Field Training Report - Day 03 on

Gravity survey using Gravimeter (CG-6)

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Content:

Aim: Estimation of subsurface geology using the processing of acquired gravity data.

Geology of Baliapur and its surroundings:

• Dhanbad's geological composition predominantly consists of the Chotanagpur Gneissic Complex, which underlies the region encompassing IIT (ISM)Dhanbad. The lithology is marked by metamorphic and 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,

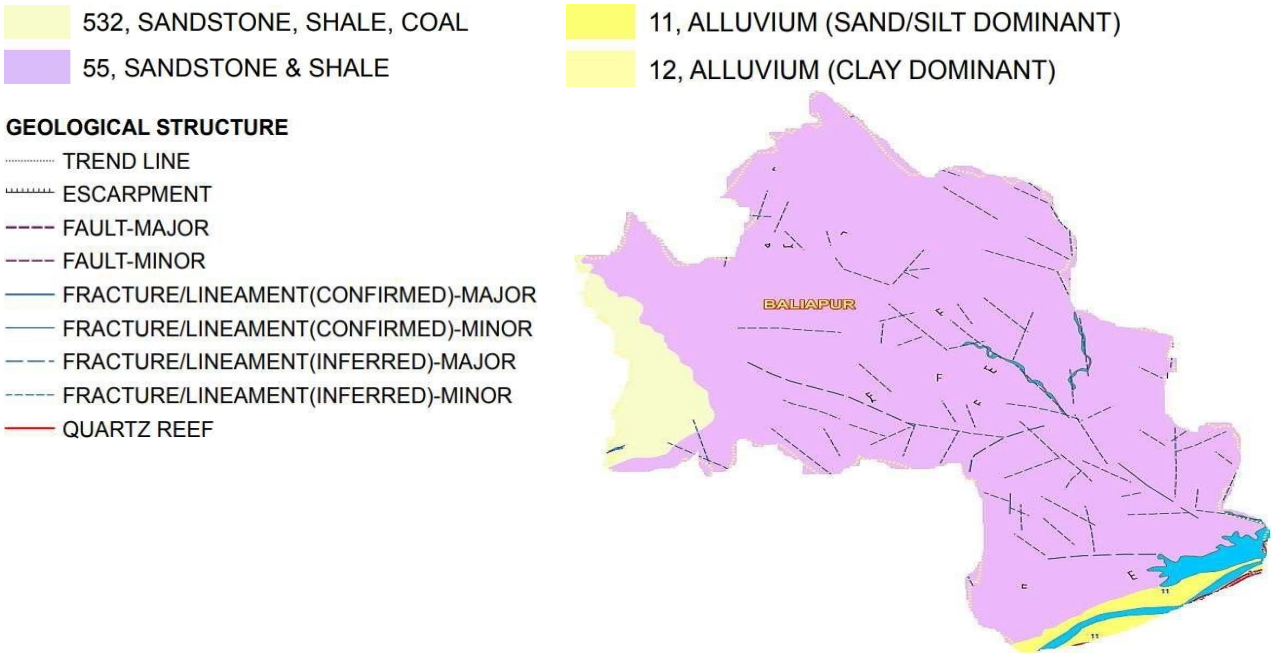


Figure 1: Lithological Map of the Baliapur region,Dhanbad

Methodology:

1. **Base Station Setup:**
    - We initiated the survey by setting up a base station at a predetermined reference point.

2. **Instrument Calibration:**
    - Calibrated our CG-6 gravimeter according to the manufacturer's recommendations prior to the survey.
    - Leveled the instrument by adjusting the knobs on the tripod to achieve the desired tuning.

3. **Survey Line Design:**
    - We planned and executed a straight-line profile for gravity measurements, maintaining intervals of 20 meters between points.

4. **Survey Execution:**
    - Gravity measurements were taken along the designed profile, ensuring smooth handling of our CG-6 gravimeter.
    - We re-leveled the gravimeter at each observation point. Taking two readings in an interval of 2 minutes and averaging them up for reading at that point

5. **Return to Base Station:**
    - Upon reaching the end of the profile, we returned to the base station to measure gravity again.

6. **Observations and Data Recording:**

- Recorded gravity measurements at each designated point along the survey line.
- Noted details such as the time of measurement, latitude, and longitude for each point of observation.
- Documented any observed environmental conditions.

7. **Quality Control Checks:**
   - Implemented regular quality control checks during the survey.
   - Compared gravity measurements with known reference values or a reference gravimeter.

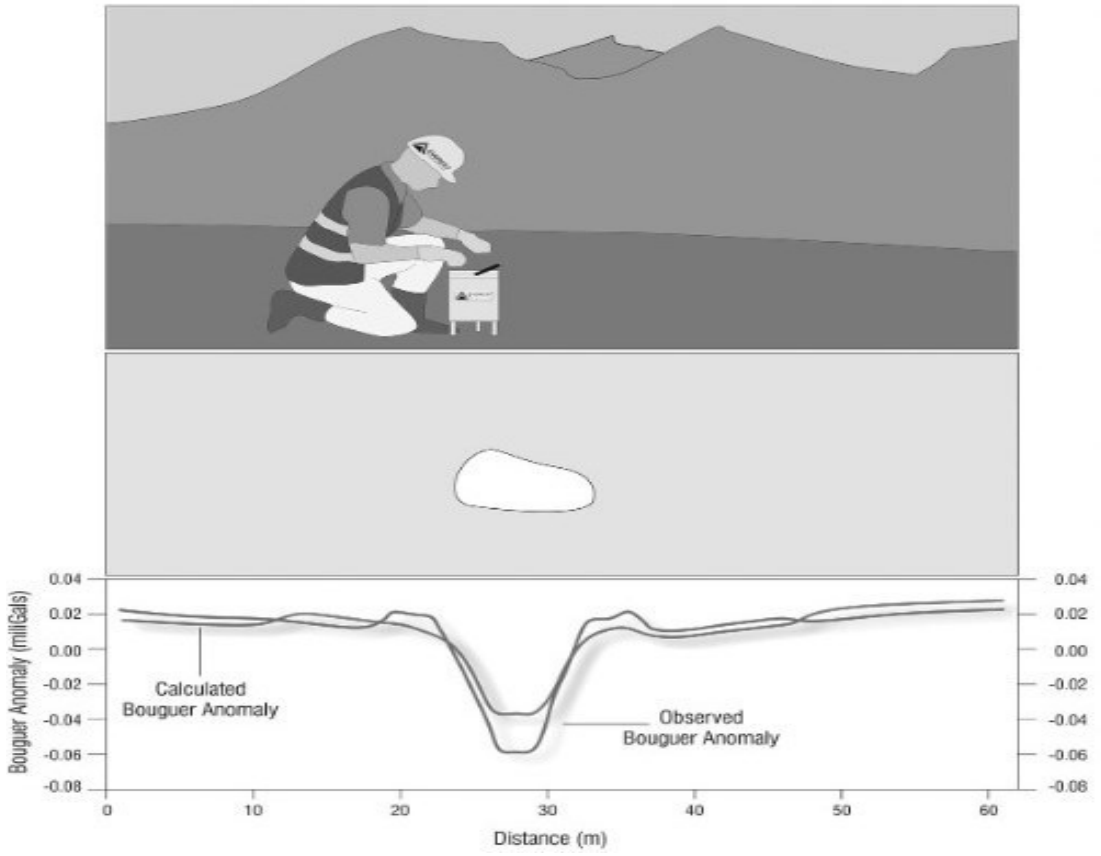
8. **Drift Analysis:**
   - Observed a change in gravity value at the base station, indicating the possible presence of instrument drift.

Instrumentation:

1. Gravimeter (CG-6 AUTOGRAV)
2. Tripod stand
3. Ranging rods
4. Measuring tape
5. Chalk powder

Fig: CG-6 AUTOGRAV (Gravimeter)

Field setup:



Formula Used:

➢ Theoretical gravity value formula:

$$g_t = 978{,}031.846\left(1 + 0.005{,}278{,}895 \sin^2\phi + 0.000{,}023{,}462 \sin^4\phi\right) \text{ mGal}$$

➢ Free-air correction (Δf) = (0.3086*h) m-gal

➢ Free-Air Anomaly: $g_{obs} - g_t + (\Delta f) + \text{Elevation}(E)$

➢ Bouguer Correction: 2πρGh

➢ Bouguer Anomaly: : $g_{obs} - g_t$ + (latitude correction + Δf – Bouguer correction)

Where h= elevation
ρ = density of earth
G= Universal gravitational constant

➢ Drift rate = $\left| \frac{g_{base}1 - g_{base}2}{t_{base}1 - t_{base}2} \right|$

$g_{base}1 = Initial\ reading\ of\ observed\ grvaity\ value\ at\ base\ station$

$g_{base}2 = Final\ reading\ of\ observed\ grvaity\ value\ at\ base\ station$

$t_{base}1 = Initial\ time\ measured\ at\ base\ station$

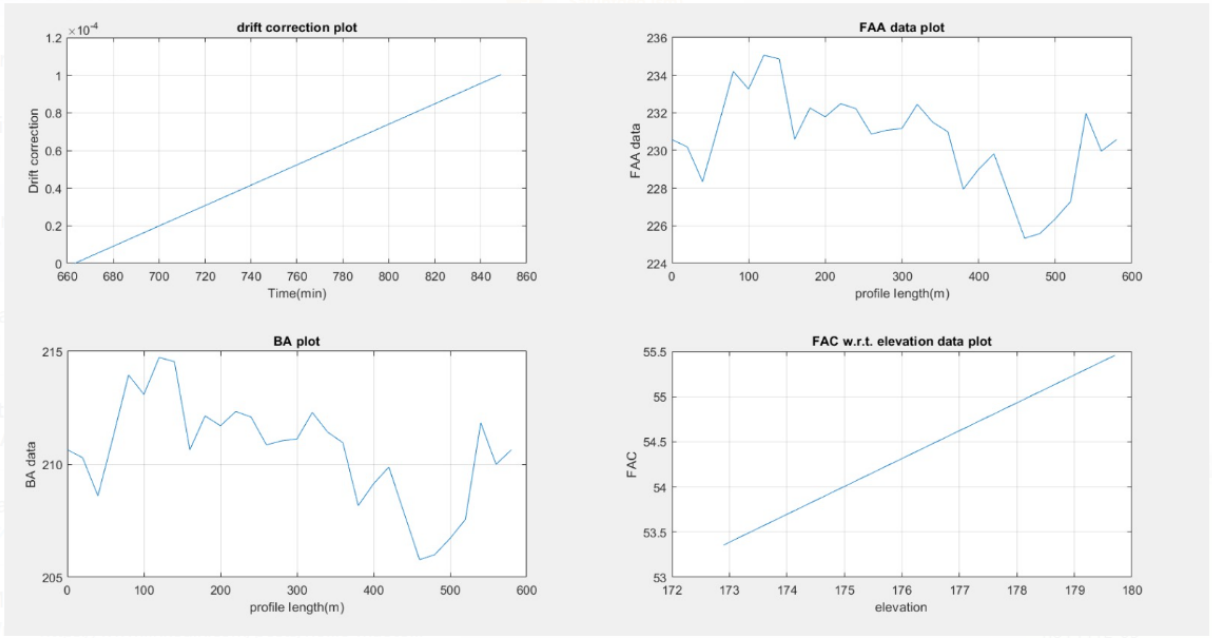
$t_{base}2 = Initial\ time\ measured\ at\ base\ station$

Drift rate = $5.405 * 10^{-7}$ mGal/min

Observation Table:

Serial	Gravity	Time	Time in min	TD(Min)	Drift Correction=(	Drift Corrected	Change in Reading	latitude	Longitude	Theoritical (g) from	Observed(g)	Elevation(m)	Gravity anomaly	Free-Air Correction	Free-Air anomaly	Bouguer Correction	Bougurer anomaly
Base	3188.2006	11:03:05	663.0833333	0	0	3188.2006	0	23.690933	86.523239	978865.9757	978865.9757	176.2	0	54.37532	230.575	19.933506	210.6418
1	3188.2106	11:13:31	673.5166667	10.43333333	5.63963E-06	3188.210606	0.01000564	23.69096	86.523048	978865.9775	978865.9875	175.9	0.01000564	54.28274	230.193	19.899567	210.2932
2	3188.1893	11:20:41	680.6833333	17.6	9.5135E-06	3188.18931	-0.011290486	23.691057	86.522903	978865.984	978865.9727	174.5	-0.011290487	53.8507	228.339	19.741185	208.5982
3	3188.1906	11:26:04	686.0666667	22.98333333	1.24234E-05	3188.190612	-0.009987577	23.691147	86.522713	978865.9899	978865.9799	176.7	-0.009987577	54.52962	231.220	19.990071	211.2296
4	3188.1636	11:31:40	691.6666667	28.58333333	1.54504E-05	3188.163615	-0.03698455	23.691233	86.522537	978865.9957	978865.9587	179	-0.03698455	55.2394	234.202	20.25027	213.9521
5	3188.1409	11:36:39	696.65	33.56666667	1.81441E-05	3188.140918	-0.059681856	23.691324	86.5224	978866.0017	978865.942	178.3	-0.059681856	55.02338	233.264	20.171079	213.0926
6	3188.1037	11:42:37	702.6166667	39.53333333	2.13693E-05	3188.103721	-0.096878631	23.691408	86.522217	978866.0073	978865.9104	179.7	-0.096878631	55.45542	235.059	20.329461	214.7291
7	3188.0369	11:47:41	707.6833333	44.6	2.41081E-05	3188.036924	-0.163675892	23.691484	86.522057	978866.0123	978865.8486	179.6	-0.163675892	55.42456	234.861	20.318148	214.5427
8	3187.9605	11:52:45	712.75	49.66666667	2.68468E-05	3187.960527	-0.240073153	23.691586	86.521889	978866.0191	978865.779	176.4	-0.240073153	54.43704	230.597	19.956132	210.6408
9	3187.7872	12:00:46	720.7666667	57.68333333	3.11801E-05	3187.787231	-0.41336882	23.691771	86.52153	978866.0314	978865.618	177.8	-0.41336882	54.86908	232.256	20.114514	212.1412
10	3187.7099	12:06:50	726.8333333	63.75	3.44594E-05	3187.709934	-0.490665541	23.691866	86.521393	978866.0377	978865.547	177.5	-0.490665541	54.7765	231.786	20.080575	211.7053
11	3187.6256	12:13:20	733.3333333	70.25	3.79729E-05	3187.625638	-0.574962027	23.691952	86.521225	978866.0434	978865.4684	178.1	-0.574962027	54.96166	232.487	20.148453	212.3382
12	3187.6193	12:20:22	740.3666667	77.28333333	4.17747E-05	3187.619342	-0.581258225	23.692024	86.521065	978866.0482	978865.4669	177.9	-0.581258225	54.89994	232.219	20.125827	212.0929
13	3187.5825	12:26:29	746.4833333	83.4	4.5081E-05	3187.582545	-0.618054919	23.692101	86.520874	978866.0533	978865.4352	176.9	-0.618054919	54.59134	230.873	20.012697	210.8606
14	3187.5244	12:31:23	751.3833333	88.3	4.77297E-05	3187.524448	-0.67615227	23.692192	86.520683	978866.0593	978865.3831	177.1	-0.67615227	54.65306	231.077	20.035323	211.0416
15	3187.4865	12:36:45	756.75	93.66666667	5.06306E-05	3187.486551	-0.714049369	23.692278	86.520531	978866.065	978865.351	177.2	-0.714049369	54.68392	231.170	20.046636	211.1232
16	3187.4612	12:45:49	765.8166667	102.7333333	5.55315E-05	3187.461256	-0.739344469	23.692352	86.520325	978866.07	978865.3307	178.2	-0.739344469	54.99252	232.453	20.159766	212.2934
17	3187.429	12:55:12	775.2	112.1166667	6.06035E-05	3187.429061	-0.771539396	23.692448	86.520172	978866.0763	978865.3048	177.5	-0.771539396	54.7765	231.505	20.080575	211.4244
18	3187.4353	13:01:36	781.6	118.5166667	6.4063E-05	3187.435364	-0.765235937	23.692526	86.519981	978866.0815	978865.3163	177.1	-0.765235937	54.65306	230.988	20.035323	210.9525
19	3187.4037	13:07:35	787.5833333	124.5	6.72972E-05	3187.403767	-0.796832703	23.692701	86.519623	978866.0931	978865.2963	174.8	-0.796832703	53.94328	227.946	19.775124	208.1713
20	3187.4135	13:12:03	792.05	128.9666667	6.97116E-05	3187.41357	-0.787030288	23.692781	86.519463	978866.0985	978865.3115	175.6	-0.787030288	54.19016	229.003	19.865628	209.1375
21	3187.3189	13:18:02	798.0333333	134.95	7.29459E-05	3187.318973	-0.881627054	23.692863	86.519279	978866.1039	978865.2223	176.3	-0.881627054	54.40618	229.825	19.944819	209.8797
22	3187.3015	13:23:54	803.9	140.8166667	7.6117E-05	3187.301576	-0.899023883	23.692926	86.519109	978866.1081	978865.2091	174.6	-0.899023883	53.88156	227.583	19.752498	207.8300
23	3187.2824	13:28:38	808.6333333	145.55	7.86756E-05	3187.282479	-0.918121324	23.693001	86.518929	978866.1131	978865.195	172.9	-0.918121324	53.35694	225.339	19.560177	205.7786
24	3187.2694	13:33:28	813.4666667	150.3833333	8.12882E-05	3187.269481	-0.931118712	23.693069	86.518745	978866.1176	978865.1865	173.1	-0.931118712	53.41866	225.588	19.582803	206.0047
25	3187.2683	13:37:40	817.6666667	154.5833333	8.35585E-05	3187.268384	-0.932216442	23.693146	86.51857	978866.1227	978865.1905	173.7	-0.932216441	53.60382	226.372	19.650681	206.7209
26	3187.2703	13:42:01	822.0166667	158.9333333	8.59098E-05	3187.270386	-0.93021409	23.693258	86.518356	978866.1301	978865.1999	174.4	-0.93021409	53.81984	227.290	19.729872	207.5598
27	3187.244	13:46:16	826.2666667	163.1833333	8.82071E-05	3187.244088	-0.956511793	23.693306	86.518227	978866.1333	978865.1768	178	-0.956511793	54.9308	231.974	20.13714	211.8371
28	3187.1973	13:50:41	830.6833333	167.6	9.05945E-05	3187.197391	-1.003209405	23.69336	86.518135	978866.1369	978865.1337	176.5	-1.003209405	54.4679	229.965	19.967445	209.9972
29	3188.2005	14:08:48	848.8	185.7166667	0.000100387	3188.2006	3.87287E-07	23.690933	86.523239	978865.9757	978865.9757	176.2	3.87314E-07	54.37532	230.575	19.933506	210.6418

Plots and Associated Codes:



Codes:

```
dc=[0
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9.5135E-06
1.24234E-05
1.54504E-05
1.81441E-05
2.13693E-05
2.41081E-05
2.68468E-05
3.11801E-05
3.44594E-05
3.79729E-05
4.17747E-05
4.5081E-05
4.77297E-05
5.06306E-05
5.55315E-05
6.06035E-05
6.4063E-05
6.72972E-05
6.97116E-05
7.29459E-05
7.6117E-05
7.86756E-05
8.12882E-05
8.35585E-05
8.59098E-05
8.82071E-05
9.05945E-05
0.000100387
```

```
];
t=[663.0833333
673.5166667
680.6833333
686.0666667
691.6666667
696.65
702.6166667
707.6833333
712.75
720.7666667
726.8333333
733.3333333
740.3666667
746.4833333
751.3833333
756.75
765.8166667
775.2
781.6
787.5833333
792.05
798.0333333
803.9
808.6333333
813.4666667
817.6666667
822.0166667
826.2666667
830.6833333
848.8
];
x=[0:20:580];
FAA=[230.575
230.193
228.339
231.220
234.202
233.264
```

```
235.059
234.861
230.597
232.256
231.786
232.487
232.219
230.873
231.077
231.170
232.453
231.505
230.988
227.946
229.003
229.825
227.583
225.339
225.588
226.372
227.290
231.974
229.965
230.575
];
ele=[176.2
175.9
174.5
176.7
179
178.3
179.7
179.6
176.4
177.8
177.5
178.1
177.9
176.9
```

```
177.1
177.2
178.2
177.5
177.1
174.8
175.6
176.3
174.6
172.9
173.1
173.7
174.4
178
176.5
176.2
];
BA=[210.6418
210.2932
208.5982
211.2296
213.9521
213.0926
214.7291
214.5427
210.6408
212.1412
211.7053
212.3382
212.0929
210.8606
211.0416
211.1232
212.2934
211.4244
210.9525
208.1713
209.1375
209.8797
```

```
207.8300
205.7786
206.0047
206.7209
207.5598
211.8371
209.9972
210.6418
];
FAC=[54.37532
54.28274
53.8507
54.52962
55.2394
55.02338
55.45542
55.42456
54.43704
54.86908
54.7765
54.96166
54.89994
54.59134
54.65306
54.68392
54.99252
54.7765
54.65306
53.94328
54.19016
54.40618
53.88156
53.35694
53.41866
53.60382
53.81984
54.9308
54.4679
54.37532
```

```
];


subplot(221)
plot(t,dc)
title("drift correction plot")
xlabel("Time(min)")
ylabel("Drift correction")
grid on
subplot(222)
plot(x,FAA)
title("FAA data plot")
xlabel("profile length(m)")
ylabel("FAA data")
grid on
subplot(223)
plot(x,BA)
title("BA plot")
xlabel("profile length(m)")
ylabel("BA data")
grid on
subplot(224)
plot(ele,FAC)
title("FAC w.r.t. elevation data plot")
xlabel("elevation")
ylabel("FAC")
grid on
```

Interpretation:

From **1st plot** this plot is in between drift correction value vs time. As we can clearly seen from the graph that there exists a linear relationship. Drift correction increases linearly with time.

The **2nd plot** is about Free air anamoly versus profile length(x). It is evident that as we approach 300m length the average elevation is of somewhat higher value than the elevation after the 300m marked length. This is clearly depicted shown in the 2nd plot by higher free air anamoly values before and lower values after the 300m mark.

The **3rd plot** is about Bouguer air anamoly versus profile length(x). It is clear from the plot that before 300m we have the basement depth (with respect to the surface of the earth) slightly lower than the same after 300m. Inn other words we can say that before 300m mark the basement is closer to the surface than the ahead 300 m zone. We also can interpret that the avg density contrast is slightly higher before the 300m mark than the rest zone.

The **4th plot** is about Free air correction versus corresponding elevation at that pount. It is evident from the plot that as the elevation increases the value of FA correction also increases. Thus we can that the elevation increases the volume of air column between our point of observation and datum increases which is clearly reflected in the increasing trend of the plot.

Field Photos:

Profiling: