Solved exercises on resistivity calculation 2025-2026

1) Wenner (single reading)

Given: spacing $a = 5\ \text{m}$, current $I = 0.25\ \text{A}$, voltage $\Delta V = 60\ \text{mV} = 0.060\ \text{V}$.

Formula: $\rho_a = 2\pi a \dfrac{\Delta V}{I}$.

Work: $2\pi a = 31.416$.

$\rho_a = \dfrac{31.416 \times 0.060}{0.25} \approx 7.54\ \Omega \cdot \text{m}$.

Answer: $\boxed{\rho_a \approx 7.54\ \Omega \cdot \text{m}}$.

2) Wenner (multi-spacing table)

Given: $I = 0.50\ \text{A}$.

a (m)	ΔV (mV)	$\rho_a = 2\pi a\, \Delta V / I$ (Ω·m)
2	120	$2\pi \cdot 2 \cdot 0.120/0.5 \approx \mathbf{3.02}$
4	150	$2\pi \cdot 4 \cdot 0.150/0.5 \approx \mathbf{7.54}$
8	210	$2\pi \cdot 8 \cdot 0.210/0.5 \approx \mathbf{21.11}$
16	260	$2\pi \cdot 16 \cdot 0.260/0.5 \approx \mathbf{52.28}$

(Convert mV → V before using the formula.)

3) Schlumberger (single reading)

Given: $MN = 1.5\ \text{m}$ (fixed), $AB/2 = 10\ \text{m} \Rightarrow AB = 20\ \text{m}$, $I = 0.40\ \text{A}$, $\Delta V = 18\ \text{mV} = 0.018\ \text{V}$.

Geometry factor:

$$K = \pi \frac{AB^2 - MN^2}{2\,MN} = \pi \frac{20^2 - 1.5^2}{3} = \pi \cdot \frac{400 - 2.25}{3} \approx 416.87$$

Apparent resistivity:

$\rho_a = K \dfrac{\Delta V}{I} = 416.87 \cdot \dfrac{0.018}{0.40} \approx 18.74\ \Omega \cdot \text{m}$.

Answer: $\boxed{\rho_a \approx 18.7\ \Omega \cdot \text{m}}$.

6) Schlumberger (mini-dataset)

Given: $MN = 2\ \text{m}$, $I = 0.50\ \text{A}$.

Factor: $K = \pi(AB^2 - MN^2)/(2MN)$ with $AB = 2(AB/2)$.

$AB/2$ (m)	ΔV (mV)	K	$\rho_a = K\,\Delta V/I$ (Ω·m)
5	40	$\pi(10^2 - 2^2)/4 \approx 150.80$	$150.80 \cdot 0.040/0.5 \approx \mathbf{6.03}$
10	22	$\pi(20^2 - 2^2)/4 \approx 703.72$	$703.72 \cdot 0.022/0.5 \approx \mathbf{13.68}$
20	12	$\pi(40^2 - 2^2)/4 \approx 3149.34$	$3149.34 \cdot 0.012/0.5 \approx \mathbf{30.08}$

5) Pole–dipole (single reading)

> Conventions differ; here we use the **common** colinear factor $K = 2\pi\, a\, n(n+1)$.

Given: $a = 5\ \text{m}$, $n = 3$, $I = 0.25\ \text{A}$, $\Delta V = 12\ \text{mV} = 0.012\ \text{V}$.

Work: $K = 2\pi \cdot 5 \cdot 3 \cdot 4 = 120\pi \approx 376.99$.

$$\rho_a = 376.99 \cdot \frac{0.012}{0.25} \approx 18.10\ \Omega\cdot\text{m}.$$

Answer: $\boxed{\rho_a \approx 18.1\ \Omega\cdot\text{m}}$.

Exercise A — 3 layers, Wenner (HK-type)

Given (already reduced to ρ_a) — constant current, multiple spacings:

a (m)	1	2	3	5	8	12	20
ρ_a (Ω·m)	40	30	22	18	16	18	35

1) Identify the curve type

ρ_a **falls** from ~40 to ~16, then **rises** to ~100 ⇒ **HK-type** (conductive middle layer):

$$\rho_1 > \rho_2 < \rho_3.$$

2) Read asymptotes (layer resistivities)

- **Small spacing** → shallow: $\boxed{\rho_1 \approx 40\ \Omega\cdot\text{m}}$.
- **Large spacing** → deep: $\boxed{\rho_3 \approx 100\ \Omega\cdot\text{m}}$.
- **Minimum** (mid-curve) ~16–18 ⇒ $\boxed{\rho_2 \approx 16–18\ \Omega\cdot\text{m}}$.

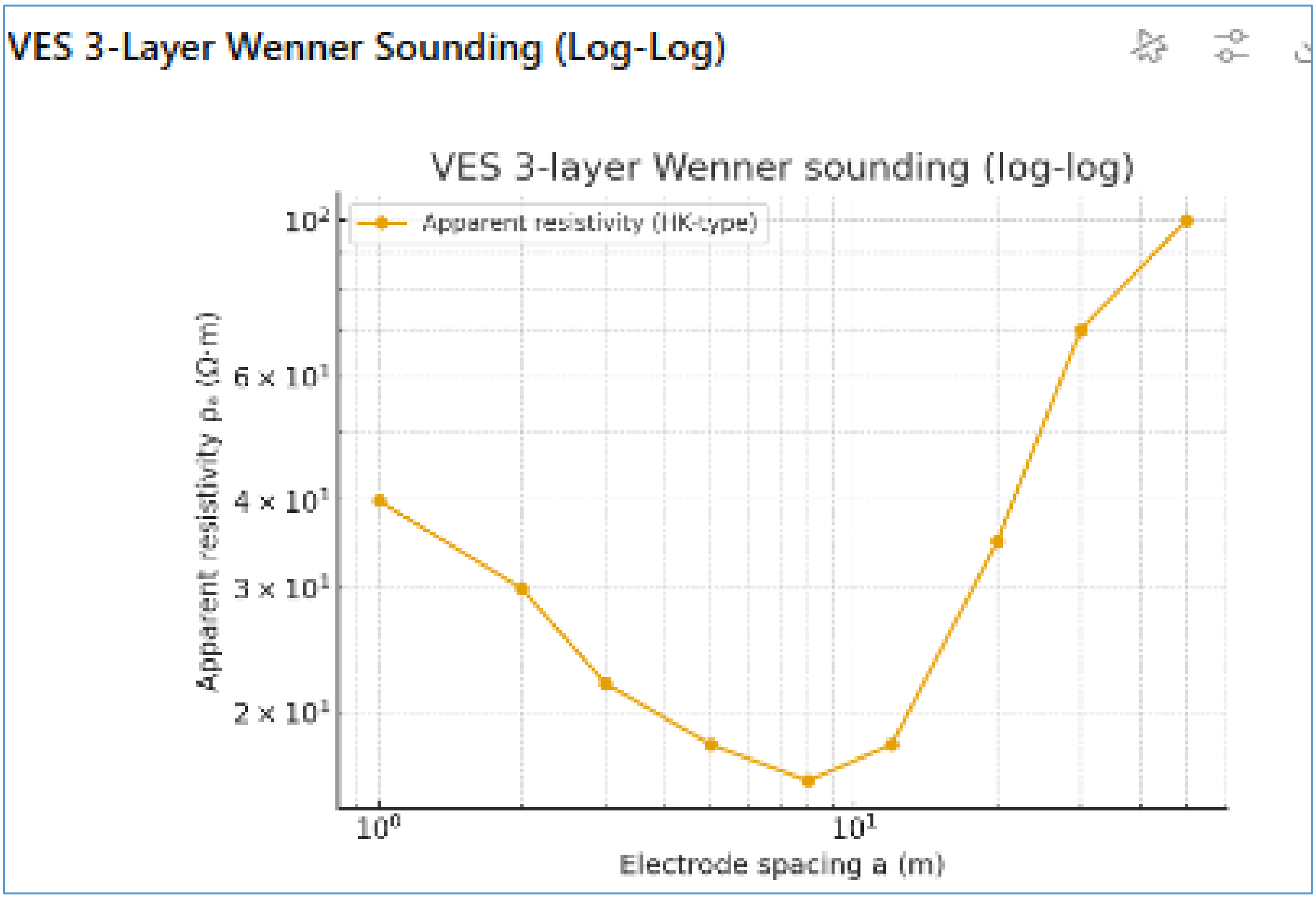
3) Estimate thicknesses h_1, h_2

Use the **shoulder abscissae** (where slope changes the most on a log–log plot).

- First shoulder (1→2) around $a \approx 2–3\ \text{m}$
  ⇒ $\boxed{h_1 \approx 2–3\ \text{m}}$.
- Second shoulder (2→3) around $a \approx 12–20\ \text{m}$
  ⇒ $\boxed{h_2 \approx 10–15\ \text{m}}$.

Solved model (order of magnitude)

$$\boxed{\rho_1 \approx 40,\ h_1 \approx 2–3\ \text{m};\quad \rho_2 \approx 16–18,\ h_2 \approx 10–15\ \text{m};\quad \rho_3 \approx 100\ \Omega\cdot\text{m}.}$$



Exercise B — 3 layers, Schlumberger (KQ-type)

Given (field readings): $MN = 1.5$ m (fixed), current $I = 0.45$ A. Measurements at various $AB/2$:

$AB/2$ (m)	6	10	16	25	40	65
ΔV (mV)	28	26	24	25	32	45

Geometry factor (Schlumberger):

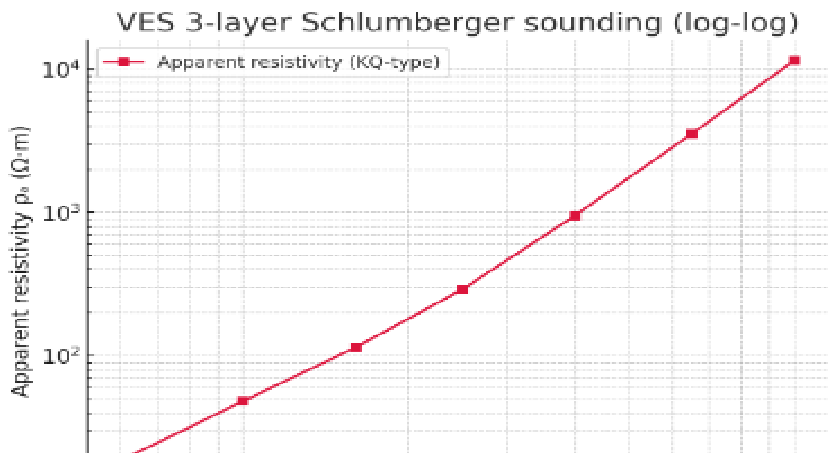
$$K = \pi \frac{AB^2 - MN^2}{2MN}, \quad AB = 2(AB/2).$$

Apparent resistivity: $\rho_a = K \dfrac{\Delta V}{I}$.

1) Compute ρ_a (rounded)

$AB/2$ (m)	AB (m)	K (m)	ΔV (V)	ρ_a (Ω·m)
6	12	≈ 299.2	0.028	**18.6**
10	20	≈ 837.7	0.026	**48.4**
16	32	$\approx 2\,148$	0.024	**114.6**
25	50	$\approx 5\,235$	0.025	**291.9**
40	80	$\approx 13\,432$	0.032	**954.3**
65	130	$\approx 35\,402$	0.045	**3,538**
100	200	$\approx 83\,680$	0.062	**11,518**

VES 3-Layer Schlumberger Sounding (Log-Log)



2) Identify the curve type

ρ_a **rises**, dips slightly, then **rises strongly** with spacing: this is a **KQ-type** behavior (resistive–conductive–very resistive overall trend), consistent with:

$$\rho_1 < \rho_2 < \rho_3 \quad \text{(net upward)} \quad \text{or} \quad \rho_1 < \rho_2,\ \rho_3 \gg \rho_2.$$

Given the strong late-rise, we take:

- **Shallow** (small $AB/2$) plateau $\Rightarrow \rho_1 \approx 20\ \Omega \cdot \mathrm{m}$ (from the first line ~18–20).
- **Intermediate** (mid-range gradient) $\Rightarrow \rho_2 \approx 100\text{–}300\ \Omega \cdot \mathrm{m}$ (use the mid values ~115–292).
- **Deep** (largest spacings) $\Rightarrow \rho_3$ very resistive (multi-kΩ·m apparent) — pick $\rho_3 \approx$ a few kΩ·m as the basement resistivity. A conservative read:

$$\boxed{\rho_1 \approx 20\ \Omega \cdot \mathrm{m}, \quad \rho_2 \approx 150\text{–}300\ \Omega \cdot \mathrm{m}, \quad \rho_3 \gtrsim 3\,000\ \Omega \cdot \mathrm{m}}.$$

3) Estimate thicknesses h_1, h_2

Shoulders (where slope changes most):

- First shoulder around $AB/2 \approx 10\text{–}16\ \mathrm{m}$
  $\Rightarrow \boxed{h_1 \approx 10\text{–}15\ \mathrm{m}}$.
- Second shoulder around $AB/2 \approx 40\text{–}65\ \mathrm{m}$
  $\Rightarrow \boxed{h_2 \approx 30\text{–}50\ \mathrm{m}}$.

Solved model (order of magnitude)

$$\boxed{\rho_1 \approx 20,\ h_1 \approx 10\text{–}15\ \mathrm{m};\ \rho_2 \approx 150\text{–}300,\ h_2 \approx 30\text{–}50\ \mathrm{m};\ \rho_3 \gtrsim 3\,000\ \Omega \cdot \mathrm{m}.}$$

How to reproduce these answers on your own (quick method)

1. **Plot** $\log \rho_a$ vs $\log a$ (Wenner) or $\log(AB/2)$ (Schlumberger).
2. **Identify type** by the global trend (K, H, Q, A, etc.).
3. **Read plateaus** → ρ_1 (small spacing), ρ_3 (large spacing).
4. **Use minima/maxima/inflections** to estimate ρ_2 and locate **shoulders**.
5. **Thickness scales:** shoulder abscissa gives the **order** of h (first shoulder → h_1, second → h_2).
6. For precision, use **master-curve matching** or a **1D inversion**.