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A PRELIMINARY HEAT FLOW MAP OF WEST TEXAS

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INTRODUCTION

Western Trans-Pecos Texas lies at the boundary of the Basin and Range and Great Plains, and should therefore reflect the heat flow characteristics of both tectonic provinces. Although few in number, previous heat flow measurements in the region are largely consistent with this assertion. Herrin and Clark (1956) determined the heat flow in the Permian Basin oilfields to be 1.1 H.F.U. (1 H.F.U.=10^{-6} cal/cm²/s=41.8 mw/m²), typical of the stable mid-continent area. Three values published by Decker and Smithson (1975) indicated the possible location of the Basin and Range boundary in the westernmost counties of Trans-Pecos, and suggested a near "normal" heat flow in the south of the area, despite the presence of an extensive Tertiary igneous field. Two further measurements (Swanberg and Herrin, 1976; Smith and Jones, 1978) in the Big Bend area again indicate a heat flow only a little above that of the Great Plains, perhaps indicating a transition zone.

Heat flow data in southern New Mexico are more abundant, and a thermal anomaly associated with the Rio Grande rift is now well established (Reiter and others, 1975; Decker and Smithson, 1975; Swanberg and Morgan, 1978), distinguishable above the "normal" heat flow for the Basin and Range (about 2 H.F.U.). Much current speculation concerns the continuation (or otherwise) of the rift into northern Mexico and West Texas.

NEW HEAT FLOW MEASUREMENTS

Six new heat flow measurements are presented for westernmost Trans-Pecos Texas. The results are given in Table 1, and, along with previous values, are used to produce the heat flow map in Figure 1. Table 2 summarizes the geological setting of the boreholes.

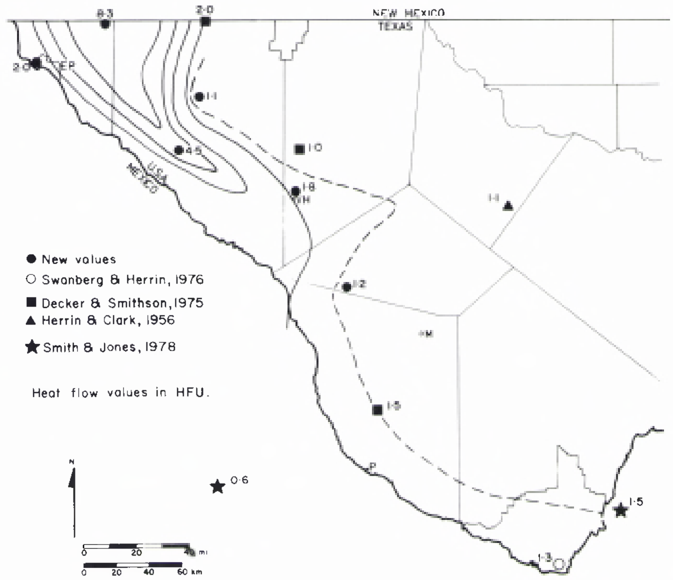

Figure 1. Heat flow map of Trans-Pecos Texas. Dashed contour is 1.5 H.F.U.; solid contours at 2, 3, 4 and 5 H.F.U. EP-El Paso, VH-Van Horn, M-Marfa, P-Presidio.

Heat flows were calculated by multiplying the geothermal gradient, obtained by a least-squares method over straight-line sections of the temperature-depth curve, by the mean thermal conductivity for that section. Temperatures were measured in the field using a thermistor probe and resistance bridge as described by Roy and others (1968), readings being made usually at 10 m intervals down the hole. Conductivities were determined in the laboratory

Table 1. Summary of heat flow results from western Trans-Pecos Texas.
(*=above water table; ±=standard error; (1)=number of samples.)

Hole no.	Longitude Latitude	Elevation (m)	Depth interval (m)	Gradient (°C/km)	Mean Conductivity (mcal/cm s°C)	Heat flow (μcal/cm²s) Uncor.	Terrain Cor.	Acknowledgments
UTEP-1	106°30′33″ 31°46′36″	1210	80-115*	32.6	5.98 (7)	1.95 ±0.01	1.96 ±0.01	
HT-13	106°06′05″ 31°59′30″	1264	170-270*	134.6	6.19 (5)	8.40 ±0.14	8.30 ±0.14	J. Navar, Hot Wells Ranch.
PSH-1	105°23′30″ 31°42′30″	1280	30- 60*	15.3	6.98 (11)	1.07 ±0.01	–	
FM-1	105°37′08″ 31°21′23″	1415	30-130*	79.5	5.90 (3)	4.69 ±0.07	4.53 ±0.07	S. Wilkey, B. French.
VHC-1	104°47′30″ 31°04′20″	1206	50-110	17.9	10.44 (6)	1.87 ±0.04	–	City of Van Horn, R. Guffey.
			120-180	16.0	11.02 (7)	1.76 ±0.05	–	
V-3	104°26′32″ 30°32′15″	1382	110-340	26.8	4.46 (12)	1.20 ±0.01 30-60°	–	C. Kovanda.

Table 2. Geological setting of heat flow holes, western Trans-Pecos Texas.

Hole no.	Location	Geological description	Use of hole
UTEP-1	UTEP campus, El Paso	Tertiary andesite porphyry	Heat flow measurement
HT-13	Hueco Tanks area, El Paso Co.	Bolson fill; Pennsylvanian cherty limestone	Geothermal exploration (heat flow)
PSH-1	Pump Station Hills, Hudspeth Co.	Precambrian rhyolite	Heat flow measurement
FM-1	Finlay Mountains, Hudspeth Co.	Tertiary diorite	Mineral exploration
VHC-1	Van Horn Airport, Culberson Co.	Quaternary bolson fill	Water supply well
V-3	Southwest Farms, Valentine, Jeff Davis Co.	Bolson fill; Tertiary volcanics (basic)	Irrigation well

on a divided-bar apparatus (Roy and others, 1968), on samples of core or cuttings obtained from the boreholes, the latter using the technique of Sass and others (1971). Topographic corrections were applied to the geothermal gradients where necessary; that is, where severe terrain variability in the vicinity of the borehole would have made the gradient in error.

DISCUSSION

A marked trend of high heat flow appears at the eastern margin of the Hueco Bolson in El Paso and Hudspeth Counties, where the stable (1.0-1.1 H.F.U. heat flow) Diablo Plateau adjoins the Rio Grande Valley. This "high" is consistent with that shown in the heat flow contour maps of Reiter and others (1975) and Swanberg and Morgan (1978) in the Tularosa (Hueco) Basin of southern New Mexico. The value of 8.3 H.F.U. was obtained during the investigation of a potential geothermal area to the east of El Paso, where it appears that thermal waters are rising along a fault zone at the edge of the Hueco Bolson. To the west of this, the figure for El Paso suggests a return to a more normal Basin and Range heat flow (2.0 H.F.U.).

Thermal waters are encountered to the south at several places either as hot springs or in wells (Dorfman and Kehle, 1974), all within a few kilometers of the Rio Grande. Temperature gradient measurements made in the five westernmost counties (Taylor and others, 1979) indicated elevated gradients in the river zone, and this is substantiated by the heat flow contours of Figure 1.

Tectonic trends in West Texas are reflected by the heat flow map. The change in direction of the Rio Grande at about 30°35′N (near Indian Hot Springs) follows the Cenozoic faulting (Muehlberger and others, 1978) of the region, and the heat flow contours make an inflection in this same area, in the vicinity of Van Horn. An inflection is also tentatively proposed here by Swanberg (1979), based on heat flow data estimated from silica geothermometry.

Reilinger and others (1980) have noted evidence for as much as 19 cm of tectonic uplift in the Diablo Plateau and have proposed intracrustal magmatism or preseismic deformation to account for this. Also noted is subsidence in the Salt Basin, at the eastern edge of the uplifted area. If this results from recent or ongoing regional extension, as suggested by Quaternary fault scarps (Muehlberger and others, 1978) and is thus a possible zone of incipient rifting (see Veldhuis and Keller, this guidebook), it has, as yet, no thermal signature, as the heat flow is only 1.0-1.1 H.F.U. However, as the observed crustal movement occurred in less than 50 years, it would take many times longer than this for any associated thermal wave to reach the surface. Cook and others (1979) have shown that the present heat flow in the southern Rio Grande rift can be explained by a thermal history of at least 30 m.y. in the crust and upper mantle.

The high heat flow of the Rio Grande rift in southern New Mexico and part of West Texas (Decker and Smithson, 1975) has been modelled by invoking crustal thinning due to an unwarp of abnormally hot mantle material (at between 30 and 45 km depth), with shallow crustal intrusions causing local anomalies. Work by Pedersen and Hermance (1976) using geo-electromagnetic soundings has defined a region of low electrical resistivity beneath El Paso, starting at about 30 km depth, and this is consistent with the interpretations of Decker and Smithson (1975). A seismic refraction profile in southern New Mexico (Cook and others, 1979) also suggests the existence of anomalous material at this depth. The configuration of the anomalous crustal zone may need modification in the light of the new heat flow data and apparent tectonic activity in the Diablo Plateau–Salt Basin graben region.

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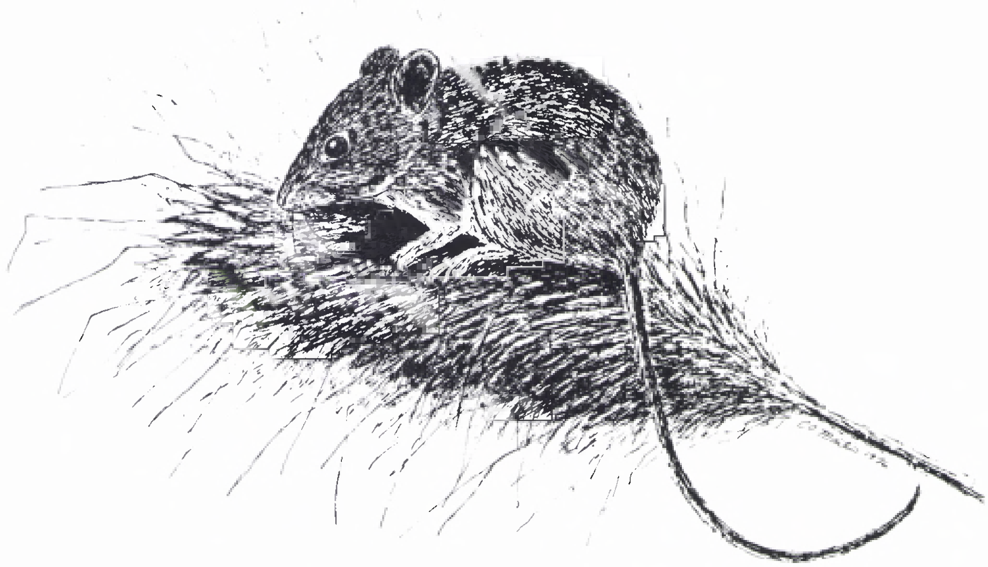

Fulvous harvest mouse, *Reithrodontomys fulvescens*.

Downy brome plant and spikelet, *Bromus tectorum*.