16.03.19

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GS543 Tutorial -2

A two-layered model response (for DC resistivity method) in isotropic media can be calculated using the following formula (TELFORD et al., 1990):

$$\rho_{a} = \rho_1 \left[1 + 2p \sum_{m=1}^{\infty} k^m \left(\frac{1}{(r_1^2 + 4m^2z^2)^{\frac{1}{2}}} - \frac{1}{(r_2^2 + 4m^2z^2)^{\frac{1}{2}}} - \frac{1}{(r_3^2 + 4m^2z^2)^{\frac{1}{2}}} + \frac{1}{(r_4^2 + 4m^2z^2)^{\frac{1}{2}}} \right) \right].$$

(3)

$$\rho_a = \underset{\text{Geometric factor}}{G} \frac{\Delta V}{I}$$

where ρ_1 the resistivity of the first layer, z denotes the thickness of the first layer, r_1 is the distance between C_1 and P_1 electrodes and it can be written as $r_1 = |C_1P_1|$. Similarly, the rest of the distances between the current and potential electrodes are $r_2 = |P_1C_2|$, $r_3 = |C_1P_2|$, and $r_4 = |P_2C_2|$, respectively (Fig. 1). Quantity k can be calculated with $k = \frac{(\rho_2 - \rho_1)}{(\rho_2 + \rho_1)}$ and p is given

$$p = \left\{ \left[\frac{1}{\underset{C_1P_1}{r_1}} - \frac{1}{\underset{P_1C_2}{r_2}} \right] - \left[\frac{1}{\underset{C_1P_2}{r_3}} - \frac{1}{\underset{P_2C_2}{r_4}} \right] \right\}^{-1}. \qquad (4)$$

m is a constant for summing variables which was chosen as 45 for this study. Thus, one can calculate a two-layered earth model response analytically using Eq. (3). Figure 1 shows a sketch of current and potential electrode configurations on the surface and a simple two-layered earth.

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(2)

$\rho_1 = 10\ \Omega m$, $AB = C_1C_2 = r_4 + r_2 = r_2 + r_4$;

$\rho_2 = 500\ \Omega m$, $P_1P_2 = 0.5\ m = r_2 - r_4 = r_2 - r_4$

$z = 15m$

r_2 & r_4 only

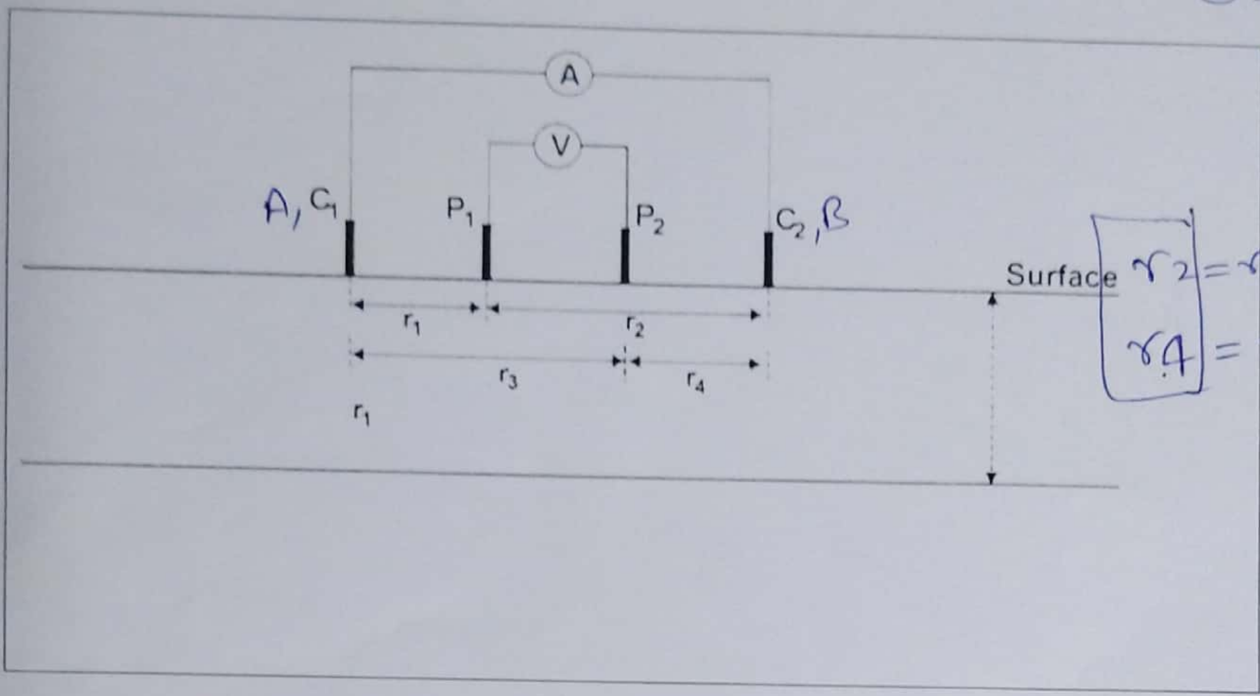

Figure 1: A sketch of current and potential electrode configuration and spacing on the earth surface

Write a Fortran program to compute the two-layer model response and complete the table accordingly.

AB/2	ρ_a	AB/2	ρ_a	AB/2	ρ_a
1.5		40		300	
2		50		350	
3		60		400	
4		80		500	
6		100		600	
8		120		700	
10		140		800	
15		160		900	
20		180		1000	
25		200			
30		250			

$2r_2 = C_1C_2 + P_1P_2$

$r_2 = \dfrac{C_1C_2 + P_1P_2}{2}$

$2r_4 = C_1C_2 - P_1P_2$

$r_4 = \dfrac{C_1C_2 - P_1P_2}{2}$