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LETTER TO THE EDITOR

TEMPERATURE GRADIENTS IN THE SUBSURFACE OF THE DEAD SEA AREA, ISRAEL

E. ROSENTHAL AND Y. ECKSTEIN
Hydrogeological Division, Geological Survey of Israel

In three papers (Mazor, 1968a, b; Mazor, Rosenthal and Eckstein, 1968), the problem of temperature gradients in the subsurface of the Dead Sea area (south-western part), was mentioned. For unknown reasons, different versions were published in these papers. Being co-authors of one of the above-mentioned papers, we wish to elucidate the subject and re-evaluate the facts in their right sense.

To the present date, no specific measurements adequately planned and prepared for the purpose of investigation of subsurface heat gradients have been carried out in this country. There are two exceptions: the relatively shallow water-wells of Nahal Zeelim 1 (486 m deep) and Hamme Zohar 2 (148 m). In all other cases the available data on subsurface temperatures are the result of sporadic measurements not made under standardized conditions. In most cases the measurements are actually BHT values (Bottom Hole Temperatures) registered during logging operations in uncased boreholes, several hours after cessation of drilling operations.

The collected data and the temperature gradients calculated for various intervals (defined by logging operations) are given in Table I and are depicted in Fig. 1. Considering evidence from wells Admon 1, Sedom 1 and Sedom 2, a ground-level temperature of 33°C was chosen. An exception was made for the Nahal Zeelim 1 well where a ground level temperature of 37.5°C was measured. This value was used while computing the temperature gradients in the upper depth-intervals. These gradient-values are marked on Table I by (*).

Following the analysis of data presented in Table I and in Fig. 1, we reached the following conclusion:

1. In the subsurface of the investigated area (i.e. in the south-western part of the Dead Sea area), two distinct temperature gradients were discerned. The first temperature gradient, of approx. 160 m/1°C, characterizes the upper parts of the subsurface and was followed down to a depth of 800 m below surface. The second gradient, of 54 m/1°C on average, is valid for the deeper sections and was traced to a depth of 3600 m. This last value seems to be the true temperature gradient prevailing in

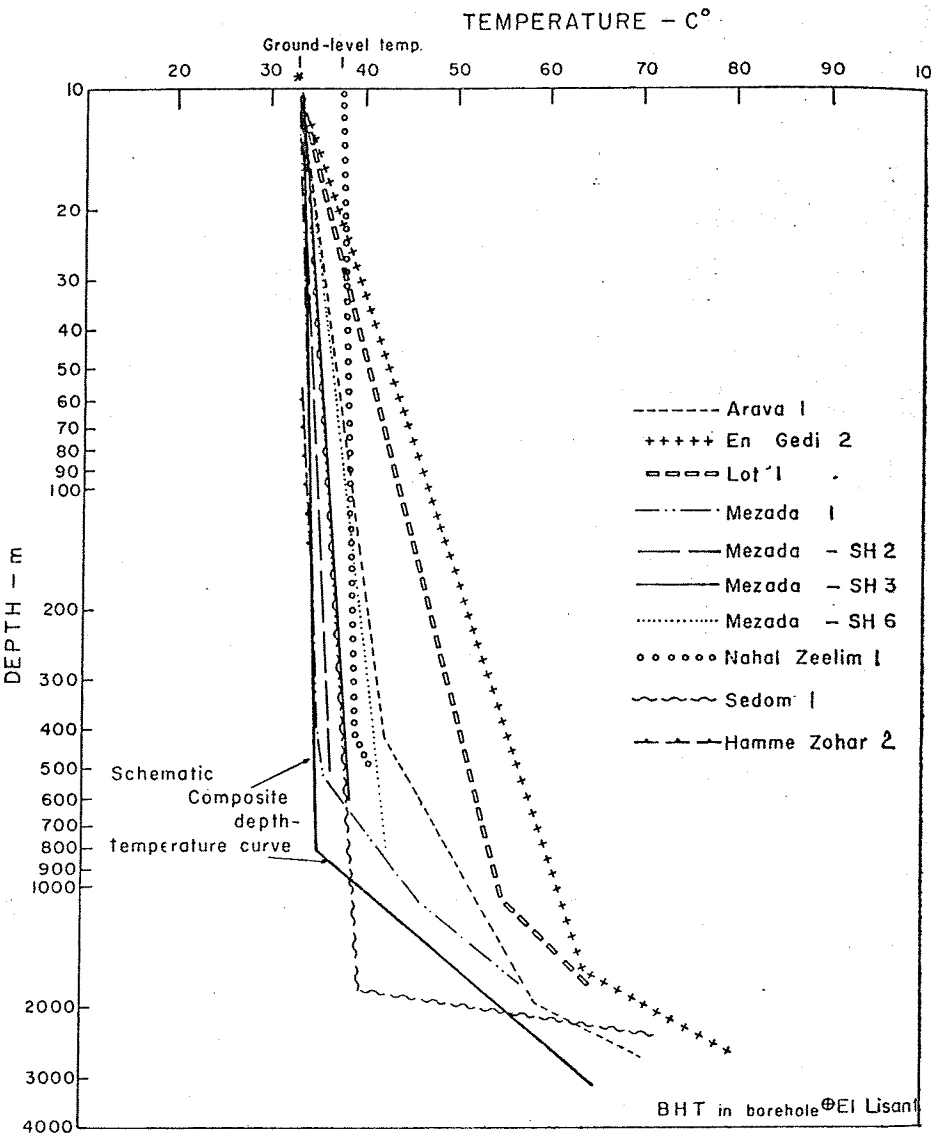
TABLE I

DATA ON TEMPERATURE MEASUREMENTS IN BOREHOLES LOCATED IN THE SOUTH-WESTERN PART OF THE DEAD SEA BASIN

Name of borehole	*Depth of temperature measurement*	*Temperature °C*	*Conditions of casing*	*Purpose of measurements*	*Investigated depth interval (in m)*	*Lithological composition of interval*	*Calculated temperature gradient (in m/1°C)*
ADMON 1	2	33.0	none	—	—	Limst. and Dolom.	
EL LISAN 1	3580	90.5	0—152.6	Elect. Logging	—	Clays, Marls, Gravel, Rock Salt	62.5*
SEDOM 2	near surface	32.0	none	—	—	—	—
ARAVA 1	417	42.2	none	Elect. Logging	27— 417	Gravel, Sand, Shales	45.3*
	1903	58.8	0— 184	Elect. Logging	417—1903	Gravel, Sand, Shales	99.0
	2653	70.0	0— 184	Elect. Logging	1903—2653	Gravel, Sand, Shales	70.0
EN GEDI 2	1670	64.4	0— 389	Elect. Logging	400—1670	Gravel, Sand, Shales	53.2*
	2371	76.6	0— 389	Elect. Logging	1670—2371	Limst. and Dolom.	57.5
	2550	80.0	0— 389	Elect. Logging	2350—2550	Shales, Sandstones	52.0
HAMME ZOHAR 2	60	33.3	0— 5	Therm. Invest.	5— 60	Boulders, Shales	88.0
	148	34.3	0— 55	Therm. Invest.	60— 148	Boulders, Shales	120.0
LOT 1	1048	55.0	none	Elect. Logging	28—1048	Lims. Dol; Shales; Sandstone	47.6*
	1769	64.4	0—1048	Elect. Logging	1048—1769	Lims. Dol; Shales; Sandstone	76.0
MEZADA 1	353	35.0	0— 11	Elect. Logging	20— 353	Limst. Dolom. Marl Shales	176.5*
	527	36.0	0— 11	Elect. Logging	353— 527	Sandstone	174.0

HAMME ZOHAR 2	60	33.3	0— 5	Therm. Invest.	5— 60	Boulders, Shales	88.0
	148	34.3	0— 55	Therm. Invest.	60— 148	Boulders, Shales	120.0
LOT 1	1048	55.0	none	Elect. Logging	28—1048	Lims. Dol; Shales; Sandstone	47.6*
	1769	64.4	0—1048	Elect. Logging	1048—1769	Lims. Dol; Shales; Sandstone	76.0
MEZADA 1	353	35.0	0— 11	Elect. Logging	20— 353	Limst. Dolom. Marl Shales	176.5*
	527	36.0	0— 11	Elect. Logging	353— 527	Sandstone	174.0
	1101	46.0	0— 675	Elect. Logging	676—1101	Shales, Limst.	57.3
	1356	52.0	0— 675	Elect. Logging	?—1356	Limst., Shales	42.5
	1516	54.4	0— 675	Elect. Logging	1070—1516	Limst., Shales	50.0
	1708	56.6(?)	0— 675	Elect. Logging	1478—1708	Limst., Shales	87.0(?)
MEZADA — SH.2	506	36.6	none	Elect. Logging	0— 506	Shales, Gravel, Rock Salt	140.0*
— SH.3	593	38.8	none	Elect. Logging	0— 593	Shales, Gravel, Rock Salt	102.0*
— SH.6	800.5	42.2	none	Elect. Logging	28— 800.5	Shales, Gravel, Rock Salt	87 *
NAHAL ZEELIM 1	403	39.0	0— 346	Therm. Invest.	0— 403	Limst. Dolom. Sst. Shales	268
	486	40.5	0— 346	Therm. Invest.	403— 486	Limst. Dolom. Sst. Shales	55
SEDOM 1	Close to surface(?) after equilb. period	33	—	—	—	—	—
	1810	40	0— 70	Elect. Logging	70—1810	Shales, Gravel	256
	2308	70	0—1900	Elect. Logging	1750—2308	Rock — Salt	19

Borehole ARAVA 1 : The Israel National Oil Co. Ltd.
Boreholes EN GEDI 2; LOT 1 : Naphtha, Israel Petroleum Corp. Ltd.
Boreholes MEZADA 1; MEZADA SH. 2;3;6; SEDOM 1,2 : Lapidoth, Israel Oil Prospecting Corp. Ltd.
Well HAMME ZOHAR 2: Dead Sea Develop. Co. Ltd.
Well NAHAL ZEELIM 1 : Mekoroth Water Co. Ltd.
Well ADMON 1 : Dead Sea Co. Ltd.



the area, whereas the previous figure of 160 m/1°C is probably due to a cooling effect caused by descending meteoric waters. Similar phenomena were described by White and Brannock (1950), and by Bullard (1960). On the other hand Van Orstrand (1939) has shown that the average temperature gradient in the sedimentary area of the U.S.A. is approx. 60.4 m/1°C. A similar figure (150 feet/1°C) was indicated by White (1957). There is good correlation between these values and that of the "deep" gradient in the investigated area in Israel.

2. In several cases it has been possible to discern a certain correlation between lithological changes (actually changes in porosity) and heat-gradient. Van Orstrand (1934) stated that porosity decreasing with depth causes a parallel increase of the temperature gradient. A similar situation was observed in borehole Arava 1 drilled to a depth of 2738 m into unconsolidated graben fill. Of special interest is the high temperature gradient recorded in borehole Sedom 1. The authors attribute this phenomenon either to the high heat-conductivity in rock-salt and the possible deep roots of the salt structure, or to the possible existence of a volcanic mass beneath this dome. A combined mechanism is also not excluded. Quaternary volcanic activity is well known along the Israeli part of the Rift Valley. Lately, additional data on young hydrothermal activity in adjoining areas was reported by Shraga (1967) and Issar et al. (1968).

3. We confirm our initial conclusion (Mazor et al., 1968) that the temperatures of groundwaters in the area derive from deep circulation and are controlled by the previously mentioned gradients.

Taking into consideration that to the present date temperature gradients elsewhere in the Israeli part of the Rift Valley have not been investigated and calculated, it should be emphasized that the conclusions presented in this note are strictly limited to the south-western part of the Dead Sea region. The generalization that "no abnormal heat gradients and no magmatic contributions seem to occur in the Israeli Rift Valley. . ." (Mazor, 1968a) has no proof and is misleading.

Note added before printing

Since this letter was sent to the Editor, another borehole has been drilled in the area – King Sedom 1 (Arava Co. Ltd.). A B.H. temperature of 86.5°C has been measured at a depth of 3222 m (drilled through clastic sediments). The calculated temperature gradient is 60.1 m/1°C. This figure fits well with all other values presented above.

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