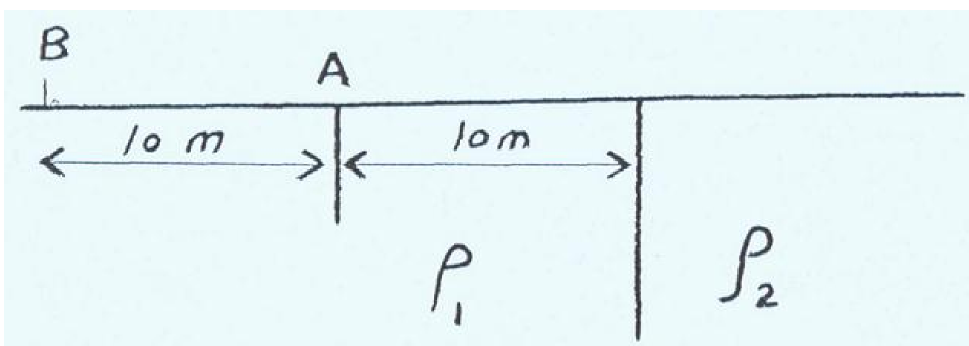
HOMEWORK ASSIGNMENTS

1. CONSIDER A VERTICAL CONTACT BETWEEN TWO GEOLOGIC UNITS OF GREATLY DIFFERENT RESISTIVITIES P_1 AND P_2 .

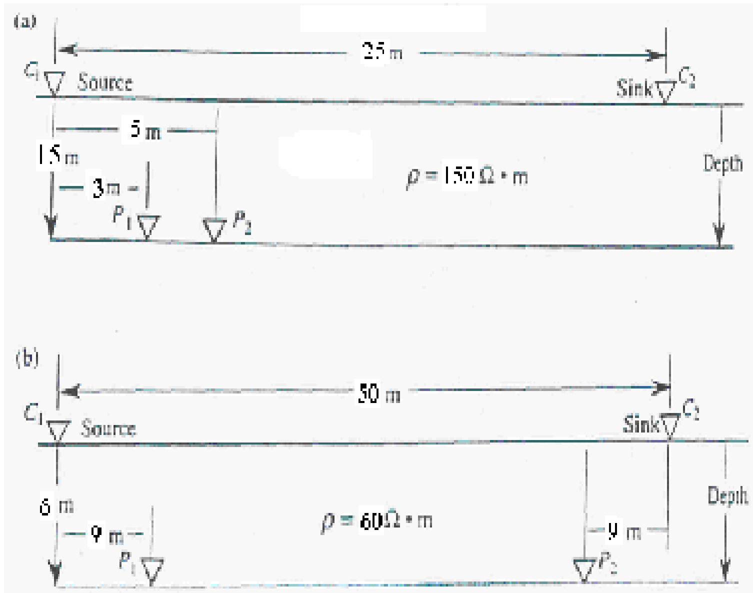
A. CALCULA TE THE DIRECTION THAT ELECTRICAL CURRENT WILL LEAVE THE BOUNDARY INTO P_2 IF IT APPROACHES THE BOUNDARY AT AN ANGLE OF 45° TO THE NORMAL.

B. CALCULATE THE ELECTRICAL POTENTIAL AT POINT A FROM A SINGLE SOURGE OF CURRENT ($+I$) A T POINT B. REMEMBER THAT THE BOUNDARY WILL CREATE A REFLECTED IMAGE OF THE CURRENT SOURCE WITH MAGNITUDE KI. FOR P1 = 100 Ωm AND $P_2 = 0.1$ Ωm

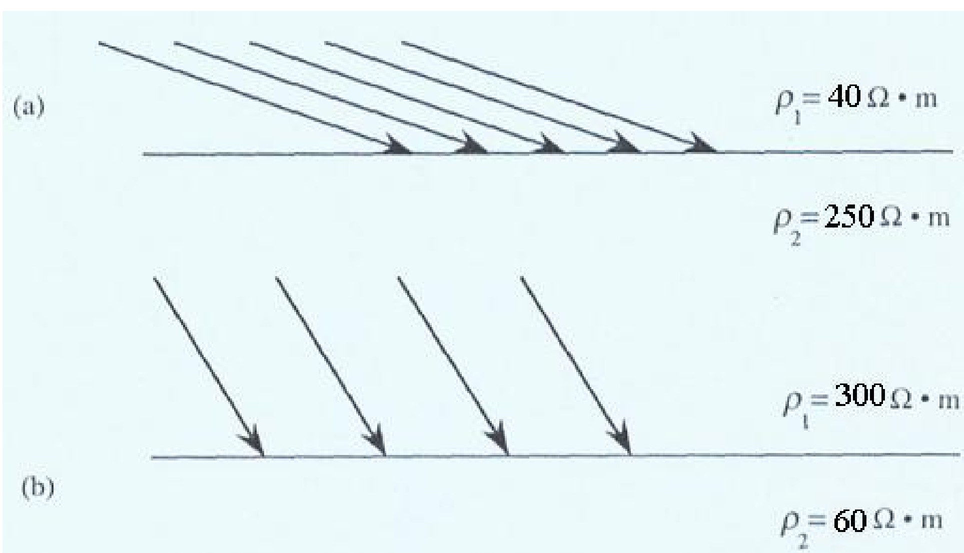
C. REPEAT (A) AND (B) FOR P1 = 100 Ωm AND $P_2 = 10000$ Ωm



2. Determine the potential difference between the two potential electrodes for cases (a) and (b). Assume a current of 0.5 ampere for (a) and 0.8 ampere for (b).



3. Construct the current-flow lines beneath the interface in (a) and (b).



4 - Interpret the following data, which were obtained with a Schlumberger traverse.

Electrode Spacing (m)	ρ (Ω . m)	Electrode Spacing (m)	ρ (Ω . m)	Electrode Spacing (m)	ρ (Ω . m)
I.00	108	14.68	307	215.44	293
1.47	121	21.54	245	316.23	381
2.15	I4X	31.62	168	464.16	479
3.16	191	46.42	122	681.29	580
4.64	244	68.13	115	1000.0	675
6.81	295	100	162		
10.00	323	146.78	220		

5- The following data were gathered with a Wenner, expanding-spread traverse in an area of thick deltaic sands. Bedrock depths are greater than 30 m. What is your best estimate of the depth to the water table in this area?

Electrode Spacing (m)	ρ (Ω . m)	Electrode Spacing (m)	ρ (Ω . m)
0.47	2590	6.81	8753
0.69	3288	10.00	7630
1.00	4421	14.68	4805
1.47	5198	21.54	2160
2.15	6055	31.62	995
3.16	6686	46.42	584
4.64	7782		

6. The following data were gathered with a Wenner. expanding-spread traverse in an area of dune sands underlain by lake clays which in turn are underlain by Triassic sedimentary rocks. Estimate a value for clay thickness.

Electrode Spacing (m)	ρ (Ω . m)	Electrode Spacing (m)	ρ (Ω . m)
0.69	1298.90	10.00	360.67
1.00	1398.06	14.68	240. 1 1
1.47	1306.98	21.54	191.51
2.15	1153.02	31.62	153.81
3.16	925.27	46.42	116.38
4.64	762.40	68.13	98.03
6.81	554.13	100.00	86.08

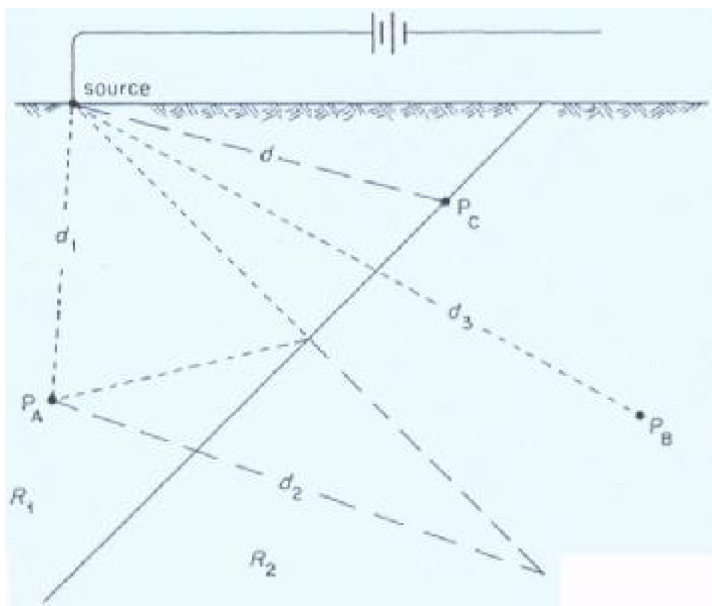
7. Interpret the following data, which were obtained with a Wenner traverse.

Electrode Spacing (m)	p_a (Ω • m)	Electrode Spacing (m)	p_a (Ω • m)	Electrode Spacing (m)	p_a (Ω • m)
1 .00	984	14.68	72	215.44	327
1.47	955	21.54	53	316.23	432

2.15	883	31.62	63	464.16	554
3.16	742	46.42	87	681.29	686
4.64	533	68.13	124	1000.00	818
6.81	311	100.00	174		
10.00	150	146.78	241		

8. Assume a homogeneous medium of resistivity 120 ohm-m. Using the wenner electrode system with a 60-m spacing, assume a current of 0.628 ampere. What is the measured potential difference? What will be the potential difference if we place the sink (negative-current electrode) at infinity?

9. Suppose that the potential difference is measured with an electrode system for which one of the current electrodes and one of the potential electrodes are at infinity. Using the Figure below and a current of 0.5 ampere, compute the potential difference between the electrodes at P_A and infinity for $d_1 = 50$ m, $d_2 = 100$ m, $R_1 = 30$ ohm-m, $R_2 = 350$ ohm-m.



10. Plot resistivity data as a function of electrode spacing, and determine the particular electrode spacing corresponding to the inflection point for the data given in Exercise 9. Compare the electrode spacing at the inflection point with the depth of the boundary from Exercise 9.

11. If the Schlumberger electrode system with AB/2 : MN/2 = 5. is used to conduct the resistivity survey explained in Exercise 9, what will the potential readings be? Use resistivity values found in Exercise 9 to compute potential differences for each of the electrode spacings

AB/2 = 1, 2, 4, 6, 8, 10, 15, 20, 25, 30, 40, 50 m while a constant current of 0.250 ampere is applied.

12. Suppose that an electrical resistivity survey was done using an expanding Wenner electrode-configuration. The current of 0.25 ampere was kept the same for all the readings. Potential differences measured with different electrode spacings are given in the following table. Interpretations of these measurements indicate that a layer of resistivity R_1 lies above another layer of resistivity $R_{.2}$. Determine the depth of the boundary between these two layers. Estimate the resistivities of the layers.

ELECTRODE SPACING (m)	**POTENTIAL DIFFERENCE (v)**
1	0.8
2	0.42
4	0.28
6	0.155
8	0.125
10	0.120
15	0.105
20	0.10
25	0.098
30	0.086
40	0.076
50	0.064

13. For purposes of an IP survey, resistivity values are determined from both direct and alternating current using the same electrode arrangement. If the resistivities for direct and alternating current are R_{dc} = 50 ohm-m and R_{ac} = 40 ohm-m, respectively, what will the frequency effect and the metal factor values be.

14. Assume- that a telluric current survey is to be carried out to outline large-scale features of a sedimentary basin 5 km deep. A resistivity of 50 ohm-m is supposed to represent the sedimentary section. What is the maximum frequency of the telluric current that will penetrate below the basin?

15. Suppose That a magnetotelluric survey indicates an apparent resistivity of 5 ohm-m at a frequency of 1 Hz, What is the thickness of the layer?

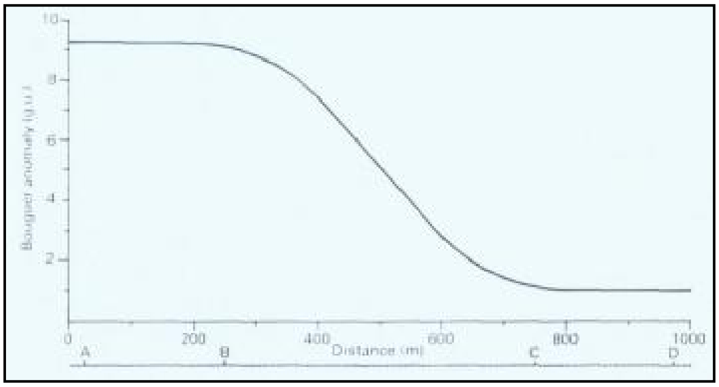
16. Using the method of electrical images, drive therelationship between apparent resistivity, electrode spacing, layer thicknesses and resistivities for a VES performed with a Schlumberger spread over a single horizontal interface between media with resistivities ρ_1 and p_2.

17. Calculate the variation in apparent resistivity along a HEP profile at right angles to a vertically faulted contact between sandstone and limestone, with apparent resistivities of 50 ohm m and 600 ohm m. respectively, for a Wenner configuration. What would be the effect on the profiles if the contact dipped at a shallower angle.

18. Why are the electrical methods of exploration particularly suited to hydrogeological investigations? Describe other geophysical methods which could be used in this context, stating the reasons why they are applicable.

19. Let *A* and B represent two different geologic sections, and let H_1 and H_2 represent the thicknesses of the first and second layers in a three-layer sequence. It is well known that one type of equivalence occurs for a three-layer case when $p_1 < p_2 > p_3$. $p_{1A} = p_{1B}$, $p_{3A} = p_{3B}$, $H_{1A} = H_{1B}$, and $P_{2A}. H_{2A} = P_{2B}. H_{2B}$. Demonstrate that this is true. Does equivalence exist if $p_1 > p_2 < p_3$?. Explain.

20. At locations A, B, C , D along the gravity profile shown below, VES were performed with a Wenner array with the spread laid perpendicular to the profile.



It was found that the sounding curves, were similar for locations A ,and B and for C and D. A borehole close to A penetrated 3m of drift, 42 m of limestone and bottomed in sandstone. Downhole geophysical surveys provided the following values of density (ρ_D) and resistivity (ρ_R) for the lithologies encountered.

Unit	ρ_R (Ω m)	ρ_D (Mg m^{-3})
Drift	40	2.00
Limestone	2000	2.75
Sandstone	200	2.40

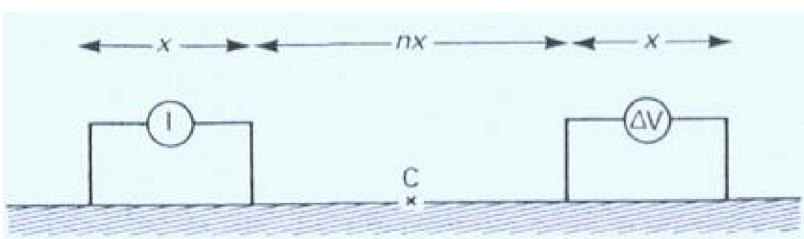
A seismic refraction line near to D revealed 15m of drift, although the nature of the underlying basement could not be assessed from the seismic velocity.

(a) Interpret the geophysical data so as to provide a geological section along the profile.
(b) What further techniques might be used to confirm your interpretation?
(c) If a HEP were to be performed along the profile, select, giving reasons, a suitable electrode spacing to map the basement. Sketch the expected form of the HEP for both longitudinal and transverse traverses.

21. The following table represents the results of a frequency domain IP survey of a Precambrian shield area. A dipole-dipole array was used with the separation (x) of both the current electrodes and the potential electrodes kept constant at 60m. n refers to the number of separations between the current and potential electrode pairs and c to the distance of the center of the array from the origin of the profile, where the results are plotted (Figure below). Measurements were taken using direct current and an alternating current of 10Hz. These provided the apparent resistivities p_{dc} and p_{ac} respectively,

(a) For each measurement point, calculate the percentage frequency effect (PFE) and metal factor parameter (MF).

	$n = 1$		$n = 2$		$n = 3$		$n = 4$	
c (m)	ρ_{dc} (Ω m)	ρ_{ac} (Ω m)	ρ_{dc} (Ω m)	ρ_{ac} (Ω m)	ρ_{dc} (Ω m)	ρ_{ac} (Ω m)	ρ_{dc} (Ω m)	ρ_{ac} (Ω m)
0	49.8	49.6			101.5	100.9		
30			72.8	72.4			99.6	98.5
60	46.0	45.8			86.2	85.2		
90			61.3	60.6			90.0	86.1
120	42.1	41.7			72.8	70.1		
150			55.5	54.4			57.5	53.5
180	44.0	43.5			49.8	46.6		
210			53.6	51.1			47.9	44.0
240	42.1	41.8			44.0	41.4		
270			65.1	64.1			47.9	44.9
300	49.8	49.6			95.8	91.7		
330			82.3	81.3			132.1	129.4
360	51.7	51.3			114.9	114.1		
390			86.2	85.9			164.7	164.0
420	49.8	49.6			120.7	120.1		
450			78.5	78.0			170.4	169.7



The dipole-dipole electrode configuration.

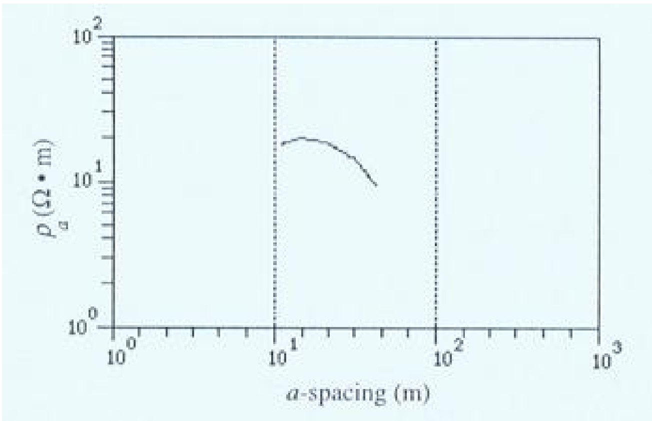
(b) For both the PFF, and MF plot four profiles for $n = 1, 2$, 3 and 4.

(c) The area is covered by highly-conductive glacial deposits 30-60m thick, It is possible that massive sulphide mineralization is present within the bedrock. Bearing this information in mind, comment upon and interpret the profiles.

22. For each of the following subsurface models sketch an appropriate apparent resistivity curve on the designated graph. The general shape of the curve is what is important. Base your curves on what you know about current penetration, current density, and measured resistivities.

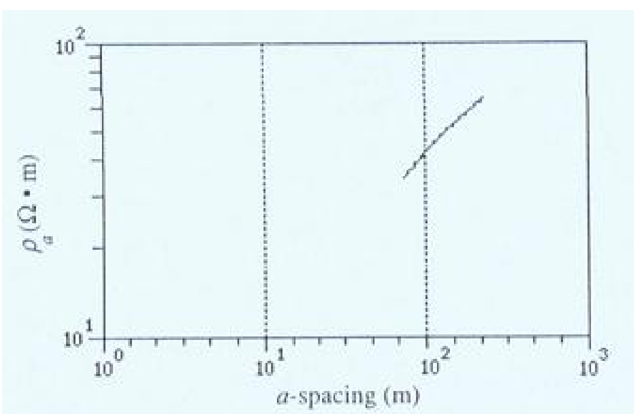
(a)

Layer	Thickness (m)	Resistivity (Ω .m)
1	1	100
2	5	10
3	5	100
4	Infinite	1

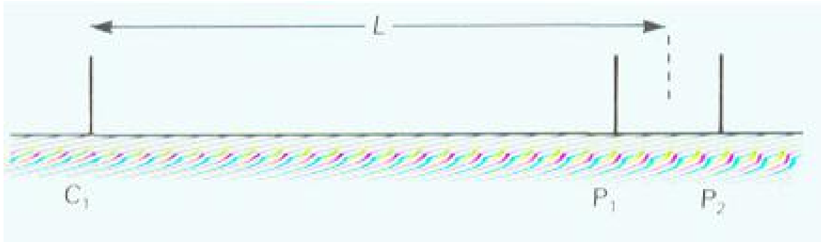


(b)

Layer	Thickness (m)	Resistivity (Ω .m)
1	10	100
2	10	10
3	Infinite	100



23. The figure below shows a half-Schlumberger resistivity array in which the second current electrode is situated at a great distance from the other electrodes. Derive an expression for the apparent resistivity of this array in terms of the electrode spacings and the measured resistance.



The half-Schlumberger electrode configuration.

24. Calculate the potential at P_1 due to a current at C_1 of 0.6 ampere. The material in this section view extends to infinity in all directions. The bold line represents an interface between p_1 and p_2 – material.