REVISED HEAT FLOW MAP OF COLORADO

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ABSTRACT

This present map of Colorado is a revision of the heat flow map published by Pearl and others in 1976. The heat flow values were gathered from previously published reports. The parameters necessary to compute the heat flow values are described.

Regionally, Colorado is separated into three heat flow provinces. They are: the Great Plains, the Southern Rocky Mountains, and the Colorado Plateau provinces. The Great Plains province, except for the Raton Basin and Canon City Embayment, indicates normal heat flow. The Southern Rocky Mountain province which encompasses both the Rio Grande Rift and an anomalous zone located near Ouray are the most promising areas for high heat flow. The Colorado Plateau province is considered normal to slightly above normal compared with the regional heat flow of the United States.

INTRODUCTION

This heat flow map of Colorado represents an update of the map published in 1978 by Pearl and others. This map is based on published data by Galloway (1980); Decker and Bucher (1979); Edwards and others (1978); Reiter and others (1975); and Sass and others, USGS OFR 74-9 (1974). The measurements performed by the aforementioned authors have shown heat flow in much of Colorado is above the national average of 60 mW/m^2.

Regionally, Colorado may be segmented into three terrestrial heat provinces, (Reiter, 1975): the Great Plains, the Southern Rocky Mountains, and the Colorado Plateau (Fig. 1). Grose, (1974) has shown that crustal thickness is much greater beneath the Colorado Plateau and Great Plains, and is much shallower beneath the Southern Rocky Mountains, especially the Rio Grande Rift zone. Grose (1974) also mentions that the measured heat flow values are lowest in the Colorado Plateau and highest in the Ouray and Rio Grande Rift area. Therefore, it appears that a correlation between heat flow and crustal thickness exists. There are, however, high heat flow areas at the western edge of the Great

Plains province, such as the Raton Basin and Canon City Embayment areas. The discussion below will cover methods of determining heat flow and the evaluation of the heat flow provinces within the state.

METHOD OF DETERMINING HEAT FLOW

Sass and others (1971) determined the temperature gradient for the United States from temperature measurements performed at discrete depths in boreholes. Their measuring system consisted of a multiconductor cable, hoist, thermometer and a resistance measuring device. The majority of the thermal conductivity measurements were made with a modified Birch-type divided bar.

It should be noted that the heat flow values on the Colorado map are not entirely based on conductive processes. Heat flow values were derived through three processes (Combs, 1980), conduction, where heat transfer occurs gradually through a solid medium such as the rock formations. Convection, which takes place in a fluid medium and always transports the heat upward, and the third type, radiogenic heat, due to decay of radioactive minerals.

REGIONAL EVALUATION OF COLORADO HEAT FLOW

As noted above, for determination of heat-flow values, Colorado may be subdivided into three distinct provinces. A brief evaluation of the three heat flow provinces is presented.

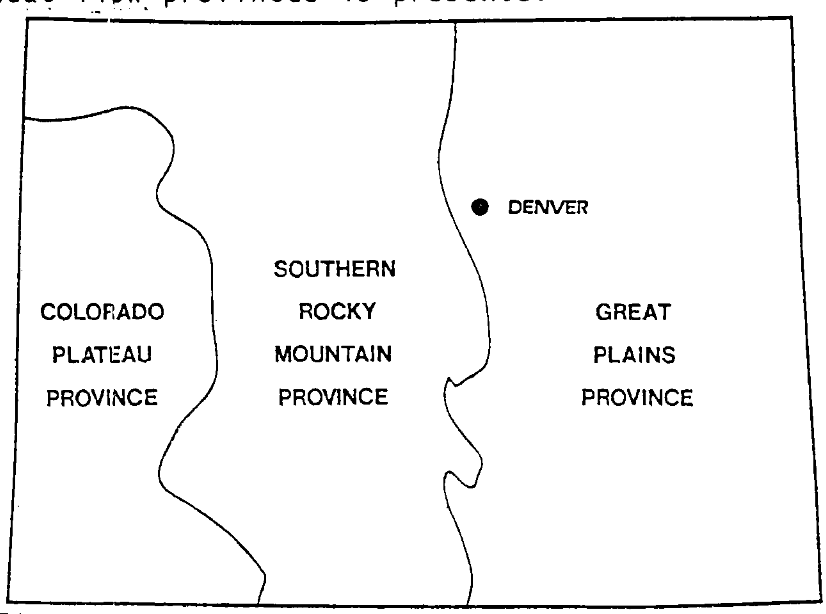

Figure 1. Heat Flow Provinces

Great Plains Province

The Great Plains province encompasses that area of the State east of the Front Range. Heat flow data is sparse for this province (Fig. 1). Within this province, there are two localized anomalies, the Raton Basin area and the Pueblo-Canon City embayment. The heat flow for these areas are the Raton Basin area, reflecting approximately 200 mW/m^2 and the Pueblo-Canon City embayment area, indicating between 100 to 120 mW/m^2. Radiogenic heat, a direct result of radioactive decay in the upper crust, contributes a constant amount of heat flow in the Pueblo-Canon City embayment of approximately 16 mW/m^2 (Decker, 1975). Generally, the heat flow in the rest of the Great Plains province ranges from 60 to 100 mW/m^2.

Southern Rocky Mountain Province

The Southern Rocky Mountain province encompasses that area west of the Front Range, extending to the western portion of the San Juan Volcanics and north to the Wyoming border. The Southern Rocky Mountain province (Fig. 1) is a region of high heat flow with values greater than 100 mW/m^2. The Rio Grande rift, which is an integral part of the Southern Rockies province (Grose, 1974), is of abnormally high heat flow. Structurally, the Rio Grande rift zone represents an area of crustal thinning and is characterized by deep faulted basins with deep circulating thermal water and higher than normal heat flow values.

Another anomalous heat flow zone exists between Ouray and Gunnison with values ranging from 100 to 200 mW/m^2. This anomalous zone shows the most promise for heat potential in the Southern Rocky Mountains, but it is also one of the most remote and least populated areas of Colorado.

The volcanic rocks that exist along the middle and western part of the Southern Rockies province are 22 to 30 m.y. old and are not believed to be a major contributing factor of the heat.

Colorado Plateau Province

The Colorado Plateau Province encompasses that portion of the State from Durango in the south to the Piceance basin in the north and west to the Utah border (Fig. 1). Heat flow in the Colorado Plateau province generally ranges from 60 to 100 mW/m^2 , which is considered normal to slightly above the United States average. However, the data for this area is sparse and somewhat varied, especially in the southwest area near Durango, and the northwest part of the State. This area shows the least promise for heat flow potential in Colorado.

SUMMARY

The State of Colorado reflects above average heat flow (USGS, CIR 790, 1978). The heat flow map of Colorado indicates a relatively wide spectrum of values (60 to 240 mW/m^2). The most promising areas, both for thermal potential and areal extent, are the San Luis Valley, which is part of the Rio Grande rift zone, and the Ouray-Gunnison trend in the southwest central part of the state. Additional heat flow data is recommended to further delineate these potential heat sources.

ACKNOWLEDGEMENTS

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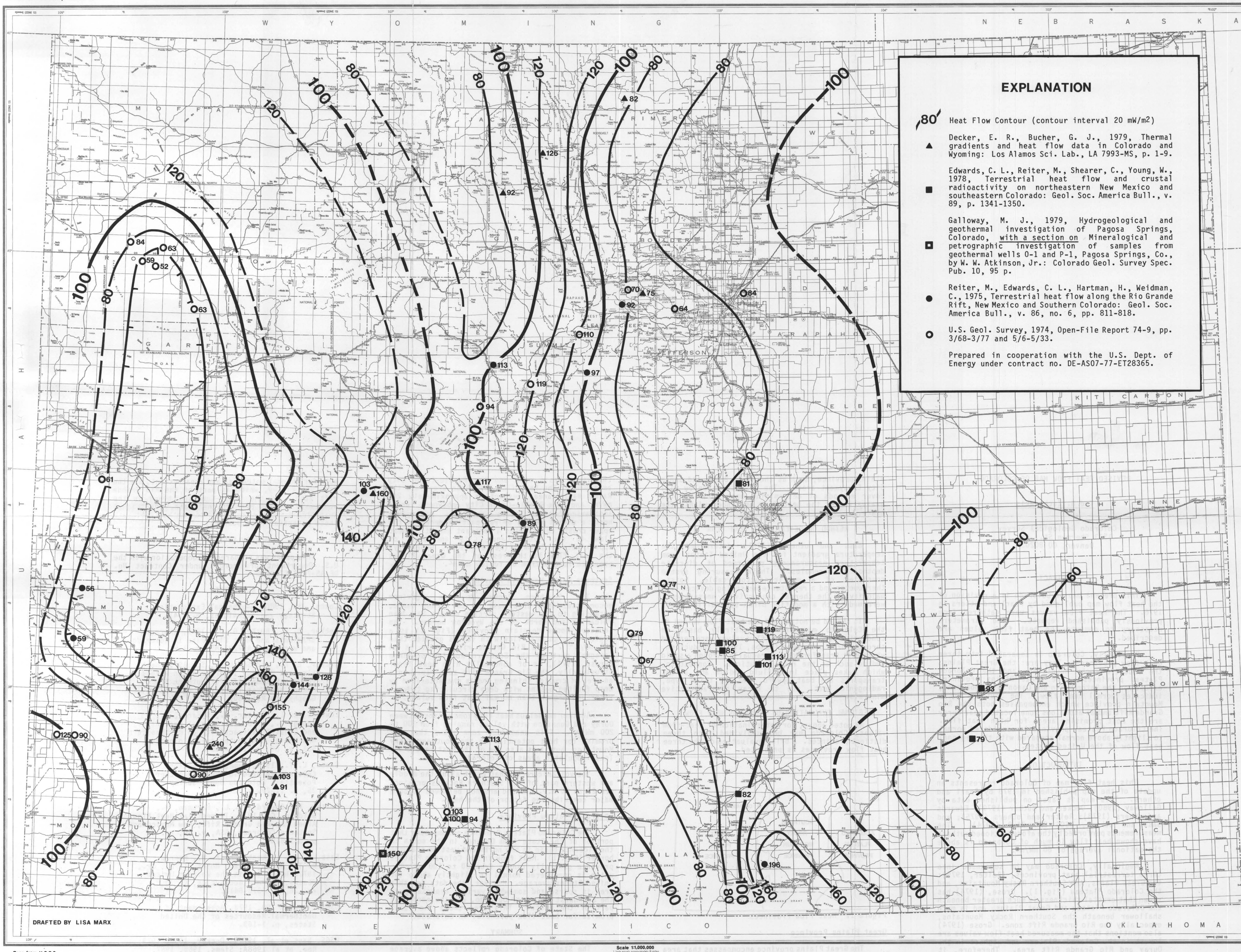

Base from U.S.G.S.

Scale 1:1,000,000

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by

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