8.1.5 Remarks on Gravity Reduction

Gravity reduction may be summarized as follows (for more details cf. (Heiskanen and Moritz, 1967, pp. 130–151)):

1. *Removal of topography.* Gravity g_P is measured at a surface point P (Fig. 8.8). The attraction A_T of the topographic masses above sea level is computed by a similar

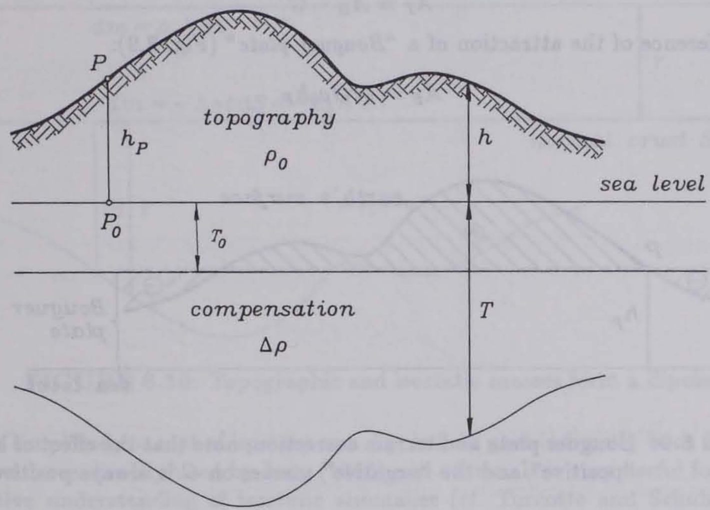

FIGURE 8.8: Topographic and compensating masses contribute to gravity reduction

formula as (8–31a), with ρ instead of $\Delta\rho$ and $z = -h$, and subtracted from g_P. The result is

$$g_P - A_T \quad . \tag{8–33}$$

However, $g_P - A_T$ continues to refer to P, therefore the next step is

2. *Free-air reduction to sea level.* This is done by adding the "free-air reduction"

$$F = -\frac{\partial\gamma}{\partial h} h_P \doteq 0.3086\, h_P \,\text{mgal} \quad , \tag{8–34}$$

with h_P in meters. (The *milligal*, abbreviated mgal, is the conventional unit for gravity differences: $1\text{mgal} = 10^{-5}\,\text{m}\,\text{s}^{-2}$.) The replacement of actual gravity g by normal gravity γ is only an approximation, and the numerical value given in (8–34) is conventional. The result is *Bouguer gravity*

$$g_B = g_P - A_T + F \quad . \tag{8–35}$$

Subtracting normal gravity γ we get the *Bouguer anomaly*

$$\Delta g_B = g_B - \gamma = g_P - A_T + F - \gamma \quad . \tag{8–36}$$

3. *Effect of isostatic compensation.* This effect A_C as expressed by (8–31b) is to be added to (8–36) to give the *isostatic anomaly*

$$\Delta g_I = \Delta g_B + A_C = g_P - A_T + A_C + F - \gamma \quad . \tag{8–37}$$

Bouguer plate and topographic correction. The attraction A_T is conventionally computed as

$$A_T = A_B - C \tag{8–38}$$

as the difference of the attraction of a *"Bouguer plate"* (Fig. 8.9):

$$A_B = 2\pi G \rho_0 h_P \tag{8–39}$$

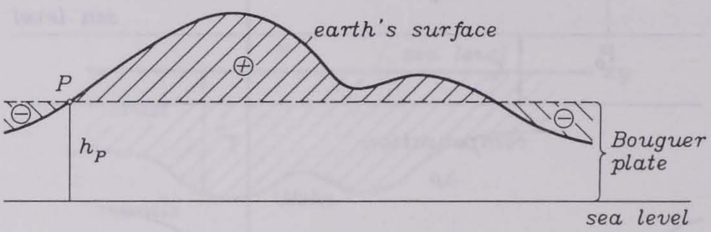

FIGURE 8.9: Bouguer plate and terrain correction; note that the effect of both the "positive" and the "negative" masses on C is always positive

and a *"topographic correction"*, or *"terrain correction"*, C which is usually quite small but *always positive.* For more details cf. (Heiskanen and Moritz, 1967, pp. 130–133); see also sec. 8.2.2 below. Isostatic and other reduced gravity anomalies may also be defined so as to refer to the topographic earth surface rather than to sea level. This is the modern conception related to Molodensky's theory, which is outside the scope of the present book (cf. Heiskanen and Moritz, 1967, secs. 8–2 and 8–11; Moritz, 1980, Part D).

8.2 Isostasy as a Dipole Field

In the case of local compensation, the isostatically compensating mass inside a vertical column is exactly equal to the topographic mass contained in the same column. This holds for both the Pratt and the Airy concept, by the very principle of local compensation. Fig. 8.10 illustrates the situation for the Airy–Heiskanen model. Approximately, the topography may be "condensed" as a surface layer on sea level S_0, whereas the compensation, with appropriate opposite sign, is thought to be concentrated as a surface layer on the surface S_T parallel to S_0 at constant depth T (T is our former T_0). Both surface elements dm for topography and $-dm$ for compensation thus form a dipole. This fact is also expressed by the difference $A_C - A_T$ in (8–37).