HEAT FLOW AND THERMAL GRADIENTS IN PORTUGAL

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ABSTRACT

In this paper we present the available heat flow data in Portugal. The number and location of the boreholes don't allow contouring of heat flow; so, we show the heat flow values and thermal gradients, making some considerations about the anomalous values.

INTRODUCTION

The determinations of heat flow in Portugal have been done by the Instituto Nacional de Meteorologia e Geofísica (INMG), the Centro de Geofísica da Universidade de Lisboa (CGUL) and the Universidade de Évora.

Now, a total of 24 values is available; we can see the location of the boreholes on Fig 1.; 16 of these values correspond to sedimentary basins and the other values were obtained in the Ossa-Morena Zone and South Portuguese Zone.

HEAT FLOW PARAMETERS AND VALUES

In the sedimentary basins the heat flow values were computed on the basis of data collected in drilling holes for oil prospecting (Bottom hole temperatures -BHT- and lithological logs). Bottom hole temperature data affected by the drilling process were corrected by applying the method of Horner (Jones *et al*, 1984) whenever, at any depth, several values of BHT were measured at different times. The thermal conductivity of the different formations described in the lithological logs was estimated using adequated tables of rock conductivity.

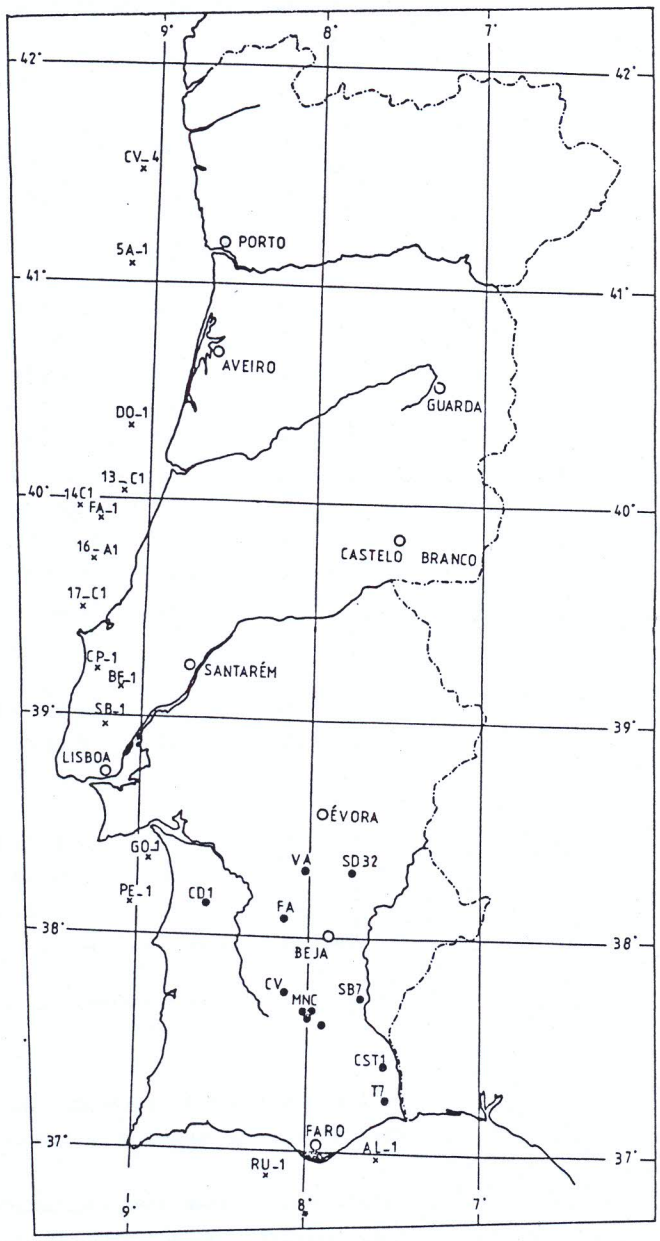

Fig. 1. Location of heat flow boreholes.

The heat flow values were computed by general least squares inversion which theory was presented by Vasseur and Lucazeau (1985).

The geographical coordinates of the boreholes and the results are shown in **Table 1**.

NAME	COORDINATES		GRAD	HEAT FLOW
	LAT	LONG	(°C/Km)	(mW/m^2)
LUSITANIAN BASIN OFFSHORE:				
CAVALA - 4	41 30 51.4	09 05 18.6	26	77
5 A-1	41 08 02.1	09 07 45.0	22	71
DOURADA IC	40 19 43.8	09 06 23.3	28	83
13 C-1	40 01 34.9	09 08 01.0	32	106
14 C1A	39 58 07.5	09 24 03.0	26	90
FANECA-1	39 54 09.9	09 15 52.0	30	78
16 A-1	39 43 12.6	09 18 09.3	27	79
17 C-1	39 29 01.8	09 22 00.2	24	83
GOLFINHO-1	38 20 35.2	08 57 12.4	34	90
PESCADA-1	38 08 07.1	09 02 08.6	21	65
ALGARVE BASIN OFFSHORE:				
RUIVO-1	36 53 10.6	08 11 28.6	21	63
ALGARVE-1	36 59 04.5	07 33 59.5	28	73
LUSITANIAN BASIN ONSHORE:				
SOBRAL-1	38 57 28.3	09 11 39.0	31	91
BENFEITO-1	39 07 57.0	09 07 11.0	30	79
CAMPELOS-1	39 12 21.9	09 14 56.8	28	77

Table 1. Heat flow values and thermal gradients related to oil wells.

The other values of heat flow were gathered in boreholes drilled for mineral prospection: here the temperature measurements were made every ten meters.

Core thermal conductivity determinations were made in laboratory. The computations of heat flow were made assuming that heat transfer only

takes place by conduction, in the vertical direction and in a steady-state regime

$$Q = K \left(d T / d Z \right)$$

Q is the heat flux, K is the thermal conductivity and $d T / d Z$ is the thermal gradient. The results concerning these boreholes and their respective location are presented on **Table 2**.

NAME	COORDINATES		GRAD	HEAT FLOW
	LAT	LONG	(°C/Km)	(mW/m^2)
PORTEL. S-32	38 16 42	07 44 54	33	127
VIANA, V. A.	38 18 18	07 57 54	43	162
FERREIRA, F. A.	38 03 00	08 06 18	78	187
CASTRO VERDE	37 42 18	08 07 30	30	91
CD 1	38 08 48	08 32 54	22	71
SB 7	37 40 42	07 41 00	22	67
MN CORVO	37 35 00	07 56 00	28	95
CST 1	37 22 22	07 32 00	22	74
T7	37 13 35	07 32 45	19	61

Table 2. Heat flow and thermal gradient related to mineral boreholes.

ANALYSIS OF THE RESULTS

We can divide the offshore values in three groups. One is related to the Minho continental shelf (holes CV-4 and 5A-1) with an average of 74 mW/m^2. The second group is related to the Beira Litoral continental shelf; here the average is 87 mW/m^2. The anomalous values for holes 13C-1 and 14-C1A are probably related to the very thick salt sequences.

The heat flow values concerning the Baixo Alentejo and Algarve continental shelf gave an average value of 65 mW/m^2. The heat flow value and thermal gradient obtained in offshore well PE-1 seem to agree with those of the onshore hole CD1.

The RU-1 well values present the lowest temperature ones.

In the Golfinho-1 (GO-1) well, the temperature gradient (34 °C/Km)

is very high; probably related to a doleritic dyke. In this area a large contrast of thermal conductivities and an inclination of sedimentary layers may explain the high temperature values found at relatively shallow depths.

In the onshore Alentejo, the heat flow values may be separated in two classes: one for the South Portuguese Zone and another for the Ossa-Morena Zone.

In the South Portuguese Zone, the heat flow values in the Pyrite Belt show an average value of 90 mW/m^2, decreasing as we move away from this belt (67-74 mW/m^2). The relatively high heat flow value for the hole CST-1 may be explained by the anomalous high thermal conductivity values (3.5 W/K m).

In the Ossa-Morena Zone the heat flow values are higher than those concerning the South Portuguese Zone.

The heat flow value for the hole FA, located in the contact zone between the Ossa Morena and the South Portuguese zones, is the highest with a thermal gradient of 78 °C/Km.

The heat flow values for Hercynian zones in Europe - 40-50 mW/m^2 for the Bohemian Massif (Onuoha, 1981), 72.5 mW/m^2 for the Hercynian fold belt in Central Europe (Hurtig and Oelsner, 1977), 120 mW/m^2 at sites associated with granite and 60 mW/m^2 at sites remote from granite in SW England (Wheildon *et al*, 1980) - are in general below the heat flow values obtained at Alentejo.

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