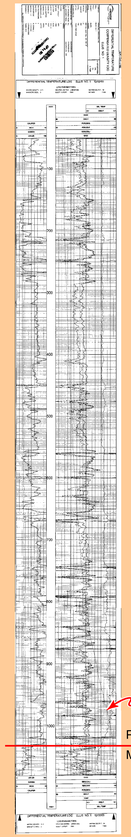
DIFFERENTIAL TEMPERATURE LOGS -- a new data set in eastern Kansas

CBM wells in Kansas are typically air-drilled and take about 1 day to reach TD. The wells usually fill with water, with most of the water entering the well bore from the Mississippian. Thermal effects of drilling are likely minimal, and certainly less than mud-drilled wells.

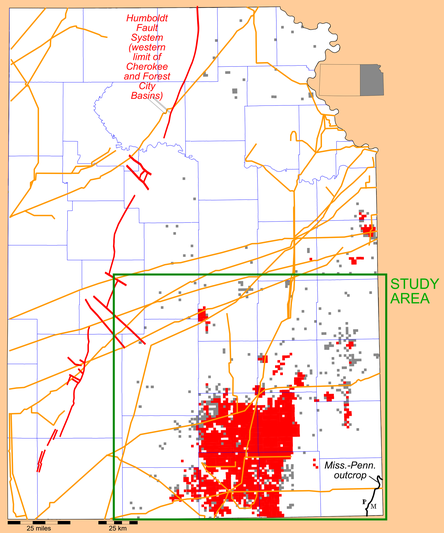
Approximately 2200 of the 7000 CBM wells in Kansas were logged using a differential temperature log, which records a detailed record of temperature and temperature changes from the bottom of the hole to the surface. This log was commonly ran as a no-cost add-on to the logging programs.

A typical temperature log is shown in this panel. Temperature commonly increases downhole, and shows a maximum in the Mississippian limestones near TD. This maximum temperature and associated depth was used in calculation of geothermal gradients for Mississippian rocks.



Differential temperature log from eastern Kansas

Obtaining cuttings at the blewie line at an air-drilled CBM well in eastern Kansas

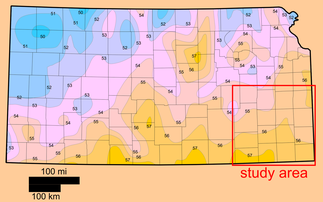


Red Sections have recorded CBM production
Gray Sections were drilled for CBM, but have no recorded production
Orange Lines are gas pipelines

Kansas CBM development (from Newell and Yoakum, 2010)

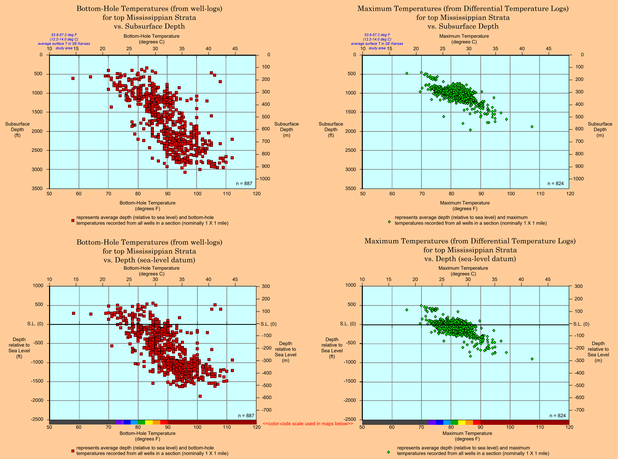
COMPARISON OF DIFFERENTIAL TEMPERATURE LOGS WITH BOTTOM-HOLE TEMPERATURE (BHT) DATA

Temperature data for top Mississippian strata are compared below. If more than one well was in a given section (nominally 1 square mile), temperature data was averaged for that section. Geothermal gradients were also calculated using average surface temperatures (see temperature map in this panel). The diagrams below show the BHTs (red squares) and maximum temperatures (green diamonds) crossplotted against their subsurface and subsea depth.

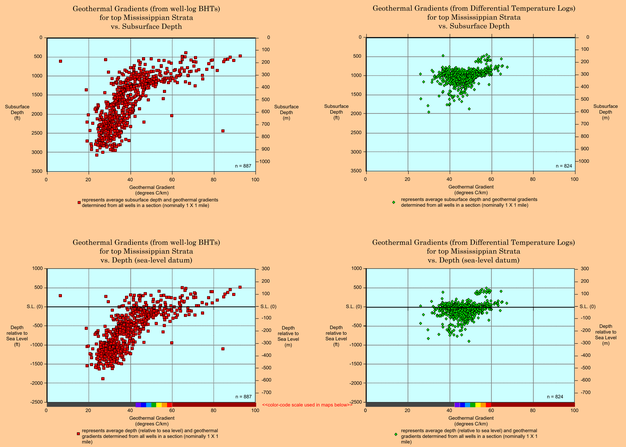


Annual Normal Temperatures (degrees F) (1971-2000) in Kansas.

These surface temperatures were used as baseline temperatures for determination of geothermal gradients.
(from Kansas State University Oznet website climate database)



BHT data is more widespread than the than data from differential temperature logs, which are derived primarily from CBM drilling, so there is more range in the depth and temperatures from the BHTs. Projection of the spread of the data to the surface temperature shows the differential temperature data better projects to the average surface temperature, thereby indicating that the differential temperature logs are a more consistent and probably more accurate measure of subsurface temperatures.

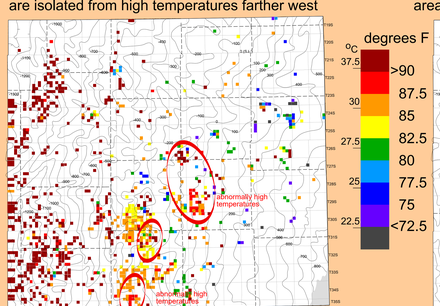


Geothermal gradients derived from BHTs decrease with increasing depth. This may be an artifact of more cooling of the wellbore by the drilling mud in deeper wells, but it also could be due to temperature anomalies only being present on the relatively shallow eastern flank of the Cherokee Basin. High geothermal gradients at shallow depth (<1500 ft; 400 m) in the BHT dataset are due to kinetic heating of the drilling mud in shallower holes. This effect is not as pronounced in the data from the differential temperature logs.

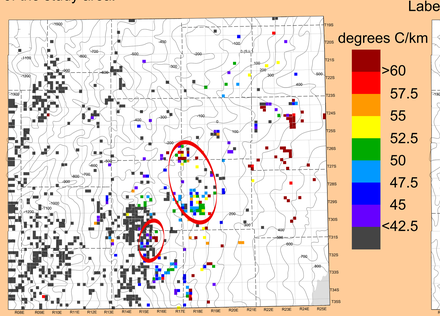
TEMPERATURE MAPS -- top Mississippian

BHT DATA The highest temperatures are in the west where this unit is buried deepest. Isolated localities farther east have elevated temperatures that are isolated from high temperatures farther west

DIFFERENTIAL TEMPERATURE LOGS Very little data are outside the area drilled for CBM, but isolated areas of high temperature are evident. These area are isolated from higher temperatures westward.



GEOTHERMAL GRADIENT MAPS -- top Mississippian

BHT DATA Higher geothermal gradients, in excess of 50º C/km are in the central and eastern part of the study area.

DIFFERENTIAL TEMPERATURE LOGS Two areas of higher geothermal gradients are defined: a narrow N-S trend and a broad area in northwestern Labette County