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 19 JULY 1962

CORE DEPTH: 2539.5 FT TO 2540.8 FT

DIAMETER: 4.92 IN.

SPECIMEN LENGTH: 9.91 IN.

RATE OF LOAD: 200 PSI/48 HR

METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

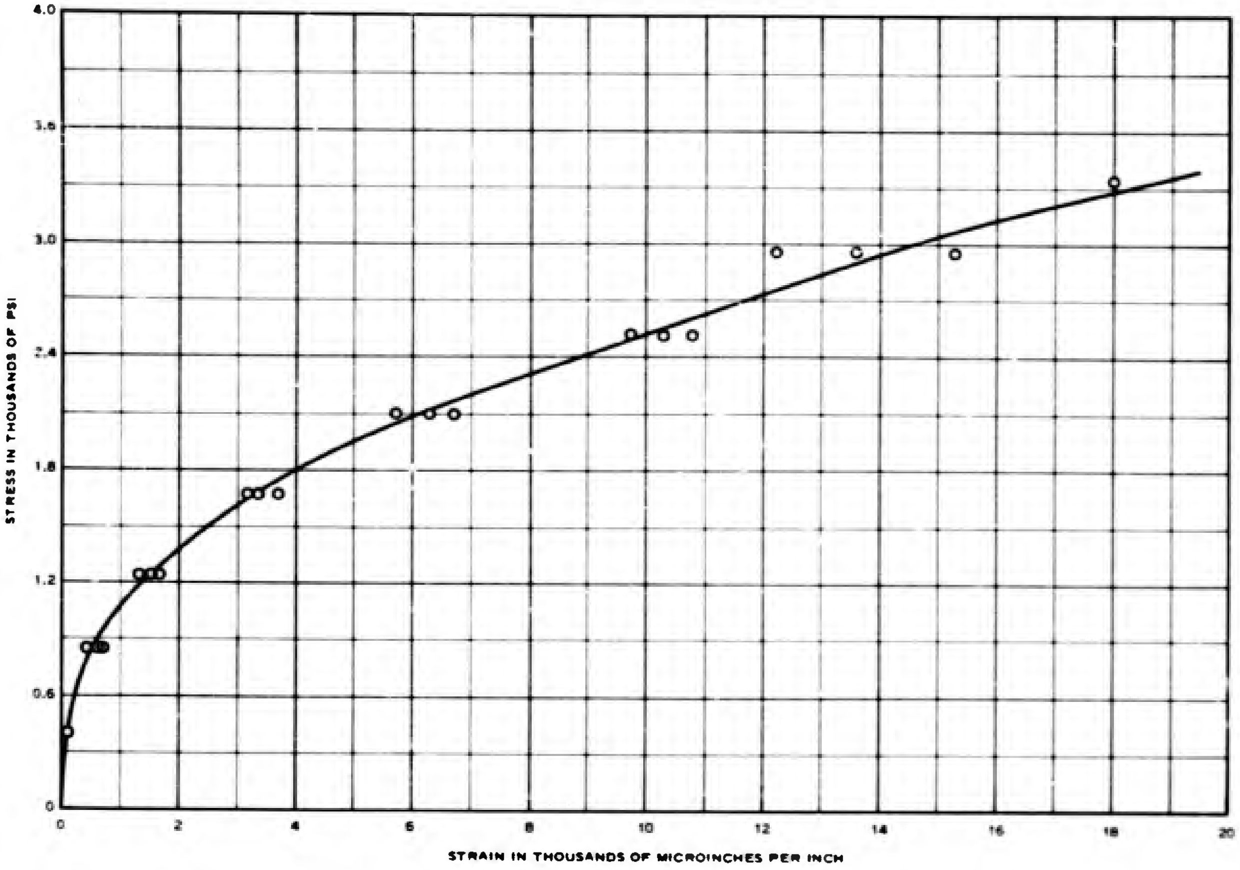
METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

TESTING TEMPERATURE: 73 ± 3 F

STRESS PSI	TIME HOURS	AVG STRAIN IN./IN. X 10^6
0	0	0
200	1	55
200	48	118
400	49	243
400	96	329
600	97	494
600	144	698
800	145	980
800	192	1,333
1,000	193	1,804
1,000	240	2,525
1,200	241	2,996
1,200	288	3,843
1,400	289	4,769
1,400	336	6,376
1,600	337	6,949
1,600	384	8,431
1,800	385	9,388
1,800	432	11,372
2,000	433	12,235
2,000	480	14,870
2,200	481	16,063
2,200	528	19,318
2,400	529	21,961
2,400	576	26,369
2,600	577	29,584
2,600	624	37,129
2,800 ULTIMATE STRENGTH	624	

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSION TESTS BY INCREMENTAL LOADING HOLE WP-1 - SPECIMEN 46B



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 20 APR 1962

CORE DEPTH: 2693.1 FT TO 2695.0 FT

DIAMETER: 4.95 IN.

SPECIMEN LENGTH: 10.0 IN.

RATE OF LOAD: 420 PSI/HR

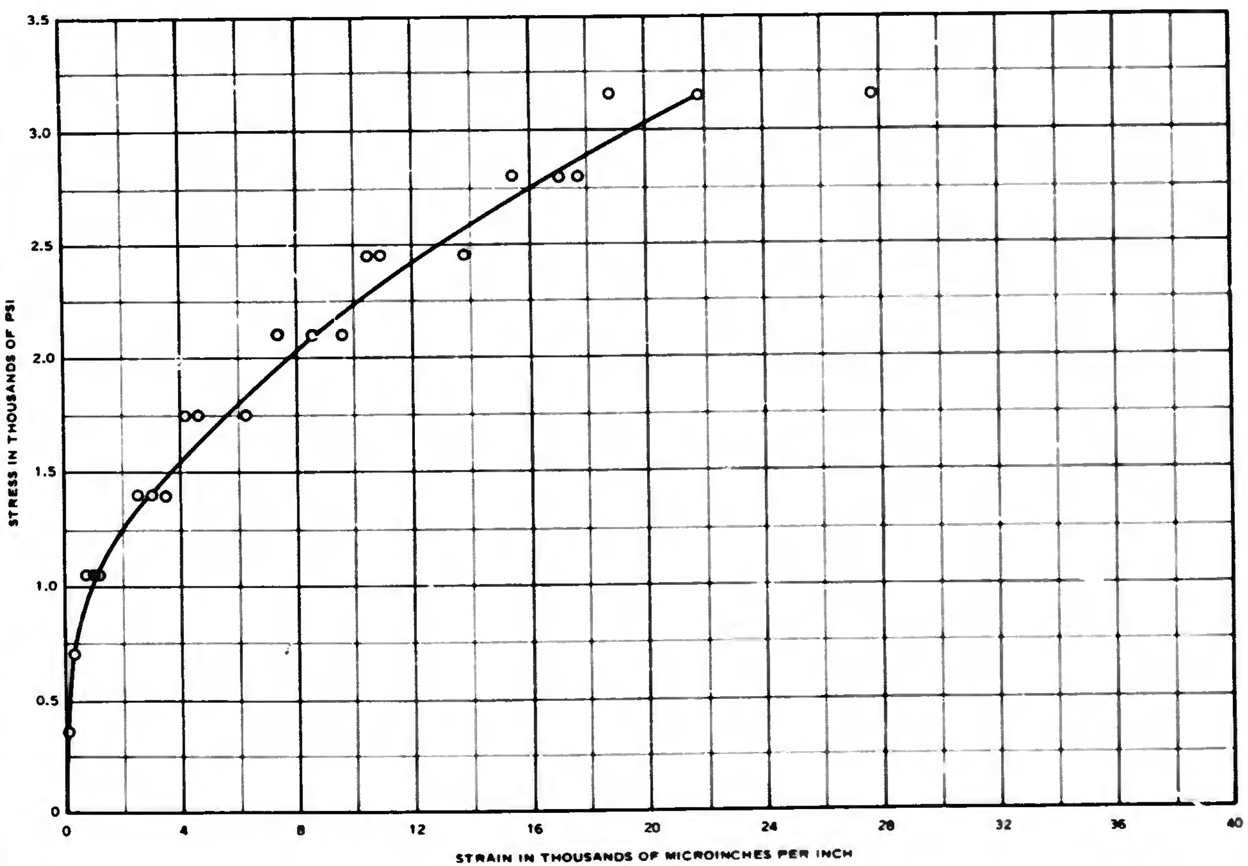
METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

TESTING TEMPERATURE: 73 ± 3 F

STRESS PSI	TIME HOURS	AVG STRAIN IN./IN. X 10^6
0	0	0
420	0.1	86
420	0.5	94
420	1.0	110
840	1.1	478
840	1.5	533
840	2.0	549
1,260	2.1	1,333
1,260	2.5	1,490
1,260	3.0	1,647
1,680	3.1	3,200
1,680	3.5	3,372
1,680	4.0	3,733
2,100	4.1	5,749
2,100	4.5	6,274
2,100	5.0	6,674
2,520	5.1	9,733
2,520	5.5	10,345
2,520	6.0	10,847
2,940	6.1	12,204
2,940	6.5	13,592
2,940	7.0	15,349
3,360	7.1	18,000
3,360	7.5	
3,360	8.0	
3,980 ULTIMATE STRENGTH	8.1	

STRESS-STRAIN CURVE
UNIAXIAL COMPRESSION TESTS BY INCREMENTAL LOADING
HOLE WP-1 - SPECIMEN 62A



HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 19 JULY 1962

CORE DEPTH: 2659.8 FT TO 2662.5 FT

DIAMETER: 4.54 IN.

SPECIMEN LENGTH: 9.85 IN.

RATE OF LOAD: 350 PSI/12 HR

METHOD OF SAWING TO LENGTH: BRINE SOLUTION DIAMOND SAW

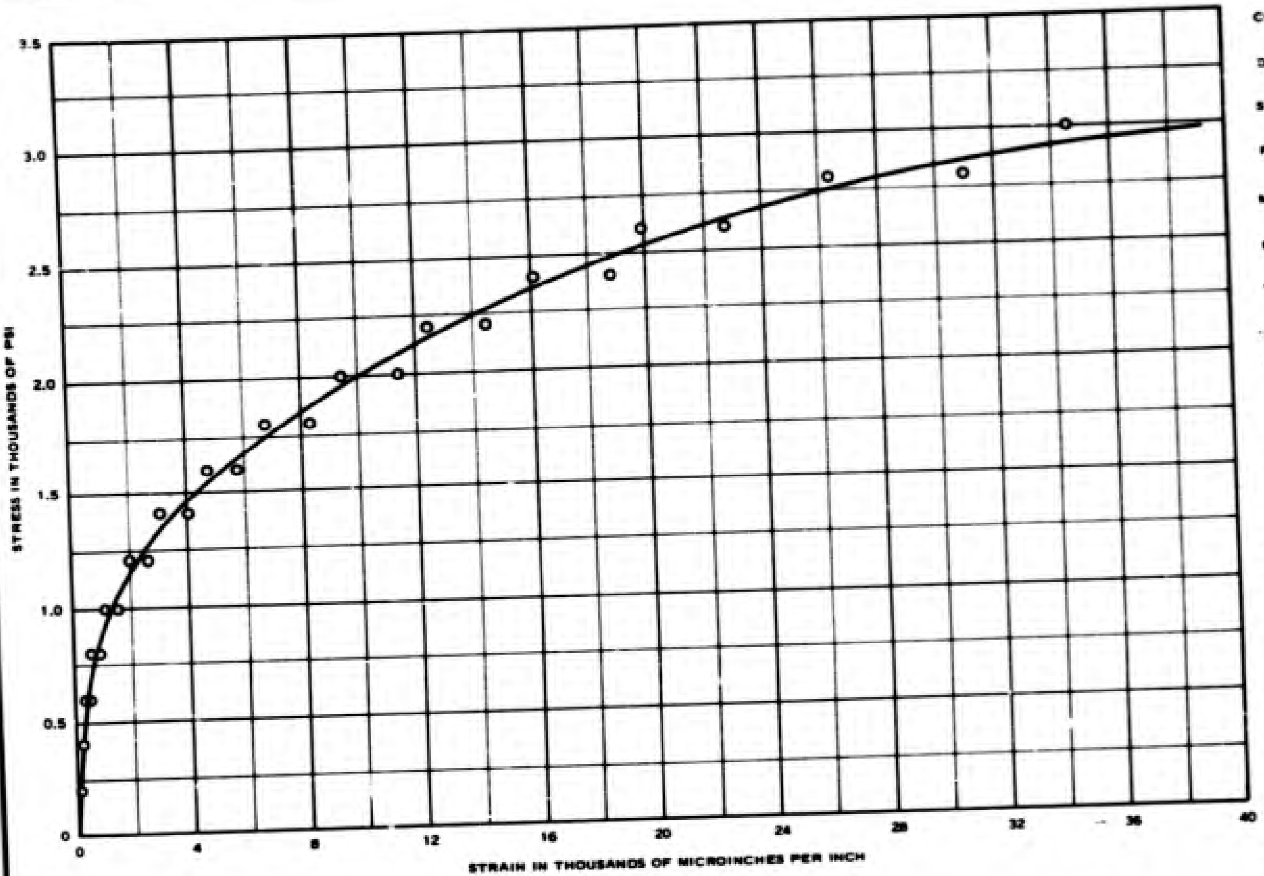
METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

TESTING TEMPERATURE: 73 ± 3F

STRESS PSI	TIME HOURS	AVG STRAIN IN./IN. x 10^6
0	0	0
350	0.2	16
350	4.0	31
350	12.0	71
700	12.2	227
700	16.0	306
700	24.0	369
1,050	24.2	755
1,050	28.0	975
1,050	36.0	1,474
1,400	36.2	2,478
1,400	40.0	3,043
1,400	48.0	3,451
1,750	48.2	4,204
1,750	52.0	4,627
1,750	60.0	6,314
2,100	60.2	7,396
2,100	64.0	8,572
2,100	72.0	9,608
2,450	72.2	10,525
2,450	76.0	10,886
2,450	84.0	13,780
2,800	84.2	15,474
2,800	88.0	17,122
2,800	96.0	17,749
3,150	96.2	18,847
3,150	100.0	21,914
3,150	108.0	27,843
3,440 ULTIMATE STRENGTH	108.1	

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSION TESTS
BY INCREMENTAL LOADING
HOLE WP-1 - SPECIMEN 63B



DATE: 19 JULY 1962

HOLE COORDINATES:
N 10188.85, E 8040.83

CORE DEPTH:
2693.1 FT TO 2695.0 FT

DIAMETER:
4.94 IN.

SPECIMEN LENGTH:
9.89 IN.

RATE OF LOAD:
200 PSI/48 HR

METHOD OF SAWING TO LENGTH:
BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION:
CAPPED WITH SULFUR-SILICA COMPOUND

TESTING TEMPERATURE:
73 ± 3F

STRESS PSI	TIME HOURS	AVG STRAIN IN./IN. X 10^6
0	0	0
200	1	55
200	48	125
400	49	196
400	96	[illegible]
600	97	[illegible]
600	144	[illegible]
800	145	[illegible]
800	192	[illegible]
1,000	193	1,215
1,000	240	1,576
1,200	241	2,015
1,200	288	2,674
1,400	289	3,145
1,400	336	4,054
1,600	337	4,760
1,600	384	5,811
1,800	385	6,823
1,800	432	8,352
2,000	433	9,490
2,000	480	11,372
2,200	481	12,454
2,200	528	14,479
2,400	529	16,188
2,400	576	18,780
2,600	577	19,921
2,600	624	22,824
2,800	625	26,440
2,800	672	31,00[illegible]
3,000	673	34,380
3,000	720	
3,100 ULTIMATE STRENGTH	720	

STRESS-STRAIN CURVE

UNIAXIAL COMPRESSION TESTS
BY INCREMENTAL LOADING
HOLE WP-1 - SPECIMEN 62B

PLATE 117

HOLE COORDINATES: DATE: 24 NOV 1961
N 10166.85, E 8040.89

CORE DEPTH:
1720.0 FT TO 1721.5 FT

DIAMETER:
5.00 IN.

SPECIMEN LENGTH:
12.90 IN.

CREEP LOAD:
525 PSI

METHOD OF SAWING TO LENGTH:
BRINE SOLUTION (DIAMOND SAW)

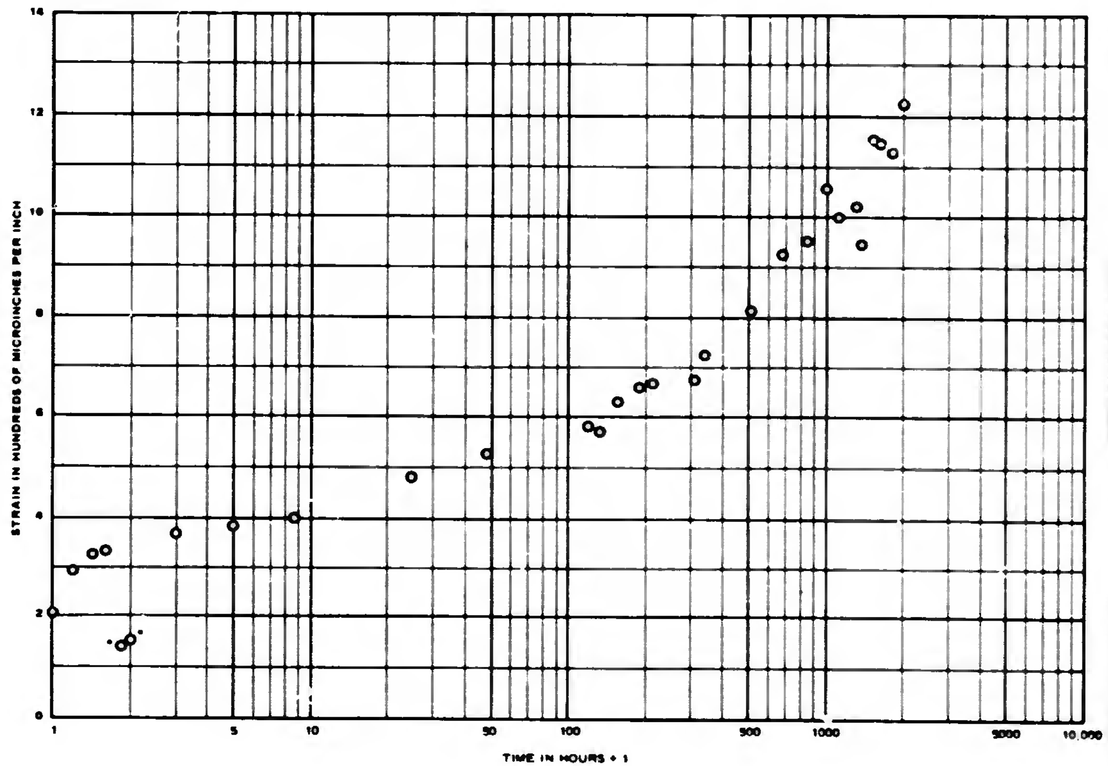
METHOD OF END PREPARATION:
CAPPED WITH S[illegible] [illegible]R-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT:
MECHANICAL

TEST CONDITIONS:
73 ± 2 F; RELATIVE HUMIDITY = 50 ± 5%

TIME	STRAIN, MICROINCHES PER IN.		
	MECHANICAL, GAGE LINE		
(t + 1 HR)	1	2	AVG
1.0	217	200	208
1.2	283	300	292
1.4	300	350	325
1.6	300	367	333
1.8	133*	133*	133*
2.0	117*	183*	150*
3.0	317	417	367
5.0	300	427	383
8.5	317	467	392
25.0	400	567	483
48.0	417	633	525
121.0	417	750	583
145.0	417	733	575
169.0	483	783	633
193.0	483	833	658
217.0	517	817	667
313.0	517	833	675
341.5	500	950	725
510.0	517	1,117	817
678.0	617	1,233	925
846.0	667	1,290	958
1,014.0	783	1,333	1,058
1,130.0	783	1,217	1,000
1,304.0	800	1,250	1,025
1,396.0	600	1,283	942
1,540.0	900	1,417	1,158
1,657.0	817	1,483	1,150
1,831.0	817	1,450	1,134
2,001.0	983	1,467	1,225

NOTE: TIME REQUIRED TO LOAD SPECIMEN = 4 MIN.
* NO CONFIDENCE IN THESE READINGS; READINGS OBVIOUSLY IN ERROR.



STRAIN-TIME CURVE
UNIAXIAL CREEP TEST
HOLE WP-1 - SPECIMEN 15B

HOLE COORDINATES: DATE: 24 NOV 1961

N 10166.85, E 8040.83

CORE DEPTH:

2151.8 FT TO 2153.5 FT

DIAMETER:

5.00 IN.

SPECIMEN LENGTH:

12.50 IN.

CREEP LOAD:

1750 PSI

METHOD OF SAWING TO LENGTH:

BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION:

CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT:

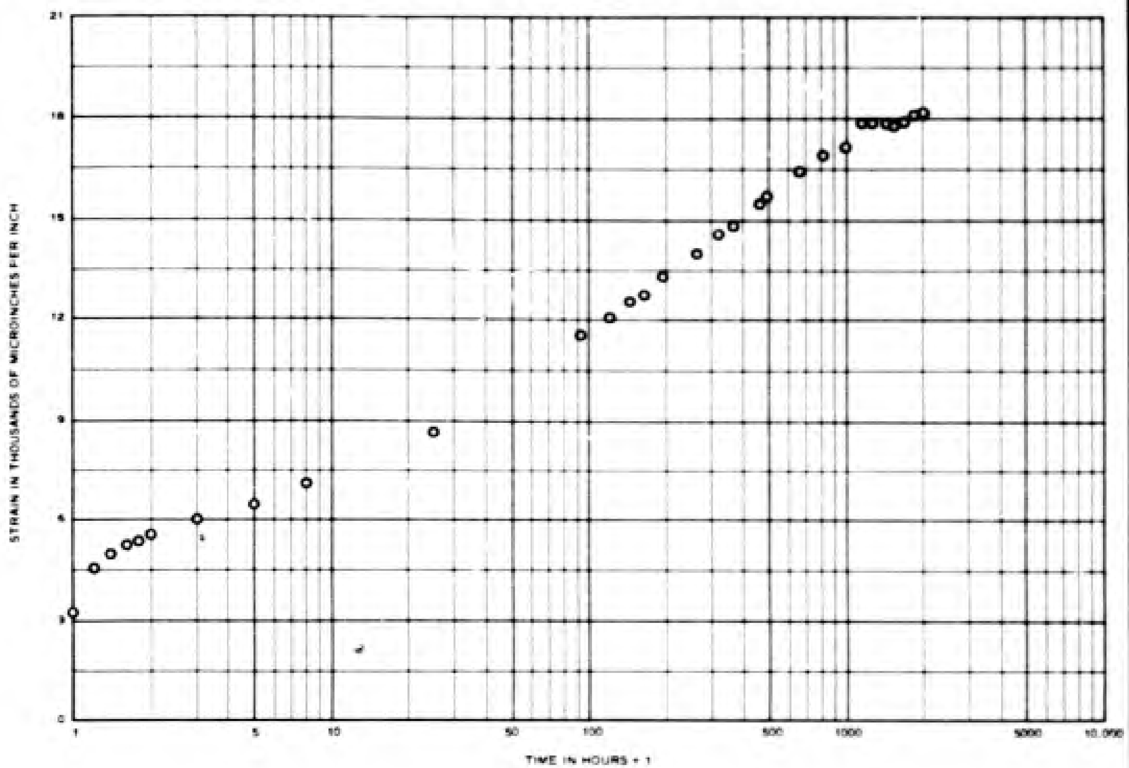
MECHANICAL

TEST CONDITIONS:

73 ± 2 F; RELATIVE HUMIDITY = 50 ± 5%

TIME	STRAIN, MICROINCHES PER IN. MECHANICAL GAGE LINE		
(t + 1 HR)	1	2	AVG
1.0	3,517	2,950	3,233
1.2	4,917	4,033	4,475
1.4	5,433	4,467	4,950
1.6	5,667	4,733	5,200
1.8	5,833	4,867	5,350
2.0	6,000	5,000	5,500
3.0	6,483	5,350	5,917
5.0	7,033	5,883	6,458
8.0	7,617	6,483	7,050
25.0	9,267	8,117	8,692
97.0	12,300	10,833	11,567
121.0	12,833	11,250	12,042
145.0	13,383	11,750	12,567
169.0	13,850	11,667	12,758
193.0	14,050	12,500	13,275
265.0	14,833	13,317	14,075
318.5	15,550	13,800	14,675
361.0	15,783	14,017	14,900
462.0	16,333	14,567	15,450
486.0	16,483	14,867	15,675
654.0	17,517	15,433	16,475
822.0	17,917	15,717	16,817
990.0	18,300	16,083	17,192
1,158.0	19,383	16,400	17,892
1,274.0	19,417	16,350	17,884
1,448.0	19,350	16,350	17,850
1,540.0	19,300	16,150	17,725
1,684.0	19,533	16,433	17,983
1,801.0	19,617	16,550	18,084
2,001.0	19,767	16,633	18,200

NOTE: TIME REQUIRED TO LOAD SPECIMEN = 2 MIN.



STRAIN-TIME CURVE

UNIAXIAL CREEP TEST

HOLE WP-1 - SPECIMEN 33B

HOLE COORDINATES: DATE: 7 NOV 1961

N 10166.85, E 8040.83

CORE DEPTH:

2196.5 FT TO 2198.0 FT

DIAMETER:

5.00 IN.

SPECIMEN LENGTH:

12.50 IN.

CREEP LOAD:

2250 PSI

METHOD OF SAWING TO LENGTH:

BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION:

CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT:

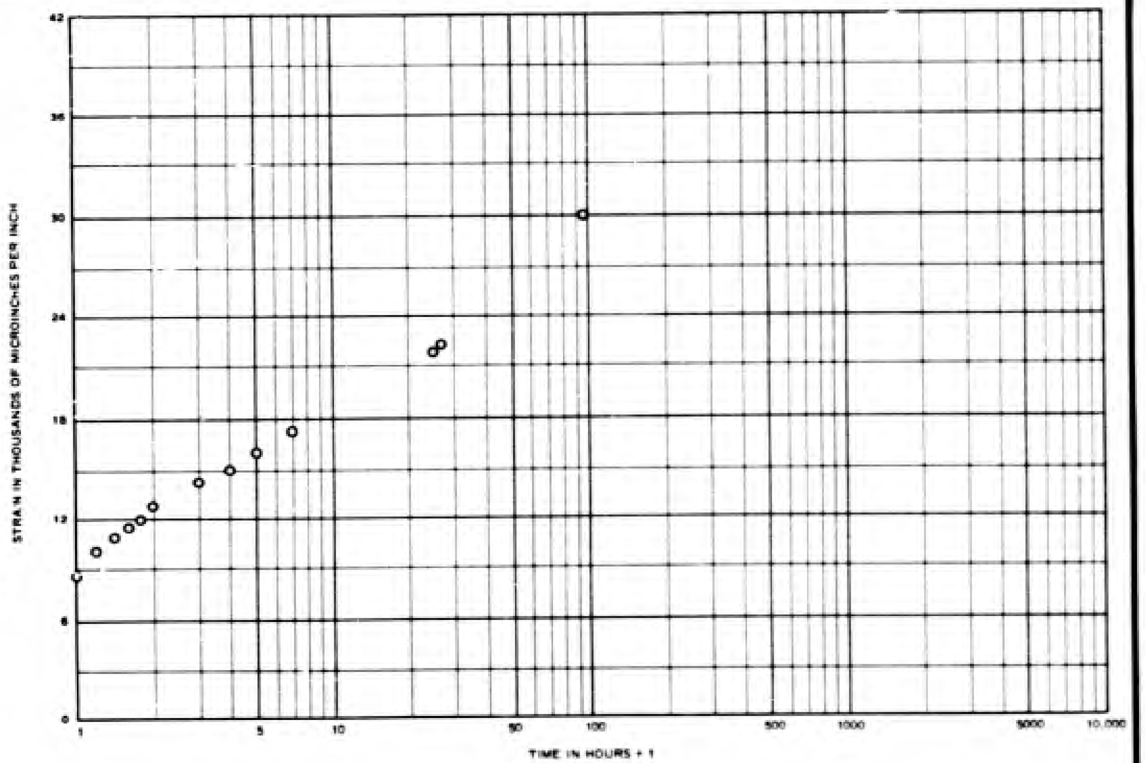
VERTICAL STRAIN–MECHANICAL GAGE
LATERAL STRAIN–YOKE WITH DIAL GAGE

TEST CONDITIONS:

73 ± 2F; RELATIVE HUMIDITY = 50 ± 5%

TIME	STRAIN, MICROINCHES PER IN. MECHANICAL, GAGE LINE				POISSON'S
(T + 1 HR)	VERTICAL 1	VERTICAL 2	VERTICAL AVG	LATERAL	RATIO
1.0	3,833	13,433	8,633	7,333	0.85
1.2	4,933	15,433	10,183	8,913	0.88
1.4	5,350	16,567	10,958	10,200	0.93
1.6	5,683	17,033	11,358	11,053	0.97
1.8	5,717	18,133	11,925	11,867	1.00
2.0	6,683	18,800	12,742	12,433	0.98
3.0	7,850	20,567	14,208	—	—
4.0	8,583	21,500	15,042	14,200	0.94
5.0	9,167	22,733	15,950	15,493	0.97
7.0	10,033	24,100	17,066	17,173	1.01
25.0	13,300	30,050	21,675	25,007	1.15
27.0	13,500	30,900	22,200	26,840	1.21
97.0	14,367	45,633	30,000	—	—

NOTE: TIME REQUIRED TO LOAD SPECIMEN = 4 MIN.
SPECIMEN FAILED AFTER 4 TO 5 DAYS OF TEST.



STRAIN–TIME CURVE
UNIAXIAL CREEP TEST
HOLE WP-1 – SPECIMEN 23B

HOLE COORDINATES: DATE: 20 SEPT 1961

N 10166.85, E 8040.83

CORE DEPTH:

1672.0 FT TO 1673.6 FT

DIAMETER:

4.94 IN.

SPECIMEN LENGTH:

12.50 IN.

CREEP LOAD:

3000 PSI

METHOD OF SAWING TO LENGTH:

BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION:

CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT:

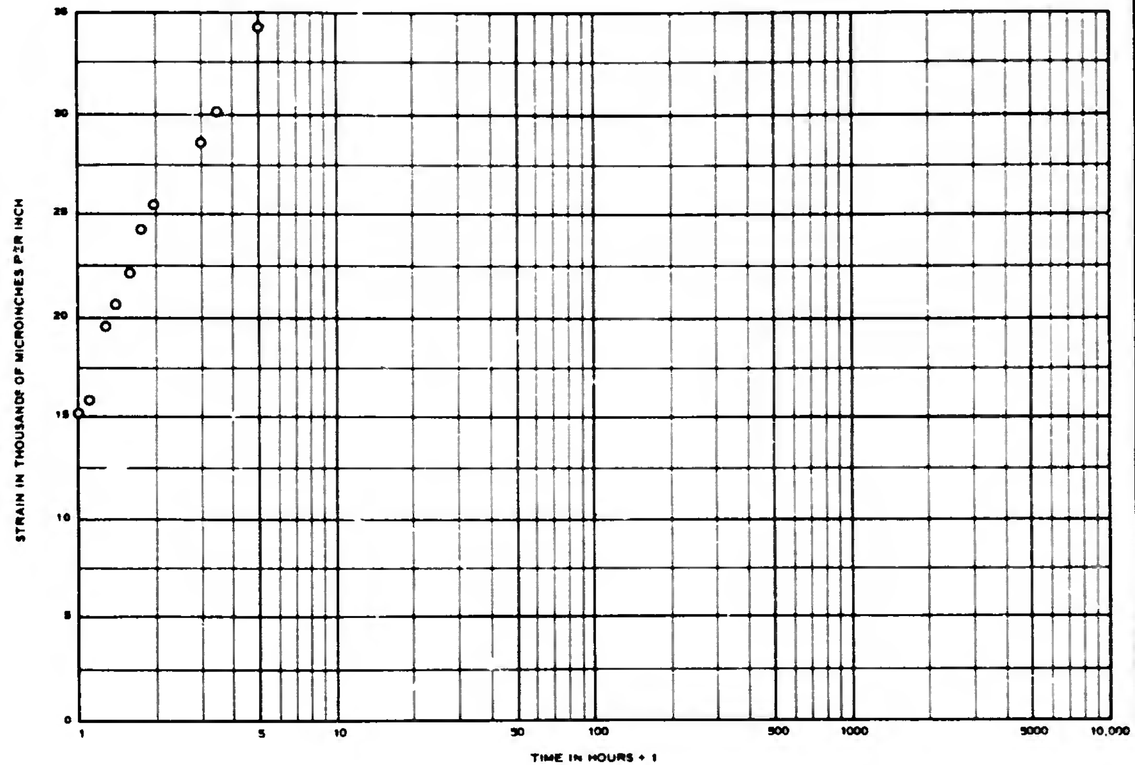
MECHANICAL

TEST CONDITIONS:

73.4 ± 2 F; RELATIVE HUMIDITY = 50 ± 5%

TIME (T + 1 HR)	STRAIN, MICROINCHES PER IN MECHANICAL, GAGE LINE 1	2	AVG
1.0	15,883	14,400	15,142
1.1	16,933	14,867	15,900
1.3	20,517	18,967	19,842
1.4	21,860	19,817	20,883
1.6	23,267	20,967	22,117
1.8	25,400	23,083	24,242
2.0	26,633	24,267	25,450
3.0	29,717	27,383	28,550
3.5	31,367	28,767	30,067
5.0	34,950	33,450	34,200

NOTE: SPECIMEN FAILED 5 HR 50 MIN AFTER LOADING.



STRAIN-TIME CURVE
UNIAXIAL CREEP TEST
HOLE WP-1 - SPECIMEN 14C

HOLE COORDINATES: DATE: 12 DEC 1961

N 10166.86, E 8040.83

CORE DEPTH:

2239.8 FT TO 2241.5 FT

DIAMETER:

5.00 IN.

SPECIMEN LENGTH:

12.80 IN.

CREEP LOAD:

780 PSI (TIME REQUIRED TO LOAD = 3 MIN)

METHOD OF SAWING TO LENGTH:

BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION:

CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT:

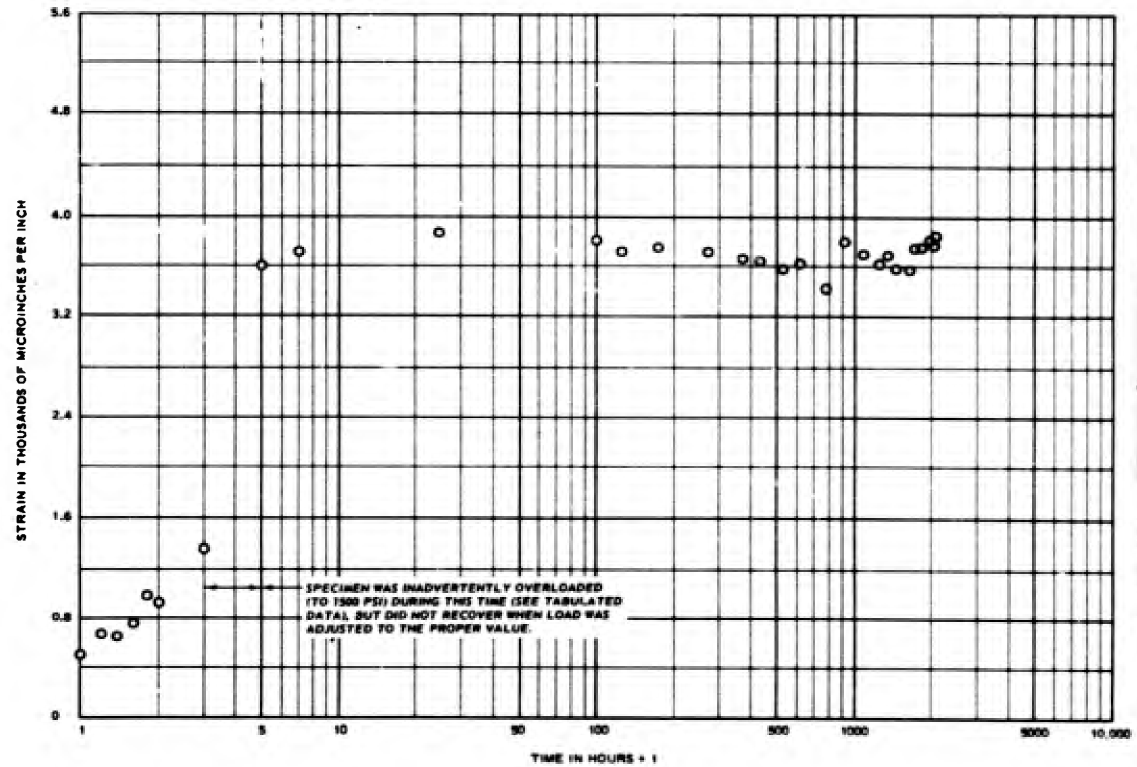
MECHANICAL

TEST CONDITIONS:

150 ± 3F

TIME (t + 1 HR)	STRAIN, MICROINCHES PER IN. MECHANICAL, GAGE LINE 1	2	AVG
1.0	433	533	483
1.2	550	780	665
1.4	600	683	642
1.6	767	767	767
1.8	917	1,033	975
2.0	917	967	942
3.0	1,000	1,717	1,358
5.0	1,950*	5,250*	3,600*
7.0	2,050	5,367	3,708
25.0	2,250	5,467	3,858
101.0	2,233	5,367	3,800
127.0	2,117	5,300	3,708
173.0	2,133	5,367	3,750
268.0	2,133	5,283	3,708
365.0	2,167	5,133	3,650
437.0	2,167	5,133	3,650
533.0	2,183	4,933	3,558
606.0	2,117	5,100	3,608
775.0	2,100	4,750	3,425
937.0	2,267	5,300	3,784
1,104.0	2,200	5,200	3,700
1,275.0	2,200	5,017	3,608
1,371.0	2,200	5,167	3,684
1,464.0	2,083	5,033	3,558
1,632.0	2,067	5,017	3,542
1,708.0	2,267	5,217	3,742
1,801.0	2,300	5,200	3,750
1,888.0	2,333	5,250	3,792
2,000.0	2,300	5,250	3,775
2,017.0	2,383	5,317	3,850

* SPECIMEN INADVERTENTLY OVERLOADED TO 1500 PSI PRIOR TO THIS READING, BUT LOAD WAS CORRECTED PRIOR TO NEXT READING.



STRAIN-TIME CURVE
UNIAXIAL CREEP TEST
HOLE WP-1 - SPECIMEN 30B

HOLE COORDINATES DATE 12 DEC 1961
N 10166.85, E 8040.83

CORE DEPTH
1679.0 FT TO 1680.5 FT

DIAMETER
5.00 IN.

SPECIMEN LENGTH
12.50 IN.

CREEP LOAD
1750 PSI

METHOD OF SAWING TO LENGTH
BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION
CAPPED WITH SULFUR-SILICA COMPOUND

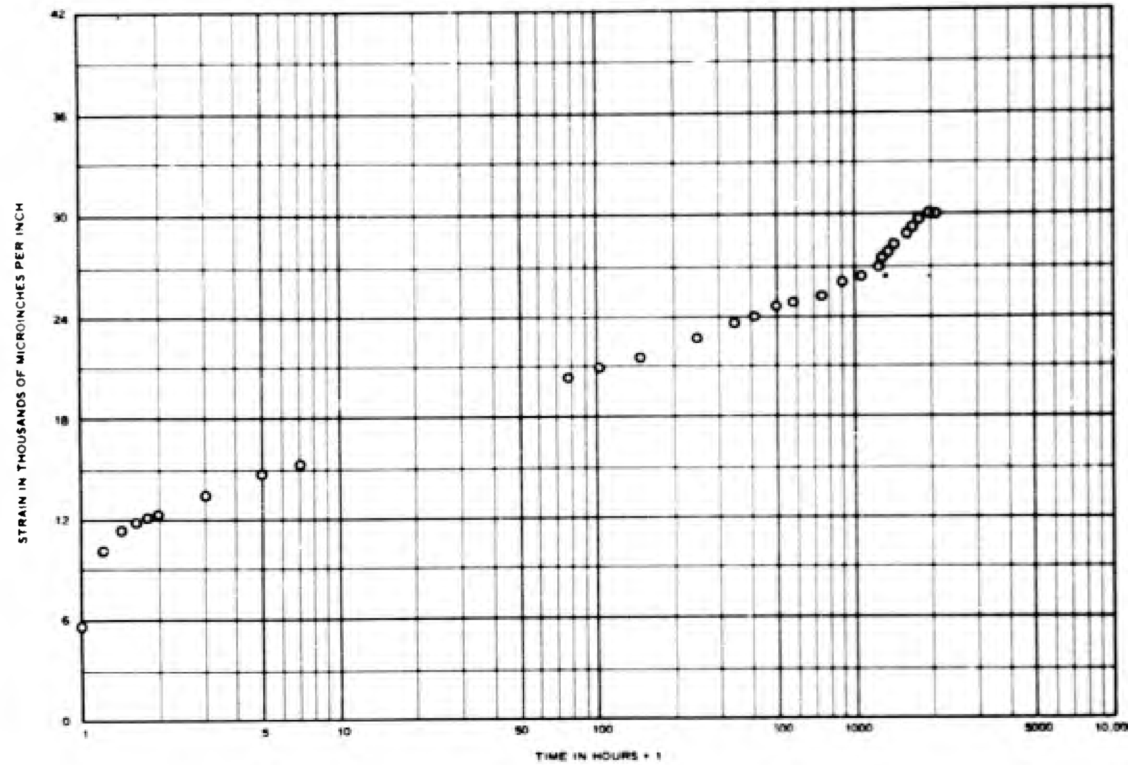
METHOD OF STRAIN MEASUREMENT
MECHANICAL

TEST CONDITIONS
150 ± 3F

TIME (t + 1 HR)	STRAIN, MICROINCHES PER IN. MECHANICAL, GAGE LINE 1	2	AVG
1.0	3,567	7,750	5,658
1.2	4,500	15,750	10,125
1.4	5,150	17,267	11,208
1.6	5,517	17,933	11,725
1.8	5,767	18,467	12,117
2.0	6,000	18,833	12,416
3.0	6,617	20,083	13,350
5.0	7,533	21,667	14,600
7.0	8,450	23,433	15,942
77.0	11,533	28,800	20,166
103.0	11,700	29,950	20,825
149.0	12,233	30,717	21,475
245.0	12,933	32,417	22,675
341.0	13,917	33,300	23,608
413.0	14,333	33,517	23,925
509.0	15,100	34,000	24,550
581.0	15,500	34,150	24,825
751.0	15,567	34,417	24,992
913.0	16,867	35,133	26,000
1,080.0	17,383	35,250	26,316
1,251.0	17,983*	35,533*	26,758*
1,279.0	17,917	37,083	27,500
1,347.0	17,883	37,883	27,883
1,440.0	17,867	38,700	28,284
1,608.0	18,017	39,733	28,875
1,686.0	18,383	40,100	29,242
1,776.0	18,783	40,667	29,725
1,945.0	18,633	41,017	29,825
2,000.0	18,750	41,183	29,966
2,017.0	18,700	41,200	29,950

NOTE: THIS TEST WAS REPEATED USING ANOTHER SPECIMEN.

* ONE BRASS SLEEVE TOOK PART OF LOAD OVER THE WEEKEND PRIOR TO THIS READING. THIS WAS CORRECTED PRIOR TO THE NEXT READING.



STRAIN-TIME CURVE

UNIAXIAL CREEP TEST

HOLE WP-1 - SPECIMEN 18B

HOLE COORDINATES:
N 10166.85, E 8040.63

DATE: 17 JAN 1962

CORE DEPTH:
1723.2 FT TO 1724.7 FT

DIAMETER:
5.00 IN.

SPECIMEN LENGTH:
12.50 IN.

CREEP LOAD:
2250 PSI

METHOD OF SAWING TO LENGTH:
BRINE SOLUTION (DIAMOND SAW)

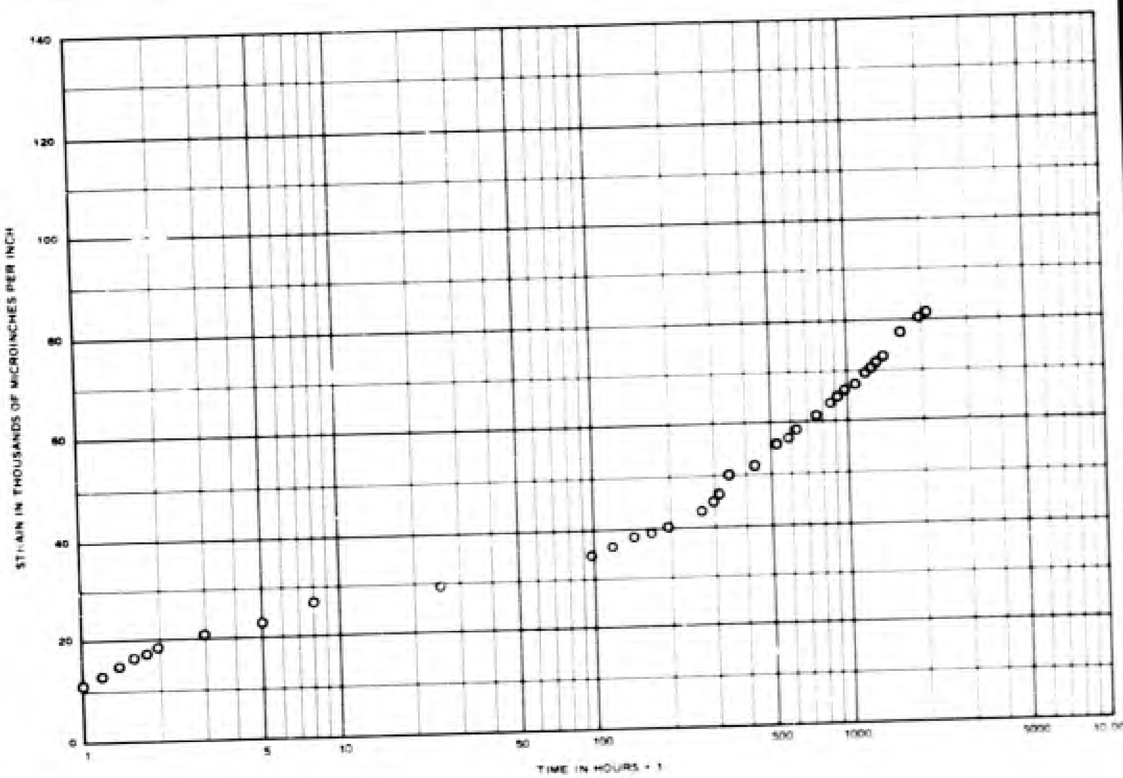
METHOD OF END PREPARATION:
CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT:
VERTICAL STRAIN—MECHANICAL GAGE
LATERAL STRAIN—YOKE WITH DIAL GAGE

TEST CONDITIONS:
150 ± 3F

TIME	STRAIN, MICROINCHES PER IN.				POISSON'S
	MECHANICAL GAGE LINE				
(t + 1 HR)	VERTICAL 1	VERTICAL 2	VERTICAL AVG	LATERAL	RATIO
1.0	11,600	9,717	10,658	8,000	0.75
1.2	14,300	11,383	12,842	10,067	0.78
1.4	15,967	13,867	14,917	11,133	0.75
1.6	17,233	14,933	16,083	12,267	0.76
1.8	18,267	16,233	17,250	13,200	0.77
2.0	19,367	18,017	18,692	14,533	0.78
3.0	21,900	20,000	20,950	17,000	0.81
5.0	24,150	22,500	23,325	19,867	0.85
8.0	28,217	25,533	26,875	23,467	0.87
25.0	31,483	27,700	29,592	26,140	0.88
97.0	37,050	32,133	34,592	29,100	0.84
121.0	38,833	34,600	36,716	30,513	0.83
145.0	40,417	36,000	38,208	31,640	0.83
169.0	41,733	37,100	39,416	32,940	0.84
193.0	42,783	37,617	40,200	33,700	0.84
199.0	44,583	38,217	41,400	33,967	0.82
267.0	47,183	38,917	43,050	35,227	0.82
291.0	47,967	41,600	44,784	36,660	0.82
312.0	48,833	43,417	46,125	36,873	0.80
343.0	52,350	47,683	50,016	39,187	0.78
434.0	53,533	49,617	51,575	39,733	0.77
527.0	57,667*	53,767	55,717	42,673	0.77
596.0	58,800	54,450	56,625	43,100	0.76
644.0	60,550	56,517	58,534	44,273	0.76
766.0	63,100	59,000	61,050	46,053	0.75
868.0	66,233	61,383	63,808	48,213	0.76
934.0	67,367	62,000	64,684	48,700	0.75
989.0	68,633	63,517	66,075	49,660	0.75
1,105.0	70,267	64,283	67,275	51,080	0.76
1,205.0	72,700	66,967	69,834	51,680	0.74
1,271.0	[illegible]	67,300	70,400	51,767	0.74
1,343.0	74,317	69,350	71,834	52,113	0.73
1,439.0	75,383	70,033	72,708	52,167	0.72
1,799.0	80,483	74,817	77,650	54,167	0.70
1,997.0	82,867	77,600	80,234	55,533	0.69
2,110.0	83,833	78,333	81,083	56,120	0.69

NOTE: TIME REQUIRED TO LOAD SPECIMEN = 4 MIN.
* THIS FIGURE IS BASED ON AVERAGE CHANGE (CALCULATED) BEFORE AND AFTER AS DIRECT READING COULD NOT BE TAKEN AT TIME INDICATED. AVERAGE CHANGE WAS DETERMINED FROM 6 CHANGES (3 BEFORE, 3 AFTER).



STRAIN-TIME CURVE
UNIAXIAL CREEP TEST
HOLE WP-1 - SPECIMEN 19B

HOLE COORDINATES: N 10166.95, E 8040.83

DATE: 29 SEPT 1961

CORE DEPTH: 2216.5 FT TO 2218.0 FT

DIAMETER: 5.00 IN

SPECIMEN LENGTH: 12.50 IN

CREEP LOAD: 3000 PSI

METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

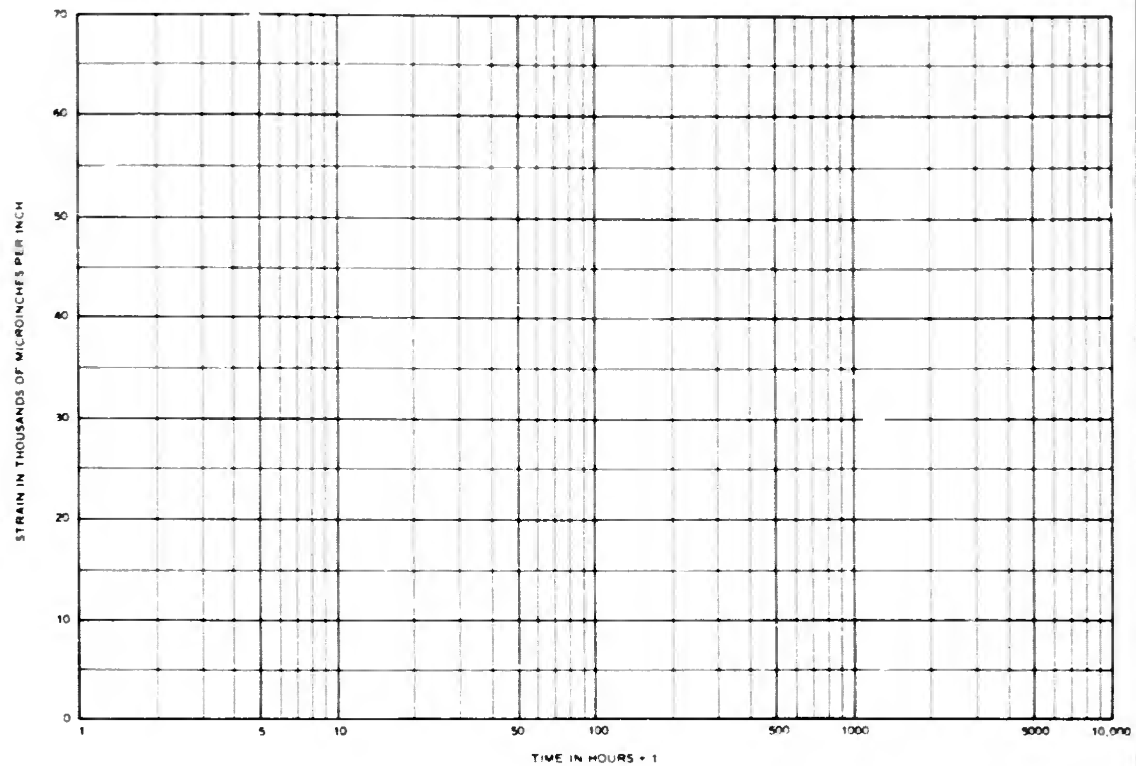
METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT: MECHANICAL

TEST CONDITIONS: 150 ± 3 F

TIME	STRAIN, MICROINCHES PER IN		
	MECHANICAL, GAGE LINE		
(T + 1 HR)	1	2	AVG
1.0	9,250	11,833	10,542

NOTE: TIME REQUIRED TO LOAD SPECIMEN = 4 MIN. SPECIMEN FAILED 11 MIN AFTER LOADING



STRAIN-TIME CURVE
UNIAXIAL CREEP TEST
HOLE WP-1 - SPECIMEN 40A

HOLE COORDINATES: DATE: 14 MAY 1962

N 10166.85, E 8040.83

CORE DEPTH:

1725.0 FT TO 1726.6 FT

DIAMETER:

5.0 IN.

SPECIMEN LENGTH:

13.0 IN. (INCLUDING CAP)

CREEP LOAD:

1750 PSI

METHOD OF SAWING TO LENGTH:

BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION:

CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT:

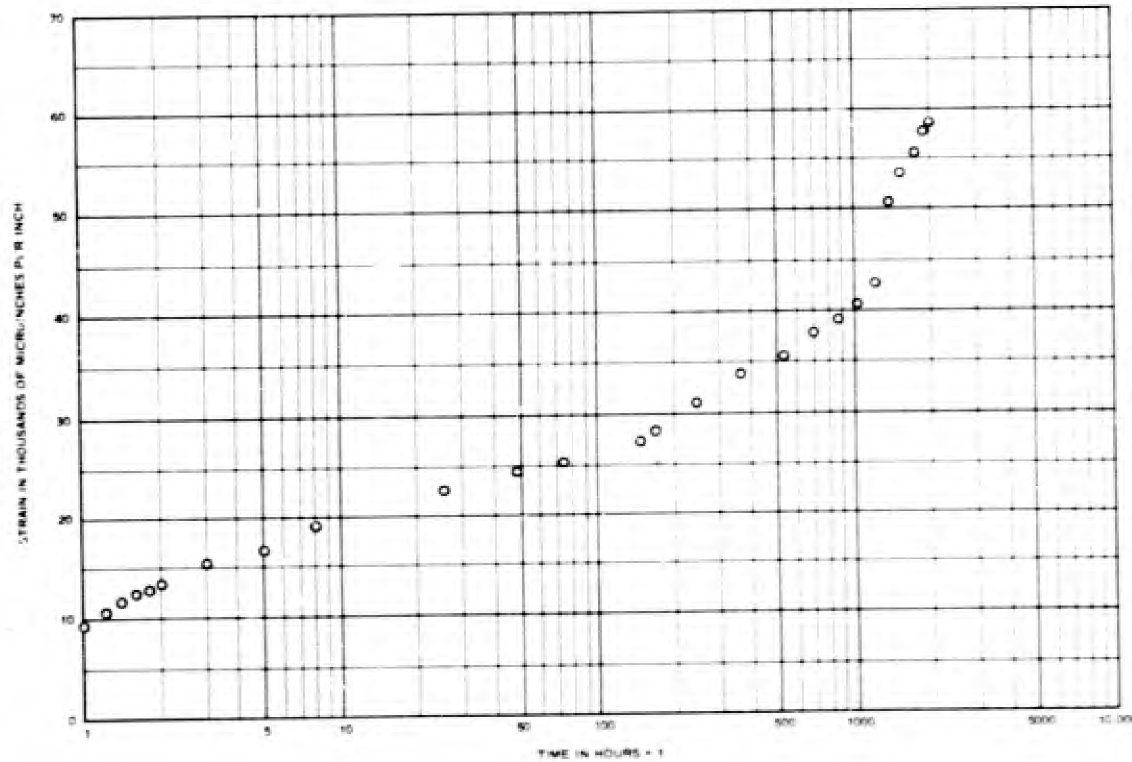
MECHANICAL

TEST CONDITIONS:

150 ± 3 F

TIME (T + 1 HR)	STRAIN, MICROINCHES PER IN. MECHANICAL, GAGE LINE 1	2	AVG
1.0	9.917	9.017	9.467
1.2	11.750	9.717	10.734
1.4	12.533	11.133	11.833
1.6	13.167	11.700	12.434
1.8	13.583	12.133	12.858
2.0	14.033	12.533	13.283
3.0	15.967	14.533	15.250
5.0	17.567	16.050	16.808
8.0	19.867	18.200	19.034
25.0	23.433	21.867	22.650
49.0	25.350	23.900	24.625
73.0	26.233	24.483	25.358
146.0	28.233	26.550	27.442
169.0	29.467	27.567	28.517
241.0	32.183	30.033	31.108
361.0	34.950	32.867	33.908
529.0	36.700	34.700	35.700
697.0	38.200	36.567	37.835
865.0	39.967	38.267	39.117
1,033.0	41.767	39.967	40.867
1,201.0	43.767	42.050	42.908
1,369.0	52.817	48.917	50.867
1,537.0	54.783	52.483	53.633
1,729.0	56.967	54.350	55.658
1,873.0	58.450	57.317	57.884
2,001.0	59.217	58.383	58.800

NOTE: TIME REQUIRED TO LOAD SPECIMEN = 4 MIN.



STRAIN-TIME CURVE

UNIAXIAL CREEP TEST

HOLE WP-1 - SPECIMEN 68B

HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 14 MAY 1962

CORE DEPTH: 2161.5 FT TO 2163.0 FT

DIAMETER: 5.0 IN.

SPECIMEN LENGTH: 13.0 IN. (INCLUDING CAP)

CREEP LOAD: 2250 PSI

METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

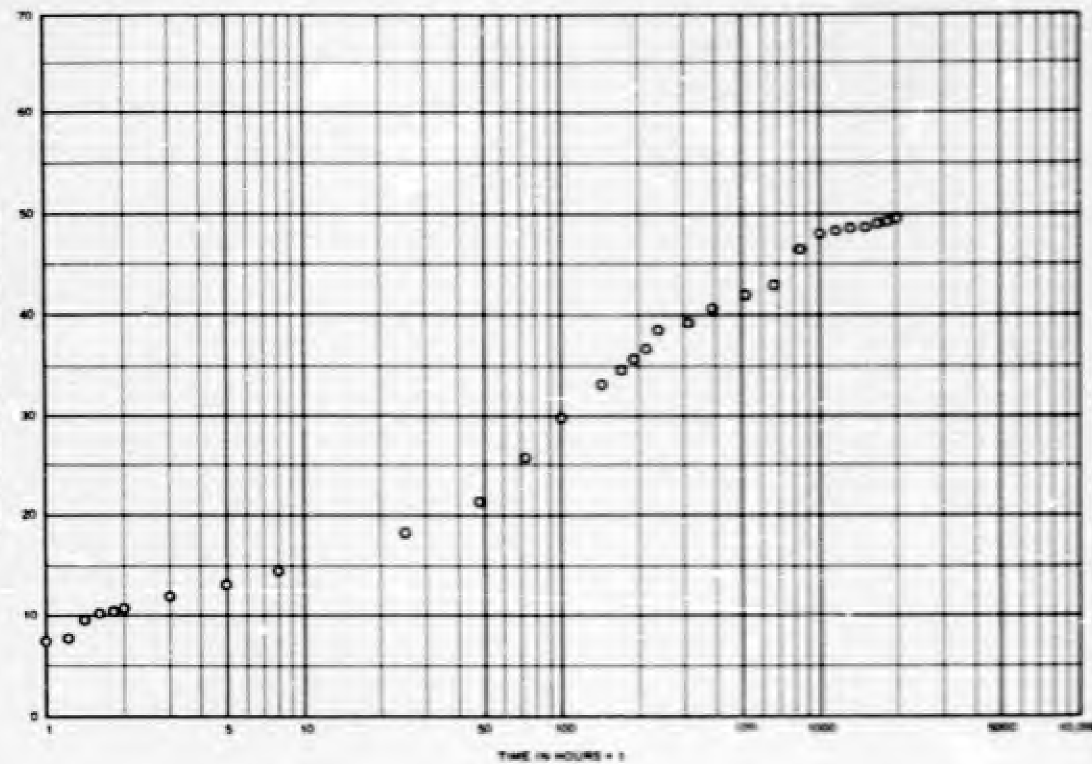
METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT:
VERTICAL STRAIN - MECHANICAL GAGE
LATERAL STRAIN - YOKE WITH DIAL GAGE

TEST CONDITIONS: 73 ± 2F; RELATIVE HUMIDITY = 50 ± 5%

TIME	STRAIN, MICROINCHES PER IN. — MECHANICAL GAGE LINE				POISSON'S
(t + 1 HR)	VERTICAL 1	VERTICAL 2	VERTICAL AVG	LATERAL	RATIO
1.0	5,033	10,350	7,692	7,173	0.93
1.2	5,817	11,767	8,792	8,100	0.92
1.4	6,467	12,783	9,625	8,907	0.93
1.6	6,900	13,383	10,142	9,580	0.94
1.8	7,233	13,867	10,550	10,060	0.95
2.0	7,567	14,367	10,967	10,487	0.96
3.0	8,533	15,533	12,033	11,860	0.99
5.0	9,650	17,167	13,408	13,660	1.02
8.0	10,817	18,433	14,625	15,327	1.05
25.0	13,983	22,317	18,150	20,060	1.11
49.0	16,683	25,717	21,200	24,967	1.18
73.0	19,483	31,967	25,725	32,033	1.25
101.0	22,867	37,100	29,984	38,707	1.29
145.0	25,583	40,850	33,216	43,993	1.32
173.0	26,650	42,833	34,742	46,573	1.34
193.0	27,650	44,117	35,884	48,707	1.36
217.0	28,333	45,117	36,725	50,273	1.37
241.0	28,967	46,033	37,500	51,867	1.38
313.0	29,467	48,917	39,192	53,847	1.37
391.0	30,117	51,133	40,625	55,400	1.36
536.0	31,467	52,700	42,084	57,927	1.38
680.0	32,217	53,700	42,958	59,440	1.38
848.0	35,317	57,933	46,625	68,680	1.47
1,016.0	36,583	59,550	48,066	72,647	1.51
1,184.0	36,783	60,083	48,433	73,300	1.51
1,352.0	36,917	60,317	48,617	73,733	1.52
1,520.0	37,033	60,400	48,716	74,380	1.53
1,688.0	37,167	60,933	49,050	74,933	1.53
1,856.0	37,217	61,283	49,250	75,707	1.54
2,001.0	37,700	61,900	49,800	76,267	1.53

NOTE: TIME REQUIRED TO LOAD SPECIMEN = 4 MIN.



STRAIN-TIME CURVE
UNIAXIAL CREEP TEST
HOLE WP-1 - SPECIMEN 69B

PLATE 127

HOLE COORDINATES: N 10166.85, E 8040.83

DATE: 14 MAY 1962

CORE DEPTH: 2238.0 FT TO 2239.8 FT

DIAMETER: 5.0 IN.

SPECIMEN LENGTH: 13.0 IN. (INCLUDING CAP)

CREEP LOAD: 750 PSI

METHOD OF SAWING TO LENGTH: BRINE SOLUTION (DIAMOND SAW)

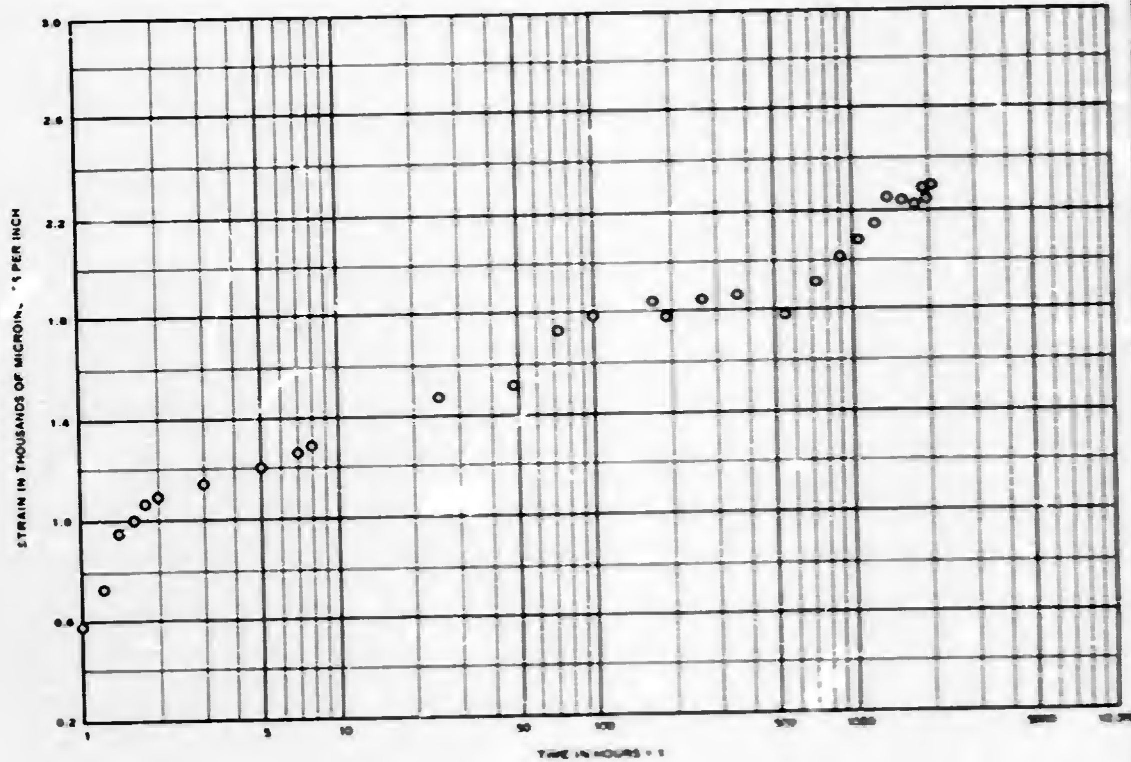
METHOD OF END PREPARATION: CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT: MECHANICAL

TEST CONDITIONS: 150 ± 3F

TIME (t + 1 HR)	STRAIN, MICROINCHES PER IN. MECHANICAL, GAGE LINE 1	2	AVG
1.0	500	667	584
1.2	600	867	734
1.4	800	1,100	950
1.6	833	1,167	1,000
1.8	900	1,233	1,066
2.0	917	1,267	1,092
3.0	950	1,333	1,142
5.0	1,017	1,400	1,208
7.0	1,067	1,467	1,267
8.0	1,083	1,500	1,292
25.0	1,317	1,633	1,475
49.0	1,400	1,650	1,525
73.0	1,667	1,800	1,734
97.0	1,700	1,867	1,784
170.0	1,783	1,900	1,842
193.0	1,783	1,800	1,792
265.0	1,833	1,850	1,842
361.0	1,850	1,867	1,858
553.0	1,750	1,833	1,792
721.0	1,933	1,900	1,916
889.0	2,033	2,000	2,016
1,057.0	2,100	2,067	2,084
1,225.0	2,167	2,133	2,150
1,393.0	2,267	2,233	2,250
1,561.0	2,267	2,217	2,242
1,753.0	2,300	2,167	2,234
1,897.0	2,333	2,250	2,292
1,969.0	2,300	2,200	2,250
2,017.0	2,367	2,250	2,308

NOTE: TIME REQUIRED TO LOAD SPECIMEN = 4 MIN.



STRAIN-TIME CURVE
UNIAXIAL CREEP TEST
HOLE WP-1 - SPECIMEN 70B

HOLE COORDINATES: DATE: 20 SEPT 1961

N 9217.06, E 9272.30

CORE DEPTH:

2603.5 FT TO 2604.5 FT

DIAMETER:

2.125 IN.

SPECIMEN LENGTH:

5.50 IN.

CREEP LOAD:

2500 PSI

METHOD OF SAWING TO LENGTH:

BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION:

CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT:

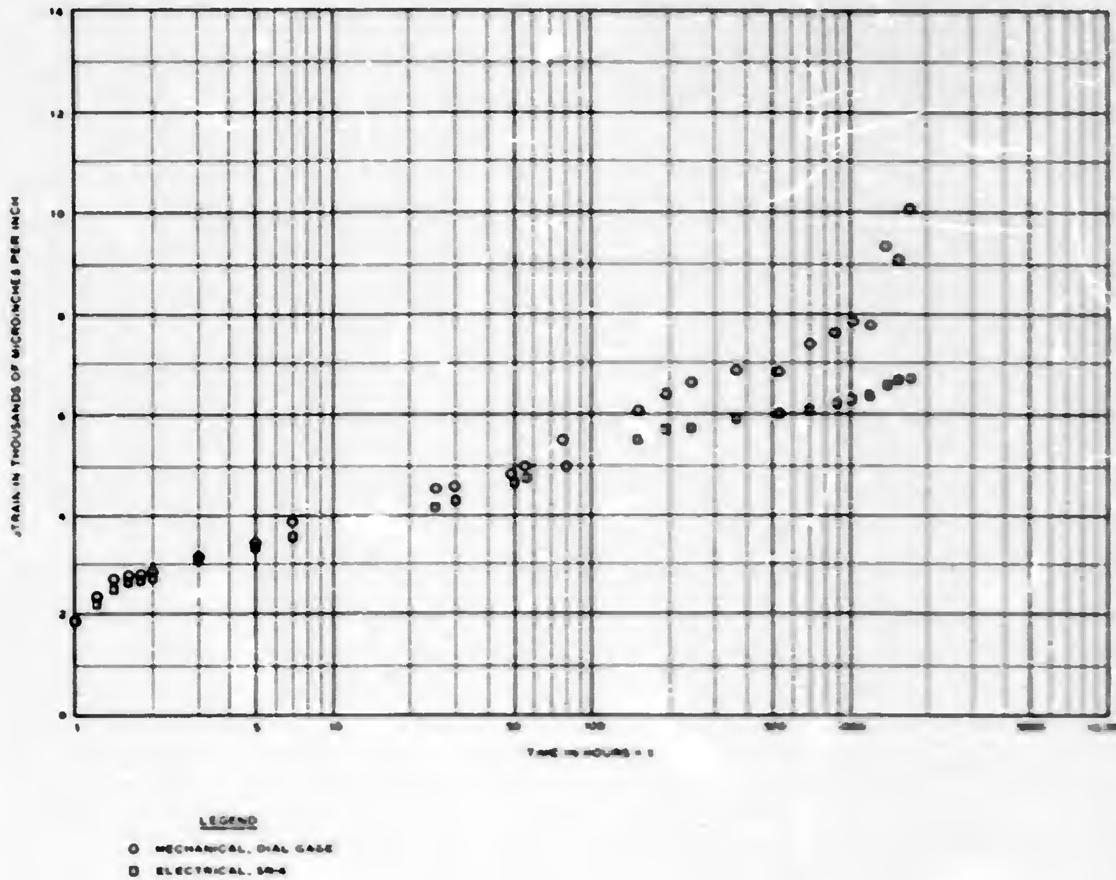
MECHANICAL AND SR-4 STRAIN GAGES

TEST CONDITIONS:

73.4 ± 2 F; RELATIVE HUMIDITY = 50 ± 3%

TIME (T + 1 HR)	STRAIN, MICROINCHES PER IN. MECHANICAL, GAGE LINE 1	2	AVG	SR-4
1.0	1,650	2,050	1,850	1,850
1.2	1,850	2,850	2,350	2,330
1.4	2,200	3,150	2,675	2,500
1.6	2,200	3,300	2,750	2,630
1.8	2,200	3,300	2,750	2,700
2.0	2,250	3,400	2,825	2,760
3.0	2,350	3,950	3,150	3,100
5.0	2,550	4,300	3,425	3,370
7.0	2,800	4,850	3,825	3,520
25.0	3,000	6,050	4,525	4,170
29.5	3,050	6,150	4,600	4,300
49.0	3,050	6,600	4,825	4,640
55.0	3,150	6,850	5,000	4,720
77.5	3,350	7,550	5,450	4,980
151.5	3,550	8,550	6,050	5,470
193.0	3,650	9,100	6,375	5,670
241.0	3,700	9,500	6,600	5,760
361.0	3,750	9,950	6,850	5,940
529.0	3,400	10,250	6,825	6,020
697.0	4,000	10,750	7,375	6,100
865.0	4,050	11,150	7,600	6,245
1,033.0	4,200	11,500	7,850	6,320
1,201.0	4,000	11,550	7,775	6,380
1,369.0	4,350	14,300	9,325	6,570
1,537.0	4,150	14,100	9,125	6,620
1,705.0	5,050	15,050	10,050	6,640

NOTE: TEST ENDED DUE TO FAILURE OF COMPANION SPECIMEN.



STRAIN-TIME CURVE
UNIAXIAL CREEP TEST
HOLE WP-4 - SPECIMEN NXC-10

HOLE COORDINATES: DATE: 20 SEPT 1961
N 9217.06, E 9272.30

CORE DEPTH:
2647.5 FT TO 2648.6 FT

DIAMETER:
2.125 IN.

SPECIMEN LENGTH:
5.50 IN.

CREEP LOAD:
2500 PSI

METHOD OF SAWING TO LENGTH:
BRINE SOLUTION (DIAMOND SAW)

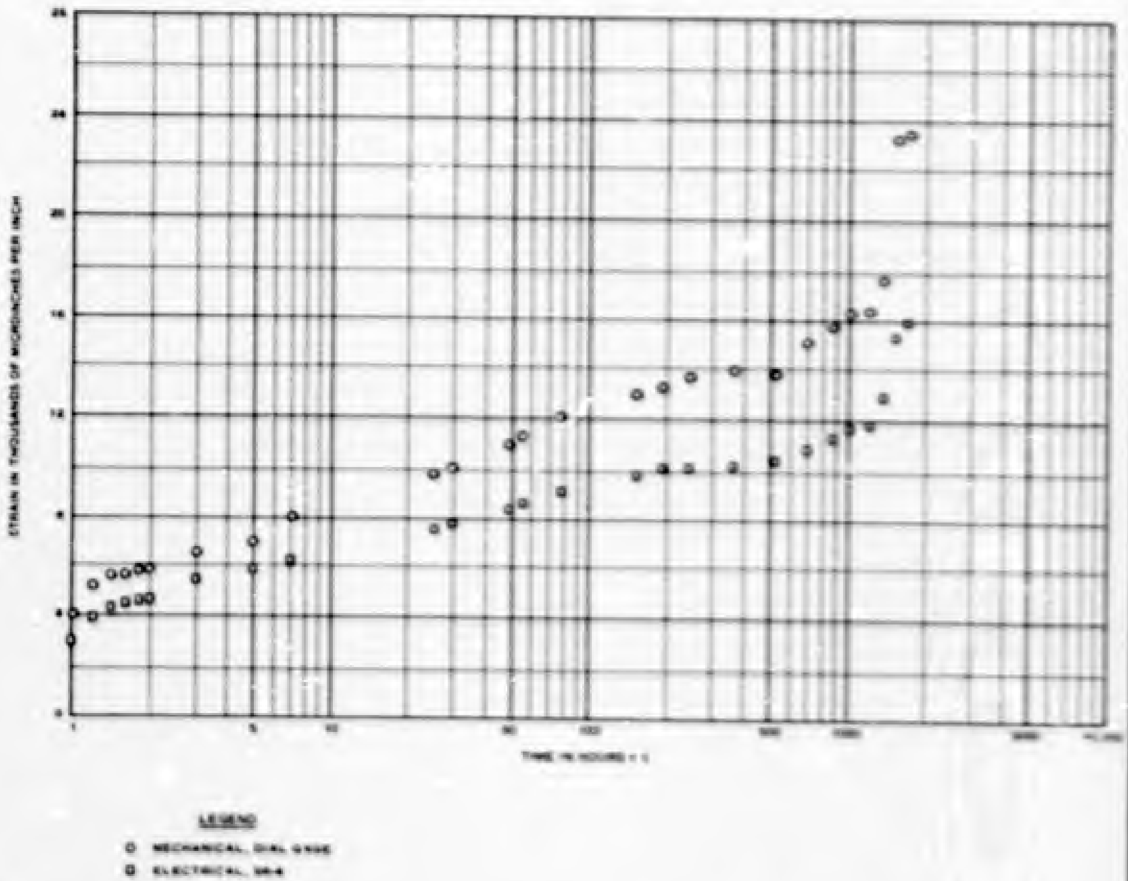
METHOD OF END PREPARATION:
CAPPED WITH SULFUR-SILICA COMPOUND

METHOD OF STRAIN MEASUREMENT:
MECHANICAL AND SR-4 STRAIN GAGES

TEST CONDITIONS:
73.4 ± 2 F; RELATIVE HUMIDITY = 50 ± 5%

TIME	STRAIN, MICROINCHES PER IN.			
	MECHANICAL, GAGE LINE			
(t + 1 HR)	1	2	AVG	SR-4
1.0	3,250	4,800	4,025	3,030
1.2	4,600	5,850	5,225	3,990
1.4	5,050	6,050	5,550	4,290
1.5	5,250	6,100	5,675	4,510
1.8	5,450	6,250	5,850	4,650
2.0	5,500	6,300	5,900	4,750
3.0	6,200	7,000	6,600	5,410
5.0	6,950	7,100	7,025	5,930
7.0	7,750	8,350	8,050	6,220
25.0	9,650	10,000	9,875	7,520
29.5	10,000	10,150	10,075	7,790
48.0	11,200	10,900	11,050	8,460
55.0	11,750	11,000	11,375	8,550
77.5	12,400	11,650	12,025	9,170
151.5	13,750	12,150	12,950	9,830
193.0	13,800	12,750	13,275	10,040
241.0	14,050	13,250	13,650	10,050
361.0	14,300	13,500	13,900	10,260
528.0	13,850	13,550	13,700	10,470
697.0	15,800	14,400	15,100	10,950
865.0	16,500	14,950	15,725	11,345
1,033.0	16,900	15,750	16,325	11,640
1,201.0	17,100	15,600	16,350	11,875
1,369.0	18,500	16,870	17,650	14,580
1,537.0	24,200	22,20[illegible]	23,200	15,750
1,705.0	24,500	22,900	23,700	15,940

NOTE: TEST ENDED BECAUSE OF FAILURE OF SPECIMEN.



STRAIN-TIME CURVE
UNIAXIAL CREEP TEST
HOLE WP-4 - SPECIMEN NXC-12

HOLE COORDINATES DATE 16 MAR 1962
N 10146.05, E 6040.61

CORE DEPTH
2456.7 FT TO 2458.5 FT

DIAMETER
4.97 IN

SPECIMEN LENGTH
9.90 IN

METHOD OF SAWING TO LENGTH
BRINE SOLUTION (DIAMOND SAW)

METHOD OF END PREPARATION
MACHINED BY LATHE

LATERAL LOAD, PSI
2000 ± 100

AXIAL LOAD, PSI
1000 ± 51

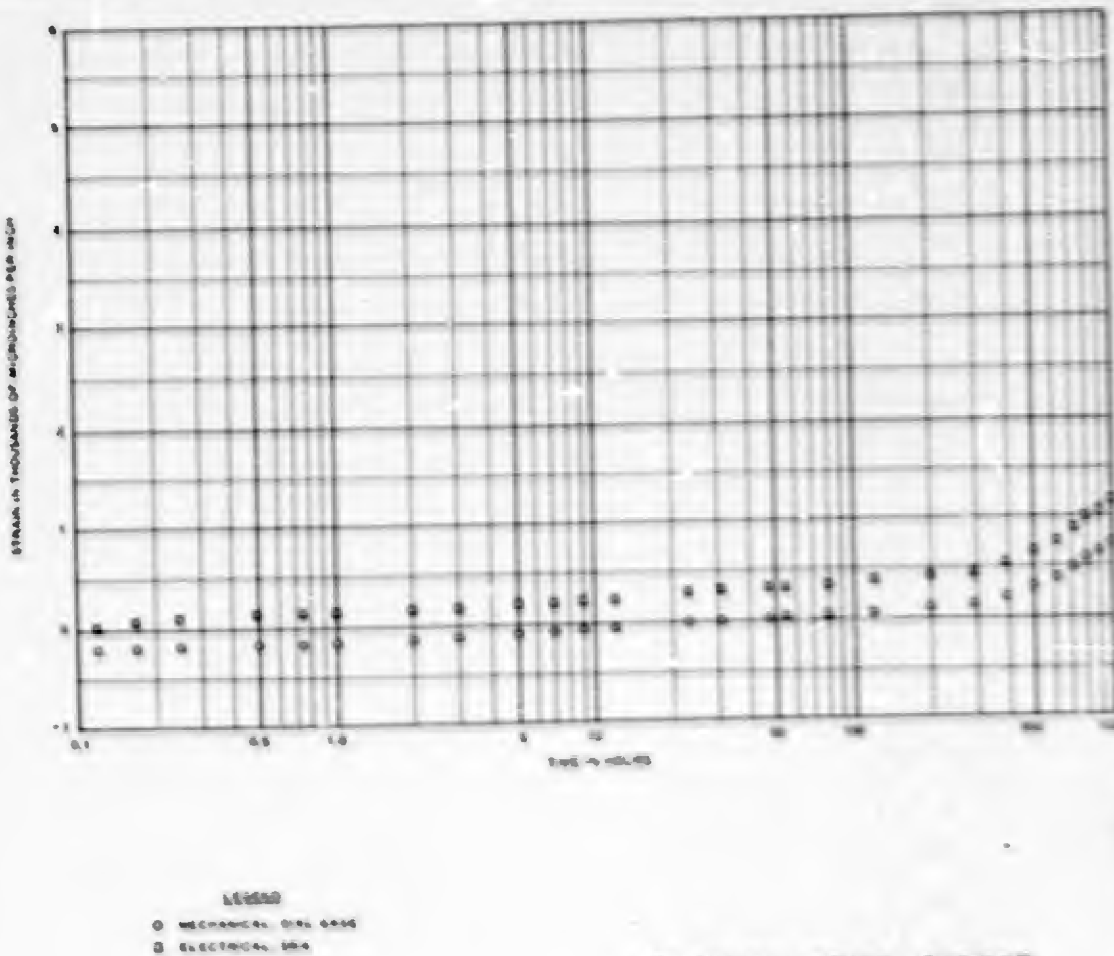
TEST CONDITIONS
73 ± 3F

REASON FOR TERMINATION OF TEST
COMPLETION OF REQUIRED 1000 HR UNDER TEST

LOCATION OF FRACTURE
NONE

TIME HR	STRESS, PSI AXIAL	STRESS, PSI LATERAL	AVG STRAIN, MICROIN./IN. MECHANICAL	AVG STRAIN, MICROIN./IN. ELECTRICAL
0	100	100	0	0
0.04	300	510	-77	15
0.08	570	1,000	-127	20
0.12	830	1,510	-207	25
0.17	1,000	2,000	-166	80
0.25	1,000	2,000	-166	135
0.50	1,000	2,000	-153	160
0.75	1,000	2,000	-140	165
1.0	1,000	2,000	-135	170
2.0	1,000	2,000	-110	180
3.0	1,000	2,000	-100	195
5.0	1,000	2,000	-80	215
7.0	1,000	2,000	-58	225
9.0	1,000	2,000	-45	240
12.0	1,000	2,000	-18	255
23.0	1,000	2,000	5	310
31.0	1,000	2,000	15	320
47.0	1,000	2,000	30	333
56.0	1,000	2,000	50	341
80.0	1,000	2,000	60	358
120.0	1,000	2,000	80	380
200.0	1,000	2,000	115	430
255.0	1,000	2,000	142	450
350.0	1,000	2,000	205	515
503.0	1,000	2,000	310	610
623.0	1,000	2,000	390	740
719.0	1,000	2,000	520	865
833.0	1,000	2,000	535	910
895.0	1,000	2,000	650	1,055
1,008.0	1,000	2,000	725	1,160
1,008.2*	100	100	665	965
1,015.0*	100	100	665	820
1,036.0*	100	100	675	795
1,150.0*	100	100	510	750

* RECOVERY READINGS



STRAIN-TIME CURVE
TRIAXIAL EXTENSION TEST
HOLE WP-1 - SPECIMEN 48A

HOLE COORDINATES: [illegible] DATE: [illegible]

CORE DEPTH: [illegible]

DIAMETER: [illegible]

SPECIMEN LENGTH: [illegible]

METHOD OF SAWING TO LENGTH: [illegible]

METHOD OF END PREPARATION: MACHINED BY LATHE

LATERAL LOAD, PSI: [illegible]

AXIAL LOAD, PSI: [illegible]

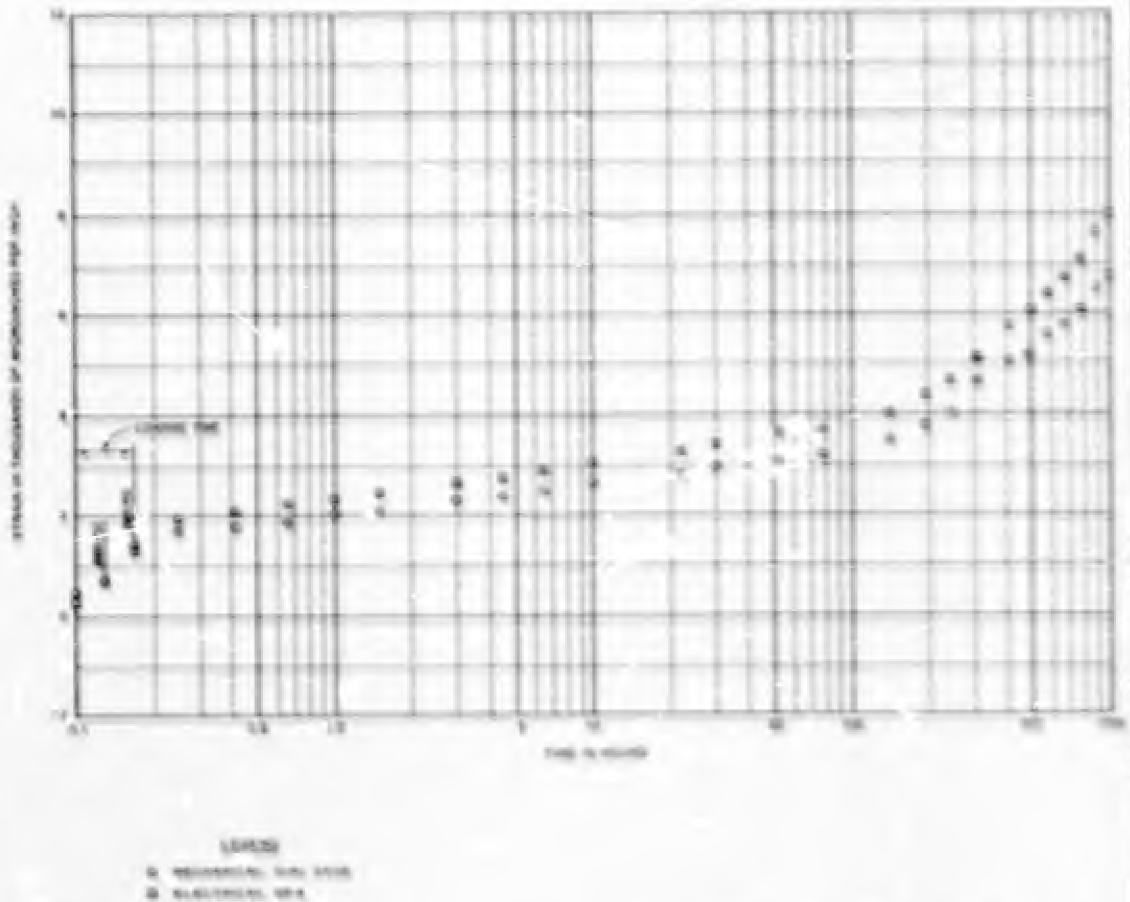
TEST CONDITIONS: [illegible]

REASON FOR TERMINATION OF TEST: COMPLETION OF REQUIRED 1000 HR UNDER TEST

LOCATION OF FRACTURE: NONE

TIME (HR)	STRESS, PSI AXIAL	LATERAL	AXIAL STRAIN, MICROIN./IN. MECHANICAL	ELECTRICAL
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

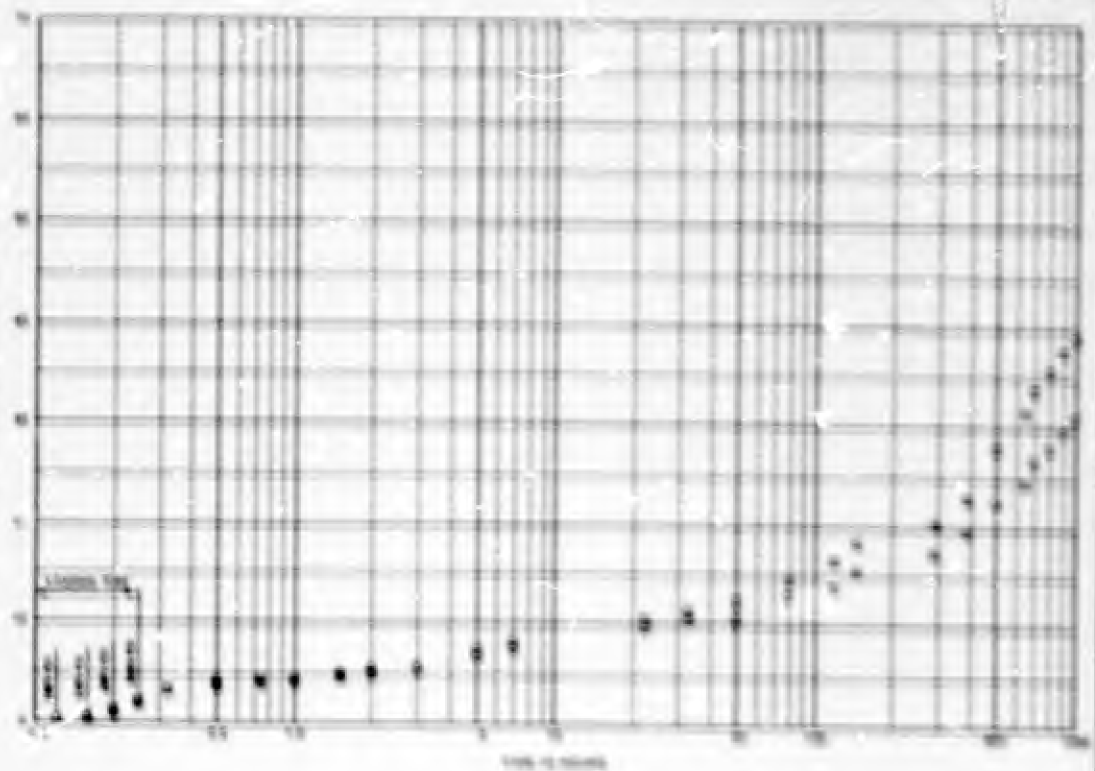
† RECOVERY READINGS



STRAIN-TIME CURVE

TRIAXIAL EXTENSION TEST

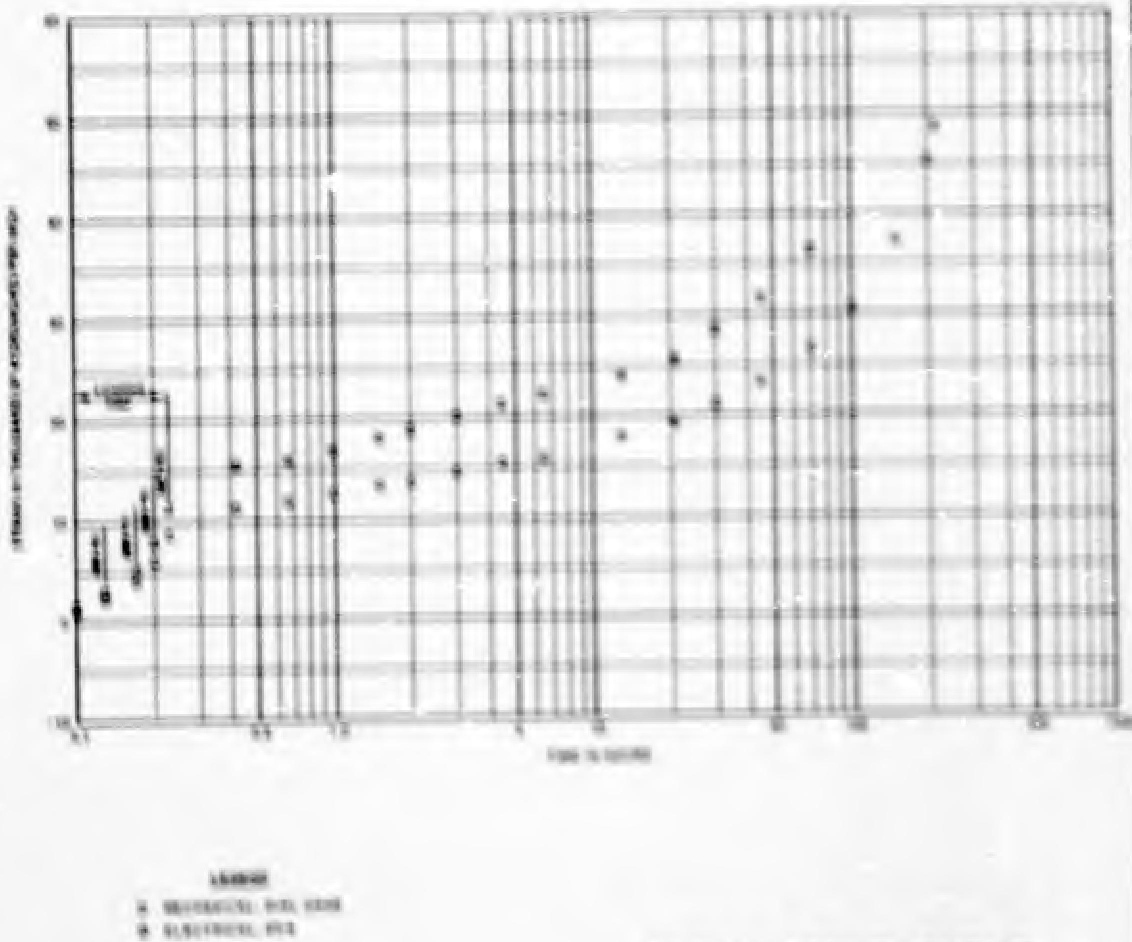
HOLE WP-1 - SPECIMEN 67B



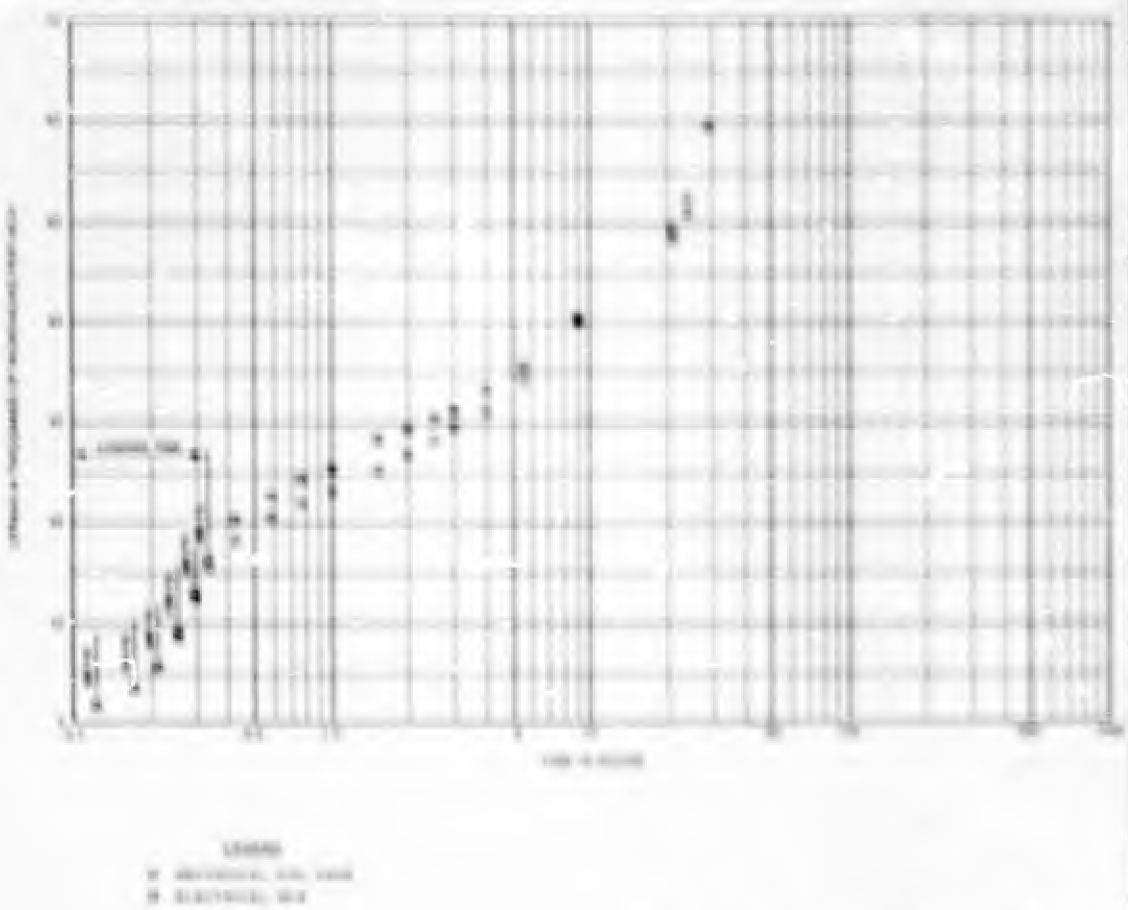
STRAIN-TIME CURVE

TRIAXIAL EXTENSION TEST

HOLE WP-1 - SPECIMEN 51B



STRAIN-TIME CURVE
TRIAXIAL EXTENSION TEST
HOLE WP-1 - SPECIMEN 18B



STRAIN-TIME CURVE

TRIAXIAL EXTENSION TEST

HOLE WP-1 - SPECIMEN 49A

RESULTS OF TRIAXIAL EXTENSION TESTS

STEEL CYLINDER

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APPENDIX A: TESTS OF CORES FROM CAREY SALT MINE, WINNFIELD, LA.

Samples

1. Thirty-two rock salt cores were drilled from the floor at the 811-ft level of the Carey Salt Mine, Winnfield, La. These cores were examined petrographically and then 30 were tested for creep. The diameters of the cores and the lithologic types represented were:

Core No.	Designation	Lithology
	4-15/16-in.-Diameter Cores	
2, 3, 5, 6, 7, 9A, 9B, 10, 11, 16	Group I	Alternating zones of pure rock salt and salt containing anhydrite
14, 18, 19, 20, 26, 33, 35, 37	Group II	Anhydrite-bearing salt
15	Group III	Pure rock salt
	2-1/8-in.-Diameter Cores	
2, 5, 31, 32, 35	Group I	Alternations of pure and impure rock salt
1, 11, 12, 15, 19, 20, 21, 22, 23, 24	Group II	Impure rock salt
9	Group III	Pure rock salt

Missing numbers in the series of 4-15/16- and 2-1/8-in. cores represent cores that were broken in handling or were too short for creep tests. Detailed petrographic examinations were made of cores 9A and 9B, which were two broken pieces of one 4-15/16-in.-diameter core classified in Group I but containing a section of pure rock salt, and of core 14, a short or broken section classified in Group II. Neither core 9 nor core 14 was chosen for creep testing. No core of pure rock salt of Group III was available for petrographic examination. It was recommended that cores representing both (Groups I and II) major lithologic types in both diameters be tested for creep at both 73 and 150 F.

Test Procedures

Petrographic examination of cores selected for creep tests

2. Each core was examined visually to observe its texture and degree of homogeneity. Since some of the cores had strain gages taped on them and others had been mounted in the creep-testing frames when they were examined, the examination was hindered to some extent. An estimate of the mineral composition of each core was made (table A1). Detailed sketches

Table A1

Estimated Anhydrite Content of 32 Rock Salt Cores from Winnfield, La.

Core Diameter	Anhydrite Content, %																	
	Group I*									Group II**								Group III†
	Core No.								Avg	Core No.							Avg	Core No.
	2	3	5	6	7	10	11	16	Value	18	19	20	26	33	35	37	Value	15
4-15/16 in.	15	15-20	5	5	5	5	<5	5	7-8	25	20-25	20-25	25	25-30	25	25	24-25	0-1

Core Diameter	Group I*						Group II**											Group III†
	Core No.					Avg	Core No.										Avg	Core No.
	2	5	31	32	35	Value	1	11	12	15	19	20	21	22	23	24	Value	9
2-1/8 in.	10-15	10-15	15	15	20	15	25-30	20	20	25-30	20	25-30	25-30	25-30	25-30	20	24-25	<1

* Alternating zones of pure rock salt and salt containing anhydrite.
** Anhydrite-bearing salt.
† Pure rock salt.

were made of the first few cores examined, but once it became apparent that all cores could be assigned to one of three lithologic types, major emphasis was placed on recognizing the characteristics of each type.

Petrographic examination of cores 9A, 9B, and 14

3. Each of these three cores was sawed axially, and the sawed surfaces were etched with water to remove the saw marks and reveal less soluble constituents. One-half of each core was photographed (photographs A1-A3). Small portions of cores 9A and 14 were dissolved in water. The insoluble residue was examined with a stereomicroscope, and individual crystals were selected and examined with a petrographic microscope.

X-ray examination

4. Powders of some of the 2-1/8-in. cores, of cores 9A, 9B, and 14, and of the insoluble residue from core 14 were examined by X-ray diffraction, using an XRD-5 diffractometer with nickel-filtered copper radiation.

Thin-section study

5. Two thin sections were made from a scrap 2-1/8-in. core and examined with a petrographic microscope.

Description of Cores

6. The major constituent of all of the cores was colorless halite (NaCl), but light- to medium-gray anhydrite ($CaSO_4$) amounted to 5 to 30 percent of the two abundant types. Traces of dolomite were present in most of the cores. The cores were classified in three lithologic groups, which are discussed below. The distribution of cores by types is shown in table A1.

Alternating zones of pure rock salt and salt containing anhydrite (Group I)

7. Zones of coarsely crystalline, massive, pure rock salt alternated with zones of coarsely crystalline rock salt containing sheared out lenses of anhydrite in isolated well-formed tablets and patches of subhedral crystals. The salt crystals were larger in the pure salt than in the anhydrite-bearing salt in the cores of this group. The salt crystals had no crystal faces, but formed a massive granular texture with individual crystals generally having inconspicuous sinuous boundaries and shapes rather like those in a recrystallized quartzite or a gneiss of high quartz content. There was no recognized evidence of the hopper-shaped crystals that are characteristic of primary salt; no liquid inclusions were found, and there was ample evidence of shearing and deformation of the anhydrite lenses, so that it appeared highly probable that the texture of the salt in these cores is the result of recrystallization. Some of the cores included portions of single crystals up to 3 or 4 in. in maximum dimension; these crystals formed porphyroblasts or large, translucent, clear inclusions in the salt, which in the groundmass ranged in crystal size from 1/4 to 2 in. In many of these cores the most conspicuous features were slightly wavy or stepped, subparallel, horizontal fractures normal to the axis of the core, the three sets of fractures marking the cubic cleavage of the salt, and fractures parallel to the long axis of the cores (photographs A1 and A2).

The salt in place in the mine was described as fractured, so that it appeared certain that some of the fractures in the cores were present before they were drilled, but the fractures normal to the axis of the cores were probably related to damage in drilling. Salt is brittle at normal temperature and atmospheric pressure; attempts to polish one-half of a core opened up many more cleavage cracks in the polished surface than in the unpolished half. However, these cleavages and similar fractures on the outer surfaces of untested cores appear to penetrate 1/4 or 3/8 in. at a maximum into the clear salt. It is difficult to estimate how well the properties of cores of massive recrystallized salt like the salt in cores of Groups I and III may represent the properties of salt in place in a large mass.

8. The anhydrite in the cores of this group occurred in thin sheared lenses dipping at about 60 degrees, with the lenses varying in thickness, in concentration of anhydrite, and in distance from lens to lens normal to the plane of greatest extent of the lens. The anhydrite-bearing zones were darker gray and the salt was of smaller crystal size than in the pure salt. There was a tendency for the rounded irregular salt crystals to be elongated parallel to the anhydrite lenses. One small cavity, 1/8 by 1/2 by 1/4 in. deep, was seen in 2-1/8-in.-diameter core 32 at the contact of pure and anhydrite-bearing salt.

Anhydrite-bearing salt (Group II)

9. Cores in this group contained an estimated 20 to 30 percent of anhydrite (table A1) in lenses thicker than those in most of the cores of the Group I (photograph A3). The major constituent of the cores was massive gneissic-textured rock salt in bands ranging from one to several inches thick, alternating with sheared and offset or broken and crumpled bands of much finer grained anhydrite. The salt bands and anhydrite bands dip about 60 degrees. The anhydrite lenses appeared to "rust" on exposed surfaces of the cores after several weeks of exposure in air; the surfaces changed from fairly dark or medium gray to tan or orange-tan, possibly because of the release of iron from iron-bearing dolomite rhombs which occurred scattered in the anhydrite lenses. It seems possible that as the exposed cores pick up moisture from the air, the brine formed may attack the iron-bearing dolomite and release some of the iron to form a hydrated ferric chloride, which would produce the color observed. The crystal size

of the anhydrite was less than a millimeter in this group of cores. The salt crystals were considerably larger, up to about 1.5 cm in maximum dimension; anhydrite inclusions along the grain boundaries of the salt and within the salt crystals were common.

Pure massive salt (Group III)

10. Only two cores of this group were included in the 32 cores examined before creep testing; thus neither was available for detailed examination. The salt resembled that in pure rock salt zones of Group I cores. Photograph A3 shows an area of pure salt.

Results of Thin-Section Study

11. The two thin sections made and examined were taken from core 3, in a part of the core that contained some anhydrite. One section was oriented parallel to the long axis of the core, and the other normal to it. In both thin sections, the largest grains were clear halite, with almost straight or gently arcuate boundaries, an occasional short cleavage crack, and no sign of strain or liquid inclusions or of the sections of hopper-shaped crystals common in bedded salt deposits. The other important constituent was anhydrite, in crystals ranging from rectangular prismatic (brick-shaped) to similar crystals with truncated corners, to crystals without any crystal outline because their boundaries were formed by interfering crystals. There were a few rhombic sections of dolomite, most of them pale tan in color with a central core containing many dark inclusions; the dolomite rhombs were distributed at random within groups of anhydrite crystals. Many of the anhydrite crystal groups contained irregular opaque inclusions, usually concentrated along grain boundaries; these did not show metallic reflections when they were examined in reflected light; they may be droplets of petroleum residue. Some of the anhydrite crystals contained inclusions of much lower index of refraction. The principal difference between the two sections was that in the section cut normal to the axis of the core, the majority of the anhydrite crystals were essentially equidimensional, whereas in the section cut parallel to the long axis of the core, the majority of the anhydrite crystals were elongated and there was a rough but perceptible tendency for the anhydrite grains to have their

long axes subparallel. This difference indicated the major direction of deformation in the rock salt to be essentially parallel to the axis of the core and parallel to the vertical axis of the salt dome.

Cores After Creep Tests

12. The creep testing of the Winnfield cores was done primarily to become familiar with test methods and procedures to use with salt specimens. Since very little rock salt had been tested it was not known whether the equipment available would perform satisfactorily or what modifications might be required. Initially, two specimens were placed monolithically in a spring-loaded frame and loaded to the same stress. Several attempts at this procedure resulted in uneven strains, crushing of the caps between specimens, and tilting of the frames. Also, if one specimen failed, the test of the companion specimen was terminated. Subsequently, it was decided to test one specimen per rig with particular attention being given to correct alignment and perpendicularity. Difficulty was also encountered with strain measurement. The following methods were tried and abandoned for the reasons given:

- a. Carlson strain meters bound with wire to the specimens could not be held fast against the cylindrical surface.
- b. SR-4 electical strain gages mounted on the specimen were loosened by the spalling of crystals on highly stressed specimens.
- c. Compressometers proved too susceptible to accidental bumping

The method which proved most successful was measurement of strain between inserts embedded in the specimen with a mechanical device commonly known as the Whittimore gage. Measurements were taken periodically to fully define the creep curve.

13. Two cores representing the extreme creep conditions tested were examined after the end of the test. Both were cores of nominal 5-in. diameter from lithologic Group I. Core 5 was loaded at 2250 psi and tested at 150 F; core 6 was loaded at 750 psi and tested at 73 F. When the cores were mounted in the creep frames and the first loads were applied, the more heavily loaded core whitened perceptibly, losing translucency, probably because of the formation of fractures, perhaps by slipping on grain

boundaries or by the opening of grain boundaries to form air gaps between crystals. The more heavily loaded specimen lost some fragments by flaking as it was loaded. After the test, the outer surfaces of the more heavily loaded core were perceptibly uneven to the touch, as if both flaking of small fragments and irregular lateral bulging of the core had taken place.

Summary of Results

Lithologic varieties

14. Visual examination of 32 cores before creep testing and detailed examination of two cores not used in the test indicated that they represented three lithologic varieties:

- a. Group I. Alternating bands of pure massive rock salt and anhydrite-bearing salt
- b. Group II. Anhydrite-bearing salt
- c. Group III. Pure massive rock salt

The distribution of cores by types is shown in table A1. The pure massive rock salt formed large crystals, up to 1 or 2 in. in maximum dimension, in an even-grained texture of crystals with sinuous inconspicuous grain boundaries, or large porphyroblasts, up to 3 in. or more in maximum dimension, in a groundmass of pure rock salt of smaller grain size and gneissic texture. The anhydrite-bearing salt was banded, with paler, coarser rock salt alternating with darker, much finer grained anhydrite in sheared, faulted, crumpled, or offset bands up to 2 in. thick. The anhydrite bands and the elongated salt crystals in the gneissic salt dipped about 60 degrees. The alternating bands of darker anhydrite-rich salt and paler salt essentially free of anhydrite represent original banding in the undeformed salt deposit, preserved in the metamorphosed salt.[6*]

Mineral composition

15. The two most abundant minerals in the Winnfield cores, and the only two that are expected to affect significantly the engineering properties of the rocks that the cores represent, are halite and anhydrite. Halite, or rock salt, is the predominant constituent of all the cores; in the

* Raised numerals refer to similarly numbered items in list of references at end of main text.

bands of massive pure rock salt it is, to all intents and purposes, the only constituent. Halite is cubic, with perfect cubic cleavage, conchoidal fracture, and low hardness (2 on Mohs' scale). Although salt is brittle at ordinary temperatures and pressures, the least shear stress at which it begins to slip is reported to be 30 kg per sq cm, or 427 psi; the important slip planes are the planes of the dodecahedron.[4] Vertical elongation of highly deformed salt crystals, and vertical orientation of the longest body axis of anhydrite crystals are frequently found in the deformed salt of Gulf Coast domes,[4] and were seen in these cores.

16. Anhydrite ($CaSO_4$) is the most abundant mineral other than halite in these cores, and in samples from other Gulf Coast salt domes; it usually amounts to 99 percent of the water-insoluble residues from salt.[6] It is harder than salt (3-1/2 on Mohs' scale), crystallizes in the orthorhombic system, and has three cleavages at 90 degrees to each other. Like salt, it recrystallizes fairly easily under load.

Structure

17. The salt-anhydrite rock of these cores is highly deformed, as the gneissic texture, the shearing, crumpling, and offsetting in the anhydrite-rich bands, and the steeply dipping elongation of salt crystals and anhydrite crystals demonstrate. The features of these rocks, and of salt-anhydrite rock from other salt domes, most likely to affect the engineering properties of the rocks are the high degree of deformation, and the high degree of preferred orientation in rocks composed of relatively soft minerals.

Cross-fractures in the cores

18. In coarse-grained, almost transparent rock salt, cleavage cracks opened by drilling dip at angles of about 45 degrees to the long axes of the cores and die out into the core, penetrating to depths of 1/8 to 3/8 in. Similar cleavage cracks of similar depth were opened on a saw cut parallel to the long axis in trying to polish one-half of a semitransparent core. However, many of the cores also showed cracks normal to the long axis of the core that apparently pass through the whole core as sets of subparallel planes. These may represent either a set of joints normal to the direction of structural elongation in the dome, or a set of fractures brought about when the core was wedged to break it loose from the bottom

of the core hole, or a set of joints in the dome emphasized by wedging the cores to break them loose from the bottom of the hole. These cross-fractures were more abundant in cores which contained very coarse pure salt as a major constituent. In the gneissic salt and anhydrite rock, the cores were less transparent, and were also finer grained and had a strongly developed, steeply dipping structural direction. Cross-fractures in this rock are likely to be stopped at grain boundaries, and the increased proportion of anhydrite increases the strength above that of purer salt.

Conclusion

19. As a result of these preliminary examinations, it appears reasonable to concentrate in later examinations on the structural features of the cores as they may be revealed by more detailed examination of the cores before physical tests, by examination of sawed water-etched surfaces, and by more detailed examination of cores before and after creep tests. It is intended to check the gross mineral composition of a few cores from Tatum by X-ray of a few samples representing lithologic extremes; the probability is overwhelming that salt and anhydrite will be the only constituents present in large enough amounts to be significant in terms of physical properties.

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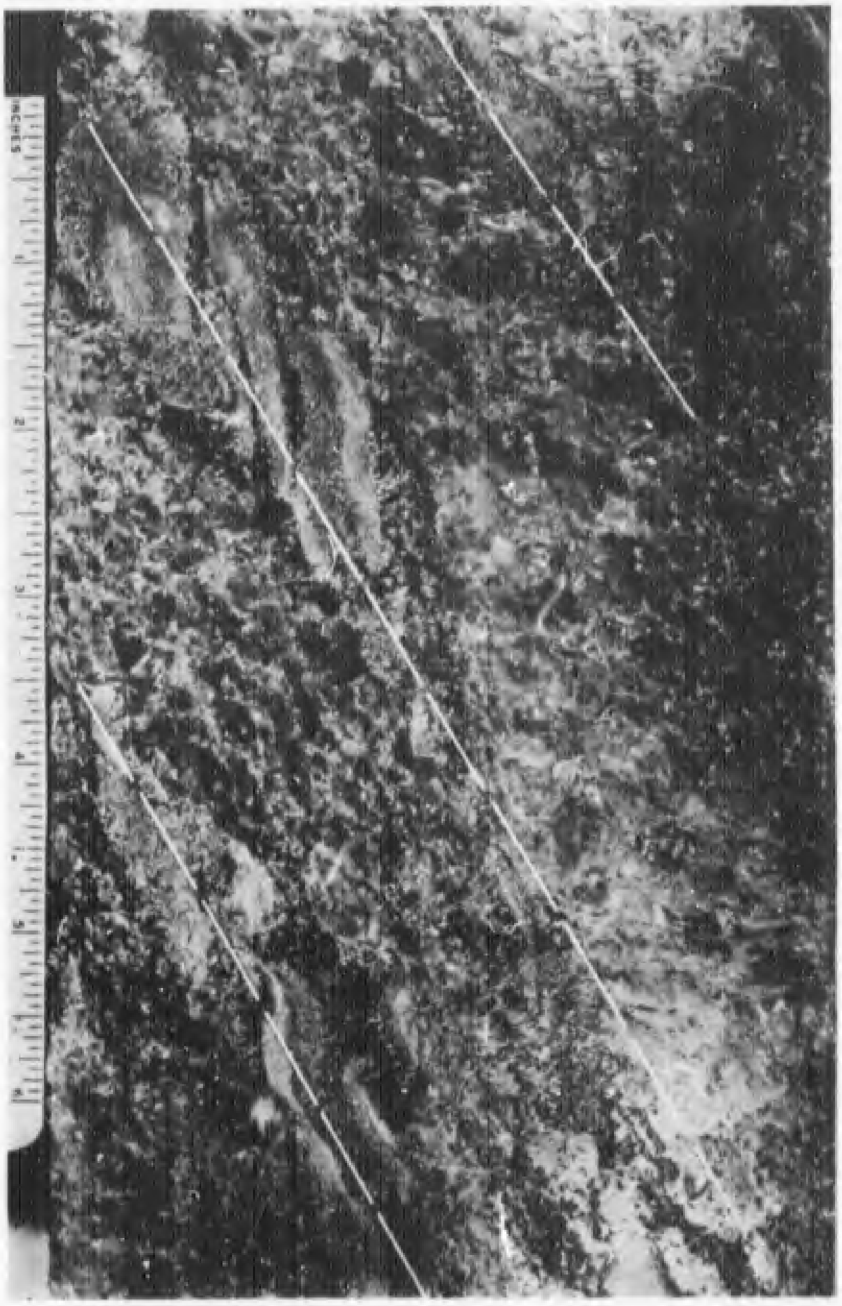
Photograph A1. Group I Winnfield core. The dashed line shows the location and orientation of the small amount of anhydrite that is seen. (This is upper half of core 9)

Photograph A2. Group I Winnfield core. Almost 100 percent pure rock salt. (This is lower half of core 9)



Photograph A3. Group II Winnfield core. The dashed lines are drawn down the center of three anhydrite patches to locate them and to show their orientation. (This is core 14)

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APPENDIX B

WATERWAYS EXPERIMENT STATION	PETROGRAPHIC REPORT		
SYMBOL: 441-6387.3	PROJECT: Dribble	DATE REPORT SUBMITTED: 18 May 1961	INITIALS: KM
SERIAL NO:	SOURCE: Hole No. 4, Tatum Salt Dome		

1. Samples. Eleven pieces of core from hole No. 4 were received on 12 May 1961; two more on 17 May.

2. Test procedure. The cores were measured, examined visually and with a stereomicroscope; some were tested with dilute hydrochloric acid.

3. Descriptions of cores.

Core No.	Depth, ft	
1	948 - 948.5	Top and bottom not marked; 0.5 ft of brownish-gray, sheared, brecciated, friable, porous carbonate rock containing a little quartz as quartz crystals; very loosely cemented; the color is in the rhombic carbonate and did not come off when the core was wetted with xylol. Both ends of this core are irregular surfaces which might mark the limits of the cementation.
2	999 - 1000	Top and bottom not marked; NX core in 2 pieces taped together with masking tape. A fresh fracture at one end of the core and the weathered fracture one-quarter of the length of the core away from it are both coated with radiating flat rosettes of crystals, possibly aragonite. Core is irregularly banded in darker and lighter gray, blue-gray, and pinkish-tan. Somewhat porous, medium fine-grained crystalline limestone. See fig. B1. Composition ranges from strontium-rich carbonate rock as in NXC-15, hole WP-1, to pure limestone.
3	1107 - 1108	Top and bottom not shown; NX core 0.93 ft long; one end an old fracture, other end a fresh fracture. Massive medium-grained anhydrite with no visible structure.
4	1199.5 - 1200.5	Top and bottom marked; NX core 0.94 ft long, with both ends bounded by fresh fractures approximately normal to the long axis of the core. Medium gray, massive, fine-grained anhydrite; only structure a bruise and a few cracks near bottom where core was hit, probably with a hammer.

Core No.	Depth, ft	
5	1299 - 1300	Top and bottom marked; 1.03 ft long. Top a fresh break, roughly normal to long axis of core; bottom a break started by sawing a groove around the core. Massive, medium dark gray, fine-grained anhydrite with inconspicuous pale banding near bottom and about 0.25 to 0.3 ft below top. See fig. B2.
6	1392.5 - 1393.5	Top and bottom marked; 1.0 ft long. Top is a surface ground flat by the core above moving on it; bottom is a fresh fracture. Inconspicuous banding near bottom; top 0.2 ft of core has four paler bands that are softer than the rest of the core and slightly lower than the adjoining darker surface; this banding looks more like a result of a wobbling core barrel than structure. Massive, medium dark gray, fine-grained anhydrite. Fig. B3.
7	1491.5 - 1492.5	Top marked; 1.1 ft long; fracture at top and bottom; massive halite grains up to 1/2 in. in maximum dimension, with subparallel irregular planes in several intersecting sets dipping 30 to 40 degrees. Pure rock salt, semitransparent; gneissic texture.
8	2317 - 2318	Top marked; 1.0 ft long; top and bottom both fresh fractures. Banded salt and anhydrite, with bands about 3/8 in. thick, dipping 60 degrees or steeper. Anhydrite content about 5 percent.
9	2402 - 2403	Top and bottom marked; 1.1 ft long; top a fracture, bottom a flat cut. Gneissic salt with a few anhydrite bands in the length of the core; salt in elongated grains dipping about 50 degrees; one of the anhydrite bands looks sheared. Anhydrite content less than 5 percent.
10	2495.5 - 2496.5	Top and bottom marked; 0.90 to 0.99 ft long with fractures at both ends. Banded salt and anhydrite, the salt up to 3/4 in. in maximum dimension with the elongation of the salt grains parallel to the anhydrite banding; gneissic texture. In the top 0.37 ft of core, at one side there is a higher concentration of anhydrite. Anhydrite content about 5 percent.
11	2603.5 - 2604.5	1.03 ft long; gneissic banded salt and anhydrite in steeply dipping bands; a low concentration of anhydrite, less than 5 percent.

Core No.	Depth, ft	
12	2647.5 - 2648.6	Top, bottom marked; 1.05 ft long; anhydrite-bearing salt; maximum dimension of halite grains 1-3/4 in., predominantly 3/8 to 1/2 in.; anhydrite up to 1 mm. One side of the core has an elongated patch of darker gray salt of higher anhydrite content. Textural elongation of halite grains dips about 50 to 60 degrees. Anhydrite content 5 percent. See fig. B4.
13	2698.5 - 2699.5	1.12 - 1.11 ft long; top and bottom marked. An etched-looking core of anhydrite-bearing salt; top break etched, bottom not etched. Coarse-grained, gneissic-textured, anhydrite-bearing salt with more development of cubic cleavage inside grains than in the overlying cores. Anhydrite content 1 percent or less. See fig. B5.

4. Summary table.

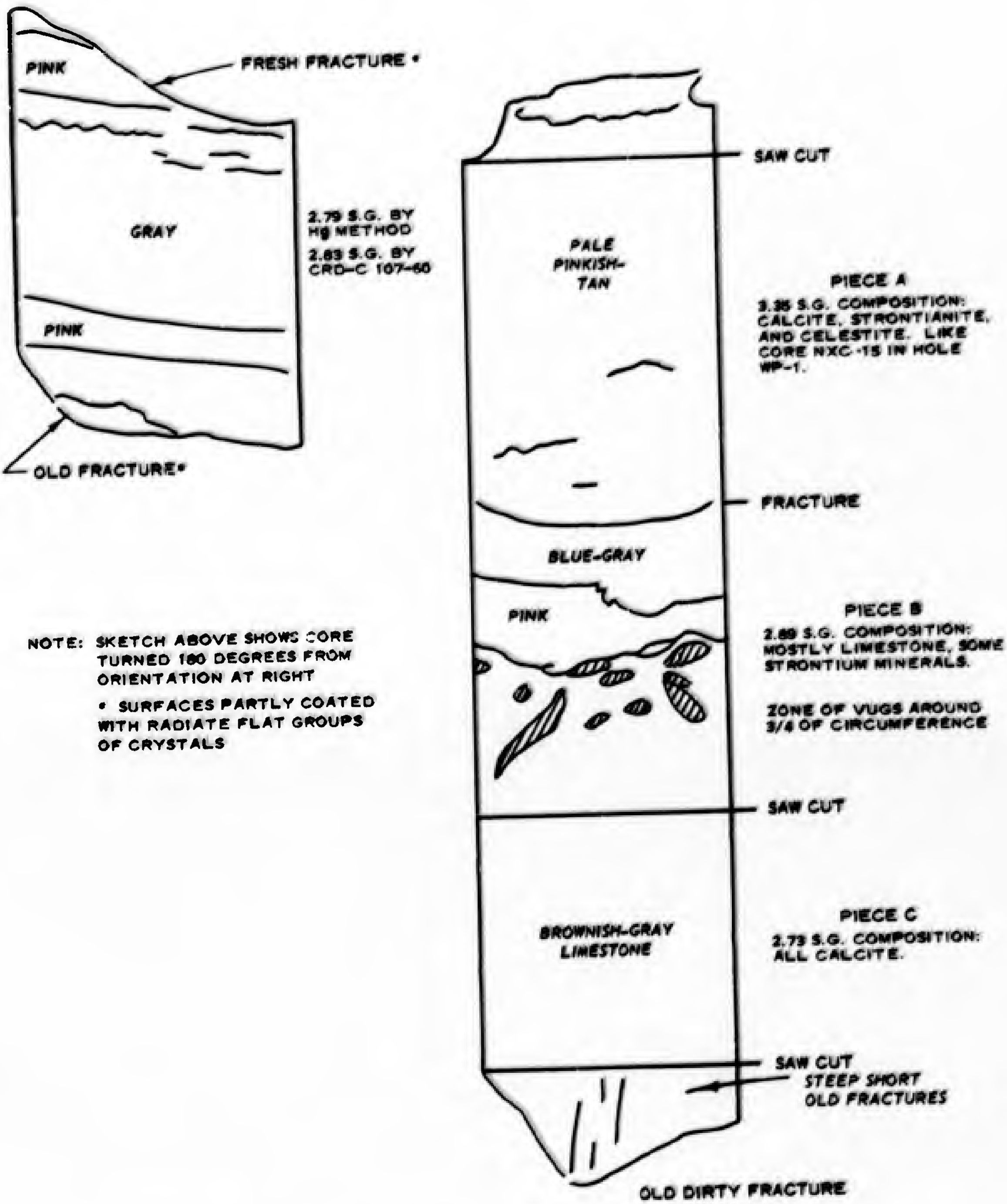
Rock Type	Classification by Winnfield Grouping		Core No.	Depth of Core ft
Limestone	-	Porous, soft, friable, poorly cemented	1	948 - 948.5
Limestone	-	Dense, fine-grained, with some closed pores and vugs	2	999 - 1000
Anhydrite	-	Medium-grained, massive	3	1107 - 1108
Anhydrite	-	Fine-grained, massive	4	1199.5 - 1200.5
Anhydrite	-	Fine-grained, massive	5	1299 - 1300
Anhydrite	-	Fine-grained, massive	6	1392.5 - 1393.5
Pure rock salt	Group III	Coarse-grained, massive, gneissic texture	7	1491.5 - 1492.5
Banded salt and anhydrite	Group I	Thickest bands 3/8 in.	8	2317 - 2318
Banded salt and anhydrite	Group I	Gneissic salt, sparse anhydrite	9	2402 - 2403
Banded salt and anhydrite	Group I	Gneissic salt	10	2495.5 - 2496.5
Banded salt and anhydrite	Group I	Gneissic salt, sparse anhydrite	11	2603.5 - 2604.5

(Continued)

Rock Type	Classification by Winnfield Grouping		Core No.	Depth of Core ft
Anhydrite-bearing salt	Group II	Gneissic salt; one region of moderate anhydrite content	12	2647.5 - 2648.6
Anhydrite-bearing salt	Group II	Sparse anhydrite in coarse gneissic salt	13	2698.5 - 2699.5

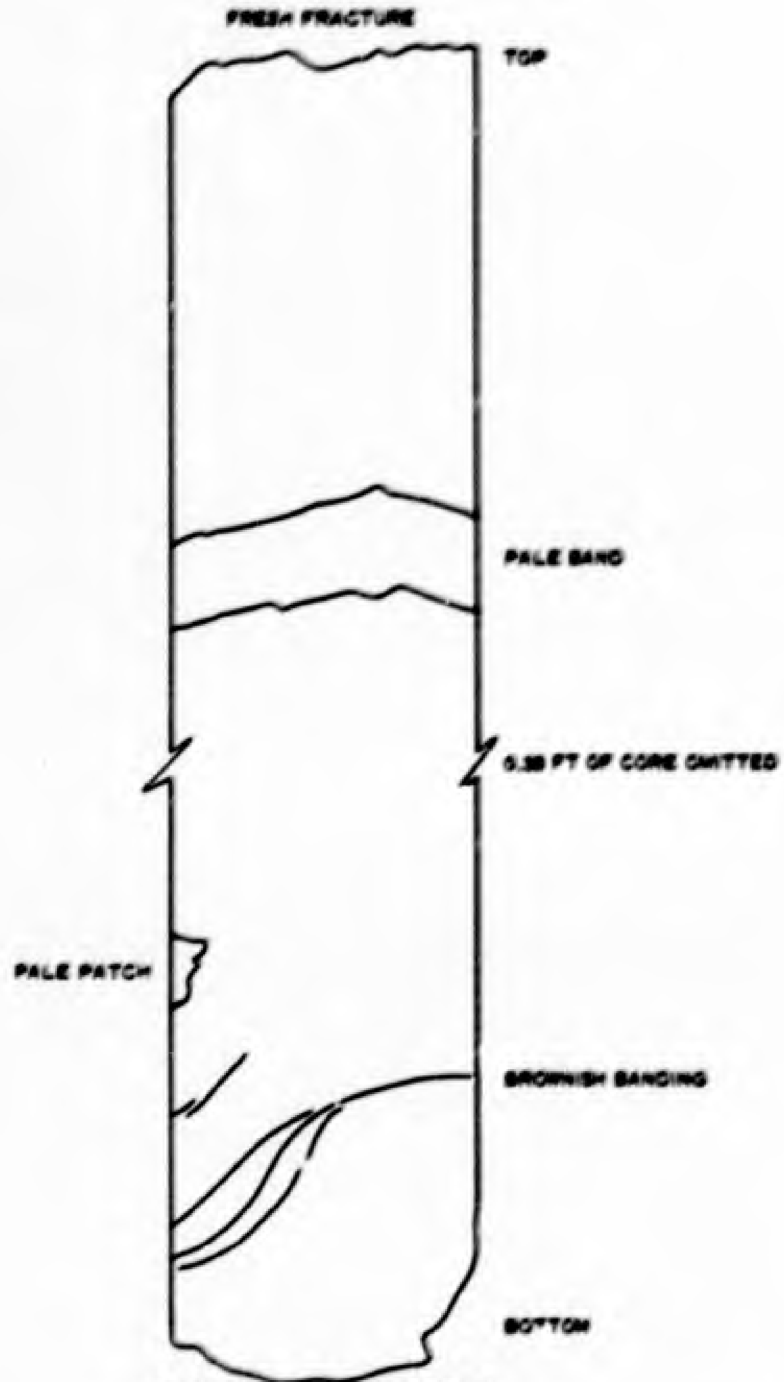
5. Discussion. Cores 1 and 2, both called limestone, differ widely in physical properties; No. 1 looks like a residual accumulation in a zone of weathering, although it is principally calcite; No. 2 is massive and dense $SrCO_3$ rock. Cores 3, 4, 5, 6, the anhydrite group, should be virtually interchangeable in physical properties except that No. 3 is slightly more coarse-grained; all are massive, essentially structureless anhydrite. The salt cores as a group differ in the following respects from the cores from Winnfield: none has as many cracks in open cleavage planes as almost all the Winnfield cores showed; none is as coarse-grained as the coarsest-grained cores from Winnfield; none so far has shown the relatively high concentrations of anhydrite found in some of the Winnfield cores. As a result of the lower anhydrite content, it is harder to divide cores into a banded salt and anhydrite group and an anhydrite-bearing salt group than it was with the Winnfield cores, because the highest anhydrite content so far encountered within the salt plug is low compared to that encountered in the Winnfield cores.

Cores 8, 9, 10, and 11, classed as banded salt and anhydrite, should differ among themselves only to the extent that there is variation in dip of the banding and direction of elongation of the longest direction of the salt crystals; cores 12 and 13, classed as anhydrite-bearing salt, contain less anhydrite and are consequently somewhat coarser-grained than cores 8 through 11; the two should differ from each other only if the differences in dip of the elongation of the salt crystals affect physical properties.



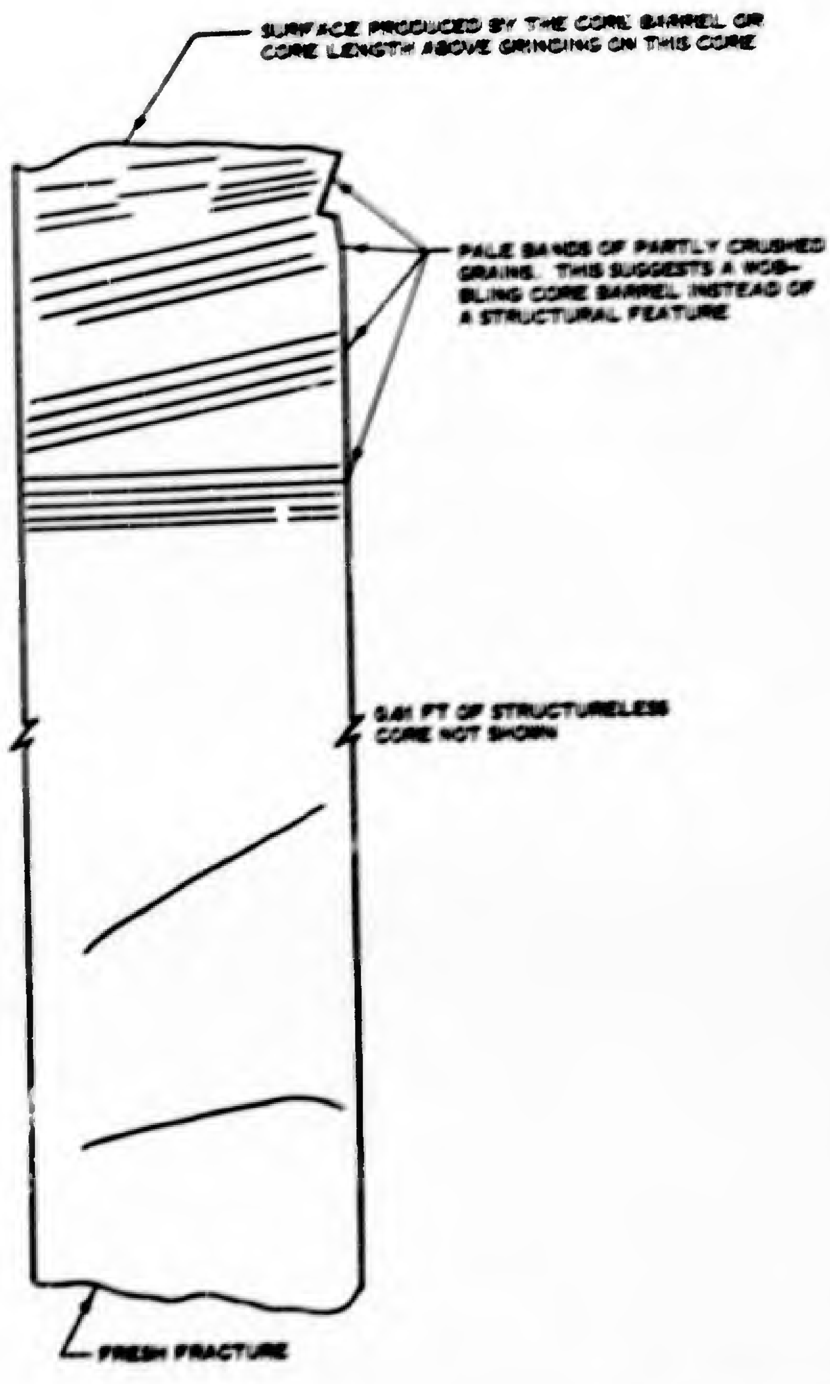
Limestone, core NXC-2, hole 4, Tatum Dome, 999-1000 ft depth

FIGURE B1



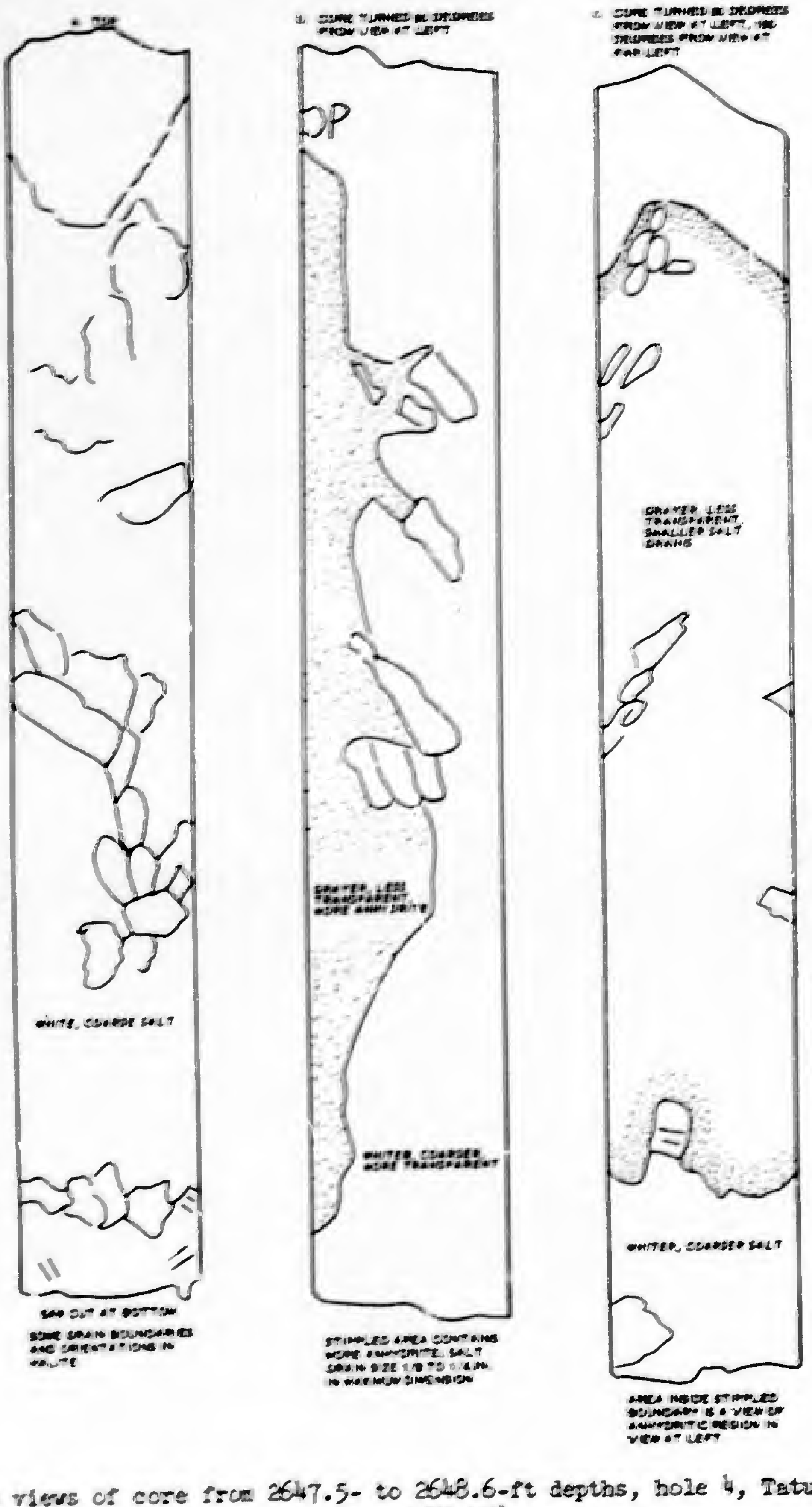
Massive anhydrite, core NXC-5, hole 4, Tatum Dome, 1299-1300 ft depth

FIGURE B2



Massive anhydrite, core HKC-6, hole 4, Tatum Dome, 1392.5-1393.5 ft depth

FIGURE 37



Three views of core from 2647.5- to 2648.6-ft depths, hole 4, Tatum Dome
(core NXC-12)

FIGURE B4

Grain boundaries in gneissic, anhydrite-bearing salt, dipping 25 to 30 degrees. Depth: 2698.5-2699.5 ft, core NMC-13, hole 4, Tatum Dome

FIGURE 85

APPENDIX C

U. S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION
CORPS OF ENGINEERS
OFFICE OF THE DIRECTOR
Vicksburg, Mississippi

Refer to
WESCI

14 November 1961

MEMORANDUM FOR: ATOMIC ENERGY COMMISSION

ATTN: Mr. W. W. ALLAIRE, ALO

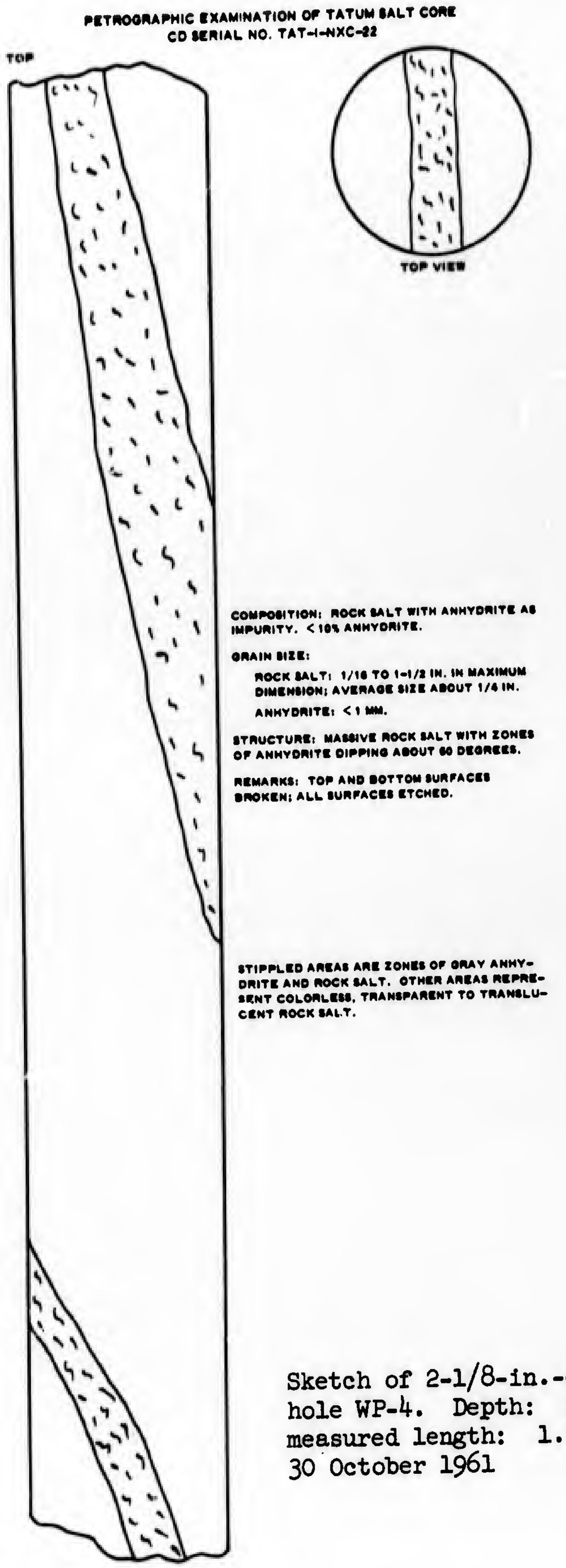
SUBJECT: Test Data for Project DRIBBLE, Report No. 5

This fifth report covers results of petrographic examination of Tatum salt cores NXC-22, 23, 24, 25; all from hole WP-4, Coordinates: N 9217.06, E 9272.30; depths as shown on the logs attached.

/s/ Thomas B. Kennedy
THOMAS B. KENNEDY
Chief, Concrete Division

4 Incl
as

Copies furnished:
Mr. Phil Pack, H & N
Dr. D. U. Deere, Univ. of Ill.
Mr. W. O. Tynes, WES-CD
Mrs. K. Mather, WES-CD



Sketch of 2-1/8-in.-diameter core from hole WP-4. Depth: 2462.5 to 2463.5 ft; measured length: 1.15 ft; examined 30 October 1961

FIGURE C1

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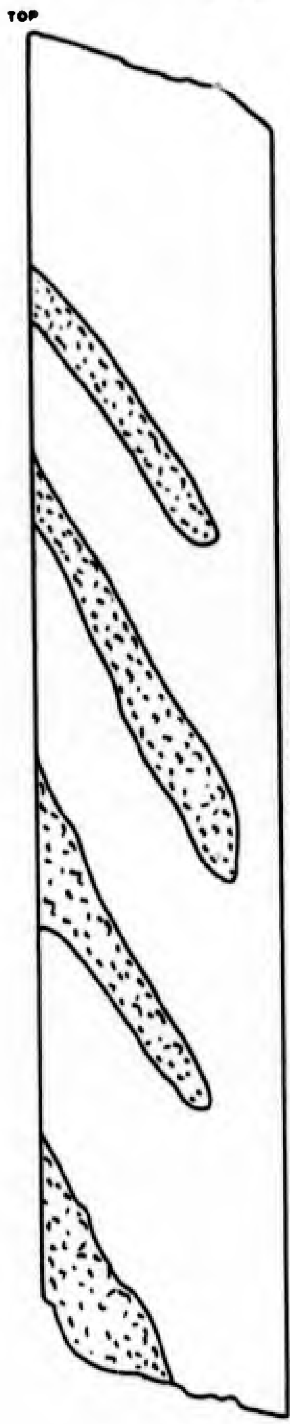
PETROGRAPHIC EXAMINATION OF TATUM SALT CORE
CD SERIAL NO. TAT-1-NXC-84



COMPOSITION: ROCK SALT WITH ANHYDRITE AS IMPURITY. <5% ANHYDRITE. THE ANHYDRITE CONTENT OF THIS CORE IS APPRECIABLY LOWER THAN THAT OF WP-4 CORES FROM DEPTHS OF 2462.5 TO 2463.5, 2476 TO 2477.4, AND 2513 TO 2514 FT.

GRAIN SIZE: 1/4 TO 1 IN. IN MAXIMUM DIMENSION; AVERAGE SIZE 1/2 TO 3/4 IN. THE AVERAGE GRAIN SIZE IS LARGER THAN IN THE THREE CORES MENTIONED ABOVE.

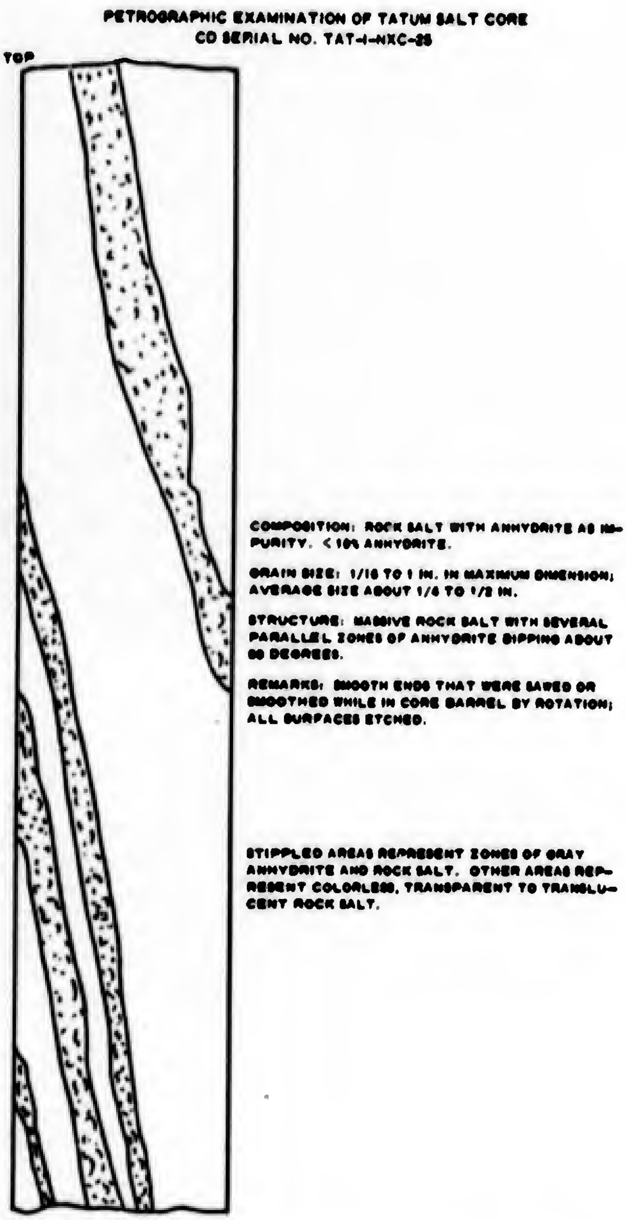
STRUCTURE: MASSIVE ROCK SALT WITH FAINT ZONES OF ANHYDRITE DIPPING ABOUT 60 DEGREES.

REMARKS. TOP AND BOTTOM SURFACES BROKEN; ALL SURFACES ETCHED.

STIPPLED AREAS ARE FAINT ZONES OF ANHYDRITE AND ROCK SALT. OTHER AREAS REPRESENT COLORLESS, TRANSPARENT TO TRANSLUCENT ROCK SALT.

Sketch of 2-1/8-in.-diameter core from hole WP-4. Depth: 2522.0 to 2522.9 ft; measured length: 0.95 ft; examined 30 October 1961

FIGURE C3



Sketch of 2-1/8-in.-diameter core from hole WP-4. Depth: 2533.0 to 2534.0 ft; measured length: 0.78 ft; examined 30 October 1961

FIGURE C4