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EFFECT OF THE ALASKAN EARTHQUAKE OF MARCH 27, 1964, ON GROUND-WATER LEVELS IN TENNESSEE

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INTRODUCTION

Earthquakes have long been known to affect ground water. Meinzer (1942) reported many temporary and permanent changes, as the rise or fall of the water level in wells, the roiling of the water in springs and wells, changes in temperature of water, changes in the amounts of gas and mineral constituents, causing of new springs, and changes in the flow of existing springs. In Tennessee, Fuller (1912), reporting on the New Madrid earthquake of 1811, stated that the quake added large amounts of sulphur to ground water, threw water from wells and springs, made spring and well water muddy, started flow in dried-up springs, and caused new springs. Taber (1916) reported that the large earthquake in the Southern Appalachians in 1916 increased the flow from springs, and in some instances the water became muddy.

PREVIOUS INVESTIGATIONS

As early as 1928, continuous water-level recorders installed on artesian wells recorded the effect of earthquake shock waves on the water level. Stearns (1928), Leggette and Taylor (1935), and La Rocque (1941) reported on the recordings of earthquakes that were identified from water-level recorders in California. Several articles have presented the possibility of using water-level recorders as secondary phreatic seismographs to supplement data collected by seismographs. Blanchard and Byerly (1935), using an extended time-scale recorder, succeeded in picking up most of the types of seismic waves, but they state that a more satisfactory instrument would be a buried well or tank equipped with a sensitive pressure-recording device. The major objection to the use of a water-level recorder as a seismograph is that the traces of the various shocks are superimposed as a result of the compressed time scale on the chart; this reflects a single vertical line on the graph and reduces the true character of the shock wave. In 1955 Vorhis reported on records taken from an especially sensitive well in Milwaukee, Wisconsin, which was fitted with an extended time-scale gear ratio that made possible the recording of several "hydroseismograms" showing primary, secondary, and surface waves of earthquakes.

THE ALASKAN EARTHQUAKE, MARCH 27, 1964

In Tennessee many interesting natural effects were observed as results of the Alaskan earthquake. At the Cumberland Plateau Seismological Observatory near McMinnville two instruments were rendered temporarily out of adjustment by the shocks from the seismic waves; foot-high swells appeared on Norris Lake on a windless night, causing the loosing of moorings on several boat docks; and many instances of muddied wells and springs were reported to the Tennessee Division of Water Resources.

The data taken from water-level recorders in the State provided the basis for the accompaning graphs. Recorder wells 20 and 21 (Figs. 1 and 2) are equipped with charts whose time scales are relatively large—2½ inches to 24 hours—and thus afford a more favorable basis for analysis than the charts from the other recorder wells.

The recorded fluctuations of ground-water levels in the accompanying wells during the Alaskan earthquake ranged from a trace in several wells to 3.90 feet in a well in the Capleville area (Table 1). The wells are completed in formations that range in age from Cambrian to Pliocene or Pleistocene, and are in lithologies ranging from dolomite to unconsolidated sand. The depths of the wells range from 91 to 1,558. Apparently, all the wells are under artesian pressure, and all obtain their water from confined aquifers, with the possible exception of well No. 12 which is in terrace deposits of Pliocene or Pleistocene age.

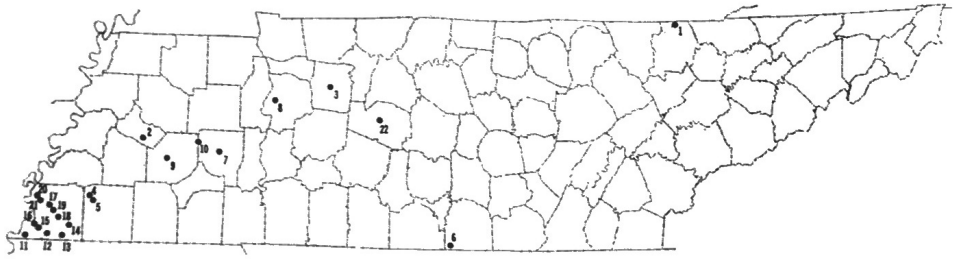

Fig. 1. Locations of recorder wells included in this report.

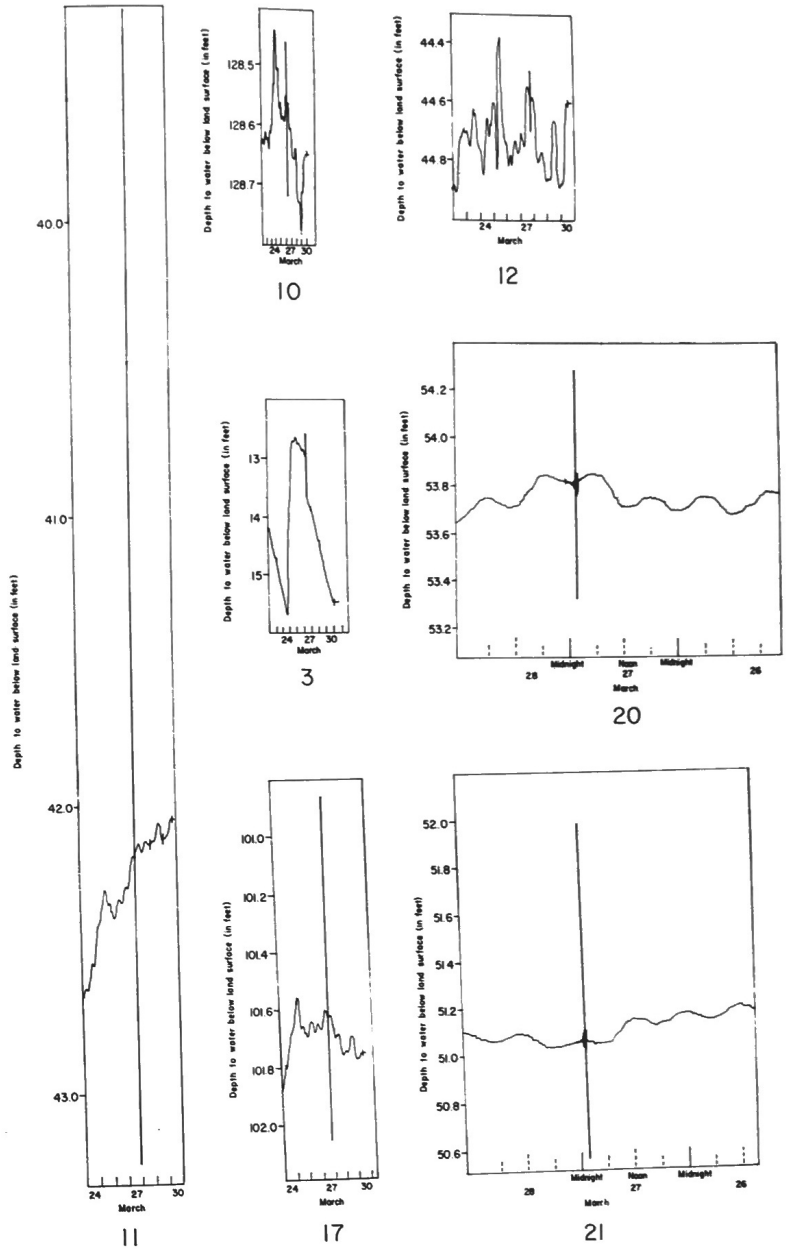

Fig. 2. Typical recorder charts reflecting the water-level fluctuations during the March 27, 1964, Alaskan Earthquake.

Table 1

Wells Included in This Report, Each Showing the Total Fluctuation (Amplitude) and Decline in Water Level during the Alaskan Earthquake, March 27, 1964.

Report No.	U. S. G. S. Field No.	Location	Water-bearing Group or Formation	Total Depth (in feet)	Total Fluctuation (in feet)	Decline (in feet)
1	Ch:O-6	Jellico	Rockcastle(?)	620	>2.0(?)	>1.0(?)
2	Ck:B-5	Bells	Claiborne	537	.61	.34
3	Di:F-19	Dickson	Fort Payne	387	1.00	.65
4	Fa:W-1	Braden	Wilcox	1,025	.18	.15
5	Fa:W-2	Braden	Claiborne	365	.06	.04
6	Fr:F-1	Huntland	Fort Payne	100	.21	.105
7	He:J-5	Lexington	Coffee	491	Not readable	
8	Ha:H-1	New Johnsonville	Fort Payne	187	>2.0(?)	>1.0(?)
9	Md:G-45	Jackson	Wilcox	133	Not readable	
10	Md:N-1	Claybrook	Ripley	659	.26	.14
11	Sh:J-1	Capleville	Claiborne	334	3.90	1.04
12	Sh:K-75	Memphis	Terrace deposit	91	.21	.09
13	Sh:L-1	Capleville	Claiborne	578	.005	0
14	Sh:L-15	Forrest Hill	Claiborne	220	.185	.04
15	Sh:O-170	Memphis	Wilcox	1,387	.10	.05
16	Sh:O-179	Memphis	Claiborne	472	.80	.38
17	Sh:P-1	Raleigh	Claiborne	344	1.21	.42
18	Sh:Q-1	Cordova	Claiborne	384	.147	.13
19	Sh:Q-24	Bartlett	Claiborne	336	.14	.04
20	Sh:U-1	Sloanville	Wilcox	1,558	.96	.49
21	Sh:U-2	Sloanville	Claiborne	440	1.35	.39
22	Wm:M-1	Franklin	Knox	1,160	.27	.27

On most of the charts the water-level fluctuation is shown as a vertical line. The two wells equipped with Stevens A35 recorders with the larger time scale show the three types of seismic waves (primary, secondary, and surface). The water levels in both wells fluctuated for approximately 3 hours after the major shock. The U. S. Coast and Geodetic Survey (1964) gives the origin of the initial shock of the Alaskan earthquate as 03:36:13 (Greenwich mean time), or 09:36:13 PM CST. The Cumberland Plateau Seismological Observatory gives travel time of the first primary waves as 8 minutes 43 seconds, or arrival in McMinnville at approximately 9:45 PM CST, and travel time of the major surface wave as 22 minutes 26 seconds, or arrival at approximately 9:58 PM CST. The curves on the A35 recorders show the first waves arriving at approximately 10:00 PM CST, and the major fluctuation of the water level occurring at approximately 10:20 PM CST.

The largest water-level fluctuation of all the wells occurred in Well No. 11; two of the major aftershocks on March 29th and 30th also were recorded at this location.

No appreciable lowering of the water levels is indicated in most of the wells after the major shocks subsided. The water level declined in numerous wells immediately after the earthquake, but it is presumed that normal water levels were resumed within days or several weeks.

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NOTICE TO MEMBERS OF TAS

Please notify the Secretary, Dr. James L. Wilson, Belmont College, Nashville, Tennessee, of change of address.