

because the formation explodes into the wellbore. Cavings are also produced by stress relief mechanism, characteristically blocky and varying in size tremendously, depending on the formation characteristics.

4. Mud Properties

(a) Flowline Temperature

Heat flow is generated radially from the earth's core with a constant heat flux across any depth increment. For any given area, the geothermal gradient is usually assumed to be constant. While this may be true for the average gradient across normally pressured formations, geopressured formations have exhibited abnormally high geothermal gradients. The top of a geopressured zone will be marked by a sharp increase in geothermal gradient due to the higher than normal porosity and fluid content of the formation which reduces the thermal conductivity. The seal above geopressured zones may exhibit a decrease in the geothermal gradient due to the insulating effect of the geopressured zone below and/or due to the greater thermal conductivity at the abnormally compacted seal rock.

The temperature of the drilling fluid at the flowline may reflect the geotemperature, and the recording of flowline temperature is a practical method of determining temperature gradient. However, many variables must be accounted for, including the mixing, treatment and addition of new cooler mud into the circulatory system, pump rate, lag time, ambient temperature, lithology, solid content of mud (weighing material), penetration rate, casing size, and the length of marine riser. Exlog uses a dual temperature probe system with sensors at the flowline and suction pit - surface effects may be removed if lagged differential temperature is plotted.

Returns are often circulated prior to pulling each bit, and after significant drilling breaks. A plot of these circulated returns temperatures usually provides a better approximation of the geothermal gradient than that obtained from the flowline temperature over the bit run. As with the standard method, recent mud additions can have a serious effect upon the circulated returns temperatures.