Field Training Report - Day 08 on

SELF POTENTIAL (SP) METHOD

Supervisor: Dr. PARTHA PRATIM MANDAL

Name: **Rajkumar Mondal**

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Department of Applied Geophysics

IIT (ISM), Dhanbad

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Content:

OBJECTIVE: SELF POTENTIAL METHOD FOR SHALLOW SUBSURFACE INVESTIGATION.

Geology of Baliapur and its surrounding:

• Dhanbad's geological composition predominantly consists of the Chotanagpur Gneissic Complex, which underlies the region encompassing IIT (ISM)Dhanbad. The lithology is marked by metamorphicand igneous rocks, including granites and gneisses. Notably, the Khudia Nala section offers a prime view of these rocks, showcasing gneisses with distinct compositional banding. The Khudia Nala traverse also reveals the rock's deformational history, illustrated by reclined folds. Baliapur CD Block is encircled by Dhanbad and Govindpur CD Blocks to the north, Nirsa CD Block to the east, Raghunathpur II CD Block in Purulia district (West Bengal) to the south, and Jharia CD Block to the west.

The lithology and geology structure are shown below figure,

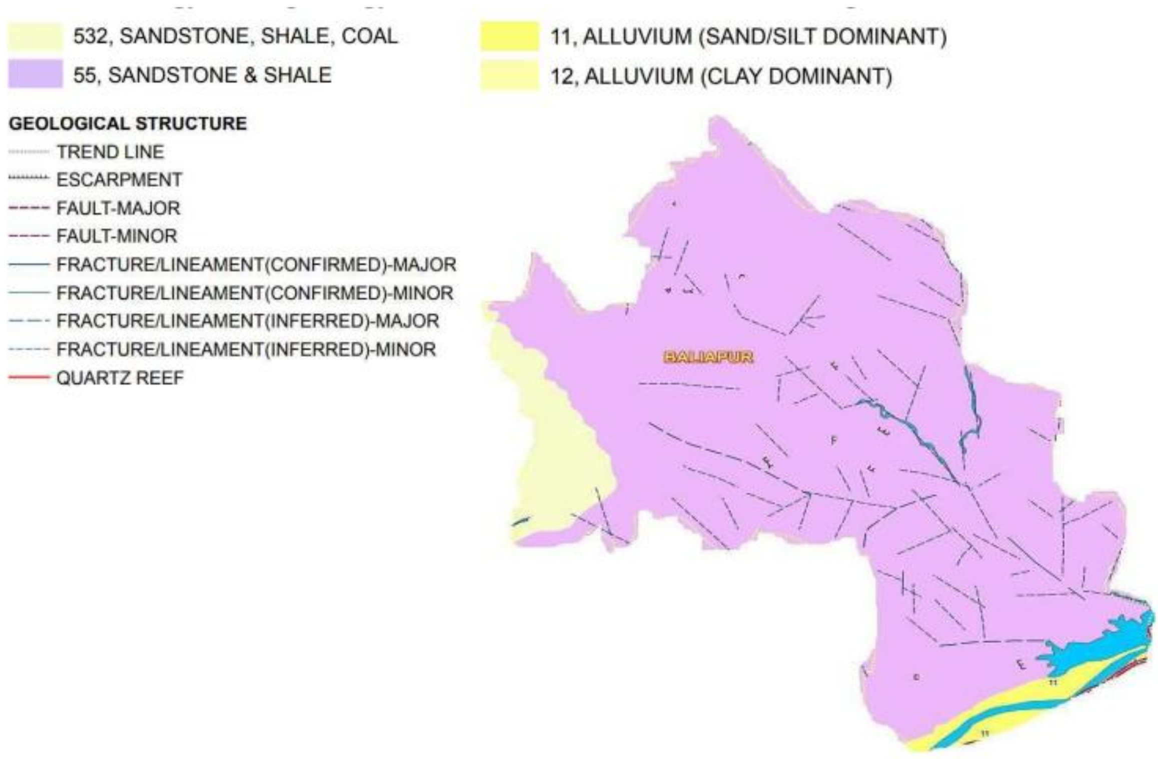


***Figure 1**: Lithological map of Baliapur ,Dhanbad*

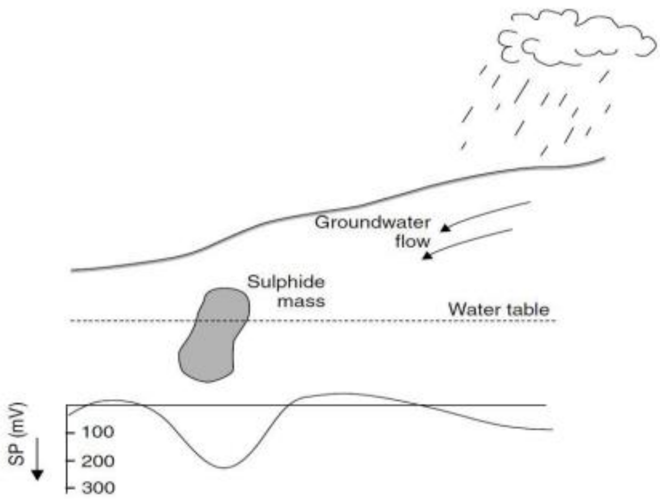
THEORY:

Electrical Self Potential (SP) Surveys

SP surveys were at one time popular in mineral exploration because of their low cost and simplicity. They are now little used because some near-surface ore bodies that are readily detected by other electrical methods produce no SP anomaly.

Origins of natural potentials

Natural potentials of as much as 1.8 V have been observed where Alunite (Alunite is a hydroxylated aluminium potassium sulphate mineral, formula $KAl_3(SO_4)_2(OH)_6$), weathers to sulphuric acid, but the negative anomalies produced by sulphide ore bodies and graphite are generally less than 500 mV. The conductor should extend from the zone of oxidation near the surface to the reducing environment below the water table, thus providing a low-resistance path for oxidation–reduction currents (see the following figure). From the following figure Sources of SP effects. The sulphide mass straddling the water table concentrates the flow of oxidation–reduction currents, producing a negative anomaly at the surface. The downslope flow of groundwater after rain produces a temporary SP, in this case inversely correlated with topography.



sometimes SP surveys are useful in hydrogeology but can make mineral exploration surveys inadvisable for up to a week after heavy rain. Movements of steam or hot water can explain most of the SPs associated with geothermal systems, but small (<10 mV) voltages, which may be positive or negative, are produced directly by temperature differences. Geothermal SP anomalies tend to be broad (perhaps several kilometres across) and have amplitudes of less than 100 mV, so very high accuracies are needed. Small alternating currents are induced in the Earth by variations in the ionospheric component of the magnetic field and by thunderstorms. Only the long-period components of the associated voltages, seldom amounting to more than 5 mV, are detected by the DC voltmeters used in SP surveys. If, as is very occasionally the case, such voltages are significant, the survey should be repeated at different times of the day so that results can be averaged.

METHODOLOGY:

❖ SURVEY DESIGN:

- We need to define our survey area.
- We need to design our survey profile (we did in a linear fashion).
- What should be our base station.
- We need to defining the spacing between porous pot electrodes depending upon objectives (we take it 2m).
- What need to use same solution (we used copper sulphate solution).

❖ Instrumentation:

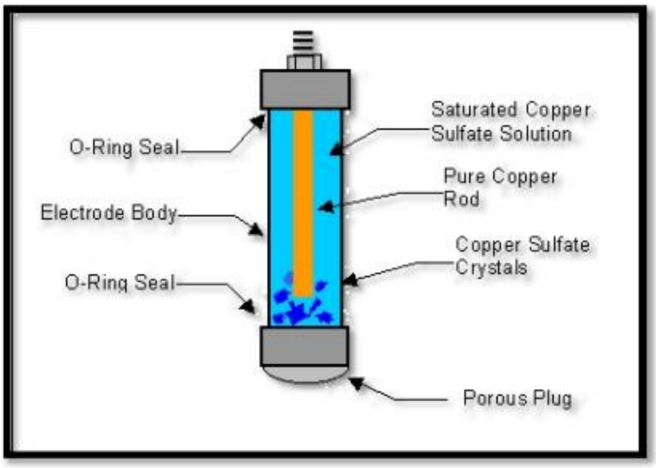
- 4 porous pot electrodes.
- Copper solution.
- Multimeter.
- Salt.
- Wire.
- Ranging rod.
- Measuring tape.
- Connecting clip.

❖ Field Procedure:

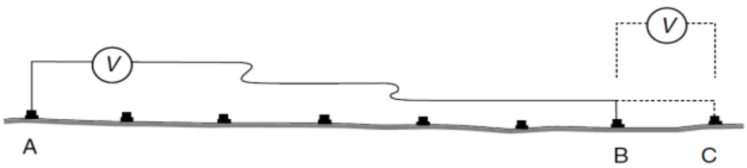
- First, we need to complete a profile of 200m.
- Then we need to dig holes at every 2m separation.
- Then we need to add salt water.
- Before starting the survey make sure that porous pots having low voltage.
- Make sure porous pots having same solution.
- Then one fixed in a base station and relative to that we took readings at every 2m.

SP surveys:

Voltmeters used for SP work must have millivolt sensitivity and very high impedance so that the currents drawn from the ground are negligible. A pair of copper/ copper-sulphate 'pot' electrodes are almost universal is used; see the following figure, and linked to the meter by lengths of insulated copper wire. An SP survey can be carried out by using two electrodes separated by a small constant distance, commonly 5 or 10 m, to measure average field gradients. The method is useful if cable is limited, but errors tend to accumulate and coverage is slow because the voltmeter and both electrodes must be moved for each reading. More commonly, voltages are measured in relation to a fixed base. One electrode and the meter remain at this point and only the second electrode is moved. Subbases must be established if the cable is about to run out or if distances become too great for easy communication. Voltages measured from a base and a sub-base can be related provided that the potential difference between the two bases is accurately known.



The following figure shows how a secondary base can be established. The end of the cable has almost been reached at field point B, but it is still possible to obtain a reading at the next point, C, using the original base at A. After differences have been measured between A and both B and C, the field electrode is left at C and the base electrode is moved to B. The potential difference between A and B is thus estimated both by direct measurement and by subtracting the B to C voltage from the directly measured A to C voltage. The average difference can be added to values obtained with the base at B to obtain values relative to A.



The figure above shows how to move a base station in an SP survey. The value at the new base (B) relative to A is measured directly and also indirectly by measurements of the voltage at the field point C relative to both bases. The two estimates of the voltage difference between A and B are then averaged.

Constraints:

If two estimates of a base/sub-base difference disagree by more than one or two mill volts, work should be stopped until the reason has been determined. Usually, it will be found that copper sulphate solution has either leaked away or become under saturated. Electrodes should be checked every two to three hours by placing them on the ground a few inches apart. The voltage difference should not exceed 1 or 2 mV. Accumulation of errors in large surveys can be minimized by working in closed and interconnecting loops around each of which the voltages should sum to zero.

Correction in Collected SP data:

The reference correction is applied to connect all of the sections of a single SP profile together. It must be applied for each SP profile, section by section, to connect each section to the end of the previous one. Only the first section will remain unchanged, whereas the others will be corrected section by section along the direction in which the measurements were acquired.

Closure correction: In the case of a closed profile, the first point is geographically the same as the last one: The measured SP value should theoretically be the same as the well. This would be true if no environmental perturbations occurred within the time span when the first and last measurements were made. However, during a survey, the measurement conditions can change (e.g., rain events inducing variations in the soil moisture, the soil temperature, instrument error such as the progressive increase of potential between the two electrodes themselves, etc.); consequently, a drift in the measurements will be observed.

The closure correction is $SPc = SPr - (D/N)*n$ where SPc is the SP value after the closure correction, SPr is the SP value after the reference correction, D is the observed drift, N is the total number of data points in the profile excluding the reference, and n is the place of the data point in the profile, determining, together with D and N, the correction factor.

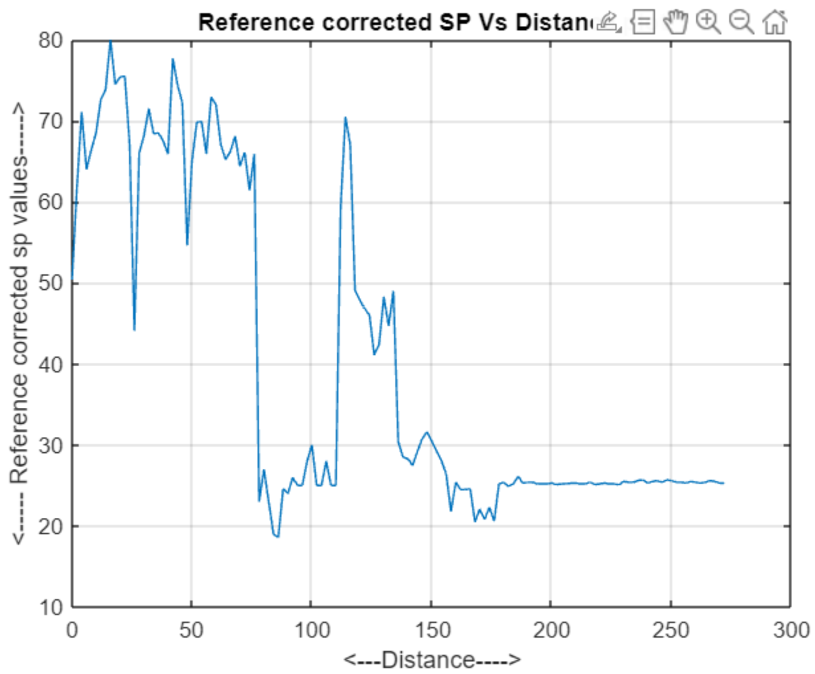
Observation, Result and Interpretation:

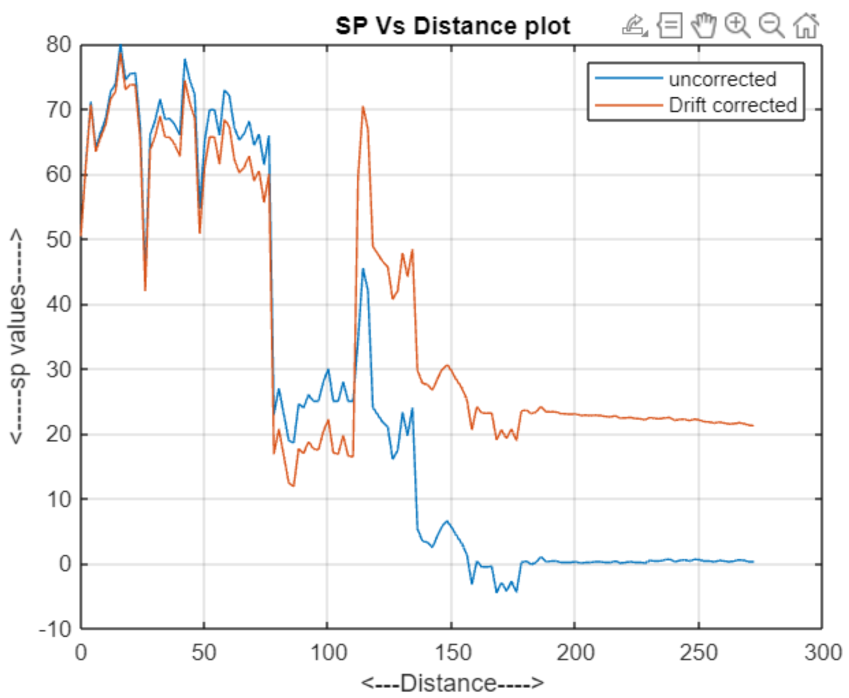
Station No.	Distance	SP (in mV)	Reference Correction	Drift Corrected SP (in mV)
Base1_start	0	50.4	50.4	50.4
2	2	61.6	61.6	61.29454545
3	4	71.1	71.1	70.64181818
4	6	64	64	63.38909091
5	8	66.4	66.4	65.63636364
6	10	68.5	68.5	67.58363636
7	12	72.6	72.6	71.53090909
8	14	73.9	73.9	72.67818182
9	16	80	80	78.62545455
10	18	74.5	74.5	72.97272727
11	20	75.4	75.4	73.72
12	22	75.5	75.5	73.66727273
13	24	67.1	67.1	65.11454545
14	26	44.1	44.1	41.96181818
15	28	66	66	63.70909091
16	30	68.2	68.2	65.75636364
17	32	71.5	71.5	68.90363636
18	34	68.4	68.4	65.65090909
19	36	68.5	68.5	65.59818182
20	38	67.5	67.5	64.44545455
21	40	65.9	65.9	62.69272727
22	42	77.7	77.7	74.34
23	44	74.4	74.4	70.88727273
24	46	72.2	72.2	68.53454545
25	48	54.6	54.6	50.78181818
26	50	65	65	61.02909091
27	52	69.8	69.8	65.67636364
28	54	69.9	69.9	65.62363636
29	56	65.9	65.9	61.47090909
30	58	72.9	72.9	68.31818182
31	60	72	72	67.26545455
32	62	67.1	67.1	62.21272727
33	64	65.2	65.2	60.16
34	66	66.2	66.2	61.00727273
35	68	68.1	68.1	62.75454545
36	70	64.4	64.4	58.90181818
37	72	66.1	66.1	60.44909091
38	74	61.4	61.4	55.59636364
39	76	65.9	65.9	59.94363636
40	78	23	23	16.89090909
41	80	27	27	20.73818182
42	82	23	23	16.58545455

43	84	19	19	12.43272727
44	86	18.6	18.6	11.88
45	88	24.6	24.6	17.72727273
46	90	24	24	16.97454545
47	92	26	26	18.82181818
48	94	25	25	17.66909091
49	96	25	25	17.51636364
50	98	28	28	20.36363636
51	100	30	30	22.21090909
52	102	25	25	17.05818182
53	104	25	25	16.90545455
54	106	28	28	19.75272727
55	108	25	25	16.6
56	110	25	25	16.44727273
Base1_end	0	42	42	42
Base2_start	0	34.4	59.4	59.4
2	2	45.5	70.5	70.4
3	4	42	67	66.85
4	6	24	49	48.8
5	8	22.9	47.9	47.65
6	10	21.8	46.8	46.5
7	12	21.06	46.06	45.71
8	14	16.1	41.1	40.7
9	16	17.4	42.4	41.95
10	18	23.3	48.3	47.8
11	20	19.7	44.7	44.15
12	22	24	49	48.4
13	24	5.4	30.4	29.75
14	26	3.5	28.5	27.8
15	28	3.3	28.3	27.55
16	30	2.5	27.5	26.7
17	32	4.2	29.2	28.35
18	34	5.8	30.8	29.9
19	36	6.6	31.6	30.65
20	38	5.5	30.5	29.5
21	40	4.2	29.2	28.15
22	42	3.1	28.1	27
23	44	1.4	26.4	25.25
24	46	-3.2	21.8	20.6
25	48	0.4	25.4	24.15
26	50	-0.5	24.5	23.2
27	52	-0.5	24.5	23.15
28	54	-0.4	24.6	23.2
29	56	-4.5	20.5	19.05
30	58	-2.9	22.1	20.6

31	60	-4.2	20.8	19.25
32	62	-2.7	22.3	20.7
33	64	-4.4	20.6	18.95
34	66	0.2	25.2	23.5
35	68	0.4	25.4	23.65
36	70	-0.1	24.9	23.1
37	72	0.2	25.2	23.35
38	74	1.1	26.1	24.2
39	76	0.3	25.3	23.35
40	78	0.4	25.4	23.4
41	80	0.4	25.4	23.35
42	82	0.2	25.2	23.1
43	84	0.2	25.2	23.05
44	86	0.2	25.2	23
45	88	0.3	25.3	23.05
46	90	0.1	25.1	22.8
47	92	0.2	25.2	22.85
48	94	0.2	25.2	22.8
49	96	0.3	25.3	22.85
50	98	0.3	25.3	22.8
51	100	0.2	25.2	22.65
52	102	0.2	25.2	22.6
53	104	0.4	25.4	22.75
54	106	0.1	25.1	22.4
55	108	0.2	25.2	22.45
56	110	0.3	25.3	22.5
57	112	0.2	25.2	22.35
58	114	0.2	25.2	22.3
59	116	0.1	25.1	22.15
60	118	0.5	25.5	22.5
61	120	0.4	25.4	22.35
62	122	0.4	25.4	22.3
63	124	0.6	25.6	22.45
64	126	0.7	25.7	22.5
65	128	0.3	25.3	22.05
66	130	0.5	25.5	22.2
67	132	0.6	25.6	22.25
68	134	0.4	25.4	22
69	136	0.7	25.7	22.25
70	138	0.6	25.6	22.1
71	140	0.4	25.4	21.85
72	142	0.4	25.4	21.8
73	144	0.3	25.3	21.65
74	146	0.5	25.5	21.8
75	148	0.4	25.4	21.65
76	150	0.3	25.3	21.5

77	152	0.4	25.4	21.55
78	154	0.6	25.6	21.7
79	156	0.5	25.5	21.55
80	158	0.3	25.3	21.3
81	160	0.3	25.3	21.25
Base2_end	0	30.4	55.4	55.4





Interpretation:

1. The SP values seem to increase initially, peaking around stations 9 to 10 (81.2) means around 20m distance, and then gradually decreasing.

2. There are noticeable dips in SP values around stations 14 and 49 (46.05 and 28.85), which could indicate specific geological features or changes in subsurface conditions.

3. While there is a general trend, there are fluctuations in SP values, suggesting localized variations in the subsurface properties.

4. Toward the end of the profile, SP values stabilize around 33 to 35, indicating a relatively consistent environment.

To interpret these results further, we can consider geological and hydrogeological factors in the area. Peaks might correspond to areas of increased mineralization or changes in fluid flow locally. Dips could indicate resistive structures or near surface shifts in lithology.

The sudden fall in SP values at the 40th station (28.85) could be attributed to:

- The subsurface lithology may have changed abruptly at this station. A shift from a more conductive to a resistive layer or vice versa can influence SP values.

- The 40th station might be located near a fault or fracture zone. These features can act as barriers to fluid flow, affecting SP values due to changes in groundwater chemistry. Changes in the direction of flow can also affect SP value. Changes in layer permeability could influence fluid movement and SP values.
- Changes in mineralization levels can also lead to variations in SP. A decrease in mineral content could result in a lower SP value.

To get more accurate and resolutive interpretation we need to integrate our results with other geophysical information, such as borehole logs, seismic data, or geological maps of the area.