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# Results of Gravitational Observations in the region of Grosny in 1928.

By **B. Numerov.** — (With three Illustrations.)

Upon the proposal of the Grosny Oil Trust the Astronomical Institute effected in the fall of 1928 determinations of the force of gravity in 14 points north of the Tersky Ridge in the vicinity of the town Grosny.

Simultaneously the gravitation section of the Trust undertook a set of profile determinations with the aid of torsion-balances. The profil was started from village Nikolaevskaya, 30 km north, passing then to the South, towards Tersky Ridge and continuing over Tersky Ridge to Sunshensky Ridge. Their purpose was to fix the method of interpretation of the gravitational observations to detect the possible anticline fold sunk in the sediments north of Tersky Ridge.

The works with torsion-balance were started in the field on April 28th and closed October 18th. To June 15th two small Bamberg torsion-balances No. 543 and No. 544 were in action, from June 15th two new ones — No 562 and No. 563 — were added. In the total 802 points and 60 reobserved ones were obtained, the torsion-balance No. 543 giving 261 points, No. 544 = 243 points, No. 562 = 172 points and No. 563 = 186 points. The observations were conducted along the profile in two parallel lines and points 500 to 250 m apart were selected. The total length of the completed profile reached about 200 km. The schematic map (see fig. 1) shows the direction of the profile and the pendulum points determined by the Astronomical Institute in the region of the variometric works. A great negative anomaly in the points mentioned is expressed in 0.001 cm sec$^{-2}$.

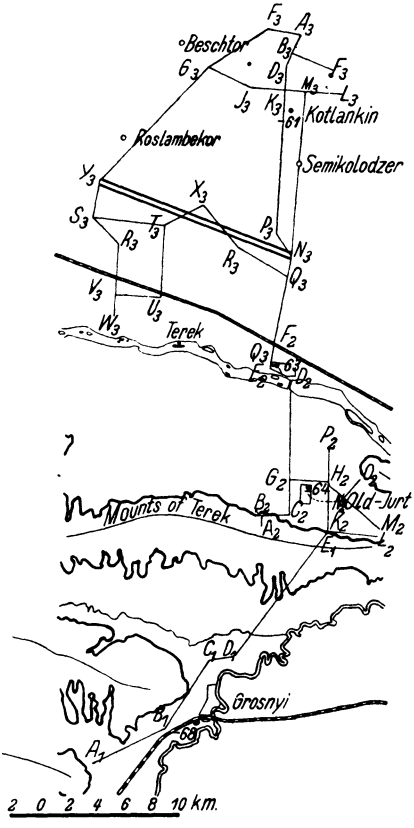


fig. 1. Scheme of gravity works in Grosny region 1928. Anomaly of gravity by pendulum observations in 0.001 cm sec$^{-2}$.

The observations with torsion-balance included at each point several repeated cycles in 5 or 3 azimuths. The topographic reduction was calculated within a circle of meters radius by formulae of B. V. Numerov*).

The torsion-balance was installed on a possibly level ground in a special hut, covered by a tent to protect the instrument from the effect of the sun. The balance itself was kept in a warm wrapper.

North of river Terek is a level step, cut by dunes and therefore little convenient for mounting the torsion-balances. In this district the vectors of gravitational variation were small (in mean 6.10) and had mostly an accidental disposition. Only near Terek prevailed northern directions and in the vicinity of farm Kotlankin — southern ones, with fact demonstrated a maximum of gravitation in the center of the district. South of the river Terek there is also a level plateau gradually mounting towards the apparent fold of Tersky Ridge, which is about 200 m high. With the approach to the ridge all vectors points to the South thus indicating the uplift of the fold and of the strata underlying the sediments. The vectors increase considerably in ascending Tersky Ridge and grow small at the pass. In descending the southern slope they take a direction northwards indicating thus the sinking of the fold of ridge. In the vicinity of Grosny the vectors distinctly mark the sunken fold among the new and old oil settlements, and finally at the end of the profile they change their direction, following the lift of the fold of Sunshensky Ridge. We are thus justified to state that the apparent folds stretching on under the sediments are indicated by the torsion-balance and are based upon the difference in densities of the sediments (determined 1.5) the tertiary depositions (2.1) and more ancient strata (2.6).

The curvature gradients behave in better agreement, than the vector of gravity variations, the former marking everywhere the direction of the uplift of heavy masses under the sediments. Only when crossing the Tersky Ridge the curvature gradients reach immense anomalous values. Owing to the difficulty of calculating the topographic relief, their investigation here seems rather superfluous. Especially peculiar is the spot near river Terek at the ascent of the terrace about 60 m above Terek. Here we are dealing with a kind of fault phenomenon and the curvature gradients show characteristics of a sharp change in direction on 90°. Similar sharp changes in curvature are observed in some places near Tersky and Bragunsky Ridges, which fact is probably in connexion with disturbances in the underground structure.

The enormous material obtained, should naturally be presented in a summary condition, as only slight anomaly was detected, especially northwards of river Terek. Our aim was to plot the curves of gravitational variations along the profiles. To this end we built curves of the gradients mean ones of both apparatus along the profiles and integrated curves of gravitation force (of an

*) See Bulletin of Astronomical Institute, No. 17.

arbitrary zero) by individual profiles, particularly by the principal meridional profile from town Grosny to farm Kotlankin; 60 km in length (see fig. 2).

The problem arises as to the accuracy of the obtained curve of gravitation when integrating along a profile of this length. Moreover the vectors showed changes of accidental character in certain districts. Supposing about $N = 400$ points were made use of and denoting by $\varepsilon$ the mean error of one gradient, we can write that the error of difference in gravity force at the sides of the profile reaches a value of $\frac{\varepsilon s}{\sqrt{2N}} = 2 \cdot 10^5 \varepsilon$ or at $\varepsilon = \pm 2 \cdot 10^{-9}$ we have a mean error of gravitation difference $+ 0.0004$ cm sec$^{-2}$, with other words, the curve will be correct to 0.001 cm sec$^{-2}$. This was confirmed by pendulum

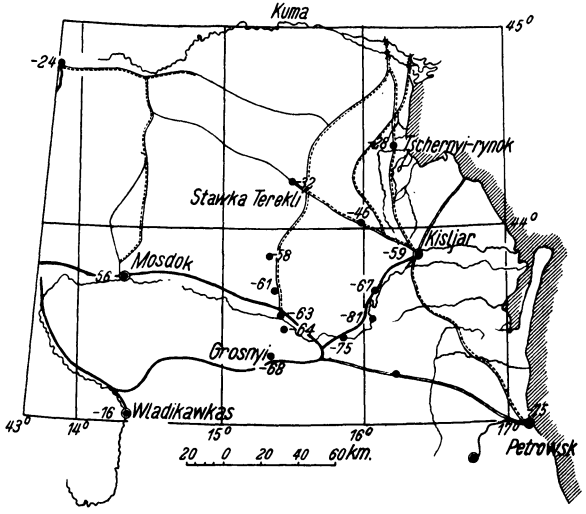


fig. 2. Gravitational observations in the region of Grosny in 1928. Lenght E. Leningrad.

observations. In fact, Table 2 (p. 275) of results of pendulum observations and the results of variometric observations (see fig. 2) gives us and shows that the difference in the variometric data (result of numerical integration) and the pendulum observations does not exceed 0.002 cm, i. e. it lies within the limits of pendulum observation errors. These considerations lead us to give more credit to the curve of gravitational anomaly, built along the meridional profile.

Table 1 of anomalies of gravitation in 0.001 cm sec$^{-2}$.

| Point | Data of | | Difference |
|---|---|---|---|
| | Variometer | Pendulum | |
| Grosny . . . . . | — 68 | — 68 | 0 |
| Stary Jurt . . . . . | — 66 | — 64 | — 2 |
| Nikolaevskaya . . . . . | — 63 | — 63 | 0 |
| Kotlankin . . . . . | — 60 | — 61 | + 1 |

Remarking upon the obtained curve, we notice, that the first maximum in gravitation corresponds to the sunken fold of Grosny Ridge. We could, of course, have a much larger maximum should we have crossed the ridge itself. The second and largest maximum is above the Tersky Ridge. Finally the third maximum is indicated near farm Kotlankin (Semikolodezkaya). A cursory glance at the curve discloses a general increase of gravity force from South to North. This general tendency towards an increase of gravitation is supported by pendulum observations (see fig. 3). Table 2 gives the results of pendulum observations obtained by the Astronomical Institute.

In fig. 3 we actually see that in the region Hasav Jurt is the deepest minimum of gravitation (— 0.081). Beginning with this region the gravity force grows in all directions. It is natural to suppose that the largest negative anomaly in Grosny region depends upon the condition of crystallic strata, forming in the district of Grosny and Petrovsk a deep valley, abruptly rising towards the principal ridge and smoothly dropping towards Astrakan and

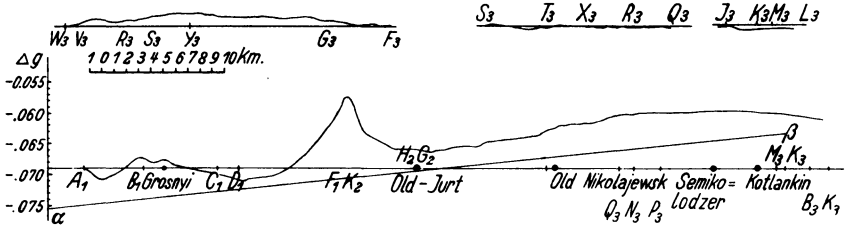


fig. 3. Gravity curves along profiles in Crosny region 1928.

Stavropol. On the canvas of this anomaly slight periodical variations in gravity force may be observed, depending on the folds of tertiary depositions (Tersky Ridge and other).

Therefore in order to solve the problem in connexion with the detection of the buried anticline north of Tersky Ridge the observed curve of gravity ought to be corrected for the influence of "deep geology", utilizing for this purpose the pendulum observations along the profile — Grosny — farm Kamishev. In fact, the pendulum observations shows in the region of the meridional profile a gradual increase of gravity, about 0.000 18 cm a kilometer. This systematic increase clearly marked in the variometric curve as well and which may be connected with the behavior of the crystallic rocks, ought to be excluded of the results of variometric observations. Then the local periodical variations of gravity related to the folds of tertiary deposits will show off more sharply.

To exclude the systematic increase of gravity force (see fig. 2) a new axis $\alpha\beta$ has been drawn with regard to which the periodical variations are better marked. We can note with a sufficient degree of accuracy the maximum of gravity north of the railway-line, at about 6 km. This maximum, similar to

that of Grosny, is less sharp, than the maximum above the Tersky Ridge. It trails and may be accounted for by a very smooth buried fold. It would be of value to continue the variometric observations along the profile, north of farm Kotlankin to gain certitude.

Table 2. Results of pendulum observations in North Caucasus, in the region of Grozny in 1928:

| Point | $\varphi$ | $\lambda$ from Gr. | $\lambda$ in meters | $g$ observed | $\Delta_1 g$ | $\gamma_0$ | $\Delta g$ |
|---|---|---|---|---|---|---|---|
| 1. Farm Nikolaevskaya | 43°32′ | 45°47′ | + 54 | 980.403 | + 17 | 980.483 | − 63 |
| 2. „ Kotlankin | 43 42 | 45 46 | + 60 | 980.418 | + 19 | 980.498 | − 61 |
| 3. „ Kamyszow | 43 52 | 45 45 | + 56 | 980.438 | + 19 | 980.513 | − 58 |
| 4. Hausing Terekli | 44 12 | 45 49 | + 28 | 980.501 | + 9 | 980.543 | − 32 |
| 5. „ Jankiszi | 44 0 | 46 21 | − 14 | 980.483 | − 4 | 980.525 | − 46 |
| 6. Tcherny Rynok | 44 24 | 46 33 | − 18 | 980.539 | − 6 | 980.561 | − 28 |
| 7. Kizlar | 43 51 | 46 43 | − 9 | 980.456 | − 3 | 980.512 | − 59 |
| 8. Farm Kurdukovskaja | 43 42 | 46 27 | + 2 | 980.430 | + 1 | 980.498 | − 67 |
| 9. „ Novo Gladkowskaja | 43 32 | 46 22 | + 8 | 980.400 | + 2 | 980.483 | − 81 |
| 10. „ Novo Sczedrinskaja | 43 29 | 46 6 | + 27 | 980.395 | + 8 | 980.478 | − 75 |
| 11. Stary Jourt | 43 27 | 45 47 | + 100 | 980.381 | + 31 | 980.476 | − 64 |
| 12. Grozny | 43 18 | 45 41 | + 125 | 980.355 | + 39 | 980.462 | − 68 |
| 13. Mozdok | 43 45 | 44 39 | + 129 | 980.407 | + 40 | 980.503 | − 56 |
| 14. Prikumsk | 44 49 | 44 11 | + 119 | 980.538 | + 37 | 980.599 | − 24 |

The alterations in gravity along other profiles do not show noticeable maxima and minima, except profile which confirms the existance of a gravity anticline, parallel to Tersky Ridge.

When interpreting the observations in Grosny region, we ought to reckon with two sharp limits in the underground structure. On one hand we should consider the limit between the sediments and tertiary deposits having a difference in density about 0.5 and between the tertiary deposits and the more ancient strata with a difference in density not less, than 0.5 on other ones.

As by all evidence the tertiary deposits and the ancient strata are lying in discordance, we can venture to separate these two chief influences by combining the variometric and pendulum observations. This forms the base the interpretation of gravitational observations of 1928 is built upon. If we charge the periodic gravitational changes (after exclusion of the general change) to the account of the alteration in the relief of tertiary deposits, we may figure that with the increase of gravity on 0.001 cm sec$^{-2}$ the depth of tertiary deposits will grow less by a value of about 50 m.

The results obtained prove once more the great importance of pendulum observations not only for the general geophysical problem, but also for purely utilitarian purposes of geological survey. Therefore it seems appropriate to draw attention to the organisation of a general gravitational survey and in the first place: in North Caucasus, Circum-Caspian region and Donetsky Basin.