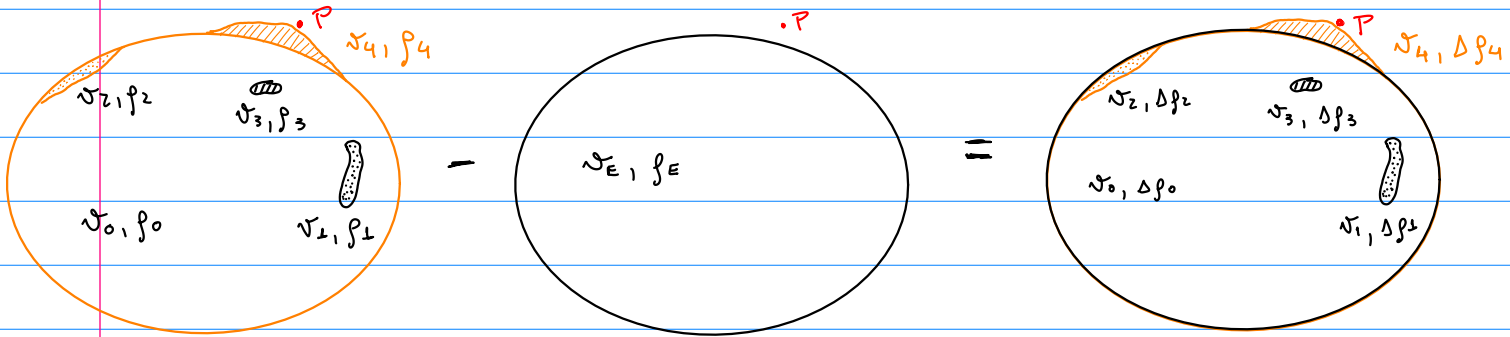


Gravity modeling

True Earth

Normal Earth

True - Normal Earth



$$P = (x, y, z)$$

$$\sigma_E = \sigma_0 \cup \sigma_1 \cup \sigma_2 \cup \sigma_3$$

elipsoid volume

$$\Delta \rho_0 = \rho_0 - \rho_E$$

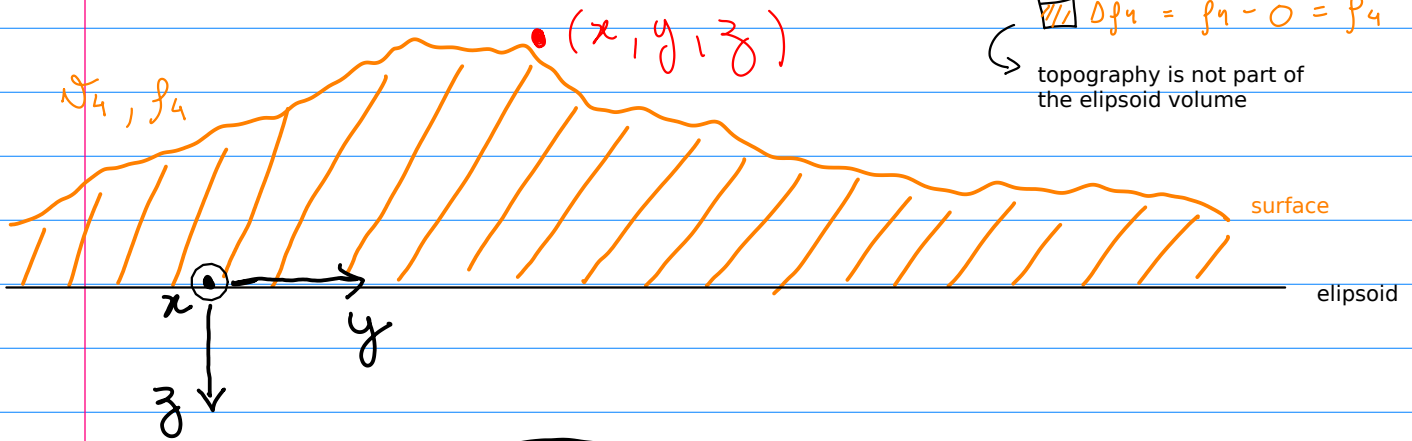
$$\Delta \rho_1 = \rho_1 - \rho_E$$

$$\Delta \rho_2 = \rho_2 - \rho_E$$

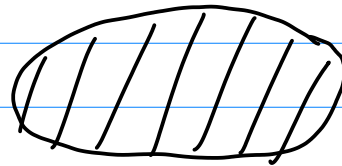
$$\Delta \rho_3 = \rho_3 - \rho_E$$

$$\Delta \rho_4 = \rho_4 - 0 = \rho_4$$

topography is not part of the elipsoid volume



$$\sigma_0, \Delta \rho_0$$



Consider that this geological body is our target

$$\sigma_3, \Delta \rho_3$$

gravitational acceleration produced by the geological body



centrifugal component

gravitational component

gravity vector

$$a_P = a_P^{(0)} + a_P^{(1)} + a_P^{(2)} + a_P^{(3)} + a_P^{(4)}$$

$$a_P^{(k)} \equiv a(x, y, z) = G \iiint_{\sigma_k} \left(\frac{\nabla \cdot \mathbf{r}}{r^3} \right) \rho_k(x', y', z') dv$$

gravity disturbance vector

gravity vector

normal gravity vector

centrifugal component

gravitational component

$$\delta g_P = g_P - \gamma_P$$

$$\gamma_P = \kappa_P + a_P^{(E)}$$

$$a_P^{(E)} = G \iiint_{V_E} \left(\nabla \frac{1}{r} \right) \rho_E(x', y', z') dV$$

purely gravitational effect

$$\delta g_P = \cancel{\kappa_P} + a_P - \cancel{\kappa_P} - a_P^{(E)} = a_P - a_P^{(E)}$$

$\delta g_P = \left(\sum_{K=0}^4 G \iiint_{V_K} \left(\nabla \frac{1}{r} \right) \rho_K(x', y', z') dV \right) - G \iiint_{V_E} \left(\nabla \frac{1}{r} \right) \rho_E(x', y', z') dV$

$= \left(\sum_{K=0}^3 G \iiint_{V_K} \left(\nabla \frac{1}{r} \right) \Delta \rho_K(x', y', z') dV \right) + G \iiint_{V_4} \left(\nabla \frac{1}{r} \right) \rho_4(x', y', z') dV$

$$g_P = \gamma_P + \delta g_P, \quad \|\gamma_P\| \gg \|\delta g_P\|$$

gravity

normal gravity

gravity disturbance

$\|g_P\|$

$\|\gamma_P\|$

$$\delta g_P = g_P - \gamma_P$$

$$\approx (\cancel{\gamma_P} + \hat{z}^T \delta g_P) - \cancel{\gamma_P}$$

Consider a coordinate system satisfying:

$$\hat{\gamma}_P = \hat{z} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix},$$

for any point P in the study area.

$\delta g_P \approx \left(\sum_{K=0}^3 G \iiint_{V_K} \partial_{\hat{z}} \frac{1}{r} \Delta \rho_K(x', y', z') dV \right) + G \iiint_{V_4} \partial_{\hat{z}} \frac{1}{r} \rho_4(x', y', z') dV$

$$\approx \frac{\partial \gamma}{\partial h} h - \frac{\partial \gamma}{\partial h} N$$

$$\Delta g_P^B = g_P - \left(\gamma_Q + \frac{\partial \gamma}{\partial h} H \right) - a_P \approx \left\{ g_P - \gamma_P \right\} + \frac{\partial \gamma}{\partial h} N - a_P$$

$$\approx \left\{ G \iiint_{V_3} \frac{1}{r} \Delta \rho_3(x', y', z') dV + G \iiint_{V_4} \frac{1}{r} \rho_4(x', y', z') dV \right\} + \frac{\partial \gamma}{\partial h} N - a_P$$

$\overline{V_3}$
 vertical component of the gravitational
 acceleration produced by the geological
 body with volume V_3

 $\overline{V_4}$
 vertical component of the gravitational
 acceleration produced by the mass located between the ellipsoid
 and the surface (the topography)

$$\approx G \iiint_{V_3} \frac{1}{r} \Delta \rho_3(x', y', z') dV + \left(\frac{\partial \gamma}{\partial h} + a_P \right)$$

geophysical indirect effect
(Hinze et al, 2005)

$$\Delta g_P^B \approx \delta g_P^B + \left(\frac{\partial \gamma}{\partial h} + a_P \right)$$