UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Ground Water Branch

REPORT ON EXPLORATORY DRILLING AT DEATH VALLEY NATIONAL MONUMENT, INYO COUNTY, CALIF.

Prepared at the request of the
National Park Service
Department of the Interior

OPEN-FILE REPORT
60-59

Long Beach, California
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INTRODUCTION

A continuing study has been in progress since 1955 to determine the adequacy of the ground-water supply in the Furnace Creek Wash area of the Death Valley National Monument. This study has been made by the U.S. Geological Survey at the request of the National Park Service, U.S. Department of the Interior.

A previous report by Pistrang and Kunkel (1958) summarizes through November 1957 the results of the studies in the Furnace Creek Wash area. The present report describes the drilling and testing of a water well and tabulates and analyzes periodic measurements of ground-water discharge from springs, sumps, tunnels, and trenches from December 1957 through April 1959.

This work has been carried on by personnel of the Long Beach subdistrict office of the Geological Survey, U.S. Department of the Interior, under the general supervision of H. D. Wilson, Jr., District Engineer for California.

LOCATION OF AREA

The Furnace Creek Wash area of Death Valley National Monument includes a part of the alluviated slope on the eastern side of Death Valley, Inyo County, Calif., between lat 36°25' N. and 36°32' N. and long 116°47' W. and 116°53'W. (pl. 1). The area studied is shown on

Plate 1. Vicinity map of southern California.

the Furnace Creek and Chloride Cliff quadrangles (scale 1:62,500) of the Geological Survey (pl. 2).

Plate 2. Map of Furnace Creek Wash area.

DISCHARGE-POINT NUMBERING SYSTEM

The system of numbering ground-water discharge points used in this report conforms to the well-numbering system used in virtually all ground-water investigations made by the Geological Survey in California since 1940. This system has been adopted as official by the California Department of Water Resources and by the California Water Pollution Control Board for use throughout the State.

The discharge points are assigned numbers according to their location in the rectangular system for the subdivision of public land. For example, in the number 27/1-3A1, which was assigned to Cow Spring, the part of the number preceding the slash indicates the township (T. 27 N.), the part between the slash and the hyphen is the range (R. 1 E.), the number between the hyphen and letter indicates the section (sec. 3), and the letter indicates the 40-acre subdivision of the section as shown in the accompanying diagram.

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

Within each 40-acre tract the discharge points are numbered serially as indicated by the final digit. No distinction has been made between springs, phreatophyte areas, or other types of discharge points in the numbering system. Thus, discharge point 27/1-3A1 is the first discharge point to be listed in the NE$\frac{1}{4}$NE$\frac{1}{4}$ sec. 3. The entire Furnace Creek Wash area of this report lies north and east of the San Bernardino base and meridian lines; therefore, the foregoing abbreviation of the township and range is sufficient.

SUMMARY OF DRILLING AND TESTING ACTIVITIES

In May 1958 the Park Service deepened and extended an existing trench, 27/1-26B3 (pl. 2), across Furnace Creek Wash, thereby increasing the flow from the trench from 0.24 cfs (Pistrang and Kunkel, 1958) to 0.35 cfs. During the same period several test holes were drilled with a truck-mounted power auger to determine the depth to bedrock beneath the wash. Bedrock was not encountered in the center of the wash within the 24-foot depth limit of the auger.

Ground-water flow did not occur in the trench in its entire length but was restricted to places where the trench cut permeable gravel lenses. The lack of uniform flow and the difficulty and expense of excavating the alluvium to the bedrock floor indicate that an attempt to measure the total underflow in the wash probably is not feasible.

During November 1958 a well was drilled for the National Park Service in the SW$\frac{1}{4}$NW$\frac{1}{4}$ sec. 24, T. 27 N., R. 1 E. (pl. 2) to a depth of 250 feet to test the thickness, character, and water-yielding properties of the deposits in an area where Pistrang and Kunkel (1958) had postulated the existence of a ground-water body. The lithologic log of the well and pumping test data follow.

Furnace Creek test well. National Park Service. Altitude about 490 ft. Cable-tool well, drilled and gravel packed by Roscoe Moss Drilling Co. in November 1958. 14-inch casing, perforated with hydraulic perforator from 100 to 240 ft. Log by U.S. Geological Survey.

	Thickness (feet)	Depth (feet)
Pleistocene:		
Alluvium:		
Clay, silt, sand, and gravel. The gravel is up to 1 inch in diameter. Materials are quartzite, marble, and other metamorphic rocks derived from Funeral Mountains	50	50
Same material, somewhat cemented (harder drilling)	20	70
Same material, finer (clay to gravel ¼ inch in diameter) much easier drilling	45	115
Same material, particles up to 3/4-inch diameter. Fairly easy drilling (5 ft per hr)	10	125
Same material, better sorted; majority of particles in 1/8-1/4-inch range. Drilling somewhat harder	30	155
Same material, particles up to 3/4-inch diameter	15	170
Same material, drilling somewhat harder	20	190
Fanglomerate:		
Clay, silt, sand, and gravel; trace of calcite "onyx" cementing material	20	210
Same material, gravel somewhat finer (1/8-1/4-inch range) larger proportion of rounded particles; calcite cement	5	215
Gravel as above; abundance of calcite "onyx" cementing material. Harder drilling	15	230
Pliocene and Pleistocene(?):		
Lacustrine deposits:		
Gravel, somewhat finer (1/8-1/4-inch range) larger proportion of rounded particles; less "onyx." Abundant clay (brown). Easier drilling	15	245
Abundant clay; gravel as above, mostly cavings	5	250

The well was developed by surging and pumping on November 20, 1958, and the water level was allowed to recover for a period of $8\frac{1}{2}$ hours before test pumping was begun on November 21. The well was pumped at a rate of about 390 gpm (gallons per minute) resulting in a drawdown of 102 feet after 72 hours of pumping. A summary at a lower rate of pumping, 140 gpm, the drawdown was only 15 feet of the drawdown and the subsequent recovery is given in the following table.

Date (1958)	Time (hour)	Discharge[1] (gpm)	Water level[2] (feet)	Drawdown (feet)	Specific capacity[3]
Nov. 20	7:50 a.m.	0	76.51	-	-
21	7:30 a.m.	0	76.61	-	-
24	8:00 a.m.	393	179	102	3.9
	8:25	351	174	97	3.6
	8:55	357	168	91	3.9
	9:10	320	144	67	4.8
	10:00	320	144	67	4.8
	10:05	250	123	46	5.4
	11:00	257	117	40	6.4
	11:15	205	103	26	7.9
	11:50	205	102	25	8.2
	12:10 p.m.	140	92	15	9.3
	12:25	140	92	15	9.3
	12:34:00	Pump off	-	-	-
	12:34:30		84		
	12:34:40		79		
	12:34:40		78.90		
	12:34:50		77		
	12:38:00		77.88		
	12:40:00		77.64		
	12:50:00		77.56		
	1:05:00		77.52		
	3:15		77.38		
25	9:35 a.m.		77.10		

1. Discharge was measured with a pipe orifice using calibrations made by Purdue University for Layne and Bowler, Inc.
2. Water-level measurements in tenths and hundredths of a foot were made by steel tape and are below top of casing. Measurements in whole feet were made by air line.
3. Specific capacity is the yield of the well in gallons per minute per foot of drawdown of water level below the static or nonpumping level.

A water-level recorder installed on Texas Spring (pl. 2) showed no change in the spring flow during the period of development and pumping of the test well. A very slight rise during the first few hours of pumping the well was due to an external disturbance at the recorder and was not caused by the test pumping. Measurements at other discharge points in the Furnace Creek area showed no change during the test. However, these results are not conclusive and cannot be considered proof that pumping the test well has no effect on the discharge of the Texas and Travertine Springs.

Under the nearly natural conditions now existing in the Furnace Creek Wash area the hydraulic system that supports the discharge at the Texas and Travertine Springs is in a state of dynamic balance or equilibrium. The long-term average natural discharge of the springs in the vicinity of Furnace Creek Wash is equal to the long-term average recharge. Also, the water table or piezometric surface at the springs which is in hydraulic continuity with the springs and the test well has shown very little fluctuation in the past, indicating virtually no long-term change of ground water in storage. Pumping from the Furnace Creek test well will be a new and additional discharge superimposed on the natural system. Pumping of water from the well will cause a draw-down of the water table in the vicinity of the well, thus upsetting the natural dynamic balance or equilibrium. Before a new equilibrium can be established, water levels must fall throughout the aquifer to an extent sufficient to reduce the natural discharge or increase the recharge by an amount equal to the amount pumped by the well. Until this new equilibrium is established, ground water will be withdrawn from storage.

The hydraulic system of the Furnace Creek Wash area is such that pumping the test well probably will induce virtually no additional recharge. Therefore, any pumping of the test well must ultimately result in a decreased discharge of the springs. However, it may take many months of pumping before this effect can be demonstrated, and perhaps years of pumping before the effect is substantial.

Periodic measurements of ground-water discharge made at selected sites in the Furnace Creek Wash area are shown in table 1. Except for the trench (27/1-26B3) which was deepened and lengthened as previously described, these measurements show virtually no change from those reported by Pistrang and Kunkel (1958). The discharge of the trench (27/1-26B3) shows an increase of about 0.11 cfs as a result of the excavation.

Table 1.--Periodic measurements of ground-water discharge in the Furnace Creek Wash area, 1957-59[1]

(Discharge in cubic feet per second. Measurements by Death Valley Hotel Company, Ltd., except as indicated.)

Date	Furnace Creek Inn tunnel (27/1-22H1)	Texas Spring tunnel (27/1-23B1)	Travertine Springs (combined flow of 27/1-23R1, 25D1, and 26A1-7)	Sump in Furnace Creek Wash (27/1-26B1)	Trench in Furnace Creek Wash (27/1-26B3)
1957					
Dec. 5	0.18	0.50	1.76	1.46	0.43
1958					
Jan. 8	-	-	1.76	-	-
9	.18	.50	-	1.46	.45
Feb. 4	.18	.50	1.74	1.42	.45
Mar. 6	.18	.50	1.68	1.44	.47
Apr. 8	.22	.50	a1.94	1.33	.42
29	-	-	1.82	-	-
30	.20	.50	-	1.33	-
May 14	-	-	b1.86	b1.28	-
27	.24	.50	1.82	1.33	.37
June 25	.14	.50	1.82	1.28	.37
July 25	.10	.50	1.78	1.28	.27
Aug. 26	.11	.50	-	-	-
27	-	.50	1.82	1.28	.36
Sept. 25	.12	.50	1.86	1.33	.37
Oct. 21	.10	.50	1.88	1.33	.37
Nov. 13	.10	.47	1.88	1.42	.37
13	b.10	b.47	b1.92	b1.42	b.35
24	-	b.47	b1.92	b1.46	b.35
Dec. 9	.11	.47	1.88	1.33	.37
1959					
Jan. 6	.10	.47	1.86	1.33	.37
28	.11	-	-	-	-
29	-	.50	1.88	1.37	.37
Mar. 4	.11	.50	1.86	-	.41
5	-	-	-	1.37	-
Apr. 6	.12	-	-	-	-

1. For measurements prior to December 5, 1957, see tables 1 to 5 of Pistrang and Kunkel (1958).

a. Spring cleaned out.

b. Measurement by Geological Survey.

CHEMICAL QUALITY OF WATER

A chemical analysis of water from the test well is given below. The chemical analysis is by the Geological Survey, Quality of Water Branch, Sacramento, Calif.

Constituents in parts per million	
Silica	-
Iron	-
Calcium	32
Magnesium	23
Sodium	140
Potassium	11
Bicarbonate	332
Carbonate	0
Sulfate	a157
Chloride	40
Fluoride	1.0
Nitrate	-
Boron	1.0
Sum[1]	a569
Hardness as $CaCO_3$	176
Percent sodium	62
Specific conductance (micromhos at 77°F)	955
pH	8.1
Temperature (°F)	97
Date collected	11-24-58

1. The sum of determined constituents is the arithmetic total in parts per million of all constituents determined, except for bicarbonate which is divided by 2.03 (Collins, W. D., Water-Supply Paper 596-H, p. 253). Where the sulfate is calculated by difference the sum includes that quantity and is approximate only.

a. Calculated by the author; approximate only.

The analysis in the preceding table shows that water from the test well is of the sodium bicarbonate sulfate type. It is relatively low in dissolved solids and is suitable for domestic use and for irrigation with some provisions for the control of soil salinity. The fluoride content of 1.0 ppm (parts per million) is within the acceptable limit for drinking water according to the U.S. Public Health Service standards (1946); therefore, the water is of better quality for human consumption than that from the Texas and Travertine Springs, which have water containing fluoride concentrations that range from 2.0 to 4.0 ppm (Pistrang and Kunkel, 1958, table 6).

REFERENCES CITED

Pistrang, M. A., and Kunkel, Fred, 1953, A brief geologic and hydrologic reconnaissance of the Furnace Creek Wash area, Death Valley National Monument, Calif.: U.S. Geol. Survey open-file rept., 63 p., 6 pls., 6 tables.

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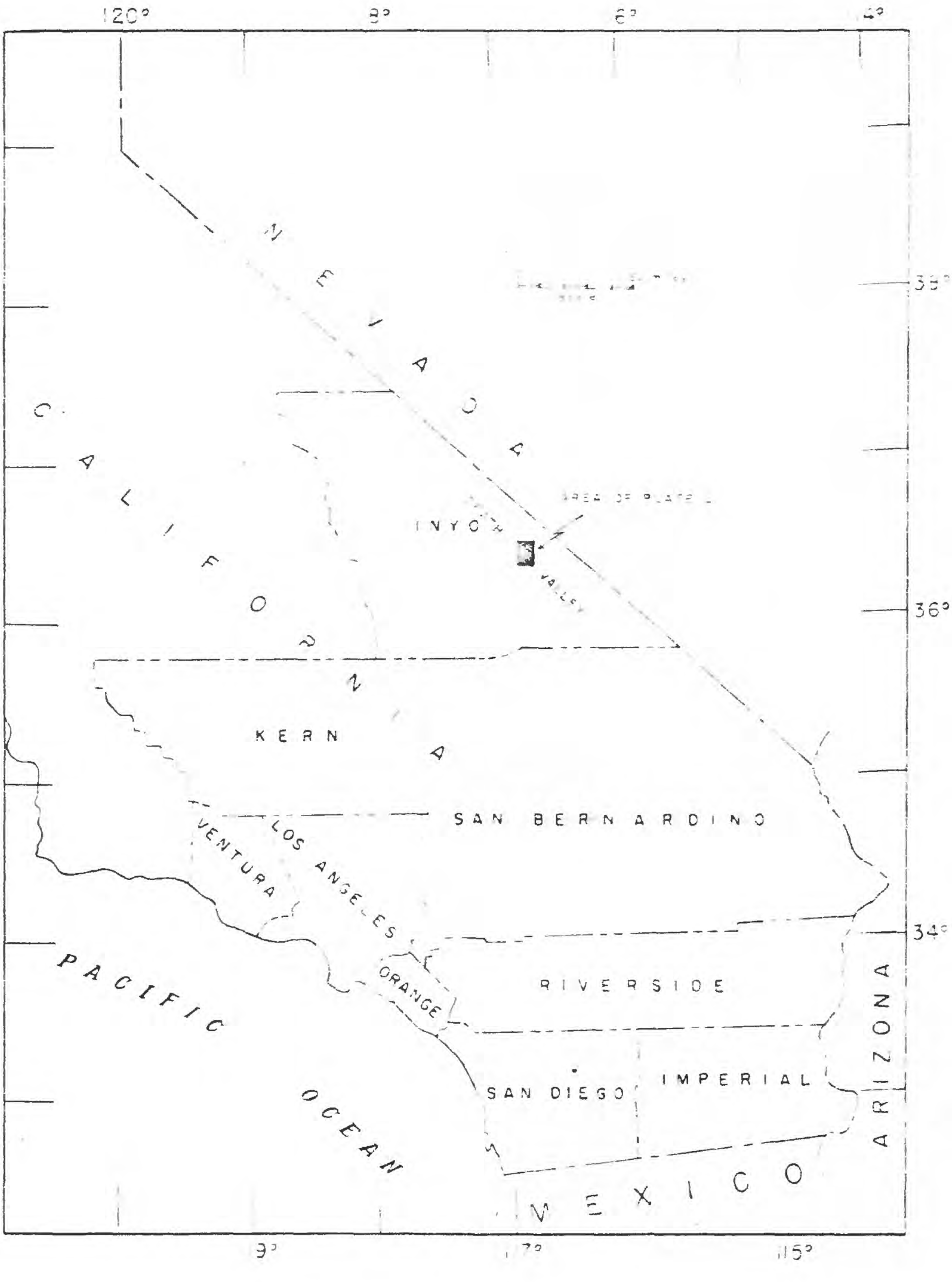

VICINITY MAP OF
SOUTHERN CALIFORNIA
SHOWING AREA OF THIS REPORT