AIR INFORMATION DIVISION

LIBRARY OF CONGRESS

DATE: 10 February 1960

STAT

TITLE: Special Geodetic Assignment: LVII. Magnetic and Astronomical Determinations Along the Ob'-Yenisey Connecting System and Along the Siberian Railroad From Chelyabinsk to Krasnoyarsk (T)

SOURCE: P: Akademiya Nauk SSSR. Otdeleniye Fiziko-Matematicheskikh Nauk, Zapiski, seriya 8, Tom XVII, No. 7, 1906, pp. 1-104

MAGNETIC AND ASTRONOMICAL DETERMINATIONS ALONG THE OB'-YENISEY CONNECTING SYSTEM AND ALONG THE SIBERIAN RAILROAD FROM CHELYABINSK TO KRASNOYARSK (T)

by D. A. Smirnov

Studies of the Imperial Academy of Sciences of St. Petersburg, VIIIth Series of the Physico-Mathematical Department, Volume XVII. No. 7 and Last

Magnetic and Astronomical Determinations Along the Ob'-Yenisey Connecting System and Along the Siberian Railroad From Chelyabinsk to Krasnoyarsk, by D. A. Smirnov. (Reported on at the 15 December 1904 Session of the Physico-Mathematical Department).

Noted Errors:

Page	Line	Printed	Should Read
6	18 from the top	June 27th	July 27th
22	4 from the bottom	July 26th	June 26th
48	19 from the top	130° 3' 21"	130° 3' 15"
59	4 " " "	95 15	95 16
60	23 " " "	13° from north	3° from the north
"	24 " " "	21° 40'	11° 40'
"	10 " " bottom	$2^h\ 11^m\ 49^s.3$	$4^h\ 11^m\ 49^s.3$
67	In footnotes	Observ. on the 2nd	Observ., June 26th on the 2nd
69	1 from the bottom	233.92	223.92
73	In footnotes	57° 16' 24".0	58° 26' 24".0

TABLE OF CONTENTS

During the spring of 1900, the Council of the Tomsk Imperial University, detailed me to take magnetic and astronomic measurements during summer vacations, in the Tomsk and Yeniseysk provinces.

F. Ya. Kapustin, professor at the Tomsk University, made numerous determinations of the magnetic elements in Tomsk during the summer of 1899. It was on his initiative that I undertook the magnetic research in Siberia. Under his guidance, I had the opportunity, that same summer, to get myself acquainted with the equipment available at the physical laboratory of the University and study methods for accurate magnetic measurements.

The universal magnetic field theodolite (designed by the academician H. I. Wild), was acquired by the office in 1897 for field work. It was not meant for detailed magnetic surveys of any one region because of the accuracy specifications for which it had been designed and because of difficulties and lack of transportation safety over poor roads. The main goal of a detailed surveying of a region would have been an increase in frequency of observation

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

points and not the accuracy of measurements, especially when the portability and stability of the instrument under various conditions of locomotion, might have played a predominant role. Due to these considerations, and also lacking as yet a general work plan for this little known and huge expanse of Siberia, I decided, on the advice of professor Kapustin, to use for the first trip, the continuous waterway of the Ob'-Yenisey Joint System. Baron B. A. Aminov, chief of the Tomsk Waterways Region, and S. S. Zhbikovskiy, chief of the Ob'-Yenisey Sector, both courteously promised cooperation thus increasing the advantages of water transport for complicated instruments. Thanks to this cooperation, I was able to take advantage of trips made by government steamers up the Ket' River and over the Joint Waterways System.

The Tomsk observations made by professor Kapustin were processed by the summer of 1901, when the University Council again detailed me to continue magnetic observations, and the analytical results of the Tomsk observations made by Prof. Kapustin showed that the reduction of the elements observed in Tomsk to their mean annual values in relation to the two nearest magnetic observatories, the one in Irkutsk by $1^h\ 17^m$ to the east, and the one in Yekaterinburg [Sverdlovsk] by $1^h\ 37^m$ to the west, agreed satisfactorily. Consequently, in the present instance, i.e., during the work in Siberia, it might have been best to be satisfied by the two, although very distant observatories, and devote one's efforts to determining the mean annual values of the elements of the earth's magnetic field for a small number of basic points spread out, if possible, over all of Siberia. In such an event, all annual fragmentary or incidental observations in the region of Siberia, could always be reduced to the one epoch, if after repeating the measurements, at the same basic points, several years later, we obtained reliable information on the secular motion of the magnetic elements at different places.

Several points along the Siberian Railroad partially answered this purpose. The direction of this railroad from the west to the east, was favorable in this respect because the secular motion of certain magnetic elements, differs particularly in this direction. On the other hand, these points were close to the latitude of Yekaterinburg [Sverdlovsk] and Irkutsk, which was of importance because of smaller daily variations in the motion of the earth's magnetism.

However, having taken on the task of gathering uniform material which would allow to judge of the contemporary secular motion of the elements at points of observation, it was necessary to strive for a possible accuracy in the final results of measurements, and in determining the points which could have been easily located again in a few years time of observations. The analytical results of 1900 and 1901 data, published here, indicate how justified had been the expectation of their accuracy: judging by the agreement of the magnitudes reduced to Irkutsk and Yekaterinburg [Sverdlovsk] observatories the mean annual values of the declinations taken from 3 to 4 observations at each point, gave the satisfactory accuracy of up to 1/2 a minute of the arc. This accuracy in reduction is probably explained by very calm condition of the earth's magnetism during these years.

The advantages of railroad travel became apparent during the 1900 and 1901 trips. In 1900 the travelling mostly by steamers and boats was rather slow at times. At times also, a week or more was lost waiting for a steamer. But in 1900, quite independently from travel conditions, I had to abandon all observations after having completed only half of the route, and hurry back to Tomsk due to the mobilization of the Siberian Military District. The number of points at which observations had been made was 14, ten of these had been magnetic points. Not always the same number of observations was made at all points and in most instances, these observations were not complete.

In 1901, it was possible to determine 20 points along the railroad between Chelyabinsk and Krasnoyarsk, and 5 more points down the Yenisey up to the 60th degree of the northern latitude, during the same lapse of time, i.e., two months, due to the fact that two daily trains with a regular schedule were available. Furthermore, the points of 1900 were distributed somewhat haphazardly and irregularly, while in 1901, they were separated from each other by about 100 versts.

While travelling by steamer or rail, it was difficult to adhere to the goal of visiting primarily points where magnetic observations had been made at some time or other. Steamers stopped only at definite locations and did not stay very long, moreover their runs on Siberian rivers were rare and the time of a steamers' arrival was not known in advance. On the other hand, the numerous observations made by Hansteen and his companions in the late twenties of the last century, and the observations made by Dr. Fritshe, had been made along the mail stage route. The Siberian railroad approached the old Siberian mail stage route only in some locations, but even in those instances, at times one would have had to travel quite a distance to reach these points, for example, over 10 versts separated the Kainsk railroad station from the town.

The desire to revisit, if possible, the old magnetic points was, in most instances further weakened by the absence of definite indications as to their locations. This being the case, the calculation of secular changes in terrestrial magnetism, would not have been completely reliable.

In general, these were the reasons[1)] why determinations made by me could be compared to preceeding determinations only in rare instances, as we will see further.

---

1) Furthermore, in Tomsk, I could not obtain the original of the well known book by Chr. Hansteen, otherwise I would have probably visited several more Hansteen's points on the Yenisey River. I also bypassed the city of Omsk, as at the time I had been planning to make a separate trip up the Irtysh River in the near future.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

STAT

I. The 1900 and 1901 Trips.

It was proposed that in 1900 the sparsely populated and magnetically little known region of the Ob'-Yenisey Joint Waterways region be visited.[2]

2) It is known that this waterway starts on the Ob' side with the deep and winding Ket' River, right tributary of the Ob', the "Togurskaya channel" serving as the mouth of the Ket' near the Togura and Kolpashevo villages. The waterway reaches the water divide of the Yenisey and Ob' River through the Ozernaya, Lomovataya and Yazevaya, tributaries of the Ket' River. Not far from the water divide, between the Ob' and Yenisey Rivers is lake Bol'shoye. A canal, 7 1/2 verst long, connects this Lake with the system of the Yenisey tributaries, the Malyy Kas and the Bol'shoy Kas. Starting from the mouth of the Lomovataya River and up to the mouth of the Malyy Kas, i.e., an extent of about 130 versts, part of the system has already been provided with locks and straightened out (for ships drawing five quarters [of a fathom]). However, the main ~~part~~ of the system over a length of about 600 versts along the Ket' River and for about 200 versts along the Bol'shoy Kas River, has hardly had any improvements. Only the lower reaches of the Ket' River are inhabited. There is one village, the Maksimoyarovskoye, in its middle course and several native yurts further on. The Bol'shoy Kas is inhabited even less.

The history of the preliminary surveys of ways for joining the Ob' and Yenisey River basins, and the history of operations in the chosen direction over the Ket' and Kas Rivers, surveys of economic potentialities of this waterway and its present status, may be found in the works by Lt. Capt. A. K. Sindensner, entitled: "Expedition of the Ministry of Transport to the Ob'-Yenisey water shed in 1875" (Izvest. Imp. R. Geogr. Obshch.-Bulletin of the Russian Imperial Geographic Society, vol. XIV, 1878). Also the work by S. A. Zhbikovskiy: "Ob--Yenisey waterway and its economic potential" (published in the <u>Materialy dlya opisaniya russkikh rek i istorii uluchsheniya ikh sudokhodnykh usloviy - Materials for Description of Russian Rivers and for the History of Their Navigational Improvements,</u> Fascicle II. St.-Petersburg, 1903). A map of the waterway from the mouth of the Ozernaya River to the Yenisey River and a schematic profile is appended to the last article.

The first detailed description of the Ket' River, was made in the well known study by Nikolay Spafariy, of Moldavian origin, who in 1675, was sent as tsar's envoy from Moskva to China. The most convenient route from Tobol'sk to China, was found to be along rivers and portages to Yeniseysk, namely along the Ket' River to its upper reaches. This choice of route points to the historic importance of the Ket' River in settling Siberia. This importance was lost at a later date, when other means of communications were opened up. Description of Spafariy's trip through Siberia from Tobol'sk to the Chinese border, was published by Yu. Arsen'yev in the Zapiski Imp. R. Geogr. Obshch. po otd. etnografii (Studies of the Russian Imperial Geographic Society, Ethnographic Department, vol. X, 1882.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

Geographically, this region had been studied because of the proposed hydrotechnical projects. Already in 1875, Lt. Capt. A. K. Sidensner made a route survey of this waterway. He determined many points astronomically with a small Pistor circle and 3 pocket chronometers. The basis for determining longitudes were: the accurate longitude of Tomsk and the longitude of Yeniseysk according to lunar observations by Fedorov.[3]

STAT

Although astronomical determinations were not my main goal, and although the lack of a second chronometer did not allow for great accuracy in calculated longitudes, it seemed to me that astronomical observations during the impending trip, may have a certain value as such. The existing maps of the Ket' River, in some instances, carry considerable errors in geographical positions of points in latitude.

Preparations for the trip consisted mostly of a preliminary checking of instruments, adapting them to transportation and arranging a tent for magnetic observations. The following instruments, described below, were taken: an astronomical Hildebrand theodolite, a magnetic Wild theodolite, an Erickson table chronometer, aneroids, thermometers, a Richthofen compass and other equipment for topographic surveying.

The Wild theodolite gives horizontal magnetic intensity only to a relative degree. Its comparison with absolute instruments had been made by prof. Kapustin yet in 1897. For a new comparison, I was sent by the University to Irkutsk during the Easter of 1900, where for 5 days I was able to study the theodolite at the magnetic observatory with the kind cooperation of A. V. Voznesenskiy, director of the observatory.

The problem of protecting the instruments from the direct heat of the sun and the action of the wind during magnetic observations in the field, especially for observations pretending to any degree of accuracy is of great importance. It was almost necessary to use a tent for certain instruments. This same tent could also be conveniently used while travelling in a sparsely populated region and could serve as quarters for personnel in case of necessity, providing a shelter from rain and cold. A tent, which was made of tarpaulin for this very purpose, and which of course had no iron parts, proved to be very practical during the long time it was used. For this reason, I am stopping to describe it. The requirements for its arrangement were as follows: 1) The walls of the tent could slide as curtains along an upper rope, thus, all four sides of the tent could be opened. This meant that one was not confined to the choice of mire towards any part of the horizon, and one had protection from the sun and wind from any direction. 2) The roof could be moved in sections from every

---

3) Sidensner and Vagner: "Astronomic determinations of points on the Ob'-Yenisey Rivers watershed, made in 1875". Izv. Imp. R. Geogr. Obshch. (Bulletin of the Russian Imperial Geographic Society), vol. XIII, 1877, p 66, with an appended map. The article indicates that route maps (1/2 a verst and 1 verst to the inch scale) are on file at the Ministry of Transportation. Telegraphic determination of the Yeniseysk longitude made by colonel Vil'kitskiy in 1895, will allow to make the necessary corrections in Sidensner's longitudes (see further).

corner, or completely removed, without disrupting the whole and the stability of the tent. 3) The tent could withstand gusts of thunder storms and allowed to make observations during rain. The bad feature of the tent was the fact that it was heavy and occupied considerable space when folded up.4) This was due to the fact that the material used for making the tent was cheap and rough. But the size of the tent allowed to walk freely around the theodolite on the tripod. All steps were taken so that the tent could be rapidly pitched.

The departure was somewhat delayed due to the late arrival of our chronometer, which had been sent to St. Petersburg for cleaning during the winter. It was received and set up only on the 18th of June. On the 20th and 21st, its correction from the stars was found and referred to a post in the University garden, the coordinates of which had been determined accurately by Prof. Kapustin and to which I always referred my Tomsk timepiece. The run of the chronometer could not be established prior to departure, due to the lack of time. The Waltham working watch was not very reliable. These conditions so unfavorable to the determination of longitudes during the impending trip, were corrected to some extent later on. It was discovered that during the same summer, only at a slightly later date, the precise astronomical determinations made by the geodesist Yu. Schmidt along the Ob' River were being organized. I was able to connect two of his points, the town of Narym and the Kolpashevo village, with my determinations, which gave me the daily run of our chronometer at the beginning of the trip.

Vladimir Vladimirovich Vinogradov, 4th year student of the Tomsk University medical Faculty, came with me as a companion and collaborator. He had already acquainted himself with the methods of observations and even could perform them himself. One of his observations, that of a declination and also of the longitude of Narym, became part of the results published here. The main responsibility undertaken by V. V. Vinogradov and carried out very conscientiously, was recording the moments by the working Waltham watch, writing down all the readings dictated by me, and finally, the observation of the Rosenthal galvanometer while determining the inclination by an induction inclinometer. It should be stated unreservedly that such a distribution of work was very effective.

We left Tomsk, early in the morning of the 23rd of June (new style) 1900, on the steamer of the Associated Steamship Lines for West Siberian Rivers. The route was to follow Ob' and Tom Rivers as far as the town of Narym, where magnetic observations had been made some years back by Hansteen and Fritshe. On the way, during an hour and a half stopover, at the "Krasnyy Yar" landing (for loading wood), we attempted, not quite successfully, due to the shortage of time, to determine the declination and the horizontal intensity with the Wild instrument. From Narym, we backtracked on another steamer up the Ob' River, to Kolpashevo village located at the Togurskaya channel of the Ket' River. We did not consider it feasible to wait here for a state steamer to sail to the upper reaches of the Ket', due to unforseen changes in the steamer's schedule. Therefore, after having finished our work at Kolpashevo, we decided to buy a rowboat and go up the river, stopping for observa-

---

4) Five poles (two of them higher than others, over 1 sazhen' high, with a cross bar for the ridge of the roof, were installed in diametrically opposite angles of the square) used to be wrapped in the tarpaulin of the tent, when the tent was folded up. Two side sections and the roof section were used for this purpose.

tions at villages along the banks of the Ket' River, for a stretch of about 100 versts from its mouth. Travelling this way, we reached the last of these villages, Bol'shoye Panovo. From there, we had the choice of either continuing the river in the boat, but without being able to get the shelter of housing, as only rare "summer" Ostyak yurt as could be encountered between the Bol'shoye Panovo and Maksimoyarovsk, or backtrack and await a state steamer. The first choice would have added the difficulties of a fairly swift current, and therefore, moving up the river would have been very slow and expensive, and furthermore we would risk missing the state steamer in one of the numerous branches of the river, if and when the steamer caught up with us. Backtracking would have been useful for determining the run of the chronometer, of which, so far, we had only a faint idea, based on observations at Kolpashevo. Having turned back, we began awaiting the steamer at Maloye Panovo village. In this village, the determination of time by means of a rough topographic survey, could be connected to observations made during the first trip to the Kalmakovo settlement (otherwise called Rodionovo), 1 verst from Maloye Panovo. We spent only 10 days in Maloye Panovo, awaiting the steamer which finally arrived on the 27th of July, new style. On the steamer, we met Stanislaw Antonovich Zbikovski, engineer in charge of the work on the canal. I consider it my duty to express my deep gratitude to Mr. Zbikovski for his co-operation in our work and for the facilities extended to us for comfortable travel along all of the joint waterway system.

The trip up the Ket' River on the steamer "Tomsk", was interrupted rather seldom. In day time, we made observations only twice: in Yurty Muleshkiny and at the landing near Maksimoyarovsk village, where we determined the latitude from the sun only. The steamer stopped more frequently at night, for several hours at a time, because of darkness and the danger to navigation from tree trunks, and in places, shallows in the river. We took advantage of these stops to make observations from the stars with the Hildebrand theodolite. In Yurty Shirokovy, we made complete astronomical determinations. In Yurty Berkunovy (or Pyrgynovy) only brief determinations were made due to the appearance of clouds.

In Yurty Shirokovy, where we arrived fairly early, while it was still daylight, we attempted to make magnetic determinations with the Wild theodolite using a copper hand lantern with a stearin candle for lighting. A great number of mosquitoes and gnats, the so called "gnus" presented a serious obstacle. It was very difficult to focus the light of the hand lantern on the mirror which was lighting the crosshair of the tube's eyepiece and to focus it on the magnet. However, we had to give up magnetic observations altogether when it came to reading off verniers of the horizontal circle. It was impossible to light them up sufficiently, even after completely removing the case with the magnet. This experience made us give up completely night observations with the Wild theodolite, whenever it was necessary to read off the verniers of the horizontal circle.

In Yurty Muleshkiny, after assembling the surveying parts of the Wild theodolite, an accident occured which deprived us of further possibility of measuring angles of inclination. The movable leg of the stand had not been fastened securely enough and folded up under the weight of the instrument. The theodolite fell and hit with the side which housed the vertical circle. However, by a lucky chance, there was no great damage done. The plane of the vertical circle and its alidades were bent, so that the rotation of one relative to the other became impossible. Removing the alidade of the vertical and after having unscrewed the circle itself, I became convinced that other basic parts had not suffered in the fall. Neither the moveme STAT around the vertical axis, nor the horizontal limb, nor the horizontal axis of the theodolite had suffered, thanks to springs which had reduced the shock. This was attested not only by a meticulous examination of the instrument, but also by the fact that the accuracy of astronomic observations made with this theodolite during the following year, was not impaired. The instrument was used again the following year, after the vertical circle and the alidade, which had been sent to the shop of Dr. Edelman in Munich, had been replaced by new ones.

After having adjusted all the parts of the instrument, there was no reason to to consider the observations of the horizontal intensity and of declination as having changed in any way. However, astronomical determinations were made only with the Hildebrand theodolite from that time on.

On the 2nd of August, the steamer "Tomsk", reached the terminal point of its 1900 trip, that is the mouth of the Ozernaya River. From there, after making astronomical and magnetic observations, we rode on horseback for about 30 versts over a fairly good road to the Main Field Headquarters ("Glavnyy Stan") residence of the commander of the Ob'-Yenisey sector. During this trip, I held the chronometer in my hands and the instruments were carried on horseback at a walking pace, so that they would not be damaged by jolting.[5] Together with Stanislaw Antonovich, we travelled further from Main Field Headquarters by the "Ozernyy" steamer, and then by boat. The evening of the 7th of August, at the "Georgiyevskiy" camp, where work was in progress on the construction of a new lock, I was informed that there was a note for me at the next, the Alexandrovskiy camp. The note was from the rector of the Tomsk University, to the effect that, as an ensign in reserve, I was to report for active duty because of the mobilization orders from the Siberian Military District. The very next day, I received the rector's paper and had to leave immediately to join the unit I was assigned to in Tomsk. The paper had been sent to me through the county administration of the Yeniseyskaya guberniya. It was brought to me after many detours by four peasants of the Antsyferovskaya volost' of the Yeniseyskiy county, from the villages on the Yenisey, near the mouth of the Kas River.

Thus, the observations were dropped, and, using the above mentioned peasants as travelling companions, we left immediately and travelled down the Bol'shoy Kas River in two boats. We entered this river from the last lock of the Ob'-Yenisey system. Without losing time for lengthy stops and taking advantage of the river's current to move along, we made astronomical determinations only once, at the mouth of the "Kasovskaya" Stream. After 3 days travel on the Bol'shoy Kas, we reached the Yenisey and having sailed several versts upstream, we arrived at the Nizhne-Shadrino village (also called "Sukovatka") late in the evening on the 11th of August. Here we stayed up all night, awaiting in vain the appearance of stars. At dawn, we determined only the horizontal magnetic intensity. We did not remain to await suitable condition for determining the local time and the ground target azimuth from the sun. We left for Yeniseysk by postal boat, towed up the Yenisey River by horses. On the 14th, we were in Yeniseysk, from where we left on a

5) It should be noted that transporting the Wild theodolite in poor carriages was not always safe. Thus in Tomsk, during one of the changes of location, certain regulating screws lossened up, and one of them even fell out completely.

STAT

steamer for Krasnoyarsk and on the night of the 19th of August, we reached Tomsk. We had been unable to find time for observations either in Yeniseysk or Krasnoyarsk, where we should have taken advantage of precise longitudes to check our chronometer. Observations were made in Tomsk on the 20th and 21st of August.

The 1901 travels had the advantages of railroad service as stated above. I tried, as much as possible, to lighten my baggage and therefore decided to take only one theodolite. It was the magnetic universal Wild instrument. The vertical circle and its alidade had been replaced by new ones of high quality, during the winter. Furthermore, taking advantage of the experience gained during the preceeding trip, certain modifications were made in the equipment and some parts of the instrument. The theodolite had to be checked again at the magnetic observatory, due to the fact that the constant multiplier for obtaining absolute intensity with our theodolite, as determined by me in Irkutsk, differed rather considerably from the one found by prof. Kapustin in Pavlovsk in 1897. I went to Irkutsk again and between the 30th of May and the 2nd of June (new style), determined the temperature coefficient of the magnet and found the constants and the corrections for the instrument. It was while in Irkutsk, that I decided to limit the area of surveys to the region along the Siberian railroad. This was due to the fact that the director of the observatory was himself planning to make magnetic determinations along that same railroad from Irkutsk to Krasnoyarsk.

After returning to Tomsk, and the final preparations, the departure took place on the evening of the 11th of June (new style) in the direction of Chelyabinsk. The first observation point was the railroad station Polomoshnaya, located on the Tom' River. This time I was accompanied by Dmitriy Tatarinov, employee of the physical laboratory. During the first part of the trip, as far as Chelyabinsk, I was accompanied by Vladimir Nikolayev, a pupil of the Tomsk gymnasium [high school] who helped me by writing down most of the observations, which saved a considerable amount of our time.

The selection of points was done so that the distance between them would be about 100 versts.. Usually about 5 - 6 hours were spent in transit. Each time, we got railroad tickets and checked some of our effects into the bagage car. In anticipation of complications or misunderstandings which might arise while working along the line, the chief of the Siberian Railroad at my request, gave me an open letter requesting full cooperation of the railroad's administrative personnel. It is true that no instance necessitating such cooperation, ever arose.

We tried to remain a day and a half or two days at each point. This allowed to increase the number of observations on which, to a great extent, depends the reliability of the final results, due to periodic and occasional changes in the earth's magnetism. Astronomical work this year, had been greatly facilitated by the fact that many of the points along the Siberian railroad from Omsk to Bogotol and partially even west of Omsk, had been precisely determined by the geodesist Yu. Shmidt in 1896 and 1897. Thus, time observations and the roughest surveys with an angle prism gave accurate coordinates of points and in addition an accurate daily run of the chronometer.

STAT

Magnetic elements had been determined at 15 stations during these short trips, before we reached Chelyabinsk. It had required about a month's time. On the 14th of July, we left Chelyabinsk back for Krasnoyarsk. Having finished observations in Krasnoyarsk, and still having a lot of time, I decided on the 22nd of July to go as far as possible down the Yenisey River, in order to complete the work left unfinished the preceeding year. We took the steamer as far as the Kazachinskoye village. Without waiting for the next steamer, we hired a boat on which we went down as far as Yeniseysk. We did not stop there at the time, but continued on postal boats. We made observations at the Kolmogorovo village. To my knowledge, astronomical and magnetic measurements had been taken there by Col. Vil'kitskiy in 1894; and astronomical measurements had also been made by the Irkutsk Department of the General/Staff in 1899. In Nizhne-Shadrino village, i.e., where I had been the preceeding year, I met L. A. Yachevskiy, mining engineer, surveying the northern Yenisey gold bearing region and intending shortly to move northward on the Vorogovka River, going up stream into the tayga woods. The fact that our theodolite was not adapted to rapid, even though inacurate, reconnaissance measurements, and especially to being transported by pack animals, which would have been the case in the woods, forced me to decline to participate in the trip. I limited myself to taking abbreviated observations at the mouth of the Garevka River, right tributary of the Yenisey (some 12 versts south of N. Shadrino), where L. Yachevskiy was camped. We reached there close to sunset. I determined the azimuth of the ground target from the sun. The chronometric correction for the local time was made several hours later, from the star. This point, is the only one of my points located on the right bank of the Yenisey, which magnetically was slightly different from the neighboring point. On the return trip, we stopped in Yeniseysk. Finally, on our way from Krasnoyarsk to Tomsk, we made observations at 4 more points. At one of them, namely in Bogotol, we had to stop for several days, awaiting the sun, and even so, we were forced to leave without having seen either the sun or the stars and had to give up determining the magnetic declination.

We arrived in Tomsk, the evening of 13 August. Altogether the trip took almost two months and resulted in 25 magnetic points. Somewhat later, I made observations twice more at Prof. Kapustin's point near Tomsk, on the other side of the Tom' River.

As detailed a description as possible of all the 1900 and 1901 points of observation will be found below. The method to set-up the instruments and methods used during magnetic and astronomical measurements, will be found in an appropriate chapter. Here I will only indicate the considerations which guided us in the choice of location for observations and the way the time was allocated for work. The predominant factor of the choice of a location was the abscence near it of any kind of iron mass. The slightest doubt to that effect made us change the location. For example in 1900, we made observations at two locations in Narym, Maloye Panovo, and at the mouth of the Ozernaya River. In Narym, an iron pile, the mark of the water gauge, appeared quite close to the initial position of the instrument. These fears, however were not fully justified, after comparing the magnetic elements at both locations (see list of points). In M. Panovo, we moved our tent because some lumbering work was begun near it. At the mouth of the Ozernaya River, where we began our astronomical observations at night, we had to move because we saw in the morning a considerable mass of iron was piled up on a cape, not very far from us.

STAT

In 1901, we moved away from the railroad tracks, usually for 200 meters or more, avoiding also railroad buildings and water pipes. The presence of water pipes could easily be determined at once by external signs. According to an approximate theoretical calculation the influence of the water pipe magnetism, induced by the earth's magnetic field, on the measured elements is insignificant for the stated distance, even when not taking into account the fact that pipes do not constitute an uninterrupted[6] and solid iron core.

Insofar as the arrival and departure of trains, maneuvering at the same distance from the instrument, it was impossible to prove their direct influence on the instrument, although I have the appropriate material. If there was any influence, it was insignificant. This is apparent from the fact that points which previously were located very far from the rail tracks, such as Chik, Kozhurla, Mar'yanovka, Makushino and others, give no greater agreement in reduction of magnetic elements than other stations, located near the railroad tracks (Polomoshnaya, Tebis, Tatarskaya, Isil'-Kul', Chelyabinsk and others; see table X below). Therefore, one may suppose that the influence of incidental earth's currents circulating through the rails, was not noticeable.

In chosing the location for observation, we were also frequently guided by considerations of conveniences of spending the night in the tent, because it was very difficult to find lodgings in small station settlements. Lodging in the tent was inconvenient only in one respect: the chronometer was then subjected to high daily variations in temperature. However, at times it had been possible to turn it over for the night to the RR station's postal telegraph office for safekeeping in a locked trunk, and at other times in the hut of some reliable inhabitant. When we were to stay in the tent the clock around, we installed the stand with the instrument the first thing in the morning, which saved us considerable time. Thus, except for brief intervals for rest, the whole time was devoted to observations. In towns, we had to stop at hotels, and use hacks for driving beyond the city limits. This required that the instruments and tent be installed anew in each instance.

Magnetic observations seldom were made without a tent - only in instances of brief stops, while travelling by steamer or by boat, when the observations were also incomplete. Only once, at the mouth of the Garevka River, in 1901, the whole series of magnetic observations was performed without the tent, due to complete calm in the evening; it was possible to make a very good determination of the inclination even with the galvanometer without any protection. Astronomical observations require less protection, but even then, our tent fully replaced an umbrella. We could protect the instrument and its levels well from the heat of the sun while observing it, by stretching out or partially rolling away the removable roof of the tent. During night observations, the same arrangement protected the lens and other parts of the theodolite from too heavy deposits of dew. Finally, closing the tent completely, we were able, in many instances to continue making magnetic observations in the tent while it was raining. Only the verniers then were dark.

6) As a rule, pipes are joined by lead packing.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

Weather conditions in 1900 and 1901 had been rather favorable, but observat STAT by the stars were still fairly rare. In 1900, stellar observations could have been easily made with the Hildebrand theodolite, but smoke from large forest fires, extending over huge areas, frequently interfered. This handicap has also been mentioned by Yu. Shmidt[7] who worked that summer on the Ob' River. In addition, there were fires along the Ket' and the Bol'shoy Kas Rivers[8]. In 1901, observations from the stars with the Wild theodolite were rather difficult but possible, if the verniers of the horizontal circle were not used. They gave good results at Mar'yanovka and Chelyabinsk stations and at the mouth of the Garevka River.

In 1901, observations were made much more intensively than during the preceeding trip. However, it was seldom that one succeeded to make in one day all the desired observations, despite certain abbreviation in the measuring methods, made to improve the final results. These desired observations were: 2 determinations of the time and azimuth from the sun; three determinations of the declination; three determinations of the horizontal intensity, and at least one determination of the inclination. It was necessary also to make a rough survey of the locality from the sun at noon. Especially, a great deal of time was spent to determine the inclinations, even when all parts of the instrument proved to be in good order right from the start. This latter factor of course depended on how complicated was the process of assembling the component parts of the instrument, mainly of the control parts and the difficulty of installing the galvanometer. Usually all the above mentioned observations, could be made without too much difficulty, even in a large number, within one and a half working days.

II. MAIN AND AUXILIARY INSTRUMENTS USED DURING THE TRIPS, THEIR CONSTANTS AND CORRECTIONS

First of all, let us enumerate the instruments which were used for various auxiliary measurements.

Gerl. aneroid No. 1226, belonging to prof. Kapustin, and a Boelau aneroid were compared with the barometer in the physical laboratory prior to the trips. The temperature coefficient was studied also. The Gerl. aneroid was found to have no temperature error. It was not taken along during the 1901 trip. The following were obtained:

For the spring of 1900:	mm	
Correction to Gerl. 1226	-2.16	mm
" " Boelau	+3.7	-0.03 t°

7) "Opredeleniye astronomicheskikh punktov parokhodnymi reysami v basseyne rek Obi i Irtysha v 1900 godu. "Zap. Voyenno-Topogr. Otd. Gl. Shtaba ("Determination of Astronomical Points by Steamer Trips in the Ob' and Irtysh River Basin in 1900." Transactions of the Military Topographical Department of the General Staff), vol. 59, p. 173.

8) The four peasants who delivered to me the document from the rector of the Tomsk University were caught by a forest fire according to their statements. At that point they left their boat prefering a shorter and more rapid way on foot leading directly to the mouth of the Malyy Kas River and Aleksandrovskiy stan. While detouring the fire they got lost and reached the destination tired and hungry. We also saw the fire during our travel.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

STAT

For the spring of 1901:	mm	mm
Correction to the Boelau	+3.9	-0.03 t°

F. Muller No. 98 sling thermometer, which I used exclusively to determine the temperature of the air, had corrections of less than 0°.1.

The thermometer of the Wild theodolite (W) was once checked aginst the No. 98 and the difference between them was:

$$\text{No. } 98 - W = 0°.15.$$

As all observations were made with the same W thermometer, there was no necessity to use corrections. This thermometer was graduated up to 36° C only. In 1901, during a heat wave the thermometer burst as the crate containing it had been left standing out in the sun[9]. The broken thermometer was replaced by a spare thermometer P taken from one of the instruments belonging to the physical laboratory. The checking of this thermometer gave the following:

At 16°	P - No. 98 = 0°.85	
At 24°	P - No. 98 = 0°.80	P - No. 98 = 0°.87
At 26°	P - No. 98 = 0°.95	

Therefore, in order to reduce the temperature of the magnet to the old W thermometer for the observations made in 1901 and beginning on 29 June (new style) at Mar'yanovka station, a correction of - 1°.02 was made in the readings of P thermometer.

In 1900, a Richthofen compass of excellent Hildebrand make, graduated to degrees, was taken along for topographic work. This compass could have been used also for determining the declination of the magnetic needle from the sun. According to tests made by me in Tomsk, the accuracy for determining the declination by the known azimuth of the ground target, reached up to ± 4', and the constant error of the compass remained within these limits also. However, it was not used to determine the declinations en route. In 1901, I just did not take it along, having taken for surveying a small angle prism with two verniers on a special stand for readings to 2'.

Only one Erickson table chronometer No. 85, with the run to mean time was taken on both trips. At home, its rate was insignificant and very constant. In the field, its daily run was also very satisfactory as shall be seen from observations in table III, and this despite the fact that it had not been possible to really protect it from jolting and from temperature variations. A Waltham watch, belonging to prof. Kapustin, and used by me in 1900 as a work chronometer, became unreliable in the course of time (see Table IX) and needed to be checked frequently with a chronometer. This was the reason why in 1901, I used the Erickson chronometer exclusively to work with.

9) Frequently a temperature of + 33° was registered in the tent, later at Makushino station it was + 38°.

STAT

A field Hildebrand theodolite (universal) No. 2601, was used for astronomical observations. It had a lens of about 35 mm in diameter; the vertical circle had a diameter of 14 cm with verniers giving readings up to 10"; the horizontal circle had a diameter of 12 cm with verniers up to 30". Six vertical threads, and two horizontal threads were arranged close to each other (one of them was especially marked to help differentiate them) in the diaphragm of the eyepiece. Among the vertical, the central ones were also placed close together. The angular distance between threads equalled 50".

The value of the division of levels according to the previous measurements taken by prof. Kapustin, gave the following on the level testing standard:

for the vertical circle level 10"

for the horizontal axis level 27".

Consequently, a correction to the mean readings of the verniers of the vertical circle was:

$$\left(10 - \frac{n_1 + n_2}{2}\right) 10'',$$

where n_1 and n_2 are the readings of the ends of the level's bubble. The inclination of the horizontal axis of the striding level in magnitude and sign was determined by the following formula:

$$i = \frac{m_o \text{ to right} - m_o \text{ to left}}{2} \, 27''$$

where m_o to right and m_o to left stand for arithmetical means of the readings of the bubble ends, when the zero division of the level is to the right and to the left of the observer standing in front of the instrument and looking at the light.

The theodolite was used for observations in Tomsk and for the field observations in 1900.

The Wild magnetic universal field theodolite, belonging to the Tomsk University, was made by the firm of Dr. Edelman in Munich. By its mechanism, this theodolite resembled closest the theodolite type of H. I. Wild, described by him in 1894[10] and again later in 1896[11]. Therefore I will give only the main features of this theodolite and its certain peculiarities differentiating it from others.

The lens of the astronomic telescope has a 28 mm diameter; the graduation of verniers of the vertical circle equals 20". At first, the horizontal circle's verniers were also graduated to 20", the diameter of the horizontal circle, was about 17 cm. The graduation value of the vertical circle as

10) H. Wild. "Beitrage zur Entwicklung der erdmagnetischen Beobachtungsinstrumente," ("Contributions to the Development of Instruments for Observation of Terrestrial Magnetism,"), p 17. Rep. fur Meteorologie, vol. 17.

11) H. Wild. "Theodolith fur magnetische Landesaufnahmen." Vierteljahrsschrift der Naturforschenden Gesellschaft in Zurich. ("A Theodolite for Topographic Surveys." Quarterly of the Natural Science Assoc. in Zurich). 1896. Jubille Volume. Vol. II, p 139.

determined by prof. Kapustin, corresponds to about 15" in its center.[12] Therefore, instead of taking the mean readings N of the verniers one should take:

$$N + \left(\frac{n_1 + n_2}{2} - 10\right) 15''.$$

STAT

The division value of the applied level equals 20", and the inclination of the axis determined by reversing this level, is computed according to the formual [13].

$$i = \frac{m_o \text{ to left} - m_o \text{ to right}}{2} \cdot 20''.$$

Finally, the level inside the inductor had 20" division values (not quite uniform throughout).

The thodolite had the following features: the astronomical telescope was placed eccentrically; the horizontal axis was elongated with extensions at both ends used as supports for the device holding the deflecting magnet. Furthermore, the center of the horizontal axis was replaced by a large ring, so that the pivots were on the extensions of one of the ring's diameters. The ring serves, first, to eliminate difficulties in installing cases with magnets in the center of the theodolite; second, to make it possible to screw to it the small tube with light reflected by a mirror on the eyepice scale for aiming at the magnet and at the ground target; and third, to provide a place within it for a copper ring with an induction coil which serves for determining the magnetic inclination. Therefore, the same vertical circle serves both for taking readings of the inclination angle of the inductor and for astronomical observations.

The main magnet in a large box, placed in the center of the theodolite serves to determine the declination and the time of oscillation of the magnet. In determining the angle of deflection, the main magnet is fixed in the same box, without being taken out, perpendicularly to the original position and the whole box is set, with different sides in turn, on the ends of the horizontal axis of the theodolite. Simultaneously, another box with an auxiliary magnet and a strong copper damper is placed in the center [of the theodolite]. The same small tube with the eyepiece scale, is used for aiming at this magnet (according to Lamont). Thus the deflection is made from one distance only and it is impossible to obtain the horizontal intensity in absolute units, even if only because of the difficulty in determining the distance between the magnets.

In order to observe currents in the inductor, while determining the inclination, a galvanometer of the Rosenthal system was used; initially with an air damper.[14] The galvanometer is placed on a separate stand, with a ball level, the whole installed on a separate stand.

One can see from this brief description of the theodolite, how different it is from the earlier prototype of field instruments of the same make, e.g., from the instrument used by V. Kh. Dubinskiy for making magnetic observations in Zapadnyy Kray[15] (Western Region). Our theodolite differed from the latest type instrument (described in our last work, mentioned above) by only the following details: the main magnet of our theodolite was not suspended in a separate instru-

12) Whenever the bubble shifted too much to the side, the more accurate table was used to center it:

The center of the level at	5 div.	6	8	10	12	14	15 div.
	-68"	-52"	-28"	0	+30"	+55"	+64 "

13) The numerals on the horizontal circle of this theodolite increased counterclockwise looking at the circle from above.

14) Prof. Kapustin installed a copper damper replacing the bone coils by copper coils.

15) H. Wild. "Instrument für erdmagnetische Messungen und astronomische Ortsbestimmungen auf Reisen" ("An Instrument for Measuring Terrestrial Magnetism and for Making Astronomical Determinations During Trips"). Rep. für Meteor. vol. 16, No. 2.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

ment case in which it could revolve around its own axis[16], but by two pegs at the top and the bottom of the magnet. Furthermore, both boxes (magnet housings) in our theodolite are installed in a removable cone, the other end of which, also conical, is inserted into a receptacle in the center of the theodolite. Finally, t STAT Rosenthal galvonometer was replaced in later models by the more practical Weiss galvanometer.

Due to the fact that despite a fairly long lapse of time since the H. Wild field type of theodolite was described and that during this period very few analytical results of magnetic observations (made with instruments of such type)[17] have been published, I consider that it might not be superfluous to dwell in greater detail on the two years' experience which demonstrated the practical qualities of these field instruments. This in a way, would develop some of the ideas submitted by prof. Kapustin.

The fact that the instrument is universal is, of course, very advantageous on field trips[18] and the layout of parts by the academician Wild, is efficient in this sense.

From the point of view of design, the instrument showed a defect which, in my opinion, limited the accuracy of most observations made with the theodolite, so that in final results, this accuracy did not correspond to the measuring (surveying) potential of the theodolite. The defect consisted in the fact that the connection of supports for pivots with the vertical axis was not strong enough. The massive upper lid, at the edges of which the supports were fixed, was subject to buckling, despite the weight and solidity of the lid. Consequently, the necessity for alternate loading of the theodolite and moving of the whole case with the magnet to different ends of the horizontal axis and in general the use of counterweights[19] cause difficulties.

Furthermore, the method of moving the whole box with the magnet to the ends of the instrument's axis, had its fault's at least in the Tomsk model, although in fact the temperature of the magnet was reliably registered. The fact was that the complicated system of fixing the magnet within the box with a large number of small screws, did not guarantee complete uniformity and invariable position of the magnet for any length of time. Thus, there were times when the magnet swayed a bit between the two clamping forks. At times, despite all precautions, the upper fork itself wobbled noticeably and it was not possible to tighten it hard enough. Even less expected had been the fact that the main regulating screw, placed on the outside of the suspension cylinder and determining the height of the upper fork and hence the height of the main magnet during deflections, apparently losened up. We will describe this below.

---

16) This rotation was produced mechanically during the determination of declination in the models described and the magnet was not touched by hand.

17) I only know that a similar theodolite was used by prince B. Golitsyn on Novaya Zemlya (Izv. Imp. Ak. N. - Bulletin of the Imperial Academy of Sciences - vol. 6, No. 3, 1897) and in Vorob'yevka village (l. c. vol. 5, No. 5, 1896), and by Col. Drizhenko on Lake Baykal.

18) Only a small modification in the design would be needed in order to eliminate the necessity of repeated complete adjustment of parts taking so much time in the field. The Tomsk model required an adjustment when the auxiliary telescope was affixed so that the eyepiece scale would be horizontal, and an adjustment of the ring with the inductor so that the inductor rotation axis would remain perpendicular to the horizontal axis, etc.

19) Apparently, a considerable reduction in the size of all parts, and in the weight of all those parts of the theodolite wherever possible, and also change to the usual system of affixing the supports of the horizontal axis and to resetting of one magnet, without the housing, would facilitate the observations without even reducing their precision.

STAT

There is another reason why putting on and removing the tightly set whole box, without swaying the ground in ends of the horizontal axis, is convenient. Without a doubt, these manipulations can cause a slight displacement of the whole axis of the theodolite on its pivots, either to the left/or to the right, in the course of the same observation, and therefore the mean distance between the magnets will change. One should be aware of this very serious source of errors, which might arise if in the process of the full circle of observations one has to use the micrometric screw near the horizontal axis of either to raise or lower the eyepiece image in the telescope. Such manipulation had to be performed at times on the Tomsk model.

To conclude, I am going to enumerate those peculiarities of our model which explain the choice of observation methods and different measures taken by me during field work.

1) The weak point of the upper part of the Wild theodolite was apparent when the micrometric screws of both axes of the theodolite were used at which time the images of the objects on the ground were greatly and irregularly displaced in the telescope eyepiece. Thus, under the action of the screw of the vertical axis, objects were shifted in relation to the horizontal thread of the telescope, etc. The same indication was given by levels, which displaced noticeably under the action of the screw for the vertical axis.[20] However, astronomical methods of observation can eliminate, almost completely, errors arising from defects of the instrument, if one does not touch at all the screws at the moment of contact of the telescope's thread with the celestial body, and if one reads off immediately the appropriate levels. These were the reasons why I used, only in extreme cases, the usual simplified method for sighting the cross threads on the center of the sun, or even, in general, the simultaneous aiming of the telescope by both the vertical and the horizontal threads. I prefered to make separate (and more accurate, considering our instrument) observations for the height and the azimuth of the celestial body.

2) After/changing the "circle right" to "circle left" while observing the azimuth of the sun, the elevated lens end of the astronomical telescope hindered the reading of the second vernier of the horizontal circle. It was necessary to losen the axis and lower the telescope.

3) The striding level can not be safely left all the time on the horizontal axis of the theodolite. At the time of very high sun, the inclination of this axis can not be determined at all if the clamping screw is not loosened and the telescope lowered down. However, it is especially important to determine the inclination of the axis immediately after the sun passed over the eyepiece cross-hair.

---

20) This circumstance and other, enumerated by me here, were mentioned by prof. Kapustin; see his article "Opredeleniye magnitnykh elementov v g. Tomske," printed as an appendix to Izv. Imperatorskago Tomskago Universiteta (Bulletin of the Imperial University of Tomsk), in the Sbornik trudov v pamyat' E. G. Salishcheva (Collection of Works in Memory of E. G. Salishchev). Tomsk, 1904. See also Protokoly Obshchestva Yestestvoispytateley i Vrachey pri Imp. Tomsk. Universitete za 1898 - 1899 gody (Protocols of the Association of Natural Scientists and Physicians at the Imperial University of Tomsk for 1898-1899), p. 10.

Not measuring the inclination of the axis each time after contact (because of thi necessity), and at times even after loosening the screw, we of course make an erro. However, one may suppose that the error is constant, if we terminate the motion of micrometric screws always uniformly to the right. Fortunately, all astronomic operations for the purpose of magnetic measurements, especially in the field, do not require extreme accuracy. The accuracy of astronomic operations in 1901 with the Wild theodolite, was in general adequate. But, it would have been desirable that it could have been reached without a useless loss of time and labor, as for instance would have been the case with a smaller size and better quality instrument.

4) The so called "optical noniuses" (verniers) were found not to be practical, due to the variability of values in their graduations. This was mentioned by H. I. Wild[21]. Prof. Kapustin also noted their constant change (later it was found to be due to the load of the theodolite) and instead of adjusting the microscopes each time, he determined the value of vernier division. Later, he deliberately reduced the sensitivity of verniers 1 1/2 times. In 1901, I reduced it even 2 times, so that very frequently the verniers had not only one but two coinciding lines, and both of them could be read. Their difference gave the value of the vernier. A special table was then used to change the readings into minutes and seconds of the arc. As the division of the horizontal limb = 10', I did not use the verniers for some of the measurements, but took the readings by the eye to 1/10th of the division, i.e., up to 1'. Another difficulty was the relative darkness of these verniers, and at night, candle light was not adequate.

5) Traces of iron[22] were found in certain parts of the theodolite: in the fork of the locking device, which was always located directly under the magnet. Also in the lens part of the frame of the small telescope through which the magnet was sighted.

The influence of the locking device, at least the possibility of its alternate influence on the magnet, was nullified by placing the locking device before each sighting and while observing the oscillation period in the position perpendicular to the magnet. The difference between the declination with the locking device parallel to the magnet and perpendicular to it, was however less than $0'.3$. The influence of the locking device manifested itself more clearly when observing the time of the magnet's oscillation. Special observations made in the laboratory of the Tomsk University gave the following T (period oscillation) with different positions of the locking device:

Locking device placed parallel	12^h50^m	at $16^\circ.64$	$3^s.4373$
" " " "	1 0	16 .61	4374
Locking device placed perpendicularly	1 21	16 .85	$3^s.4457$
" " " "	32	16 .75	.4467
Locking device placed parallel............	1 50	16 .79	$3^s.4386$
" " " "	2 1	16 .79	4397
Locking device placed perpendicularly	2 12	16 .66	$3^s.4465$
" " " "	2 24	16 .60	.4463

21) "Theodolith für ...." l. c., p. 165.
22) F. Ya. Kapustin: "Determination of magnetic elements in Tomsk". l.c.

STAT

Observations were made with a special telescope, installed at a distance. mean amplitude of oscillations was about 1°.1, so that the correction to the infinitely small amplitude would have been about - $0^s.0001$. Average for

the locking device placed parellel	for	16°.70	$T = 3^s.4382$
the locking device placed perpendicularly	"	16°.71	$T = 3\ .4463$

The decrease of T when the locking device is parallel to the magnet indicates an increased intensity of the magnetic field in this instance, as the influence of a relatively large decrement in this position on the locking device would in itself have influenced T in the opposite direction.

Immediately after these measurements were taken, the telescope of the Wild theodolite was mounted and with a perpendicular position of the locking device, the T for 16°64 = $3^s.4447$, so it would appear that the small telescope of the theodolite also has a certain influence on the magnetic field near the theodolite.

Later on we will come back to the influence that the presence of iron in the instrument should have on the reliability of the results. Now we will point out that we always lowered the locking device, as much as possible and placed it in a position perpendicular to the magnet with the exception of those instances of errors which were noted in the journal and therefore completely excluded, and also instances of errors which were perhaps completely undetected.

6) The glass in the front lid of the main box, through which the magnet was sighted was not polished planoparallel, therefore the sighting of the ground target had to be done also through this glass. However, the difference between sighting the ground target through the glass, or without it, was very slight, about 0.'3.

It should also be mentioned that due to the fact that even a slight wind had an adverse influence on the Rosenthal galvonometer and on the results of the work with the inductor, i.e., on the unknown inclination, the galvanometer stand was shortened so much that one had to make observations sitting on the ground. It also appeared more convenient to place all the parts of the Wild theodolite into three boxes instead of one, thus making it easier to assemble the theodolite under the field observation conditions. Finally, I can recommend, as a result of personal experience, always to cover with something the apperture drilled through along the whole length of the horizontal axis, from the side of the astronomical telescope[23]. Not only dust penetrates through

23) It should be covered in such a way as to leave the end of the horizontal axis completely free for an accurate rest against the glass of the case, when the housing is put on.

this aperture into the telescope, but also insects, which is very annoying because the crossthreads stretched in the telescope eyepiece were twice put indanger.[24]

STAT

---

24) In 1900, in the town of Narym, while V. V. Vinogradov was observing the sun, the image of a huge insect appeared in the focal point of the telescope. Fearing that the thread would be torn, I unscrewed the lens of the telescope and a small horsefly flew out. The threads were not damaged. In 1901, several times during night observations, a small prism was used (as it should be) for lighting the telescope field. This prism was inserted in the aperture of the horizontal axis described above. One time, I evidently forgot to cover the aperture with a piece of paper. At the Chernorechanskaya railroad station, while focusing the astronomic telescope on the target, I noticed that instead of the crossthread there was a whole irregularly shaped net of threads. The crossthread to which the cobweb was attached, was also deformed. A small spider had crawled into the telescope. While cleaning the eyepiece the crossthread was weakened and one thread was completely sagging. I tore it off, and having no suitable material other than silk, I separated a fine strand and stretched it across the old space, having secured the end with shellac. The new thread was somewhat thicker than the old threads and the net was placed so that the new thread was used as the vertical one. The sun rays did not burn the silk thread.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

III. ASTRONOMICAL OBSERVATIONS, FIELD READINGS AND CALCULATIONS

STAT

Astronomical observations, were not our purpose directly, but had mostly an auxiliary character for the calculation of magnetic declination. These observations consisted of determining the local time, the latitude and the azimuth of the mark (target) and were made from the sun for the most part.

A Waltham watch without the seconds' beat, was used in 1900 as a working chronometer and the time was noted by the assistant V. Vinogradov on a signal from the observer. In 1901, the Erickson chronometer was always used. It was placed on the theodolite case, so that its beat could be well heard by the observer.

During field trips, theodolites were installed on their stands, at times (especially the Hildebrand theodolite) stuck directly into the ground. More frequently, however, wide stakes were first driven into the earth, flush with the ground and hollows corresponding to the sharp edges of the shoes of the support were pressed into the stakes. By varying the length of the stakes (from 1/2 to 1 arshin) depending on the type of ground, it was possible to set up the instruments very solidly. Due to the fact that at times, the mark was quite close, a fourth stake was also driven in flush with the ground each time in the exact center for the setting-up of the theodolite (or two theodolites, as was the case in 1900). One could use this stake for marking very accurately with a pencil the center of theodolites by the plumb line suspended to the central stem of the stands [tripods].[25] The instrument was usually protected from the sun either by an umbrella or the roof of the tent. In case of variable cloudiness when the sun had to be sighted either through a red glass or without a glass, the prism of the Hildebrand theodolite proved very convenient with its movable red glass. In similar instances, when using the Wild theodolite, one had to remove the red glass completely and use a hand glass. Conditions of sky transparency varied a great deal in cloudy weather and when one had to interrupt observations and when the edges of the sun were strongly washed out, the quality of observations was impaired. Such instances are mentioned in special notes in the general tables, given later.

<u>The determination of local time</u>, to be more exact, the corrections of the chronometer to the local time, were made by the stars as well as by the sun, by measuring zenith distances of heavenly bodies near the first vertical. All other methods of determining time during field trips, lose considerably their advantage, if no great accuracy is required, as is the case during trips for the special purpose of taking magnetic measurements. According to the alloted time, weather conditions, and others, observations of zenith distances of the sun away from the meridian, will always be less troublesome because our moderate requirements for accuracy, give a wide choice of time for such observations.

---

25) If a marked displacement of the theodolite from the required position was noted, it was possible, after measuring the deflection of the plumb line, to calculate the correction for "centering" the theodolite, if the correction was important enough not to be disregarded.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

The Hildebrand theodolite gave completely satisfactory results in 1900 with the following method ob observation. Two hours or an hour and a half before the true noon time, it was possible to begin measuring the zenith distances of the sun, then to repeat the whole performance about noon, and, finally, once more after the noon hour, symmetrically in relation to the meridian; determination of the azimuth of the target could be done during the same lapse of time of 3 to 4 hours, although conditions for it, especially with the sun being high, are considered disadvantageous. It is understood, that with such a method for determining time, the error in the latitude calculated by the noon zenith distances of the sun, and the systematic errors of the theodolite, and to some extent, the refraction errors are excluded. Bringing all the astronomical observations close to noon, is advantageous, because it leaves the instrument free for the rest of the time exclusively for magnetic measurements. This circumstance outweighs the decrease in accuracy in determining the time and the meridian, sufficient for our purposes as shown by the results (see tables for determining time in Kolpashevo and Maloye Panovo).

Although such set of observations of the sun near the meridian requires a greater number of sightings of the edges of the sun and a greater number of readings, it appeared to me as more advantageous than the generally known method of determining the time and azimuth at equal elevations.[26] With this latter method we are tied by the time element and risk to lose the observations completely if the sun happens to be clouded after the noon hour at the time we need to make the observation,[27] while even a single observation with actual reading of both circles of the theodolite would still give the time and the azimuth when we determine also the latitude of the location with the same instrument by the sun. The number of sightings would make up for the poor accuracy in this method of measuring zenith distances.

However, the time was determined much more frequently without any preconceived plan, as operations progressed, i.e., by taking advantage of intervals of clear sky, making the instrument available for astronomical work, etc. In so far as possible, the time was observed from the stars as well as from the sun at each station on both sides of the meridian and symmetrically. When it was impossible to make twosided observations, I tried at least to make another independent observation.

Usually 8 sightings were made on a star or different edges of the sun, with different positions of the circle - right and left. Four sightings were less frequent. Their number and also information of the mean hourly angle and the mean zenith distance of the celestial body are given in the table of observations. This permits to judge of the relative quality of observations. In two instances, specially mentioned in the tables (at the Tebis station and at the mouth of the Garevka River in 1901), the time determination had to be limited to sighting the sun and the star only in one position of the circle, due to the appearance of clouds. In Tebis, the time determination was immediately followed by determining the location of the zenith on the circle, according to a ground object. This

26) The telescope is clamped in its vertical position and one of the edges of the sun is allowed to cross several horizontal threads of the reticle dividing the sun in halves by the vertical thread and reading each time the horizontal circle. The same is repeated after the noon hour without loosening at all the horizontal axis of the theodolite during all that time.

27) Furthermore, one should have several horizontal threads, which was not the case with our theodolites. When working with a stand, furthermore, a checking telescope is almost necessary, or the determination of the azimuth will be little reliable.

location was fairly accurately known after the preceeding and the following obs STAT vations of the sun had been calculated. By the same considerations it was determined at the mouth of the Garevka River that the possible (maximum ± 10") error in the change of the location of the zenith would have influenced the results of time determination according to α Lyrae but little.

The chronometer correction was computed according to measured zenith distances of the celestial body by a known formula giving its hour angle <u>t</u>:

$$\sin^2 \frac{t}{2} = \frac{\sin \frac{z + \varphi - \delta}{2} \sin \frac{z - \varphi + \delta}{2}}{\cos \varphi \cos \delta}$$

Here z stands for the zenith distance, φ - for the latitude of the location, δ - the declination of the celestial body. The most accurate value of φ was taken, i.e., the mean of all determinations made at a given location,[28] if no other more accurate data was available. Accurate latitudes determined by other observers were taken after reducing them to the location of the theodolite.

I used 6 place logarithms of the so called "Navigation Tables", published by the Main Hydrographic Administration, for computing. The main reason was because it had a convenient table of logarithms of the square of the sine of a half angle, applicable also to computing the hour angles from the formula written above, and to computing the azimuths of the <u>z</u> magnitude. Four place logarithms were used wherever necessary. I used the convenient Albrecht[29] tables for computing refraction and other corrections. These tables especially facilitated the calculation of approximate coordinates of the Polar Star. The tables also have data for precise reduction to the meridian of sourthern celestial bodies (up to 120 minutes of the hour angle), for the computation of precise latitude and azimuth from observations of the Polar Star. The use of these tables eliminates almost completely the use of multiple place logarithms.

Coordinates of the stars and sun were taken from the Nautical Almanac or from Berliner Jahrbuch, and the declination of the sun was interpolated by the differences of the second order, usually directly for the mean moment of observation, corrected by the longitude of the location, either from Greenwich of Berlin. In instances of strong change in the declination of the sun to consecutive differences $z + \varphi - \delta$ and $z - \varphi + \delta$ corrections were sometimes applied depending on the change in the declination of the sun during the whole time of observation. The lesser or greater agreement of results of individual sightings, became more apparent at the

28) It should be noted that when computing the time from the sun close to the meridian, it is more correct to take the value obtained by the same theodolite, the same day from the sun, near the very meridian, and not the precise value of the latitude. The results would then depend less on systematic errors in measuring zenith distances. This condition is important especially for large errors and for unilateral observation of the sun 1 or 2 hours before noon. Therefore, in one instance in Narym, on 26 June 1900, time observation was computed with the latitude determined by the same Wild theodolite, although it differs significantly from the real value, namely by 12".

29) Albrecht: <u>Formeln und Huelfstafeln fur geographische Ortsbestimmungen</u> (<u>Formulas and Auxiliary Tables for Geographical Bearings</u>), Leipzig, 1894.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

STAT

end of a complete set of observations. It is for this purpose that the sightings of each edge of the sun, always computed separately, were corrected by the magnitude of the mean half diameter of the sun. In addition, the refraction (with corrections for atmospheric pressure and temperature) and the parallax of the sun were added.

<u>The determination of the latitude of a location</u> was also made exclusively by measuring the zenith distances of the sun or southern stars near the meridian and the Polar Star. As the degree of latitude accuracy required was not very great and the places of observation were mostly alike, and fixing them to some standing out objects was not always possible (in 1900), I did not try to attain the most accurate results which could have been obtained with theodolites. Therefore I never took several pairs of stars, southern and northern, circumstances mostly forced me to limit myself to one star or to one solar observation. In 1901, determinations of latitude in certain instances were made only for the sake of comparison with the already known and more exact results. In 1900, near the Maksimoyarov village, the latitude was determined by the approximately known local time. The accuracy suffered but little as the sun was near the very meridian. On the Kasovskaya Stream, the sun had already passed the meridian when we began the observations. A new measurement of zenith distances of the sun, an hour after the first, made it possible to calculate both coordinates of the location by subsequent approximations, entailing of course less reliable results than other observations made during the trip.

Computations of latitude were made with a known correction to the chronometer using the auxiliary Albrecht tables. The expansion for computing the latitude by the Polar Star looks as follows:

$$\varphi = 90 - z - \pi \text{ Cos } t + \frac{\pi^2}{\pi_0^2} M_0 \text{ Sin}^2 t + \frac{\pi^3}{\pi_0^3} N_0;$$

is the polar distance of the star taken from astronomic tables for the time of observation, M_0, $\frac{\pi^2}{\pi_0^2}$, $\frac{\pi^3}{\pi_0^3}$, and N_0 are taken from Albrecht. The last member of the expansion is already insignificant and I took the last two for the mean moment of observation.

For southern celestial bodies the tables give the coefficient <u>m</u> and <u>n</u> in the formula:

$$\varphi = \delta + z - Am + A^2 \text{ Cot } (\varphi - \delta) n$$

up to 120 minutes of the hour angle. For observation close to the noon hour, I used to take an even simpler formula:

$$= \delta + z - Ct^2$$

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

for which C and t^2 are given in Albrecht for different latitudes, declinations and hour angles.[30]

STAT

In some instances, when computing the latitude from the sun during strong changes in its declination, the Gauss set was used for simple exclusion of the effect of these changes[31] and for judging the agreement of results of individual sightings of the sun.

Determinations of the azimuth of the target (mark) were done more frequently from the sun, and in 1900 also from the Polar Star. If possible, a distant target was chosen and such that the sightings of the target could not be exact and uniform. Objects serving as the target are enumerated further down in the description of stations.

As the installation of reliable signals, which could be used day and night, appeared difficult during field trips, the observations of the Polar Star were done only as follows: either after a preliminary computation of the location of the meridian from the sun and an estimated computation of the approximate coordinates of the Polar Star the star was located an hour or half an hour before sunset, when the object chosen as target was still clearly visible, or by aiming the telescope on the star during the twilight and await the dawn, at which time both the Polar Star and the target would be clearly distinguishable. Whether the good qualities of the Hildebrand theodolite would permit to sight the Polar Star even in day time, remained unknown to me. Evening determination of the azimuth from the Polar Star were made in Bol'shoye Panovo, and in Maloye Panovo at the second location. Morning determinations - in Kolpashevo, and in Maloye Panovo at the first location.

The determination of the azimuth from the sun, I made almost exclusively by aiming the vertical thread of the telescope on the edges of the sun and taking the chronometer corrections known from special determinations. The Hildebrand theodolite had only 6 vertical threads in the eyepiece (the central ones very close together) and when using it for observations, it was possible to direct the reticle in relation to the disk of the sun in such a way that its (the sun's) edge first touched the last left thread of the reticle then moving further, the disk would leave the last right thread through its back edge. The distance between the two last threads was chosen in such a way that one did not have long to wait from the moment of the first contact to the moment of the last contact (about 1 minute). The mean moment would give the moment of the passage of the sun through the mean arithmetic between the two threads. It is obvious that with one vertical thread, the time interval between the contacts would have been long, and it would have been useless, although such a method is usually recommended. In 1900, when there was no need for it as it appeared later, I considered it necessary to increase the number of vernier readings (as in the Hildebrand theodolite their value = 30") and not the number of chronometer notations. Therefore, I aimed separately each of the central close threads on different edges of the sun, in turn. I did it

30) Even with t = 15 minutes, the errors of this abbreviated formula are less than 1".
31) The zenith distances of the sun are reduced to the moment when the sun is at its greatest height with the hour angle = $0^s.255\,(\tan\varphi - \tan\delta)\Delta\delta$, where $\Delta\delta$ stands for the hour change in the declination of the sun expressed in seconds of the arc and not to the moment when the sun's hour angle = 0. The zenith distances should not be taken at the moment when the hourly angle of the sun = 0. See Albrecht, page 54. It is understood that in this instance, the value of the declination of the sun should be considered precisely at that moment. The declination of the sun for the mean moment for the whole set of observations should not be taken instead.

STAT

8 times in all, and read the verniers each time, consequently twice as many readings were obtained as there were required for the above mentioned set. I had to regret it very much when I made the calculations. Separate calculation had to be made for each sighting, which was especially necessary to be able to evaluate the absence of big errors in journal entries. Each sighting gave the position of the meridian which had to be corrected by a reduction to the center of the sun and to the center of the reticle, as one will see below.

In 1901, the Wild theodolite with a single vertical thread was used, but it seemed to me still more advantageous not to await for the passage of both edges of the sun over the thread, but to read each sighting separately. Less time was used up and the calculation was simpler than with the Hildebrand theodolite which I used in 1900.

When observing the azimuths of heavenly bodies, especially at their considerable height, the determination of the inclination of the theodolite's horizontal axis, plays an important part. In this respect, observations made with the Hildebrand theodolite could be considered as being without reproach. The level usually held well and the data provided by the theodolite was accurate, without exception, despite the apparently rough verniers of the horizontal circle.

Things were worse with the Wild theodolite (see above, page 17, source, par. 1, 2 and 3), but still for the sake of simplicity, I made it a rule to measure the inclination of the horizontal axis by moving the level before and after observing the sun for each position of the circle: right and left. With the circle left, it was first necessary to loosen the clamp and lower the telescope to read the second vernier, the same was necessary when applying the level when the sun was high.[32)]

The calculations of the azimuth by observing the Polar Star was done with the Albrecht table by the formula:

$$\tan a_n = -\frac{\cot \delta \ \sec \varphi \ \sin t}{1 - \cot \delta \tan \varphi \ \cos t}$$

Only the numerator had to be computed precisely. The component from table 33 is added to the log of the numerator, where the independent variable is a four-place log second of the member of the denominator. The correction $i \cot z$ was applied to the readings from the star, for the inclination i of the horizontal axis (see source pages 13 and 14).

The calculation of the azimuth from the sun with a known, accurate correction of the chronometer for the true time, was made according to the formula with an auxiliary angle which seemed to me more convenient than others:

32) The results of azimuth measurements with the Wild theodolite in 1901, demonstrated that adequate accuracy could be achieved with the said method of measurement. However, it seemed to me that the more important differences in the results were usually due not only to the error in time, but also partly to the less accurate measurement of the inclination of the axis. Had it been necessary to increase the accuracy in determining the meridian, it would have been imperative first of all to improve the registration of the inclination of the Wild theodolite's horizontal axis.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

$$\tan \alpha = \frac{\cos M \tan t}{\sin (\varphi - M)}, \text{ where } \tan M = \frac{\tan \delta}{\cos t}.$$

The azimuth of the center of the sun was thus calculated for each moment of sighting the edge of the sun. The reading of the horizontal circle corrected for the inclination of the horizontal axis[33] gave a reading of the circle slightly different from the meridian, namely by a value of ± R cosec z. Where R is the half diameter of the sun.[34] Usually the mean was taken from two positions of the meridian on the circle, obtained by sighting different edges of the sun, although with a change of z, the correction of R cosec z also changes. With such method of calculation the error is not big in most instances and is completely excluded if the sightings of sun edges are made in reverse, i.e., at the right edge, at the left, then again at the left and at the right. This error will always exist with the method of passing the sun through one thread, when z changes. When making observations with the Hildebrand theodolite in 1900, the sightings made on two central threads in turn, could be reduced to the center of the eyepiece net by still another correction, that is, ± 25" cosec z. There were rare instances when by mistake the edges of the sun were not observed symmetrically, or the sighting on one of the threads was omitted, etc. The magnitudes R cosec z or 25" cosec z still allowed to use all the readings which were part of the mean derivations.

At times, during short stops, simultaneous observations of time and of the azimuth of the mark were made. The crosshair was sighted by the eye, approximately in the center of the sun, then both circles were read. The azimuth of the sun was calculated according to the observed zenith distances from the formula:

$$\sin^2 \frac{a}{2} = \frac{\cos \frac{\varphi + z + \delta}{2} \sin \frac{\varphi + z - \delta}{2}}{\cos \varphi \sin z}$$

One could use again the special section of the "Navigation Tables". On [source] page 17, above it is stated why I avoided to make such observations with the Wild theodolite, requiring simulataneous sighting of the telescope over two threads.

---

33) To avoid the calculation of z from the formula i cot z for the moment of observation in most instances in 1901, special sightings of the sun were made, also readings of the vertical circle and of the moment by the chronometer.
34) We are not mentioning here the magnitudes c cosec z, where c is the collimation error excluded on the average from the circle right and left.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

IV. MAGNETIC OBSERVATIONS AND CALCULATION OF THE ABSOLUTE VALUE OF THE ELEMENTS ON THE BASIS OF THE STUDY OF THE THEODOLITE AT THE IRKUTSK OBSERVATORY.

The magnetic Wild theodolite was checked against the absolute instruments three times. The first time by prof. Kapustin in 1897 at the Pavlovskaya Observatory, the following constants were obtained:

Temperature coefficient of the magnet .... 0.000723 ± 0.000079
Induction " " " " 0.000766
Conversion factor for the horizontal intensity .... B = 4.0809 ± 0.0004

I checked out the same theodolite at the Irkutsk Observatory twice. The results are stated below while describing the measurements and calculations of different magnetic elements separately.

a) Declination.

During the 1900 and 1901 trips, the determination of declination was done in usual order, by aiming the telescope on the target prior to and after aiming it on the mirror of the magnet. The last sightings were made four times for detailed observations: with the magnet marker x upwards, then x downwards twice, then x again upwards. For shortened observations, only 2 sightings were made x upwards and x downwards.

Prior to setting the box with the magnet to observe declination, an auxiliary telescope and its counterbalance were screwed on. At the final tightening, the telescope had to be placed in such a way that the eyepiece scale was in a horizontal position. The back cover of the box was removed for sighting the mire, while the front cover was put on.[35] After a sufficient calming of the magnet, the locking device was removed, as stated above on [source] p. 18 and the oscillations were reduced by a small magnet, removed to the side, to the corner of the tent.

It has already been stated above how we used the verniers of the horizontal circle in instances when more accurate readings were desirable. Let us quote from the observations of declination:

10 July 1901, at the Shumikha railroad station

The thread unwound. The circle of winding 8.2$^{div.}$

At the target (flagpole of the terminal)

	DIV.	
161° 50'	10.5	161° 56' 40"
	10.5	

35) See [source] p. 18 above. In several instances because of smoke or mist, the front cover was removed to allow seeing the target more clearly. Then —0'.3 was added to the readings of the circle.

x upwards

		Div.	Div.	
9^h24^m a.	136°10'	13.5 ...	29.0	
				136° 18' 34"
	10'	13.5 ...	29.5	

x downward

		Div.	
9^h29^m	135°50'	2.0	
			135° 51' 25"
		2.5	

x downward

9^h33^m	135°50'	2.5	
			135°51' 25"
		2.0	

x upward

		Div.	
9^h38^m	136°10'	13.5	
			136°18'34"
		13.5	

On the target

161°50'	10'.5	
		161°56'50"
	11..0	

Double colimational error of the magnet 27'9") 27'9") Mean 27'2

Mean on the target: 161°56'45"
Azimuth of the target: 14° 0'12 from S to E

On South: 147°56'33"

Mean on the magnet: 136 5 0

- 11°51'33" or

- 11°51.5

Correction - 0.5

δ = - 11°52'.0

For 9^h31^m α, chron.

For the readings of the 1st and 2nd verniers, corresponding to 9^h24^m, two concurrent divisions were entered into the journal. For the 1st vernier 13.5 div. and 29.0 div. For the 2nd 13.5 div. and 29.5 div. From this, we compute one division of the limb, namely 10' equaling 15.5 div. of the 1st and 16.0 div. of the 2nd, mean of 15.7. With a special table computed for such verniers, all the readings are changed into minutes and seconds of the arc.

The untwisting of the thread on which the magnet was suspended, was done as often as possible, whenever one could take advantage of an extended and secure position of the theodolite in closed premises.

STAT

The effect of the thread on the magnitude of the declination was, however, very small because when it was twisted 360° the magnet deviated only from 10' to 16'. An error of 0'.1 in the declination could occur only when the thread was twisted for 4° to 2°, i.e.,by 1/2 of the division of the circle of rotation placed in the upper part of the suspended cylinder. 360° were divided there into 60 parts.

In 1901, I had less frequently the possibility to use the rigid installation of the instrument for twisting the thread. Furthermore, by mistake the spare thread taken along was not of a very matching quality, too thin and not resistant enough. It tore several times as it was unwinding gradually. Replacement of the threads by new ones, had to be followed by their unwinding at night. I made such replacement at three stations: at Oyash, Makushino and Bogotol. In addition, I made it a rule to unwind new threads almost every time prior to measuring declination.[36)]

Once in Narym, in 1900, after determining the thread winding (to compute the magnitude of Δ in the corrective multiplier during the time of the magnet's oscillation) the winding circle was set incorrectly by mistake, at the 49.1 division instead of 59.1. Further observations of declination were made while the thread was in this position. When the error was discovered, I determined several times the difference in declination, with the index coinciding with 49.1 and 59.1, corresponding to the unwound thread. The correction of 2'26" ± 7" was obtained and applied. A similar error was made at the Kozhurla station in 1901, and a correction of 1'48", was applied there for the two results of declination.

On 27 July 1900, in M. Panovo village, frequent sightings of magnet were made from the morning on, to obtain the 24 hour run of the declination.[37)] Such varying observations with our theodolite[38)] had to be accompanied by sighting the target from time to time because experience has demonstrated that the instrument stand could not have been considered sufficiently stable during a prolonged course of time.

To conclude, I will mention that each sighting on the magnet, as demonstrated by experience, can give a declination with a sufficient degree of accuracy. The error, probably, never reached 0'.4, i.e., that limit in the accuracy of declination which was conditioned by an outside circumstance: by the reduction of different observations to the mean annual value.

36) To save time, one does not have to wait for the copper rod suspended from the thread to stop oscillating completely. After careful caging, it [copper rod] should be left to oscillate near the place of equilibrium corresponding to a fully unwound thread. Directing the eye along the length of the rod for the two or three consecutive end positions of this direction, one can enter the division on the upper circle of winding, passing directly opposite the eye. The mean of such readings for two or three consecutive extreme positions of the axis of the rod, gives precisely the divisions of the winding circle which corresponds fully to the unwound thread. The fact that this set is satisfactory (even on a stand inside the tent) was confirmed by many repetitions. The oscillation period of the copper mass, was of course very long and therefore 10 to 15 minutes were needed even for this shortened method of unwinding the thread.

37) They were interrupted at $2^h 49^m$ by the arrival of the long awaited steamer.

38) Prince B. B. Golitsyn made similar observations on Novaya Zemlya during a solar eclipse (l.c.). However, he used the eyepiece scale of the telescope to measure the variations.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

One can not but agree that in order to increase the accuracy of the final results, which greatly improve with an increasing number of observations, one had to use abbreviated methods of measurements, even to a greater extent than I did in order to have the time to repeat them.

Corrections, found after checking the theodolite at the Irkutsk Observatory, were applied to the results of all declinations, obtained in 1900 and 1901.

In 1900, I made there 4 determinations of declination and during the same time on the 23rd and 24th of April, I made frequent readings of the single thread variometer at the Observatory. Each observation, was made to 4 figures giving corrections which should be added to the value of the magnetic declination found with the theodolite, in order to obtain for the same moment, the absolute values of the declination at the Observatory. The first and the fourth corrections, pertain to the magnet's position x upward, the second and the third - x downward. The following column has the mean declination of each correction derived from their agreement for identical positions x separately. The column before last gives the double collimational error of the magnet's mirror (at its north end), and finally the last column gives the correction which should be added to the mean value of declination derived from complete determination. Observations were made on the monument in the Observatory's yard. The bell tower of the Uspenskaya Church was used as the target, its azimuth was given to me by the director and equalled 16°47'22".2 from N to E.

Irkutsk. 1900

Corection to the readings of the Magnet

Mean time	x upwards	x downwards	x downwards	x upwards	Accuracy of one sighting	Double collimational error	Correction to the average of x upwards and x downwards	Readings on the target	
23 April									
From $11^h 9^m$ - 11^h 21^m a.[.m.]	-14'.6	12'.6	12'.8	-14'.8	± 0'.0	27'.4	-1'.0	Until $11^h 9^m$ a.[.m.]	331°55'28"
11 31 - 11 50	-14'.6	12'.9	13'.2	-14'.5	0 .1	27'.6	-0'.7		
12 4 - 12 24 p.[.m.]	-13'.8	12'.5	12'.6	-13'.8	0 .1	26'.4	-0'.6	After $12^h 24^m$ p. [.m.]	331 56 30
24 April									
6 38 - 6 50 p.[.m.]	-14'.6	12'.7	12'.5	-14'.5	0 .1	27'.1	-1'.0	Prior to observ.	357 20 14
						27'.1	-0'.8 ±0'.2	After " "	357 20 43

Irkutsk. 1901.

Mean time	x upwards	x downwards	x downwards	x upwards	Accuracy of one sighting	Double collimational error	Correction to the average of x upwards and x downwards	Readings on the target	
1 June									
From $1^h 10^m$ - $1^h 25^m$ p.[.m.]	-14'.1	13'.1	13'.1	-14'.1	± 0'.0	27'.2	-0'.5	Prior to observ. After " "	49°21'27" 21 17
1 36 - 1 50	-14'.3	13'.4	12'.9	-14'.0	0'.2	27'.3	-0'.5	Prior to observ. After............	49 21 4 21.5
2 0 - 2 15	-14'.1	12'.8	13'.0	-13'.7	0'.2	26'.8	-0'.5	Prior to observ. After observ.....	49 21 9 21 0
						27'.1	-0'.5 +0'.0		

STAT

Unfortunately, observations made during the first day were not especially reliable as the sightings on the target were made only at the beginning and at the end of all observations, and the reading on the target changed considerably. All observations gave the correction for the 1900 declination,

$$-0'.8 \pm 0'.2;$$

the mean deviation of $\pm$ 0'.2, was greater than the deviations of each sighting of the magnet, probably due to a larger change in the reading on the target.

In 1901, the Uspenskaya (church) target which even the previous time had been almost covered by the post of the new metereological booth, was completely covered by buildings, therefore, I determined the azimuth of the new target twice with the Wild theodolite by the sun, from the same post. The edge of a house gable to the NNE was used as the target. Due to the closeness of this target, I took care to have the theodolite installation completely identical for all these observations 39).

Both determinations of the azimuth of the target in Irkutsk were not without fault. During the first one, the levels were not held very satisfactorily 40). During the second, the time for the observation of the chronometer correction was not advantageous (for $1^h\ 45^m$ before noon).

The correction to the Wiren chronometer No. 73, was:

1 June - $3^h.1$ p.[.m.] equal to the mean time - $7^h 40^m 56^s.0$
2 June - 10.2 a.[.m.] - 7 40 58 .7

As the run of the Wiren No. 73 chronometer equaled - $2^s.0$ by the Observatory data, then the agreement of two time determinations on different sides of the meridian, could be considered as satisfactory.

The azimuth of the target computed with these corrections to the chronometer was obtained as:

1 June at	$3^h.1$ p.[.m.] mean time	156°37'12"	from S to E
2 June	$9^h.8$ a.[.m.]	156 37 23	
	Mean	156°37'.3.	

This value was used for computing declination observations on the 1st of June, which gave the following correction for the theodolite:

$$- 0'.5 \pm 0'.0$$

39) One of the observations of declination (on 31 May), which gave a correction of -0'.7 to the theodolite, had to be rejected just because the set-up of the instrument during this determination could not be duplicated the following day, due to the fact that the markings of the theodolite's legs on the stake had been lost.
40) On the first of June, the time and the azimuth were determined simultaneously. On the 2nd of June, they were determined separately.

STAT

From the table for 1901, cited above, it is apparent that the accuracy of individual sightings of the magnet corresponded to the accuracy of the verniers. The division of the verniers was set approximately at 37", instead of 28" and 20", as first proposed last year.

Due to certain changes in the theodolite by 1901, one can not consider that the difference in corrections during the two comparions in Irkutsk indicates directly the degree of reliability of each one separately. But even from this viewpoint, one can agree that the correction to the theodolite was determined with an accuracy probably exceeding 0'.3.

For all declinations of 1900 I used the correction of 0'.8 (to the eastern declination of 0'.8) and 0'.5 for 1901.

b) Inclination.

Determinations of inclination were made with an induction inclinometer installed inside the same theodolite. Considering that this new method of the academician Wild for measuring magnetic inclination has been used relatively little under field conditions, I consider it permissible to dwell in some detail on the subject, all the more so, as following prof., Kapustin, I departed in some instances from the methods of procedure indicated by H. I. Wild.

The horizontal axis of the theodolite must be set perpendicularly to the magnetic meridian. It is understood, that the magnetic meridian in its relation to the horizontal axis of the theodolite will be known by the readings of the magnet during the preceeding observations of declination, only if the collimating error of the auxiliary telescope aimed on the magnet, is small enough.

Having placed the inductor into the ring of the theodolite's axis and having set the inductor rotation axis almost vertically, one has to use the adjusting screw almost every time. The purpose of this adjusting screw is to set the rotation axis of the inductor perpendicularly to the horizontal axis of the theodolite. This adjustment with the aid of the level inside the inductor is at times quite time consuming. After the adjustment is completed, the inductor has to be tightened in the ring of the theodolite. Then one has to determine the readings of the vertical circle completely corresponding to the vertical position of the rotating axis of the inductor in relation to the meridian plane. For this purpose, the level inside the inductor acts as guide. It is not necessary to achieve complete immobility for this level during the rotation of the coil. It is sufficient to note[41] the reading of the buble <u>k</u> for the two positions of the coil: <u>O</u>, the position of the level to the right of the observer looking on from the side of the vertical circle, and then <u>O</u> to the left (after turning the coil 180°). Then one has to read immediately the level of the vertical circle and its verniers.

Then, the "vertical position" of the coil will be calculated by the following formula, where the signs are of course determined by the direction of divisions on the circle on the levels and a given side from where one looks at them.

41) F. Ya. Kapustin, l.c.

STAT

$$N + \left(\frac{n_1 + n_2}{2} - 10\right)15'' + \frac{k_o \text{ to right} - k_o \text{ to left}}{2}\, 20''.$$

The described, apparently complicated method for determining "the vertical position", could have been perhaps superfluous with a more stable theodolite. Using the Tomsk instrument, this method expedited the work and increased its accuracy.

It remained then to obtain the circle reading when an appropriately inclined inductor gives no current during its rotation. Finding this position can be done rapidly, but the main obstacle for obtaining accurate results seems to be a) the presence of thermoelectric currents in the chain and b) a disturbance in the constancy of the axis of rotation if it begins to wobble in the bearings, or if the installation of the whole theodolite changes with the rotation of the coil. Occurances of these latter instances could be observed directly. In order to minimize their effect one has to follow attentively the precise regulation of the coil rotation axis, which at times is disturbed during observations. Secondly, very energetic rotation should be avoided. It is best not to use the gears attached to the instrument, and put the pliant shaft in motion simply by hand, otherwise the whole instrument shakes noticeably.

The method indicated by H. I. Wild, excluding the influence of thermoelectric currents on the galvanometer, permits the observer to ascertain that the rotation of the coil does not displace the mirror in the galvanometer in relation to its position prior to and after the rotation.

It is possible that our Rosenthal field galvanometer, was not sensitive enough[42], but this method did not give good results even with a high rotation velocity of the inductor. During observations in the field it was almost impossible to wait long enough for the galvanometer mirror to become completely motionless. Furthermore, I noticed that the thermoelectric difference in potentials, changed at times during the rotation of the coil, and therefore observations had to be of short duration. These were the reasons why, in 1900, a key was inserted in the galvanometer's chain. The use of this key allowed to achieve the best results towards the end of 1901. Locking the key at the moment the observer found most convenient, it was possible to perceive even very small displacements of the galvanometer's mirror, and, what is more important, lose less time in instances, almost constant, when the wind was interfering. On the other hand, the key allowed to judge of the presence of thermoelectric difference of potentials within the chain and rapidly estimate the magnitude of this difference. In most cases, a small, hardly noticeable thermoelectric influence was manifested, which when disregarded introduced a noticeable error into the results. Therefore, as a general rule, when determining the inclination, we did the following: the direction and approximate deflection (usually 0.1 - 0.2 of the scale division) were noted. This deflection occured from locking the key during a moderate rotation of the coil. Next, the rotation was stopped and the key was immediately locked again. If this time the deflection took place to the same side and was of the same magnitude as before, then the position of the rotation axis of the inductor, was considered as coinciding fully with the lines of the forces of the earth's field. The observations were apparently more accurate if no harmful currents were observed in the galvanometer.

42) Its sensitivity, determined in Tomsk, approximately = 0.5×10^{-6} amp. per 1 division of the scale.

STAT

After reading the level and the verniers of the vertical circle all these observations were repeated with the inductor in a different position, and theodolite turned 180° about the vertical axis.

It was necessary to install the galvanometer on a very low stand, less than 2 feet high to render it more stable. The stand was placed in a corner of the tent, the best protected from the wind. The galvanometer was observed by my collaborators, only in the middle of the 1901 trip did I sit to observe the galvanometer while the rotation of the inductor was performed by my collaborator. In 1900, observations suffered because the galvanometer's mirror did not give a clear image. It, probably, became bent by the drying shellac with which it was glued. For the 1901 trip, the mirror was glued anew.

Pausing somewhat to consider the large number of determinations of the inclination with a Wild inductor, let me state that the mean difference in the readings of the "vertical position" found at Circle W and Circle E was

$$\text{Circle W} - \text{Circle E} = 4'' \pm 12''$$

The mean error of a single determination of the "vertical position" thus corresponds to the precision of the verniers.

In conclusion, an example of one observation of the inclination is given:

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

	Time according to the chronometer	Level inside the inductor	Corresponding correction to the vertical circle	Level of the vertical circle	Corresponding correction to the vertical circle	Readings of the verniers	Corrected readings	90°-J	Inclination J
					Circle to the W				
Vert. pos.		0 left 7.5 - 17.0	0"	5.4 - 16.2	+13"	89°46'10"	89°45'48"		
		0 right 7.4 - 17.2				45 0			
				4.1 - 15.1	- 6	72 27 50	72 27 4		
Current = 0	11^h29^m a.[m.]					26 30		17°18'44"	J_w = 72°41'16"
					Circle to the E				
						89 46 0	89 45 59		
Vert. pos.		0 right 7.0 - 17.0	-4"	5.8 -16.6	+18	45 30			
		0 left 7.0 - 17.3		4.7 -15.5	+ 2	107 5 10	107 4 47		
Current = 0	11 38					4 20		17 18 48	J_e = 72°41'12"
						Mean for 11^h34^m a.			J = 72°41' 2

Neither in 1900 nor in 1901 during my stay at the Irkutsk Observatory had I sufficient time to establish clearly the correction to the inclination shown by our theodolite with respect to the instruments at the observatory: the number of observations was very small, and, moreover, the quality of each of them was inferior to the observations made on the road, due to the fact that at the observatory I had to conduct the observations alone.

On 23 April 1900 I obtained the following magnitudes:

		Theodolite	Variometer	Correction
5^h59^mp.[m.] (mean/time)	circle W	70°14.'2	70°14.'5	+0.3
	E	70 16. 5	70 14. 5	-2.0
	Mean J =	70°15. 3	70°14. 5	-0.'8

On 2 June 1901 I could make only two determinations at circle W, because the pliable shaft for rotating the induction coil broke.

		Theodolite	Variometer	Correction
$3^h\ 7^m$p.[m.] (mean/time)	circle W	70°14.'9		
3 15	" "	70 15. 5		
3^h11^m	Mean J_w =	70°15.'2	70°16.'0	0'.+8

The following should be added to the results of these comparisons: observations of the inclination in two positions of the theodolite with the circles W and E have this significance that in case of an iron content in certain parts of the theodolite the determination results at circle W and circle E will vary, and in certain cases, e.g., when there is an iron content in the vertical circle, the mean of the results J_w and J_e will be free of the effects of this iron.

The following are the deductions obtained on the average from all observations during the trip; the difference between J_w and J_e was:

For 1900 .... $J_w - J_e = 0.'9 \pm 1.'0$

For 1901 .... $J_w - J_e = 0.'0 \pm 0.'8$

Obviously, it can be concluded that there was either a systematic error (?) in the graduations of the vertical circle used in 1900 and changed by 1901, or it [the vertical circle] contained iron[43].

Observations of 1901 do not give a systematic difference between J_w and J_e, and therefore the correction +0.'8 derived in Irkutsk for 1901 at one circle should be considered to be the same for the mean from both W and E circles.

Thus, the following correction for the inclination given by our theodolite was obtained in Irkutsk:

In 1900 .... -0.'8

In 1901 .... +0.'8

43) It should be noted that parts which expressly contained iron, of which we spoke on [source] p. 18 are not considered in the determination of the theodolite inclination.

STAT

Although there were not many observations, it can be concluded that, in any case, the error due to the theodolite was not large; this was established also by prof. Kapustin in Pavlovsk. The effect of iron possibly contained in the theodolite, judging by all observations made in 1901, hardly showed up, otherwise it would be reflected in the difference between J_w and J_e; if in 1900 the exasperating effect of iron was noticeable, it was probably excluded, to a great degree, from the mean of J_w and J_e; actually the entire error -0.'8 found in Irkutsk for the mean of J_w and J_e: was of the same order as the difference between them, [i.e.] equal to 0.'9.

On the basis of what has been said above and greatly due to the fact that the observations in Irkutsk were little satisfactory, the difference in the errors -0'.8+0.'8 for various years should be considered as due to errors in observations and to the very small number of them [observations]. I find it, therefore, more correct not to introduce any corrections to the inclination angles obtained by our inductor.

The precision of the separate (complete) determination of the inclination made during the trip is indicated by the magnitudes cited above if we assume that J_w agrees with J_g:

For 1900 .... ± 0.'5
For 1901 .... ± 0. 4

A comparison of several separate measurements at the same point gives a still greater precision of each of them, i.e., to ± 0.'3, as we shall see below. By taking 0.'0 ± 0.'8 as correction for our theodolite with respect to the instruments at the Irkutsk Observatory, we characterize the reliability of the determination of the inclination by the magnitude of 0.'8. Probably, the errror in the absolute inclination, derived from a large number of measurements with our theodolite, is considerably smaller than 0.'8, but this opinion is difficult to prove due to the too small number of my observations in Irkutsk.[44]

c) The Horizontal Component of Intensity

In order to obtain the horizontal magnetic intensity with a Wild theodolite, it was necessary to determine preliminarily the following constants: the temperature and induction coefficients of the magnet and the multiplier for converting the intensity magnitudes, obtained from the measurement of the angular deflection and from the period of oscillation, to absolute units.

44) We do not touch upon the possibility of a systematic error in all induction inclinators, which depends on the deflection of the axis of their [the inclinators'] rotation, or on the axis being loose in the bearings. Of course, the method of observation from two positions of the theodolite does not eliminate this error, and the necessity of checking whether the coil axis is loose, has already been emphasized above; theoretically, when the axis is loose the inclination shown is greater than the actual one.

In order to decrease errors of this type, it seems to me that it is desirable to lighten, as far as possible, and even to decrease the size of the inductor coil, if it is very heavy.

The temperature coefficient was determined by me in Irkutsk in 1901; the following data were obtained from the observation of the oscillation period T of the magnet in the yard of the observatory, then in a heated pavilion, and again in the yard:

Irkutsk Observatory, 1 June 1901.

	Time	T	Temperature	Horizontal force accord. to variometer
In the yard on the monument	7^h37^ma.[m.]	3^s.2105	12°.73	2.0117
	49	3 .2104	12 .73	2.0117
	8 2	3 .2110	13 .21	2.0117
In the pavilion	8 57	3 .2265	27 .76	2.0118
	9 7	3 .2273	28 .18	2.0117
	9 21	3 .2292	28 .62	2.0114
In the yard on the monument	9 55	3 .2185	19 .62	2.0107
	10 11 a.[m.]	3 .2189	19 .74	2.0107

In view of the very good agreement of the figures in each group, the following means were taken:

3^s.2106	at 12°.89	2.0117	3^s.2107
3 .2277	28 .19	2.0116	3 .2277
3 .2187	19 .68	2.0107	3 .2180

In the last column are the oscillation periods of the magnet reduced to the same horizontal force, i.e., to H = 2.0116. The figures in the column were reduced according to the following differential formula:

$$dH = \frac{2H}{T} dT$$

where for the mean values of H and T in Irkutsk dT = 0.8dH, dT and dH being expressed in the same decimals. Finally, according to the formula

$$\mu + 2\sigma = \frac{T_1^2 - T_2^2}{T_1^2 t_1 - T_2^2 t_2} \qquad 45)$$

where _ is the temperature coefficient of the magnetic moment of the magnet, _ is the steel expansion coefficient, and t is the temperature of the magnet, we obtain

for raising t from 12° to 28° ..... $\mu + 2\sigma = 0.0006809$
for decreasing t from 28° to 19° ... $\mu + 2\sigma = 0.0006930$

Mean $\mu + 2\sigma = 0.000687 \pm 0.000006$

45) M. Rykachev. Erdmagnetishche Beobachtungen am Kaspischen Meer im Sommer 1881 (Terrestrial Observations on the Caspian Sea in the Summer of 1881). Repert f. Meteor (Repertorium fur Meteorologie). B. IX, No. 1, 1885, p. 28.

[redacted] STAT

When $2\sigma = 0.000025$, $\mu = 0.000662$. I calculated all observations in 1900 and in 1901 taking this value for μ. The coefficient proved to be considerably smaller than the one (0.000723 ± 0.000079) derived by prof. Kapustin in 1897.

I had neither time nor means to determine the induction coefficient of the magnet during my stay in Irkutsk. In Tomsk, the usual method, i.e. the Lamont method, could be applied still less due to lack of variometers for terrestrial magnetism. However, I was able to find a certain approximate value of the induction coefficient by another method, ordinarily used for measuring the magnetic susceptibility. I could follow partly the work of H. I. Wild[46]. However, I had no instruments of similar design of those used by the later [H. I. Wild], and I made the determination in the following manner: the magnet was placed inside a long (27.8 cm) cylindrical coil [solenoid] with 16.47 turns of wire to one cm of the length, wound in one helix; the diameter of the coil was 4.5 cm. It could be placed, together with the magnet, lengthwise from the E to the W, on a wooden bar on both sides of the magnetometer made over from a galvanometer. The last had a small magnet of a bell shape, suspended on a very fine silk thread. The measurement was set up in January 1902, as follows: the reading telescope stood 239 cm from the magnetometer mirror; the above described coil, and the corresponding compensating one, which was shorter, were set up on both sides of the magnetometer in such a way that the current which passed through these coils had no effect on the magnetometer; then a magnet was inserted into the long coil with its center approximately 264.9 mm distant from the center of the magnetometer. The angle of deflection φ of the magnetometer was measured separately.[47]

Then, the magnetometer was returned to the primary position of the mirror with the aid of the compensating magnet having the form approximately the same as that of the main magnet. Finally, a current[48] was passed through both coils, which

46) H. Wild. "Bestimmung der Inductioncoefficienten von Stahlmagneten." Mem. de l'Ac. Imp. d. Sc. ("Determination of Induction Coefficients of Steel Magnets." Memoirs of the Imperial Academy of Sciences , v. 34, No. 7, 1886, S.-Petersburg.

47) Because of the large magnitudes of the angles φ_1 and φ_2 caused by the north and south ends of the magnet, they could be measured only by the following complicated method: two more telescopes were installed on the right and left of the main reading telescope, by means of which it was possible to take readings while the magnetometer mirror was deflected. Later, after all manipulations were completed, a Wild theodolite was set in the same center instead of the magnetometer, and a mirror was fastened in the center of its alidade. The angles of the swing of that mirror, read by means of the theodolite verniers (from the reading of the middle telescope, corresponding to the magnetic meridian, to the readings of each side telescopes), gave the deflection angles of the magnetometer quite accurately. Thus the main reading telescope was designed only for rendering possible a sufficiently accurate measurement of the small angle subtended by the magnetic induction of the magnet under examination.

48) We moreover satisfied ourselves that no induction effect of the compensating coil on the compensating magnet lying farther outside the coil was observable.

was measured with an adjusted milliamperometer in one and then in the other direction. The force of the induced magnetic field was ± 0.388 absolute cgs units = ± 3.88 gauss, i.e., only twice as high as that usually encountered in measuring the terrestrial magnetism.

The deflections of the magnetometer to one and to the other side were in this case up to 6 - 7 mm of the scale from the previous position. Under the influence of such induction the increase and decrease of the magnetic moment of our magnet proved to be the same in magnitude; when the N pole half of the magnet was turned toward the magnetometer and its middle was at 264.9 mm the total deflection φ_1 of the magnetometer was 19°35': after compensation, the deflection due to the current was about 0.595 cm of the scale. When the S pole end of the magnet was turned toward the magnetometer, from a distance of 250.8 mm, the full φ_2 angle was 22°53', and the induction of the artificial field gave a deflection of 0.700 cm.

Therefore, according to a simplified formula, from which the distance between the magnets was altogether excluded, i.e., according to the formula

$$\nu = \frac{S}{2D\tan\varphi\, 4\pi ni},$$

where ν is the induction coefficient, S - deflection in cm due to induction, D - distance of the telescope scale from the magnetometer mirror, φ - angle of deflection under the influence of the magnet, n - number of the coil turns per cm of its length and i - the strength of the current in absolute electromagnetic units, in both cases the results obtained agreed sufficiently well, i.e.

$$\nu = 0.00902 \text{ and } \nu = 0.00894.$$

Mean ν = 0.00898 in cgs intensity units, or ν= 0.000898 gauss.

The value obtained was considerably greater than the one obtained for our magnet by V. Kh. Dubinski in 1897 by the Lamont method (0.000766), but first the magnetic moment of the magnet became somewhat weaker by that time, second, I could not consider the results of my measurements as completely reliable: after leaving Tomsk University I had no possibility to study in detail the method and my instrument, as well as, the effects of the simplifications introduced into the formula. Considering the figure cited only as an approximate one giving only the order of the magnitude of the coefficient, I used in all my calculations the coefficient obtained in 1897; my determination is interesting in this respect that for all values for the horizontal force, which I had occasion to measure with the Wild theodolite, and which are in the narrow limits of 2.01 to 1.47 gauss, the difference between the new and the old figures does not show any effect on the final result, remaining beyond the limits of accuracy of the determined force (less than 0.0002 - 0.0003 gauss).

In addition to the temperature and induction coefficients and to the B multiplier, other constants of the theodolite could not be determined, or there was no sense of doing so, and I am giving only [their] approximate figures.

The distance between the magnet centers during the deflection is about 245 mm. The measurements of the main magnet are 59.6 mm and (diameter) 10.0 mm, obviously deflecting 25 to 28 mm and 10 mm (it was not taken out of the housing). STAT

During the work in Irkutsk a great deal of attention was devoted to determination of the <u>conversion factor</u> B in the formula given below by repeated successive determination of the oscillation period T and of the deflection angle v, while the horizontal force H was known from the observatory's variometers.

The generally accepted observation method of the T and of v is indicated in the description of the H measurement on the road. The value for B was calculated from the formula in the form $B = HT \sin v\,[1 + \varepsilon]$ derived from the expression for H given below; ε is the sum of the correction members. The magnetic moment M_0 was calculated only relatively by its reduction to 0° according to the formula, also given below.

On the 20 and 21 April 1900 I could avail myself only of hourly readings of the two thread variometer, on the 24th and 25th the readings were more frequent, i.e. every 15 minutes. Inasmuch as in addition to the above, the observations on 20 April produced greatly differing results, I am excluding them altogether.

The chronometer used in the observations was Wiren No. 135 with a daily [24-hour] run of $8^s.7$: the thread torsion was determined daily and gave

16'.1, 15'.2, 17'.1, 16'.4, i.e., on the average 16'.2.

The magnitudes 8'.7 and 16'.2 were introduced into the formula. As it can be seen from the tables given below usually only two adjacent values for T and v were used in the calculation of each separate value for B, and the changes in H during the observation time were taken into account in the following manner: in cases when the horizontal component in the observation of the oscillation was different than in the observation of the deflections, a correction was added to T magnitude; e.g. in the first measurement at 12^h40^m p. [m] on 21 April the variometer showed H = 2.0130, while the observation of the oscillations at about 12^h40^m p. [m.] gave H = 2.0134; therefore the oscillation period $T = 3^s.2015$ was reduced to that value which would be obtained with H = 2.0130 by the simple formula derived above

$$dT = -0.8dH,$$

i.e., $0^s.0003$ were added to the observed $T = 3^s.2015$, and thus, instead of the observed, the following magnitudes were used in the formula for the final calculation of B:

$$H = 2.0130, \quad T = 3^s.2018, \quad v = 23°31'49''.$$

In 1901 the number of observations in Irkutsk was small due to the fact that I had to reject those observations during which I had in my pocket iron keys and a watch through an oversight. The daily run of the chronometer Wiren No. 73 was $2^s.0$, the thread torsion gave the magnitude of 13'.3 on 2 June.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

Magnetic and Astronomical Determinations

Irkutsk Observatory	Local time	Deflection angle V	Oscillation period T	Temperature of the magnet t in oscillation τ in deflections	Horizontal component H from variometer	Relative value of magnetic moment M_0 at 0°	Theodolite conversion factor B	Remarks
Year 1900								
21 Apr	12h19m p. [m.]	23°31'49"		19°83	2.[illegible]	19995	4.0790	
	40		3s2015	19.97	2.0134			
" "	12 56	23 29 48		20.17	2.0137	19985	4.0779	
" "	1 22		3.2016	20.18	2.0141			
" "	1 39	23 28 52		20.55	2.0143	19983	4.0778	Previous adjacent oscillation period T taken
	1 22		3.2016	20.18	2.0141			
" "	2 27	23 28 40		21.12	2.0146	19989	4.0781	Mean of two defl. angles taken
	45		3.2017	20.95	2.0147			
	59	23 28 12		21.18	2.0147			
24 Apr	1 30 p. [m.]	23 34 29		16.64	2.0133	20000	4.0765	
	56		3.1961	16.30	2.0134			
	2 12	23 35 19		16.[illegible]	2.[illegible]	19996	4.0798	
	[illegible]		[illegible]	[illegible]	[illegible]			
	3 7	23 35 52		16.[illegible]	[illegible]	19990	4.0768	
	3 28		3.1968	16.[illegible]	[illegible]			
	3 50	23 35 6		16.[illegible]	[illegible]	20000	4.0786	Previous adjacent oscill. period T taken
	3 28		3.1968	16.[illegible]	[illegible]			
25 Apr	10 30 a.[m.]	23 39 12		[illegible]	[illegible]	19992	4.0783	
	53		3.1973	[illegible]	[illegible]			
	11 13	23 38 28		14.[illegible]	2.0108	19984	4.0783	
	37		3.1978	14.[illegible]	[illegible]			
	11 57 a.[m.]	23 38 24		14.[illegible]	[illegible]	19992	4.[illegible]780	
	12 22 p.[m.]		3.1965	14.[illegible]	[illegible]			
	12 40	23 37 48		14.45	2.0122	19991	4.0788	
	1 1		3.1964	14.42	2.0126			
	1 20	23 36 54		14.6[illegible]	[illegible]	19989	4.0788	Previous adjacent oscill. period T taken
	1 1		3.1964	14.42	[illegible]			
					Mean	19992.[illegible]	4.0782	±0.0006
Year 1901								
31 May	4 6 p. [m.]		3.2128	16.[illegible]	2.[illegible]	19786	4.0761	
	4 21	23 18 11		16.53	2.[illegible]			
2 June	12 27 p. [m.]	23 8 52		27.00	2.0096	19770	4.0753	
	44		3.2288	27.06	2.0096			
	12 59	23 8 20		27.05	2.0102	19760	4.0774	
	1 16		3.2295	26.95	2.[illegible]			
	1 30	23 7 27		26.38	2.[illegible]	19758	4.0770	Previous adjacent oscill. period taken
	1 16		3.2295	26.95	2.[illegible]			
						19768.9	4.0765	±0.0007

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

STAT

As can be seen from these tables, the accuracy in the determination of B in 1901 was somewhat smaller than before; this occurred, perhaps, because of the fact that I decided not to use the verniers of the horizontal circle for reading the deflection angles in the observations on the road in 1901 and also during the test in Irkutsk: each division of the horizontal limb was equalled to 10', and I simply estimated whole minutes at sight.[49)]

Thus the comparison of the theodolite with the absolute instruments gave:

In 1897[50)]	$B = 4.0809 \pm 0.0004$	$M_o = 20440 \pm 6$
In 1900	$B = 4.0782 \pm 0.0006$	$M_o = 19991 \pm 4$
In 1901	$B = 4.0765 \pm 0.0007$	$M_o = 19768 \pm 9$

The means of the deviations of the determined magnitudes B seemingly indicate a high accuracy of each separate measurement of the horizontal component with the Wild theodolite: from 0.0001 to 0.0002 of the whole magnitude, i.e., for Irkutsk, e.g. to 0.0003 gauss.

However, the shortcomings in our instrument, indicated by me above, in connection with several cases of unexpectedly strong fluctuations in the measured angle[51)] render taking the given mean deviations as a measure of reliability of the measurements made with the theodolite totally impossible. One can assume that the excellent agreement of the figures obtained each year was due only to the fact that during its comparison the instrument did not undergo any changes, ordinarily it even did not move from its place during the entire time.

At each new comparison of the theodolite the value B changed comparatively a great deal while both the magnetic moment and the constant multiplier B <u>decreased</u> with time: the magnetic moment decreased more than 3 per cent during the entire time, and multiplier B - about 0.1 per cent, i.e., was about 30 times less.

If these changes in B are not considered accidental, then their causes may be as follows:

---

49) I limited the accuracy of the readings because, theoretically, such accuracy is sufficient for the usual magnitudes of v, and because there were important circumstances which, anyway, rendered the results to be little reliable. The presumed causes for the large accidental errors in the measurement of the horizontal intensity are listed below.

50) It should be noted that the comparisons were made by prof. Kapustin in Pavlovsk who made three observations for each value of B, and not two as it was done by me, and, moreover, the values for the horizontal component were actually taken completely simultaneously from a self-recording variometer. Reduction of M to 0°, if it were made with the same temperature coefficient, as in the succeeding years, would give a somewhat smaller magnitude for M_o in 1897.

51) Insufficiently stable fastening of the magnet in the housing and, particularly a possibility of a shift of the horizontal axis during the observations. The measurements of 20 April 1900, which gave poor results and, therefore, were partly excluded by me, showed in addition the necessity for a careful levelling of the instrument at each use in the future, i.e., before each observation of the deflection angle, what I tried to do also during observations on the road.

STAT

First, it is possible that the magnitude B actually depends on the magnetic moment of the magnet. Second, that due to <u>gradual</u> loosening and unscrewing of the regulating screw (see above, source p. 16) the deflecting magnet gradually changed its height with respect to the deflected (namely, it rose; unfortunately, it is impossible to establish the exact initial position of the magnet). Finally, the difference between the Pavlovsk and Irkutsk comparisons can be attributed to the difference of induction in the theodolite parts, undoubtedly containing some iron, or to the inexact induction coefficient of the magnet. The difference in the two comparisons in Irkutsk was, perhaps, due to replacement of certain parts in the theodolite with new ones.

In any case, the following conclusion can be drawn from the above: our theodolite was quite sensitive and could register small changes in the horizontal force up to 0.0003 gauss, what, it is true, corresponds to the theoretical precision of the measurements both of the oscillation periods and of the angles with this theodolite.

But, the greater the sensitivity the smaller the confidence in the results of the measurements if we recall that sometimes the errors in determination increased a great deal and that the values for B differed considerably from one to another comparison with absolute instruments.

Therefore, I consider it more correct to give up the claim to precision up to 0.0002 or 0.0003 gauss, and to confine myself to the following measure of reliability of the Wild theodolite, as an instrument registering absolute intensity, without predetermining the causes of the changes in B in various comparisons: the mean value of B for 1897, 1900, and 1901 is thus

$$4.0785 \pm 0.0016,$$

which corresponds to the mean deviation in the intensity up to 0.0004 of its magnitude ($\pm$ 0.0008 gauss for Irkutsk). Such deviation is considerably greater than the mean deviation of <u>each separate</u> measurement, cited above, and even almost equal to the higher limit of the error in a separate measurement under the observation conditions as existed at the observatory. In the field, accidental errors of each measurement will be, perhaps, greater, but we have no right to take an error in the mean of several measurements of absolute intensity which would be greater than 0.0004 of its magnitude if we take B = 4.0785 for all measurements.

A reservation should be made yet with respect to those cases in which we shall use our theodolite for measuring such intensities which by far exceed the range of 1.6 - 2.0 gausses. In those cases the reliability of the results will decrease considerably due chiefly to the iron content in the theodolite and to its consequently varying induction and differing force of the magnetic field.[52]

---

52) In order to obtain reliable results with theodolite containing iron, it would be necessary as a rule, to find the induction coefficient for the whole instrument. Such requirement is reduced simply to a comparison of the theodolite at two observatories with the marked differences in the magnitudes of their horizontal intensities.

The Tomsk theodolite was compared at two observatories with the horizontal intensities of 1.65 and 2.01, and all magnitudes measured by me in Siberia fall within this range, i.e., 1.47 to 2.01, which makes it possible to attribute the nSTAT indicated reliability of intensity measurements to all my determinations in Siberia, if we exclude for the time being a possibility of large accidental errors in separate measurements and of errors in reduction to mean annual values.

All said above with respect to comparisons of our instrument with the absollute instruments at the observatories does not hinder, all the same, to consider it more correct to apply the constant multiplier B = 4.0782 in 1900, and B = 4.0765 in 1901 to the calculations of the observations in the field, which I did.

This, so to say, added a dominant significance to a possibility of gradual change in B according to the changes of the magnetic moment of the magnet, or its position in the housing, and also to the fact of replacing theodolite parts with new ones. It did not add a greater significance to a probability that changes in B take place simultaneously with changes in the horizontal force.[53]

Complete observation of the horizontal intensity in the determinations during the trip consisted of measuring the angle of deflection of the principal magnet, of measuring its oscillation period, and of measuring again the angle of deflection. The angle of deflection v was measured in four positions of the housing in which the magnet was mounted. I personally, saw to it that the position of the last [magnet] remained the same, that the position of the horizontal axis was unchanged during the observation (which, however, could not be ever guaranteed), and that the entire theodolite was levelled. In 1901, the readings were made at sight to 1', as explained above. The suspension thread of the deflected magnet was untwisted, as indicated for [each] set by H. I. Wild[54], although it was done very seldom, in 1901 only once before departure for the field. It is true that the thread was very old and not once was it noticed to be twisted.

In order to determine the oscillation period T of the principal magnet, the oscillations were always regulated to the amplitude of 40'; the catch was dropped down completely and moved to the perpendicular position (see source p. 19). The moment [time] at which the magnet passed the zero position for each 7th time was noted; about 10 - 12 of such moments [series] were noted, then after a pause required for 100 oscillation, other 10 - 12 moments were noted. In 1900 when a Waltham clock was used which did not strike seconds, we did the following: V. Vinogradov my companion, equipped with a lense noted and recorded the moments by the clock's hand indicating seconds according to the uniform signals given by me. In 1901 a table chronometer, striking semiseconds, was used always in both, the astronomical observations and in the work at the Irkutsk Observatory, which enabled the observer to apply the Bradley method of "eye and ear".

53) Results of all measurements of this element on the road, given below, on the other hand, provide a measure of precision up to ± 0.0005 gauss of a single observation with our instrument at each point, this magnitude containing also the error in reduction of the observation to the annual mean. Consequently it proved to be (contrary to what we saw with respect to the declination) that it did not interfere with having a greater confidence in conversion of the intensity obtained by means of our theodolite to the absolute instruments than that which we have to accept in the meantime taking the precision of value B as ± 0.0004 of its magnitude (up to ± 0.0008 gauss in Irkutsk).

54) Theodolith fur magnetische Landesaufnahmen (Theodolite for Magnetic Land Surveying), l. c., p. 155.

STAT

The magnitude of the "twisting" of the thread, denoted by Δ in the formula, i.e., the average deflection of the magnet in minutes of the arc with 360° twisting clockwise and counterclockwise, was determined for the correcting multiplier. The Δ was determined quite frequently, somewhat less frequently in 1901, namely almost once at each station (see Table IX).

To save time and to increase the number of separate results for the horizontal component, sometimes the angle v and the period T were observed only once; the magnetic moment of the magnet, given in the tables for such cases, would indicate the absence of large errors in the measurement of the horizontal force, although variations of the last were not excluded. Sometimes I confined myself to the observation of one oscillation, or to observation of a single deflection of the angle. In that case the result was compared with the value of the same magnitude but in the complete measurement, ordinarily made on the same day and at the same point: thus only the variation of the horizontal force with respect to the adjacent measurement was calculated; of course, the precision of the result suffered, but as I convinced myself repeatedly, [period] T was measured very accurately and the error caused in H [horizontal force] by the indicated method of calculation, was not greater than the error in the reduction to the mean annual magnitude, i.e., 0.0005 gauss.

H was calculated from the observed magnitudes for T and v from the formula given by H. I. Wild, in which I modified a little the members with the temperature and induction coefficients for convenience in calculating.[55]

$$H = \frac{B}{T\sqrt{\sin v}} \left\{ 1 + \frac{\mu + 2\sigma}{2}(t - \tau) - \frac{3m - 2\sigma}{2}\tau - \frac{v}{2}H - 0.00031 - 0.0000463\frac{\Delta'}{2} - 0.000023\frac{s}{2} \right\}$$

Here t is the temperature of the magnet in oscillations, τ, - in deflections, m - coefficient of linear expansion for brass Δ - magnitude for "twisting", s - daily run of the chronometer. No corrections for the amplitude were required due to its insignificant and constant value. The meaning of the remaining letters was indicated earlier.

The calculated values for coefficients taken were:

$$\frac{\mu + 2\sigma}{2} = 0.000343, \quad \frac{3m - 2\sigma}{2} = 0.000014, \quad \frac{v}{2} = 0.000383.$$

55) See Theodolith fur ... l.c., p 167. Instead of $\frac{\mu + 2\sigma}{2}t - \frac{\mu + 3m}{2}\tau$, $\frac{\mu + 2\sigma}{2}(t - \tau) - \frac{3m - 2\sigma}{2}\tau$ was taken while the products were taken from computed tables. The member $\frac{v}{2}(1 + \sin v)H$ is equivalent to $\frac{v}{2}H + H_o \sin v_o$ because H sin v can be considered as a constant for the magnet even at varying temperatures; the mean value $\frac{v}{2}H_o \sin v_o = 0.00031$.

The magnitude proportional to the magnetic moment at 0°, was calculated from the formula

STAT

$$M_o = 10^5 X \frac{\sqrt{\sin v}}{T} \left\{ 1 + 0.00070 \frac{t + \tau}{2} - 0.0000463 \frac{\Delta'}{2} - 0.000023 \frac{s}{2} - \frac{v}{2} H + 0.00031 \right\}.$$

Here the correction for the temperature was obtained from the completely precise expression

$$\frac{\mu + 2\sigma}{2} (t + \tau) + \frac{3m - 2\sigma}{2} \tau,$$

disregarding the very small magnitude

$$\frac{1}{2} \frac{3m - 2\sigma}{2} (\tau - t) = 0.000007 (\tau - t);$$

namely

$$\left\{ \frac{\mu + 2\sigma}{2} + \frac{1}{2} \quad \frac{3m - 2\sigma}{2} \right\} (t + \tau) = 0.00070 \frac{t + \tau}{2}$$ was taken.

Of the remaining correction multipliers, the member with the daily run of the Waltham clock (which was carefully compared with the chronometer when it was inaccurate) was of a considerable value occasionally in 1900.

To calculate these observations when oscillation period T_2 only was determined, the following formula was applied:

$$H_2 = \frac{H_1 T_1^2}{T_2^2} \left\{ 1 - (\mu + 2\sigma) (t_1 - t_2) \right\}$$

where the letters with subscripts 1 refer to the nearest preceeding or subsequent complete observations. When only the angle of deflection v_2 was determined, H_2 was obtained from the formula:

$$H_2 = \frac{H_1 \sin v_1}{\sin v_2}\left\{1 + (\mu + 3m)\,(\tau_1 - \tau_2)\right.$$

STAT

where $\mu + 3m = 0.000716$.

V. Description of the Observation Points.

A detailed topographical survey of the location where magnetic measurements are being made, [although] extremely important for making it easier to find the observation point in the future, is unfortunately, burdensome for the observer because it requires too great an amount of time.

On the other hand, sometimes even a few-word description of the location of the instrument, if it, besides, is just connected with any definite local objects or buildings, is entirely sufficient. I am citing, as far as it is possible, all data which may facilitate finding the described points, sometimes including angles and distances from certain objects and buildings. However, these last figures may not be of large practical advantage in a search for points and may not replace a detailed plan. Not being able to include detailed plans of the locations, I consider it almost useless to include here diagrams of the locations of the point where the instrument stood with respect to 2 or 3 (less often) local points, which I could do for the greater number of my stations. In order to make such a diagram it is sufficient to draw the vectors given below, with their lengths and directions with respect to the astronomical meridian.

Should the descriptions given below be of no aid in finding the point, then use of a compass is recommended: the direction of the unknown point from the local object should be estimated according to the approximately known declination, and, if it is possible in that location, by simply counting the needed number of steps in the given direction; otherwise it may be necessary to use the compass alone, checking the directions of the given objects.[56)]

In 1901, the topographical connection with local prominent objects was determined by me more systematically by the following method which proved to be the most convenient: a tripod with a angle prism was placed toward the side several tens of sazhens from the stand with the magnetic instrument, and the distance between the instruments was measured with a 5-sazhen tape. Then both instruments interesected with each other and in addition with certain points, i.e., of the mark for determining the meridian, and, particularly, with those objects whose precise coordinates had been known from the work by the geodesist Yu. Shmidt, or others.[57)]

---

56) The only correct means facilitating finding of points is their selection according to their purpose. Therefore, it seems to me that special attention should be paid to the advise given by the late P. T. Pasal'ski: "one selects points which are easily found, i.e., road crossings, crossing of roads by rivers, by valleys, city and village suburbs, mounds, etc., e.i., points which are marked precisely on large scale maps, e.g. on the 3-verst map of European Russia by the General Staff. See: Pasal'ski. <u>Ob" izuchenii raspredeleniya magnetizma na zemnoy poverkhnosti (Study of the Distribution of Magnetism on the Earth's Surface)</u>, Odessa, 1901, p. 49.

57) As it was inconvenient to take very long bases with the 10-m long tape, and sometimes even difficult due to the local conditions, the precision in the distances of our survey was in most cases up to 1 per cent, and sometimes even less.

In describing the points we give also their geographical coordinates, as finally accepted, which, moreover, are included also in the general tables given below.

1) City of Tomsk. The principal astronomical point to which I refer the "Tomsk time" was a brick monument in the University garden, located between the south end of the main building of the University and the iron fence along Sadovskaya St. The precise coordinates of the monument were determined by prof. Kapustin on the basis of several points given by Col. Sharngorst and Capt. Kul'berg.[58)]

$$\varphi = 56^\circ 18' \, 6''.6$$

$$\lambda \text{ Greenwich} = 5^h 39^m 47^s.9$$

$$\lambda \text{ Pulkovo} = 3^h 38^m 29^s.3 = 54^\circ 37' 19''.5$$

The azimuth of the cross on the main dome of the new cathedral in Tomsk from the monument = 15°16'28" from north to the east.

2) City of Tomsk, beyond the Tom' River. Prof. Kapustin's magnetic point of 1899. It is located on the left bank of the Tom' River opposite the south end of the city. In order to find the precise direction one should stand in line with the bell tower shaft of the Uspenskaya Women's Convent Cemetary Church, and the two city border posts on the Moskva track [Highway]. The theodolite was placed about 15 steps (or arshins) from the upper bank bluff, i.e., about 50 steps from the water (at the summer level of the river).

From the survey the reduction to the University monument was

$$d\varphi = -33''.8$$

$$d\lambda = -7^s.0 \quad \text{, thus}$$

$$\varphi = 56^\circ 27' 32!8 \text{ [sic]}$$

$$\lambda \text{ Pulkovo} = 3^h 38^m 22^s.3 = 54^\circ 35' 34''.5.$$

During the observations in the spring of 1900 the theodolite stood precisely in the center [of the place] of 1899 from which the azimuth of the cross on the new cathedral was determined by prof. Kapustin, and was

49°52'22" from the north to the east, or

130° 7'38" from the south to the east.

58) "Astronomicheskiya opredeleniya osnovnykh punktov v Sibiri posredstvom telegrafa s 1873 to 1876 g", (Zap. V.-Top. Otd. Gl. Sht. ("Astronomical Determinations of the Principal Points in Siberia by Telegraph During the Period of 1873 to 1876". Notes of the Military Topographical Department of the General Staff), v. 37, 1880.

During the observations in 1901 the position of the theodolite was somewhat different, the azimuth of the same mark was determined by me and was 130° 3'21" from the south to the east.

a) Magnetic and Astronomical Points of 1900

3) Krasnyy Yar.

The steamer landing place of the Soyedinennoye Tovarishchestvo parokhodstva po rekam Zapadnoy Sibiri (United Steamship Line on the Rivers of Western Siberia) on the Ob' River, 18 versts above Nikol'skoye village.

Approximate coordinates were taken from a map.

$$\varphi = 57° \, 5'$$

$$\lambda_{\text{Pulk}} = 3^h 36^m.1 = 54° \, 1'.$$

The theodolite stood on the high bank, about 90 steps from the precipitous edge.

Note: The magnetic observations were little reliable. The azimuth of the mark was determined by the run of the chronometer and by the above described approximate longitude (2^m22^s to the West of Tomsk) because the sun was very near the meridian. Therefore the magnetic declination as found $\delta = -11°54'$ may be incorrect to ± 5'. The horizontal intensity is also comparatively little reliable, therefore it is given in tables only to four significant figures.

4) Narym City.

A settlement on the bank of the Ob' River, at the former city landing place, which is located above the present landing place.

The observation points were around the water gauge post of the Ob' Section of Tomsk okrug [District], with a mast, bench mark, and rain gauge, opposite the Nesterov house.

At first the stand was placed 25 steps (arshins) south of the iron bench mark. Then, fearing that this bench mark would affect magnetic elements, the theodolite was transferred 105 steps (35 sazhens) south of it [bench mark], from where Narym City and its cathedral could be seen.

The data of precise astronomical determinations made by Yu. Shmidt in Narym in 1900 is given, and the plan of the section near the ladning place of Narym City is included in table 3, in the Zap. V.-Top. Otd. Gl. Shtaba (Notes of the Eastern Topographical Department of the General Staff), part 59, p. 188. My calculations made on the basis of that plan gave the following reductions from the Yu. Shmidt's post:

For Point I $d\varphi = -8''.7$, $d\lambda = -1^s.3$

For Point II $d\varphi = -10''.9$, $d\lambda = -1^s.3$.

Using the coordinates derived by Shmidt, we obtain

For Point I $\varphi = 58°55'31.''5$

$\lambda_{Pulk} = 3^h24^m54.^s4 = 51°13'36''$

For Point II $\varphi = 58°55'29.''3$

$\lambda_{Pulk} = 3^h24^m54.^s4 = 51°13'36''$.

At the first point the house gable to southeast served for the target, for which the azimuth = 45° 3'15" was taken from the south to the east, at the second - the cathedral bell tower in Narym City, its azimuth = 82°41'34" from the south to the east.59)

Note: The fear that the iron bench mark would affect the magnetic elements obtained at the first place, obviously, cannot be considered confirmed by the measurement results; actually it was obtained:

At the first:		At the second:	
δ =	$-14°29.'4$	δ =	$-14°30.'7$
J =	$74°\ 0.'3$	J =	$74°\ 2.'6$
H =	1.6038	H =	1.6049
V =	5.5950	V =	5.6130
T =	5.8203	T =	5.8379

Although the differences in the declination and inclination, obviously, indicate an effect of the south [pole] magnetism which should have been apparent at the upper end of the bench mark lying to the north or NNW of the theodolite, however, the difference in the values of the horizontal force contradicts an assumption of such an effect. I tried to isolate, experimentally, the effect of the bench mark for which I observed oscillations of the magnet at the following distances from the bench mark:

25 June	7^h18^mp.[m.]	1.3 meters to the south	$T = 3.^s5534$
	7 39	50 " " " "	T = 3.5909
	8 0	1.3 " " " north	T = 3.6593
	8 17	17.8 " " " south	T = 3.5916 (at the 1st point).

59) The lines on the cathedral bell tower and on the old church, obviously, were drawn incorrectly in the above mentioned plan of Yu. Shmidt; their directions from his point do not correspond even to the azimuths given by the author.

STAT

The oscillation time of the magnet was reduced to the same temperature of 25° [C], and the variometer in Irkutsk did not show considerable changes in the horizontal force for that time. The bench mark at the distance of 1.3 m produced a change in the T amounting to 1.5 per cent of its normal magnitude, thus showing a change of 3 per cent in the horizontal force. Therefore at a distance of 17.8 m, considering the strength of the pole inversely proportional to the square of the distance, the change in the normal force was at least 100 times smaller, i.e., the effect of the bench mark should have become so small that it would be beyond the possibility of being measured.

All the same, in conclusions for Narym, only the observations at point II were taken: see Table XI.

5) Kolpashevo Village on the Ob'River, at the Tugurskaya Channel of the Ket' River.

The observation point was at the ascent from the "lower landing place" to the Ob' River bank cape farthest to the west. The tent was located about 70 steps to the north of the precipice of the Ob's bank and approximately the same distance to the east of the ascent from the landing place. The measurements of the azimuth of the Kolpashevo church bell tower gave 97° 1'17" from the south to the east, and the distance to it was 953 m (447 sazhens). The coordinates of the church were determined, just as in Narym, by Yu. Shmidt[60], and the reduction to our point according to my measurements was: $d\varphi = -3''.8$, $d\lambda = -3''.9$, hence

$$\varphi = 58^\circ 18' 15''.7$$

$$\lambda_{\text{Pulk.}} = 3^h 30^m 16^s.2 = 52^\circ 34' \, 3''.$$

The same latitude was obtained from the stars.

6) Kolmakovo (or Rodionovo) Village on the left bank of the Ket' River. During our brief stop, the instrument stood on the bank opposite the eastern end of the village.

The end of a log in one of the sheds to the west served for the target, its azimuth = 100°54'18" from the south to the west.

Subsequently this point was referred to our point in Malo-Panovo Village (see below); for this conversion we obtained $d\varphi = +5''.8$; we take

$$\varphi = 58^\circ 26' 31''$$

$$\lambda_{\text{Pulk.}} = 3^h 32^m 49^s.5 = 53^\circ 12' 22'';$$

the longitude was calculated by transporting the chronometer from Kolpashevo.

Note. The magnetic observations made were not complete, and no tent was used in making them.

---

60) Our point is located at the westernmost end of the village, and therefore it is outside the borders of the plan attached to the article by Yu. Shmidt.

7) Bol'shoye Panovo Village on the right bank of the Ket' River.

During our short stay the instrument stood on the high bank directly opposite the building in which the school met and where it was proposed to build also a church. The observations gave

$$\varphi = 58°28'51''$$

$$\lambda_{Pulk.} = 3^h34^m 5'' = 53°31'15''$$

A shaft of a large snag covered with sand on that bank of the river served as the mark, its azimuth = 18°20'31" from the south to the west.

8) Malo-Panovo Village on the left bank of the Ket' River.
Both points were located near the house of Gr. St. Rodionov, which stood on the edge of the river backwater southeast of the village close to its border.

The first point was located in the yard of the house on the very edge of the backwater. When the damming work was begun, the tent was moved from the yard to the 2nd place across the road about 80 steps southwest of the first; thus for the 2nd place we have $d\varphi = -1''.4$, $d\lambda = -0''.2$.

The following coordinates were taken (the longitude according to Kolmakovo: the second point was located $4^s.6$ east of Kolmakovo):

For the 1st $\varphi = 58°26'25''.6$

$\lambda_{Pulk} = 3^h32^m54^s.3 = 53°13'35''$

For the 2nd $\varphi = 58°26'24''.2$

$\lambda_{Pulk} = 3^h32^m54^s.1 = 53°13'31''$.

The house dormer to the east served as the target, its azimuth

From the 1st place = 81°52'19" from the south to the east

From the 2nd " = 84 46 58 " " " " " "

Note. The difference in the results for the magnetic elements between the two points was very small, and simply the mean magnitudes were taken for M. Panovo.

9) Yurty Shirokovy (summer resort), landing place for government steamers on the left bank of the Ket' River. Only astronomical determinations were made from the stars.. The theodolite stood at the very edge of the bank's precipice beside the descent to the landing place.

$$\varphi = 58°27'59''$$

$$\lambda_{Pulk} = 3^h39^m 0^s = 54°45' 0''.$$

STAT

10) Yurty Muleshkiny (summer resort), landing place for government steamers on the left bank of the Ket' River. The theodolite was taken to the southeast of the landing place and put near the garden facing the small lake.

In order to calculate the time and the azimuth from the sun, the latitude of the place was taken according to the map of the "Yuzhnaya pogranichnaya polosa Sibiri" ("Southern border strip of Siberia") taking into account the systematic error, obviously the error for the Ket' River area (The effect of the inaccuracy in the latitude did not play a large role, as the sun was near the first vertical; see the tables).

$$\varphi = 58°33'15''$$

$$\lambda_{Pulk} = 3^h41^m28^s = 55°22'0''.$$

11) Maksimoyarskoye village

The landing place for government steamers is located on the left bank of the Ket' River, i.e., on the other side of the river and about 1 to 1.5 versts with the stream below the village. Only the latitude was determined from the sun, with the local time known approximately, on the high bank beside the landing place.

$$\varphi = 58°39'55''$$

$$\lambda_{Pulk} = 3^h46^m.1 = 56°31'.$$

12) Yurty Berkunovy, Pyrgynovy on certain maps.

Astronomical stellar observations were made on the landing place for government steamers on the left bank of the Ket' River, opposite the above named yourts but below them down stream of the river. Obtained were:

$$\varphi = 58°45'21''$$

$$\lambda_{Pulk} = 3^h47^m21^s = 56°50'15''.$$

13) Ust'ye r. Ozernoy (Mouth of the Ozernaya River), right tributary of the Ket' River.

The place of the astronomical stellar observations was located on the right bank of the Ozernaya River, opposite the elevated cape of its opposite wooded bank. The post indicating the distance in versts and standing on the cape could be seen from the place where the instrument was located under an angle of 45° from the south to the east. Obtained were:

$$\varphi = 58°53'28''$$

$$\lambda_{Pulk} = 3^h49^m39^s = 57°24'45''.$$

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

In order to make the magnetic observations (see above, source p. 10) we we STAT
40 sazhens upstream the Ozernaya River, in the directions N 16°36' W, and the coordinates changed by $d\varphi = 4''.1$, $d\lambda = -0^s.2$.

Therefore

$$\varphi = 58°53'32' \text{ [sic]}$$

$$\lambda_{\text{Pulk}} = 3^h49^m39^s = 57^b24'42''.$$

The trunk of a tall pine tree, which could be seen high along the river, served for the target. The azimuth determined for the target equalled 125°23'35" from the south to the east.

14) Glavnyy stan [Main Field Headquarters] located on the Ob'-Yenisey Connecting Waterway System.

The point of the magnetic and astronomical observations was located in the open plain in the near northeast of the quarters of the director for the Ob'-Yenisey River sector of the Tomsk Okrug RR.

The determinations gave

$$\varphi = 59° \ 3'25''$$

$$\lambda_{\text{Pulk}} = 3^h51^m24^s = 57°51' \ 0''.$$

The figure 5 on the milepost in versts to the northeast of the instrument served as the target (azimuth 140°45'12" from the south to the east).

15) Ust'ye "Kasovskoy" rechki (Mouth of the Kasovskaya Stream), right tributary of the Bol'shoy Kas River, about 25 versts from its confluence with the Yenisey River.

The theodolite stood on the low and sandy right bank of the Bol'shoy Kas River several sazhens below the mouth of the "Kasovskaya" Stream.

Only solar observations were made in the afternoon from which the following were calculated through subsequent approximations

$$\varphi = 59°53'28''$$

$$\lambda_{\text{Pulk}} = 4^h \ 0^m20^s = 60° \ 5' \ 0''$$

16) Nizhne-Shadrino Village, otherwise Sukovatka, on the left bank of the Yenisey River.

Only the horizontal component was determined with the instrument standing near the place where more detailed measurements were made in 1901 (see below).

b) The points of 1901

17) Polomoshnaya station on the Siberian RR at the Tom' River.

The observation point was located south of the railroad bed, some 44 sazhens south of the bell tower of the church of the Siberian RR Committee.

The direction toward the top of the water tower, or pumped water tank, precise coordinates for which were given by Yu. Shmidt[61], and the distances to it from our point were:

	Direction	Distance
To the water tower	11°39' from N to W	290 meters (136 sazhens)
To the church bell tower	3 28 " N " W	94 meters (44 sazhens)

The reductions of the coordinates from the water tower to our point were $d\varphi = -9''.4$, $d\lambda = +0^s.2$, therefore

$$\varphi = 55^\circ 45' 11'.0 \text{ [sic]}$$

$$\lambda_{Pulk} = 3^h 38^m 38^s.1 = 54^\circ 39' 31''.$$

A distant stake in the fence to the northwest served as the target.

18) Ovash RR Station

Observations were made north of the RR and of the station buildings, beyond the settlement, beyond the gardens, and to the east of the ravine with a small stream. The flagpole of the RR terminal, determined astronomically by Yu. Shmidt, served as the target.

	Direction	Distance
To the RR terminal flagpole	8° 3' from south to east	391 meters (183 sazhens)
To the water tower	5°13' from south to east	

Reductions from the RR terminal flagpole to the place of the instrument gave $d\varphi = 12''.5$, $d\lambda = -0^s.2$, hence

$$\varphi = 55^\circ 27' 58''.1$$

$$\lambda_{Pulk} = 3^h 33^m 57^s.4 = 53^\circ 29' 21''.$$

61) Among the stations given below, the following were determined by Yu. Shmidt in 1896 and published in the Zap. V.-Top. Otd. /Transactions of the Military Topographical Dept. [Op. cit.]), vol. 55: Polomoshnaya, Oyash, Kargat, Kozhurla, Tebis, Tatarskaya, Kormilovka, Bogotol, Marlinsk, and Sudzhenka. Later, Kurgan and Shumikha were also determined by Shmidt, and their coordinates were given in vol. 56 of the Transactions.

STAT

19) Chik RR Station.

The observations were made in Prokudna village located on the old Siberian trunk highway north of the station. The point was located on the very edge of the left bank of the Chik Stream, approximately in the center of the village. The distance from it to the RR station water tower (the target) was 980 meters (459 sazhens) according to the survey, the direction on it [the target] was 19°47' from the south to the west (about a verst on the road from the station through the village, then turn left into the lane leading to the river).

The coordinates were determined from the sun:

$$\varphi = 55^\circ\ 0'26''$$

$$\lambda_{Pulk} = 3^h28^m27^s.7 = 52^\circ\ 6'55''.$$

20) Kargash Station

Observations were made on the east end of the settlement located on the north bank of the Kargata Stream near the station. The tent stood about 109 steps (arshins) from the right bank of the stream near the trunk highway from Kolyvan' to Kainsk [now Kuybyshev, Novosibirskaya o.]

To the south stack of the terminal	31°56'	from S to W	561 meters (263 sazhens)
To the water tower (the target)	42 53	from S to W	540 m (253 sazhens)

Reductions of the Yu. Shmidt's coordinates for the top of the water tower to those of the observation place gave $d_\varphi = +12''.8$ and $d\lambda = +1^s.4$, and hence

$$\varphi = 55^\circ 12'\ 2''.1$$

$$\lambda_{Pulk} = 3^h19^m50^s.8 = 49^\circ 57'42''.$$

21) Kozhurla RR Station.

Observations were made in Svyato-Aleksandrovskiy settlement, located south of the railroad bed.

The tent stood in the south row of houses of the east end of the village street. In addition to the line of the street, the point was determined also by the fact that the direction on the church was deflected by 35°.45 from the north to the west.

The direction of the target, i.e., the railroad water tower was deflected by 20°35' from the north to the west, and the distance to it was 699 meters (328 sazhens). Taking the coordinates according to Yu. Shmidt and correcting them by $d\varphi = -21''.2$ and $d\lambda = +0^s.9$, we obtain for our point

$$\varphi = 55^\circ 19'56''.6$$

$$\lambda_{Pulk} = 3^h14^m49^s.0 = 48^\circ 42'15''.$$

22) <u>Tebis RR Station</u>. The tent stood at the east end of the small settler (north of the station) on the bank of the Perkul' (?) Lake, about 100 sazhens fr STAT the railroad bed. The following directions and distances were determined fr m . observation place.

To the west stack of the terminal	17°49' from S to W	274 m (128 sazhens
To the water tower (the target)	31 3 from S to W	334 m (157 sazhens
On the semaphore to the east	74 19 from S to E.	

The reductions from the (west?) stack of the terminal[62], according t Yu. Shmidt, with the magnitudes $d\varphi = 8''.4$ and $d\lambda = 0^s.3$, gave

$$\varphi = 55°21'30''.2$$
$$\lambda_{Pulk} = 3^h\ 8^m 34^s.6 = 47°\ 8'\ 39''.$$

23) <u>Tatarskaya RR Station</u>

Observations were made in the settlement near the station, about 132 saz north of the railroad bed. The church and the school could be seen to the wes water tower to the left, and the front of the engine house and the weather vane of the meteorological station still further to left; the steeple of the immigr barracks could be seen to the east.

The directions and distances were as follows.

To the front of the school		101°43'	from S to W	414 meters	(194 sa
"	church bell tower	96 49	"	480 "	[illegible]
"	water tower	57 2	"	661 "	(310
"	depo	48 20			
"	weather vane of the meteorol. station	37 52		316 "	(148

Reductions from the water tower: $d\varphi = 11''.6$ and $d\lambda = 2^s.1$ gave according to Yu. Shmidt

$$\varphi = 55°12'57''.3$$
$$\lambda_{Pulk} = 3^h\ 2^m 31^s.6 = 45°37'54''$$

62) After the fire the terminal was rebuilt on the same foundation and, obviously, was expanded by additions.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

STAT

24) Kormilovka RR Station.

The observation place was located north of the railroad bed beyond the shacks of the station settlement and 80 sazhens (measured by steps with a perpendicular) east from the water conduit running from the Omi River to the water tower for a distance of 3 versts.

Directions and distances were measured to the following points:

To the south stack of the terminal	11°33' from S to W	292 meters (137 sazhens)
" the semaphore to Omsk, serving for the target	62 49 "	
To the water tower	25 46	291 " (136 ")

For the distance from the Yu. Shmidt's point to the south stack of the terminal we have $d\varphi = 9''.3$, and $d\lambda = 0^s.2$, therefore

$$\varphi = 54°59'58''.9$$

$$\lambda_{Pulk.} = 2^h55^m5^s.2 = 43°46'18''.$$

25) Mar'yanovka RR Station

Observations were made at the farmstead of the Tambov Molokanes [exiled religious sect], located some distance north of the station. The tent stood in the row of houses and sheds nearest to the station, beyond the row of wells. The location of the point in that row was designated by the direction on the target, i.e., the station water tower; this direction deflected 12°19' from the south to the east. The distance to the tower was about 2.5 versts, more exactly 2,560 meters (1,200 sazhens).

Astronomical observations from the sun and the stars gave the following magnitudes:

$$\varphi = 54°58'55''$$

$$\lambda_{Pulk.} = 2^h49^m12^s = 42°18'0''.$$

26) Isil' Kul' RR Station

Observations were made to the northeast of the railroad bed at the exit from Pavlovskiy settlement located near the terminal along the road to Pavlovskoye village.

The tent stood at the edge of the woods, north of the above mentioned road to the village, opposite the new log cabin on the very edge of the settlement. Forges and a wind-driven flour mill could be seen to the side toward the station. The shortest distance to the railroad bed was = 145 sazhens (measured by steps).

STAT

Here are the directions and distances:

To the church bell tower at the station (the target)	50°39' from S to W	1,137 meters (533 sazhens)
" water tower	64 9 "	629 " (295 ")

The coordinates according to observations from the sun:

$$\varphi = 54°54'40''$$
$$\lambda_{Pulk} = 2^h43^m47^s = 40°56'45''.$$

27) <u>Petropavlovsk RR Station</u>.

The observation place was beyond the settlement located south of the terminal and populated by railroad workers.

The instrument stood in the back of the Semenov's house (34 sector) in front of the open steppe. Here are the directions and distances of the following points:

To the water tower	58° 7' from N to W	682 meters (320 sazhens)
" the middle stack of the terminal	49 31 "	580 (272 ")
" the church bell tower (the target)	27 3 "	787 (369 ")
" the east front of the engine house	5 1 from N to E	405 (190 ")
" the semaphore to Omsk	55 49 from N to E	

The coordinates according to solar observations:

$$\varphi = 54°51'11''$$
$$\lambda_{Pulk} = 2^h35^m22^s = 38°50'30''.$$

28) <u>Makushino RR Station</u>.

We moved far south of the station to Makushino village for making the observations. The tent stood in the garden of one of the houses on the shore of the lake. The point was tied first with the trunk of the water pump standing on the north end of the same lake and feeding the railroad conduit, and then with the church bell tower, located between the terminal and the village.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

To the water pump trunk	98° 6' from S to W,	1010 meters	(473 sazhens)
To the church bell tower	132 10 "	1249 "	(585 ")

Determinations obtained from the sun were as follows:

$$\varphi = 55°12'27''$$

$$\lambda_{Pulk} = 2^h 27^m 39^s = 36°54'45''$$

29) Kurgan.

We made the observations in the station settlement south of the terminal. The tent stood in the row of houses facing a large open area; the cemetery could be seen to the right and Kurgan City to the left; in the back was the lake, and beyond it were the station structures, terminal, etc.

The place was determined by the following directions and distances:

To the water tower	28°25' from N to W	461 meters	(216 sazhens)
To the flag pole of the terminal	21 56 "	515 "	(241 ")
To the bell tower of the cathedral of Kurgan	112°37' from N to E	1534 "	(719 ")

Using the determinations made by Yu. Shmidt in 1897, published in Zap. V.-Top. Otd. Gl. Sht. (Transaction of the Military Topographical Department of the General Staff), vol. 56, (the coordinates for the Shumikha Station are published there also, see below), and the reductions from the water tower equal $d\varphi = -13''.1$, $d\lambda = 0^s.8$, we obtained for our observation point:

$$\varphi = 55°26'13''.6$$

$$\lambda_{Pulk} = 2^h 19^m 58^s.8 = 34°59'42''.$$

30) Shumikha RR Station.

Observations were made in the yard of a house in the extreme north of the station settlement, at the end of a lane running perpendicularly to the railroad line, north of the terminal. The flag pole in the north face of the terminal served for the target, exactly 389 meters (182 sazhens) distant, with its azimuth being = 14° 0' from the south to the east.

Reductions from this target, determined astronomically by Yu. Shmidt (see Kurgan Station) were: $d\varphi = 12''.2$, and $d\lambda = -0^s.3$, giving for our observation point:

$$\varphi = 55°13'38''.1$$

$$\lambda_{Pulk} = 2^h 11^m 49^s.3 = 32°57'20''.$$

STAT

31) Chelvabinsk RR Station

Observations were made beyond the settlement located east of the terminal (west of it is the large Novo-Nikolayevskiy settlement, where the church bell tower served us for the target).

The tent stood beyond the last row of houses and earth shacks beside the road running in the rear of the settlement. The following directions and distances were determined.

To the east front of the terminal	87°43' from S to W,	671 meters	(314 sazhens)
To the church bell tower (the target)	95 15 "	1127 "	(528 ")
To the south (left) stack of the water tower	110 30 "	665 "	(312 ")
To the front of the city abattoir	213 36 "	868 "	(407 ")

It was obtained by solar and stellar observations:

$$\varphi = 55° \; 8'29''$$

$$\lambda_{Pulk} = 2^h \, 4^m 24^s = 31° \; 6' \; 0''.$$

32) Krasnovarsk City.

Observations were made on the mountains between Zakachenskaya (beyond the Kacha River) settlement and the cementery; farther on this mountain is an open field where military training took place.

A topographical tie between the instrument and the cemetery church gave the distance of 429 meters (201 sazhens) to its bell tower, and the direction azimuth 81° 6' from the south to the west.

In addition the following directions were taken:

On the bell tower of the old cathedral	2°16' from S to E
On the bell tower of the new cathedral (the target)	68 14 from S to W
On the sole tower on the mountain	97 26 from S to W

The distance to the bell tower of the new cathedral, the coordinates for which were determined accurately by Col. Miroshinichenko[63], was measured by my survey and equalled 2626 meters (1231 sazhens); reductions to our point were $d\varphi = 31''.6$, $d\lambda = 9^s.4$.

63) Zap. V.-Top. Otd. Gl. Sht. (Transactions of the Military Topographical Department of the General Staff), vol. 51, p. 184.

Therefore the following coordinates were taken for the point:

$$\varphi = 56^\circ\ 1'22''.4$$

$$\lambda_{Pulk} = 4^h 10^m 16^s.2 = 62^\circ 34'\ 3''.$$

33) <u>Kazachinskoye Village</u>, or Kazach'ye, on the Yenisey River.

The tent stood on the site beside the church and beside the quarters of the Zemstvo (elective district council). The distance of the instrument from the church bell tower was 51 sazhens, the direction to it being 49°25' from the south to the west. The top of the watch tower bearing almost exactly on the south (by 1°56' from the south to the east) served for the target at a distance of approximately 207 sazhens.

The latitude and longitude according to our determinations[64]:

$$\varphi = 57^\circ 41' 58''$$

$$\lambda_{Pulk.} = 4^h 11^m 49^s = 62^\circ 57' 15''.$$

34) <u>Kolmogorovo Village</u>, on the left bank of the Yenisey River.

The observations were made southeast of the church, i.e., somewhat higher [of the church] upstream and closer to the bank.

North of the church was a monument with the inscription: "Astronomical chronometer point 1899" (which I also used for determining the latitude by the sun). The place of our theodolite during magnetic and other astronomical observations was about 26 sazhens from this monument and about 17.3 sazhens from the church bell tower; the directions to these points from our instrument were:

To the post 24°51' from the north to the west

To the bell tower 43°54' from the north to the west

The top of a quite distant tree standing on the high bank of the Yenisey River in the direction of 28° from the north to the east served for the target.

---

64) The exact coordinates, i.e., $\varphi = 57^\circ 49' 59''.8$, $\lambda = 2^h 11^m 49^s.3$ of the Kazach'ye church bell tower, determined by Lt. Col. Osipov in 1902, are given in Zap. V. T. Upr. Gl. Sht. (Transactions of the Military Topographical Administration of the General Staff), v. 61, published recently. The declination of the magnetic needle found by the author (see pp. 253 and 232 of Section II of the indicated volume with a Brauer azimuth compass for 5^hp [.m.] on 14 June 1902 was $\delta = -10^\circ 50'$, which differs considerably from that found by me. Unfortunately the author does not indicate whether his instrument was compared with the absolute instruments in order to exclude a possibility of an error in the prism of the eye diopter.

As the exact coordinates determined by the Irkutsk or Siberian Topographic Department, obviously, were not published[65] I am using the results of my determinations, having decreased the observed latitude of the monument by 1".6:

$$\varphi = 59°15'37"$$

$$\lambda_{Pulk} = 4^h 3^m 55^s = 60°58'45".$$

35) Nizhne-Shadrino Village, or Sukovatka, on the left bank of the Yenisey River, near the mouth of the Bol'shoy Kas River.

The observations were made on the right bank of the Sukovatka Stream, opposite the village, which is located on the high left bank of that stream. The tent stood on the site opposite the Zemstvo (elected district council) quarters (the house which belonged to the peasant Kirillov) about 10 sazhens from the bank of the stream 220 sazhen upstream from the mouth located almost to the north (13° from the north to the west). A distant birch tree trunk in the direction of 21°40' from the north to the west served for the target.

The following coordinates were obtained:[66]

$$\varphi = 59°54'57"$$

$$\lambda_{Pulk} = 4^h 1^m 17^s = 60°19'15".$$

36) The mouth of the Garevka River (Gorevka on some maps), right tributary of the Yenisey River. The theodolite stood on the sandy bank of the Yenisey some 40 steps from the water and 100 steps below the mouth of the Garevka River.

The latitude taken for the point was according to a map, based on the latitude of N.-Shadrino Village.

$$\varphi = 59°52'.0$$

$$\lambda_{Pulk} = 4^h 1^m 49^s = 60°27'15".$$

Note:
Magnetic observations were shortened and made without a tent.

---

65) According to the information received by the V. T. Upr. Gl. Sht. (Military Topographical Administration of the General Staff) the coordinates of the monument were as follows: $\varphi = 59°15'36".0$, $\lambda = 4^h 3^m 55^s.2$.

66) The Atlas r. Yeniseya (Atlas of the Yenisey River), compiled by a hydrographic expedition headed by Lt. Col. Vil'kitskiy, published in 1900 by the Gl. Gidr. Upr. Morsk. Min. (Main Hydrographic Administration of the Navy) gives the following coordinates for this village: $\varphi = 59°53'$, λ Greenwich = 90°42'. The quite large difference between those coordinates and my determinations is incomprehensible because, obviously, there is no large error in my measurements or in calculations. This difference exists also with respect to the next point No. 36.

STAT

37) Yeniseysk City.

The observation place was located at the exit from the east end of the city onto the Krasnoyarsk postal road; having passed the bridge across the Lazarevka Stream, turn left before reaching the Abalakskaya cemetery church. The theodolite stood some 38 sazhens from the bell tower of that church; the direction to it deflected about 25°42' from the south to the east[67].

The following directions and distances were obtained by a survey:

To the bell tower of the monastery	87°58' from S to W	1940 meters	(909 sazhens)
To the bell tower of the convent	92 34 "	912	(427 ")

The reductions calculated from the monastery were: $d\varphi = 2''.2$, $d\lambda = 8^s.0$.

The longitude of the monastery was determined telegraphically by Lt. Col. Vil'kitskiy and Lt. Ivanov in 1895[68], and the coordinates obtained for our point by reduction from the monastery were

$$\varphi = 58^\circ 27' 5''.4$$

$$\lambda_{Pulk} = 4^h 7^m 29^s.1 = 61^\circ 52' 16''.$$

38) Chernorechenskaya Station. Siberian RR.

Observations were made in the rear of the settlement near the station, south of the terminal. A survey produced directions and distances to the following objects.

To the water tower (the target)	53°54' from N to E	513 meters	(240 sazhens)
To the western face of the engine house	47 26 "	501 "	(235 sazhens)
To the terminal flag pole	11 12 "	401 "	(188 ")

A monument with the inscription: "Astronomical and chronometer point 1900" stood in the direction of 16° from the north to the east, some 182 sazhens from our point.

As the results of the determinations for this monument, obviously, have not yet been published, and as I have had no time to determine the latitude of my point, I took its approximate value according to the map of the "southern border belt of Siberia", of 56°16'11", which corresponds to the value of 56°16'23" for the monument. An error in the latitude will have almost no effect on the longitude of the place calculated by me, but on the azimuth of the target and on the magnetic declination the effect will be such that if we add $\Delta\varphi = 1'$ to

67) The plan of Yeniseysk City can be found in the Atlas reki Yeniseya (Atlas of the Yenisey River), cited above.
68) Zap. po Gidrografii (Hydrographic Transactions), 1895, Fascicle 18, p 92.

STAT

the magnitude of 56°16'23" for the post, then 41" = 0!7 should be added to the eastern declination given later by me for Chernorechenskaya Station (i.e., to the negative declination should be added - 41") according to the formula $\Delta\delta = -0.7\Delta\varphi$ 1[69].

The longitude was calculated from our chronometer:

$$\varphi = 56°16'11"$$

$$\lambda_{Pulk} = 4^h\, 3^m\, 2^s = 60°45'30"$$

39) Bogotol Station.

The observation place was beyond the eastern end of the settlement located on a comparatively high site north of the railroad bed and left of the road running perpendicularly to the line of the Siberian RR.

Here are distances and directions from the mean magnetic meridian to the following objects:

To the flag pole of the terminal	4°37'	from magn. S to E,	834 meters	(391 sazhens)
To the water tower	20 9	"	718 "	(336 ")
To the church bell tower	7 17	"	985 "	(462 ")

The directions given are from the magnetic meridian because the prevailing weather conditions made observations of the sun or stars impossible.

For the passage from the flag pole of the terminal and from the water tower, coordinates for which are given by Yu. Shmidt[70], to the place of observation, we take the probable inclination value of $\delta = -11°0'$. We shall obtain

According to the flag pole (6°23' from S to W) $d\varphi = +26".8$, $d\lambda = +0^s.36$

According to the water tower (9° 9' from S to E) $d\varphi = +22".9$, $d\lambda = -0^s.44$ and using the coordinates for these points[71], we obtain for our point:

According to the flag pole of the terminal $\varphi = 56°13'15".86$, $\lambda_{Pulk} = 3^h56^m49^s.15$; According to water tower $\varphi = 56°13'12".81$, $\lambda_{Pulk} = 3^h56^m49^s.14$

69) According to information at the V.T.Upr.Gl.Sht. (Military Topographical Administration of the General Staff) the coordinates of the monument proved to be $\varphi = 56°16'20".5$, $\lambda = 4^h\, 3^m\, 3^s.2$, therefore no changes of any kind in our results will be made subsequently.

70) See station No. 17 on our list and the remarks

71) Of course, using these data one could calculate approximately and roughly the direction of the astronomical meridian on the theodolite and, consequently, the magnitude of the declination in Bogotol. Unfortunately, this proved to be impossible due to the fact that either there was an error in these data, or one of the structures had been moved to another place since 1896. The precise declination in Bogotol could have been found had the Yu. Shmidt's monument near the RR terminal been preserved, because the author gives precise azimuths from his monument to both structures.

40) <u>Mariinsk City</u>.

Observations were made in the woods opposite Bol'shaya Street west of the city from where there was a view on the barracks of the Mariinsk City Command, certain structures of the [RR] station, and on the prison under construction.

Distances and directions to the following objects were determined:

To the flag pole of the terminal (the target)	18° 47' from N to E,	925 meters	(434 sazhens)
To the water tower	1 4 from N to W,	732 "	(343 ")
To the dome of the new prison church	33 5 from N to E.		

Therefore the reductions of the coordinates, found by Yu. Shmidt, will be

From the flagpole ($d\varphi = -28''.3$; $d\lambda = -1^s.15$;   From the water tower ($d\varphi = -23''.7$; $d\lambda = +0^s.05$

which gives the mean for the point of our observations:

$$\varphi = 56°12'19''.1$$
$$\lambda_{Pulk} = 3^h49^m38^s.0 = 57°24'30''.$$

41) <u>Sudzhenka RR. Station.</u>

The tent was placed beyond the terminal along the road to the Sudzhenka coal fields, i.e., to the northwest of the terminal.

The point was determined by the fact that it was 446 meters (209 sazhens) distant from the water tower which served for the target, and whose azimuth = 61°17' from the south to the east. The direction to the terminal flagpole was 49°56' from the south to the east, and to the brick stack of the water pump (seen from the gully) 15° 6' from the north to the west.

The reductions from the water tower: $d\varphi = 8''.1$ and $d\lambda = -1^s.1$ gave according to Yu. Shmidt:

$$\varphi = 56° 6'49''.0$$
$$\lambda_{Pulk} = 3^h43^m19^s.1 = 55°49'46''.$$

VI. The Results of Astronomical Observations

STAT

Table I contains the results of the determined corrections for the chronometer with respect to the local time at various stations.

The mean moments of observations are given according to the chronometer, i.e., approximately by the Tomsk time, in which civil days, and not astronomical, were taken - beginning from midnight, and not from noon.

The Tomsk time, as stated above, refers to the monument in the university garden.

Certain corrections of the chronometer to the local time in Table I are printed in bold face, i.e., in those instances when these corrections served for calculating the differences from the "Tomsk mean time - chronometer", i.e., when the known longitudes were used more or less accurately for the points with respect to Tomsk; these longitudes were taken, as a rule, from table II.

For such cases the found differences from the "Tomsk mean time - chronometer" are printed also in bold face, according to which the daily rate of the chronometer was computed and is compared for various time intervals in Table III; the data for the daily rate of the chronometer calculated from repeated observations made, e.g. in Tomsk before and after the trip, and at certain other points, especially for 1900, is given also in Table III.

The magnitudes of the differences from "Tomsk mean time - chronometer" for other points are interpolated in Table I (using the daily rate from Table III), and in the next column are given the longitudes of these points thus obtained with respect to Tomsk.

The longitudes of Narym and Kolpashevo village were known as reliable among the points of 1900; the longitude of Kolmakovo (or Rodionovo) was also taken as basic for all other [points] because it was determined by a chronometer brought from Kolpashevo using the daily rate for only 4.9 days; then the longitude of M. Panovo is almost just as reliable as that of Kolmakovo in absolute magnitudes, because these points were later connected by a topographical survey giving the mean daily rate of the chronometer for 20 days.

One can judge of the good quality of the chronometer by its daily rate shown in Table II. The infrequent irregularities in the rate in 1901, probably, can be explained by inaccuracies in the calculation with very small time intervals between the moments when the correction determinations for the chronometer were made.

This table shows partly also the reliability of the longitudes for the points determined in 1900 and 1901, given separately in Table IV. The longitudes of points determined on the way back from M. Panovo to Tomsk in 1900 are less reliable as I could not take advantage of precise longitudes of the points on the Yenisey River.

A comparison of my figures with the determination results obtained by A. K. Sidensner can serve as the criterion of precision of the longitudes along the Ket' River if the latter are corrected according to the precise longitude of Yeniseysk determined after the Sidensner's observations had been plotted by Wagner and [corrected] for the obvious systematic error in the latitude. The longitudes were compared by me in Table IV, Sidensner's longitude for Kolpashevo village was compared by me also with the precise value obtained by Yu. Shmidt, given in Table II.

Errors in our longitudes depending on the precision in the determination of time at each point, probably, almost do not play any role in comparison with the errors resulting from changes in the daily rate of the chronometer. At least, the repeated determinations of the correction to it, even with unsuccessful and incomplete observations, seldom differed more than by 2 - 3 seconds. Less reliable were the determinations of time at Narym on 26 June, at Yurty Maleshkiny where I had not determined the latitude, and particularly at the mouth of the Kasovskaya Stream, where both the time and latitude were determined by observations in the afternoon by subsequent approximations (See above p. 23, and Tables I and V). In 1901 the time was in general, determined reliably enough, less certain were those [determinations] for which the observations were made only on one side of the meridian (Tatarskaya, Isil'-Kul', Shumikha, Nizhne-Shadrino, the mouth of the Garevka River, and Sudzhenka).

The determinations of latitudes are assembled in Table V where in addition to separate measurement results also the mean latitudes for each point are included as they were finally accepted and used for the calculation of time and azimuth. Finally, the latitudes reduced to the places of our observations according to topographical surveys from the points which had been determined accurately, chiefly, by the geodesist Yu. Shmidt and others[72] are given also for comparison.

Table VI contains all azimuth determinations of the mark, expressed in degrees, minutes, and seconds of the arc from the south to the west or to the east.

In order to evaluate the relative weight of each separate result the number of sightings of the heavenly body and its mean azimuth during the observations are given; it is stated sometimes in the remarks how the correction of the chronometer was derived, and when a result with 50 per cent weight was taken.

The results obtained in 1900 with a Hildebrand theodolite almost always agreed together sufficiently well; thus, observations on the Polaris and from the sun gave almost the same results.

In 1901 the observations of the sun on various sides of the meridian with a Wild theodolite agreed well enough; on the average, the difference between the azimuths determined from the sun from the east to the west equalled ±9".3, thus the arithmetic mean of the precision should be ±5".

72) The latitude observations made from the sun in 1901 with a new circle in the Wild theodolite agreed well with the precise values obtained by Yu. Shmidt.

This high precision was due, in the majority of cases, to the fact that the correction of the chronometer was determined on both sides of the meridian and that the principal cause of the difference in the azimuths [determined] from the sun from the east to the west was eliminated. If we take the agreement of separate determinations of the azimuth at each point as the basis, and disregard their weight and the fact whether the sun was on one or the other side of the meridian, we obtain the same magnitude of ±5" for the mean deviation of a separate measurement.

The following arguments can be given in order to evaluate astronomical qualities of our theodolite: according to our observations a systematic error in measurements of the zenith distances cannot be observed with a Hildebrand theodolite; evidently it [the error] is not greater than 2".

In 1901, the Wild theodolite with the new circle showed also an insignificant systematic error of +2" in sighting the sun as can be judged by the errors in the latitudes; moreover this error seems to be on the side as if caused by a sagging of the eyepiece hairs, or by a flexure of the telescope. In stellar observations this error increased to 5".

Table I. Determination of the Local Time

Location	Chronometer time New style, civil day		Hildebrand or Wild theodolite	Sun or Star	Mean hour angle	Mean zenith distance	Number of sightings	Mean local chronometer time		Time from arbitrary beginning (in days)	Tomsk mean chronometer time	Longitude from Tomsk (University)	Remarks
	1900	h			h					d			
Tomsk (University)	19 Jun	4.7p.	H	Sun to W	4.7	60°	8	$3^m37^s.6$		169.20			
	20 "	3.5p.	"	Sun to W	3.5	50	8	3 37.2		170.15			
	20 "	11.8p.	"	α Cygni to E	-2.8	29	8	3 36.7	$3^m36^s.8$	170.50			
	21 "	0.3a.	"	η Urs. Mj. to W	4.5	40	8	3 37.0					
	21 "	10.6p.	"	α Cygni to E	-4.0	38	8	3 35.7	3 35.5	171.45	$3^m35^s.5$		
	" "	11.1p.	"	α Can. Ven.to W	4.3	45	8	3 35.4					
(After the journey)	20 Aug	2.7p.	"	Sun to W	2.7	54	8	4 32.1	4 32.9	231.79	4 32.9		
	21 "	11.0p.	"	β Andr. to E	-4.0	45	8	4 33.6					Observ. of 9 Sept.
	9 Sep	7.9p.	"	η Peg. to E	-3.3	45	8	4 57.3	4 57.9	251.34			by prof. Kapustin
	" "	8.2p.	"	α Cor. Bor.to W	4.0	51	8	4 58.6					
Narym	24 Jun	6.0p.	W	Sun to W	5.7	68	8	-9 58.8	-9 58.1	174.54	3 36.8	$13^m34^s.9$W	Observ. at 2nd location (dλ =0). The result unreliable
	25 "	8.1a.	"	Sun to E	-4.1	56	8	-9 57.3					
	26 "	2.4p.	"	Sun to W	2.1	42	8	-9 59.8					
Kolpashevo	29 "	4.2p.	H	Sun to W	4.1	55	8	-4 37.3					
	30 "	0.0a.	"	ε Urs. Mj.to W	5.6	42	8	-4 36.7	-4 37.0	179.51	3 36.1	8 13.1W	
	" "	0.7a.	"	γ Cass. to E	-5.7	41	8	-4 37.3					
	2 Jul	9.3a.	"	Sun to E	-1.8	40	8	-4 35.8	-4 35.3	181.99	3 37.8		
	" "	2.1p.	"	Sun to W	2.0	41	8	-4 34.9					
Kolmakovo (or Rodionovo)	7 "	8.8a.	W	Sun to E	-3.3	50	4	-1 58.3		186.87	3 41.5	5 39.8W	
B. Panovo	8 "	9.8a.	H	Sun to E	-2.3	44	8	-0 42.5					
	9 "	11.7p.	"	η Urs. Mj.to W	5.6	44	8	-0 40.0	-0 40.5	189.51	3 43.7	4 24.2W	
	10 "	1.0a.	"	β Pegasi to E	-2.8	43	8	-0 41.0					
	14 "	2.3p.	W	Sun to W	2.2	44	8	-0 37.9		194.10			
M. Panovo (1st location)	17 "	3.3p.	"	Sun to W	2.8	48	8	-1 45.7					The result unreliable
	" "	11.0p.	H	γ Boot. to W	4.2	44	8	-1 44.7	-1 44.6	197.48	3 50.4	5 35.0W	Reduction to the 2nd point
	" "	11.9p.	"	η Peg. to E	-3.7	43	4	-1 44.4					= +0s.2
(2nd location)	19 "	10.5a.	"	Sun to E	-1.7	42	8	-1 43.6	-1 43.3	199.00			
	" "	1.8p.	"	Sun to W	1.7	42	10	-1 42.9					
	22 "	10.9a.	"	Sun to E	-1.2	40	8	-1 41.4	-1 41.8	202.02			
	" "	2.1p.	"	Sun to W	2.0	44	8	-1 42.2					
	26 "	8.9a.	"	Sun to E	-3.2	52	8	-1 39.2	-1 39.5	206.03	3 55.7	5 35.2W	Longitude by survey accord.
	" "	4.4p.	"	Sun to W	4.2	60	6	-1 39.9					to Kolmakovo
Yurty Shirokovy	28 "	10.8p.	"	ε Boot. to W	4.6	56	8	4 30.2	4 30.1	208.46	3 59.2	0 30.9E	
	" "	11.3p.	"	α Andr. to E	-4.3	53	8	4 29.9					The azimuth of the mark de-
Yurty Muleshkiny	29 "	4.2p.	W	Sun to W	4.2	60	6	6 58.6		209.17	4 0.2	2 58.4E	termined simultaneously by sighting at the center of the sun

Table I (contd.)

Location	Chronometer time New style, civil day		Hildebrand or Wild theodolite	Sun or Star	Mean hour angle	Mean zenith distance	Number of sightings	Mean local chronometer time		Time from arbitrary beginning (in days)	Tomsk mean chronometer time	Longitude from Tomsk (University)	Remarks STAT
	1900	h			h					d			
Yurty Berkunovy	1 Aug	0.5a	H	α Lyrae to W	2.7	33°	4	12m55s.0		211.52	4m 3s.6	8m51s.4E	
Mouth of Ozernaya River	1 "	11.2p.	"	α Andr. to E	-4.4	50	8	15 14.5	15m15s.0	212.51	4 5.0	11 10.0E	
	2 "	1.3a.	"	α Lyrae to W	3.6	40	8	15 15.5					
	3 "	9.9a.	"	Sun to E	-2.0	46	4	15 16.5		213.91			At another place some 0s.2 east of the previous one
Gl. Stan	4 "	11.0p.	"	β Peg. to E	-2.9	43	8	17 3.5	17 4.0	215.50	4 9.4	12 54.6E	
	5 "	0.8a.	"	i Herc. to W	4.3	39	4	17 4.6					
	6 "	11.0a.	"	Sun to E	-0.5	43	8	17 5.5		216.96			
Mouth of Kasovskaya Stream	11 "	1.8p.	"	Sun to W	2.1	50	8	26 9.9		222.07	4 18.7	21 51.2E	
	1901												
Tomsk (University)	20 Apr	2.3p.	W	Sun to W	2.4	53	8	4 21.2		109.10			Observations on 20 April from a window of the physics laboratory
	18 May	10.3p.	H	γ Leonis	3.8	55	8	4 7.5	4 7.2	137.44			
	" "	10.6p.	"	β Lyrae	-4 4	49	8	4 7.0					
	19 "	9.7p.	"	γ Leonis	3.3	51	8	4 7.0	4 7.0				
		10.0p.	"	α Lyrae	-4.7	49	8	4 7.0					
	21 "	10.1p.	"	α Lyrae	-4.5	46	8	4 6.4	4 6.8				
		10.4p.	"	γ Leonis	4.1	58	8	4 7.2					
	26 "	10.1p.	"	α Lyrae	-4.2	44	8	4 4.9	4 5.2	145.43	4 5.2		Observations by prof. Kapustin
		10.5p.	"	δ Leonis	3.7	54	8	4 5.5					
(After the trip)	18 Aug	9.6p.	"	α Cor. Bor.	4.0	51	8	5 19.4	5 18.9	229.41	5 18.9		
	" "	10.0p.	"	α Andr.	-4.2	52	8	5 18.4					
Tomsk beyond the Tom' River	3 Sep	10.0a.	W	Sun to E	-1.9	53	8	5 39.2	5 39.1	245.01	5 46.1		The point is beyond the Tom' River some 7s.0 west of the University
	" "	2.7p.	"	Sun to W	2.8	59	8	5 39.0					
	22 "	1.3p.	"	Sun to W	1.5	59	8	6 4.9		264.05	6 11.9		
Polomoshnaya	12 Jun	4.6p.	"	Sun to W	4.7	60	8	4 15.4	4 16.4	162.50	4 7.6		
	13 "	7.4a.	"	Sun to E	-4.6	59	8	4 17.3					
Oyash	13 "	3.9p.	"	Sun to W	3.8	53	8	- 0 24.4	- 0 23.9	163.51	4 8.0		
	14 "	8.6a.	"	Sun to E	-3.4	49	8	- 0 23.4					
Chik	16 "	9.3a.	"	Sun to E	-2.7	44	8	- 5 51.9	- 5 52.1	166.00	4 9.5	10 1.6W	
	" "	2.8p.	"	Sun to W	2.7	44	8	- 5 52.3					
Kargat	18 "	4.1p.	"	Sun to W	3.8	53	8	-14 28.4	-14 27.2	169.03	4 11.3		On the 19th, sightings at the sun through the cloud
	19 "	3.9p.	"	Sun to W	3.6	51	4	-14 25.9					
	20 "	9.3a.	"	Sun to E	-3.0	46	8	-14 24.9					
Kozhurla	20 "	5.0p.	"	Sun to W	4.6	59	8	-19 29.3	-19 28.7	170.52	4 11.6		
	21 "	8.0a.	"	Sun to E	-4.2	57	8	-19 28.2					On 23rd, readings at the circle to the right only
Tebisskaya	22 "	3.2p.	"	Sun to W	2.8	44	8	-25 40.3	-25 40.3	172.49	4 14.4		
	23 "	8.1a.	"	Sun to E	-4.3	57	4	-25 40.2					

STAT

Table I (contd.)

Location	Chronometer time New style, civil day		Hildebrand or Wild theodolite	Sun or Star	Mean hour angle	Mean zenith distance	Number of sightings	Mean local chronometer time		Time from arbitrary beginning (in days)	Tomsk mean chronometer time	Longitude from Tomsk (University)	Remarks
	1901:	h			h					d			
Tatarskaya	24 Jun	3.5p.	W	Sun to W	2.9	45°	8	- 31m45s.3	- 31m44s.5	174.64	4m13s.2		
	25 "	3.1p.	"	Sun to W	2.5	42	8	- 31 43.8					
Kormilovka	26 "	8.7a.	"	Sun to E	-4.0	54	8	- 39 10.0	- 39 9.4	176.04			
	26 "	5.1p.	"	Sun to W	4.6	57	8	- 39 8.8	- 39 9.1	176.54	4 15.0		
	27 "	8.7a.	"	Sun to E	-4.0	54	8	- 39 9.5					
Mar'yanovka	29 "	10.7p.	"	α Cygni	-4.1	39	4	- 45 0.2	- 44 59.2	179.46	4 18.0	49m17s.2W	
	29 "	11.2p.	"	Arctur.	2.7	46	8	- 44 58.2					
	29 "	3.5p.	"	Sun to W	2.7	43	8	- 45 0.0	- 44 59.6	179.53			
	30 "	9.9a.	"	Sun to E	-2.9	45	8	- 44 59.2					
Isil'-Kul'	2 Jul	8.1a.	"	Sun to E	-4.7	61	8	- 50 22.1		181.86	4 20.4	54 42.5W	
Petropavlovsk	3 "	4.2p.	"	Sun to W	3.2	48	8	- 58 45.7	- 58 44.8	183.53	4 22.0	1h 3 6.8W	
	4 "	9.5a.	"	Sun to E	-3.5	50	8	- 58 43.9					
Makushino	5 "	10.2a.	"	Sun to E	-2.9	46	8	-1h 6 26.0	-1h 6 26.8	185.06	4 23.6	1 10 50.4W	
	5 "	4.8p.	"	Sun to W	3.6	52	8	-1 6 27.7					
Kurgan	8 "	9.7a.	"	Sun to E	-3.6	51	12	-1 14 4.3	-1 14 3.9	188.05	4 26.6		
	8 "	4.8p.	"	Sun to W	3.5	50	8	-1 14 3.4					
Shumikha	10 "	4.4p.	"	Sun to W	3.0	47	8	-1 22 8.4	-1 22 8.1	190.70	4 31.9		
	11 "	5.1p.	"	Sun to W	3.6	52	8	-1 22 7.8					
Chelyabinsk	13 "	9.5a	"	Sun to E	-4.1	56	8	-1 29 31.7	-1 29 31.2	193.06	4 33.7	1 34 4.9W	
	13 "	5.5p.	"	Sun to W	3.9	54	8	-1 29 30.7					
	14 "	0.4a.	"	Arctur.	4.1	58	8	-1 29 30.0	-1 29 30.6	193.53			
	14 "	0.8a.	"	α Andr.	-5.3	61	4	-1 29 31.3					
Krasnoyarsk	20 "	8.8a	"	Sun to E	-2.6	46	8	0 36 25.8	36 26.4	199.98	4 39.5		On 23 July, sightings through the clouds
	20 "	2.1p.	"	Sun to W	2.6	46	8	36 27.0					
	21 "	3.0p.	"	Sun to W	3.5	53	8	36 27.0					
Kazachinskoye	23 "	3.0p.	"	Sun to W	3.5	54	4	38 2.3					
Kolmogorovo	24 "	7.5a.	"	Sun to E	-4.0	57	8	38 3.9	38 4.0	203.93	4 44.6	33 19.4E	
	24 "	1.2p.	"	Sun to W	1.8	42	4	38 4.1					
	27 "	2.4p.	"	Sun to W	2.8	50	8	30 15.3	30 14.7	207.48	4 49.2	25 25.5E	
	28 "	8.8a.	"	Sun to E	-2.8	50	8	30 14.1					
N. Shadrino	30 "	9.6a.	"	Sun to E	-2.0	47	8	27 39.6		209.90	4 52.3	22 47.3E	
Mouth of Garevka River	30 "	10.0p.	"	Arctur.	4.8	64	4	28 12.8		210.42	4 53.0	23 19.8E	Observations at the circle to the right only
Yeniseysk	3 Aug	8.8a.	"	Sun to E	-2.7	50	8	33 58.1	33 57.8	213.99	4 58.0		
	3 "	2.7p.	"	Sun to W	3.1	53	8	33 57.4					
Chernorechenskaya	7 "	8.6a	"	Sun to E	-2.9	52	8	29 36.0	29 36.	217.99	5 3.2	24 33.1E	
	7 "	2.8p.	"	Sun to W	3.2	54	8	29 36.7					
Mariinsk	11 "	10.1a.	"	Sun to E	-1.6	45	8	16 16.4	16 17.1	222.03	5 8.4		
	11 "	3.0p.	"	Sun to W	3.2	54	8	16 17.8					
										233.92	5 12.2		

STAT

Table II. Coordinates of Points According to a More Precise Data by Various Authors Reduced to Places of Our Observations (See Descriptions of Points)

Location	Latitude	Longitude east of Pulkovo λ Pulk	Longitude from Tomsk (University)
Tomsk, monument in the University garden	56°28' 6".6	3h38m29s.3	
Tomsk, point along the Tom' River	56 27 32.8	3 38 22.3	0m7s.0 W
Narym	58 55 29.3	3 24 54.4	13 34.9 W[73)]
Kolpashevo	58 18 15.7	3 30 16.2	8 13.1 W[74)]
Polomoshnaya	55 45 11.0	3 38 38.1	0 8.8 E
Oyash	27 58.1	33 57.4	4 31.9 W
Kargat	12 12.1	19 50.8	18 38.5 W
Kozhurla	19 56.6	14 49.0	23 40.3 W
Tebisskaya	21 30.2	8 34.6	29 54.7 W
Tatarskaya	12 57.3	2 31.6	35 57.7 W
Kormilovka	54 59 58.9	2 55 5.2	43 24.1 W
Kurgan	55 26 13.6	19 58.8	1 18 30.5 W
Shumikha	13 38.1	11 49.3	1 26 40.0 W
Krasnoyarsk	56 1 22.4	4 10 16.2	0 31 46.9 E
Yeniseysk	58 27 5.4	4 7 29.1	28 59.8 E
Bogotol	56 13 14.3	3 56 49.1	18 19.8 E
Mariinsk	56 12 19.1	3 49 38.0	11 8.7 E
Sudzhenka	6 49.0	3 43 19.1	4 49.8 E

73) We saw the following inscription on the post at the water gauge station: "2 Otdeleniye O.U.T.O.P.S. [2nd Department, Ob' Section, Tomsk Okrug, of Railroads], 15 August 1898. Lat. = 58°45'17" (?), long. west of Tomsk = 2°45'45" [i.e., 11m3s (?)].

74) According to Yu. Schmidt the latitude of the bell tower in Kolpashevo is $\varphi = 58°18'19".5$ and the $\lambda = 3^h30^m20^s.08$, determined by Lt. Commander Sidensner (Sidensner and Vagner Izv. Imp. R. Geogr. Obshch. - Bulletin of the Russian Imperial Geographic Society), vol. XIII, 1877, p. 73; the last magnitude, however, as indicated by Vagner, should be corrected for the error in the longitude of Yeniseysk city according to the formula 0.22 ΔE. We take the Vil'kitskiy's correction of - 9s.4 for the monastery in Yeniseysk city, therefore, according to Sidensner the longitude of Kolpashevo $= 3^h30^m19^s$.

On the post near the church in Kolpashevo we saw the inscription: "Start of the work by a detachment of Department II. Latitude N 58°18'19", longitude 2°5'15" west of Tomsk. 1898 July 25. O.U.T.O.P.S. (Ob' Section, Tomsk Okrug of Railroads)."

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

STAT

Table III. Daily Rate of the Chronometer

	Time interval	Daily rate in transit	Daily rate at stops	
1900				
	d			
In Tomsk before departure.	1.0		$-1^{s}.3$	
From Tomsk to Narym.	3.0	$+0^{s}.4$		
From Narym to Kolpashevo	5.0	-0. 1		
In Kolpashevo.	2.5		+0. 7	In calculating the longitude, from Kolpashevo to Kolmakovo for 4.9 days we took $+ 0^{s}.75$.
From Kolmakovo to M. Panovo. . . .	10.6	0.84		This magnitude was used in calculating the magnitude of B. Panovo.
In M. Panovo	1.5		1. 0	
	3.0		0. 5	
	4.0		0. 6	
From M. Panovo to Tomsk	25.8	1.44		This magnitude served for calculating all remaining longitudes in 1900.
At mouth of Ozernaya R.	1.4		0. 9	
At Gl. Stan.	1.5		1. 0	
In Tomsk after return.	19.5		1. 3	
1901 r.				
In Tomsk before departure:				
From 20 April to 18 May.	28.3		-0.49	
From 18 May to 26 May.	8.0		-0.25	

To Polomoshnaya.	17.1	0.14		
To Oyasha.	1.0	0. 4		
To Kargat.	5.5	0. 6		This magnitude was taken for calculating the longitude of Chik Station
To Kozhurla.	1.5	0. 2		
To Tebisskaya.	2.0	1. 4		
To Tatarskaya.	2.1	-0. 6		
To Kormilovka.	1.9	0. 9		
To Kurgan.	11.5	1. 0		$1^s.0$ was taken for calculating the longitudes of Mar'yanovka, Isil'-Kul', Petropavlovsk, and Makushino
To Shumikha.	2.7	2. 0		
To Krasnoyarsk	9.3	0. 8		
To Yeniseysk.	14.0	1. 3		$1^s.3$ was taken for calculating the longitudes of Kazachinskoye, Kolmogorovo, Nizhne-Shadrin, Garevka R. mouth, and Chernorechenskaya RR station
To Mariinsk.	8.0	1. 3		
To Sudzhenka	1.9	2. 0		
To Tomsk.	5.5	1. 2		
Obtained on the average for all time of the trip	d 84.0			$0^s.88$
In Tomsk after return:				
To 3 September.	15.6		1.76	The chronometer was carried beyond the Tom' River.
From 3 to 22 September. . . .	19.0		1.36	

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

STAT

Table IV. Calculated Longitude of Points

	Longitude from Tomsk (University)	Longitude east of Pulkovo λ_{Pulk}	
1900			
Kolmakovo..................	$0^h\ 5^m39^s.8$ W	$3^h32^m49^s.5$	
B. Panovo..................	4 24.2 W	3 34 5.1	Sidensner's determination with corrections gives $3^h34^m7^s$ 75)
M. Panovo (2nd location)...	5 35.2 W	3 32 54.1	
Yurty Shirokovy............	0 30.9 E	3 39 0.2	
Yurty Muleshkiny...........	2 58.4 E	3 41 27.7	
Yurty Berkunovy............	8 51.4 E	3 47 20.7	
Ozernaya R. mouth..........	11 10.0 E	3 49 39.3	Sidensner's determination with a correction gives $3^h49^m40^s$ 76)
Gl. Stan...................	12 54.6 E	3 51 23.9	
Kasovskaya R. mouth........	21 51.2 E	4 0 20.5	
1901			
Chik.......................	0 10 1.6 W	3 28 27.7	
Mar'yanovka................	49 17.2 W	2 49 12.1	
Isil'-Kul'.................	54 42.5 W	2 43 46.8	
Petropavlovsk..............	1 3 6.8 W	2 35 22.5	
Makushino..................	1 10 50.4 W	2 27 38.9	
Chelyabinsk................	1 34 4.9 W	2 4 24.4	
Kazachinskoye..............	0 33 19.4 E	4 11 48.7	
Kolmogorovo................	25 25.5 E	4 3 54.8	
Nizhne-Shadrino............	22 47.3 E	4 1 16.6	
Garevka R. mouth...........	23 19.8 E	4 1 49.1	
Chernorechenskaya..........	24 33.1 E	4 3 2.4	

75) Taking the $\varphi = 58°27'0"$ (we obtained $58°28'51"$) for this village according to his field survey, the author gives the longitude $53°28'9"$ dependent on the error in the latitude ($2.4\ d\varphi$) and dependent on the error in the longitude of Yeniseysk ($0.32\Delta E$). Therefore we calculated the error in the longitude from $d\varphi = 4'26"$, and the error from ΔE - equal $-0.32 \times 9^s.4 = -45"$ (See the note to Table II). And thus we obtain for the village Panovo (on the landing place) $53°28'9" + 4'26" - 45" = 53°31'50" = 3^h34^m7^s$.

76) The author obtained the longitude for the mouth of the Ozernaya River $= 57°27'20" = 3^h49^m49^s.3$ topographically (according to adjacent points); introducing the error in the longitude of Yeniseysk city ($-9^s.4$) in full, as indicated by the author for the adjacent point (the article by Sidensner and Vagner, pp. 72-73, Table S, No. 12), we obtain the longitude for the mouth $= 3^h49^m40^s$.

Table VI. Determinations of the Azimuth of the Mark

Location	Time by chronometer New style, civil days		Hildebrand, or Wild theodolite	From the Sun, or from Polaris	Number of sightings	Mean azimuth of the Sun	Correction to chronometer taken for calculating Mean chronometer time	Azimuth of the mark coSTAT ting from S to W, or E.	The means.	From S to W, or E	Remarks
	1900	h									
Narym, 1st place	24 Jun	5.3p.	W	Sun to W	4	104°	-9m58s1	45° 3'18"	45° 3'15"	E	
	25 "	8.7a.	"	" " E	4	-68	-9 58.1	3 12			
Narym, 2nd place	26 "	11.9a.	"	" " E	4	- 8	-9 59.0	82 41 42	82 41 34	E	Mean of all correction observations at the 1st and 2nd place taken as correction for the chronometer
	" "	2.8p.	"	" " W	4	55	-9 59.0	41 25			
Kolpashevo	29 "	4.9p.	H	" " W	8	86	-4 37.3	97 1 14	97 1 17	E	
	30 "	2.1a.	"	Polaris	4		-4 37.0	1 18			
	2 Jul	2.6p.	"	Sun to W	8	54	-4 35.3	1 19			
Kolmakovo (Rodionovo)	7 "	9.1a.	W	" " E	4	-61	-1 58.3	100 54 18	100 54 18	W	
B. Panovo	8 "	10.9a.	H	" " E	8	-26	-0 42.5	18 20 35	18 20 31	W	
	11 "	8.9p.	"	Polaris	8		-0 39.0	20 27			
M. Panovo, 1st location	18 "	2.7a.	"	Polaris	4		-1 44.5	81 52 22	81 52 19	E	Observ. by Polaris taken with double weight. Correct. to the chronom. taken accord. to stellar observ. during the night from 17th to the 18th.
	17 "	3.7p.	W	Sun to W	4	69	-1 44.8	52 12			
M. Panovo, 2nd location	22 "	2.9p.	H	" " W	8	56	-1 41.8	84 46 59	84 46 58	E	Correct. to the chron. taken for both azimuths accord. to solar observ. of same day.
	22 "	8.3p.	"	Polaris	6		-1 41.6	46 57			
Yurty Muleshkiny	29 "	4.2p.	W	Sun to W	6	103		34 2 25	34 2 25	W	The azimuth calcul. accord. to zenith dist. from the center of the sun measured indirectly.
Ozernaya R. mouth	3 Aug	10.2a.	H	" " E	8	-34	15 16.5	155 23 35	155 23 35	E	
Gl. Stan	" "	10.2a.	"	" " E	8	-33	17 4.4	140 45 12	140 45 12	E	Correct. to the chron. taken accord. to previous stellar observations.
	6 "	0.6p.	"	" " W	8	16	17 5.5	45 13			Correct. to the chron. taken accord. to solar observations.
	1901										
Polomoshnaya	12 Jun	5.5p.	W	" " W	4	98	4 16.3	148 32 58	148 32 56	W	
	13 "	7.0a.	"	" " E	4	-92	4 16.6	32 54			
Oyash	" "	3.4p.	"	" " W	8	70	-0 24.1	8 2 44	8 2 44	E	
	14 "	8.2a.	"	" " E	8	-77	-0 23.7	2 45			

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

Latitude Determinations

Table V.

STAT

Location	Time by chronometer New style, civil days.		Hildebrand, or Wild theodolite	By the sun or stars	Number of sightings	Mean hour angle	Mean zenith distance	Observed Latitude	Mean [latitude]	Latitude[1)] according to other data reduced to those points		Remarks
	1900									58°55'31"	According to Yu. Shmidt	
Narym (1st location)	25 June	h 12.5p.	W	Sun	6	m 17	35°	58°55'19"	58°18'15"9	58 18 15.7	According to Yu. Shmidt	
Kolpashevo	30 "	0.4a.	H	α Aquilae	4	-59	51	58 18 11.2		58 17 35	According to Sidensner	
	" "	1.0a.	"	Polaris	4		32	18 21.0				
	2 July	12.1p.	"	Sun	8	- 1	35	18 14.6	58 23 50.9	58 27 0	According to Sidensner	
B. Panovo	10 "	0.5a.	"	Polaris	8		31	58 28 53.8				Observations on 10 July with double weight
	8 "	12.1p.	"	Sun	12	- 2	36	28 45.0				
M. Panovo (1st location)	17 "	12.1p.	W	Sun	4	- 3	37	58 26 10.3	58 26 25.6			Observ. of the 17th not included in derivation of the mean. Reduction of observ. of 22 July to the 1st place would give 57°26'24"0.
	18 "	0.2a.	H	Polaris	4		31	26 24.9				
	" "	1.0a.	"	ζ Cygni	4	-20	29	26 27.9				
M. Panovo (2nd location)	22 "	12.1p.	"	Sun	12	- 4	38	26 22.6	58 27 59.2			
Yurty Shirokovy	29 "	0.0a.	"	Polaris	8		32	58 28 1.2				
	" "	0.7a	"	ζ Cygni	8	4	29	27 57.2				
Maksimoyarovskoye	31 "	12.1p.	"	Sun	8	10	40	58 39 55				
Yurty Berkunovy	1 Aug	0.8a.	"	Polaris	4		31	58 45 21	58 53 28.3	58 52 51	According to Sidensner	
Ozernaya R. mouth	1 "	11.7p.	"	Polaris	8		31	58 53 28.7				
	2 "	0.3a.	"	ζ Cygni	8	2	29	53 28.0	59 3 25.1			
Gl. Stan	4 "	11.7p.	"	Polaris	8		30	59 3 23.2				
	5 "	12.1p.	"	Sun	8	12	42	3 26.3				
	6 "	11.8a.	"	Sun	8	1	42	3 25.8				
Kasovskaya R. mouth	11 "	1.8p.	"	Sun	8	69	46	59 53 28				
	1901											
Chik	16 June	12.1p.	W	Sun	16	- 4	32	55 0 26		55 12 57.3	According to Yu. Shmidt	
Tatarskaya	24 "	1.2p.	"	Sun	12	40	33	55 12 58	54 58 55.3			
Mar'yanovka	29 "	11.6p.	"	Polaris	6		36	54 58 50.7				
	30 "	0.1a.	"	α Ophiuchi	8	16	42	59 0.5				
	30 "	0.8p.	"	Sun	10	- 1	32	58 54.6				
Isil'-Kul'	2 July	12.9p.	"	Sun	8	1	32	54 54 40.4				
Petropavlovsk	4 July	1.0p.	W	Sun	16	- 5	32	54 51 11.2				
Makushino	5 "	1.1p.	"	"	16	- 2	32	55 12 27.1				
Kurgan	8 "	1.2p.	"	"	12	- 4	33	55 26 13.5		55 26 13.6		
Shumikha	10 "	1.6p.	"	"	8	10	33	55 13 43.9		55 13 38.1		
Chelyabinsk	13 "	11.6p.	"	Polaris	8		35	55 8 23.2				
	14 "	0.1a.	"	α Ophiuchi	8	27	43	8 31.8	55 8 29.3			50% of weight added to the observ. of 14th by the sun
	" "	2.0p.	"	Sun	6	23	34	8 36.8				
Krasnoyarsk	20 "	11.7a.	"	"	8	15	35	56 1 23.0		56 1 22.4	According to Miroshnichenko	
Kazachinskoye	23 "	11.7a.	"	"	8	14	38	57 41 54.5	57 41 58.3			
	24 "	11.5a.	"	"	4	5	38	42 2.1				
Kolmogorovo	27 "	11.6a.	"	"	8	1	40	59 15 38.6				
Nizhne-Shadrino	30 "	11.7a.	"	"	8	5	41	59 54 57.0				
Mariinsk	11 Aug	11.8a.	"	"	8	- 2	41	56 12 18.4		56 12 19.1	According to Yu. Shmidt	

1) For sources see description of points. Sidensner's points in B. Panovo and at the Ozernaya R. mouth were not reduced to our points due to lack of indications, but, probably, were not too far away from ours; see remarks to Table II.

STAT

Table VI. Determinations of the Azimuth of the Mark (Cont'd)

Location	Time by chronometer New style, civil days		Hildebrand, or Wild theodolite	From the Sun, or from Polaris	Number of sightings	Mean azimuth of the Sun	Correction to chronometer taken for calculating. Mean chronometer time.	Azimuth of the mark counting from S to W, or E.	The means.	From S to W, or E	Remarks
	1901										
Chik	16 Jun " "	8.9a. 3.2p.	W "	Sun to E " " W	8 8	-68° 67	- 5m52s.2 - 5 52.0	19°47' 4" 47 17	19°47'10"	W	
Kargat	18 " 19 "	4.5p. 5.5p.	" "	" " W " " W	4 8	83 96	-14 28.0 -14 27.0	42 52 48 52 42	42 52 45	W	
Kozhurla	20 " 21 "	5.3p. 7.6a.	" "	" " W " " E	4 8	91 -90	-19 29.0 -19 28.4	159 24 41 25 26	159 25 11	W	During the observations on June 20 the sun peripheries were not seen clearly through the clouds; a 50% weight was added to the azimuth.
Tebis	22 "	3.7p.	"	" " W	8	68	-25 40.5	31 2 32	31 2 32	W	
Tatarskaya	24 " 25 " " "	4.1p. 3.6p. 4.1p.	" " "	" " W " " W " " "	4 4 4	73 66 73	-31 45.0 -31 44.0 -31 44.0	57 1 43 1 42 1 28	57 1 38	W	Observations on 25 June interrupted due to clouds.
Kormilovka	26 " 26 " 27 "	8.1a. 4.4p. 9.2a.	" " "	" " E " " W " " E	4 4 8	-86 76 -72	-39 9.5 -39 9.3 -39 9.2	62 48 30 48 36 48 38	62 48 35	W	
Mar'yanovka	29 " 30 "	4.1p. 10.3a.	" "	" " W " " E	8 8	69 -56	-14 59.9 -44 59.6	12 18 41 18 35	12 18 38	E	
Isil'-Kul'	1 Jul 2 "	5.5p. 7.7a.	" "	" " W " " E	6 8	87 -95	-50 22.5 -50 22.1	50 38 36 38 29	50 38 33	W	
Petropavlovsk	3 " 4 "	5.6p. 9.1a.	" "	" " W " " E	8 8	86 -79	-58 45.0 -58 44.6	152 56 38 56 21	152 56 30	W	
Makushino	5 " 5 "	9.8a. 5.4p.	" "	" " E " " W	8 8	-70 82	-1h 6 27.0 -1 6 26.7	98 6 14 6 14	98 6 14	W	
Kurgan	8 " 8 "	8.6a. 5.3p.	" "	" " E " " W	8 8	-88 78	-1 14 4.0 -1 14 3.8	152 39 12 39 12	152 39 12	W	
Shumikha	10 " 11 "	5.0p. 5.6p.	" "	" " W " " W	8 8	72 80	-1 22 8.4 -1 22 7.6	14 0 5 0 23	14 0 14	E	
Chelyabinsk	13 " 13 "	9.0a. 6.5p.	" "	" " E " " W	8 4	-86 90	-1 29 31.3 -1 29 31.0	95 15 37 15 51	95 15 44	W	
Krasnoyarsk	20 " " " 21 "	9.4a. 2.7p. 3.5p.	" " "	" " E " " W " " W	6 8 8	-46 66 76	0 36 26.3 36 26.5 36 27.0	68 13 50 13 42 14 4	68 13 52	W	
Kazachinskoye	24 " 24 "	[illegible]a. [illegible]p.	" "	" " E " " W	8 8	-82 32	38 3.9 38 4.0	1 55 41 55 36	1 55 39	E	
Kolmogorovo	27 " 28 "	3.8[illegible] [illegible].5a.	" "	" " W " " E	8 8	77 -75	30 14.4 30 14.9	152 0 28 0 45	152 0 36	E	
Nizhne-Shadrino	30 July	7.3a.	W	" " E	4	-78	27 39.6	168 20 14	168 20 14	W	
Garevka R. mouth	" "	6.7p.	"	" " W	4	113	28 12.7	2 13 15	2 13 15	W	
Yeniseysk	" 3 Aug "	8.3a. 3.3p.	" "	" " E " " W	8 8	-62 69	33 57.7 33 57.8	87 57 49 57 50	87 57 50	W	
Chernorechenskaya	7 "	9.3a.	"	" " E	8	-48	29 36.2	126 5 51	126 5 51	E	
Mariinsk	11 " " "	10.7a. 5.2p.	" "	" " E " " W	4 8	-27 90	16 17.0 16 17.2	161 13 27 13 34	161 13 30	E	
Sudzhenka	13 "	10.5a.	"	" " E	4	-30	10 2.0	61 16 53	61 16 53	E	
Tomsk, beyond the Tom' River	3 Sep 22 "	3.2p. 1.8p.	" "	" " W " " W	8 8	59 34	5 39.2 6 4.9	130 3 21 3 2	130 3 15	E	Correction to the chronometer was determined on 22 Sept only from the sun to the west. A 50% weight was added to the result.

VII. Results of Magnetic Observations

Table VII contains the magnitudes of the declination east therefore the minus signs have been omitted everywhere therein.

The moments, as in all subsequent tables, are given in the mean Tomsk time, but the longitude is given in the time interval for each place with respect to Tomsk. The double collimating error of the magnet (mark X upper minus mark X lower) was reduced twice for each observation of four sightings to the north pole [end] of the magnet, and once for two sightings (shortened observation).

Reduction of the observed declination, or of another magnetic element, to its mean annual magnitude for a given place was made as indicated by M. A. Rykachev[77] according to the two observatories - in Irkutsk and in Yekaterinburg [Sverdlovsk since 1924] longitudes of which differ by $2^h54^m44^s$, and thus the Tomsk time differs from that of Irkutsk by 1^h17^m, and from the Yekaterinburg time by 1^h37^m.

Correction a), found for the mean moment of each observation of an element at point A, should be added to the simultaneous declination at the given observatory in order to obtain its mean annual value there. In addition, before the found magnitude a) is added directly to the observed element at point A, correction b) should be found according to the mean daily rate in order to reduce the element observed at point A to that daily time [hour] which corresponds to the mentioned correction found at the observatory.

I did this and the other according to the data of the two observatories while being able to avail myself only of an interpolation of hourly magnetic elements maintained at the archives of the Nikolayevsk [Pugachev since 1918] Main Physical Observatory of which I had been graciously informed in part before they had been placed in the archives by the directors of the Irkutsk and Yekaterinburg [Sverdlovsk] Observatories. It should be observed that, judging by the selfrecording instruments in Pavlovsk, not once were any magnetic disturbances recorded during my observations.

As far as the mean daily variations of magnetic elements are concerned, which are necessary for the calculation of correction b), I drew two curves of the mean values for June, July, and August 1900, and separately for 1901,[78] for Yekaterinburg [Sverdlovsk] and Irkutsk.

The sum of corrections a) and b) used for reducing observed elements to the mean annual is given in the subsequent tables separately for Irkutsk and Yekaterinburg (Sverdlovsk). The difference between them, of course, gives in addition ready material for evaluating the reliability of the whole method for reducing the magnetic observations to the mean annual in case of a greater distance between the observation points and the observatory; certain deductions from this material are considered below.

77) l.c., p. 39

78) A station farther north than Yekaterinburg [Sverdlovsk], and particularly Irkutsk, should have been used for this purpose, but reductions according to two stations east and west of the observation point showed that the inaccuracy in the daily variation should be excluded to a certain extent because the correction for the daily variation is usually used with various signs in changing from the west to the east.

Table VIII contains observations and reductions, as previously, of the magnitudes of angles of dip. The magnitudes found at circle W and circle E are given separately; when at certain times in 1900 observations were made only at one position of circle W, the result was corrected by +0!5, obtained as the mean of all observations in 1900 (see above) [source p. 35].

In Table IX, are angles of deflection observed directly while measuring the horizontal component of intensity and the oscillation time of the magnet, as well as its temperatures, Δ - torsion magnitude, and S - daily run of the Waltham clock, or of the Erikson chronometer[79]; relative magnitudes of the magnetic moment of the magnet at 0° were calculated and are given for checking purposes, then the horizontal intensity values are given. Reductions according to the data of the observatory were made in relation to the mean moment for the whole series of the observations of intensity. Although the magnitudes of the intensity derived from observations of only one angle of deflection or of one oscillation time are less reliable in precision, they were introduced into the mean deductions for each point with the same weight as the remaining ones (see source p. 45).

In table X, means of all element values for each point[80] reduced to the yearly mean are compared separately for Irkutsk and Yekaterinburg [Sverdlovsk]. As far as the reductions to yearly magnitudes are concerned it appears (from the reference to Tables VII, VIII, and IX, but confined to 1901 only) that on the average the difference for each reduction of the declination with respect to Irkutsk and Yekaterinburg (Sverdlovsk) is equal to ± 1!25 (disregarding the sign), of the inclination to 0!44 and of the horizontal strength to 0.0007 gauss. Therefore it is understandable that if the desired precision of the result is to be above half of the reduced figures, e.g., if the precision of the yearly value of the declination is desired to be above 0!6, then it remains to increase only the number of separate determinations.

We can see from the data in Table X[81] that the mean of declination reductions with respect to one observatory for a single station differs from the mean of reductions with respect to both observatories by the magnitude of ± 0!4 in 1901 (obviously magnetically quieter than 1900 when the magnitude was up to ± 0!6), In addition, it can be seen from Table X that the declination east reduced to Irkutsk is on the average a little smaller than that reduced to Yekaterinburg [Sverdlovsk], in 1900 by 0!2, in 1901 by 0!5.

The reductions of the inclination and of the horizontal intensity agree better so that when the results from two observatories are compared we obtain a mean error of ± 0!2 for the inclination reductions at the given station, ± 0.0002 or 0.0003 gauss for the intensity.

It is interesting yet to consider the fluctuations of the yearly declination magnitude itself at each point after comparing separate observations reduced to

79) For the chronometer S = 0'. was taken everywhere.

80) Only a series of different declination observations in M. Panovo village was set out.

81) See the figures in the parantheses denoting the mean difference "Irkutsk - Yekaterinburg [Sverdlovsk]" disregarding the sign.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

any of the observatories. This time the fluctuation magnitude depends yet on the precision in the determination of the actual declination at the given place, and moreover on the peculiarity of this place with respect to its variations in the terrestrial magnetism (e.g. on the latitude).

It was shown that separate determinations of the deflection adjusted with respect to Irkutsk gave a mean deviation of ± 1!1 in 1900, and ± 0!9 in 1901, but the reductions to Yekaterinburg [Sverdlovsk] were better, giving the same precision to ± 0.8 of each measurement for both years[82].

For the inclination, the deviation of each yearly mean magnitude reduced either to Irkutsk or Yekaterinburg [Sverdlovsk] was ± 0!3, and for the horizontal intensity ± 0.0005 gauss.

Returning again to the determination of the declination, we repeat that a separate measurement of the declination, reduced to the yearly mean with respect to one observatory during the magnetically calmest year gave the accuracy to ± 0!8 or ±0!9; the precision of the declination reduced with respect to two observatories proved to be to ± 0!6 [in this case we disregard the varying distance of the observation point, and we speak of the position of the point as of the mean position of all points].

With 3 to 4 observations at each point the agreement of reductions with respect to both observations for the same year comes, on the average, to ± 0!4.

In Table X, the mean quantities of the reductions made separately with respect to Irkutsk and to Yekaterinburg [Sverdlovsk] were used for the declination. These quantities were intended for deriving the general mean, while taking into account the greater or smaller proximity of the point to one or the other observatory. However, it was clearly shown that this proximity had no particular significance. Also, the mean reductions to Irkutsk or to Yekaterinburg were, as a rule, quite close to each other. Therefore, only the stations from the Irtysh River, i.e., from Mar'yanovka to Chel'yabinsk, were selected, and the double weight was added to their reductions with respect to Yekaterinburg [Sverdlovsk] in relation to the reduction with respect to Irkutsk. The stations along the Yenisey River can be reduced equally well with respect to both observatories, therefore, simply the mean magnitudes were taken in all remaining cases.

82) Here we do not take into consideration the greater or smaller proximity of the station to one or the other observatory, but in any case, it cannot be said that even in 1901 a greater number of stations was nearer in longitude to Yekaterinburg [Sverdlovsk] than to Irkutsk. Regardless of the fact that the Yekaterinburg [Sverdlvosk] observatory is situated in a local magnetic anomaly it was not observed that even the points along the Yenisey River agreed better in reduction to Irkutsk than they did to Yekaterinburg [Sverdlovsk]. At stations located farther north it was clearly observed that reductions of declination observations made in the morning produce too large figures for the yearly declination; this means that the mean daily amplitude taken for such stations is smaller than that which should have been taken.

Double weights were added also to the reductions with respect to Yekaterinburg [Sverdlovsk] in deriving the final values of the horizontal intensity for the stations from the Irtysh River to Chelyabinsk; the inclination was taken everywhere simply as the mean.

Table XI, finally, contains all results of the magnetic and astronomic determinations.

Here the points are arranged in their geographical sequence, and not chronologically, and this is why a number was placed at each point indicating the number under which the description of the given point can be found in Chapter 5 of this study. In addition to the magnetic elements δ, J, and H, measured directly, which, as it is clear from the preceding, are given here in reductions to epochs corresponding to 1900.5 and 1901.5; the yearly mean values of the vertical component V, and of the entire [resultant] intensity T were also calculated.

It appears from the consideration of the declination in the stretch from Chelyabinsk to the Yenisey River that we are almost all the time in the area of easterly declination of 11° to 12°; this result is due to the fact that the Siberian RR runs here almost parallel to isogonic lines.

Then, regardless of the plain character of the Siberian lowland, there are in the Baraba Steppe frequent deviations of the magnetic needle by about 1/2° in comparison with the points in the nearest proximity. The distribution of the terrestrial magnetism is more irregular along the Yenisey River from Krasnoyarsk to Nizhne-Shadrino.

It has been shown clearly that the inclination increases with the longitude of the places on the same parallel. The resultant intensity increases similarly to the inclination (See Shumikha and Kargat stations). We found the greatest resultant intensity in Kazachinskoye village on the Yenisey, perhaps partly due to the local anomaly in the terrestrial magnetism and partly to the fact that this point lies closer than others to the East Siberian area of the highest magnetic intensity (See the map by F. Muller)[83].

The greatest vertical intensity was found on the right bank of the Yenisey at the mouth of the Garevka River; it is true that the difference between it and the value of the element in Nizhne-Shadrino village, the most northerly of all my points, located 12 miles only north of the Garevka River, is not great and perhaps is close to the precision limit of the measurements as magnetic determinations were made once only each time [for each element] in the Garevka River mouth.

83) F. Muller. "Study of Terrestrial Magnetism in East Siberia. Results of the Expeditions to Nizhnyaya Tunguzka and Olenek Rivers in 1873 and 1874. Zap. Imp. Rus. Geogr. Obshch. po Obshch., geogr. (Probable English expansion: Studies of the Imperial Russian Geographical Society, General Geography), Vol. 29, no. 1, 1895.

Table VII. Declination (East)

Location and its longitude from Tomsk	Mean Tomsk time		X upper minus X lower	Observed declination	Corrections to the yearly mean according to Irkutsk	Corrections to the yearly mean according to Yekaterinb.	Yearly mean value of inclination according to Irkutsk	Yearly mean value of inclination according to Yekaterinb.
Tomsk, beyond Tom' River	1900 11 Jun	11h47ma.	26![illegible]; 26.5 } 26!3	11°53!7	0!6	0!4	11°54!3	11°54!1
(0m.1 W)	" "	5 25 p.	27.3; 27.2 } 27.3	11 49.7	2.2	4.4	51.9	54.1
Narym, 1st location	24 "	7 21 p.	26.9; 27.2 } 27.1	14 26.8	0.5	1.0	14 27.3	27.8
(13m.6 W)	25 "	11 52 a.	27.1; 27.3 } 27.2	14 30.1	4.1	0.5	34.2	30.6
	" "	3 27 p.	27.4; 27.9 } 27.6	14 23.6	4.9	4.7	28.5	28.3
Narym, 2nd location	26 "	12 21 p.	26.4	14 28.1	2.1	2.2	14 30.2	14 30.3
(13m.6 W)	" "	3 47 p.	26.5	14 26.7	3.4	5.4	30.1	32.1
Kolpashevo (8m.2 W)	28 "	7 39 p.	26.9	13 38.4	-0.3	1.6	13 38.1	13 40.0
	29 "	10 45 a.	27.1; 27.0 } 27.0	13 42.9	-5.4	0.4	37.5	43.3
	" "	7 45 p.	28.1	13 38.7	0.6	1.4	39.3	40.1
	30 "	5 1 p.	27.5; 26.7 } 27.1	13 32.9	2.8	5.7	35.7	38.6
	1 Jul	9 1 a.	27.2; 26.7 } 27.0	13 45.0	-5.8	-4.4	39.2	40.6
	3 "	8 22 a.	27.1; 26.9 } 27.0	13 44.7	-5.5	-3.4	39.2	40.0
Kolmakovo (Rodionovo) (5m.7 W)	7 "	9 32 a.	26.4	14 3.6	-3.5	-2.7	14 0.1	14 0.9
B. Panovo (4m.4 W)	8 "	6 14 p.	27.1; 27.1 } 27.1	13 40.1	1.0	2.1	13 41.1	13 42.2
	9 "	4 8 p.	27.3; 26.6 } 27.0	13 39.3	4.4	5.0	43.7	44.3
	11 "	12 51 p.	26.6; 26.7 } 26.7	13 42.0	1.7	4.4	43.7	46.4
	14 "	3 18 p.	26.9; 26.9 } 26.9	13 37.5	4.1	4.7	41.6	42.2
M. Panovo, 1st location	16 "	11 44 a.	26.4; 27.4 } 26.9	13 52.5	1.4	1.3	13 53.9	13 53.8
(5m.6 W)	" "	4 55 p.	28.0	13 49.7	3.1	3.8	52.8	53.5
	17 "	8 16 a.	26.8; 27.0 } 26.9	14 1.1	-5.3	-5.2	55.8	55.9
M. Panovo, 2nd location	19 "	6 16 p.	27.1; 26.9 } 27.0	13 52.9	0.9	1.9	13 53.8	13 54.8
(5m.6 W)	20 "	9 40 a.	26.9; 27.4 } 27.2	14 0.5	-5.1	-2.9	55.4	57.6
	21 "	3 23 p.	27.0	13 51.9	3.1	3.5	55.0	55.4
	26 "	10 55 a.	27.6	13 53.8	1.0	1.6	54.8	55.4

STAT

STAT

Table VII (contd.)

Location and its longitude from Tomsk	Mean Tomsk time		Mean local time	X upper minus X lower	Observed declination	Corrections to the yearly mean according to Irkutsk	Corrections to the yearly mean according to Yekaterinb.	Yearly mean value of inclination according to Irkutsk	Yearly mean value of inclination according to Yekaterinb.
[Variable observations]	1900 27 Jun	7h52ma.	7h46ma.		13°58!8	-3!1	-3!9	13°55!7	13°54!9
		8 0 a.	7 54 a.		58.9	-3.4	-3.9	55.5	55.0
		33	8 27		59.4	-4.2	-3.8	55.2	55.6
		41	35		59.0	-4.4	-3.7	54.6	55.3
		54	48		58.8	-4.6	-3.4	54.2	55.4
		58	52		58.6	-4.6	-3.3	54.0	55.3
		9 5	8 59		57.9	-4.9	-3.2	53.0	54.7
		14	9 8		57.9	-5.0	-3.0	52.9	54.9
		20	14		58.3	-4.8	-2.9	53.5	55.4
		26	20		58.7	-4.4	-2.6	54.3	56.1
		32	26		58.3	-4.5	-2.5	53.8	55.8
		49	43		58.0	-3.8	-2.1	54.2	55.9
		54	48		58.2	-3.6	-1.9	54.6	56.3
		10 11	10 5		57.3	-3.0	-1.4	54.3	55.9
		20	14		57.2	-2.7	-1.2	54.5	56.0
		27	21		56.9	-2.3	-0.8	54.6	56.1
		37	31		56.5	-1.9	-0.5	54.6	56.0
		44	38		56.1	-1.6	-0.2	54.5	55.9
		11 32	11 26		53.9	0.2	0.9	54.1	54.8
		40	34		53.3	0.2	1.2	53.5	54.5
		47	41		53.2	0.4	1.4	53.6	54.6
		58 a.	52 a.		53.0	0.7	2.0	53.7	55.0
		12 10 p.	12 4 p.		52.5	1.0	2.5	53.5	55.0
		15	9		52.6	1.2	2.8	53.8	55.4
		46	40		51.6	2.4	3.7	54.0	55.3
		54	48		51.2	2.7	3.8	53.9	55.0
		1 4	12 58		51.0	3.1	4.3	54.1	55.3
		17	1 11		51.1	3.4	4.9	54.5	56.0
		26	20		50.7	3.7	5.4	54.4	56.1
		37	31		50.3	3.9	5.4	54.2	55.7
		48	42		50.6	4.2	5.9	54.8	56.5
		55	49		50.3	4.4	5.8	54.7	56.1
		2 0	1 54		50.6	4.6	5.7	55.2	56.3
		10	2 4		51.0	4.7	5.5	55.7	56.5
		17	11		51.2	4.7	5.4	55.9	56.6
		30	24		51.0	4.9	5.2	55.9	56.2
		41	35		51.3	4.8	4.9	56.1	56.2
		46	40		51.5	4.8	4.8	56.3	56.3
		55	49		51.0	4.8	4.8	55.8	55.8
Yurty Muleshkiny (3m.0 E)	29 "	3 23 p.		27!1	12 50.6	4.7	3.8	12 55.3	12 54.4
		3 44 p.			12 52.1	4.1	3.6	56.2	55.7
Ozernaya R. mouth (11m.2 E)	3 Aug	7 47 a.		27.6; 27.0 } 27!3	13 27.2	0.6	-4.2	13 27.8	13 23.0
	" "	9 23 a.		25.6	13 28.1	-2.4	-3.8	25.7	24.3
Glavnyy Stan	4 "	5 15 p.		27.3; 26.9 } 27.1	12 36.1	1.2	0.8	12 37.3	12 36.9
(12m.9 E)	6 "	8 25 a.		27.1; 27.2 } 27.2	12 42.8	-2.5	-4.0	40.3	38.8
		9 52 a.		27.4	12 40.6	0.1	-1.1	40.7	39.5
Polomoshnaya (0m.1 E)	1901 12 Jun	8h35ma.		27.3; 27.0 } 27.1	11 44.8	-2.5	-3.2	11 42.3	11 41.6
		0 23 p.		27.1; 27.4 } 27.2	11 40.3	2.2	3.1	42.5	43.4
		2 25 p.		27.0	11 38.3	4.5	3.4	42.8	41.7

Table VII (contd.)

Location and its longitude from Tomsk	Mean Tomsk time		X upper minus X lower	Observed declination	Corrections to the yearly mean according to Irkutsk	Corrections to the yearly mean according to Yekaterinb.	Yearly mean value of inclination according to Irkutsk	Yearly mean value of inclination according to Yekaterinb.
	1901							
Oyash (4^{m}.5 W)	13 Jun	6^{h}39^{m}p.	27'.6	11°40'.0	1.5	3.5	11°43'.5	11°43'.5
	14 "	11 6 a.	27.3, 27.3 } 27'.3	11 44.8	0.5	-0.7	45.3	44.1
		5 28 p.	27.2, 27.3 } 27.2	11 43.4	1.8	1.6	45.2	45.0
	15 "	8 39 a.	26.5, 26.8 } 26.6	11 47.2	-2.9	-3.4	44.3	43.8
Chik (10^{m}.0 W)	16 "	8 26 a.	27.4, 27.2 } 27.3	11 55.1	-3.1	-4.0	11 52.0	11 51.1
	" "	4 2 p.	27.8, 27.2 } 27.5	11 46.7	2.7	5.5	50.4	52.2
	" "	5 32 p.	27.3	11 47.9	0.9	3.8	48.8	51.7
	17 "	11 48 a.	27.6, 27.6 } 27.6	11 49.3	1.7	1.8	51.0	51.1
Kargat (18^{m}.6 W)	18 "	8 44 p.	26.8	12 33.6	0.7	1.0	12 34.3	12 34.6
	19 "	7 53 a.	26.8, 27.1 } 27.0	12 37.0	-6.1	-3.6	30.9	33.4
		9 55 a.	27.3	12 33.8	-3.8	-2.6	30.0	31.2
		2 55 p.	27.6, 26.9 } 27.3	12 28.0	6.0	4.5	34.0	32.5
Kozhurla (23^{m}.7 W)	20 "	7 54 p.	27.1, 27.3 } 27.2	12 5.5	0.3	2.2	12 5.8	12 7.7
	21 "	10 18 a.	26.6, 27.3 } 27.0	12 8.1	-3.6	-1.3	4.5	6.8
	" "	0 4 p.	26.4	12 4.3	1.0	1.5	5.3	5.8
Tebis (29^{m}.9 W)	22 "	10 2 a.	27.3, 27.5 } 27.4	12 48.5	-1.6	-1.9	12 46.9	12 46.6
		11 31 a.	27.6	12 46.0	1.6	-1.0	47.6	45.0
		5 50 p.	27.4, 27.3 } 27.3	12 43.8	2.3	2.3	46.1	46.1
	23 "	10 37 a.	26.6, 27.3 } 27.0	12 47.6	-2.0	-0.6	45.6	47.0
Tatarskaya (36^{m}.0 W)	24 "	11 42 a.	27.4	12 5.5	0.2	0.4	12 5.7	12 5.9
		5 35 p.	26.8, 26.7 } 26.8	12 4.2	1.8	3.3	6.0	7.5
		6 47 p.	26.9	12 6.5	-0.7	2.1	5.8	8.6
	25 "	10 21 a.	26.9, 27.5 } 27.2	12 10.5	-3.7	-2.9	6.8	7.6
Kormilovka (43^{m}.4 W)	26 "	10 36 a.	26.9, 27.3 } 27.1	12 36.0	-3.6	-2.0	12 32.4	12 34.0
	" "	6 52 p.	27.1, 27.4 } 27.3	12 33.6	0.6	1.4	34.2	35.0
	27 "	10 57 a.	27.2, 28.0 } 27.6	12 36.6	-1.4	-1.5	35.2	35.1
	" "	2 59 p.	27.5, 27.5 } 27.5	12 30.5	4.8	5.5	35.3	36.0
Mar'yanovka (49^{m}.3 W)	29 Jun	5 58 p.	27.1, 26.9 } 27.0	12 3.2	2.7	3.1	12 5.9	12 6.3
	30 "	11 44 a.	27.3, 27.0 } 27.1	12 4.8	0.2	1.3	[illegible]	6.1
	" "	6 20 p.	27.3, 27.2 } 27.3	12 6.7	1.2	1.3	7.9	8.0
Isil'-Kul' (54^{m}.7 W)	1 Jul	6 59 p.	27.7	12 28.2	0.3	-0.3	12 28.5	12 27.9
	2 "	10 7 a.	26.9, 26.8 } 26.9	12 33.1	-6.6	-3.0	26.5	30.1
	" "	11 29 a.	27.0	12 30.4	-2.6	-0.8	27.8	29.6

STAT

STAT

Table VII (contd.)

Location and its longitude from Tomsk	Mean Tomsk time		X upper minus X lower	Observed declination	Corrections to the yearly mean according to Irkutsk	Corrections to the yearly mean according to Yekaterinb.	Yearly mean value of inclination according to Irkutsk	Yearly mean value of inclination according to Yekaterinb.
	1901							
Petropavlovsk	3 Jun	0^{h}28^{m}p.	27'.2, 27.2 } 27'.2	12°25'.8	2'.3	-0.6	12°28'.1	12°25'.2
(1^{h}3^{m}.1 W)	" "	7 24 p.	27.6, 27.2 } 27.4	12 24.4	0.4	1.7	24.8	26.1
	" "	8 31 p.	27.3, 27.0 } 27.2	12 25.2	0.7	1.0	25.9	26.2
	4 "	11 29 a.	27.2, 27.7 } 27.5	12 27.3	-1.0	-1.7	26.3	25.6
Makushino (1^{h}10^{m}.8 W)	5 "	0 1 p.	27.2	12 27.5	0.0	-1.3	12 27.5	12 26.2
	6 "	11 5 a.	26.6	12 32.4	-6.3	-3.8	26.1	28.6
	" "	5 21 p.	27.1, 27.0 } 27.0	12 21.3	3.5	3.9	24.8	25.2
	" "	6 45 p.	26.9	12 21.6	1.7	3.1	23.3	24.7
Kurgan (1^{h}18^{m}.5 W)	8 "	10 44 a.	27.0, 27.3 } 27.2	12 23.4	-3.4	-2.5	12 20.0	12 20.9
		6 4 p.	27.3, 27.1 } 27.2	12 18.5	2.8	2.0	21.3	20.5
	9 "	9 9 a.	27.0, 27.1 } 27.0	12 24.8	-6.0	-2.7	18.8	22.1
Shumikha (1^{h}26^{m}.7 W)	10 "	9 36 a.	27.2, 27.2 } 27.2	11 52.0	-5.3	-3.6	11 46.7	11 48.4
	" "	4 5 p.	27.5, 27.5 } 27.5	11 42.8	4.8	6.0	47.6	48.8
	" "	8 9 p.	27.4, 27.4 } 27.4	11 48.6	0.1	0.0	48.7	48.6
	11 "	0 6 p.	27.2, 27.8 } 27.5	11 50.9	-0.6	-1.5	50.3	49.4
Chelyabinsk (1^{h}34^{m}.0 W)	12 "	7 56 p.	27.5, 27.2 } 27.3	12 5.2	0.7	0.7	12 5.9	12 5.9
	13 "	0 2 p.	26.9, 27.1 } 27.0	12 7.6	-3.1	-0.7	4.5	6.9
	" "	3 39 p.	26.8, 27.2 } 27.0	12 4.0	4.8	2.9	8.8	6.9
Krasnoyarsk (31^{m}.8 E)	20 "	6 42 a.	26.4, 27.5 } 26.9	9 3.9	-4.2	-3.4	8 59.7	8 60.5
		10 15 a.	27.0, 27.3 } 27.1	8 59.0	0.4	-1.8	59.4	57.2
		1 50 p.	26.9, 27.2 } 27.0	8 54.1	4.0	3.4	58.1	57.5
	21 "	10 21 a.	27.3, 27.3 } 27.3	9 0.6	-2.0	-0.5	58.6	60.1
	" "	10 47 a.	27.0, 27.7 } 27.4	9 0.0	0.0	0.5	60.0	60.5
	" "	2 12 p.	27.8, 27.6 } 27.7	8 54.3	4.1	3.8	58.4	58.1
Kazachinskoye (33^{m}.3 E)	23 "	9 14 a.	26.9, 26.8 } 26.9	10 14.1	-4.7	-1.8	10 9.4	10 12.3
	23 Jun	2 43 p.	27.2, 27.0 } 27.1	10 4.6	3.9	3.8	58.4	58.1
	" "	4 31 p.	27.4	10 6.7	1.8	2.6	8.5	8.4
	24 "	9 26 a.	26.8, 27.0 } 26.9	10 13.1	-1.3	-3.4	11.8	9.7
	" "	2 53 p.	27.3	10 5.4	3.5	3.2	8.9	8.6
Kolmogorovo (25^{m}.4 E)	27 "	4 42 p.	27.3, 26.7 } 27.0	10 24.6	1.8	3.2	10 26.4	10 27.8
	" "	7 17 p.	27.3, 27.5 } 27.4	10 25.3	0.4	0.9	25.7	26.2

Table VII (contd.)

Location and its longitude from Tomsk	Mean Tomsk time		X upper minus X lower	Observed declination	Corrections to the yearly mean according to Irkutsk	Yekaterinb.	Yearly mean value of inclination according to Irkutsk	Yekaterinb.
	1901							
Kilmogorovo (25ᵐ.4 E)	28 Jul	6ʰ59ᵐa.	27!1 / 27.3 } 27!2	10°32!3	-3!6	-4!5	10°28.7	10°27!8
	" "	10 35 a.	26.3	10 27.9	-1.4	0.8	26.5	28.7
Nizhn. Shadrino	29 "	6 5 p.	27.5	10 56.0	-0.2	1.0	10 55.8	10 57.0
(22ᵐ.8 E)	30 "	10 53 a.	26.7 / 27.2 } 27.0	10 56.5	-1.6	1.0	54.9	57.5
Garevka R. mouth (23ᵐ.3 E)	30 "	7 9 p.		11 13.5	0.1	1.7	11 13.6	11 15.2
Yeniseysk (29ᵐ.0 E)	3 Aug	9 41 a.	26.9 / 27.4 } 27.2	9 42.2	-1.7	-2.9	9 40.5	9 39.3
	" "	10 55 a.	26.3	9 38.6	2.7	-0.2	41.3	38.4
	" "	0 55 p.	27.1 / 27.6 } 27.3	9 33.3	5.2	3.2	38.5	36.5
		2 15 p.	27.4	9 32.0	5.4	4.5	37.4	36.5
Chernorechenskaya	7 "	10 3 a.	27.1 / 27.5 } 27.3	10 26.3	-1.5	-1.9	10 24.8	10 24.4
(24ᵐ.6 E)	" "	3 54 p.	27.5 / 27.3 } 27.4	10 21.4	2.4	3.3	23.8	24.7
	" "	5 5 p.	27.4	10 23.5	1.4	0.9	24.9	24.4
		5 51 p.	26.8	10 23.5	0.9	-0.2	24.4	23.3
Mariinsk (11ᵐ.1 E)	11 "	1 21 p.	27.3 / 27.5 } 27.4	11 13.5	2.1	4.5	11 15.6	11 18.0
	" "	2 35 p.	27.5	11 12.5	3.1	5.0	15.6	17.5
	" "	6 12 p.	27.2 / 27.0 } 27.1	11 15.2	-0.1	-0.9	15.1	14.3
Sudzhenka (14ᵐ.8 E)	12 "	5 13 p.	27.3 / 26.9 } 27.1	11 42.7	1.3	0.7	11 44.0	11 43.4
	13 "	11 14 a.		11 41.9	0.6	-0.3	42.6	41.7
Tomsk, beyond Tom' R.	3 Sep	11 24 a.	27.2 / 27.3 } 27.2	11 54.7	3.3	0.9	11 58.0	11 55.6
(0ᵐ.1 W)	" "	1 30 p.	27.3	11 51.9	4.1	4.9	56.0	56.8
		5 11 p.	27.3 / 27.2 } 27.2	11 56.2	0.9	1.1	57.1	57:3
	22 "	10 5 a.	26.9 / 27.5 } 27.2	12 1.2	-1.6	-2.7	11 59.6	11 58.5
	" "	11 3 a.	26.3 / 26.7 } 26.5	11 58.7	-0.6	-0.5	58.1	58.2
	" "	2 27 p.	26.9 / 27.0 } 27.0	11 56.0	2.1	4.0	58.1	60.0
	" "	4 21 p.	26.8	11 57.9	1.4	1.3	59.3	59.2

Table VIII. Inclination

Location and its longitude from Tomsk	Mean Tomsk Time		Circle W	Circle E	Mean Tomsk Time	Mean Inclination	Correction to yearly mean according to Irk.	Yekat.	Yearly mean inclination according to Irk.	Yekat.
	1900									
Tomsk, beyond Tom' R. (0ᵐ.1 W)	17 Jun	2ʰ33ᵐp.	72°29' 6"		2ʰ37ᵐ p.	72°29'6" 84)	0!8	0!0	72°30!4	72°29!6
		2 42	72 29 10	72°29'39"						
	" "	4 9 p. 21	72 29 18		4 15 p.	72 29.5	1.3	0.6	30.8	30.1
Narym, 1st location (13ᵐ.6 W)	25 "	2 5 p.	73 59 1		2 7 p.	73 59.6 84)	1.0	0.2	74 0.6	73 59.8
	" "	2 9 34	73 59 18	73 59 54	2 38 p.	73 59.7	0.9	0.7	0.6	74 0.4
		43	59 32							
2nd location (13ᵐ.6 W)	26 "	1 31 p. 40 47	74 0 28 1 26 2 58							
		2 56 2		74 0 54 74 3 33	1 46 p.	74 1.9	0.8	0.6	74 2.7	74 2.5
Kolpashevo (8ᵐ.2 W)	29 "	2 24 p. 30	73 37 18 36 13		2 37 p.	73 38.1	0.7	-0.2	73 38.8	73 37.9
		41 45 49		73 39 27 38 6 40 40						
	30 "	6 50 p. 54	73 37 55 37 18		7 0 p.	73 37.8	0.3	0.7	38.1	38.5
		7 7 11		73 38 12 37 55						
	1 Jul	11 34 a. 39	73 38 38 38 52		11 42 a.	73 38.5	-0.9	-0.2	37.6	38.3
		47 50		73 37 55 38 26						
	3 "	10 26 a. 37	73 37 33 39 54		10 44 a.	73 38.8	-0.9	-0.3	37.9	38.5
		11 51 1		73 39 51 38 4						
B. Panovo (4ᵐ.4 W)	9 "	6 6 p. 12	73 51 5 50 27		6 27 p.	73 51.8	1.0	0.6	73 52.8	73 52!4
		39 51		73 52 22						
	11 "	2 40 p.	73 53 19 50 49		2 43 p.	73 50.2 84)	0.3	0.2	50.5	50.4
	14 "	6 46 4 p. 12 18	73 48 40 48 37	73 52 6 51 32	6 12 p.	73 50.2	0.9	1.3	51.1	51.5
M. Panovo, 1st location (5ᵐ.6 W)	16 July	5 42 p. 55	73 43 49 44 5		5 54 p.	73 44.3	1.0	0.6	73 45.3	73 44.9
		6 3 6		73 43 55 45 31						
	17 "	2 11 p. 15	73 45 6 45 9		2 20 p.	73 44.8	0.8	0.6	45.6	45.4
		26 29		73 44 38 44 26						

84) Added 0!5 to Circle W (See p. 77).

STAT

Table VIII. Inclination (cont'd)

Location and its longitude from Tomsk	Mean Tomsk Time	Circle W	Circle E	Mean Tomsk Time	Mean inclination	Correction to yearly mean according to Irk.	Correction to yearly mean according to Yekat.	Yearly mean inclination according Irk.	Yearly mean inclination according Yekat.
	1900								
M. Panovo, 2nd location. (5.6m W)	19 Jul 7h42m p. 8 1 8 15 19	73°43'27" 44 30	73°47' 1 46 16	8h 0m p.	73°45'.3	0'.4	0'.6	73°45'.7	73°45'.9
	20 " 1 15 p. 19 36 40	73 46 8 46 53	73 46 20 45 15	1 27 p.	73 46.1	-0.4	0.1	45.7	46.2
	26 " 2 50 p. 53 3 5 12	73 46. 1 46 23	73 46 10 47 40	3 1 p.	73 46.6	0.1	0.0	46.7	46.6
	1901								
Polomoshnaya (0.1m E)	12 Jun 11h.9m a. 25	72 0 8	71 55 0	11 17 a.	71 57.6[85]	-0.5	-0.3	71 57.1	71 57.3
Oyash (4.5m W)	14 " 1 31 p. 34 43 48	71 42 41 41 8	71 41 15 39 45	1 40 p.	71 41.2	-0.5	-0.5	71 40.7	71 40.7
	" " 4 39 p. 48	71 41 11	71 40 24	4 44 p.	71 40.8	-0.4	-0.4	40.4	40.4
Chik (10.0m W)	16 " 11 19 a. 11 29 39	71 14 18 13 28	71 16 2 13 3	11 29 a.	71 14.2	-0.9	-1.0	71 13.3	71 13.2
	17 " 10 59 a. 11 2 9 19	71 12 57 14 58	71 14 36 14 7	11 9 a.	71 14.2	-1.3	-1.3	12.9	12.9
Kargat (18.6m W)	19 " 11 6 a. 11 22 25	71 15 59 17 25	71 13 48 16 27	11 15 a.	71 15.9	-0.4	-0.8	71 15.5	71 15.1
	" " 1 49 p. 58	71 16 46 17 2	71 16 7 16 24	1 54 p.	71 16.6	0.5	-0.4	17.1	16.2
Kozhurla (23.7m W)	21 Jun 9 16 a. 26 35 39	70 50 22 49 52	70 50 33 47 53	9 28 a.	70 49.7	0.6	0.7	70 50.3	70 50.4
Tebis (29.9m W)	22 " 0 11 p. 18 25 29	70 50 14 53 43	70 50 32 52 41	0 20 p.	70 51.8	-0.4	-1.0	70 51.4	70 50.8
	" " 2 36 p. 2 50	70 49 43 52 46	70 51 20	2 43 p.	70 51.3	0.3	-0.1	70 51.6	51.2

85) Due to an oversight the large difference between Circle W and Circle E was not noticed, and therefore the observation was not repeated.

STAT

Table VIII. Inclination (cont'd)

Location and its longitude from Tomsk	Mean Tomsk Time		Circle W	Circle E	Mean Tomsk Time	Mean inclination	Correction to yearly mean according to Irk.	Correction to yearly mean according to Yekat.	Yearly mean inclination according to Irk.	Yearly mean inclination according to Yekat.
Tatarskaya (36^m.0 W)	1901 24 Jun	2^h 3^{m}p. 6 13 20	70°44'52" 42 13	70°41' 5" 41 21	2^{h}11^{m}p.	70°42'.4	0'.3	-0'.2	70°42'.7	70°42'.2
Kormilovka (43^m.4 W)	26 "	5 42 p. 46 53 58	70 32 2 33 2	70 31 3 31 38	5 50 p.	70 32.2	0'.3	0.2	70 32.5	70 32.4
	27 "	0 42 p. 46 55 58	70 28 21 70 31 53 32 13 32 30		0 44 p.	70 30.1	0.3	-0.3	30.4	29.8
	" "	1 10 p. 15		70 30 12 31 13	1 5 p.	70 31.5	0.3	-0.1	31.8	31.4
Mar'yanovka (49^m.3 W)	29 "	7 17 p. 21 29 33	70 5 56 6 56	70 7 56 6 46	7 25 p.	70 6.9	1.0	0.8	70 7.9	70 7.7
	30 "	1 36 p. 39 47 52	70 6 5 6 53	70 12 23 9 23	1 40 p.	70 8.7	0.3	-0.6	9.0	8.1
Isil'-Kul' (54^m.7 W)	1 Jul	8 19 p. 29 36 44	69 52 20 54 50	69 51 48 52 0	8 32 p.	69 52.7	-0.5	-0.1	69 52.2	69 52.6
Petropavlovsk (1^{h}3^m.1 W)	3 "	2 30 p. 39 45 51	69 34 17 32 32	69 30 13 32 8	2 40 p.	69 32.3	-0.1	-0.6	69 32.2	69 31.7
	4 "	10 28 a. 32 40 48	69 30 40 32 17	69 34 8 33 39	10 38 a.	69 32.7	-0.6	-0.9	32.1	31.8
Makushino (1^{h}10^m.8 W)	6 "	0 4 p. 10 21 24	69 41 55 42 3	69 42 41 42 38	0 14 p.	69 42.3	-1.0	-0.6	69 41.3	69 41.7
	" "	1 13 p. 28	69 39 54	69 43 43	1 20 p.	69 41.8	-0.4	-0.3	41.4	41.5
Kurgan (1^{h}18^m.5 W)	8 Jul	0 30 p. 34 40 44	69 44 6 69 43 9	69 42 48 43 6	0 37 p.	69 43.3	-1.0	-1.2	69 42.3	69 42.[illegible]
Shumikha (1^{h}26^m.7 W)	10 "	11 18 a. 25 36 41	69 18 54 20 14	69 20 47 20 32	11 30 a.	69 20.1	-0.9	-0.7	69 19.2	69 19.4
	11 "	1 38 p. 58 2 6 9	69 19 30 20 36	69 20 19 19 13	1 54 p.	69 19.9	-0.1	-0.4	19.8	19.5
Chelyabinsk (1^{h}34^m.0 W)	13 "	1 35 p. 39 50 2 5	69 29 35 29 32	69 29 12 28 44	1 50 p.	69 29.3	-1.5	-0.5	69 27.8	69 28.8

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

Table VIII. Inclination (cont'd)

Location and its longitude from Tomsk	Mean Tomsk Time		Circle W	Circle E	Mean Tomsk Time	Mean inclination	Correction to yearly mean according to Irk.	Correction to yearly mean according to Yekat.	Yearly mean inclination according to Irk.	Yearly mean inclination according to Yekat.
	1901									
Chelyabinsk ($1^h34^m.0$ W)	14 Jul	0^h38^mp. 44	69°27' 9" 28 30							
		54 59		69°27'46" 27 49	0^h48^mp.	69°27'.8	-1'.2	-0'.6	69°26'.6	69°27'.2
Krasnoyarsk ($31^m.8$ E)	20 "	0 25 p.	72 40 53							
	21 "	0 38 45 55 p.	72 41 10 42 5	72 41 7	0 32 p.	72 41.0	-1.3	-0.3	72 39.7	72 40.7
		1 12 15		72 40 28 40 34	1 0 p.	72 41.1	-0.7	0.3	40.4	41.4
Kazachinskoye ($33^m.3$ E)	23 "	11 9 a.	74 32 14							
	24 "	10 55 a.	74 33 4	74 32 20	11 9 a.	74 32.3	-1.1	-0.9	74 31.2	74 31.4
		11 6		74 32 29	11 0 a.	74 32.8	-1.4	-0.8	31.4	32.0
Kolmogorovo ($25^m.4$ E)	27 "	6 21 p.	75 29 19							
		35		75 29 8	6 28 p.	75 29.2	-0.5	0.1	75 28.7	75 29.3
Nizhne-Shadrino ($22^m.8$ E)	29 "	7 45 p.	75 44 34							
				75 43 51	7 45 p.	75 44.2	-0.6	0.6	75 43.6	75 44.8
	30 "	0 42 p.	75 44 57							
		1 4		75 44 45	0 53 p.	75 44.8	-0.7	0.1	44.1	44.9
Garevka R. mouth	30 "	7 45 p.	75 43 27							
				75 44 49	7 45 p.	75 44.1	-0.4	0.6	75 43.7	75 44.7
Yeniseysk ($29^m.0$ E)	3 Aug	11 35 a.	74 58 50							
		47		74 59 16	11 41 a.	74 59.0	-0.8	-0.9	74 58.2	74 58.1
Chernorechenskaya ($24^m.0$ E)	7 "	0 21 p.	73 1 50							
		33		73 1 52	0 27 p.	73 1.9	-0.5	0.0	73 1.4	73 1.9
Bogotol ($18^m.3$ E)	9 "	11 34 a.	72 41 16							
		43		72 41 12	11 39 a.	72 41.2	-0.9	-0.3	72 40.3	72 40.9
	" "	3 30 p.	72 40 0							
		38		72 40 2	3 34 p.	72 40.0	-0.3	0.2	39.7	[illegible]
Mariinsk ($11^m.1$ E)	11 "	4 31 38 p.	72 46 49 46 47							
		46		72 46 26	4 38 p.	72 46.6	-0.2	0.2	72 46.4	72 46.8
Sudzhenka ($4^m.8$ E)	12 Aug	6 33 p.	72 22 7							
				72 21 35	6 33 p.	72 21.9	-0.3	0.2	72 21.6	72 22.1
Tomsk, beyond Tom' River ($0^m.1$ W)	3 Sep	2 12 p.	72 29 47							
	22 "	0 24 p.	72 31 35		2 17 p.	72 30.0	0.0	-0.1	72 30.0	72 29.9
		36		72 31 0	0 30 p.	72 31.3	-0.9	-0.7	30.4	30.6

Table IX. Horizontal Component of Intensity

Location and its longitude from Tomsk	Mean Tomsk time		v	T	τ or t	Δ	s	M_0	Mean Tomsk time	Horizontal component	Corrections to yearly mean according to Irk.	Corrections to yearly mean according to Yekat.	Yearly mean horizontal intensity according to Irk.	Yearly mean horizontal intensity according to Yekat.
	1900													
Tomsk, beyond Tom' R. ($0^m.1$ W)	17 Jun	5^h56^m p.	26°59'19"		28.95	14.9	0^s							
		6 12 p.		$3^s.4472$	28.31			19920	6^h11^m p.	1.7528	-15	- 7	1.7513	1.7521
		26	27 0 11		28.04									
Krasnyy Yar ($2^m.4$ W)	23 "	11 21 a.		3.5057	38.00		0		11 21 a.	1.706	- 5	9	1.706	1.707
Narym, 1st location ($13^m.6$ W)	24 "	7 45 p.		3.5969	23.97	11.5	0		7.45 p.	1.6046	- 9	-13	1.6037	1.6033
		8 43	29 55 30		20.67									
		9 7		3.5918	20.00			19933	8 55 p.	1.6048	- 9	-12	6039	6036
	25 "	4 0 p.	29 35 10		34.03		0							
		26		3.6091	33.10			19896	4 24 p.	1.6049	-10	- 7	6039	6042
		44	29 36 59		32.11									
2nd location ($13^m.6$ W)	26 "	0 37 p.	29 39 49		32.27	13.8	+25	19929	0 46 p.	1.6043	6	- 4	1 6049	1.6039
		55		3.6057	31.58									
	" "	4 21 p.		3.5990	29.04		+25							
		41	29 42 42		29.20			19943	4 41 p.	1.6063	-12	- 7	6051	6056
		5 0		3.5985	28.33									
Kolpashevo ($8^m.2$ W)	29	0 34 p.	29 2 22		25.88	12.5	+ 2							
		1 0		3.5564	25.87			19929	0 56 p.	1.6436	6	6	1.6442	1.6442
		18	28 58 57		26.45									
	30 "	5 35 p.	28 54 52		27.46		+ 2	19920	5 44 p.	1.6468	- 9	-15	6459	6453
		53		3.5555	27.32									
	1 Jul.	9 37 a.	28 54 4)		29.66	11.5	+ 2							
		59		3.5602	29.30			19922	9 58 a.	1.6444	29	9	6473	6453
		10 16 a.	28 54 5		30.50			19923	10 17 a.	1.6442	26	9	6468	6451
		36		3.5634	31.73									
	3 "	8 54 a.	28 57 57		26.69	11.5	+ 2							
		9 13		3.5567	27.06			19922	9 13 a.	1.6452	22	8	6474	6460
		31	28 56 53		27.52									
Kolmakovo (Rodionovo ($5^m.7$ W)	7 "	9 48 a.		3.5649	29.40				9 48 a.	1.640	-10	8	1.639	1.641
B. Panovo ($4^m.4$ W)	8 "	6 55 p.	29 16 48		20.77		+10							
		7 21		3.5609	21.54			19915	7 8 p.	1.6353	-10	- 3	1.6343	1.6350
	" "	7 44		3.5594	20.93									
		8 3 p.	29 15 57		21.47			19920	7 53 p.	1.6356	-10	- 8	6346	6348
	9 "	4 40 p.	29 19 43		18.44	14.8	+10							
		5 5		3.5531	17.49			19930	4 52 p.	1.6368	-18	- 2	6350	6366
	11 "	1 18 p.	29 16 54		21.61	14.8	+10							
		38		3.5613	21.56			19919	1 28 p.	1.6346	1	0	6347	6346
	14 "	4 3 p.	29 14 20		22.50		+10							
		4 24		3.5595	20.72			19915	4 23 p.	1.6358	-17	- 5	6341	6353
		4 42	29 15 34		20.94									
M. Panovo, 1st location ($5^m.6$ W)	16 July	0 15 p.	29 11 44		24.80		+ 6		0 26 p.	1.6352	8	12	1.6360	1.6364
		37		3.5651	24.99			19918						
	17 "	8 54 a.	29 20 28		17.38		+ 6		9 15 a.	1.6356	17	13	6373	6369
		9 17		3.5550	16.84			19916						
		33	29 21 33		17.62									

STAT

Table IX. Horizontal Component of Intensity (cont.d)

Location and its longitude from Tomsk	Mean Tomsk time		v	T	τ or t	Δ	s	M_0	Mean Tomsk time	Horizontal component	Corrections to yearly mean according to Irk.	Corrections to yearly mean according to Yekat.	Yearly mean horizontal intensity according to Irk.	Yearly mean horizontal intensity according to Yekat.
M. Panovo, 2nd location (5m.6 W)	1900 19 Jul	6h47m p. 7 7	29° 9'53"	3s.5585	22°.62 22.89		+6s	19906	6h57m p.	1.6392	-8	-7	1.6384	1.6385
	20 "	10 14 a. 34 52	29 8 39	3.5668	25.95 27.28 25.75	13°.7	+6	19917	10 33 a.	1.6363	28	16	6391	6379
	21 "	3 48 p. 4 6	29 9 5 29 12 20	3.5596	21.83 20.77		+6	19903	3 57 p.	1.6369	-4	-2	6365	6367
	26 " "	11 20 a. 0 10 p.	29 8 9 29 6 49	3.5677	26.81 27.24 26.66	13.5	+6	19907	11 20 a. 0 19 p.	1.6350 1.6357	19 11	14 3	6369 6368	6364 6360
Yurty Muleshkiny (3m.0 E)	29 "	3 38 p.		3.5945	27.29		+14		3 38 p.	1.613	-12	-14	1.612	1.612
Ozernaya R.mouth (11m.2 E)	3 Aug "	8 26 a. 8 44 a. 8 56 a.	30 39 21	3.6558 3.6566	27.36 27.62 27.74	9.9	+25	19893	8 35 a. 8 56 a.	1.5595 1.5586	9 12	13 15	1.5604 5598	1.5608 5601
Glavnyy Stan (12m.9 E)	4 " 6 "	5 49 p. 6 7 8 49 a. 9 6 24	30 12 13 30 14 5 30 14 32	3.6322 3.6321	26.79 26.29 27.98 28.42 28.23	11.7	+38 +35	19871 19905	5 58 p. 9 6 a.	1.5795 1.5792	-9 8	4 14	1.5786 5800	1.5799 5806
Nizhne-Shadrino (22m.8 E)	12 "	4 47 a. 5 41 a.	33 7 12	3.7485	11.12 11.74	10.2	+30	19861	5 14 a.	1.4698	-6	-10	1.4692	1.4688
Polomoshnaya (0m.1 E)	1901 12 Jun "	9h 5m a. 9 38 54 1 49 p. 2 7 p.	26 13 29 26 12 47 26 9 4	3.4063 3.4068	19.41 17.70 19.60 19.09	13.2	0s	19753 19742	9 34 a. 1 58 p.	1.7965 1.7988	17 -4	13 -16	1.7982 7984	1.7978 7972
Oyash (4m.5 W)	14 " " 15 "	11 30 a. 48 a. 0 6 p. 5 46 p. 6 4 6 19 9 2 a. 20	25 40 11 25 39 45 25 41 30 25 44 37 25 39 22	3.3899 3.3845 3.3936	20.18 26.77 26.93 27.06 24.18 22.40 21.75 28.91 29.32	12.5	"	19768 19759 19771	11 48 a 6 5 p. 9 11 a.	1.8241 1.8252 1.8227	8 3 21	15 -4 13	1.8249 8255 8248	1.8256 8248 8240
Chik (10m.0 W)	16 Jun " 17 "	9 54 a. 10 15 31 4 28 p. 49 0 9 p. 25 41	25 14 26 25 15 30 25 9 50 25 6 37 25 7 45	3.3630 3.3558 3.3694	25.72 25.25 25.02 26.46 25.58 31.92 31.38 30.90	13.4	"	19751 19771 19748	10 14 a. 4 38 p. 0 25 p.	1.8528 1.8592 1.8536	31 -10 26	27 -13 16	1.8559 8582 8562	1.8555 8579 8552
Kargat (18m.6 W)	19 " "	8 54 a. 9 11 25 3 16 p. 38	25 9 19 25 6 10 25 1 15	3.3690 3.3721	27.57 29.57 30.62 33.87 33.14	10.6	"	19727 19726	9 10 a. 3 27 p.	1.8539 1.8551	8 -12	7 2	1.8547 8539	1.8546 8553

Table IX. Horizontal Component of Intensity (cont'd)

Location and its longitude from Tomsk	Mean Tomsk time		v	T	τ or t	Δ	M_o	Mean Tomsk time	Horizontal component	Corrections to yearly mean according to Irk.	Corrections to yearly mean according to Yekat.	Yearly mean horizontal intensity according to Irk.	Yearly mean horizontal intensity according to Yekat.	STAT
Kozhurla (23^m.7 W)	1901 20 Jun	8^{h}17^{m}p.	24°56'52"		15°.78	11°.7	19714	8^{h}26^{m}p.	1.8829	-14	-14	1.8815	1.8815	
		36		3^s.3269	14.31									
	21 "	10 39 a.	24 54 48		17.15		19720	10 48 a.	1.8840	- 2	- 3	8838	8837	
		57 a.		3.3311	19.35									
	" "	11 23 a.		3.3351	21.10		19711	11 30 a.	1.8826	- 1	0	8825	8826	
		37	24 50 7		21.76									
Tebisskaya (29^m.9 W)	22 "	10 25 a.	25 9 30		21.00	12.4								
		43		3.3534	19.24		19716	10 43 a.	1.8594	26	15	1.8620	1.8609	
		11 0	25 15 37		19.08									
	" "	6 10 p.	25 10 48		20.88									
		27		3.3526	20.32		19724	6 27 p.	1.8607	- 7	- 6	8600	8601	
		43	25 13 7		19.18									
	23 "	10 58 a.	25 16 45		17.66			10 58 a.	1.8583	20	13	8603	8596	
Tatarskaya (36^m.0 W)	24 "	0 10 p.	25 13 22		14.57			0 10 p.	1.8642	13	18	1.8655	1.8660	
	" "	5 56 p.	25 10 26		14.56	12.8								
		6 15		3.3404	13.46		19704	6 14 p.	1.8675	- 9	- 7	8666	8668	
		31	25 12 45		12.87									
	25 "	10 49 a.	25 12 30		14.10									
		11 9		3.3410	13.99		19714	11 8 a.	1.8666	12	9	8678	8675	
		24	25 11 56		15.31									
Kormilovka (43^m.4 W)	26 "	10 58 a.	25 4 50		19.75	12.0								
		11 18		3.3480	19.13		19708	11 17 a.	1.8658	10	11	1.8668	1.8669	
		34	25 8 15		19.57									
	" "	7 11 p.	25 4 19		19.56		19703	7 20 p.	1.8681	- 4	- 6	8677	8675	
		29		3.3455	18.42									
	27 "	11 18 a.	25 5 11		20.40	12.5								
		37		3.3504	21.73		19708	11 36 a.	1.8663	7	16	8670	8679	
		54	25 3 19		22.30									
	" "	3 21 p.	24 59 56		23.35		19704	3 29 p.	1.8683	-13	- 9	8670	8674	
		37		3.3518	24.21									
Mar'yanovka (49^m.3 W)	29 "	6 19 p.	24 32 56		27.59									
		36		3.3339	26.42		19684	6 35 p.	1.8931	-18	- 8	1.8913	1.8923	
		50	24 34 30		25.68									
	30 "	0 5 p.	24 36 45		28.40		19703	0 15 p.	1.8889	5	24	8894	8913	
		24		3.3383	28.51									
	" "	6 49 p.	24 32 26		28.35	13.5	19683	6 58 p.	1.8923	1[illegible]	- 4	8924	8919	
		7 7		3.3355	27.16									
Isil'-Kul' (54^m.7 W)	1 Jul	7 17 p.	24 20 18		28.11	10.9	19690	7 26 p.	1.9082	1[illegible]	4	1.9083	1.9086	
		36		3.3222	28.11									
	2 "	10 26 a.	24 22 34		27.25									
		44		3.3223	27.12		19692	10 43 a.	1.9066	14	11	9080	9077	
		11 0	24 21 41		28.14									
Petropavlovsk (1^{h}3^m.1 W)	3 "	0 53 p.	24 13 49		22.98	11.4								
		1 16		3.3028	23.04		19697	1 14 p.	1.9234	13	21	1.9247	1.9255	
		30	24 12 43		24.49									
		7 54 p.	24 11 26		25.56		19701	8 5 p.	1.9239	- 4	- 1	9235	9238	
		8 16		3.3040	25.11									
		11 54 a.	24 2 13		32.46									
		0 12 p.		3.3147	33.34		19687	0 11 p.	1.9239	12	29	.9251	9268	
		26	24 1 30		33.87									
Makushino (1^{h}10^m.8 W)	5 "	0 21 p.	24 23 30		36.18	14.1		0 21 p.	1.8936	23	27	1.8959	1.8963	
	6 "	10 30 a.	24 26 26		33.79			10 30 a.	1.8933	20	14	8953	8947	

Table IX. Horizontal Component of Intensity (cont'd)

Location and its longitude from Tomsk	Date	Mean Tomsk time	v	T	τ or t	Δ	M_0	Mean Tomsk time	Horizontal component	Corrections to yearly mean according to Irk.	Corrections to yearly mean according to Yekat.	Yearly mean horizontal intensity according to Irk.	Yearly mean horizontal intensity according to Yekat.
Makushino ($1^h10^m.8$ W)	1901 6 Jul	4^h28^m p.		$3^s.3401$	$36^s.57$								
		41	24°20'22"		37.98		19691	4^h42^m p.	1.8950	- 4	8	1.8946	1.8958
		57		3.3473	38.00								
	" "	6 12 p.		3.3449	36.25		19664	6 21 p.	1.8950	-10	6	8940	8956
		30	24 20 19		36.01								
	8 "	11 11 a.	24 37 30		31.49	11.9							
		32		3.3490	32.47		19689	11 30 a.	1.8833	20	27	1.8853	1.8860
		45	24 34 37		33.16								
	" "	6 24 p.	24 27 14		37.18								
		41		3.3547	37.71		19669	6 32 p.	1.8855	-11	1	8844	8856
	9 "	9 46 a.		3.3460	31.05		19679	9 46 a.	1.8858	8	5	8866	8863
		10 1	24 33 19		32.18								
Shumikha ($1^h26^m.7$ W)	10 "	9 58 a.	24 27 49		27.21	11.6							
		10 18		3.3296	27.22		19682	10 16 a.	1.8994	7	11	1.9001	1.9005
		31	24 26 47		28.04								
		8 26 p.	24 22 4		30.58								
		44		3.3322	30.20		19674	8 35 p.	1.9010	- 1	1	9009	9011
	11 "	0 28 p.	24 23 52		30.43								
		45		3.3335	31.02		19684	0 47 p.	1.8996	7	13	9003	9009
		58	24 24 4		30.89								
Chelyabinsk ($1^h34^m.1$ W)	12 "	8 17 p.	24 41 0		22.05	12.0							
		40		3.3308	21.41		19683	8 39 p.	1.8904	- 4	9	1.8900	1.8913
		56	24 41 30		21.60								
	13 "	0 23 p.	24 44 48		22.28								
		43		3.3316	20.31		19690	0 41 p.	1.8874	31	22	8905	8896
		55	24 44 52		20.43								
	" "	4 4 p.	24 42 56		19.86								
		21		3.3298	19.93		19676	4 12 p.	1.8903	2	5	8905	8908
Krasnoyarsk ($31^m.8$ E)	20 "	7 10 a.	26 29 25		18.18	13.5							
		32		3.4335	17.33		19685	7 30 a.	1.7740	14	9	1.7754	1.7749
		46	26 31 15		18.00								
	" "	3 23 p.	26 19 18		25.93								
		45		3.4433	25.58		19681	3 43 p.	1.7741	- 3	15	7738	7756
		58	26 21 45		25.82								
	21 "	11 9 a.	26 17 34		28.75			11 9 a.	1.7731	23	21	7754	7752
	" "	11 21 a.	26 17 34		29.10								
		40 a.		3.4502	29.78		19675	11 40 a.	1.7726	19	26	7745	7752
		0 0	26 16 19		30.40								
	" "	2 39 p.		3.4514	31.14			2 39 p.	1.7730	0	4	7730	7734
Kazachinskoye ($33^m.3$ E)	23 "	10 7 a.		3.6243	19.78	12.8	19683	10 14 a.	1.5952	19	19	1.5971	1.5971
		28	29 42 26		20.05								
	" "	5 10 p.		3.6236	20.31		19680	5 16 p.	1.5966	1	7	5967	5973
		22	29 40 0		20.36								
	24 "	9 50 a.	29 36 23		24.16								
		10 7		3.6303	23.40		19672	10 6 a.	1.5947	27	14	5974	5961
		21	29 37 52		22.96								
Kolmogorovo ($25^m.4$ E)	27 "	5 9 p.	31 48 7		21.97	14.8							
		27		3.7433	21.40		19676	5 26 p.	1.4975	- 5	4	1.4970	1.4979
		42	31 49 49		20.93								
	27 July	7 45 p.		3.7426	19.61			7 45 p.	1.4963	1	- 1	4964	4962
	28 "	9 35 a.	31 44 15		25.52								
		54		3.7507	25.40		19674	9 54 a.	1.4959	15	17	4974	4976
		10 11	31 45 37		25.53								

Table IX. Horizontal Component of Intensity (cont'd)

Location and its longitude from Tomsk	Mean Tomsk time		v	T	τ or t	Δ	M_0	Mean Tomsk time	Horizontal component	Corrections to yearly mean according to Irk.	Yekat.	Yearly mean horizontal intensity according to Irk.	Yekat.
	1901												
Nizhne-Shadrino (22ᵐ.8 E)	29 Jul	6^h35^mp.	32° 32'26"		19ˢ.45								
		52		3ˢ.7753	18.65		19674	6^h43^mp.	1.4697	- 1	- 8	1.4696	1.4689
	30 "	11 12 a.	32 38 41		17.17								
		25		3.7751	17.18		19669	11 18 a.	1.4688	9	13	4697	4701
Garevka R.mouth (23ᵐ.3 E)	30 "	7 20 p.	32 34 45		15.88			7 20 p.	1.4717	- 2	- 1	1.4715	1.4716
Yeniseysk (29ᵐ.0 E)	3 Aug	10 3 a.	30 35 33		24.05	14.1							
		20		3.6855	24.17		19677	10 19 a.	1.5477	22	12	1.5499	1.5489
		35	30 35 41		24.48								
	" "	1 18 p.	30 30 37		26.11		19670	1 38 p.	1.5495	- 3	18	5492	5513
		58		3.6852	25.14								
	" "	3 50 p.	30 30 30		26.02			3 50 p.	1.5502	- 5	12	5497	5514
Chernorechenskaya (24ᵐ.6 E)	7 "	10 32 a.	26 58 23		31.65	13.5							
		48		3.4972	31.31		19667	10 47 a.	1.7277	12	19	1.7289	1.7296
		11 2	26 58 3		31.42								
	" "	4 24 p.		3.4954	31.31		19662	4 37 p.	1.7300	-12	8	7288	7308
		50	26 56 19		30.76								
	" "	5 26 p.		3.4918	28.37			5 26 p.	1.7296	- 7	8	7289	7304
Bogotol (18ᵐ.3 E)	9 "	9 57 a.	26 46 11		14.97	12.0							
		10 14		3.4461	14.98		19669	10 14 a.	1.7598	14	20	1.7612	1.7618
		31	26 46 37		15.22								
	" "	2 27 p.	26 40 30		18.67			2 27 p.	1.7613	- 4	3	7609	7616
Mariinsk (11ᵐ.1 E)	11 "	1 43 p.	26 43 52		26.80	6.9?							
		59		3.4705	27.08		19676	1 58 p.	1.7488	1	5	1.7489	1.7493
		2 11	26 43 15		26.86								
		6 37 p.		3.4663	23.18		19673	6 45 p.	1.7488	- 4	3	7484	7485
		53	26 48 11		22.85								
Sudzhenka (4ᵐ.8 E)	12 "	5 32 p.	26 24 11		21.60								
		50		3.4380	21.82		19680	5 49 p.	1.7753	- 6	1	1.7747	1.7754
		6 3	26 23 33		22.28								
	13 "	11 30 a.	26 18 56		27.24			11 30 a.	1.7737	10	10	7747	7747
Tomsk, beyond Tom' R. (0ᵐ.1 W)	3 Sep	11 52 a.	26 46 8		23.76	10.2							
		0 10 p.		3.4650	23.21		19674	0 8 p.	1.7501	- 2	21	1.7499	1.7522
		21	26 45 52		23.58								
	" "	4 25 p.	26 43 41		23.47								
		42		3.4622	23.51		19674	4 41 p.	1.7532	-11	-15	7521	7517
		55	26 42 53		23.42								
	22 "	11 25 a.	27 0 0		12.45	11.5							
		42		3.4523	12.27		19678	11 41 a.	1.7497	10	16	7507	7513
		55	26 59 4		13.74								
	" "	3 33 p.	26 53 34		15.87								
		48		3.4542	15.01		19666	3 48 p.	1.7519	6	-11	7525	7508
		4 3	26 54 26		14.55								

Table X. Results of Reduction of Magnetic Elements to Irkutsk and Yekaterinburg

a) Declination (east)

Location	No. of observations	To Irkutsk		To Yekaterinburg		Mean	Irk.-Yekat.
1900							
Tomsk	2	11°53'.1	±1'.2	11°54'.1	±0'.0	11°53'.6	-1'.0
Narym (1st location)	3	14 30.0	2.8	14 28.9	1.1	14 29.4	+1.1
Narym (2nd location)	2	14 30.2	0.1	14 31.2	0.9	14 30.7	-1.0
Kolpashevo	6	13 38.2	1.1	13 40.4	1.0	13 39.3	-2.2
Kolmakovo	1	14 0.1		14 0.9		14 0.5	-0.8
B. Panovo	4	13 42.5	1.2	13 43.8	1.6	13 43.1	-1.3
M. Panovo (1st location)	3	13 54.2	1.1	13 54.4	1.0	13 54.3	-0.2
M. Panovo (2nd location)	4	13 54.8	0.5	13 55.8	0.9	13 55.3	-1.0
The same for July 27	39	13 54.5	0.7	13 55.6	0.6	13 55.0	-1.1
Yurty Muleshkiny	2	12 55.7	0.5	12 55.0	0.6	12 55.3	+0.7
Ozernaya R. mouth	2	13 26.7	1.0	13 23.7	0.6	13 25.2	+3.0
Glavnyy Stan	3	12 39.4	1.4	12 38.4	1.0	12 38.9	+1.0
			±1'.1		±0'.8		-0'.2 (±1'.2)
1901							
Polomoshnaya	3	11°42'.5	±0'.2	11°42'.2	±0'.8	11°42'.4	+0'.3
Oyash	4	11 44.1	1.3	11 44.1	0.4	11 44.1	0.0
Chik	4	11 50.5	0.9	11 51.5	0.4	11 51.0	-1.0
Kargat	4	12 32.4	1.8	12 33.0	1.1	12 32.7	-0.6
Kozhurla	3	12 5.2	0.5	12 6.8	0.6	12 6.0	-1.6
Tebisskaya	4	12 46.5	0.7	12 46.2	0.6	12 46.3	+0.3
Tatarskaya	4	12 6.1	0.4	12 7.4	0.7	12 6.7	-1.3
Kormilovka	4	12 34.3	1.0	12 35.0	0.5	12 34.7	-0.7
Mar'yanovka	3	12 6.3	1.1	12 6.8	0.8	12 6.6	-0.5
Isil'-Kul'	3	12 27.6	0.7	12 29.2	0.8	12 28.7	-1.6
Petropavlovsk	4	12 26.3	0.9	12 25.8	0.4	12 26.0	+0.5
Makushino	4	12 25.4	1.4	12 26.2	1.2	12 25.9	-0.8
Kurgan	3	12 20.0	0.8	12 21.2	0.6	12 20.8	-1.2
Shumikha	4	11 48.3	1.2	11 48.8	0.3	11 48.6	-0.5
Chelyabinsk	3	12 6.4	1.6	12 6.6	0.4	12 6.5	-0.2
Krasnoyarsk	6	8 59.0	0.7	8 59.0	1.4	8 59.0	0.0
Kazachinskoye	5	10 9.4	0.9	10 9.7	1.1	10 9.5	-0.3
Kolmogorovo	4	10 26.8	0.9	10 27.6	0.7	10 27.2	-0.8
Nizhne-Shadrino	2	10 55.4	0.5	10 57.2	0.3	10 56.3	-1.8
Garevka R. mouth	1	11 13.6		11 15.2		11 14.4	-1.6
Yeniseysk	4	9 39.4	1.5	9 37.7	1.2	9 38.6	+1.7
Chernorechenskaya	4	10 24.5	0.4	10 24.2	0.5	10 24.3	+0.3
Mariinsk	3	11 15.4	0.2	11 16.6	1.5	11 16.0	-1.2
Sudzhenka	2	11 43.3	0.7	11 42.6	0.9	11 43.0	+0.7
Tomsk	7	11 58.0	0.9	11 57.9	1.2	11 57.9	+0.1
			±0'.9		±0'.8		-0'.5 (±0'.8)

Table X. Results of Reduction of Magnetic Elements to Irkutsk and Yekaterinburg

STAT

Location	No. of obser-vations	To Irkutsk		To Yekaterenburg		Mean	Irk. - Yekat.
1900							
Tomsk	2	72°30'.6	±0'.2	72°29'.9	±0'.3	72°30'.3	0'.7
Narym (1st location)	2	74 0.6	0.0	74 0.1	0.3	74 0.3	0.5
Narym (2nd location)	1	74 2.7		74 2.5		74 2.6	0.2
Kolpashevo	4	73 38.1	0.4	73 38.3	0.2	73 38.2	-0.2
B. Panovo	3	73 51.5	0.9	73 51.4	0.7	73 51.5	0.1
M. Panovo (1st location)	2	73 45.4	0.2	73 45.2	0.3	73 45.3	0.2
M. Panovo (2nd location)	3	73 46.0	0.4	73 46.2	0.2	73 46.1	-0.2
			±0'.4		±0'.3		+0'.2
							±0'.3
1901							
Polomoshnaya	1	71°57'.1		71°57'.3		71°57'.2	-0'.2
Oyash	2	71 40.5	±0'.2	71 40.5	±0'.2	71 40.5	0.0
Chik	2	71 13.1	0.2	71 13.1	0.2	71 13.1	0.0
Kargat	2	71 16.3	0.8	71 15.7	0.5	71 16.0	0.6
Kozhurla	1	70 50.3		70 50.4		70 50.4	-0.1
Tebisskaya	2	70 51.5	0.1	70 51.0	0.2	70 51.3	0.5
Tatarskaya	1	70 42.7		70 42.2		70 42.5	0.5
Kormilovka	3	70 31.6	0.8	70 31.2	0.9	70 31.4	0.4
Mar'yanovka	2	70 8.5	0.5	70 7.9	0.2	70 8.2	0.6
Isil'-Kul'	1	69 52.2		69 52.6		69 52.4	-0.4
Petropavlovsk	2	69 32.1	0.1	69 31.8	0.1	69 32.0	0.3
Makushino	2	69 41.4	0.1	69 41.6	0.1	69 41.5	-0.2
Kurgan	1	69 42.3		69 42.1		69 42.2	0.2
Shumikha	2	69 19.5	0.3	69 19.5	0.1	69 19.5	0.0
Chelyabinsk	2	69 27.2	0.6	69 28.0	0.8	69 27.6	-0.8
Krasnoyarsk	2	72 40.1	0.4	72 41.0	0.4	72 40.5	-0.9
Kazachinskoye	2	74 31.3	0.1	74 31.7	0.3	74 31.5	-0.4
Kolmogorovo	1	75 28.7		75 29.3		75 29.0	-0.6
Nizhne-Shadrino	2	75 43.9	0.3	75 44.8	0.1	75 44.4	-0.9
Garevka R. mouth	1	75 43.7		75 44.7		75 44.2	-1.0
Yeniseysk	1	74 58.2		74 58.1		74 58.1	0.1
Chernorechenskaya	1	73 1.4		73 1.9		73 1.6	-0.5
Bogotol	2	72 40.0	0.3	72 40.5	0.4	72 40.2	-0.5
Mariinsk	1	72 64.4		72 46.8		72 46.6	-0.4
Sudzhenka	1	72 21.6		72 22.1		72 21.8	-0.5
Tomsk	2	72 30.2	0.2	72 30.3	0.4	72 30.2	-0.1
			±0'.3		±0'.3		-0'.2
							(±0'.4)

STAT

Table X. Results of Reduction of Magnetic Elements to Irkutsk and Yekaterinburg.

c) Horizontal Component of Intensity

Location	No. of observations	To Irkutsk		To Yekaterinburg		Mean	Irk.-Yekat.
1900							
Tomsk	1	1.7513		1.7521		1.7517	-0.0008
Krasnyy Yar	1	1.706		1.707		1.706	
Narym (1st location)	3	1.6038	±0.0001	1.6037	±0.0003	1.6038	+ 1
Narym (2nd location)	2	1.6050	1	1.6048	8	1.6049	2
Kolpashevo	5	1.6463	10	1.6452	4	1.6457	11
Kolmakovo	1	1.639		1.641		1.640	
B. Panovo	5	1.6345	3	1.6353	6	1.6349	- 8
M. Panovo (1st location)	2	1.6366	6	1.6366	3	1.6366	0
M. Panovo (2nd location)	5	1.6375	10	1.6371	9	1.6373	4
Yurty Muleshkiy	1	1.612		1.612		1.612	
Ozernaya R. mouth	2	1.5601	3	1.5604	4	1.5602	- 3
Glavnyy Stan	2	1.5793	7	1.5803	4	1.5798	- 10
Nizhne-Shadrino	1	1.4692		1.4688		1.4690	4
			±0.0005		±0.0005		-0.0001 (±0.0005)
1901							
Polomoshnaya	2	1.7983	±0.0001	1.7975	±0.0003	1.7979	+0.0008
Oyash	3	1.8251	3	1.8248	8	1.8250	3
Chik	3	1.8568	10	1.8562	11	1.8565	6
Kargat	2	1.8543	4	1.8549	4	1.8546	- 6
Kozhurla	3	1.8826	8	1.8826	7	1.8826	0
Tebisskaya	3	1.8608	8	1.8602	5	1.8605	6
Tatarskaya	3	1.8666	8	1.8668	5	1.8667	- 2
Kormilovka	4	1.8671	3	1.8674	3	1.8672	- 3
Mar'yanovka	3	1.8910	11	1.8918	4	1.8915	- 8
Isil'-Kul'	2	1.9082	2	1.9081	4	1.9082	1
Petropavlovsk	3	1.9244	6	1.9254	10	1.9251	- 10
Makushino	4	1.8950	7	1.8956	4	1.8954	- 6
Kurgan	3	1.8854	8	1.8860	2	1.8858	- 6
Shumikha	3	1.9004	3	1.9008	2	1.9007	- 4
Chelyabinsk	3	1.8903	2	1.8906	6	1.8905	- 3
Krasnoyarsk	5	1.7744	7	1.7749	6	1.7746	- 5
Kazachinskoye	3	1.5971	2	1.5968	5	1.5970	3
Kolmogorovo	3	1.4969	4	1.4972	7	1.4970	- 3
Nizhne-Shadrino	2	1.4696	1	1.4695	6	1.4696	1
Garevka R. mouth	1	1.4715		1.4716		1.4715	- 1
Yeniseysk	3	1.5496	3	1.5505	11	1.5500	- 9
Chernorechenskaya	3	1.7289	1	1.7303	4	1.7296	- 14
Bogotol	2	1.7611	2	1.7617	1	1.7614	6
Mariinsk	2	1.7487	3	1.7489	4	1.7488	- 2
Sudzhenka	2	1.7747	0	1.7750	4	1.7748	- 3
Tomsk	4	1.7513	10	1.7515	5	1.7514	- 2
			±0.0005		±0.0005		-0.0003 (±0.0005)

Table XI. Magnetic Elements Reduced to the Epoch of 1900.5 or 1901.5

Name of point	No. of point in list of chapter V	Latitude	Longitude from Pulkovo	δ (east)	J	H	V	T
1900.5								
Tomsk	2	52°27'33"	54°35'34"	11°53!6	72°30!3	1.7517	5.5574	5.8269
Krasnyy Yar	3	57 5	54 1	11.°9		1.706		
Narym	4	58 55 29	51 13 36	14°30!7	74 2.6	1.6049	5.6130	5.8379
Kolpashevo	5	58 18 16	52 34 3	13 39.3	73 38.2	1.6457	5.6048	5.8415
Kolmakovo	6	58 26 31	53 12 22	14 0.5		1.640		
M. Panovo	8	58 26 25	53 13 33	13 54.8	73 45.7	1.6370	5.6211	5.8541
B. Panovo	7	58 28 51	53 31 15	13 43.1	73 51.5	1.6349	5.6488	5.8807
Yurty Muleshkiny	10	58 33 15	55 22 0	12 55.3		1.612		
Ozernaya R. mouth	13	58 53 32	57 24 42	13 25.2		1.5602		
Glavnyy Stan	14	59 3 25	57 51 0	12 38.9		1.5798		
Nizhne-Shadrino	16	59 54 57	60 19 15			1.4690		
1901.5								
Chelyabinsk	31	55° 8'29"	31° 6' 0"	12° 6!5	69°27!6	1.8905	5.0456	5.3882
Shumikha	30	55 13 38	32 57 20	11 48.6	69 19.5	1.9007	5.0367	5.3834
Kurgan	29	55 26 14	34 59 42	12 20.8	69 42.2	1.8858	5.0989	5.4364
Makushino	28	55 12 27	36 54 45	12 25.9	69 41.5	1.8954	5.1216	5.4611
Petropavlovsk	27	54 51 11	38 50 30	12 26.0	69 32.0	1.9251	5.1581	5.5056
Isil'-Kul'	26	54 54 40	40 56 45	12 28.7	69 52.4	1.9082	5.2069	5.5455
Mar'yanovka	25	54 58 55	42 18 0	12 6.6	70 8.2	1.8915	5.2357	5.5669
Kormilovka	24	54 59 59	43 46 18	12 34.7	70 31.4	1.8672	5.2796	5.6001
Tatarskaya	23	55 12 57	45 37 54	12 6.7	70 42.5	1.8667	5.3329	5.6502
Tebisskaya	22	55 21 30	47 8 39	12 46.3	70 51.3	1.8605	5.3592	5.6730
Kozhurla	21	55 19 57	48 42 15	12 6.0	70 50.4	1.8826	5.4183	5.7360
Kargat	20	55 12 2	49 57 42	12 32.7	71 16.0	1.8546	5.4687	5.7746
Chik	19	55 0 26	52 6 55	11 51.0	71 13.1	1.8565	5.4592	5.7662
Oyash	18	55 27 58	53 29 21	11 44.1	71 40.5	1.8250	5.5102	5.8046
Tomsk	2	56 27 33	54 35 34	11 57.9	72 30.2	1.7514	5.5559	5.8254
Polomoshnaya	17	55 45 11	54 39 31	11 42.4	71 57.2	1.7979	5.5181	5.8036
Sudzhenka	41	56 6 49	55 49 46	11 43.0	72 21.8	1.7748	5.5825	5.8578
Mariinsk	40	56 12 19	57 24 30	11 16.0	72 46.6	1.7488	5.6413	5.9062
Bogotol	39	56 13 14	59 12 16		72 40.2	1.7614	5.6448	5.9132
Chernorchenskaya	38	56 16 9	60 45 30	10 24.3	73 1.6	1.7396	5.6667	5.9248
Kraznoyarsk	32	56 1 22	62 34 3	8 59.0	72 40.5	1.7746	5.6888	5.9592
Kazachinskoye	33	57 41 58	62 57 15	10 9.5	74 31.5	1.5970	5.7684	5.9854
Yeniseysk	37	58 27 5	61 52 16	9 38.6	74 58.1	1.5500	5.7719	5.9764
Kolmogorovo	34	59 15 37	60 58 45	10 27.2	75 29.0	1.4970	5.7815	5.9722
Garevka R. mouth	36	59 52	60 27 15	11 14.4	75 44.2	1.4715	5.7884	5.9725
Nizhne-Shadrino	35	59 54 57	60 19 15	10 56.3	75 44.4	1.4696	5.7823	5.9662
To 1900								
Yurty Shirokovy	9	58°27'59"	54°45' 0"					
Maksimoyarovskoye	11	58 39 55						
Yurty Berkunovy	12	58 45 21	56 50 15					
Kasovskaya R. mouth	15	59 53 28	60 5 0					

STAT

VIII. Remarks on the Secular Variation of the Magnetic Elements.

In conclusion, here are certain data for deducing secular changes in the terrestrial magnetism at certain points in Siberia for the last quarter of the past century. For this purpose we use principally the values of the magnetic elements from the observations by Fritsche[86] reduced by him to the epoch of 1875.

Also given here are magnetic elements established by Hansteen, or by his companions, in 28-29 of the past century from the book by that author[87], which up to now has been the largest collection of magnetic observations in the area of interest to us.

Since the epoch of the 70's there were few observations for our area in Siberia. Without making it my purpose to collect all magnetic determinations without exceptions, I shall include here a map of Siberia bounded by the [Chelyabinsk meridian in the west and the Yenisey River in the east in order to illustrate the progress in this respect from the beginning of the past century to the latest time[88]. The points up to 1850 are marked with dots, the later ones to 1899 with circles, and those of 1900-01 with crosses.

---

86) According to the litographed publication Observations magnetiques sur 509 lieu, faites en Asie et en Europe pendant la periode de 1867 - 1894 par Dr. H. Fritsche (Magnetic Observations Made in 509 Places in Asia and Europe in the Period from 1867 to 1894 by Dr. H. Fritsche). S.-Petersburg, 1897.

87) Resultate magn., astr., und meteor. Beobachtungen auf einer Reise nach dem ostlichen Sibirien in d. Jahren 1828-1830 (Magnetic. Astronomical and Meteorological Results of the Observations During a Trip to East Siberia in 1828 - 1830) by prof. Chr. Hansteen and Lt. Due. Christiania 1863.

88) The magnetic points printed on the map were borrowed from books by Hansteen and Fritsche (greater part of them) and from others. In order not to complicate the outline, the observation points Humboldt, Fus, and Fedorov, made almost simultaneously with the Hansteen's trip, Fedorov's observations were made a little later in the 30's, in most cases made at the same places, were not marked separately. Exception was made for three Fedorov's points on the Yenisey River which did not coincide with the preceeding ones. The extensive compilation of magnetic observations by Ed. Sabin in 1872 ("The Contributions to Terrestrial Magnetism," in the Philosoph. Trans. of the R.S. of London, vol. 162, part II, p 353) adds one more point, Lutke (Nikol'skaya River), for the indicated longitude limits, and by prof. Kopal'ski in the Ob' River lowland in 1848. The Vega expedition, judging by the work Observations magnetiques, faite pendant l'expedition de la Vega 1878-1880, by Aug. Wiykander, produced only one point Dikson Bay, within the limits of the indicated longitudes. Among more recent are yet the observations made by Col. Sharngorst of 1871 to 1874 (Zap. V. T. Otd. Gl. Shtaba - Trasactions of the Military Topographical Department of the General Staff - vol. 37, s. 1, p. 82), by I. N. Smirnov in Chelyabinsk, then by Col. Shmidt in the 80's (Zap. V.-T.O.G. Sh. - Transactions of the Military Topographical Department of the General Staff - v. 44) in Akmolinskaya o., and by G. F. Abel's on the Ob' River (Surgut, Obdorsk, and Kondinsk in 1887, and in Obdorsk and Samarov in 1898).

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

STAT

Returning to the calculation of the secular changes in the terrestrial magnetism, it has to be stated that my observations furnish little material for precise calculations because, for this last purpose, both accurate observations and complete coincidence of the points with the old ones are required. Due to various causes, indicated by me above, I did not, and I could not, create such conditions (See source p. 3).

In order to increase the number of stations which are being compared I included in the tables which folow the magnitudes of the magnetic elements, from the Hansteen's book, for the villages of Oyash, Kargat, and Bogotol, even though they are located some distance from the railroad stations of the same name, where I made the observations, and also for Togura village (near Kolpashevo, where Dr. Fritsche and I made the observations) and for the "S. Peter" point, which is identical with Petropavlovsk City. On the other hand, for Omsk and Kainsk [now Kuybyshev, Novosibirskaya o.], where I made no measurements, I am including, for experimental purposes, the magnetic elements observed by me at the stations nearby: for Omsk - the mean values for Kormilovka and Mar'yanovka, and for Kainsk [Kuybyshev, Novosibirskaya o.] - the means for Kozhurla and Tebis (See the figures in parentheses). Kainsk City [Kuybyshev, Novosibirskaya o.] is located 10 versts north of the railroad line, and it was found that the secular changes in the magnetic elements obtained for that point were more satisfactory when the latitudinal changes were taken into account. This increased the declination east by 4', inclination by 5', and decreased the horizontal intensity by 0.0070. These changes were taken on the basis of the differences in the magnetic elements at a point midway between Tebis RR station and Kozhurla, and on the basis of my observations in Narym town. Reductions of all elements (δ, J, and H) according to longitude play a considerably smaller role.

The director of the expedition for the hydrographic research in the estuaries of the Yenisey and Ob' Rivers, which made also magnetic determinations, reports a preliminary data [of the latter] in the Otchety o deystviyakh Gl. Gidr. Upr. Morsk. Min. (Reports on the Activities of the Main Hydrographic Administration of the Navy) for 1896 and for previous years. Altogether 28 points were determined, but the results, as far as I know, were not published anywhere.

The Nansen expedition gave many magnetic points, two of which determined in 1893, are included in the map: Khabarovo (No. 1) and No. 2 ($\varphi = 69°54'$, $\lambda = 66°43'$). The Norwegian Northpolar Expedition 1893-1896. Scientific Results. Vol. II. Terrestrial Magnetism, p. 183

89) P. A. Muller. "Die Beobachtungen der Inclination im Observatorium zu Katharinenburg von 1837 - 1885." R. F. Met. B. 12 ("Observations of the Inclination at the Yekaterinburg Observatory from 1837 to 1885." [Probable expansion of the title] Rundschau [or Revue] fur Meteorologie - Review of Meterology, v. 12

90) P. A. Muller. "Die Beobachtungen der Horizontal -intensitat des Erdmagnetismus im Observatorium zu Katharinenburg von 1841 - 1889." R. F. Met. ("Observations of the Horizontal Intensity of the Terrestrial Magnetism at the Yekaterinburg Observatory from 1841 to 1889." [Probable expansion of the title] Rundschau [or Revue] fur Meteorologie - Review of Meterology, v. 14, No. 3.

STAT

The values for the secular variation of the terrestrial magnetism should, of course, be considered provisional for all above mentioned points; in certain cases they are, obviously, unsatisfactory and are printed in italics in the table.

As regards selection of these or other values of these elements for certain stations, the following should be noted.

For Yekaterinburg [Sverdlovsk], where, as we know, the elements differ even at different monuments for absolute magnetic measurements at the pavilion, the values of the magnetic elements referring back to epochs before 1887, i.e. prior to the reorganization of the observatory, should be selected very cautiously, so that they could be compared with contemporary values published in the Letopisi N. Gl. F. Obs. [Records of the Director of the Main Observatory of Physics]. Happily, special investigations of the inclination[89] and of the horizontal intensity[90] had already been made at that observatory prior to its reorganization by P. K. Muller.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

Availing myself of these studies, I took the magnitude of the inclination 70°24', as the mean, from the observations made by M. Rykachev (assuming, as P. Muller states, that they were made at monument α) and by I. N. Smirnov in 1872 and 1873[91]. To convert [them] to monument α a correction of + 8'.6 was applied.

The figure taken for 1873 was very close to that given by P. Muller for needle No. 2 and monument α with the correction derived by him[92].

I took the horizontal intensity for the year 1874.7 according to P. Muller as the mean of the three measurement results obtained by Fritsche in the years of 1873, 74, and 76, and related to monument β[93]. The total [resultant] intensity, calculated by me, for J = 70°25'.

Finally, for the declination I considered it best to stop on the measurements made by Fritsche at different times of the day at four different monuments[94] in 1876, after having reduced the means obtained to monument β and after the subsequent conversion with the aid of the magnitude of 3!0 to the contemporary monument ε , to which judging by the <u>Letopisi</u> (<u>Records</u> of the Director of the Yekaterinburg Main Observatory of Physics)[95] the magnitudes given therein are related. The inclination of the total force for 1901 in Yekaterinburg [Sverdlovsk] were taken by me according to the magnitudes corrected by G. F. Abel's[96].

It should be noted with respect to Chelyabinsk that our point was located 3 versts southeast of the I. N. Smirnov's point. The figures in parantheses in the tables for the secular changes in the magnetism in that city were obtained by using my measurements made later (in 1904) at the I. N. Smirnov's point, which showed local differences in the elements of the terrestrial magnetism near Chelyabinsk city.

The horizontal component for Tomsk for the epoch of 1875 was furnished by Dr. Fritsche according to his two figures being greatly at variance: 1.7992 according to measurements made in 1867, and 1.7688 in 1873.

---

91) <u>Ibid</u>., p. 35, and the "kratkiy otchet o magnitnykh izsledovaniyakh v Vostochnoy Rossii" (Brief Report on Magnetic Research in East Russia) for the corresponding year by I. N. Smirnov in the <u>Izvestiya Imperatorskogo Kazanskogo Universiteta (Bulletin of the Kazan' Imperial University)</u>.
92) P. A. Muller, l. c., v. 12, No. 12, pp. 13, 19.
93) P. A. Muller, l.c., v. 14, No. 3, p. 85.
94) <u>R. F. Met</u>. (Expansion of the probable title: <u>Rundschau</u> (or <u>Revue</u>) <u>fur Meteorologie</u> - <u>Review of Meteorology</u>) v. 6, p. 65 and 66, Supplements to yearly report for 1877-78. Report by H. Fritsche on inspection of the stations.
95) E.g. for 1889 and for 1901.
96) See the <u>Letopisi</u> N. Gl. F. Obs. (<u>Records</u> of the Director of the Main Observatory of Physics) for 1902.

The declination in Yeniseysk for the epoch of 1875 is little reliable, because the two observers, Fritsche and Muller[97], obtained in 1874 and 1873 - 9° 2!7 and -10°10!7.

Finally, in Irkutsk Fritsche obtained in 1873 the declination of 2°46' and reducing it to the year of 1875, gives it as 2°49', while F. Muller obtained 3°18!9 in 1873. We take the Fritsches figure, noting, however, that the magnitude of the declination found by him for Irkutsk in 1883, i.e., 3°2', cannot be compared with the subsequent declinations, because in 1887 the observatory gives already 2°17'.1 with a weak secular variation of the needle to the west.

The second measurement of the declination by Dr. Fritsche in 1883, i.e., for Narym, for which the declination calculated by him in 1875 also somewhat stands out, although it is possible that our points near that city were separated by a considerable distance from each other and cannot be compared.

97) l.c., p. 28.

SECULAR CHANGES

Declination

Location	1828-29		1873-76			1900-1901			Mean secular change for the epoch of 1888 (1875-1901)
Yekaterinburg [Sverdlovsk]	- 6°27'	Hansteen	- 8°58'	Fritche	year 76.6	-10° 8'.6	Obs.	year 01	-2'.8
Chelyabinsk			-10 46	I. Smirnov	" 74	-12 6	"	"	-3.0 (3'.1)
Petropavlovsk	- 8 16	"				-12 26	"	"	
Omsk	- 8 49	"	-11 37	Fritsche	" 75	(-12 20)	"	"	-1.7*
Narym	- 9 18	"	-12 56	"	" "	-14 31	"	00	-3.8 (?)
Kainsk [Kuybyshev, Novosib. o.]			-12 1	"	" "	(-12 30)	"	01	-1.1
Oyash	- 8 9	Erman				-11 44	"	"	
Tomsk	- 8 32	Hansteen	-11 34	"	" "	-11 58	"	"	-0 9
Yeniseysk	- 6 57	"	(- 9 6 (-10 11	" F. Muller	" " " 73	- 9 39	"	"	-1.3) +1.1) 0.0
Krasnoyarsk	-6 43	"	-9 18	Fritsche	" 75	- 8 59	"	"	+0.7
Irkutsk	-1 36	"	-2 49	"	" "	- 2 0.8	Obs. "	01	+1.9

* These figures are in italics in the text.

SECULAR CHANGES
Inclination

Location	1828-29		1873-76				1900-1901				Mean secular change for the epoch of 1888 (1875-1901)
Yekaterinburg [Sverdlovsk]	69°42'	Hansteen	70°24'		year	73	70°43!3	Obs	year	01	+0!7
Chelyabinsk			68 50	I. Smirnov	"	74	69 28		"	"	1.4* (1!1)
Petropavlovsk	68 26	"					69 32		"	"	
Omsk	68 54	"	69 43	Fritsche	"	75	(70 20)		"	"	1.4*
Narym	72 51	"	73 38	"	"	"	74 3		"	00	1.0
Kolpashevo (or Togur)	72 24	"	73 9	"	"	"	73 38		"	00	1.2
Kainsk [Kuybyshevo, Novosib., o]	69 36	"	70 33	"	"	"	(70 56)		"	01	0.9
Kargat	69 46	"					71 16		"	"	
Tomsk	70 47	"	72 1	"	"	"	72 30		"	"	1.1
Bogotol	71 6						72 40		"	"	
Yeniseysk	73 24	"	74 33	"	"	"	74 58		"	"	1.0
Kazachinskoye	72 54	"					74 31		"	"	
Krasnoyarsk	70 57	"	72 21	"	"	"	72 41		"	"	0.8
Irkutsk	68 13	"	69 51	"	"	"	70 16.7	Obs.	"	01	1.0

* These figures are in italics in the text.

Horizontal Intensity

Location	1828-29		1874-75			1900-1901			Mean secular change for the epoch of 1888 (1875-1901)
Yekaterinburg [Sverdlovsk]	1.864	Hansteen	1.787	Fritsche	year 74.7	1.778	Obs.	year 01	-0.0003
Chelyabinsk			1.903	I. Smirnov	" 74	1.891	"	"	– 4
Petropavlovsk	1.988	"				1.925	"	"	
Omsk	1.982	"	1.917	Fritsche	" 75	(1.879)	"	"	– 15*
Narym	1.695	"	1.636	"	" "	1.605	"	00	– 12
Kolpashevo (or Togur)	1.743	"	1.664	"	" "	1.646	"	00	– 7
Kainsk [Kuybyshevo, Novosib. o.]	1.964	"	1.869	"	" "	(1.865)	"	01	– 2*
Kargat	1.943	"				1.855	"	"	
Tomsk	1.869	"	1.780	"	" "	1.751	"	"	– 11
Bogotol	1.889	"				1.761	"	"	
Yeniseysk	1.680	"	1.567	"	" "	1.550	"	"	– 7
Kazachinskoye	1.732	"				1.597	"	"	
Krasnoyarsk	1.906	"	1.782	"	" "	1.775	"	"	– 3
Irkutsk	2.147	"	2.015	"	" "	2.012 Obs	"	"	– 1

* These figures are in italics in the text.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

STAT

Total [Resultant] Intensity

Location	1828-29		1874-75			1900-1901			Mean secular change for the epoch of 1888 (1875-1901)
Yekaterinburg [Sverdlovsk]	5.372	Hansteen	5.332		year 74	5.385	Obs.	year 01	+0.0020
Chelyabinsk			5.270	I. Smirnov	" 74	5.388	"	"	44 (34)
Petropavlovsk	5.409	"				5.506			
Omsk	5.503	"	5.530	Fritsche	" 75	(5.583)			20*
Narym	5.732	"	5.806	"	" "	5.838	"	00	13
Kolpashevo (or Togur)	5.764	"	5.741	"	" "	5.842	"	"	40
Kainsk [Kuybyshevo Novosib.o.]	5.634	"	5.613	"	" "	(5.709)	"	01	37
Kargat	5.616	"				5.775	"	"	
Tomsk	5.681	"	5.765	"	" "	5.825	"	"	23
Bogotol	5.829	"				5.913	"	"	
Yeniseysk	5.881	"	5.882	"	" "	5.976	"	"	36
Kazachinskoye	5.890	"				5.985	"	"	
Krasnoyarsk	5.840	"	5.877	"	" "	5.959	"	"	32
Irkutsk	5.786	"	5.849	"	" "	5.961	Obs. "	01	43

*These figures are italics in the text.

Declassified in Part - Sanitized Copy Approved for Release @ 50-Yr 2014/05/08 : CIA-RDP81-01043R004700170004-4

STAT

It can be concluded from a comparison of the data in these tables that the declination east in West Siberia continued to increase, i.e., that the compass needle deflected east of the meridian moved still father away from it. During the last 26 years the mean velocity of this movement, however, was smaller than before, being more noticeable in Yekaterinburg [Sverdlovsk], Chelyabinsk, and in Narym (?) - up to 3' per year. In Tomsk this velocity was on the average smaller than 1' during the last 26 years. We see quite a different thing on the Yenisey River. Judging by the cities of Yeniseysk and Krasnoyarsk it can be concluded that there the motion of the needle to the east not only ceased during these 26 years but, probably reversed to the west, similarly to that which had occurred already earlier in Irkutsk, where the needle is returning now to the meridian; very recently such motion in Irkutsk greatly decelerated, while the turn of the needle to the east in Yekaterinburg [Sverdlovsk] accelerated noticeably, up to 4' - 5' per year, during that time.

The observations at the two points on the Yenisey River, indicated above, are contradictory, and one may even ask whether the F. Muller's figure for Yeniseysk should be rejected and the local deflection of the needle in Krasnoyarsk be taken. It should be stated that my observations in that city were made quite a distance away from the previous observation place, because wishing to be farther away from the railroad bridge, one of the largest on the Siberian RR, I ascended a mountain (about 4 - 5 versts from the north end of the bridge) in the northeast end of the city. But it seems that it can be considered more probable that the compass needle moved somewhat to the west in Krasnoyarsk during these 26 years and perhaps it stopped again. It is not suggested that the observations be repeated in the future, because they would produce the same declination values which were found by Col. Vil'kitskiy during the hydrographic expedition on the Yenisey River in the middle of the 90's and of which he gives information in his preliminary report.

It is more reasonable to assume that the declination variation for Tomsk is analogous to that for Yekaterinburg [Sverdlovsk] perhaps but it has a stronger expression, i.e., the movement of the needle to the east has a sharper deceleration[98], and that for the years more recent to us this movement recommenced; this last assumption is indicated by the declination figure for Tomsk of -11°52!8 obtained by prof. Kapustin for the year of 1899.5, and by our figures of -11°53!6 and -11°57!9 for the two subsequent years.

The following conclusions from these data regarding the actual movement of the declination in Siberia can be disputed less than the above stated assumptions.

The values of the secular variation of the magnetic declination based on previous observations [values, such as, e.g., given in the tables by A. Tillo[99] for the epochs of 1850 - 1900 and 1900 - 1950] were far off from being confirmed by the observations of 1900 and 1901.

---

98) This deceleration in the movement of the needle to the east at the Yekaterinburg [Sverdlovsk] Observatory, obviously, showed most clearly in the year of about 1800; at any rate our figure for 1876 gives the yearly motion of only -1!6 up to 1887, further changes in the declination from year to year were: -2!0, -2!5, -2!7 etc., and the mean for the period from 1887 to 1901 was -3!8.

99) A. Tillo. Tables fundamentales du magnetism terrestre (Basic Tables of Terrestrial Magnetism). S.-Petersburg, 1896.

I calculated the secular variation of the declination for Tomsk, Krasn STAT k, and Irkutsk for the epoch of 1887 according to Tillo's tables respectively

-3!1 -2!4 -0!5, instead of

-0!9 +0!7 +1!9 obtained from observations.

Thus, the pause of the magnetic needle in the movement to the east, advancing successively from the side of East Siberia, obviously occurred sooner than expected.

The <u>inclination</u> during the last 26 years, just as during the entire past century, continued to increase from Irkutsk to Chelyabinsk on the average almost uniformly, i.e., by 1' per year. During the recent time (see 1892 - 99), as it is well known, this increase was slow in Yekaterinburg [Sverdlovsk], now it is increasing, but in Irkutsk the increase was quite considerable during the recent years.

The <u>horizontal intensity</u> in West Siberia decreased during the last 26 years on the average about 0.0009 gauss per year, obviously from Omsk to Tomsk only; this decrease was smaller in the east of European Russia (0.0004) and along the Yenisey River, and still smaller, i.e., 0.0001, in Irkutsk; as it is well known the horizontal force in Irkutsk even increased at times during the recent years (from 1893 to 1897); this was noticeable at the Yekaterinburg [Sverdlovsk] Observatory also during this period.

The general increase of the inclination everywhere and the pause in the decrease of the horizontal component of intensity correspond to the considerable increase in the total [resultant] magnetic force in the area of Siberia under consideration. It is true that the reliability of the calculated magnitudes of the last magnetic element is lesser than that of the other [elements] which is clearly seen from the old observations. At any rate, it can be concluded from the data of this table that the increase in the total [resultant] force in Irkutsk was particularly rapid, on the average by 0.0043 gauss per year, in the end of the past century; the secular changes of about 0.0030 were observed probably from the Yenisey River to Chelyabinsk, although intermediate stations sometimes give smaller magnitudes. The reliable data at the Irkutsk and Yekaterinburg [Sverdlovsk] Observatories for a considerable later epoch show the following: in Irkutsk from 1887 to 1901 the increase in the total [resultant] force on the average equalled 0.0047 gauss, i.e., increased still some more, but in Yekaterinburg [Sverdlovsk] even certain pauses in its increase were observed, and since 1887 the mean yearly change in the total [resultant] force was equal to +0.0017.