

REFRACTION SEISMIC STUDIES IN THE MIAMI RIVER, WHITEWATER  
RIVER, AND MILL CREEK VALLEYS, HAMILTON AND BUTLER  
COUNTIES, OHIO

BY

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Prepared in cooperation with  
the City of Cincinnati, the  
Miami Conservancy District,  
and the Ohio Department of  
Natural Resources, Division  
of Water

This report and accompanying  
maps have not been edited or  
reviewed for conformity to  
Geological Survey standards.

U. S. GEOLOGICAL SURVEY

Released to open files

April 17, 1963

Between September 17 and November 9, 1962, the U.S. Geological Survey, in cooperation with Ohio Division of Water, Miami Conservancy District, and city of Cincinnati, Ohio, conducted a refraction seismic study in Hamilton and Butler Counties, southwest Ohio. The area lies between Hamilton, Ohio, and the Ohio River and includes a preglacial valley now occupied by portions of the Miami River, Whitewater River, and Mill Creek. The valley is partially filled with glacial debris which yields large quantities of good-quality water. The object of the study was to determine the thickness of these glacial deposits and the shape of the preglacial valley.

A total of 127 lines were shot and recorded. Their locations are shown on the accompanying maps. From the refracted seismic waves on each line, the depth to the intermediate-velocity layer (generally the water table, although it was not everywhere possible to differentiate between perched and real water tables) and the depth to the high-velocity layer were computed. (The high-velocity layer always lies at or below the bedrock surface, and observed velocities indicate that the high-velocity layer in this area cannot lie more than 20 feet below the bedrock surface.)

In the remainder of this report, high-velocity layer and bedrock will be used synonymously. The depths to the intermediate- and high-velocity layers were determined at each end of each seismic line and the results given in table 1. In table 1, the intermediate-velocity

layer of line A, for example, was calculated to be 17 feet deep on the west end and 18 feet deep on the east end of the line. These facts are abbreviated in the second and third columns as "W17" and "E18." Similarly, W136 and E187 indicated that bedrock is 136 feet and 187 feet deep at the west and east ends of the line, respectively.

Flat, horizontal high-velocity surfaces yield the best records and consequently the most accurate results. The most difficult lines to interpret were those along which the high-velocity surface was irregular or doubly dipping (for example, lines C, D, and E), and they are therefore the least accurate depths. Significant changes in the dip of bedrock are noted in the "Remarks" column, as well as comments concerning miscellaneous information detectable from the records or observed during the field work. In some instances, refracted arrivals from both perched and main water tables were detected (see lines J, HH, and others). The perched water table constitutes a phenomenon known as a velocity reversal which, if undetected, introduces a serious error in the determination of bedrock depth. However, by utilizing water-well data, seismic arrivals, and geologic information (A.M. Spieker, written communication), the data were corrected for the effects of the perched water tables. Where depths to both perched and main water tables were calculated, that of the perched is given first.

Figure 1 shows the details of the shape of the preglacial valley on and around the city of Cincinnati's property in Butler County. Contour lines of equal depth beneath the present surface have been

added for a clearer presentation.

I wish to express my appreciation to the cooperating agencies for their help and interest in this project and to the other members of the seismic crew whose hard work and long hours substantially increased the total volume of work. These men were: A.M. Spieker, geologist, U.S. Geological Survey; Norman Bailey, driller, and Mark Wortman, Ohio Division of Water; Zvi Yuval, U.S. Geological Survey; and Al Helms, Cincinnati Water Works.

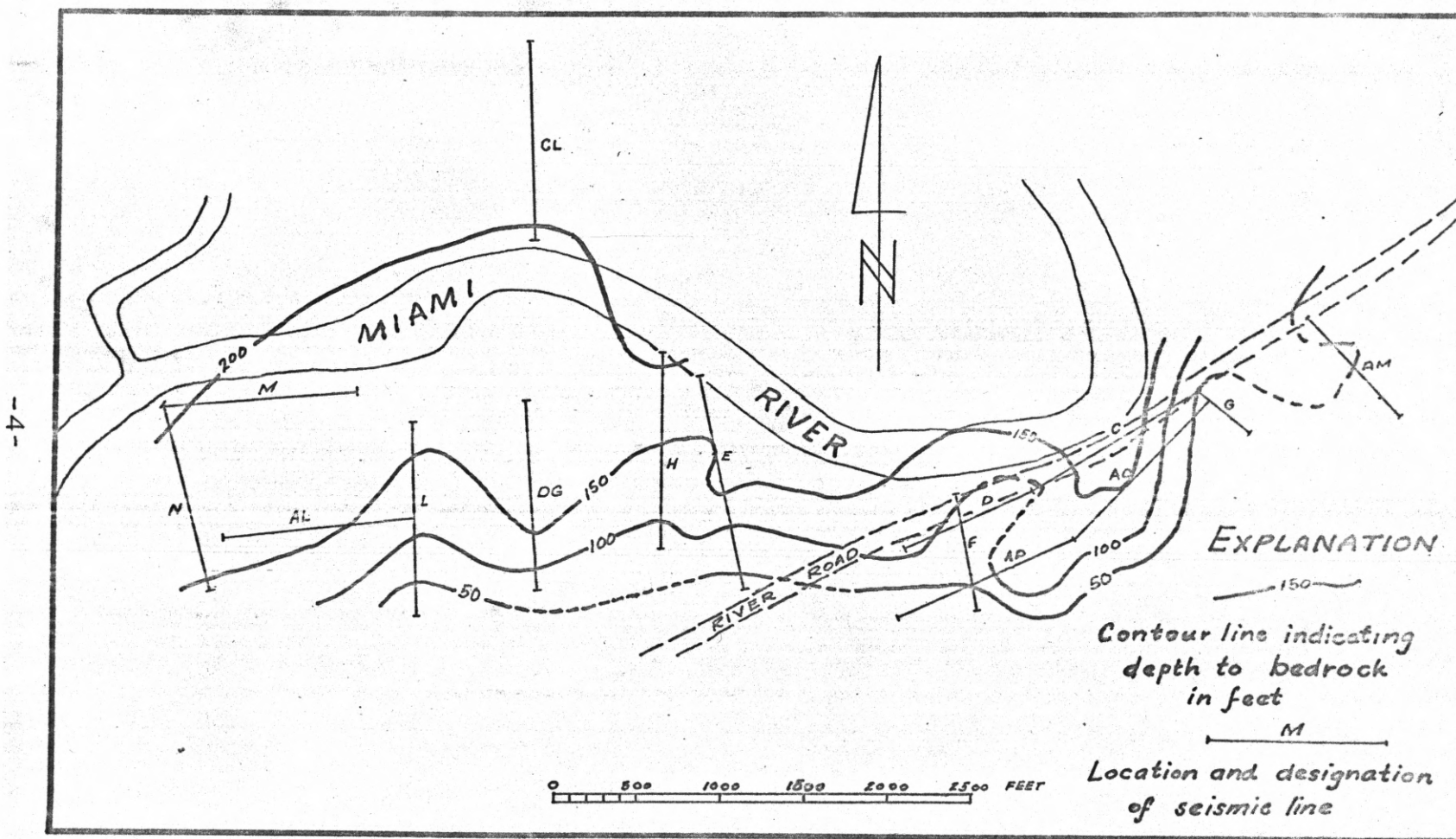


Figure 1. Contour map showing depth to bedrock in proposed city of Cincinnati well field, Butler County, Ohio. Base map after city of Cincinnati Water Works survey.



TABLE 1

Line designation	Depth to intermediate-velocity layer in feet		Depth to high-velocity layer in feet		Remarks
A	W17	E18	W136	E187	
B	W20	E20	W195	E195	
C	W26	E27	W62	E60	175-ft trough near center of line. See figure 1.
D	W25	E22	W132	E106	
E	N2	None	N172	S0	185-ft trough near center of line. See figure 1. South shot point in bedrock.
F	N26	None	N105	S10	Irregular bedrock surface. See figure 1. South shot point in bedrock.
G	N24	None	N55	S12	Drilled bedrock at 35 ft near center of this line. South shot point in bedrock.
H	N2	S13	N200+	S72	
I	N42	S33	N195	S179	
J	N6	S6	N102	S232	Till.
K	N14, 62	S17, 62	N260	S260	Perched and real water tables; till.
L	N11	None	N160	S15	Irregular bedrock surface. See figure 1. South shot point in bedrock.
M	W18	E14	W217	E174	
N	N31	S18	N202	S145	
O	N29	S31	N190	S110	Bedrock dips 13° N from S end for 300 ft. Bedrock in remainder of line is flat.
P	N32	S33	N242	S162	
Q	N35	S38	N192	S197	
R	N38	S33	N197	S197	
S	N34	S38	N192	S245	
T	N21	S21	N198	S241	
U	N22	S22	N207	S176	
V	N20	S15	N200	S197	
W	W17	E8	W245	E200	
X	W17	E16	W202	E178	
Y	W21	E16	W211	E204	
Z	W20	E19	W206	E173	

TABLE 1

Line Designation	Depth to intermediate-velocity layer in feet		Depth to high-velocity layer in feet		Remarks
AA	W20	E18	W200	E200	Bedrock dips 15°S for 400 ft from north shot point, then 4°S in remainder of line.
BB	N23	S22	N130	S182	
CC	N21	S24	N178	S196	
DD	N18	S23	N197	S206	
EE	N23	S21	N212	S208	
FF	None	S24	N17	S200	
GG	N23	S22	N187	S230	Lines HH to RR lie on till, and have perched water tables. The depths to actual water tables can be computed from lines HH, NN, and II only. Other actual water-table depths are inferred.
HH	N23,60	S16,60	N252	S230	
II	N17,56	S17,51	N237	S258	
JJ	N6,50	S10,50	N233	S270	
KK	N11,50	S10,50	N162	S230	
LL	N9,51	S12,50	N252	S284	
MM	W16,50	E10,50	W323	E289	
NN	N12,54	S17,54	N328	S343	
OO	N14,50	S10,50	N350	S269	
PP	N10	S20	N245	S220	
QQ	N10	S12	N242	S242	Bedrock dips 10°N from south shot point for 500 ft, then 6°N for remainder of line.
RR	N11	None	N180	S22	
SS	W10	E13	W90	E136	
TT	N20	S20	N157	S157	Bedrock on both ends dips inward toward a trough 150 ft below the surface located 250 ft from west shot point.
UU	N20	S28	N127	S140	
VV	NE19	SW24	NE108	SW93	
WW	W18	E12	W302	E300	
XX	N20	S30	N194	S203	
YY	N9	S12	N213	S213	
ZZ	W22	E9	W181	E105	
					Bedrock on both ends dips inward toward a trough 220 ft below the surface and located 260 ft from west shot point.



TABLE 1

Line designation	Depth to intermediate-velocity layer in feet		Depth to high-velocity layer in feet		Remarks
AB	N24	S28	N195	S195	Bedrock dips 7° S for 500 ft from north shot point, but is flat in remainder of line.
AC	N30	S14	N263	S235	
AD	N33	S27	N174	S230	
AE	N17	S17	N58	S135	
AF	N32	S22	N170	S212	
AG	N32	S32	N222	S190	Bedrock on both ends dips in toward a low 70 ft below the surface located 350 ft from the northwest shot point. Anomalous velocities yield no solution consistent with adjacent lines. Bedrock on both ends dips in toward a low 150 ft below the surface located 500 ft from west shot point. Bedrock on both ends dips in toward a low 130 ft below the surface located 400 ft from east shot point.
AH	W25	E22	W195	E190	
AI	N14	S17	N179	S242	
AJ	N18	S26	N192	S202	
AK	N22	S21	N190	S190	
AL	W14	E13	W195	E130	
AM	NW15	None	NW45	SE15	
AN					
AO	W23	E23	W101	E35	
AP	None	E13	W15	E110	
AQ	W12	E21	W200	E210	
AR	W14	E15	W213	E178	
AS	W18	E31	W190	E241	
AT	N13	S11	N264	S200	
AU	N14	S13	N224	S200	
AV	N11	S12	N225	S220	
AW	N35	S33	N192	S160	
AX	W49	E41	W280	E247	
AY	W46	E52	W220	E278	
AZ	N44	S41	N233	S203	

TABLE 1

Line designation	Depth to intermediate-velocity layer in feet		Depth to high-velocity layer in feet		Remarks
BC	W59	E60	W198	E198	Bedrock dips 13° NE from SW end for 550 ft, but is flat in remainder of line.
BD	W42	E59	W170	E188	
BE	NW18	SE18	NW149	SE150	
BF	NW18	SE17	NW143	SE117	
BG	W68	E73	W188	E190	
BH	N62	S62	N181	S252	
BI	W12	E15	W75	E58	
BJ	W17	E9	W178	E68	
BK	None	SW12	NEL50	SW19	
BL	None	None	N15	S15	Bedrock dips 20° N for 475 ft from south shot point, and dips 2° N in remainder of line.
BM	None	None	N10	S15	
BN	None	None	N12	S10	
BO	N15	None	N208	S17	
BP	N12	S15	N282	S217	
BQ	N10	S13	N270	S270	
BR	N11	S22	N253	S270	
BS	N20	S25	N182	S236	
BT	N60	S60	N285	S231	
BU	W62	E62	W243	E243	Perched water table. Perched and real water tables. Perched and real water tables.
BV	W18	E13	W228	E177	
BW	W16, 49	E15, 35	W258	E250	
BX	N13, 70	S15, 74	N201	S265	
BY	N13	S12	N262	S262	
BZ	N19	S7	N225	S225	

TABLE 1

Line designation	Depth to intermediate-velocity layer in feet		Depth to high-velocity layer in feet		Remarks
CD	N5	S29	N210	S210	No high-velocity arrivals recorded. Depth is a minimum depth, assuming that high velocity was recorded on geophone farthest from shot point.
CE	N12	S13	N283+	S283+	
CF	N15	S15	N140	S277	Bedrock dips 7°W for 400 ft from east shot point, then dips 4°W in remainder of line.
CG	N20	S22	N260	S211	
CH	N17	S10	N258	S206	
CI	N15	S15	N111	S111	
CJ	N12	S12	N164	S104	
CK	N12	S12	N132	S77	
CL	N20	S21	N250	S190	
CM	W11	E24	W165	E205	
CN	W29	E33	W160	E183	
CO	W36	E37	W170	E170	
CP	W33	E32	W190	E190	
CQ	W27	E37	W162	E171	
CR	N33	S32	N178	S155	
CS	W27	E22	W141	E136	
CT	W26	E24	W132	E126	
CU	W21	E17	W130	E130	
CV	N22	S22	N133	S133	
CW	N28	S24	N165	S130	
CX	W30	E27	W128	E128	
CY	W22	E27	W110	E131	
CZ	W21	E21	N110	S110	
DE	W23	None	W163	E25	
DF	N24	S20	N134	S104	Bedrock dips 12-1/2°N from south shot point for 460 ft, but is flat in remainder of the line.
DG	N22	S18	N175	S65	