1 **History of the Potsdam, Seddin and Niemegk Geomagnetic**

2 **Observatories – First Part: Potsdam**

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9 **Abstract**

10 The measurement series of the 3 geomagnetic observatories Potsdam, Seddin and Niemegk

11 span over more than 130 years, starting in 1890. It is one of the longest, almost uninterrupted

12 series of recordings of the Earth's magnetic field. Data users frequently emphasize the high

13 quality of the data and its significance for geomagnetic base research. Very well-known

14 outstanding geomagnetism scientists as Max Eschenhagen, Adolf Schmidt, Julius Bartels,

15 Gerhard Fanselau and Horst Wiese directed the observatories during their existence. This

16 paper describes the history of the Potsdam Observatory, which was in operation from 1890

17 until 1928.

18 **1   Introduction**

19 The direction of the Earth's magnetic field played an important role for the navigation in

20 ancient times. Long-term series of the recording of the declination and inclination are

21 available for Paris and London since the 16th century (Alexandrescu et al., 1997). Alexander

22 von Humboldt (1769-1859) carried out several measurements of the Earth's magnetic field

23 during his numerous travels. He encouraged Carl Friedrich Gauß (1777-1855) to apply his

24 talent to magnetism. That Gauss did, together with his young assistant Wilhelm Weber (1804-

25 1891), contributing greatly to the understanding of the Earth's magnetic field. In 1832 Gauß

26 and Weber also devised the method to measure the horizontal intensity of the Earth's magnetic

27 field. Gauss and Weber started in 1834 by setting up the "Göttingen Magnetic Union"

28 (Göttinger Magnetischer Verein), an international network of observatories. Alexander von

1 Humboldt stepped in by enlarging the network with the help of British and Russian authorities

2 (Stern, 2002), (Schröder and Wiederkehr, 2002).

3 In the frame of the Göttingen Magnetic Union the magnetic observatories of Munich and

4 Berlin were established. After the movement due to urban perturbations the Munich

5 observations were continued in Maisach and Fürstenfeldbruck, operated by the Ludwig-

6 Maximilian University of Munich (Beblo and Soffel, 1991). The Berlin observations were

7 terminated in 1872 caused by anthropogenic noise of the city and the growing industry

8 (Körber, 1965).

9 The marine geomagnetic observatory of Wilhelmshaven was operated 1878-1911 and 1932-

10 1934 (Voppel, 1997). It was closed due to disturbances caused by the military harbour of

11 Wilhelmshaven. Its successor station Wingst was established in 1938 by Deutsche Seewarte

12 Hamburg and is operated now by the Helmholtz Centre Potsdam GFZ German Research

13 Centre for Geosciences.

14 2   Potsdam Observatory History

15 Wilhelm Förster (1832-1921), submitted in 1871 a memorandum proposing the establishment

16 of a solar observatory at the Potsdam Telegrafenberg (Körber, 1965). Based on this the

17 Astrophysical Observatory of Potsdam was established, which was opened in 1876. In 1885

18 the Berlin Royal Prussian Meteorological Institute became an independent organisation under

19 Wilhelm von Bezold's (1837-1907) directorship. It was planned to establish outside of the

20 city of Berlin an observatory exclusively for meteorologic and magnetic observations and

21 experimental research (Hellmann, 1912). The magnetic observatory building was constructed

22 1888-1889. The regular observations were started end of 1889. The official service began on

23 1 January 1890. From 1890 onward the main building of the Meteorological Observatory was

24 constructed. The former staff member of Wilhelmshaven Observatory, Max Eschenhagen

25 (1858-1901), was appointed as the first director of the magnetic department of the

26 Meteorological-Magnetic Observatory.

27 2.1   Potsdam Magnetic Observatory Buildings

28 The first observatory building was designed to house the absolute measurements besides the

29 variometer recordings. The variometer recordings were located in the basement, while the

30 absolute measurements were carried out at the first floor. All the construction materials were

31 carefully selected. Material samples were investigated in 1887 to find out the best suitable

1   ones with as low as possible influence on the magnetic measurements later on in the building.

2   The belowground parts were constructed from Rüdersdorf limestone, while the aboveground

3   parts were made from Wefensleben sandstone. Lime mortar was exclusively used as binding

4   material. The roof with a big projection over a well aerated loft was constructed as an

5   effective shielding against solar radiation. The basement wall of 1 m thickness is surrounded

6   by an enclosing wall in a distance of 60 cm. This intelligent construction ensured suitably

7   stable temperatures in the inner rooms of the building. Especially constructed, petroleum

8   burning heaters ensured suitable temperatures in the instrument rooms. A distance of 150m to

9   the main building of the meteorological observatory as well as to the domes of the

10   astrophysical observatory prevented disturbing influences on the magnetic measurements and

11   recordings. Fig. 1 shows the view of the observatory building from North-East. The ground

12   plan of the basement is shown at fig. 2.

13   Already during the first years of the operation of the magnetic observatory the astrophysical

14   observatory started the planning of a new big telescope in a distance of only 160 m. The

15   telescope itself was of about 100 tons of iron, requiring a dome of 22 m inner diameter and

16   about 150 tons of iron. Due to the expectable perturbations on the magnetic measurements a

17   new wooden absolute house was constructed in 1897 in a distance of 260 m to the new

18   telescope building (Brückmann, 1911). The absolute house was finished before the

19   construction of the telescope building was started. Fig. 3 shows a view of the absolute house

20   from North-East.

21   The new absolute house had gas-burning heaters. The absolute measurements were carried

22   out in this new building from 1898 onward after comprehensive comparisons with the ones in

23   the old observatory building, which served henceforth exclusively for the variometer

24   recordings. The old observatory building was consequently called from that time onward

25   "variation house". Fig. 4 shows the final ground plan of the Potsdam Meteorological-

26   Magnetic Observatory with 1): absolute house, 2): variation house, 3): meteorological

27   observation field, 4): main building (Hellmann, 1912).

28   The absolute and the variation house were in use until 1928 for the observations. After this

29   period the variation house was used as a repository. It was renovated 1998-2000 according to

30   the regulations for historical monuments and is since then a palaeomagnetic laboratory used

31   by the section 4.3 of Helmholtz Centre Potsdam GFZ. The absolute house became already

1   during the 1980s a palaeomagnetic laboratory. It was in use until 2000. The house still exists

2   and is used as a repository.

3   **2.2   Observatory Instruments**

4   Magnetic observatory data can be achieved only by combining continuous recordings of the

5   temporal variations of the Earth's magnetic field with periodical absolute measurements. The

6   absolute measurements are necessary to calibrate the variation instruments (variometers). The

7   variometers were located at the basement of the observatory building (later called variation

8   house). The absolute measurements were carried out 1890-1897 at the ground floor of the

9   observatory building, from 1898 onward in the absolute house.

10   **2.2.1 Absolute Measurements**

11   According the state of the measurement technology the declination, inclination and horizontal

12   intensity were determined. The declination and the horizontal intensity were measured during

13   the first 2 years by means of the theodolite Edelmann (manufactured in Munich). The church

14   tower of the small town of Werder in a distance of 8 km was used as azimuth target as a

15   reference for the true North direction. The cross hair of a permanently mounted telescope in a

16   distance of 11.5 m inside the observatory building was further available as an azimuth target.

17   The azimuth values of both targets were determined by means of solar observations.

18   An oscillation box, also manufactured by Edelmann, Munich for the measurements of the

19   horizontal intensity also existed. By using the 2 independent measurement methods for the

20   horizontal intensity varying parameters of the deflection magnet, which was used for both

21   methods, were eliminated. The inclination was determined first by a dip needle, manufactured

22   by C. Bamberg, Friedenau near Berlin and an Earth inductor after L. Weber, made by

23   Hartmann & Braun, Frankfurt/Main (Weber, 1885). Fig. 6 shows a sketch of the Bamberg dip

24   needle (left) and a photo of the Earth inductor after L. Weber. Photos of the Edelmann

25   theodolite and oscillation box unfortunately do not exist. The Earth inductor after L. Weber

26   still exists at the Niemegk Adolf Schmidt Geomagnetic Observatory. The disposition of the

27   Edelmann theodolite and the Bamberg dip needle is unknown. The Niemegk Adolf Schmidt

28   Geomagnetic Observatory owns a historic oscillation box, which can be supposed to be the

29   Edelmann one, but it does not have any manufacturer's label.

30   Due to technical problems of the Edelmann theodolite it was replaced in 1893 by an

31   instrument set made by Wanschaff, Berlin, consisting of a theodolite and an oscillation box.

1   Fig. 5 shows both the instruments. In 1901 an Earth inductor following Eschenhagen's

2   construction, made by Schulze, Potsdam was purchased for the inclination measurements

3   (Schmidt, 1905). Fig. 7 shows this instrument. This instrument was in use until 1966 and it

4   still exists in Niemegk.

5   The observatory planned in 1903 a contribution of an instrument to the 1904 world exhibition

6   in St. Louis. For this purpose the observatory commissioned C. Bamberg, Friedenau to

7   construct a theodolite on the base of Adolf Schmidt's design. The remaining time was too

8   short to finish the construction in time. The instrument was handed over in 1907 only. Adolf

9   Schmidt proved his theory for the horizontal intensity measurement by setting the deflection

10 magnet by means of a turn table into different angular positions with respect to the magnetic

11 needle of the theodolite using this instrument. In conclusion of this development Askania,

12 Berlin constructed in 1927 a magnetic theodolite following Adolf Schmidt's specification

13 (Bock and Schmidt, 1928). Fig. 8 shows this instrument, which still exists in Niemegk. Adolf

14 Schmidt's international reputation caused a huge market demand for this excellent instrument.

15 Askania, Berlin delivered such instruments to a big number of international observatories.

16 **2.2.2 Variation Recordings**

17 Two different sets of variometers were operated for the observation of the declination

18 (unifilar), horizontal intensity (bifilar), both based on a suspended magnet, and vertical

19 intensity (balance) in separate rooms of the basement. The so-called main system consisted of

20 the 3 instruments of Mascart's construction, made by Carpentier, Paris (Mascart, 1900) and a

21 photographic recording unit made by Wanschaff, Berlin (Eschenhagen, 1894). For the backup

22 system instruments after Wild-Edelmann's construction were used with manual reading. The

23 main system was operated in the West room of the basement. The recording unit had separate

24 drums for the photographic paper for each variometer, running by a speed of 2 cm per hour,

25 but only one petrol burning light source. It was constructed following the so-called Kew

26 pattern equipment (Gordon, 1880) considering experiences achieved at Wilhelmshaven

27 Observatory. The average sensitivity of the unifilar was 1.09 minutes of arc per mm, of the

28 bifilar 5 nT per mm and of the balance 1 nT per mm (approximately). The baselines of the

29 photographic recordings were interrupted hourly by 3 minutes as time marks, controlled by a

30 non-magnetic pendulum clock. At Fig. 9 the photographic recordings of the declination,

31 horizontal and vertical intensity of the time interval from 15 February 1890 12 o'clock to 16

32 February 1890 12 o'clock (Potsdam mean local time) are depicted as an example of the

1   observatory variometer recordings. Fig. 10 shows sketches of the main system (left) and the

2   backup system (right).

3   In 1903 and 1904 equipment for galvanic scale value determination were installed at all

4   variometers of the main system and of the balance of the backup system. It was taken into use

5   regularly from 1905 onward.

6   2.3   Operation of the Potsdam Observatory

7   Every day at the same time the photographic paper was changed and afterwards developed.

8   Following the usual international practice hourly instantaneous data were determined by

9   means of distance readings between the recorded curve and the baseline manually for each

10   component and converted into magnetic units. Finally the baseline values were added and the

11   results were inscribed into the final tables for the declination (D), horizontal (H) and vertical

12   (Z) intensity, published in the yearbooks. The manual readings taken from the backup system

13   were regularly compared with the photographic recordings of the main system.

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

15   Institute.

16   The first magnetic yearbook, containing the results of 1890 and 1891 was published in 1894

17   (Eschenhagen, 1894). The following volumes were published regularly, but with different

18   delays. The volumes 1892-1900 did not contain the general information, absolute

19   measurement results and baseline values, which were published in Brückmann, 1911.

20   Adolf Schmidt published the yearbooks containing all data and general information beginning

21   with the volume of 1901. From 1905 onward he published hourly mean values (Schmidt,

22   1908) instead of instantaneous data, as it was done of 1890-1904. Gradually all the

23   international magnetic observatories followed Schmidt's example. At the same time Schmidt

24   invented the Greenwich civil mean time as the time base of the observatory (Schmidt, 1908)

25   and changed from the publication of declination (D), horizontal (H) and vertical (Z) intensity

26   to North (X), East (Y) component and vertical (Z) intensity in the yearbooks.

27   2.3.1   Operational Problems and Termination

28   The Potsdam Magnetic Observatory worked over many years undisturbed by external noise.

29   Some international stations noticed already around 1890 first disturbances on their

30   observations, mainly caused by stray currents of DC powered electrical railways. In 1898 the

1   impact of operating tram networks in Berlin on geomagnetic observations was investigated

2   (Edler, 1900). In result the authorities of the Potsdam Magnetic-Meteorological Observatory

3   established regulations for the operation of electrical trams within a 15 km diameter

4   protection circle around the Potsdam Observatory, mainly to abandon the use of the rails as

5   one of the conductors. This regulation turned out to be impossibly met by the tram society

6   from the point of view of economics, when in 1904 the town of Potsdam planned to electrify

7   the horse tramway. Similarly, for the nearby Teltow Canal, constructed 1900-1906, a towing

8   by electrical locomotives was intended to be used. So leakage earth current influences on the

9   magnetic observations seemed to be inevitable. Due to running both the rail establishments by

10   DC power the movement of Potsdam Observatory seemed to be indispensable (Schmidt,

11   1910). It was decided to establish an additional station for variometer recordings at a location

12   in secure distance to the DC powered Potdam tramway and the Teltow Canal towing engines.

13   The observations at Potsdam Observatory were intended to be continued as usual. Especially

14   the absolute measurements should be performed only in Potsdam.

15   Due to the launch of the DC powered service of the Berlin suburban railway system on 11

16   June 1928 the observatory was forced to terminate the observations step by step in the course

17   of the year 1928 (Nippoldt, 1930). Only the inclination measurements were further performed

18   in Potsdam, strictly only during the shutdowns of the railway service.

2.3.2 Affiliation and Directors of the Observatory

20   The Potsdam Observatory was affiliated during its complete existence to the magnetic

21   department of the Magnetic-Meteorological Observatory Potsdam of the Royal Prussian

22   Meteorological Institute Berlin. The institute was renamed in 1919 into "Prussian

23   Meteorological Institute Berlin".

24   Max Eschenhagen (1858-1901) was from 1890 until 1901 observer, observatory director and

25   head of the magnetic department of the Royal Prussian Meteorological Institute Berlin. Fig.

26   11 shows his portrait. Max Eschenhagen died in 1901 of an age of only 43 years after serious

27   disease. The famous Adolf Schmidt (1860-1944) could be appointed as his successor from

28   1902 onward. He kept the director's position until the closing of the observatory in 1928. His

29   portrait is shown at Fig. 12. Adolf Schmidt went retired on 1 October 1928. Alfred Nippoldt

30   (1874-1936) took over his position. Fig. 13 shows his portrait.

31 Appendix: Instrument Makers Related to the Observatory

1   **Max Thomas Edelmann** (1845-1913) an Engineer, Physicist and University Professor

2   (Techn. Hochschule München) founded in 1870 the company „Physikalisch-Mechanisches

3   Institut zur Herstellung physikalischer Präzisionsapparate" (Physical-mechanical institute for

4   the production of physical precision instruments) in Munich. He received several national and

5   international awards for his instruments.

6   **Carl Bamberg** (1847-1892) was a watchmaker and protégé of Carl Zeiss. He founded 1888

7   the „Carl Bambergs Werkstätten für Präzisions-Mechanik und Optik" (Carl Bamberg's

8   workshops for precision mechanics and optics) in Berlin-Friedenau. Besides of his magnetic

9   instruments he became famous for the construction of the telescope Bamberg-refractor.

10   Relatives continued the company after his death and changed the name after fusion with any

11   other instrument-building company in 1912 into

12   **Askania Werk AG**. This company expanded the production to nautical instruments,

13   weaponry, film cameras and projectors. They were strongly involved in producing equipment

14   for the military in the first and second world war. After the war the company was split into

15   several ventures in East and West Germany.

16   **Julius Wanschaff** (1844-1903) established a workshop for precision instruments in Berlin in

17   the 1870s. The company was inherited by Hermann Wanschaff in 1903 and absorbed in to

18   Askania Werk AG in 1922.

19

20   **Acknowledgements**

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23   Geosciences, which rendered possible to write the paper using its resources. I am especially

24   thankful to Jürgen Matzka, group leader Geomagnetic Observatories of the Geomagnetism

25   Section of the GFZ, for giving me the opportunity to work at the Niemegk Adolf Schmidt

26   Geomagnetic Observatory. Since my official retirement end of 2014 I had the chance to use

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

28   information.

29

1 **References**

2 Alexandrescu, M., Courtillot, V. and Le Mouel, J.-L.: High resolution secular variation of the

3 geomagnetic field in western Europe over the last 4 centuries - Comparison and integration of

4 historical data from Paris and London, JGR Vol. 102, No. B9, pp. 20,245-20,258, 1997

5 Beblo, M. and Soffel, H.: 150 years Earthmagnetic Observatories München-Maisach-

6 Fürstenfeldbruck, pp.11-18, Münchner Universitätsschriften, Münchner Geophys. Mitteil. H.

7 5, 1991

8 Bock, R. and Schmidt, A.: Ein neuer magnetischer Normaltheodolit, pp. 1-14, Zeitschrift für

9 Instrumentenkunde, XLVIII. Jahrgang, Januar 1928, Erstes Heft.

10 Brückmann, W.: Ergebnisse der magnetischen Beobachtungen in Potsdam, Ergänzungsband

11 zu den Jahrgängen 1892-1900, pp. 1-102, Veröffentlichungen des Königlich Preußischen

12 Meteorologischen Instituts, Nr. 232, Behrend & Co., Berlin 1911

13 Edler, J.: Untersuchungen des Einflusses der vagabundierenden Ströme elektrischer

14 Straßenbahnen auf erdmagnetische Messungen, pp. 193-199, Elektrotechnische Zeitschrift

15 Bd. 21, 1900

16 Eschenhagen, M.: Ergebnisse der magnetischen Beobachtungen des Observatoriums in

17 Potsdam in den Jahren 1890 und 1891, pp. 1-76, Veröffentlichungen des Königlich

18 Preußischen Meteorologischen Instituts, A. Asher & Co., Berlin, 1894

19 Gordon, J. E. H.: A Physical Treatise on Electricity and Magnetism (Vol.1). Sampson Low,

20 Marston, Searle, & Rivington, London, 1880

21 Hellmann, G.: Das Meteorologisch-Magnetische Observatorium bei Potsdam, pp. 1-69,

22 Veröffentlichungen des Königlich Preußischen Meteorologischen Instituts Nr. 253, Berlin,

23 1912

24 Körber, H.-G.: Zur Vorgeschichte der Gründung des Geomagnetischen Observatoriums

25 Potsdam, pp. 126-133, Jahrbuch 1963 des Adolf-Schmidt-Observatoriums für

26 Erdmagnetismus in Niemegk, Akademie-Verlag Berlin, 1965

27 Mascart, E.: Traité de magnétisme terrestre, p. 191, Paris 1900

1 Nippoldt, A.: Ergebnisse der magnetischen Beobachtungen in Potsdam und Seddin im Jahre

2 1928, pp. 3-38, Veröffentlichungen des Preußischen Meteorologischen Instituts Nr. 374,

3 Julius Springer, Berlin, 1930

4 Schmidt, A.: Ergebnisse der magnetischen Beobachtungen des Observatoriums in Potsdam im

5 Jahre 1901, pp. 1-83, Veröffentlichungen des Königlich Preußischen Meteorologischen

6 Instituts, A. Asher & Co., Berlin, 1905

7 Schmidt, A.: Ergebnisse der magnetischen Beobachtungen des Observatoriums in Potsdam im

8 Jahre 1905, pp. 1-82, Veröffentlichungen des Königlich Preußischen Meteorologischen

9 Instituts Nr. 196, Behrend & Co., Berlin, 1908

10 Schmidt, A.: Ergebnisse der magnetischen Beobachtungen des Observatoriums in Potsdam

11 und Seddin im Jahre 1908, pp. 1-97, Veröffentlichungen des Königlich Preußischen

12 Meteorologischen Instituts Nr. 225, Behrend & Co., Berlin, 1910

13 Schröder, W. and Wiederkehr, K.-H.: Geomagnetic research in the 19th century, pp. 445-466,

14 Acta Geod. Geoph. Hung. 37, 2002

15 Stern, D. P.: A millennium of geomagnetism, p.1-1 to 1-30, Reviews of Geophysics, **40**(3),

16 2002

17 Voppel, D.: Angewandte marine Geowissenschaften – von der Deutschen Seewarte und dem

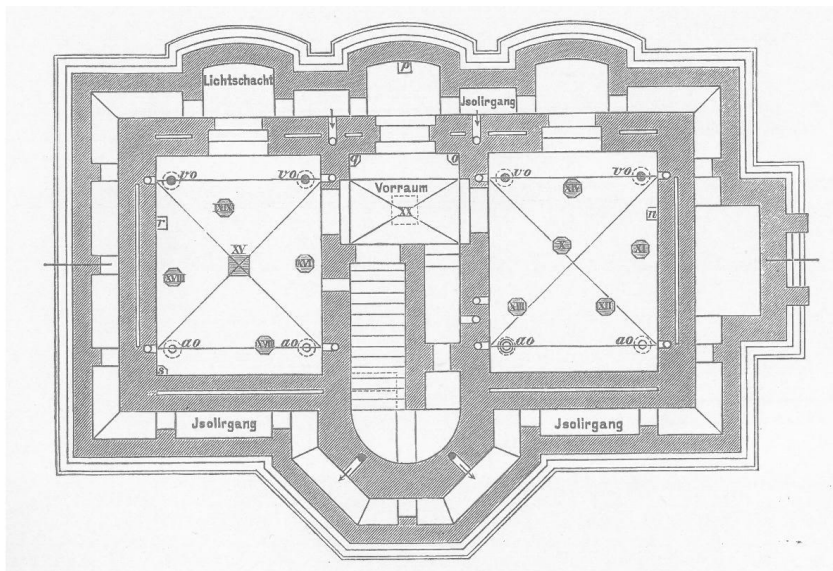
18 Marineobservatorium über das Deutsche Hydrographische Institut zum Bundesamt für

19 Seeschiffahrt und Hydrographie, pp. 128-133, Zur Geschichte der Geophys. in Deutschl.,

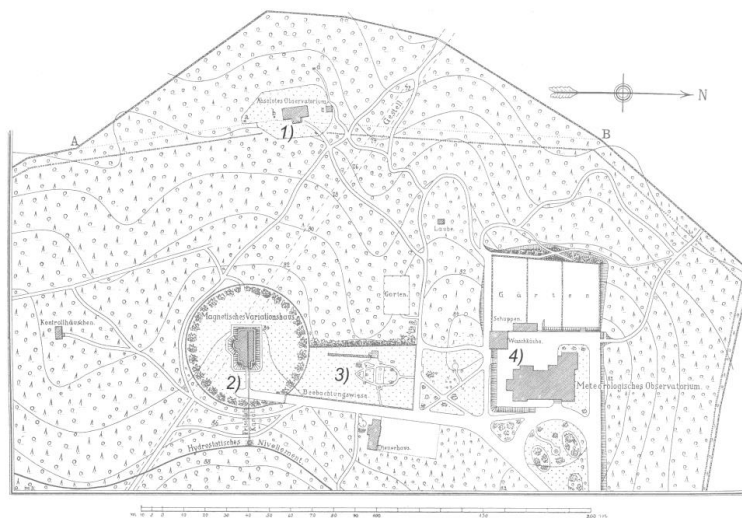
20 Hamburg, 1997

21 Weber, L.: in "Sitz.-Ber. d. Akad. d. Wiss.", S. 1105, Berlin, 1885

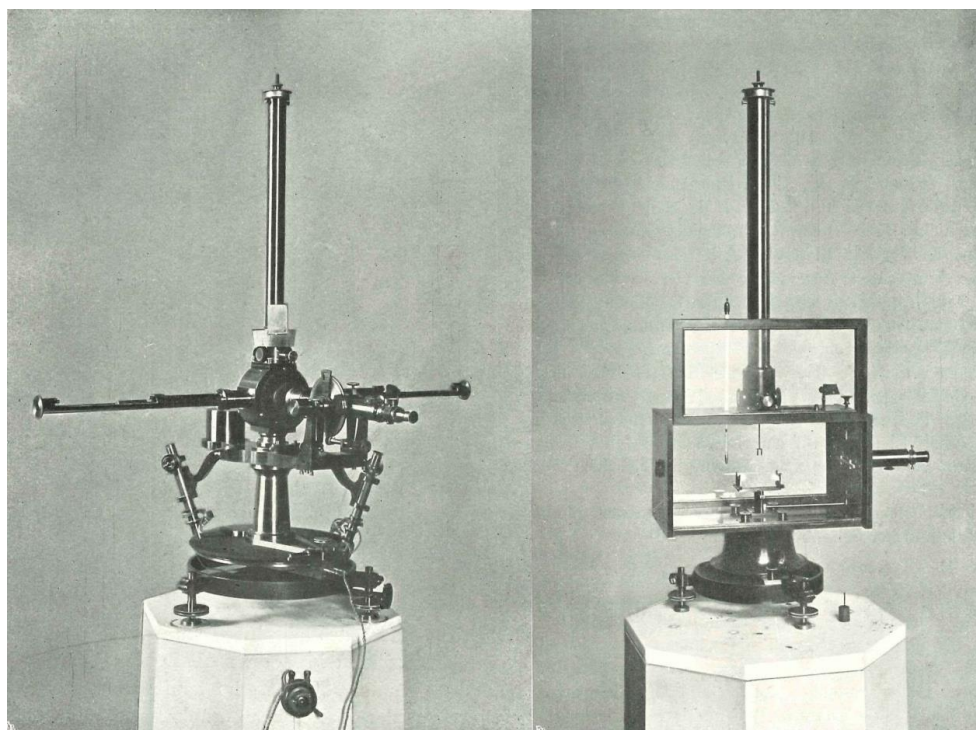
22

3   Fig. 1. View of the observatory building from North-East. Source: Hellmann, 1912 Fig. 19

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

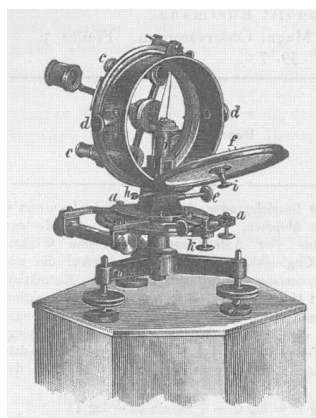
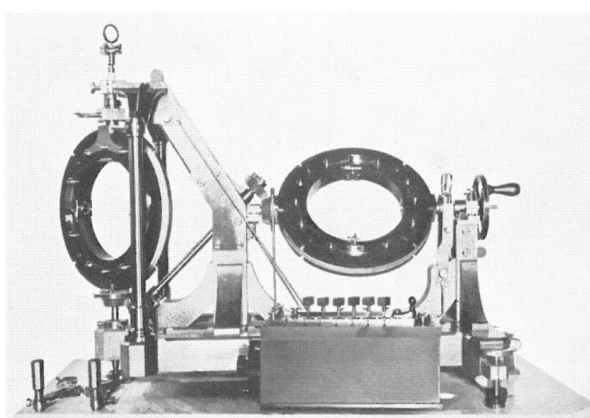
7   20

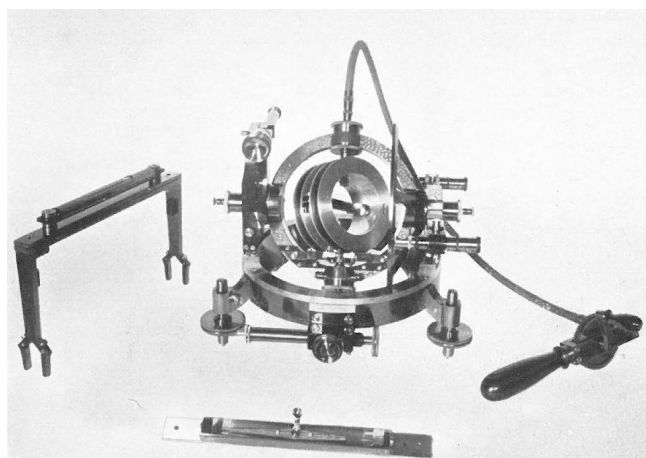
2   Fig. 3. View of the absolute house from North-East. Source: Hellmann, 1912 Fig. 23

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

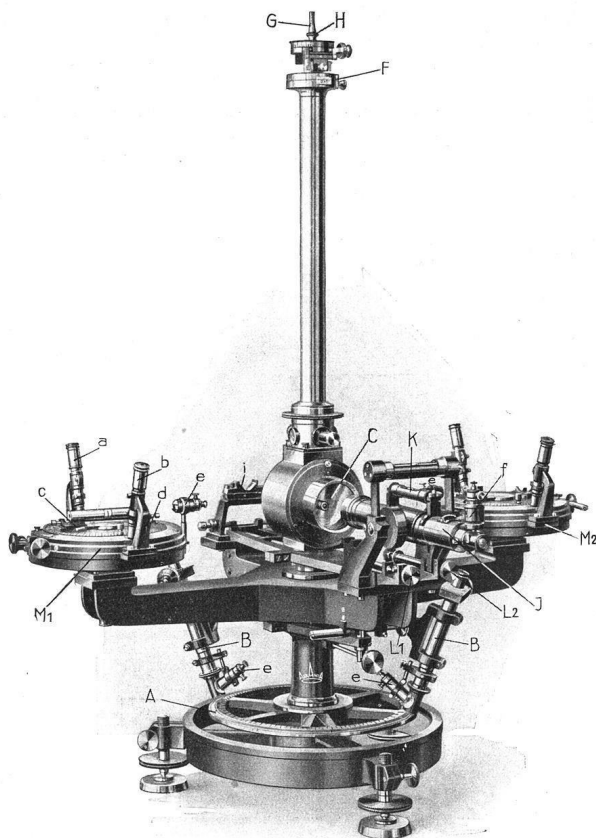
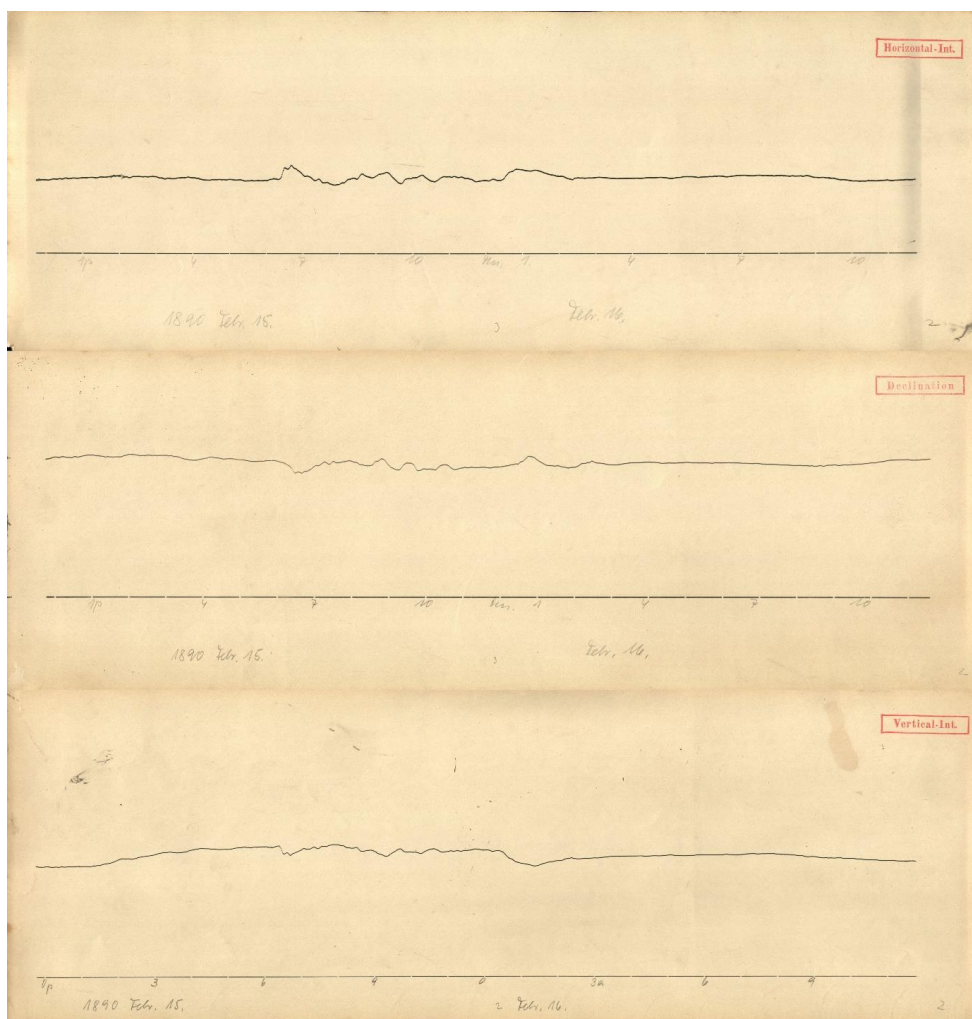
5   1): absolute house, 2): variation house, 3): meteorological observation field, 4): main

6   building. Source: Brückmann, 1911 Tafel III

2 Fig. 5. Magnetic theodolite (left) and oscillation box (right) made by Wanschaff, Berlin.

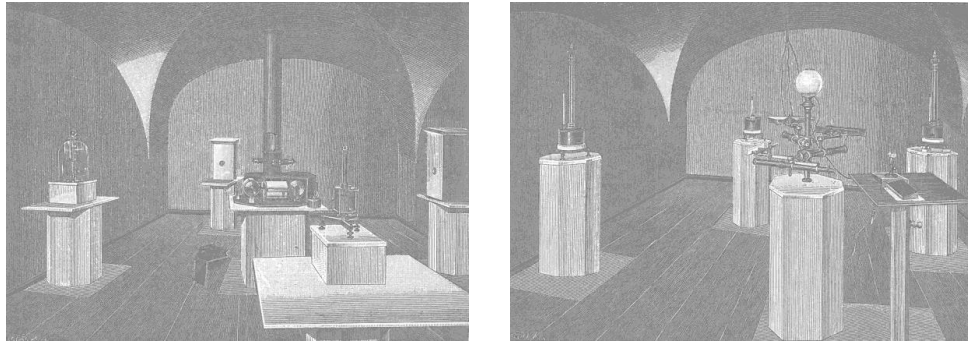
3 Source: Left:: Hellmann, 1912 Fig. 25

4 Right: dito Fig. 26

6 Fig. 6. Sketch of the dip needle by C. Bamberg, Friedenau near Berlin (left) and Earth

7 inductor after L. Weber (right). Source: Left: Eschenhagen, 1894 S. XXVIII, Right: Hellman,

8 1912 Fig. 21

2   Fig. 7. Earth inductor by Schulze, Potsdam. Source: Hellmann, 1912 Fig. 22

4   Fig. 8. Normal theodolite after Adolf Schmidt. Source: Bock, 1928 Fig. 1

2   Fig. 9. Potsdam Observatory photographic recordings of the declination, horizontal and

3   vertical intensity of the time interval 15 February 1890 12 o'clock till 16 February 1890 12

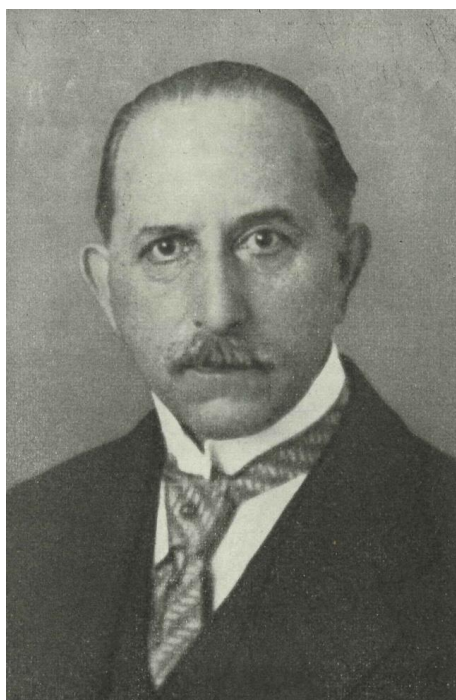
4   o'clock (Potsdam mean local time). Source: Helmholtz Centre Potsdam - GFZ

1   Fig. 10. Main recording system (left) and backup variometer system for manual reading

2   (right). Source: Eschenhagen, 1894 pp. XXXVIII and XXXIX

5   Fig. 11. Max Eschenhagen's portrait.

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

7   Potsdam - GFZ

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

4   Fig. 13. Alfred Nippoldt's portrait. Source: Bock 1937 p. III