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Geothermal Gradient of the Powder River Basin, Wyoming

A geothermal gradient map of the Powder River Basin of Wyoming and Montana was constructed using over 7000 bottom hole temperatures as recorded by well logs. Gradients range from 1.2 to 2.5 degrees F per 100 ft. Mapping of both average and maximum gradient per township indicates three areas of high geothermal gradient which trend north-northeast across the basin. Two of these areas contain most of the significant oil and gas production in the basin, as well as encompassing the areas of overpressured Cretaceous rocks. In addition to areas of production, detailed mapping of two Cretaceous Muddy sandstone fields in the basin, Amos Draw and Hilight, show high geothermal gradients associated with these fields.

It is believed that the areas of high geothermal gradient represent areas of fractured basement rocks that have allowed for a higher conductance of heat up into the sedimentary section as compared to non-fractured areas. The role of basement fracture zones in controlling the heat distribution is also indicated by correlations of the geothermal gradient of the basin with gravity and magnetic data, as well as surface linear information. The same basement fracture trends have also caused important changes in the sedimentary section, such as salt solution and location of local unconformities, which have strongly affected locations of oil and gas production. Overpressured areas are also a result of the higher geothermal gradient because of more intense oil generation within the high temperature zones.