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At the All-Union Scientific Research Institute of Geophysical Exploration Methods, in recent years investigations have been conducted on the problem of aerogravimetric surveying for solving problems of regional geophysics. In May 1969, experimental aerogravimetric measurements over the Caspian Sea were carried out using an operating mock-up of the developed apparatus. The measurements were made aboard an Il-14 aircraft at altitudes from 1 to 4 km along routes in the latitudinal direction, with lengths from 150 to 250 km. Altogether, over three days—May 17, 18, and 21—8 double flights were performed (out and back), with a total length of about 2700 km.

Measurement of the accelerations of gravity in flight was carried out by means of string gravimeters of special design, maximally protecting them from the effects of vibration. On the aircraft the gravimeters were mounted in gimbal suspensions with liquid damping. The influence of vertical disturbing accelerations was taken into account by means of string vertical-velocity meters (SVVS), operating on the barometric principle ([1]). Continuous recording of the readings of the instruments—two gravimeters and two SVVS—was carried out on the paper tape of a five-channel recording milliammeter of type N-320/5. The readings were recorded in the form of currents, the frequencies Δf_i of which were equal to the difference between the frequency f_i of the signal of the i-th string instrument and the signal of the reference frequency f_{ei}: $\Delta f_i = (f_i - f_{ei})$. Simultaneously, second time marks from a contact chronometer were recorded on the tape. This form of recording provided sufficiently high reading accuracy of the measured frequencies f_i and at the same time made it possible to carry out visual monitoring of the operation of the apparatus in flight, as well as to perform subsequent detailed analysis of the measurement conditions.

Continuous accurate recording of the flight trajectory of the aircraft, for taking into account the Eötvös correction and estimating long-period horizontal accelerations, was carried out by means of the "Koordinator" phase radiogeodetic system. Synchronization of the radiogeodetic recording with the gravimetric recording was carried out according to minute time marks, which were supplied from the contact chronometer to all tapes.

The absolute flight altitudes were determined by the barometric method from visual observations of the BN-63 microbaronivelir.

During office processing, smoothing of the readings of the string gravimeters was performed by a digital method according to the formula

$$\widetilde{G} = g_0 + C\left\{\left[\frac{1}{KT}\sum_{i=1}^{k}\left(N_{T+t_i} - N_{t_i}\right)\right] - f_0\right\},$$

where N_t is the number of oscillations of the gravimeter string from the initial instant t_0 to the instant t; f_0 is the initial frequency of oscillations of the string at the initial value g_0; C is the division value of the gravimeter (in mgal/Hz); T is the averaging time interval, equal to 200 sec; $K = \tau/\Delta t = 50$ for $\Delta t = 1$ sec and $\tau = 50$ sec.

A correction Δg_z for vertical disturbing accelerations, according to the SIVS readings, as well as the Eötvös correction, was introduced into the smoothed value G. A second-order correction for short-period horizontal disturbing accelerations was not introduced, since in most cases these accelerations did not exceed 10-12 gal and were not registered in flight. Accordingly, no second-order correction was introduced for vertical disturbing accelerations; it has a sign opposite to that of the correction for horizontal accelerations.

Comparison of the readings of two gravimeters and two SIVS instruments made it possible to estimate the instrumental error of aerogravimetric measurements.

The error of a single measurement by one gravimeter of the averaged acceleration value over a 3-4-minute interval, relative to the reading at the airport on the ground, was ± 8 mgal. In this case the agreement between the gravimeter readings did not deteriorate even at the moments when the aircraft heading was being corrected, when the effect of the horizontal accelerations reached several hundred and even a thousand milligals.

Fig. 1. Comparison of Faye anomalies measured from an aircraft with the results of a marine gravimetric survey on profile No. 1. M4, M5, M6–18 V (M4 $-H = 2$ km; M5–3 km, M6–1 km); M11, M12, M13–21 V (M11–$H = 2$ km, M12–3 km, M13–4 km); arrows–direction of the route; line–Faye anomalies according to marine survey data. Systematic errors of the routes have been allowed for: M4–15 mgal, M5–20 mgal, M13–25 mgal.

The instrumental error of a single measurement of the vertical-velocity difference $[\Delta(dh/dt)]$ (averaged over a period $\tau = 50$ sec) was found to be ± 0.6 cm/sec, which corresponds to an accuracy in determining the correction $\delta \cdot \Delta g_z = \pm 3$ mgal. The correction Δg_z itself varied within the limits from -90 to $+90$ mgal and on average was equal to ± 35 mgal.

Fig. 1. Comparison of Faye anomalies measured from an aircraft with the results of a marine gravimetric survey on profile No. 1. M4, M5, M6—18 V (M4—H = 2 km; M5—3 km, M6—1 km); M11, M12, M13—21 V (M11—H = 2 km, M12—3 km, M13—4 km); arrows—direction of the route; line—Faye anomalies according to marine survey data. Systematic errors of the routes have been allowed for: M4—15 mgal, M5—20 mgal, M13—25 mgal.

Figure 1: Fig. 1. Comparison of Faye anomalies measured from an aircraft with the results of a marine gravimetric survey on profile No. 1. M4, M5, M6—18 V (M4—H = 2 km; M5—3 km, M6—1 km); M11, M12, M13—21 V (M11—H = 2 km, M12—3 km, M13—4 km); arrows—direction of the route; line—Faye anomalies according to marine survey data. Systematic errors of the routes have been allowed for: M4—15 mgal, M5—20 mgal, M13—25 mgal.

The mean Eötvös correction in the averaging intervals on eastbound routes varied from +800 to +970 mgal, and on westbound routes from −650 to −750 mgal. Taking into account the high accuracy of the radiogeodetic measurements, the limiting error in determining this correction is estimated at 3 mgal.

An overall assessment of the accuracy of the experimental aerogravimetric measurements carried out on sections of straight-line flight was made by comparing 105 computed Faye anomalies with values taken from a 1:500,000-scale map compiled from the marine gravimetric survey. The result of the comparison on one of the profiles is presented in Fig. 1.

The random error of a single measurement of the Faye anomaly was found to be equal to $±$13 mGal. However, in individual flights systematic overestimates of the results by 15-25 mGal were observed, which may have been caused by an error in the barometric determination of the absolute flight altitude, as well as by insufficient allowance for the influence of short-period horizontal accelerations.

The investigations carried out, which demonstrated the real possibilities of conducting aerogravimetric measurements for solving problems of regional geophysics, also showed that the most difficult question, requiring additional research, is the problem of allowing for or eliminating the horizontal accelerations of the aircraft.

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