History of research institutions on the Potsdam Telegraph Hill (Telegrafenberg)

by Peter Bormann
Topics

1. Important buildings on the *Telegrafenberg*
2. History of Berlin-Potsdam Astronomy & Astrophysics
3. History of Berlin-Potsdam Geodesy
4. History of Berlin-Potsdam Geomagnetism and Meteorology
5. Contributions of Potsdam to seismology since 1889 in its relations to Strasbourg, Jena and Freiberg
6. The Central Institute of Physics of the Earth (1969-91)
7. Developments on the Telegrafenberg since 1992
1. Buildings on the *Telegrafenberg* (93.5 m a.s.l.)

- The Telegraph Hill is the highest elevation next to Potsdam on the Pleistocene *Saarmund* push moräne ridge (max. 124.6 m a.s.l.)

1832/33 **Opto-mechanical telegraph** line Berlin-Magdeburg-Köln-Koblenz set up with 62 stations, at 7.5-15 km distance

- Station No. 4 on the Potsdam Telegraph Hill

- 6 levers in 3 levels allow for 4096 sign combinations!

- State telegrams from Berlin to Koblenz and vice versa in < 10 min

- 1848 replaced by electric telegraph
Astrophysical Observatory Potsdam (built 1876/77)

Since 2001 used by the

Potsdam Institute for Climate Impact Research (PIK)

↑ Tower entrance from north

View from southeast →
Magnetic Observatory (built 1888/89)

Today used by the GFZ Working Group on Palaeomagnetism.
Geodetic Institute (built 1889-91)

Today used by the GFZ Department 1 „Geodesy and Remote Sensing“
Main Building of the Meteorologic-Magnetic Observatory (1890-93)

1949-1991 part of the Meteorological Service of the GDR
1992-2004 branch of the German Weather Service (DWD)
From 2007 onwards the building will be used by PIK
Observatory for Angular Measurements (built 1892-93)

From angular measurements

Now named „Helmert Turm“

to →

satellite tracking & ranging

with the CIPE-built SBG mounted on a ZEISS Jena satellite tracking telescope

Peter Bormann

XXIX ESC General Assembly, Sept. 12-17, 2004
Die Königlich Preußischen Observatorien bei Potsdam auf dem Telegraphen-Berge (um 1892)

Geodätisches Institut mit Observatorium für Winkelmessungen

Astrophysisches Observatorium

Magnetisch-Meteorologisches Observatorium

Eingang zum Observatoriumsgelände

GFZ
Peter Bormann
XXIX ESC General Assembly, Sept. 12-17, 2004
Great Refractor (built 1896-99)

In operation between 1899-1968.

The Great Refractor in the 1950s

d = 80 cm  
f = 12 m  
photographic

d = 50 cm  
f = 12.5 m  
visuell

4th largest refractor world-wide
Earthquake House (completed in 1902)

The 1903 WIECHERT 1000 kg-Pendulum
Einsteinturm (built 1920-24)
A43 (built 1963-64)
(Inaugurated on the occasion of the 75th anniversary of the Geomagnetic Institute Potsdam)

- 1969-91 used by the Central Institute of Physics of the Earth (CIPE); in the 1980s also headquarters of the Research Branch Geo- and Cosmics Sciences of the Academy of Sciences of the GDR.

- Since 1992 used by the Potsdam branch of the Alfred-Wegener-Institute for Polar Research (AWI)
Potsdam Institute for Climate Impact Research (since 1992)

Temporary buildings used by PIK since 1993 (until 2007)

New PIK main building, used since 2001.

← To be used by PIK from 2007 onwards
Main buildings of the GeoForschungsZentrum Potsdam (1995-98)
Laboratory of the AWI-Potsdam (built 1998-99)
2. History of Berlin-Potsdam Astronomy & Astrophysics

1700 By recommendation of Gottfried Wilhelm LEIBNITZ (1646-1716) and Royal order foundation of the „Brandenburgische Societät“ (later called Royal Prussian Academy of Sciences → Berlin Acad. of Sciences → German Acad. of Sciences → Acad. of Sc. of GDR) and of the Berlin Astronomic Observatory.

- It had the Gregorian calendar patent/monopol and close scientific relations with the Academicians LEIBNITZ, EULER, LAMBERT, LAGRANGE, MAUPERTIUS et al.

First Berlin Astronomic Observatory (1711-1832)
1832-35 Construction of the new Berlin Astronomic Observatory

- On recommendation by Alexander von Humboldt equipped with the (second after Tartu) **world-wide largest and best Frauenhofer refractor**.
- Between 1836-65 also **used also as geomagnetic observatory**
- **Pendulum measurements** at the observatory by Friedrich Wilhelm Bessel (1784-1846)
- **Operated until 1913** when the observatory moved to Neubabelberg
1846 Andreas W. G. GALLE (1858-1943) discovers with the 9-inch Fraunhofer refractor planet Neptun

1865 Wilhelm Julius FOERSTER (1832-1921) director of the observatory. He has been instrumental in:

- introducing the international metric system,
- creating the German and the international organizations for measures and weights,
- initiating in 1865 a „sun observatory“ at Potsdam which later became the world’s first Astrophysical Observatory (AOP),
- drafting with F. R. HELMERT the concept for the new Geodetic Institute Potsdam (GIP) on the Telegrafenberg
- founding, together with Wilhelm MEYER and Wernher von SIEMENS, the URANIA Society → First public astronomical observatory → pioneered Education & Outreach
1876-78 Construction of the Astrophysical Observatory Potsdam

AOP design plan front view S to N

AOP in 1886

Peter Bormann  XXIX ESC General Assembly, Sept. 12-17, 2004
1889 April 1 to Sept. 24 continuous measurements of the time-variable deflections of the vertical with a modified ZÖLLNER horizontal pendulum by Ernst von REBEUR-PASCHWITZ (1861-95) in the vault underneath the eastern cupola of AOP
v. Rebeur-Paschwitz found in the records:

- influence of air pressure and temperature changes on the records → discusses causes and need for shielding/avoidance.
- increase of instrumental period with amplitude and sees the cause in elastic deformation of suspension and bearing components (theory by Bessel).
- the dominant influence of ocean tides and related crustal deformations in near-coastal records (Wilhelmshafen, Teneriffa);
- the half-day period (lunar term) of Earth tides;
- the daily period of Earth tides;
- diurnal and seasonal variations of → microseisms and their dependence on wind conditions;
In conclusion, he stresses the *need for long-term permanent recordings* in order to be able to investigate and separate these various complex influences:

"Given such a complex composition of a phenomena one can not expect to achieve remarkable results by means of only isolated sporadic observations. Rather, ... as in other related fields of natural sciences ... the real progress is only achieved by organizing well-planned and uninterrupted observations."
And most importantly:

von Rebeur-Paschwitz identifies more than 30 transient events of different duration and amplitude which super-pose his long-period tidal records. He finds that they are often in close timely co-incidence in the synchronous records at POT and WHF.

→ earthquakes!
1899  Inauguration of the Great Double Refractor
Astronomical Observatory Babelsberg (built 1911-13)

One of the most modern and best equipped research institutions of its time.
1920-22 Construction of the „Einstein tower“ (ET)

Architect: Erich MENDELSOHN (1887-1953)

Albert Einstein at the tower in late 1921 →
1922-24 Installation of the **tower telescope** (first in Europe) and of the **spectroscopic** in the Einstein tower.

Carl Zeiss Jena mirror system for the coelostate in the cupola of the Einstein tower.

**FRAUENHOFER-Spectrum of the sun from 390-657 nm**

- Ca
- H-Beta
- Mg
- Na
- H-Alpha
4. History of Berlin-Potsdam Geodesy

1831-36 Friedrich Wilhelm BESSEL (1784-1846) → carries out the East Prussia arc measurement, assisted by Colonell J. J. Bayer.

1861 Johann Jacob BAEYER (1794-1885), General-lieutenant in the Prussian General Staff → submits memorandum: „Draft for a Central European Arc Measurement“. Goals:

- To homogenize and connect the \textit{triangulations} of all participating European countries;
- Narrow-mesh determination of \textit{deflections of the vertical} for studying the \textit{shape of the geoid}, including geodetic-astronomical measurements at 30 astronomical observatories in the area.
1862-67  Execution of the **Central European Arc Measurement**
→ **world-wide first intern. scientific cooperation between states**!

1867-86  European Arc Measurement

1870  Foundation of the **Royal Prussian Geodetic Institute at Berlin**

1878  **Theory of the figure of the Earth** by Ernst Heinrich **BRUNS**
(1848-1919), Professor of Mathematics in Berlin (1878-82).

After the death of J. J. Baeyer in 1885:

1886-1917  **International Arc Measurement (IAM)**
1885/6 Friedrich Robert HELMERT (1843-1917) elected President of the Central Bureau of the IAM and appointed Director of the Geodetic Institute

F. R. HELMERT is the founder of the mathematical and physical theories of modern geodesy

GFZ

Peter Bormann  XXIX ESC General Assembly, Sept. 12-17, 2004
1889-91 Building of the new Geodetic Institute on the Telegrafenberg
1892/93 Construction of the Geodetic-astronomical Observatory for Angular Measurements (now named „Helmert Tower“) together with two meridian houses.
1891-1910 Oskar HECKER (1864-1938) works at the GIP and makes contributions to seismology:

- Since 1896 regular use of the horizontal pendulum for earthquake observations

- Improving the Rebeur-Paschwitz pendulum by introducing air attenuation.

- Uses it as a shock and vibration meter and for determination of average velocities in north-german sands

- Proposed design for the Potsdam earthquake house, completed in 1902
• Head of the Potsdam seismic station between **1902 and 1909** and responsible for the station bulletin.

• Equipping the station with his own improved 2-component horizontal pendulum with air attenuation → and with the 1000 kg astatic 2-component horizontal WIECHERT-pendulum, operating at station POT from **1903-54**

HECKER-modified Rebeur-Paschwitz pendulum in use at POT station from 1902-14.
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1914-28 Only the horizontal 1000 kg WIECHERT pendulum and occasionally also the 80 kg vertical WIECHERT pendulum are operated at station POT.

1929-54 A vertical component GALITZYN-WILIP operated additionally at station POT.

WIECHERT response, N-comp
5. History of Berlin-Potsdam Geomagnetism and Meteorology

5.1 Geomagnetic measurements in Freiberg, Berlin and Potsdam


1890 Foundation of the Magnetic Dept. of the Meteorologic-Magnetic Observatory Potsdam.

Peter Bormann  XXIX ESC General Assembly, Sept. 12-17, 2004
1890  Max ESCHENHAGEN (1858-1901) \(\rightarrow\) first director of the Magnetic Department of the MMOP on the Telegrafenberg.

- Develops **field variometers**, produced in Potsdam by O. Toepfer and later **used** also in SCOTT’s Antarctic Expedition

1894  Pioneering work of Adolf SCHMIDT on the global representation of the geomagnetic field
5.2 Meteorology in Berlin and Potsdam

1823  Commencement of barometer observations in Potsdam by the director of the teacher’s seminar, Karl Friedrich von KLOEDEN

1842-62  First regular meteorological observations in Potsdam by the Royal gardener in Sanssouci, Wilhelm LEGELER, as voluntary observer of the Royal Prussian Meteorological Institute at Berlin.


1885  Wilhelm von BEZOLD appointed first professor of meteorology at the Berlin Humboldt University.

1890-93  Construction of the main building of the Meteorologic-Magnetic Observatory Potsdam
1893 Adolf *SPRUNG* first director of the Meteorological Observatory (until 1909);
- regular meteorological observations start
- **Secular station Potsdam** →
  → **World Climate Program**

- SPRUNG develops many instruments:
  - Barograph
  - Wind speed meter
  - Wind speed recorder and stereographic cloud camera

The unique „Secular Station“ where soil temperatures are measured in 10 boreholes between 2 cm and 12 m depth.
1901  **R. SÜRING** and **A. BERSON**
first open balloon ascent of man
into the stratosphere!

- First in-situ proof of the existence
  of the stratosphere.
- The reached altitude of **10,800 m**
  is up to now world record in an open
  manned balloon!

1909  Reinhard Joachim SÜRING (1866-1950) →
director of the MMOP between 1909-32
and 1945-50

1928-34  **KOHLHÖRSTER** of the MMOP is co-discoverer of the cosmic rays
  together with Victor **HESS**, nobel-prize winner of 1936.
  Nazi regime prevented adequate honoring of **KOHLHÖRSTER**.

1974  The Potsdam Meteorological Observatory becomes (until 1990) the
  **WMO European Regional Center for ozon measurements**.
5. Contributions of Potsdam to seismology since 1889 in its relations to Strasbourg, Jena and Freiberg

• Ernst von Rebeur-Paschwitz’s 1889 earthquake records and the inferences and recommendations drawn therefrom were the first and main „seismological event“ at Potsdam with world-wide impact.

• With the exception of O. HECKER’s instrumental improvements, initiatives for setting up the Potsdam seismological station in 1902 and organizing a seismic service (1902-54) there has been no important seismological research and publications after v. REBEUR-PASCHWITZ until the foundation of CIPE in 1969.

• The establishment of a strong seismology group on the Potsdam Telegrafenberg in 1972 profited essentially from knowhow acquired and personalities who had worked at Strasbourg, Jena and Freiberg. Therefore, this tradition line, beginning with v. REBEUR-PASCHWITZ, has to be sketched.
In his publication in 1892 about the horizontal pendulum measurements of 1889, v. REBEUR-PASCHWITZ:

- relates two other synchronous records at POT and WHF definitely to major earthquakes which had occurred in Central Asia on 11 July and in Greece on 25 August 1889, respectively;

- states that the large amplitude motions propagate dominantly not through the inner part of the Earth but rather close the surface;

- reasons that those motions may come to us along paths which supplement each other to a great circle → R1, R2, ...!!!

From NMSOP, 2002
In the year of his death there appear two major publications by E. v. REBEUR-PASCHWITZ in GERLAND’s Beiträge zur Geophysik:

In volume 2, pages 211-536, he states:

- There are **surface and body waves** which propagate through the Earth;

- The propagation **velocity is significantly larger at greater depth** than near to the Earth surface;

- Accordingly, **the apparent horizontal velocity is a function of distance!**
“EQ observations provide us ... with a means to determine the elasticity modulus of the Earth interior at different depth.”

“We will thus be in a position, particularly with strong earthquakes, to track the wave propagation through the whole Earth’s body and thus to develop the fundamentals for a new theory which will guide us, in an indirect way, gradually to the knowledge of the composition of the Earth’s Interior.”

In conclusion he publishes in 1895 („Beiträge zur Geophysik, 2, p. 773-782)

Proposals for the establishment of an international system of earthquake stations (in total 35)

and drafts a related resolution for the 6th International Geographic Convention held in London in 1895:
• „We wish to propose in the first line the foundation of an international net of earthquake stations with the task to observe, in a systematic way, the propagation of motions on the Earth’s surface and through the Earth body that emanate from large earthquake centers.“

• „It is desirable and for the success of this undertaking important that all stations select the same kind of instruments and that these are brought up to the same degree of sensitivity.“

• „All signatories consider a Central Bureau for the collection and publication of the earthquake reports from all over the world a necessary supplement to the proposed monitoring system.“

This resolution is submitted to the conference by Georg C. K. GERLAND (1833-1919) Professor of Geography at Strasbourg University.
5.1 Developments in Strasburg (until 1919)

Reinhold EHLERT (1871-1899), → assistant with Georg GERLAND.

He modifies in 1896 the single-component horizontal pendulum of v. REBEUR-PASCHWITZ to a 3-component horizontal pendulum ↓

Recommended by G. GERLAND as standard pendulum for the proposed global network

Peter Bormann  XXIX ESC General Assembly, Sept. 12-17, 2004
1897 Georg GERLAND proposes during the German Geographer Day in Jena the establishment of a seismological station in Jena.

1899 Foundation of the „Imperial Central Station for Earthquake Research“ (ICSER) in Strasbourg by Georg GERLAND (director until 1910).

• G. GERLAND proposes at the 7th International Geographic conference in Berlin the creation of an International Seismological Society

• At this Berlin conference an International Permanent Commission for Earthquake Research with 54 members was already created

← Former ICSER at Strasbourg, nowadays a seismological museum.
The conference proposed an International Association for Seismology with a Permanent Commission, a General Assembly and a Central Bureau.
1903  2nd International Seismological Conference at Strasbourg defines the statutes of IAS

1904  Foundation of the **International Seismological Association (ISA)** with its Central Bureau in Strasbourg.  →  First Chairman: G. GERLAND

  • August SIEBERG (1875-1945)  →
    employed at ICSER.
  →  Works in the field of macroseismic data
  →  Publishes „Handbuch der Erdbebenkunde“

1910  Oskar HECKER from the GI Potsdam new director of ICSER.

1912  MERCALLI-CANCANI-SIEBERG

  **12-degree macroseismic intensity scale**

1919  After Germany lost Elsaß-Lothringen to France in WWI, HECKER and SIEBERG moved to Jena.
5.2 Developments in Jena from 1900 to 1969

In response to the recommendations made by G. GERLAND at the German Geographer Day 1897 in Jena and his publication on the establishment of an earthquake monitoring system sent in 1898 to the curator of the Jena University:

1900 Rudolph STRAUBEL (1864-1964) installs at the Physical Institute of the University of Jena
   • a REBEUR-EHLERT pendulum and
   • his own Z-component seismograph

1904 Opening of JENA Seismol. Main Station at the Astronomical Observatory in Jena. The observatory is equipped with:
   • STRAUBEL Z-comp. seismograph (T = 6.6 s, V = 2030), improved by Otto EPPENSTEIN.
   • WIECHERT 1200 kg (N, E) astatic pendulum (T ≈ 10 ± 2 s; V ≈ 200 ± 30
Since April regular monthly reports and later also annual bulletins of JEN.

Recording at station JEN of the famous Tunguska/Siberian meteorite fall with the improved STRAUBEL- seismograph.

(nach Martin, 1966)
1912 PhD thesis by Walter PECHAU
„Propagation velocity and absorption of earthquake waves“
→ R1, R2, R3 etc.!

1913 Main station JEN operates additionally
• 2-comp. REBEUR-EHLERT pendulum
• 80 kg-WIECHERT Z-pendulum
• 200 kg MAINKA pendulum (N, E)

MAINKA pendulum, $T_0 \approx 26$ s, $V \approx 28$ →
1919  • O. HECKER becomes director of the main station Jena
• A. SIEBERG becomes head of the WG Macroseismic

1923 Foundation of the „Reichszentrale für Erdbebenforschung“ (RfEF) (Director: O. HECKER until 1932) with 3 Departments:

• Microseismic (Head: G. Krumbach)
• Macroseismic (Head: A. Sieberg)
• Appl. Geophysics (Head: O. Meisser)

• Opening of the new station JEN → (with support of CARL-ZEISS Foundation)
The new station JEN operates until 1964. It is equipped with:

- MAINKA 200 kg Kegelpendel
- WIECHERT 1200 kg (N, E; MP)
- WIECHERT 1300 kg (Z; MP)
- WIECHERT 15,000 kg (N, E; SP)

\[ \text{Astatic WIECHERT pendulum (N, E), } T \approx 8.5 \text{ s, } V \approx 200 \]
View into the seismometer room of station JENA
Complemented in:

1935 by a Jena-built vertical component
GALITZYN seismograph

And in the 1950s and early 1960s, respectively, by:

- short-period KRUMBACH seismographs
  (4 kg; N, E, Z; optical and galvanometric recording;
  T = 2.5 s, Vmax = 2000 (N, E) up to 23 000 in Z)

- TEUPSER HSJ-1 seismograph
  (N, E; broadband from T = 0.1-20s, V = 1000)
1924-40 Otto MEISSER (1899-1966) at the Jena RfEF

- land and air seismics
  (Handbook WIENS-HARMS)

→ Later director of the Inst. of Applied Geophysics, Mining Academy Freiberg (BAF; 1940-64)

→ again director of the Jena Institute of Geodynamics (1964-66)

1924-55 Gerhard KRUMBACH (1895-1955), student of E. WIECHERT, employed at the Jena institute

- responsible for station JEN and the microseismic research

- 1946-55 director of the institute and initiator of the new building

O. MEISSER with E. VAN GILS, Secretary General of ESC, at the 1962 ESC General Assembly in Jena
1925-61 Hans MARTIN (1899-1990) at the Jena institute
- working in Dept. of Appl. Geophysics
- 1956-61 director of the institute

1930 A. SIEBERG: „Erdbeben“ (175 pp.) and „Erdbebengeographie“ (317 pp.) in GUTENBERG’s „Handbuch der Geophysik“, Vol. 4

1934-70 Wilhelm SPONHEUER (1905-1981) working at the Jena institute with A. SIEBERG in Dept. Macroseismic on
- complementing the German earthquake catalogue
- improving the macroseismic intensity scale

1936 A. SIEBERG appointed director of the Jena institute

1940 A. SIEBERG: „Beiträge zum Erdbebenkatalog Deutschlands und angrenzender Gebiete für die Jahre 58 bis 1799“
ERKLÄRUNG

- Panzendecke
- Infrakrustale Erstarrungskruste
- Kernmasse

\[ V_1 = \text{erste Vorläufer} \]
\[ V_2 = \text{zweite Vorläufer} \]
\[ \text{einmal reflektierte Vorläufer} \]
\[ \text{zweimal reflektierte Vorläufer} \]
\[ B = \text{Hauptwellen} \]

Schematische Darstellung der Fortpflanzung der seismischen Wellen und ihres Erscheinens im Seismogramm.

Entworfen von A. SIEBERG.
1954-56 Construction of the new institute building in Jena

1960-63 Construction of the new seismological observatory MOXA, 35 km from Jena.
1962 ESC General Assembly in Jena

Prof. Savarensky ↓ Prof. Belousov ↓ Prof. S. Mueller ↓
5.3 Contributions/decisions by Jena scientists with relevance for development of seismology in Potsdam during the 1970s/1980s

Wilhelm SPONHEUER

1952 „Erdbebenkatalog Deutschlands und der angrenzenden Gebiete für die Jahre 1800-1899“ (later continued for GDR until 1975; inc.)


1960 „Methoden zur Herdtiefenbestimmung in der Makroseismik“

1964 • MEDVEJEV-SPONEUER-KARNIK intensity scale MSK-64

→ Further developed at Potsdam by G. GRÜNTHAL et al. to the EMS-98

Peter Bormann   XXIX ESC General Assembly, Sept. 12-17, 2004
Christian TEUPSER (1928-91)

Developed (in collaboration with the Jena theoreticians R. Maaz, P. Malischewski and W. Ullmann as well as with E. Unterreitmeier) all modern seismographs later used in the:

- GDR main observatories
  MOX, CLL and BGR;
- Potsdam Seismic Network
- Vogtland seismic monitoring net
- Special GDR network for investigation of the Earth crust and upper mantle by means of surface waves (H. NEUNHÖFER)
- Seismological stations BUDAPEST, TIRANA, SANTIAGO DE CUBA
- rock-burst monitoring systems in mines
Development of new electrodynamic seismographs at Jena

Der Vertikalseismograph unter besonderer Berücksichtigung des Typs VSJ-I

Von
Peter Malichowsky, Christian Trupser und Wolfgang Ullmann

AKADEMIE-VERLAG · BERLIN
1970
The TEUPSER 30m quartz strainmeter in the MOX tunnel

Assembling TSJ-1 ↑ and DRJ-1 ↓ components

The Jena mechanical workshop

Peter Bormann
Horst NEUNHÖFER

- Complements and manages after the 1961 Vogtland earthquake swarm the local Vogtland seismic network
- Uses this network for detailed microseismic investigations into the spatial, temporal and energetic peculiarities of swarm earthquakes
- Installs several seismic networks in mines and studies rock bursts
- Installs and operates from 1966-82 a special long-period seismic network with VSJ-I for crustal/UM studies by means of surface-waves
- This included the first installations of the long-period TEUPSER VSJ-I seismographs at BGR, CLL (1966) and POT (1967-74).

GFZ

Peter Bormann
XXIX ESC General Assembly, Sept. 12-17, 2004
Otto Meisser

From 1964-66 director of the Jena Institute. He renamed it „Institut für Geodynamik“ and ordered to:

- review the state of seismological practice →
- produce a much more elaborated seismic bulletin in keeping with modern instrumentation and concepts (e.g., importance of secondary phases ↓, core phases, multiple rupture process etc.)

Ryukyu Islands-Taiwan (82°<D<86°)
Heinz STILLER

1966-68 Director of the Jena Institute of Geodynamics
1969 Founding director of CIPE Potsdam
1982-86 President of the ESC

requested P. BORMANN to:

• work as scientist on duty at station MOX (1966-68) →
• study the possibility of single-station location and discrimination of seismic events

• Wolfgang ULLMANN to deal with the equations of state of Earth’s matter.
Type B
KIRNOS
SK-D BB
MPV1(B) = 6.4
MPV4(B) = 7.9
→ mB

Type A
(WWSSN-SP)
MPV(A) →
mb1 = 5.8
mb4 = 7.0
(t4-t1 = 40 s)
mb within first 5 half-cycles
(2–5 seconds?)

→ 1974: Recommendations for standardization and optimization of seismograph responses
6. The Central Institute of Physics of the Earth (1969-91)

1969  Reform of the Academy of Sciences of the GDR  
→ merging several disciplin-oriented individual institutes into  
large **interdisciplinary central research institutes**

• Astronomical Observatory **Babelsberg** → Institute for Relativistic and  
Extragalactic Research + **AOP** star physics + Astron. Obs. Sonneberg +  
Karl-Schwarzschild-Obs. ⇒ **Central Institute for Astrophysik (ZIAP)**

• Solar Obs. **Einstein Turm** + Obs. **Tremsdorf** for solar radio astronomy +  
Heinrich-Hertz-Inst. for solar-terrestrial Physics in Berlin + **Niemegk** Obs.  
⇒ **Central Institute for Solar-terrestrial Physics (ZISTP)**

Geodynamics **Jena** ⇒ **Central Institute for Physics of the Earth (ZIPE)**

XXIX ESC General Assembly, Sept. 12-17, 2004
6.1 Departments at CIPE

1. Department of Seismology (and Physics of the Earth’s Interior)

2. Department of Geodesy and Gravimetry

3. Department of Geology and Tectonics (including geochemistry, lithology and minerogeny)

4. Department of Remote Sensing and Geoinformatics

5. Geophysical Solid State and High Pressure research (1988-91 independent research unit – FHD)

6.2 Major R&D results at CIPE (with emphasis on seismology)

6.2.1 Seismology

Hardware and Infrastructure Development
The Jena group of CIPE Dept. 1 (Teupser, Unterreitmeier, Brunner, Wenk)

The triaxial electronic seismograph ← EDS1/TSJ-1e

and its overall and filtered response characteristics

XXIX ESC General Assembly, Sept. 12-17, 2004
EDS-2 triaxial electronic seismograph (E. Unterreitmeier)

QSJ-1e 4-component electronic seismograph (Ch. TEUPSER)
KSJ-3 – Teupser →
(2Hz Geophon)

← KSJ-2
short-period Sensor
(3 Hz Geophon)
with leaf spring,
for industry
Computer center at Jena for on-line digital data from MOX
Modernization of MOX observatory

Units for data reception and control at station MOX, also for the local Vogtland network and for data transmission to JEN and POT

GFZ

XXIX ESC General Assembly, Sept. 12-17, 2004
Completion of BRG into a full-fledged manned seismological main station

Realized in collaboration between the Jena and Potsdam seismology groups of CIPE

Since 1992

Peter Bormann

XXIX ESC General Assembly, Sept. 12-17, 2004
Strainmeter developments at CIPE and completion of the deep observatory TIE

Invar wire strainmeters (by H. Harwardt)

Installation at TIE of VSJ-II SP and VSJ-I LP seismographs

Portable 1m universal strain meter

Peter Bormann
XXIX ESC General Assembly, Sept. 12-17, 2004
1976-1988 Development of the centralized POTSDAM seismic network

by
M. BAUMBACH
P. BORMANN
J. BRIBACH
H. GROSSER
J. NEUMEYER
W. STRAUCH
K. WYLEGALLA et. al.

XXIX ESC General Assembly, Sept. 12-17, 2004
Local (left) and teleseismic earthquake recordings (right) at the Potsdam net.

Peter Bormann

XXIX ESC General Assembly, Sept. 12-17, 2004
Records of underground nuclear explosions at the Potsdam seismic net.

UNE at Semipalatinsk TS, 17 Apr. 1987

UNE at Nevada TS, 16 Oct. 1986

Peter Bormann

XXIX ESC General Assembly, Sept. 12-17, 2004
Average network magnitude ML

local Vogtland swarm EQs

Teleseismic distance range 10° < D < 160°
Methodological and software developments for the Potsdam seismic net

Improvement of event location for Vogtland earthquakes
(W. STRAUCH)
Improvement of POT net event location for teleseismic earthquakes (W. STRAUCH)

with WYLEGALLA's regional slowness corrections

GFZ Potsdam
Peter Bormann
XXIX ESC General Assembly, Sept. 12-17, 2004
SEIS89 Software for the Potsdam seismic net
(by M. BAUMBACH)
Controlled sources seismology - DSS

- Development of a digital field data logger
- Refraction seismic measurements along 1600 kilometer profiles over the main tectonic regions of the GDR by

E. APITZ/LÜCK, J. BRIBACH, A. SCHULZE, J. WOLTER et al.

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Peter Bormann XXIX ESC General Assembly, Sept. 12-17, 2004
Complex seismological, geophysical and geological interpretation of the DDS profiles by an **inter-institutional GDR-wide WG** (chaired by E. Hurtig, later by P. Bormann):

Members: E. APITZ, P. BANKWITZ, A. SCHULZE (CIPE); F. JACOBS, MEYER (Uni Leipzig); Ch. OELSNER, G. PORSTENDORFER (BA Freiberg); W. CONRAD (VEBGeophysik Leipzig) & experts from Gommern, Greifswald.
Investigations into seismic spectra and source processes of local earthquakes and mining events

by M. BAUMBACH, St. GRÄSSL, H. GROSSER, W. KUHNT

\[ M_0 = 2 \times \exp{13} \]
\[ R_0 = 65 \text{ m} \]
\[ \Delta \sigma = 33 \text{ MPa} \]
\[ D_0 = 4.5 \text{ cm} \]

Spectral source parameter of Vogtland swarm EQs

+ extensive comparison of in-situ source parameters observed in mines with source parameters derived from seismic spectra (W. KUHNT).

XXIX ESC General Assembly, Sept. 12-17, 2004
Fault plane solutions of Vogtland swarm earthquakes

Fault-plane solutions from FM polarities with range of 90% probability solutions for the pressure and tension poles.

Range of admissible solutions for strike, dip and rake based in P/S moment ratios as derived from data of stations MOX and PLN.

Peter Bormann

XXIX ESC General Assembly, Sept. 12-17, 2004
Earthquake magnitudes (P. BORMANN, G. KOWALLE, K. WYLEGALLA)

And calibration functions for PKP phases by Kowalle in the 1980s
Earthquake catalog, macroseismic studies and hazard assessment
by G. GRÜNTHAL

Probabilistic seismic hazard for the town Klingenthal (non-exceedence of intensity Is) during the time span D.
Since 1980 International Training Courses on Seismology and Seismic Hazard Assessment (Chairman: Peter BORMANN)

Between 1980 – 1991 246 participants from 51 countries attended these courses.

Computer exercises

Manual exercises

Visit of seismological observatories

Practical on seismometer calibration

Cultural evenings

GFZ

Peter Bormann  XXIX ESC General Assembly, Sept. 12-17, 2004
Textbooks, monographs and PhD theses on seismology and physics of the Earth

• 20 monographs and about 30 PhD and habilitation theses on seismometry, seismology and physics of the Earth’s interior

Peter Bormann

XXIX ESC General Assembly, Sept. 12-17, 2004
6.2.2 Geodesy

CIPE built satellite lasers of the 1st and 2nd generation mounted on a CARL ZEISS Jena satellite tracking telescope on top of the HELMERT tower.

1st generation; accuracy: 1-2 m
1974-81

2nd generation; accuracy: 10-30 cm
1981-93
Polar motion 1981-90 as derived from CIPE satellite laser observations

• SCHÜLER et al (1969-70): Most precise absolute gravity determination with pendulum
  \[ g = 9812601.0 \pm 3 \mu m/s \ exp^2 \]

• 1990 discovery of the 11.5 y period of \( g \) changes

Variation of length of the day and y-component of earth rotation pole:
1 - IERS
2 - CIPE LAGEOS solution
3 - VLBI (NGS Washington)
7. Developments on the Telegrafenberberg since 1992

- Foundation of the Potsdam Institute for Climatic Impact Research (PIK)

- Foundation of the Astrophysical Institute Potsdam (AIP)

- The Main Meteorological Observatory becomes part of the German Weather Service (DDG)

- The Antarctic research group of CIPE is complemented by more researchers and new research topics in both (N & S) polar areas and becomes a regional branch of the Alfred-Wegener Institute for Polar Research (AWI) with emphasis on paleoclimate and ozon studies

- Foundation of the GeoForschungsZentrum Potsdam (GFZ)
7.1 Geodesy and Remote Sensing

- Continuation of classical monitoring tasks with most modern techniques and greatly improved accuracy/resolution

GFZ Polar Motions

With GPS

Accuracy < 3 mmm

With supra-conductivity gravity meter T018
Pre-CHAMP/GRACE GFZ Geoid 1996

with SLR, GPS and terrestrial data

(c) wolfk@gfz-potsdam.de
view: 104° 60°

Peter Bormann

XXIX ESC General Assembly, Sept. 12-17, 2004
EIGEN-GRACE
1 cm, 0.02 mgal @ $\lambda/2 = 270$ km
(GRACE 3 months)

EIGEN-CHAMP
1 cm, 0.02 mgal @ $\lambda/2 = 1000$ km
(CHAMP 3 years)

Geoid Model from 40 days of CHAMP data has been as good as from previous 20 years of data from some 15 satellites

Peter Bormann

XXIX ESC General Assembly, Sept. 12-17, 2004
Earth’s magnetic field

- Main field
- Crustal field
- Decrease of main field

Differenz MagSat-CHAMP Modell (10 Jahre)

XXIX ESC General Assembly, Sept. 12-17, 2004
Measurements for continuous atmospheric temperature and humidity profiling

compared with the discrete measurements from air-borne balloon soundings (ECMWF and NCEP/USA)
Satellite laser ranging and plate motion studies


New GFZ Satellite Laser Ranging station with improved telescope, receiving equipment and range; prepared for 4th generation SLR with mm resolution

XXIX ESC General Assembly, Sept. 12-17, 2004
Site velocities from 10 years of GPS data

GPS data from 1993.0 to 2003.0

GFZ
Potsdam
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XXIX ESC General Assembly, Sept. 12-17, 2004
GPS derived co-seismic displacement of the Antofagasta EQ of 30. Juli, 1995, Mw=8.0, rupture length ca. 200 km
Remote sensing of ground deformation with satellite radar interferometry (INSAR)

Izmit earthquake, Turkey, 17 August 1999, Ms = 7.3
max. observed surface displacement 4.90 m

Bam EQ, Iran, 26 December 2003, Ms= 6.5
max. observed surface displacement 25 cm

Peter Bormann
XXIX ESC General Assembly, Sept. 12-17, 2004
7.2 Seismology

• **Continuation** of all seismological main fields such as
  - deep Earth structure (passive methods)
  - deep seismic sounding/controlled source seismology
  - source location and source processes
  - hazard assessment
  - training, etc.,
  however at a significantly deepened and world-wide co-operative scale

• **Discontinuation** of seismometer development and routine observatory practice/bulletin work

• **Discontinuation** of the Potsdam seismic network, however, world-wide deployment of broadband GEOFON stations for research purposes and global data exchange networking
Analysis of broadband seismic noise at the GRSN and search for improved alternative station sites

J. of Seismology 1997
(P. Bormann, K. Wylegalla, K. Klinge)
The permanent GEOFON network is complemented by temporary seismometer deployments for lithosphere and mantle studies
Examples are:

- Eiffel plume
- Hawai plume
- Bohemian Massif
- Trans-Alp project
- Trans-European Suture Zone
- Andes (Chile)
- Israel-Jordan (Dead Sea Project)
- Greenland
- Indonesian Arc
- Tibet

Receiver function data from Tibet and their geologic-tectonic interpretation
DESSERT PROJECT crossing the Dead Sea Transform
↓ P-wave tomography from near vertical reflection data ↓

Magnetotelluric resistivity data ↑ superposed with seismic P-wave isotaches

Peter Bormann
XXIX ESC General Assembly, Sept. 12-17, 2004
MALLIK/Canada: Gas hydrates under permafrost

JNOC/GSC/GFZ-Project

with participation of > 100 scientists from 30 countries under the ICDP

GFZ interpretation of the MALLIK cross-hole seismic surveys

Peter Bormann

XXIX ESC General Assembly, Sept. 12-17, 2004
Macroseismic scale; regional and global seismic hazard assessment

This scale with vulnerability and damage grade classification & examples → is now European standard and widely used world-wide
Erdbebengefährdung für die D-A-CH Staaten
(Deutschland, Österreich, Schweiz)
mit untersetzter Karte der Epizentren tektonischer Erdbeben
Erdbebengefährdung in Form berechneter intensitätswerte für eine
Nichtüberschreitwahrscheinlichkeit von 90% in 50 Jahren

GFZ POTS DAM

Peter Bormann

XXIX ESC General Assembly, Sept. 12-17, 2004
NEW FIELD: Mikrozonation – local amplification of ground motions

Peter Bormann

XXIX ESC General Assembly, Sept. 12-17, 2004
German Task Force Earthquakes

Chaired by the GFZ, 13 German institutions co-operate in the Task Force Earthquakes

Peter Bormann  XXIX ESC General Assembly, Sept. 12-17, 2004
Izmit (Mw 7.4) and Düzce (Mw 7.2) earthquakes in Turkey (17/08 & 12/11/1999)
Cariaco/Venezuela EQ
July 9, 1977; Ms = 6.8

P-wave velocity tomography and relocation of aftershock hypocenters

↑

a) Original aftershock epicenters on the basis of a 1-D layered velocity model

b) Relocated aftershock epicenters based on the tomographic 3-D velocity model
International Training Courses on Seismology, Hazard Assessment and Risk Mitigation

- Since 1992 alternately held in Germany and in developing regions
- Involving lecturers from 18 nations
In total: • 1500 applicants
• 609 participants from 97 nations
A major spin-off of the training course materials, further elaborated and complemented by a IASPEI WG, is the NMSOP Volume 2.

**IASPEI**

**New Manual of Seismological Observatory Practice**

**(NMSOP)**

**Volume 2**

**Annexes**

Editor

Peter Bormann

GeoForschungsZentrum Potsdam

2002

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**IASPEI**

**New Manual of Seismological Observatory Practice**

**(NMSOP)**

**Volume 2**

**Annexes**

Editor

Peter Bormann

GeoForschungsZentrum Potsdam

2002

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XXIX ESC General Assembly, Sept. 12-17, 2004
8.3 Other main GFZ research field

- Dynamics of the lithosphere
- Deformation and rheology (laboratory investigations)
- Dynamics of climate and sediments
- Paleomagnetic and geologic time scales and stratigraphy
- Anorganic and organic geochemistry
- Geomechanics
- Geothermy
- Engineering hydrology
- Operational support for the International Continental Drilling Program (ICDP)