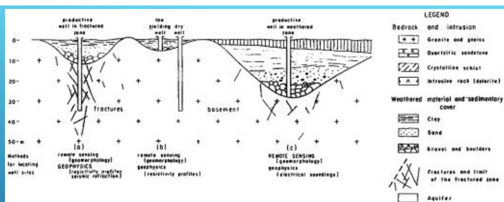
INTRODUCTION TO GEOPHYSICS:

Resistivity 101

APPLICATIONS
WHAT IS GEOPHYSICS?
GEOPHYSICAL METHODS
RESISTIVITY METHODS
INTERPRETATION OF A SURVEY
PROBLEMS



HARD ROCK OR BASEMENT FORMATIONS

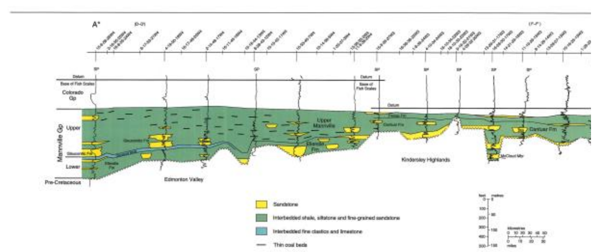
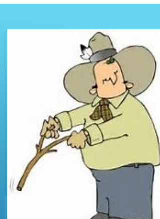


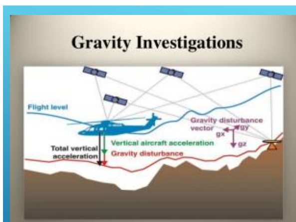
Figure 19.17 *Continued.* Regional cross section A"-A' (southeast half of A-A'). See Figure 19.14 for line of section.

SEDIMENTARY FORMATIONS

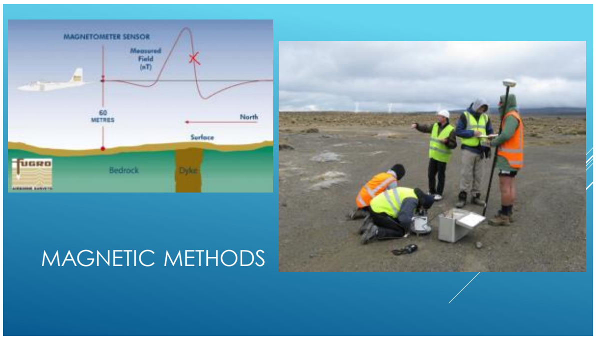
- Passive Methods
- Magnetic
- Gravity
- Active Methods
- Seismic
- Electro-Magnetic
- Resistivity

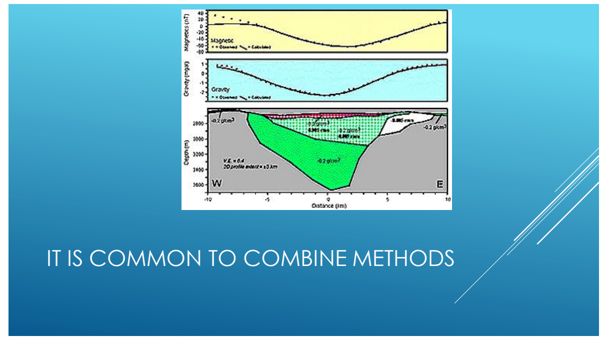


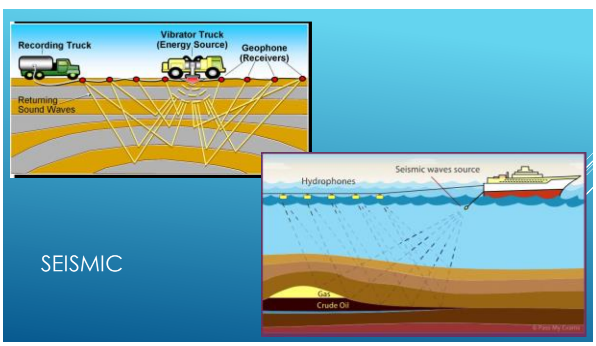
WHAT IS A GEOPHYSICAL SURVEY?

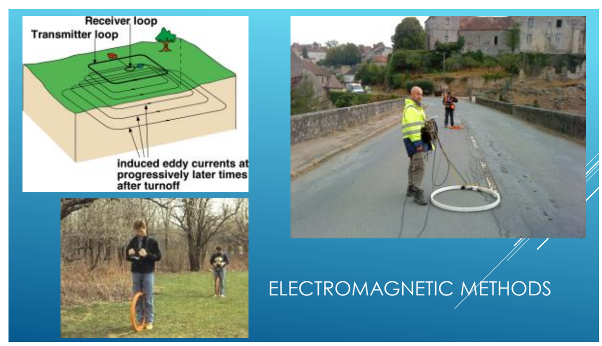


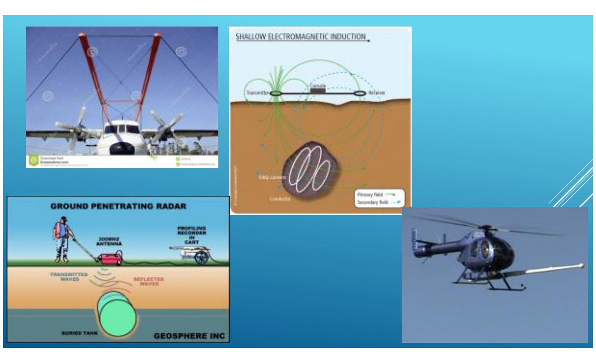
GRAVITY METHODS


MAGNETOMETER SENSOR
Measured Field (nT)
60 METRES
North
Surface
Bedrock
Dyke
FUGRO
MAGNETIC METHODS


Magnetic
Gravity
W
E
Distance (km)
IT IS COMMON TO COMBINE METHODS


Recording Truck
Vibrator Truck (Energy Source)
Geophone (Receivers)
Returning Sound Waves
Hydrophones
Seismic waves source
Gas
Crude Oil
SEISMIC

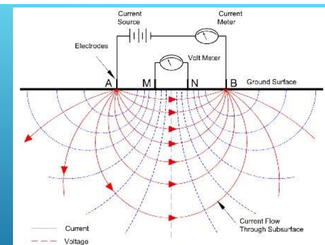

Receiver loop
Transmitter loop
induced eddy currents at progressively later times after turnoff
ELECTROMAGNETIC METHODS


SHALLOW ELECTROMAGNETIC INDUCTION
GROUND PENETRATING RADAR
GEOSPHERE INC

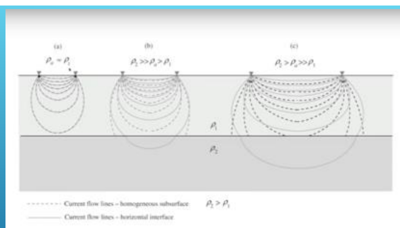

RESISTIVITY SURVEYING

Electrical Resistivity method

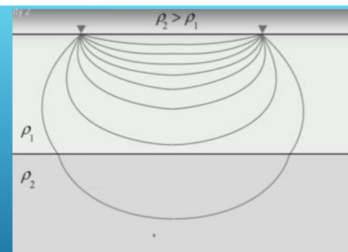
- **Profiling** and **Sounding** are two types of resistivity investigations. Profiling is done to detect lateral changes in resistivity. This study reveals the **changes in the subsurface lithology** or structure from place to place.
- Sounding is done to determine the **vertical changes in resistivity**, this study reveals changes in lithology, at a particular place with increasing depth.



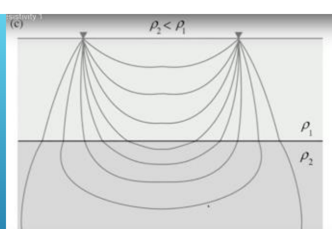
WERE DOES THE ELECTRICITY GO IN THE GROUND?



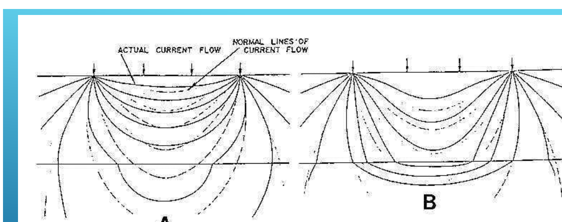
HOW THE DIFFERENCES IN THE GROUND AFFECT THE MOVEMENT OF ELECTRICITY



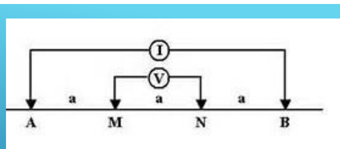
GREATER RESISTIVITY INCREASES THE DISTANCE THE ELECTRICITY TRAVELS



LOWER RESISTIVITY SHORTENS THE PATH OF THE CURRENT



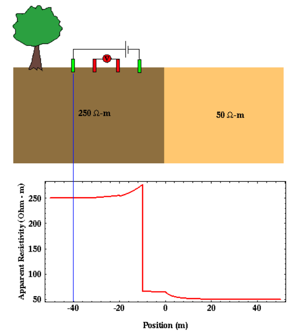
A=HIGHER RESISTIVITY, B=LOWER



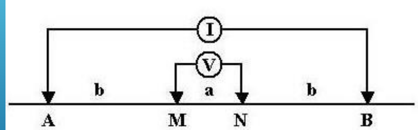
$$\rho_A = 2\pi\, a \frac{V}{I}$$

WENNER ARRAY

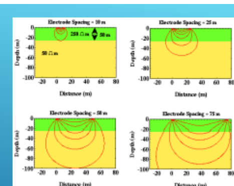
A WENNER ARRAY IS COMMONLY USED FOR PROFILING FORMATIONS

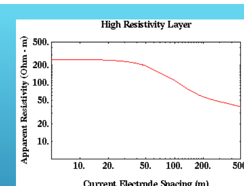


$$\rho_A = \frac{V}{I}\pi\frac{b\,(b+a)}{a} \approx \frac{V}{I}\pi\frac{b^2}{a} \quad \text{if } a << b$$



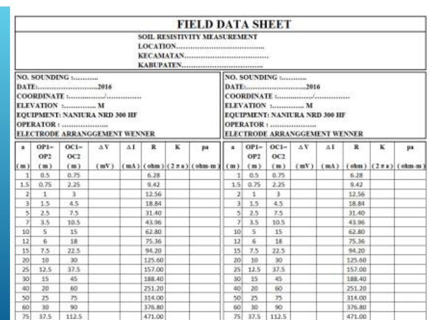
SCHLUMBERGER ARRAY





EITHER SCHULMBERGER OR WENNER ARRAY CAN BE USED FOR VERTICAL ELECTRIC SOUNDINGS VES

SET UP AND TAKING READINGS



FIELD DATA SHEET

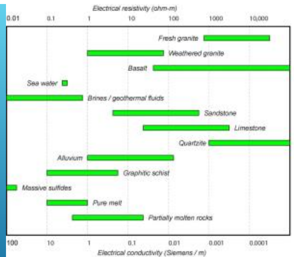
SOIL RESISTIVITY MEASUREMENT
LOCATION.......................................
KECAMATAN.......................................
KABUPATEN.......................................

NO. SOUNDING :............
DATE:..............................2016
COORDINATE :................/................
ELEVATION :............... M
EQUIPMENT: NANIURA NRD 300 HF
OPERATOR : ....
ELECTRODE ARRANGGEMENT WENNER

a (m)	OP1=OP2 (m)	OC1=OC2 (m)	ΔV (mV)	ΔI (mA)	R (ohm)	K (2πa)	ρa (ohm-m)
1	0.5	0.75			6.28		
1.5	0.75	2.25			9.42		
2	1	3			12.56		
3	1.5	4.5			18.84		
5	2.5	7.5			31.40		
7	3.5	10.5			43.96		
10	5	15			62.80		
12	6	18			75.36		
15	7.5	22.5			94.20		
20	10	30			125.60		
25	12.5	37.5			157.00		
30	15	45			188.40		
40	20	60			251.20		
50	25	75			314.00		
60	30	90			376.80		
75	37.5	112.5			471.00		
100	50	150			628.00		

NO. SOUNDING :............
DATE:..............................2016
COORDINATE :................/................
ELEVATION :............... M
EQUIPMENT: NANIURA NRD 300 HF
OPERATOR : ....
ELECTRODE ARRANGGEMENT WENNER

a (m)	OP1=OP2 (m)	OC1=OC2 (m)	ΔV (mV)	ΔI (mA)	R (ohm)	K (2πa)	ρa (ohm-m)
1	0.5	0.75			6.28		
1.5	0.75	2.25			9.42		
2	1	3			12.56		
3	1.5	4.5			18.84		
5	2.5	7.5			31.40		
7	3.5	10.5			43.96		
10	5	15			62.80		
12	6	18			75.36		
15	7.5	22.5			94.20		
20	10	30			125.60		
25	12.5	37.5			157.00		
30	15	45			188.40		
40	20	60			251.20		
50	25	75			314.00		
60	30	90			376.80		
75	37.5	112.5			471.00		
100	50	150			628.00		



RESISTIVITY OF DIFFERENT FORMATIONS

DATA TAKEN FROM A VERTICAL ELECTRIC SOUNDING

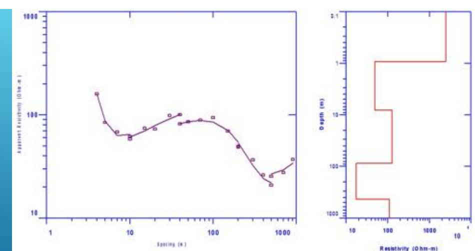
DATE: 24/08/2016 **E 005° 10' 53.2"**
LOCATION: PIVOT 2 (VES 2), EDU (SHONGA FARM 12)
SOUNDING USED: SCHLUMBERGER
TABLE 2 VES 02

S/N	A B/2 (M)	MN/2 (M)	VES 01 (ΩM)
1	1	0.5	296
2	2	0.5	232
3	3	0.5	208
4	5	0.5	211
5	6	0.5	189
6	6	1.0	238
7	8	1.0	196
8	10	1.0	189
9	10	2.5	173
10	15	2.5	153
11	20	2.5	151
12	30	2.5	139
13	40	2.5	106
14	40	2.5	88
15	50	2.5	71
16	60	7.5	7
17	70	7.5	38
18	80	7.5	37
19	80	7.5	122
20	90	7.5	140
21	100	7.5	19
22	110	15	37
23	120	15	36
24	130	15	24
25	140	15	101
26	150	15	30
27	160	15	
28	170	15	
29	180	15	
30	190	15	
40	200	20	
50	210	20	
60	220	20	
70	230	20	

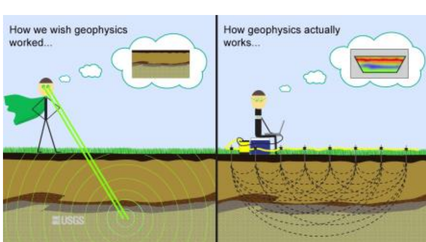
TABLE 15: THE RESULT OF THE VES CURVE INTERTRETATION INDICATING THE NUMBER OF SUBSURFACE LAYERS AND THEIR RESPECTABLE THICKNESSES AT THE PREMISES OF SHONGA FARM, SHONGA, EDU LOCAL GOVERNMENT, KWARA STATE.
TABLE 15: PIVOT 2 VES 02

Number layer	Resistivity(Om)	Thickness(m)	Description of each probable layer
1	277	0-5	Clayey Sand
2	157	5-29	Clay
3	53	29-63	Sandy Clay
4	11	63-140	Saturated Sandstone/Gravel
5	54	>140	Sandy Clay

LAYERS DERIVED FROM READINGS



GRAPH OF READINGS AND LAYERS



NEWER MODELS CAN TAKE AUTOMATED READING AND CREATE 2D & 3D PICTURES

- A Survey provides information on the formation you are investigating
- It is possible for a non-unique interpretation of the data
- Cultural Interference, barb wire fence with T-posts, powerlines, pipelines, transmitters, engines, etc.
- Experience of interpretation of the data is key
- Non-uniformity of the formation
- Always drill your anomality

GEOPHYSICAL SURVEYS DO NOT FIND WATER! THEY GIVE YOU INFORMATION ON THE PROPERTIES OF A FORMATION