TABLE II. Coefficients of surface fits to single-wire and thermocouple correction data with generalized temperature axis.[a]

	Pt10Rh	Pt	Correction
a_1	0.44487×10^{-2}	0.15302×10^{-1}	0.10853×10^{-1}
a_2	0.85626×10^{-4}	0.49488×10^{-4}	-0.36139×10^{-4}
a_3	0.54252×10^{-5}	-0.60745×10^{-6}	-0.60326×10^{-5}
a_4	0.97344×10^{-9}	-0.11452×10^{-7}	-0.12425×10^{-7}
a_5	-0.10622×10^{-7}	-0.26313×10^{-9}	0.10359×10^{-7}
a_6	-0.12372×10^{-8}	0.49230×10^{-10}	0.12864×10^{-8}
Standard deviation			
	$\pm2.0\ \mu$V	$\pm0.6\ \mu$V	$\pm1.7\ \mu$V
	Chromel	Alumel	Correction
a_1	-0.26744×10^{-1}	-0.29198×10^{-2}	0.23824×10^{-1}
a_2	0.12950×10^{-2}	0.71560×10^{-3}	-0.57939×10^{-3}
a_3	0.42384×10^{-4}	0.16332×10^{-4}	-0.26052×10^{-4}
a_4	-0.11720×10^{-4}	-0.95802×10^{-5}	0.21401×10^{-5}
a_5	-0.83299×10^{-6}	-0.29829×10^{-6}	0.53471×10^{-6}
a_6	0.17245×10^{-7}	0.27378×10^{-8}	-0.14527×10^{-7}
Standard deviation			
	$\pm4.4\ \mu$V	$\pm3.1\ \mu$V	$\pm6.9\ \mu$V

[a] The values of single-wire or correction voltages may be calculated from these coefficients by use of the following equation:

$$E=a_1tP+a_2tP^2+a_3t^2P+a_4tP^3+a_5t^2P^2+a_6t^3P,$$

where $t=T_J-20$, the hot seal (for single-wire voltages) or hot junction (for thermocouple correction voltages) temperature minus 20°C; and P = pressure in kbar.

These coefficients represent our single-wire and correction voltages to 50 kbar and 2000°C for Pt and Pt10Rh and to 50 kbar and 1200°C for Chromel and Alumel. All values above 35 kbar and 1000°C are based on graphical extrapolations.

CALCULATION OF CORRECTIONS

In most apparatus, the pressure seal does not remain fixed at ambient temperatures. It is still possible to calculate the corrections appropriate to such a case from the generalized plots in Figs. 11 and 12. First, the voltage corresponding to the junction temperature at the appropriate pressure is found from the plot. From this is subtracted the voltage corresponding to the pressure seal temperature at that same pressure. This difference is added to the observed thermocouple voltage. The temperature is then found by reference to the standard 1-atm thermocouple tables.

Alternatively, if a correction in terms of temperature rather than thermocouple voltage is desired, the voltage correction as determined above should be divided by the 1-atm relative Seebeck coefficient (thermoelectric power) of the thermocouple. For Chromel–Alumel this coefficient is essential constant at 41 μV/°C. The value for Pt–Pt10Rh is more temperature dependent and is shown in Fig. 13. A sample calculation for Pt–Pt10Rh is given below for a thermocouple operating at 800°C and 30 kbar with a seal temperature of 150°C. The correction voltage corresponding to the junction temperature, +142 μV. From this is subtracted the correction voltage for the seal temperature, +35 μV, resulting in a final correction of +107 μV. The temperature correction is found by dividing this quantity by the relative Seebeck coefficient at 800°C, 10.8 μV/°C. It is +9.9°C.

While the temperature axis in these plots is actually true temperature, using the indicated thermocouple temperature for the hot junction temperature introduces a negligible error. The error introduced in the sample calculation above would be only 1 μV or 0.1°C. For Pt–Pt10Rh the final correction is actually more sensitive to accurate determination of the effective seal temperature than the junction temperature because the curves have greater slopes in the seal temperature region. For Chromel–Alumel the case is just the reverse. In the seal temperature range of most apparatus, the slopes and magnitudes of the Chromel–Alumel correction curves are extremely small. This makes corrections to this thermocouple particularly insensitive to accurate seal temperature determination.

Several important factors enter into the accurate application of these observed corrections. In solid medium high-pressure applications, thermocouples are often installed inside a high-strength ceramic protection tube. The stress field on the thermoelements can be extremely nonhydrostatic in such cases. Experiments in this laboratory under such conditions have shown as much as a factor of two difference in the effective pressure on the wires at the same nominal cell pressure on compression and decompression parts of a pressure cycle. Thus the appropriate correction can differ from that for the nominal cell pressure by a major fraction of the correction as a result of stress and temperature gradients occurring simultaneously in the same region of the wires.[2] Some estimate of the pressure–temperature distribution along the wires should be made to account for these effects. This is usually very difficult, however.

What is thought to be chemical contamination has