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Next Page--Introduction, Materials and Methods

Heat Flow in the Cretaceous of Northwestern Kansas and Implications for Regional Hydrology

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Abstract

Temperature logs are interpreted to investigate the thermal structure of the units overlying the Kansas portion of the Cretaceous Dakota aquifer. The aim of this study is to determine if additional heat input by fluids exists and thus clarify whether the overall conductive heat flow from the basement through the sequence might be overprinted by heat advection. Although interval thermal gradients are determined for different lithologic (stratigraphic) units, the shale thermal gradients are preferred for heat-flow estimation. Shale thermal conductivity as measured in Mesozoic shales in Nebraska and South Dakota is extrapolated to the area because of the similar lithology. A few thermal-conductivity values are determined in sandstone samples of the Dakota Formation and also used in heat-flow estimation. In general, the noncalcareous, marine Cretaceous shales (Pierre, Carlile, Graneros, and Kiowa) show different thermal gradients. Gradients in the Pierre (average value 58.5° C/km) and Carlile (55.5°C/km) are slightly higher than the average gradient in the Graneros Shale (45.1°C/km) and Kiowa Formation (46.5°C/km). The higher thermal gradients are limited to the extreme northwestern corner of the study area where the Pierre and Carlile are present. The heat-flow density of 69-74 mW/m^2 observed there is slightly higher than the average of 60 mW/m^2 typical for central and eastern Kansas. The higher heat flow observed is in the range of data reported and mapped for northeastern Colorado and the Nebraska Panhandle on the western flank of the Chadron Arch, an area with geothermal overprint by warm fluids. Regional differences in heat flow in western Kansas seemingly are caused by the different composition, porosity, and permeability of the aquifer and the nearness to recharge areas.

Next Page--Introduction

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