GEOTHERMAL UPDATE REPORT FROM ISRAEL

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Abstract

Geothermal investigations have been carried out using logs from 340 deep drillholes which cover most of Israel. A number of thermal springs located along the Rift Valley, with temperatures in the range of 26° to 62° C are presently used for spas and recreation, and a few geothermal wells with temperatures of 26°-60° C are used far agriculture, greenhouses and fish farming.

Introduction

Several geothermal studies were made in Israel during the 1970's and 80's (Levine and Olshina, 1978, 1982, Mazor et al., 1980, Eckstein, 1976, Levitte et al., 1978, Rotstein et al.,1977). The studies revealed several surface anomalies having temperatures between 26" - 62° C. Investigations of heat flow and temperature gradients utilizing deep wells show an average gradient ranging between 2° - 2.7° C per 100 m.

Due to the relatively low temperarure of the geothermal water, it is used mainly for health, recreation, and agriculture (greenhouses and fish farming).

Isotherm and gradient map of Israel (Levitte and Olshina 1985)

The logs of 340 deep drillholes covering all but the south of Israel, were examined, and temperature data, circulation times and log types were noted. Temperature measurments are carried out routinely as part of different types of well logging procedures. These data (bottom hole temperature, BHT). as well as average ground temperatures taken at at a depth of l m (Meteorological service, 1975) were used as the basis for producing isotherm contour maps (Fig. 1). Linear interpolations were made between succeeding temperature measurments in individual wells. Contour maps were prepared at 250 m depth intervals from 250 m (MSL) down to 3000 m. In addition, the country was divided into a number of zones and temperature gradients were calculated for each zone (Fig. 2). The country-wide zonation was based on the major geological features. Few areas showed temperatures consistently higher than their surroundings. The first and most prominent was the Kinneret (Sea of Galilee) region.

Thermal waters far health and recreation

Two types of sources supply thermal waters for health and recreation: (a). water emanating from springs and (b) water pumped from wells

(a). All thermal springs in Israel are located in the Jordan - Dead Sea Rift, which is a segment of the Syrian - African Fault system. Geothermal phenomena including hot springs are abundent along the East African Rift section. Temperature observed in springs along the Jordan - Dead Sea Rift range hetween *26°C* and 62°C (Fig. 3, Table 1)

Table 1. Temperatures of springs along the Jordan - Dead Sea Rift.

Spring	Temperature (°C)
Tiberias	62
Russian Garden	27.5
Einot Sheva (west)	29
Einot Sheva (east)	27.5
Hammat Gader	50
Hammat Gader	42
Hammat Gader	28
Gofra	32
Zukim	27
Hammey Yesha	41.5
Hammey Zohar	30

(b). Many deep drillholes in Israel encountered thermal waters (Fig. 2). One of these (Negba 1, 1857 m depth), with a water temperature of 42° C is utilized as a Spa (Hammey Yoav, Fig. 3). This well penetrates the dolomite - limestone aquifer of the Yarkon - Taninim basin located along the western part of Israel between the foothills and the Mediterranean Sea (Fig. 3). The southern and western domains of this basin contain a large storage of brackish

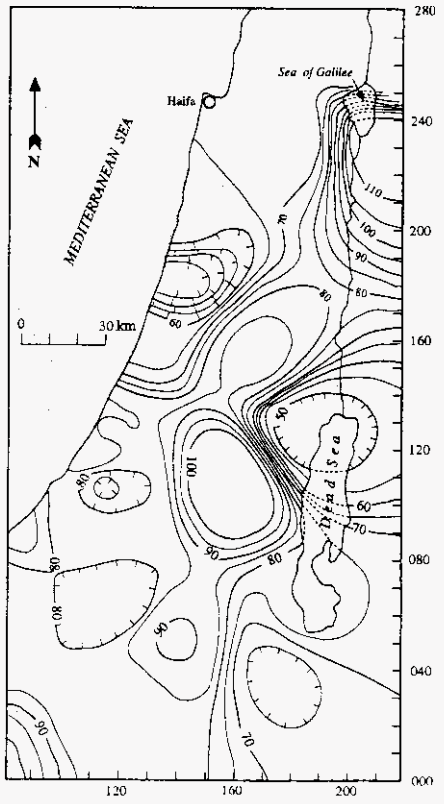

Fig. 1 Isotherm contour map -3000m. below MSL of Israel

water with temperatures ranging between 38° C and 42° C.

Agricultural utilization of geothermal water

Agricultural uses ofgeothermal water in Israel are divided into two branches: (a) greenhouses., and (b) fish farming

(a). Greenhouses

The geothermal water here is used for both, space and ground heating. A study carried by Pasternak et al . (Ben Gurion University) have demonstrated a technique for using brackish water (1000-1400 ppm. Cl at a temperature of 35° - 42° C) to grow vegetables. The hot water is supplied by Mash'abbe Sade wells located in the northern Negev. These wells tap the Yarkon - Taninim aquifer at a depth of850 - 650 m and yeald 150 - 220 cu.m./h.

Another source of geothermal water in the southern part of Israel is the huge Nubian Sandstone aquifer. The Paran deep well (which is the deepest water well in Israel - 1536 m) located 80 km. south of the Dead Sea, draws water from this aquifer at 60° C with a yield of 140 cu.m/h and 600 mg/l Cl. This water is used for heating greenhouses and fighting frost in fields.

(b). Fish farming.

Geothermal water for fish farming is used in two regions; one in northern Israel adjacent to the Jordan Valley at Hammat Gader Springs, and the other along the Mediteranean coast about 70 km north of Tel - Aviv. Four geothermal springs of diferent tempratures emerge at Hammat Gader. The spring having the lowest water temperature (27° C) is used for raising warm water fish and shrimp.

Along the Mediteranean coastal region, there are numerous fish ponds which utilize warm brackish water (26°C) supplied by shallow wells of about 30 m depth. The wells penetrate the sandstone Pleistocenie aquifer and draw water from the interface zone between sea and fresh water.

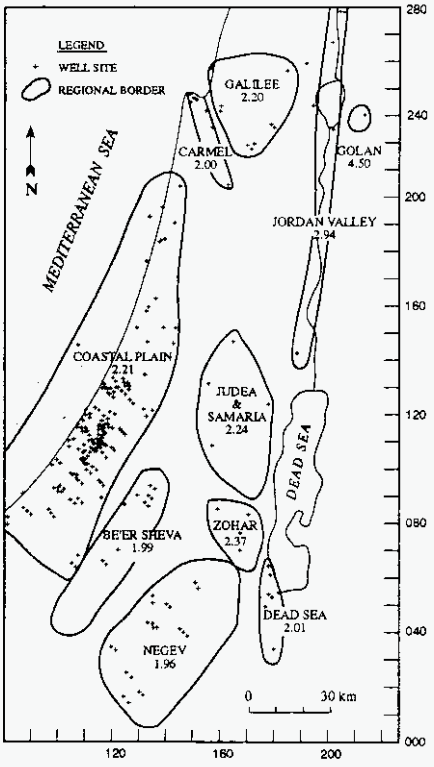

Fig. 2 Location map of borcholes and average regional geothermal gradients (°C / 100m)

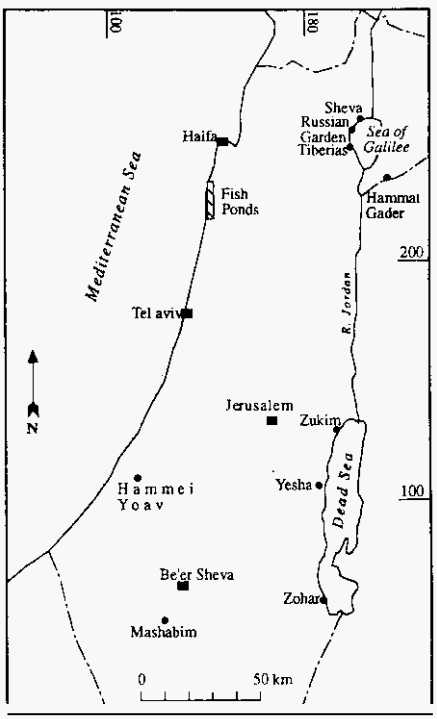

Fig. 3 Location map of Israel

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TABLE 3. UTILIZATION OF GEOTHERMAL ENERGY FOR DIRECT HEAT IN DECEMBER 1994

[1] 1 = Industrial process heat
C = Air conditioning
A = Agricultural drying
F = Fish and other animal farming
S = Snow melting
D = Space heating
B = Bathing and swimming
G = Greenhouses
O = Other (please specify by footnote)

[2] Enthalpy information is given only if there is steam or two-phase flow

[3] Energy use (TJ/yr) = Annual average water flow rate (kg/s) x [Inlet temp.(°C) - Outlet temp.(°C)] x 0.1319

Locality	Type[1]	Maximum Utilization					Annual Utilization		
		Flow Rate	Temperature (°C)		Enthalpy[2] (kJ/kg)		Average Flow Rate	Energy Use[3]	Load Factor
		kg/s	Inlet	Outlet	Inlet	Outlet	kg/s	TJ/yr	
Hammat Gader 1	F	300	27	22			300	198	
Mediterranean Coast	F	400	26	20			400	316	
Tiberias	B	20	42	30			20	32	
Hammat-Gader 1	B	200	42	32			200	260	
Hammat-Gader 2	B	140	42	32			140	185	
Hammey Zohar	B	7	30	26			7	4	
Hammey Yesha	B	10	41	30			10	14	
Hammey Yoav	B	50	42	32			25	33	
Mashabbe Sade	G	50	42	24			25	59	
Paran	G	40	60	24			20	95	
Total		1217					1147	1196	

TABLE 4. SUMMARY TABLE OF GEOTHERMAL DIRECT HEAT USES

[1] Inst. thermal power (MW_t) = Max. water flow rate (kg/s) x [Inlet temp.(°C) - Outlet temp.(°C)] x 0.004184

[2] Energy use (TJ/yr) = Annual average water flow rate (kg/s) x [Inlet temp.(°C) - Outlet temp.(°C)] x 0.1319

	Installed Thermal Power[1] MW_t	Energy Use[2] TJ/yr
Space heating		
Bathing and swimming		528
Agricultural drying		
Greenhouses		154
Fish and other animal farming		514
Industrial process heat		
Snow melting		
Air conditioning		
Other uses (specify)		
Subtotal		
Heat Pumps		
Total		1196

TABLE 6. INFORMATION ABOUT GEOTHERMAL LOCALITIES

[1] Main type of reservoir rock

[2] Total dissolved solids (TDS) in water before flashing. Put v for vapor dominated

[3] N = Identified geothermal locality, but no assessment information available
R = Regional assessment
P = Pre-feasability studies
F = Feasability studies (Reservoir evaluation and Engineering studies)
U = Commercial utilization

Locality	Location To Nearest 0.5 Degree		Reservoir		Status[3] in January 1995	Reservoir Temp. (°C)	
	Latitude N	Longitude E	Rock[1]	Dissolved Solids[2] mg/kg		Estimated	Measured
Hammat Gader	32^{30}	35^{30}	Limestone Dolomite	650-1400	U		50
Mediterranean Coast	32^{30}	35^{00}	Sandstone	1000-20,000	U		26
Tiberias	33^{00}	35^{30}	Limestone & Sandstone	10,000	U		62
Hammey Zohar	31^{30}	35^{30}	Limestone & Sandstone	80,000 - - 180,000	U		30
Hammey Yesha	31^{30}	35^{30}	Limestone & Sandstone	110,000	U		41
Hammey Yoav	31^{30}	34^{30}	Dolomite & Limestone	25,000	U		42
Mashabbe Sade	31^{00}	34^{30}	Dolomite & Limestone	- 3,000	U		42
Paran	30^{30}	35^{00}	Sandstone	1,500	U		60
Total							353