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30 November 1982

Mr. Dean Pilkington
AMAX Exploration, Inc.
1707 Cole Boulevard
Golden, Colorado 80401

Dear Dean:

This is a summary of the results of applying Teledyne Geotech's two-dimensional wave number filtering technique to the thermal gradient data at McCoy, Nevada.

Sixty temperature-depth logs provided by AMAX comprise the data base. Thermal gradients were chosen from depth intervals encompassing 30 m whenever possible. The gradients were computed using a least squares fit to the temperature-depth log in the chosen depth interval. The data were corrected for topography and elevation and reduced to a datum elevation of 5237 ft, which is the average well head elevation. A surface thermal gradient contour map (figure 1) was generated over a grid extending 20 km north-south, and 16 km east-west. Spacing between grid points was 1 km. The fit to the data was approximately 2.5%.

The two-dimensional wave number filtering technique was applied to four temperature gradient profiles (figures 2, 3, 4 and 5) and estimates of subsurface temperatures were made at five locations, corresponding to the locations of five intermediate depth wells (figures 6, 7, 8, 9 and 10).

The main conclusions drawn from the results of the wave number filtering are:

(1) The northern anomalies appear to represent shallow thermal waters. The temperature estimates at locations I1 and I5 exhibit rollovers at a depth of approximately 1500 ft (450 m), reaching a maximum temperature near 200°F (100°C). This predicted isothermal zone extends to about 4000 ft or more.

(2) The southern anomaly may represent a deeper thermal source. At location I2, which is on the flank of the main anomaly, the temperature-depth estimate is similar to those at I1 and I5, down to a depth of about 3000 ft. At locations I3 and I4, which are near the peak of the anomaly, there are again rollovers in the estimates of the temperature-depth profiles at about 1500 ft (450 m), but reaching maximum temperatures close to 300°F (150°C), persisting to about 3000 ft. Below 3000 ft, the results are less reliable, but suggest a possible recovery in the gradient.

(3) The results of the wave number processing on profile A-A' suggest the possibility of a deep source lying 1 or 2 km north of location I3 (figure 11).

A brief description of the processing procedure is presented, followed by some recommendations for future work. The two-dimensional wave number filtering technique makes use of the information about depth to the source contained in the wave number spectrum of the surface thermal gradient data. It consists of three basic steps (Li et al, 1982). The first step is to parameterize a two-dimensional model of the earth into two sets of discrete line sources, located to allow separation of the contributions from shallow and deep heat sources. The second step consists of solving for the model source strengths by minimizing the error, in a constrained least-squares sense, between the observed spectrum and the spectrum predicted by the model sources. The third step consists of constructing a filtered set of gradient data from the modeled deep source distribution. Alternatively, the model sources can be used to estimate subsurface temperatures.

This latter technique was used to estimate the subsurface temperatures at locations I1, I2, I3, I4, and I5 (figure 1) which are the locations of five intermediate-depth wells. This was done stepwise using a series of models each containing two source layers separated in depth by 600 meters (Swanberg and Li, 1982). The layers are shifted to greater depths with each model. The resulting deep source distribution from each model is used to estimate the temperature at a point midway between the two source layers. The gradient profiles A-A', B-B' and C-C', and D-D' were chosen so that they intersected at four of the five intermediate depth wells, thus providing two estimates of temperature-depth profiles at each of the four locations.

The temperature-depth profiles estimated at the two northern locations, I1 and I5, are similar in that they roll over at about 1500 ft (450 m) and reach a maximum temperature of approximately 200°F (100°C) (figures 6 and 10). The isothermal zone of 200°F persists to a depth of at least 4000 ft (1200 m), below which the estimates are judged to be less reliable.

At the southern anomaly, the problem of using a two-dimensional model in a three-dimensional problem is apparent in the estimates at location I2 (figure 7). Here, the temperature estimates from profiles B-B' and C-C' agree well to a depth of 2500 ft (800 m), rolling over at 1500 ft (450 m) at a maximum temperature of 200°F (100°C). Below 3000 ft, the two estimates diverge. Thus, the temperature estimates below 3000 ft are judged to be unreliable at location I2. At location I3 (figure 8), the temperature estimates also roll over at 1500 ft (450 m) but attain a temperature of approximately 300°F (150°C) in the depth range from 2000 ft to 3000 ft. Below 3000 ft the gradient appears to recover. In light of the results at location I2, this recovery in the gradient is questionable even though the estimates from both A-A' and B-B' show the recovery. At the location I4', which corresponds to location I4 off of profile B-B', the results are similar to those at I3 (figure 9).

The deep source distributions may also be inspected visually for trends (figure 11). For example, the source distributions from profile A-A' suggest that the peak in the source distribution shifts one or two kilometers to the north of well location I3 at depths below 3000 ft.

In conclusion, the results of the wave number filtering technique predicts a temperature roll over through much of the McCoy prospect at a depth of about 1500 ft (450 m), generally at a temperature close to 200°F (100°C) but approaching 300°F (150°C) near location I3. The results suggest that further work should be performed to determine the possibility of higher temperatures below 3000 ft and 1 or 2 km to the north of location I3. Specifically, one or two more shallow gradient holes along Edwards Creek Vally north and south of location I3 might further define the southern anomaly.

References

Li, T. M. C., C. A. Swanberg, and J. F. Ferguson, 1982, A method for filtering hot spring noise from shallow temperature gradient data, in Transactions, vol. 6, PP. 137-140, Geothermal Resources Council.

Swanberg, C. A., and T. M. C. Li, 1982, Wave number filtering of thermal data from the Valles Caldera, New Mexico, in Transactions, vol. 6, pp. 181-184, Geothermal Resources Council.

Please feel free to call me if you have any questions.

Sincerely,

Todd M. C. Li

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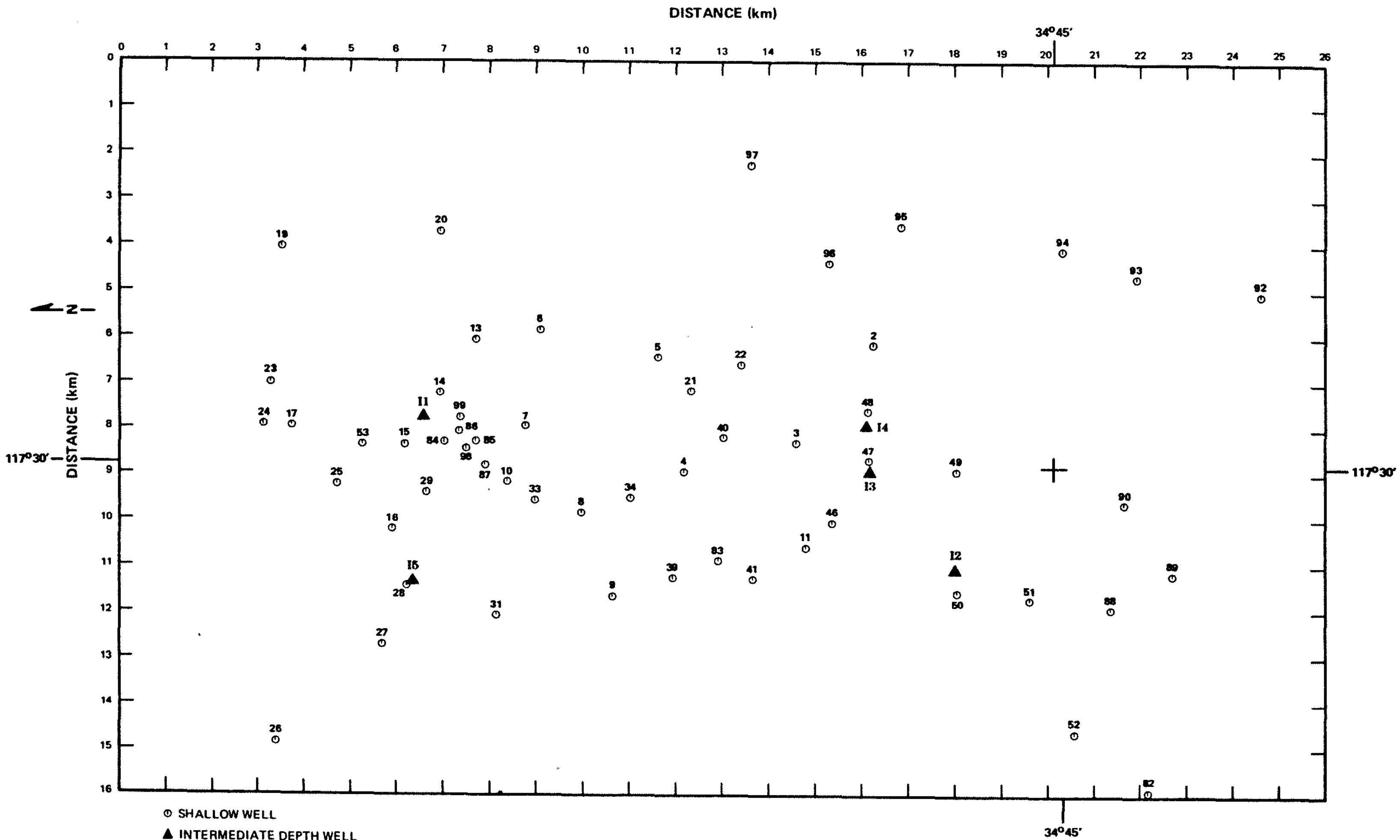
TML/gb



GRID SYSTEM AND WELL LOCATIONS AT McCOY, NEVADA
OVERLAY TO FIGURE 1

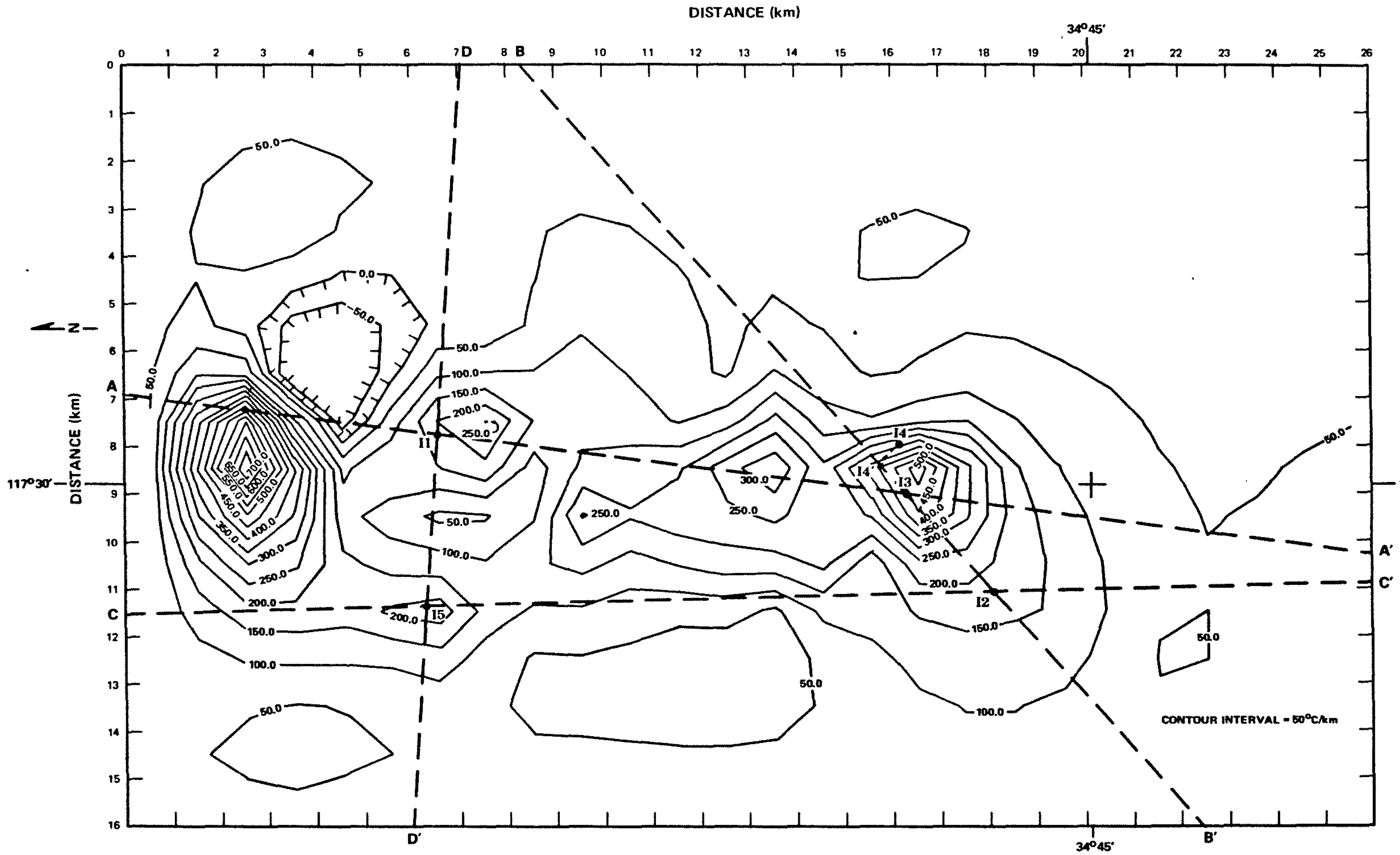


FIGURE 1. SURFACE GRADIENTS (°C/km) AT McCOY, NEVADA
ELEVATION = 5237 FT. SURFACE FIT = 2.5%

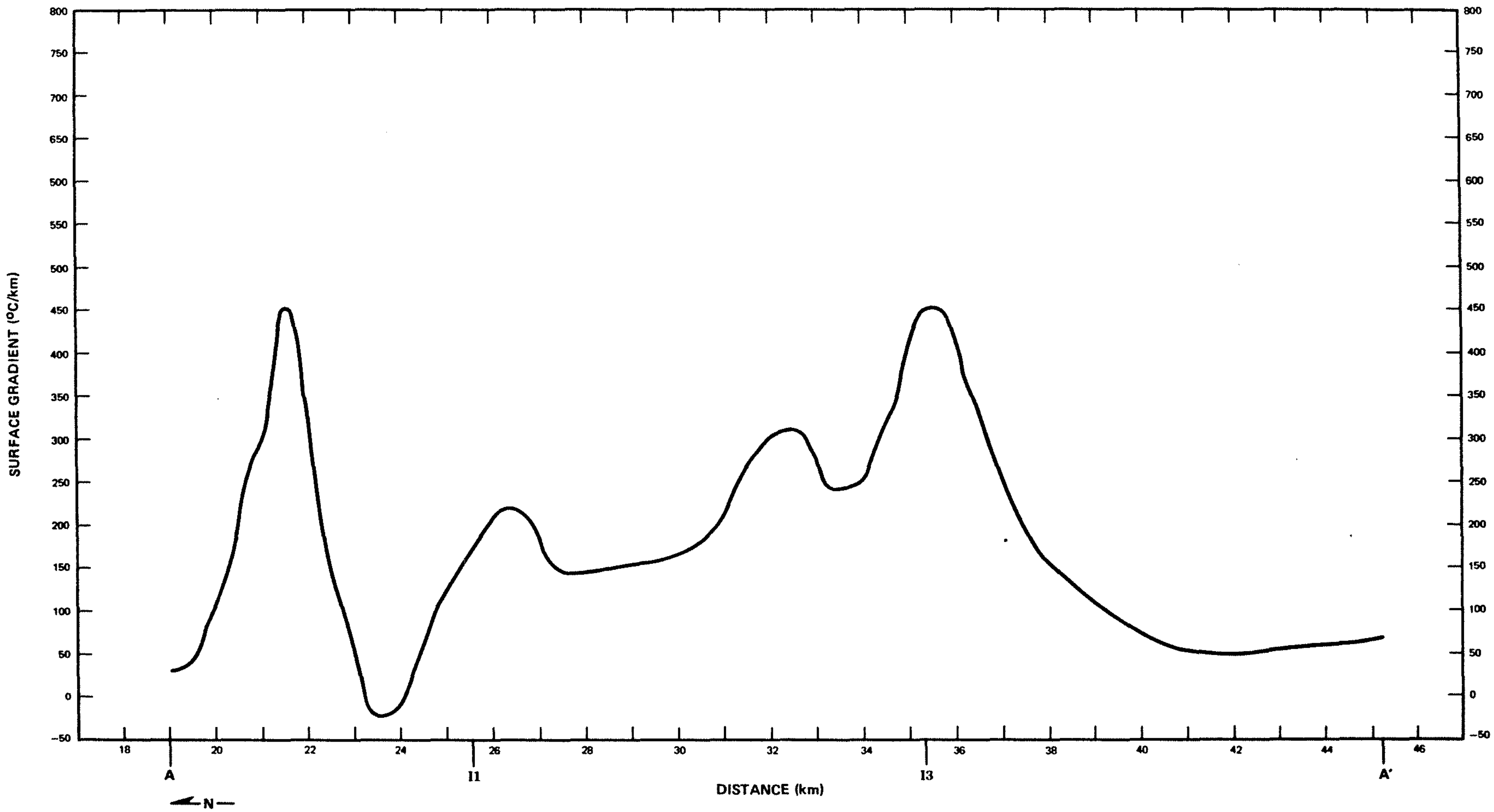


FIGURE 2. SURFACE GRADIENT PROFILE A-A' WITH LOCATIONS OF INTERMEDIATE DEPTH WELLS I1 AND I2 AT McCOY, NEVADA

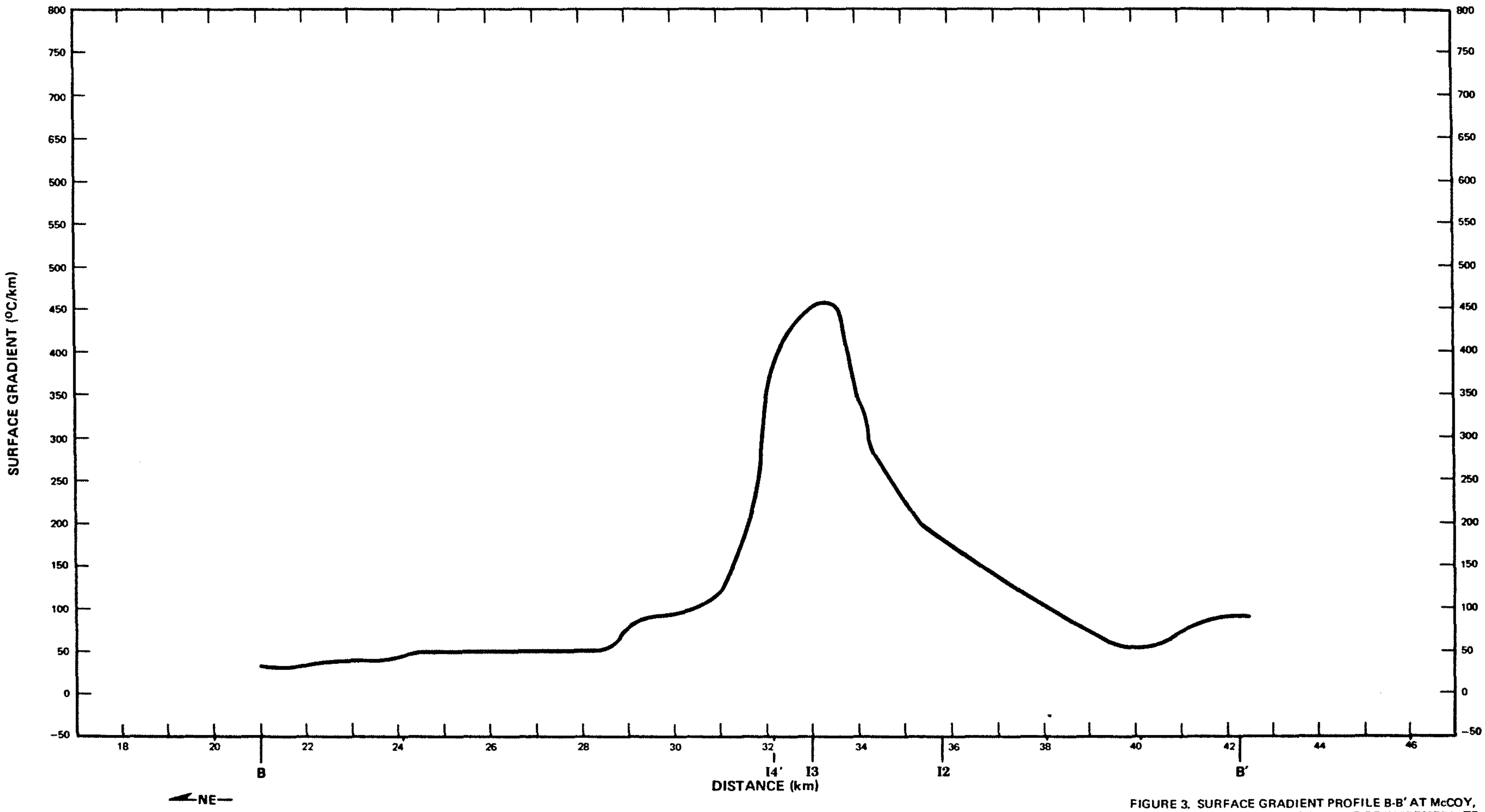


FIGURE 3. SURFACE GRADIENT PROFILE B-B' AT McCOY, NEVADA WITH LOCATIONS OF INTERMEDIATE DEPTH WELLS I2 AND I3. I4' IS THE LOCATION ON B-B' CLOSEST TO WELL I4.

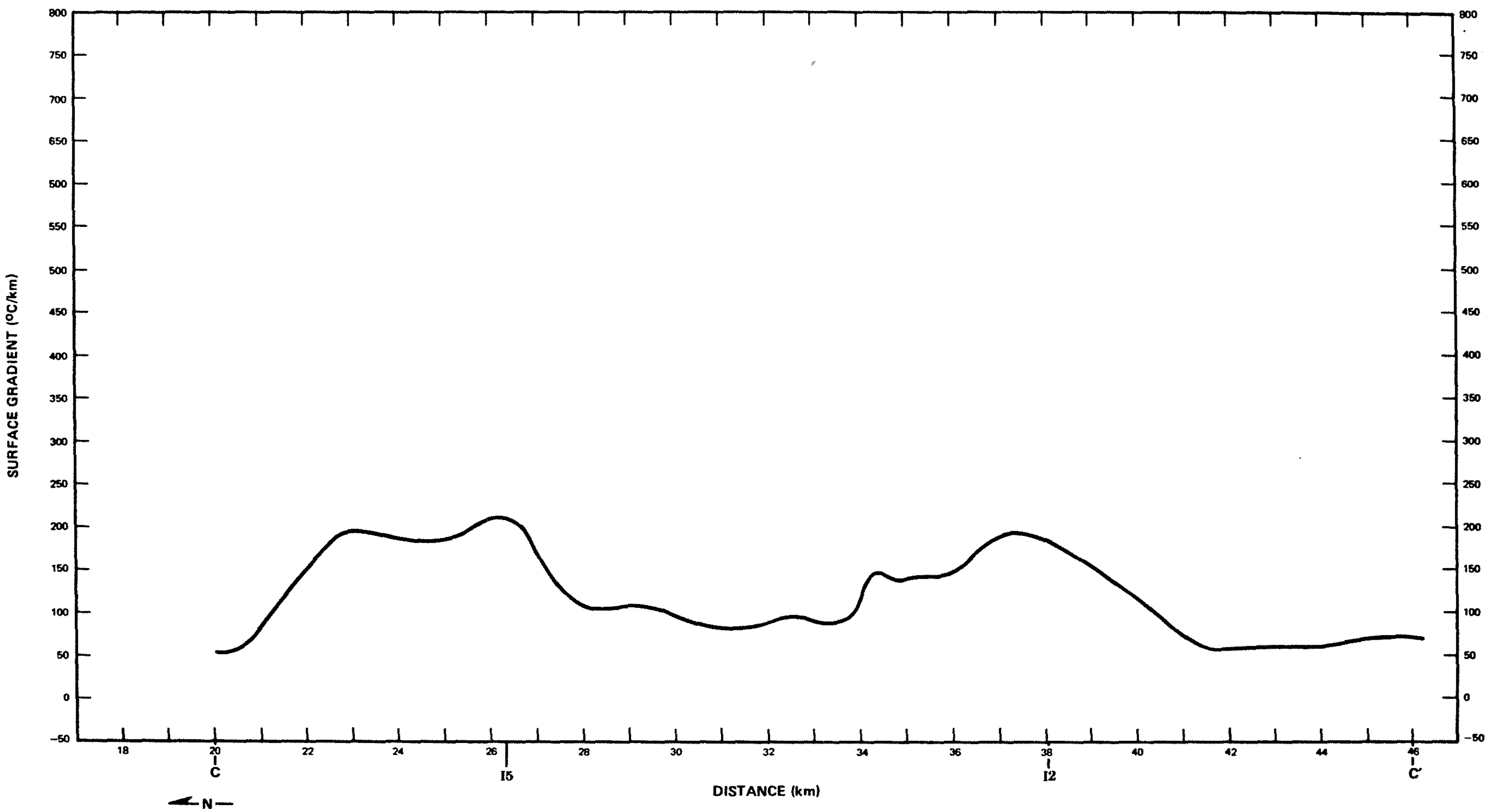


FIGURE 4. SURFACE GRADIENT PROFILE C-C' WITH LOCATIONS OF INTERMEDIATE DEPTH WELLS I2 AND I5 AT McCOY, NEVADA

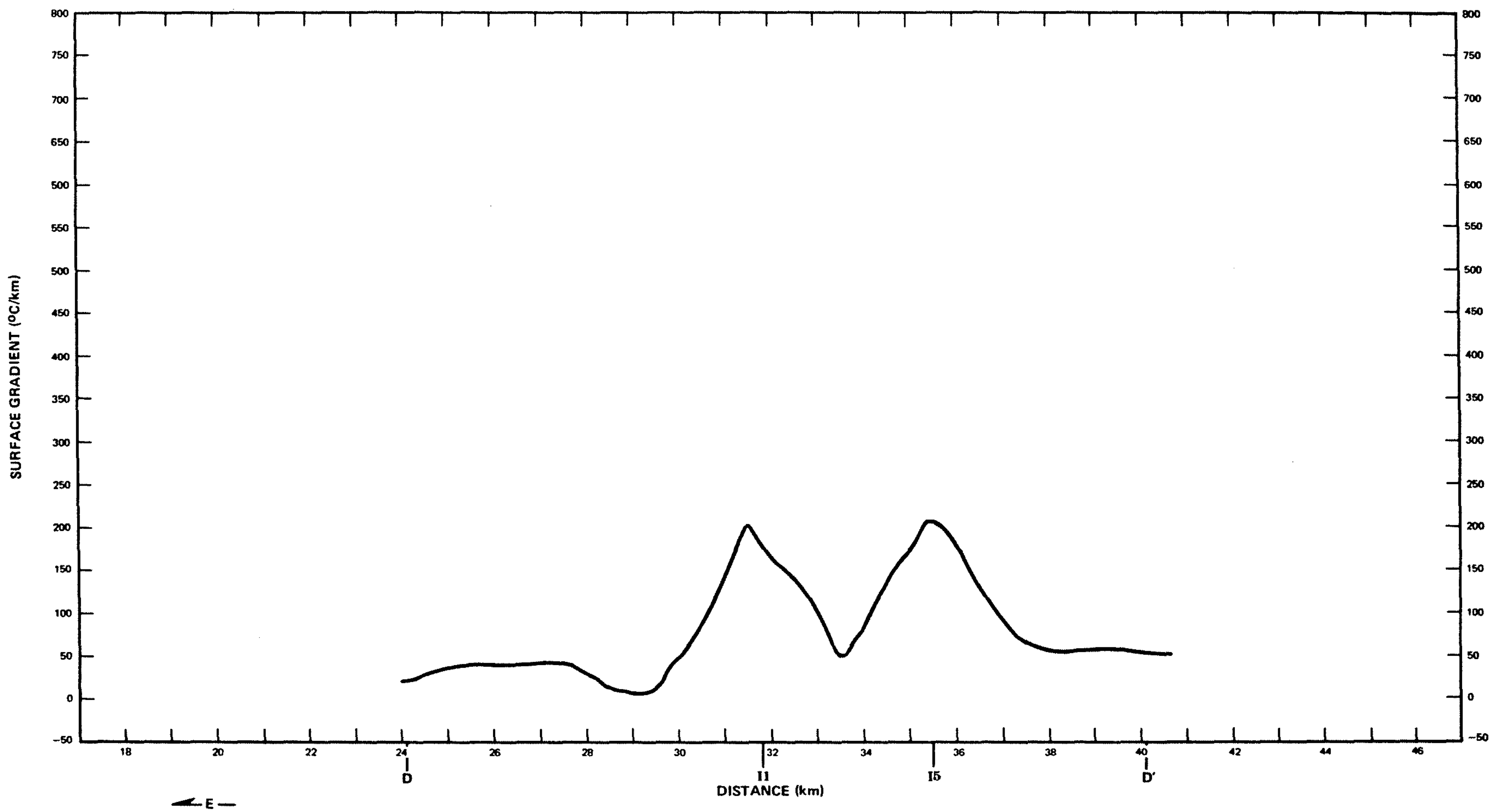


FIGURE 5. SURFACE GRADIENT PROFILE D-D′ WITH LOCATIONS OF INTERMEDIATE DEPTH WELLS I1 AND I5 AT McCOY, NEVADA

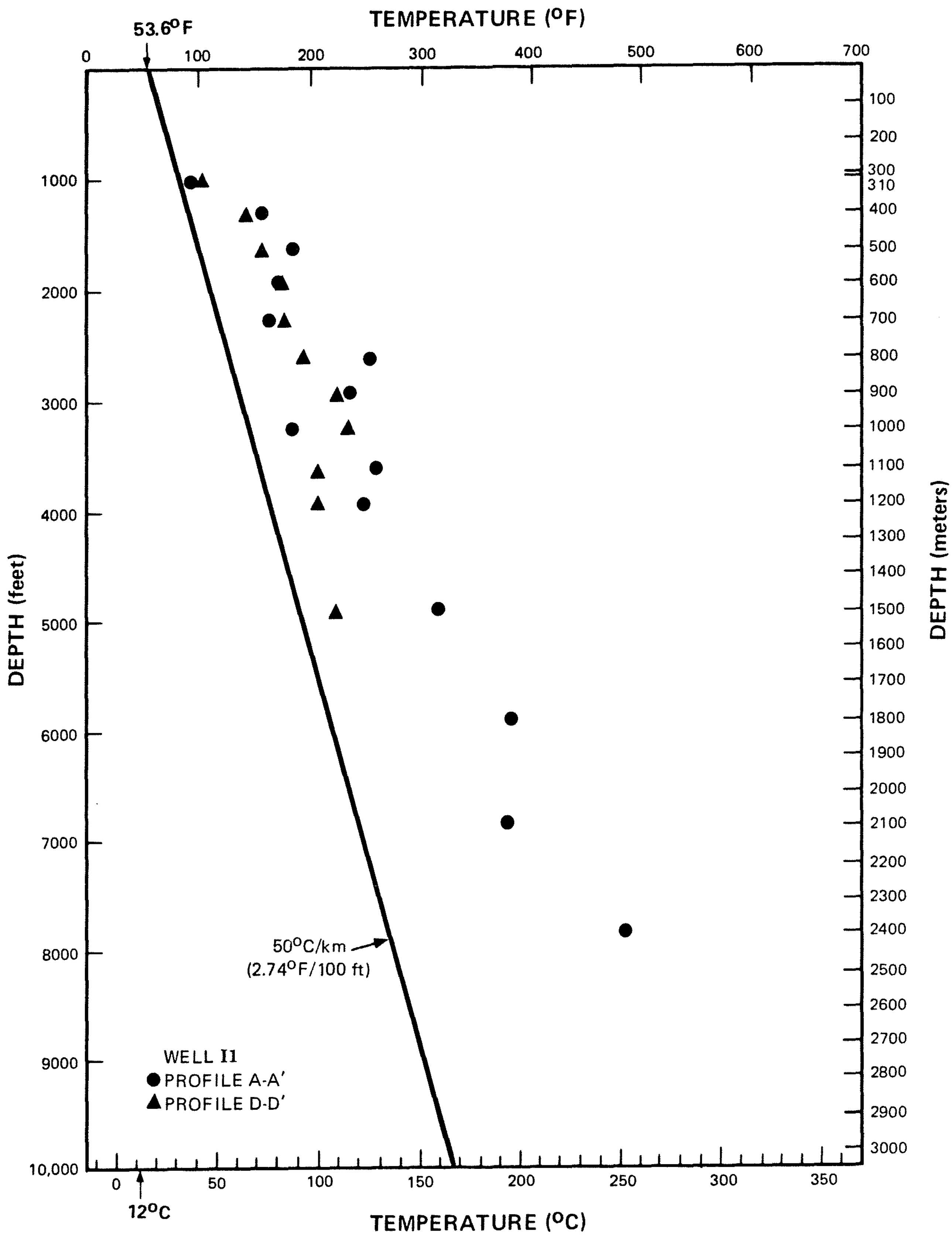


FIGURE 6. ESTIMATED SUBSURFACE TEMPERATURES AT INTERMEDATE DEPTH WELL I1 LOCATED AT THE INTERSECTION OF PROFILES A-A′ AND D-D′, McCOY, NEVADA

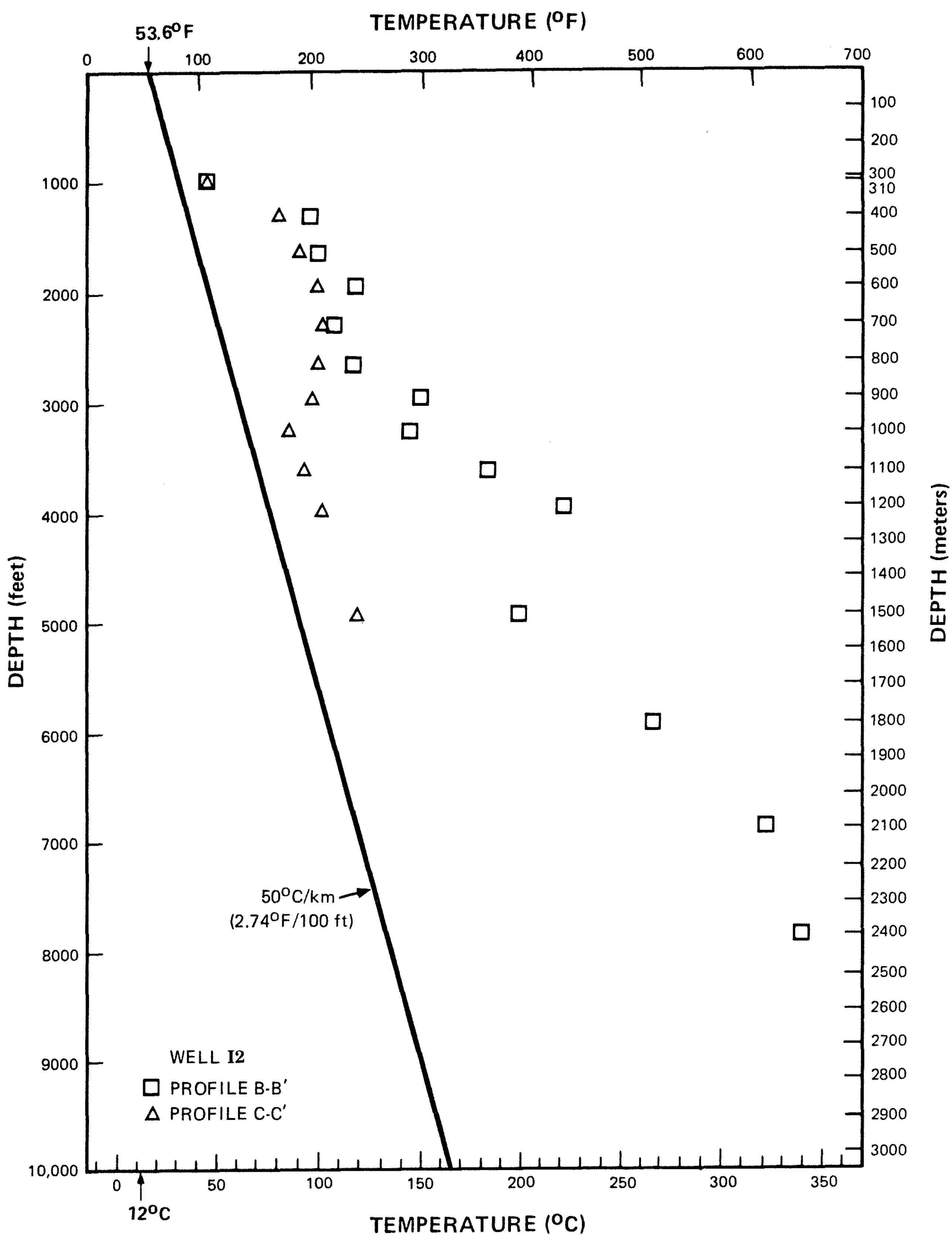


FIGURE 7. ESTIMATES SUBSURFACE TEMPERATURES AT INTERMEDIATE DEPTH WELL I2, LOCATED AT THE INTERSECTION OF PROFILES B-B′ AND C-C′, McCOY, NEVADA

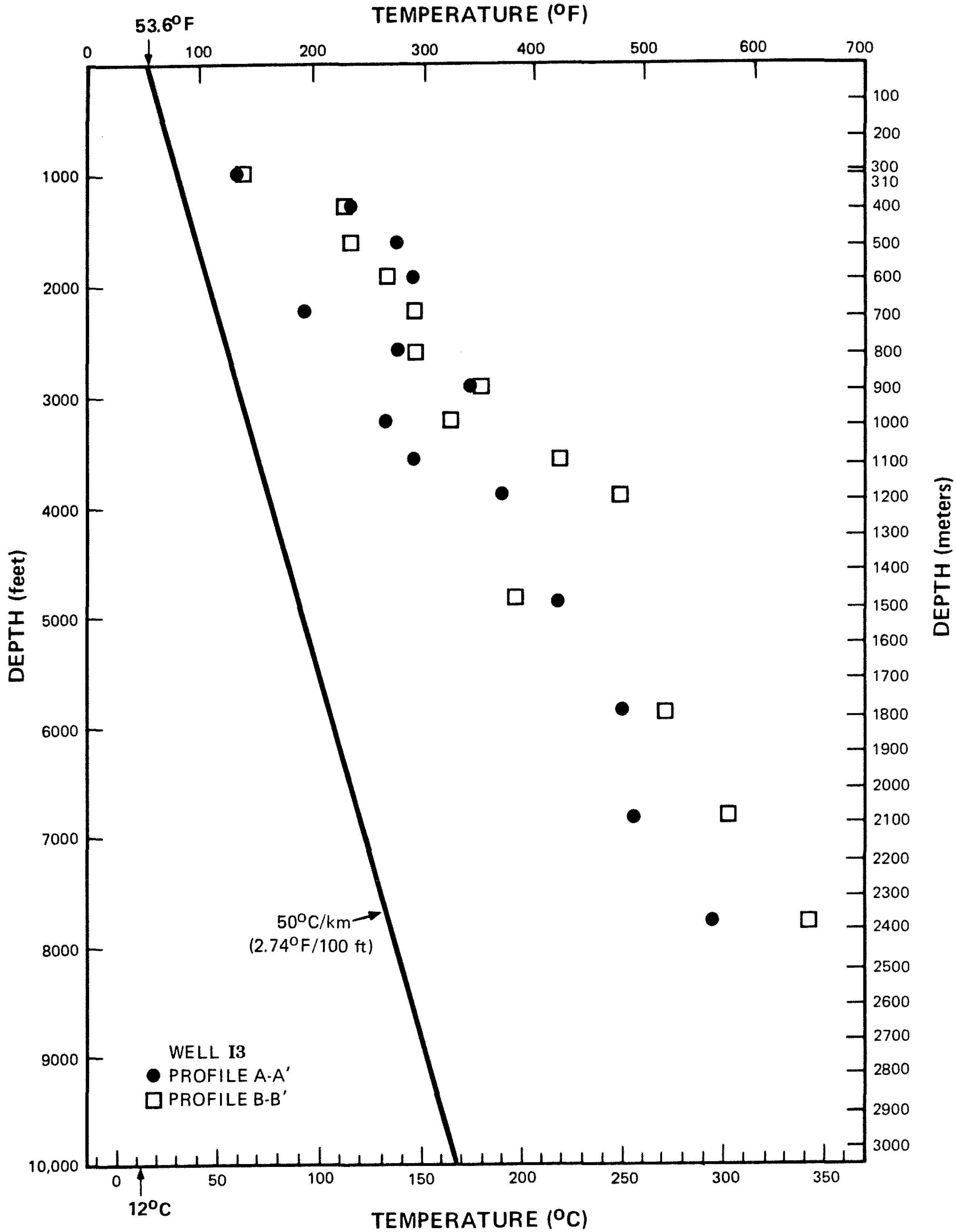


FIGURE 8. ESTIMATED SUBSURFACE TEMPERATURES AT INTERMEDIATE DEPTH WELL I3, LOCATED AT THE INTERSECTION OF PROFILES A-A′ AND B-B′, McCOY, NEVADA

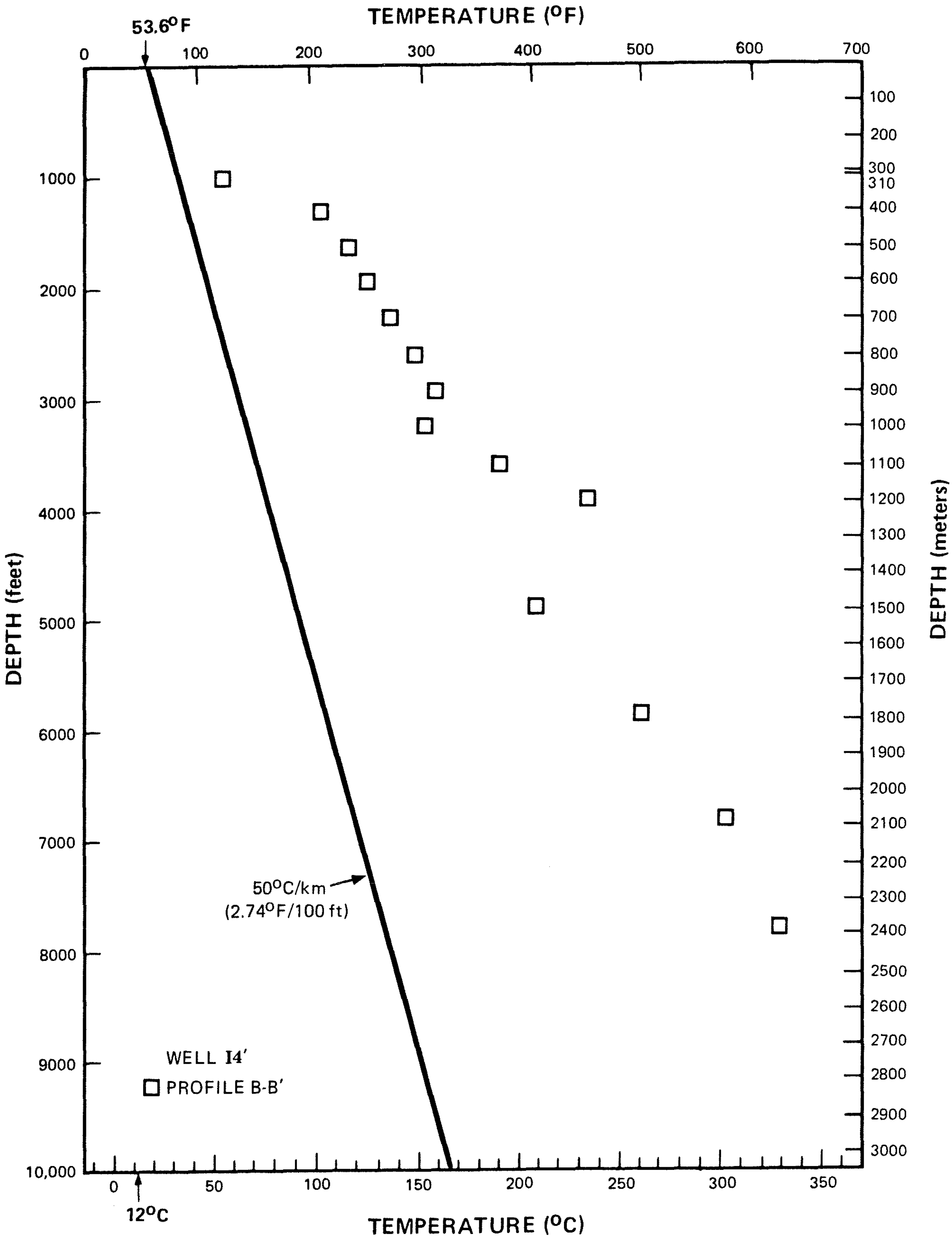


FIGURE 9. ESTIMATED SUBSURFACE TEMPERATURE AT PROJECTION OF INTERMEDIATE DEPTH WELL I4 ONTO PROFILE B-B', McCOY, NEVADA

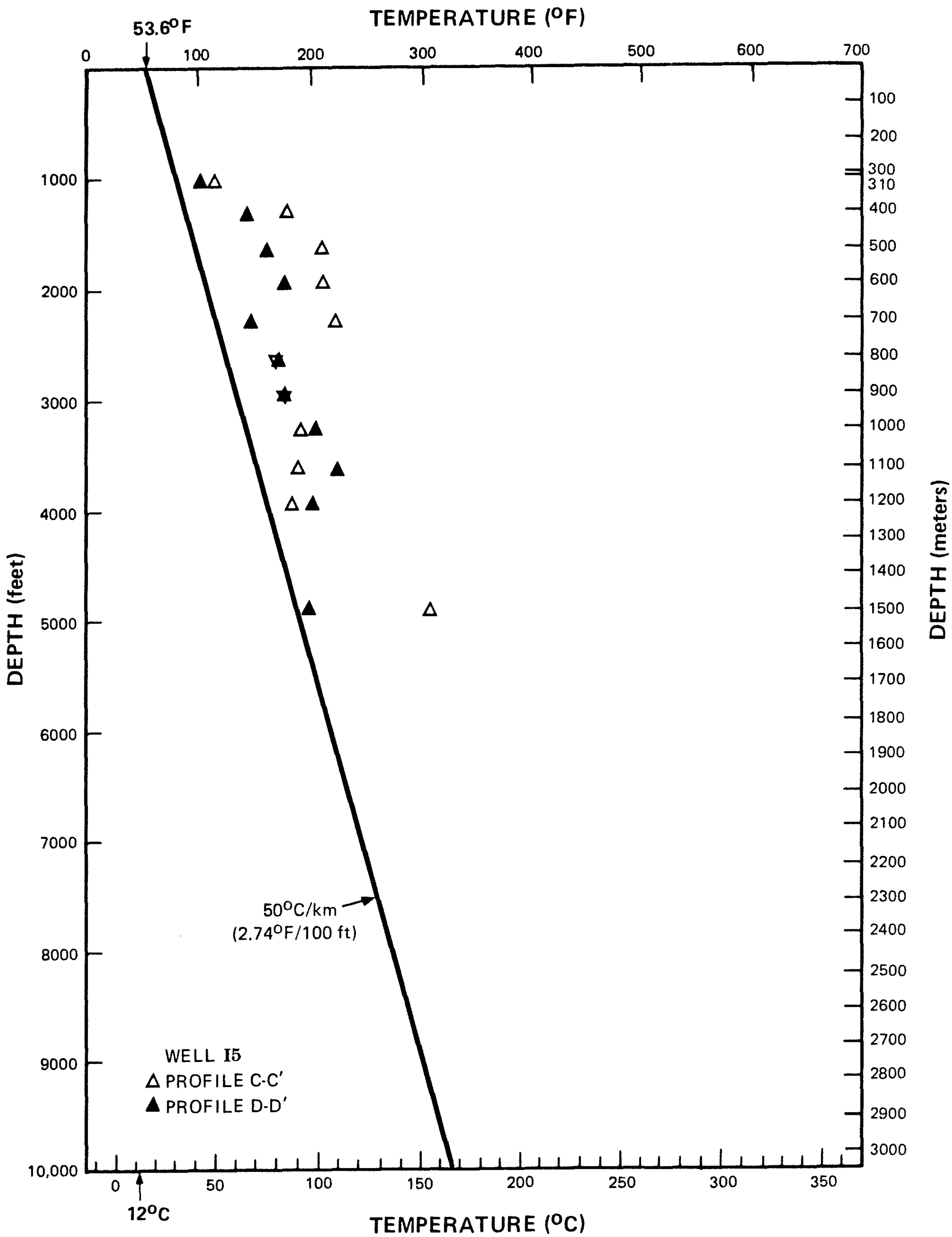


FIGURE 10. ESTIMATED SUBSURFACE TEMPERATURES AT INTERMEDIATE DEPTH WELL I5, LOCATED AT THE INTERSECTION OF PROFILES C-C′ AND D-D′, McCOY, NEVADA

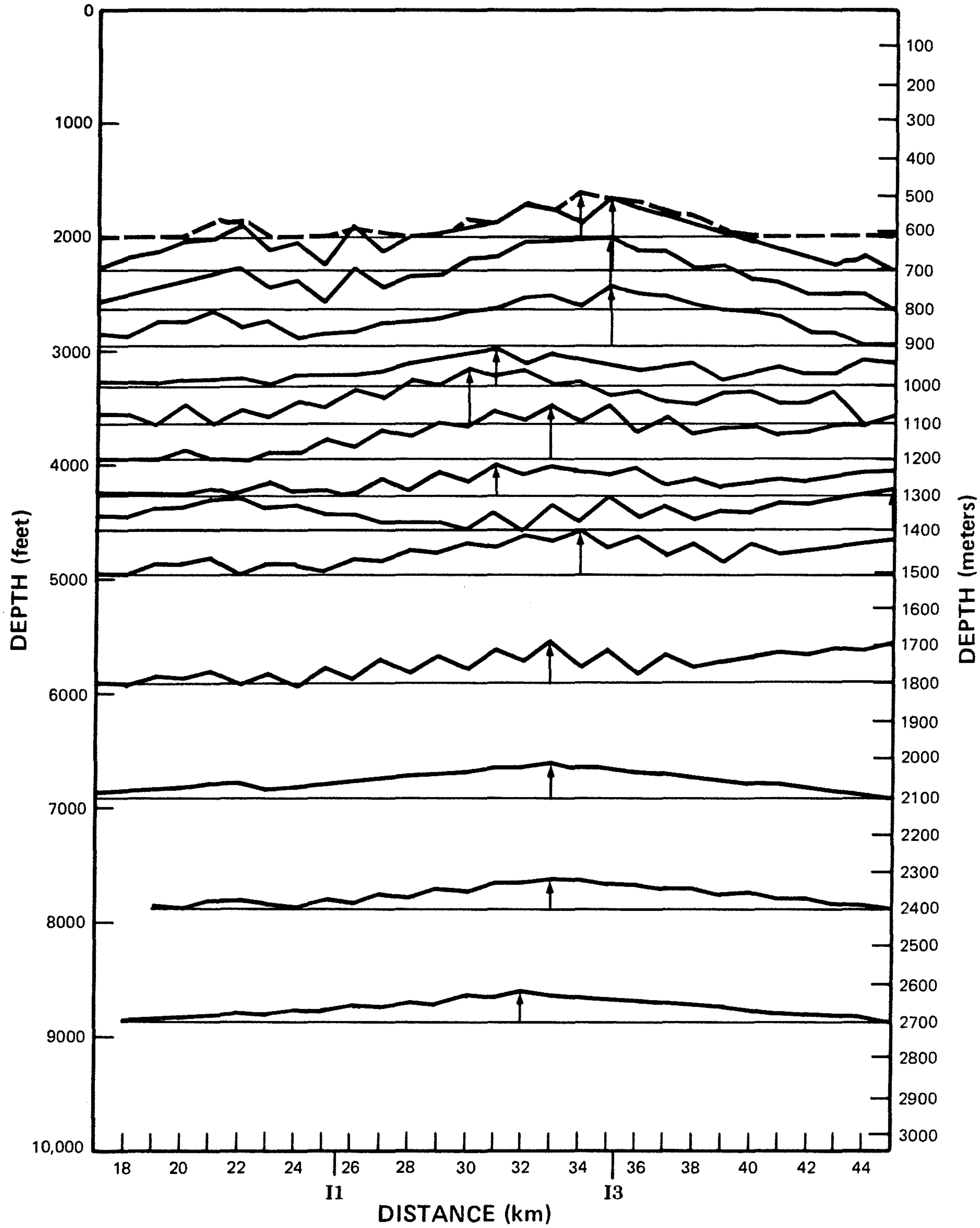


FIGURE 11. SCHEMATIC REPRESENTATION OF SOURCE STRENGTH DISTRIBUTIONS ON DEEP PLANES OF PROFILE A-A′, McCOY, NEVADA. RELATIVE HEIGHT OF THE CURVE FROM BASELINE INDICATES MAGNITUDE. ARROW CONNECTS CURVE WITH BASELINE AT HORIZONTAL POSITION OF MAXIMUM SOURCE STRENGTH.