BURNS, OREGON

Geothermal gradient, heat flow, and thermal conductivity values for the holes near Burns, Oregon are shown in the attached table. The thermal conductivity measurements have been described separately. Heat flow values were calculated for 12 of the 13 wells. BN-3 did not penetrate to a depth sufficient to obtain a meaningful geothermal gradient value. In general the heat flow values should be relatively reliable for this set of holes. There are quite a few cases where variations in gradient occur which correspond well with variations in geology indicated on the geologic logs and in general surface disturbances do not appear present on the geothermal gradient curves.

At this point perhaps a word is in order about the calculation of heat flow and thermal conductivity. The most reliable thermal conductivity for these units are the thermal conductivities for the siltstones, sandstones, and claystones. Measurements of the thermal conductivity from the holes experience elsewhere in the Harney Basin suggest values of 2.6 $\pm$ 0.3 mcal/cmsec$^{o}$C for the siltstones and "sandstones" and about 2.3 $\pm$ 0.3 mcal/cmsec$^{o}$C for the claystones. Thus in the segments of the holes penetrating these lithologies the appropriate thermal conductivity was assumed. The thermal conductivity for other lithologic units in each hole was calculated from a ratio of the gradients in the two units multiplied times the thermal conductivity of the siltstone or claystone section. If the inferred thermal conductivity is consistent with the measured values (see table of thermal conductivities), the thermal conductivity is indicated with a plus. If it is not consistent the thermal conductivity value in parentheses is indicated with an x. In holes where the thermal conductivities have pluses, heat flow values should be reliable. For the holes where the

# BURNS, OREGON

Heat Flow, Geothermal Gradient, and Thermal Conductivity. The thermal conductivity used in calculating the heat flow is not in parentheses. The thermal conductivity values in parentheses were calculated from a ratio of the gradients and are indicated by a + if they are consistent and a x if they are inconsistent with measured values. If the terrain correction will probably be less than 10% the "Direction of Terrain Correction" is shown in parentheses.

| Hole Number | Depth Interval meters | Gradient °C/km | Thermal Conductivity mcal/cmsec°C | Heat Flow μcal/cm²sec | Direction of Terrain Corr. | Lithology |
|---|---|---|---|---|---|---|
| BN-1 | 20-50 | 80.3<br>5.4 | 2.6 | 2.1 | | Sandy Clay |
| BN-2 | 10-26 | 62.1<br>9.6 | (3.9) + | | | Andesite |
| | 26-36 | 94.0<br>11.6 | 2.6 | 2.4 | + | Sandy Clay |
| | 36-48 | 117.5<br>12.4 | (2.1) x | | | Rhyolite Tuff (Pumaceous?) |
| BN-3 | | - | | | | |
| BN-4 | 24-49 | 60.1<br>5.6 | 3-4 | 1.8-2.4 | (+) | Rhyolite |
| BN-5 | 12-24 | 40.0<br>9.1 | (4.0) x | | | Sand |
| | 24-36 | 61.7<br>12.4 | 2.6 | 1.6 | - | Sandy Clay |
| | 36-48 | 19.6<br>2.3 | (8.2) x | | | Rhyolite |
| BN-6 | 12-24 | 86.1<br>12.4 | (3.7) + | | | Rhyolite |
| | 24-50 | 125.9<br>10.0 | 2.3-2.6 | 2.9-3.3 | ? | Clay and Fill(?) |

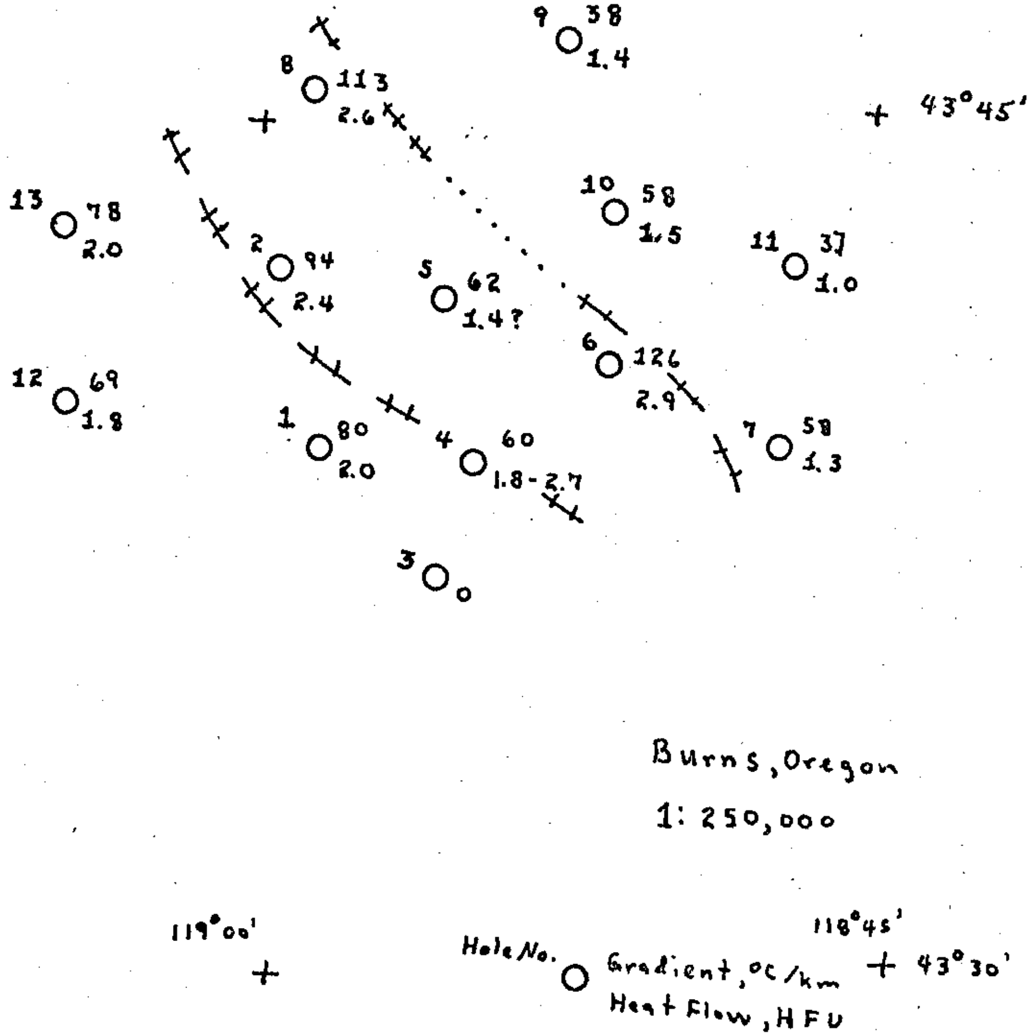
| Hole Number | Depth Interval meters | Gradient $^{o}C/km$ | Thermal Conductivity $mcal/cmsec^{o}C$ | Heat Flow $\mu cal/cm^2sec$ | Direction of Terrain Corr. | Lithology |
|---|---|---|---|---|---|---|
| BN-7 | 15-50 | 43.4<br>5.2 | 2.3 | 1.0 | | Clay |
| | 40-50 | 57.5<br>3.8 | 2.3 | 1.3 | - | Clay |
| BN-8 | 20-34 | 158.6<br>6.2 | (1.8) x | | | Welded Tuff (Pumaceous Tuff?) |
| | 36-46 | 112.5<br>8.8 | 2.6 | 2.9 | ? | Tuffaceous Silt-stone |
| BN-9 | 10-50 | 37.6<br>2.3 | (3.8) | 1.4 | + | Basalt |
| BN-10 | 12-44 | 41.7<br>1.7 | (3.6) + | | + | Basalt |
| | 44-50 | 58.3<br>2.9 | 2.6 | 1.5 | | Siltstone |
| BN-11 | 18-50 | 36.6<br>5.5 | 2.6 | 1.0 | + | Siltstone |
| BN-12 | 14-24 | 44.5<br>3.8 | (4.0) + | | | Welded Tuff |
| | 24-30 | 105.0<br>17.3 | (1.7) + | | | Pumice |
| | 30-50 | 68.6<br>8.6 | 2.6 | 1.8 | + | Siltstone |
| BN-13 | 12-38 | 77.7<br>4.8 | 2.6 | 2.0 | + | Siltstone |
| | 38-50 | 27.5<br>3.4 | (7.3) x | | | Lithic Tuff |

calculated thermal conductivity values are indicated by an x, the actual heat flow may be uncertain by the ratio of gradients.

The regional background heat flow value for this area should be in the vicinity of 1.5 to 2 $\mu cal/cm^2 sec$ and the heat flow values of drill holes BN-1, 5, 9, 10, 12 and 13 and possibly BN-4 are in this range. Heat flow values from drill holes BN-4 and BN-5 are particularly uncertain because of imperfect knowledge of the thermal conductivity to use in BN-4 and a severe disagreement between the heat flow values in the various lithologic segments in drill hole BN-5. The only other major disagreements between the thermal conductivity values assumed for the clay and siltstone segments and calculated for the remainder of lithologies are in holes BN-2, BN-8, and BN-3. The disagreements in holes BN-2, and BN-8 can be satisfied if the welded tuff and rhyolite tuffs were actually pumaceous tuffs, instead, as these very low values of thermal conductivity are typical of pumaceous tuffs elsewhere in the Harney Basin. The low value of gradient and the thus inferred high value of thermal conductivity in BN-13 is unexplained, however. Two values (for BN-7 and BN-11) are below the regional averages. These low values might be due to one of three causes, surface disturbances which lower the gradient or terrain effects, use of wrong thermal conductivity values, or regional ground water recharge. Information is not on hand to discriminate between these alternatives.

The heat flow values and geothermal gradients appropriate for the siltstone and claystone units are shown in the attached figure. The terrain corrections might change the values somewhat although it does not appear that they will effect the high values systematically. Except for BN-5, there appears to be a band of anomalous heat flow values about 6 km wide running northwest-southeast through the area, with normal to slightly high values of heat flow to the southwest and normal to slightly low values of heat flow to the northeast. As mentioned above the heat flow from BN-5 is particularly questionable and may not be valid. The average gradients in this anomalous zone are about 110°C/km, but the heat flow values are only about 25-40% above the regional heat flow because of the low thermal conductivity of the rocks cut by the holes.

Based on these data the recommendations are (1) correlation of the possible zone of anomalous heat flow with other geological and geophysical data, (2) drilling of detailed cross section, preferably with the holes in siltstone or claystone, (3) one or more deep holes (100-150 m) in the zone to verify the extrapolation to depth of the high gradients in the 50 m wells.


9 38 1.4
8 113 2.6
43°45'
13 78 2.0
10 58 1.5
11 37 1.0
2 94 2.4
5 62 1.4?
6 126 2.9
12 69 1.8
1 80 2.0
4 60 1.8-2.7
7 58 1.3
3 0
Burns, Oregon
1: 250,000
119°00'
118°45'
43°30'
Hole No.
Gradient, °C/km
Heat Flow, HFU