History of the Potsdam, Seddin and Niemegk Geomagnetic Observatories – First Part: Potsdam

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Abstract

The measurement series of the 3 geomagnetic observatories Potsdam, Seddin and Niemegk span over more than 130 years, starting in 1890. It is one of the longest, almost uninterrupted series of recordings of the Earth's magnetic field. Data users frequently emphasize the high quality of the data and its significance for geomagnetic base research. Very well-known outstanding geomagnetism scientists as Max Eschenhagen, Adolf Schmidt, Julius Bartels, Gerhard Fanselau and Horst Wiese directed the observatories during their existence. This paper describes the history of the Potsdam Observatory, which was in operation from 1890 until 1928.

1 Introduction

The direction of the Earth's magnetic field played an important role for the navigation in ancient times. Long-term series of the recording of the declination and inclination are available for Paris and London since the 16th century (Alexandrescu et al., 1997). Alexander von Humboldt (1769-1859) carried out several measurements of the Earth's magnetic field during his numerous travels. He encouraged Carl Friedrich Gauß (1777-1855) to apply his talent to magnetism. That Gauß did, together with his young assistant Wilhelm Weber (1804-1891), contributing greatly to the understanding of the Earth's magnetic field. In 1832 Gauß and Weber also devised the method to measure the horizontal intensity of the Earth's magnetic field. Gauß and Weber started in 1834 by setting up the "Göttingen Magnetic Union" (Göttinger Magnetischer Verein), an international network of observatories. Alexander von

Humboldt stepped in by enlarging the network with the help of British and Russian authorities (Stern, 2002), (Schröder and Wiederkehr, 2002).

In the frame of the Göttingen Magnetic Union the magnetic observatories of Munich and Berlin were established. After the movement due to urban perturbations the Munich observations were continued in Maisach and Fürstenfeldbruck, operated by the Ludwig-Maximilian University of Munich (Beblo and Soffel, 1991). The Berlin observations were terminated in 1872 caused by anthropogenic noise of the city and the growing industry (Körber, 1965).

The marine geomagnetic observatory of Wilhelmshaven was operated 1878-1911 and 1932-1934 (Voppel, 1997). It was closed due to disturbances caused by the military harbour of Wilhelmshaven. Its successor station Wingst was established in 1938 by Deutsche Seewarte Hamburg and is operated now by the Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences.

2 Potsdam Observatory History

Wilhelm Förster (1832-1921), submitted in 1871 a memorandum proposing the establishment of a solar observatory at the Potsdam Telegrafenberg (Körber, 1965). Based on this the Astrophysical Observatory of Potsdam was established, which was opened in 1876. In 1885 the Berlin Royal Prussian Meteorological Institute became an independent organisation under Wilhelm von Bezold’s (1837-1907) directorship. It was planned to establish outside of the city of Berlin an observatory exclusively for meteorologic and magnetic observations and experimental research (Hellmann, 1912). The magnetic observatory building was constructed 1888-1889. The regular observations were started end of 1889. The official service began on 1 January 1890. From 1890 onward the main building of the Meteorological Observatory was constructed. The former staff member of Wilhelmshaven Observatory, Max Eschenhagen (1858-1901), was appointed as the first director of the magnetic department of the Meteorological-Magnetic Observatory.

2.1 Potsdam Magnetic Observatory Buildings

The first observatory building was designed to house the absolute measurements besides the variometer recordings. The variometer recordings were located in the basement, while the absolute measurements were carried out at the first floor. All the construction materials were carefully selected. Material samples were investigated in 1887 to find out the best suitable ones with as low as possible influence on the magnetic measurements later on in the building. The belowground parts were constructed from Rüdersdorf limestone, while the aboveground parts were made from Wefensleben sandstone. Lime mortar was exclusively used as binding material. The roof with a big projection over a well aerated loft was constructed as an effective shielding against solar radiation. The basement wall of 1 m thickness is surrounded by an enclosing wall in a distance of 60 cm. This intelligent construction ensured suitably stable temperatures in the inner rooms of the building. Especially constructed, petroleum burning heaters ensured suitable temperatures in the instrument rooms. A distance of 150m to the main building of the meteorological observatory as well as to the domes of the astrophysical observatory prevented disturbing influences on the magnetic measurements and recordings. Fig. 1 shows the view of the observatory building from North-East. The ground plan of the basement is shown at fig. 2.

Already during the first years of the operation of the magnetic observatory the astrophysical observatory started the planning of a new big telescope in a distance of only 160 m. The telescope itself was of about 100 tons of iron, requiring a dome of 22 m inner diameter and about 150 tons of iron. Due to the expectable perturbations on the magnetic measurements a new wooden absolute house was constructed in 1897 in a distance of 260 m to the new telescope building (Brückmann, 1911). The absolute house was finished before the construction of the telescope building was started. Fig. 3 shows a view of the absolute house from North-East.

The new absolute house had gas-burning heaters. The absolute measurements were carried out in this new building from 1898 onward after comprehensive comparisons with the ones in the old observatory building, which served henceforth exclusively for the variometer recordings. The old observatory building was consequently called from that time onward “variation house”. Fig. 4 shows the final ground plan of the Potsdam Meteorological-Magnetic Observatory with 1): absolute house, 2): variation house, 3): meteorological observation field, 4): main building (Hellmann, 1912).

The absolute and the variation house were in use until 1928 for the observations. After this period the variation house was used as a repository. It was renovated 1998-2000 according to the regulations for historical monuments and is since then a palaeomagnetic laboratory used by the section 4.3 of Helmholtz Centre Potsdam GFZ. The absolute house became already during the 1980s a palaeomagnetic laboratory. It was in use until 2000. The house still exists and is used as a repository.

2.2 Observatory Instruments

Magnetic observatory data can be achieved only by combining continuous recordings of the temporal variations of the Earth's magnetic field with periodical absolute measurements. The absolute measurements are necessary to calibrate the variation instruments (variometers). The variometers were located at the basement of the observatory building (later called variation house). The absolute measurements were carried out 1890-1897 at the ground floor of the observatory building, from 1898 onward in the absolute house.

2.2.1 Absolute Measurements

According the state of the measurement technology the declination, inclination and horizontal intensity were determined. The declination and the horizontal intensity were measured during the first 2 years by means of the theodolite Edelmann (manufactured in Munich). The church tower of the small town of Werder in a distance of 8 km was used as azimuth target as a reference for the true North direction. The cross hair of a permanently mounted telescope in a distance of 11.5 m inside the observatory building was further available as an azimuth target. The azimuth values of both targets were determined by means of solar observations.

An oscillation box (Wiese et al., 1960), also manufactured by Edelmann, Munich for the measurements of the horizontal intensity also existed. By using the 2 independent measurement methods for the horizontal intensity varying parameters of the deflection magnet, which was used for both methods, were eliminated. The inclination was determined first by a dip needle, manufactured by C. Bamberg, Friedenau near Berlin and an Earth inductor after L. Weber, made by Hartmann & Braun, Frankfurt/Main (Weber, 1885). Fig. 6 shows a sketch of the Bamberg dip needle (left) and a photo of the Earth inductor after L. Weber. Photos of the Edelmann theodolite and oscillation box unfortunately do not exist. The Earth inductor after L. Weber still exists at the Niemegk Adolf Schmidt Geomagnetic Observatory. The disposition of the Edelmann theodolite and the Bamberg dip needle is unknown. The Niemegk Adolf Schmidt Geomagnetic Observatory owns a historic oscillation box, which can be supposed to be the Edelmann one, but it does not have any manufacturer's label.

Due to technical problems of the Edelmann theodolite it was replaced in 1893 by an instrument set made by Wanschaff, Berlin, consisting of a theodolite and an oscillation box. Fig. 5 shows both the instruments. In 1901 an Earth inductor following Eschenhagen's construction, made by Schulze, Potsdam was purchased for the inclination measurements (Schmidt, 1905). Fig. 7 shows this instrument. This instrument was in use until 1966 and it still exists in Niemegk.

The observatory planned in 1903 a contribution of an instrument to the 1904 world exhibition in St. Louis. For this purpose the observatory commissioned C. Bamberg, Friedenau to construct a theodolite on the base of Adolf Schmidt's design. The remaining time was too short to finish the construction in time. The instrument was handed over in 1907 only. Adolf Schmidt proved his theory for the horizontal intensity measurement by setting the deflection magnet by means of a turn table into different angular positions with respect to the magnetic needle of the theodolite using this instrument. In conclusion of this development Askania, Berlin constructed in 1927 a magnetic theodolite following Adolf Schmidt's specification (Bock and Schmidt, 1928). Fig. 8 shows this instrument, which still exists in Niemegk. Adolf Schmidt's international reputation caused a huge market demand for this excellent instrument. Askania, Berlin delivered such instruments to a big number of international observatories.

2.2.2 Variation Recordings

Two different sets of variometers were operated for the observation of the declination (unifilar), horizontal intensity (bifilar), both based on a suspended magnet, and vertical intensity (balance) in separate rooms of the basement. The so-called main system consisted of the 3 instruments of Mascart's construction, made by Carpentier, Paris (Mascart, 1900) and a photographic recording unit made by Wanschaff, Berlin (Eschenhagen, 1894). For the backup system instruments after Wild-Edelmann's construction were used with manual reading. The main system was operated in the West room of the basement. The recording unit had separate drums for the photographic paper for each variometer, running by a speed of 2 cm per hour, but only one petrol burning light source. It was constructed following the so-called Kew pattern equipment (Gordon, 1880) considering experiences achieved at Wilhelmshaven Observatory. The average sensitivity of the unifilar was 1.09 minutes of arc per mm, of the bifilar 5 nT per mm and of the balance 1 nT per mm (approximately). The baselines of the photographic recordings were interrupted hourly by 3 minutes as time marks, controlled by a non-magnetic pendulum clock. At Fig. 9 the photographic recordings of the declination, horizontal and vertical intensity of the time interval from 15 February 1890 12 o'clock to 16 February 1890 12 o'clock (Potsdam mean local time) are depicted as an example of the observatory variometer recordings. Fig. 10 shows sketches of the main system (left) and the backup system (right).

In 1903 and 1904 equipment for galvanic scale value determination were installed at all variometers of the main system and of the balance of the backup system. It was taken into use regularly from 1905 onward.

2.3 Operation of the Potsdam Observatory

Every day at the same time the photographic paper was changed and afterwards developed. Following the usual international practice hourly instantaneous data were determined by means of distance readings between the recorded curve and the baseline manually for each component and converted into magnetic units. Finally the baseline values were added and the results were inscribed into the final tables for the declination (D), horizontal (H) and vertical (Z) intensity, published in the yearbooks. The manual readings taken from the backup system were regularly compared with the photographic recordings of the main system.

The time base was the mean local time of Potsdam, determined by the Potsdam Geodetic Institute.

The first magnetic yearbook, containing the results of 1890 and 1891 was published in 1894 (Eschenhagen, 1894). The following volumes were published regularly, but with different delays. The volumes 1892-1900 did not contain the general information, absolute measurement results and baseline values, which were published in Brückmann, 1911.

Adolf Schmidt published the yearbooks containing all data and general information beginning with the volume of 1901. From 1905 onward he published hourly mean values (Schmidt, 1908) instead of instantaneous data, as it was done of 1890-1904. Gradually all the international magnetic observatories followed Schmidt's example. At the same time Schmidt invented the Greenwich civil mean time as the time base of the observatory (Schmidt, 1908) and changed from the publication of declination (D), horizontal (H) and vertical (Z) intensity to North (X), East (Y) component and vertical (Z) intensity in the yearbooks.

2.3.1 Operational Problems and Termination

The Potsdam Magnetic Observatory worked over many years undisturbed by external noise. Some international stations noticed already around 1890 first disturbances on their observations, mainly caused by stray currents of DC powered electrical railways. In 1898 the impact of operating tram networks in Berlin on geomagnetic observations was investigated (Edler, 1900). In result the authorities of the Potsdam Magnetic-Meteorological Observatory established regulations for the operation of electrical trams within a 15 km diameter protection circle around the Potsdam Observatory, mainly to abandon the use of the rails as one of the conductors. This regulation turned out to be impossibly met by the tram society from the point of view of economics, when in 1904 the town of Potsdam planned to electrify the horse tramway. Similarly, for the nearby Teltow Canal, constructed 1900-1906, a towing by electrical locomotives was intended to be used. So leakage earth current influences on the magnetic observations seemed to be inevitable. Due to running both the rail establishments by DC power the movement of Potsdam Observatory seemed to be indispensable (Schmidt, 1910). It was decided to establish an additional station for variometer recordings at a location in secure distance to the DC powered Potsdam tramway and the Teltow Canal towing engines. The observations at Potsdam Observatory were intended to be continued as usual. Especially the absolute measurements should be performed only in Potsdam.

Due to the launch of the DC powered service of the Berlin suburban railway system on 11 June 1928 the observatory was forced to terminate the observations step by step in the course of the year 1928 (Nippoldt, 1930). Only the inclination measurements were further performed in Potsdam, strictly only during the shutdowns of the railway service.

2.3.2 Affiliation and Directors of the Observatory

The Potsdam Observatory was affiliated during its complete existence to the magnetic department of the Magnetic-Meteorological Observatory Potsdam of the Royal Prussian Meteorological Institute Berlin. The institute was renamed in 1919 into "Prussian Meteorological Institute Berlin".

Max Eschenhagen (1858-1901) was from 1890 until 1901 observer, observatory director and head of the magnetic department of the Royal Prussian Meteorological Institute Berlin. Fig. 11 shows his portrait. Max Eschenhagen died in 1901 of an age of only 43 years after serious disease. The famous Adolf Schmidt (1860-1944) could be appointed as his successor from

1902 onward. He kept the director’s position until the closing of the observatory in 1928. His portrait is shown at Fig. 12. Adolf Schmidt went retired on 1 October 1928. Alfred Nippoldt (1874-1936) took over his position. Fig. 13 shows his portrait.

Appendix: Instrument Makers Related to the Observatory

Max Thomas Edelmann (1845-1913) an Engineer, Physicist and University Professor (Techn. Hochschule München) founded in 1870 the company „Physikalisch-Mechanisches Institut zur Herstellung physikalischer Präzisionsapparate“ (Physical-mechanical institute for the production of physical precision instruments) in Munich. He received several national and international awards for his instruments.

Carl Bamberg (1847-1892) was a watchmaker and protégé of Carl Zeiss. He founded 1888 the „Carl Bambergs Werkstätten für Präzisions-Mechanik und Optik“ (Carl Bamberg’s workshops for precision mechanics and optics) in Berlin-Friedenau. Besides of his magnetic instruments he became famous for the construction of the telescope Bamberg-refractor. Relatives continued the company after his death and changed the name after fusion with any other instrument-building company in 1912 into

Askania Werk AG. This company expanded the production to nautical instruments, weaponry, film cameras and projectors. They were strongly involved in producing equipment for the military in the first and second world war. After the war the company was split into several ventures in East and West Germany.

Julius Wanschaff (1844-1903) established a workshop for precision instruments in Berlin in the 1870s. The company was inherited by Hermann Wanschaff in 1903 and absorbed in to Askania Werk AG in 1922.

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an office, a computer and all the observatory publications to collect the necessary information.

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Fig. 1. View of the observatory building from North-East. Source: Hellmann, 1912

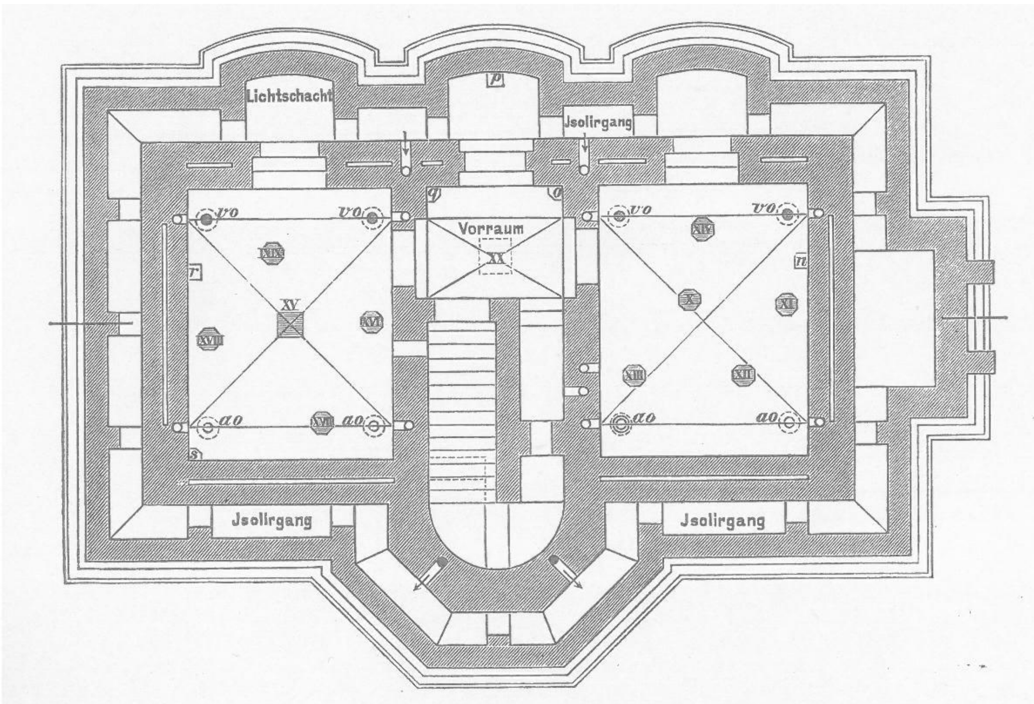

Fig. 2. Ground plan of the of the observatory building basement. Source: Hellmann, 1912

Fig. 3. View of the absolute house from North-East. Source: Hellmann, 1912

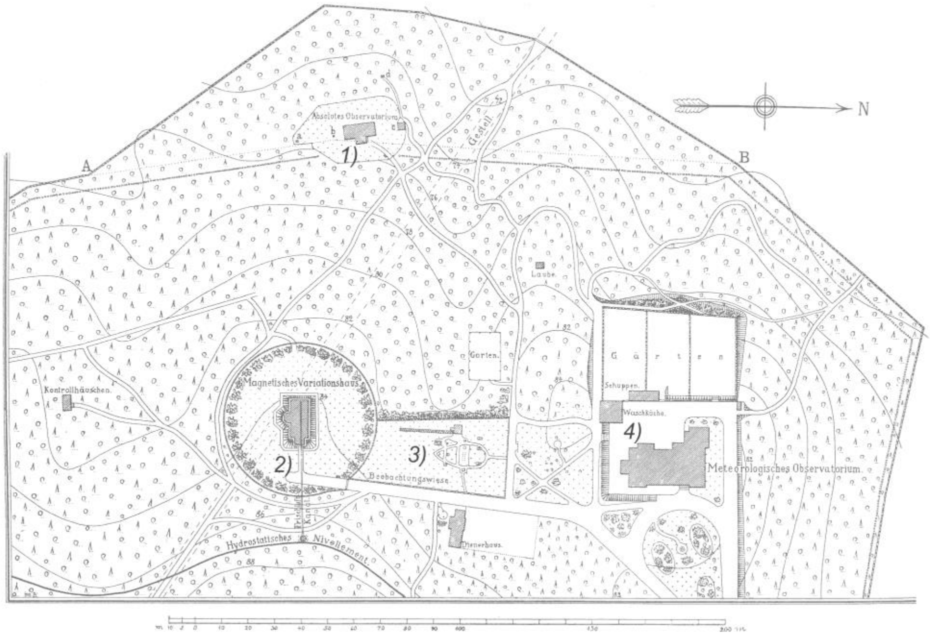

Fig. 4. Final ground plan of the Potsdam Meteorological-Magnetic Observatory

1): absolute house, 2): variation house, 3): meteorological observation field, 4): main building. Source: Brückmann, 1911

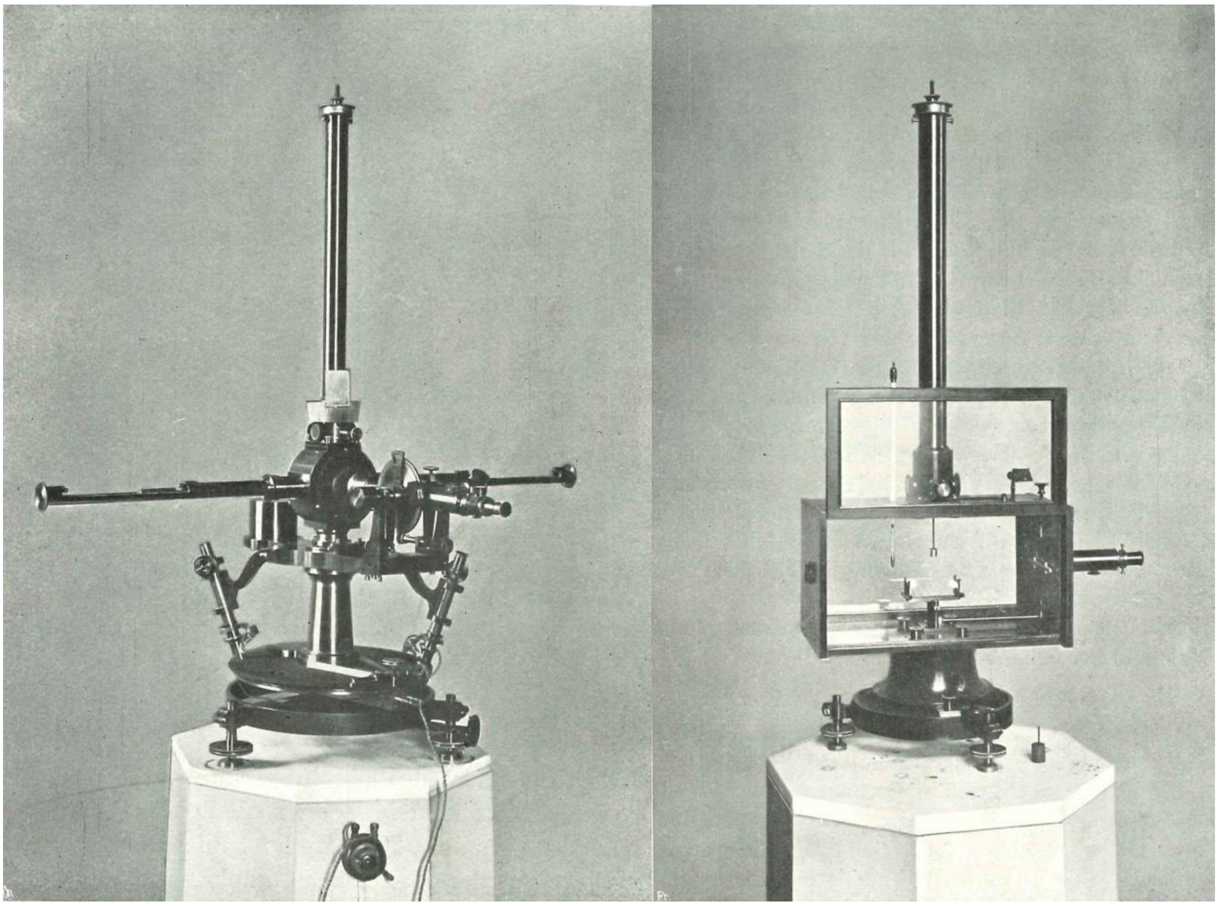

Fig. 5. Magnetic theodolite (left) and oscillation box (right) made by Wanschaff, Berlin. Source: Hellmann, 1912

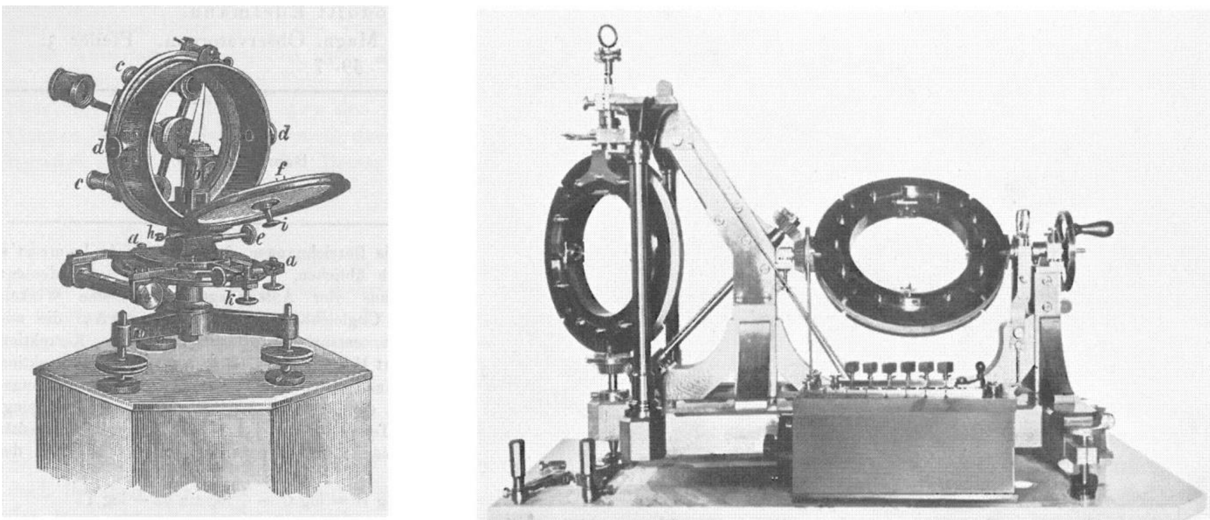

Fig. 6. Sketch of the dip needle by C. Bamberg, Friedenau near Berlin (left) and Earth inductor after L. Weber (right). Source: Left: Eschenhagen, 1894 Right: Hellman, 1912

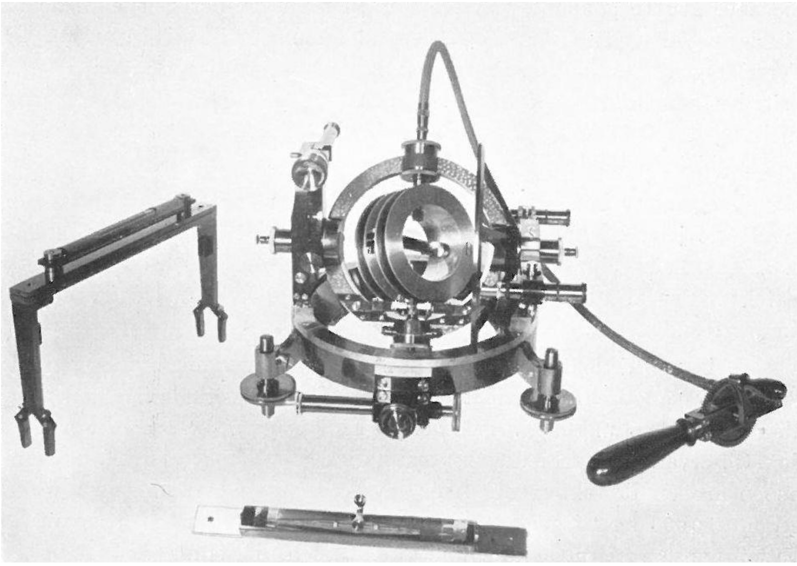

Fig. 7. Earth inductor by Schulze, Potsdam. Source: Hellmann, 1912

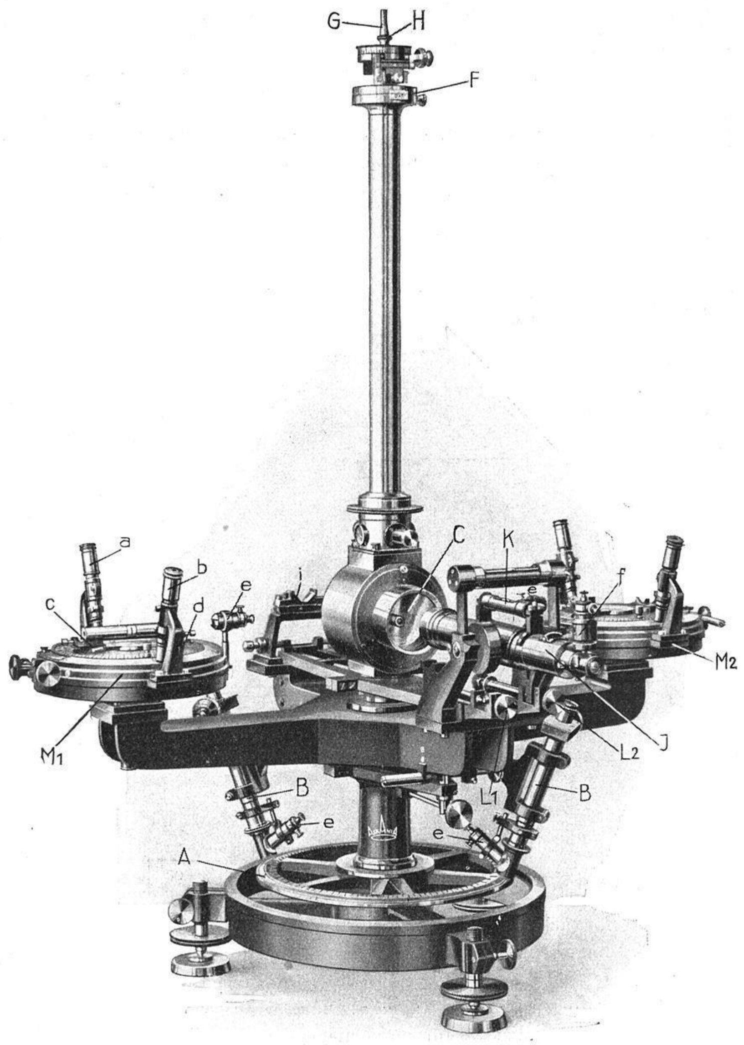

Fig. 8. Normal theodolite after Adolf Schmidt. Source: Bock, 1928

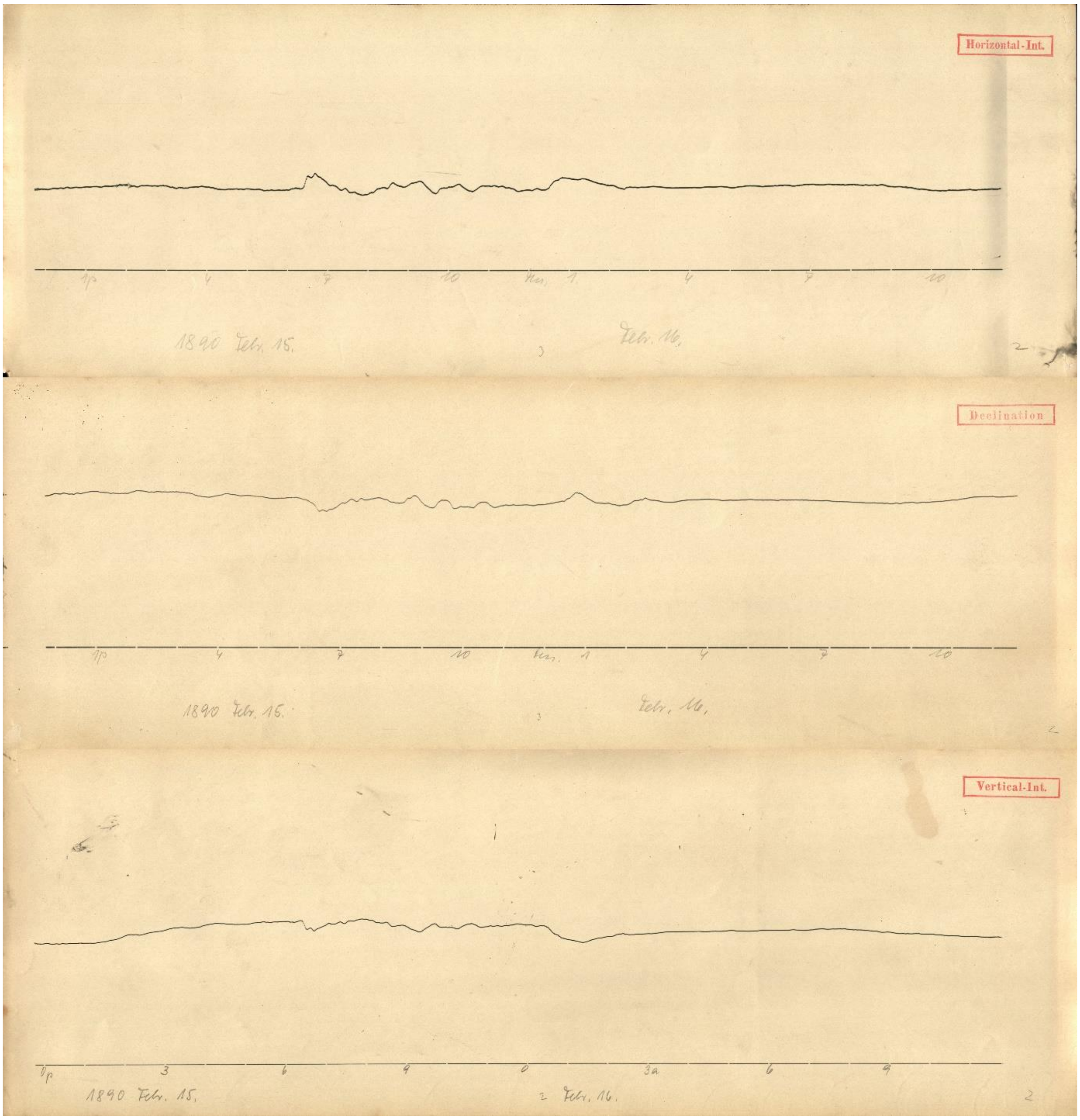

Fig. 9. Potsdam Observatory photographic recordings of the declination, horizontal and vertical intensity of the time interval 15 February 1890 12 o'clock till 16 February 1890 12 o'clock (Potsdam mean local time). Source: Helmholtz Centre Potsdam - GFZ

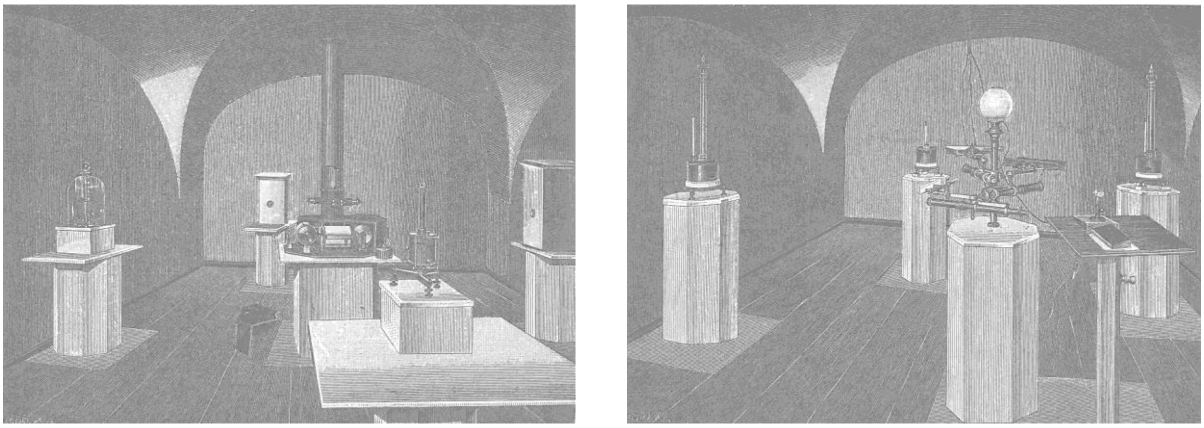

Fig. 10. Main recording system (left) and backup variometer system for manual reading (right). Source: Eschenhagen, 1894

Fig. 11. Max Eschenhagen’s portrait.

Source: https://geschichte.telegrafenberg.de/personen/eschenhagen-max/ - Helmholtz Centre Potsdam - GFZ

Fig. 12. Adolf Schmidt’s portrait. Source: Helmholtz Centre Potsdam - GFZ

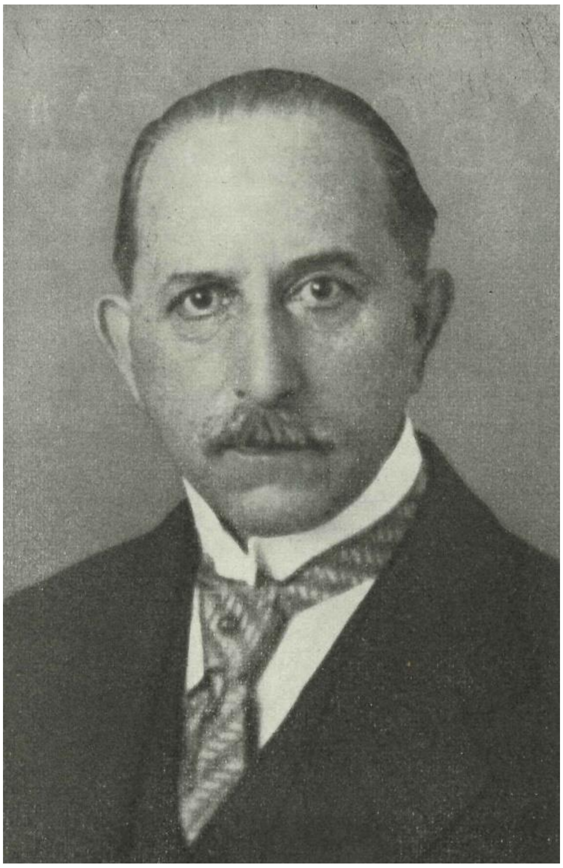

Fig. 13. Alfred Nippoldt’s portrait. Source: Bock 1937