ZAMG Geophysical Observations

- *Geophysics & Network*
- *Seismology*
- *Geomagnetics & Gravimetry*
- *Applied Geophysics*
- *Conrad Observatory*
- *National Data Centre and International Co-operation*

ZAMG
Zentralanstalt für Meteorologie und Geodynamik

Geophysics

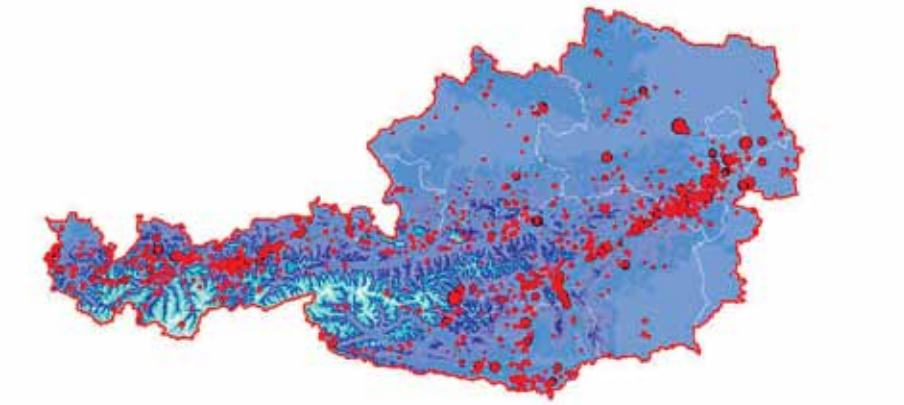
The Department of Geophysics forms part of the Central Institute for Meteorology and Geodynamics in Vienna/Austria, which was founded as „K.K.Central-Anstalt für Meteorologie und Erdmagnetismus“ in 1851. The activities of the Department cover almost the whole spectrum of Geophysics. Whether earthquakes, volcanic eruptions, explosions, landslides or rock falls, solar storms and changes of the Earth’s magnetic field or meteorite impacts, the Department is asked to provide its expertise. On a continuous basis, the Department contributes to the monitoring of seismic tremors along with the magnetic and gravitational field of our planet. In addition, the department serves as the National Data Centre for monitoring nuclear tests and supplies information on volcanic eruptions world-wide.

Network

The permanent seismic network of Austria, which is maintained by the ZAMG, currently consists of 16 broad-band stations. These are even capable of detecting very small ground movements, which are due to transient seismic waves from remote earthquakes such as in New Zealand or Japan. The stations are supplemented by 20 strong-motion stations. These are important for recording stronger ground motions due to local earthquakes. At the Conrad Observatory all geophysical disciplines are combined regarding permanent geophysical monitoring. Temporary measuring points are utilized by geomagnetic surveys on an annual basis.

Seismic network (green) and magnetic measuring points (blue).

Earthquakes



Epicentres in Austria of felt earthquakes

In total, more than 7.000 earth tremors are recorded each year by the seismic network of the ZAMG. The majority - 6.000 events - are genuine earthquakes from remote parts of the world. These earthquakes must be evaluated to aid rescue attempts of the Austrian Disaster Relief Unit (AFDRU), to detect nuclear tests and for international data exchange for research purposes, as remote earthquakes assist studies of the Earth's interior. A few of the events are caused by explosions, landslides and even meteorites, which fortunately mainly disintegrate in the atmosphere.

Historical record

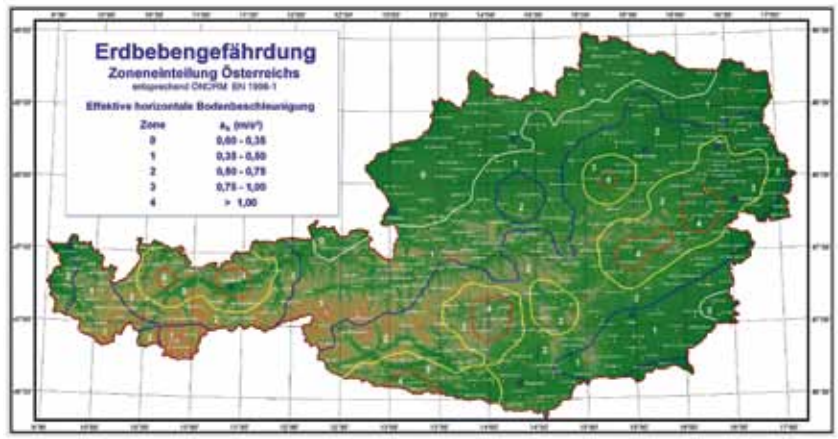
Earth tremors are more frequent in Austria than commonly perceived. More than 1.000 tremors are detected in Austria annually by the seismic network of ZAMG. Fifty percent of the tremors can be related to genuine tectonic earthquakes, while the others are of industrial origin – mainly production blasts. On average 50 earthquakes per year are strong enough to be noticed by the population in Austria, and every second year an earthquake causes minor damage. Most earthquakes in Austria tend to occur in the Vienna Basin, the Mur-Mürz Valley in Styria and in Tyrol near Innsbruck, and in Carinthia due to seismic activity in the Alpine foreland in Friuli/Italy and in Slovenia. Stronger earthquakes occur every 30 to 50 years. For Austrian standards, the last very strong earthquake happened on April 16, 1972, causing havoc in Vienna. The fire brigade had to secure hundreds of damaged chimneys and clear the roads from debris.

Earthquakes constitute a relatively high risk to Austria's economy. To meet international requirements for earthquake building safety, the department has for many years also been studying historical earthquakes.

The Seismological Service of Austria of the ZAMG sustains its national obligations with co-operation with partner-institutions in neighbouring countries and world-wide institutions, such as the World Data Centres and the International Seismological Centre (ISC) in Edinburgh/UK, Observatories and Research Facilities for European Seismology (ORFEUS), Mediterranean Seismological Center (EMSC) and the International Research Institutes for Seismology (IRIS).

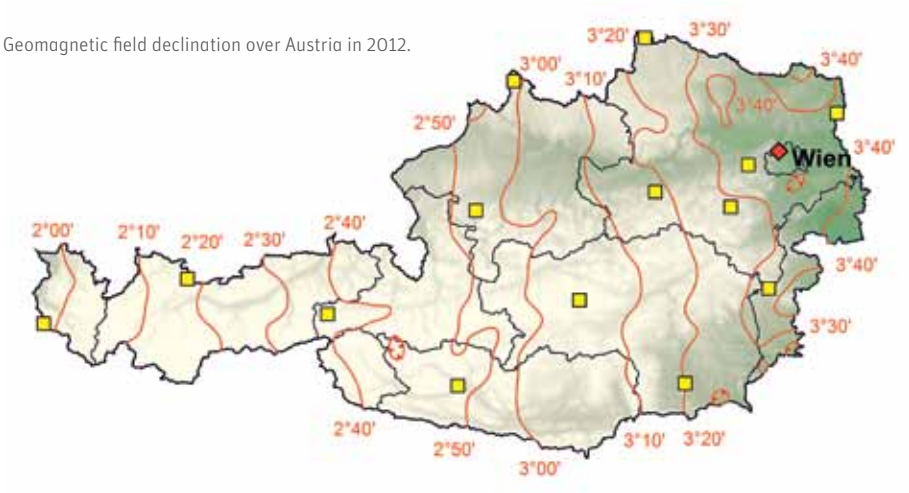
The Department provides seismological expertise, earthquake information, historical earthquake expertise, publication of seismic bulletins and international data exchange and maintains a 24/7-service for the governmental crisis management.

Building damage in Vienna 1972



Earthquake hazard in Austria. The zones indicate areas of lower and higher hazard. The map is used to regulate earthquake resistant building design.

Geomagnetism and Gravity

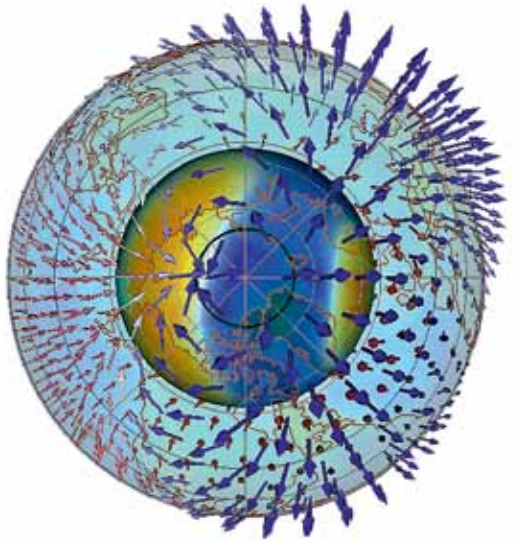


Geomagnetic field declination over Austria in 2012.

Since 1852, our Department performs systematic measurements of the Earth's magnetic field in Austria. Data from our magnetic observatory and from 134 foreign geomagnetic observatories permit the determination of the state of global geomagnetic field and its changes over time. Observatory records are integrated in yearly surveys at 14 locations in Austria to obtain a detailed map of the geomagnetic field of our territory. The latest survey of Austria was conducted between 1995 and 1998.

Magnetic measurements are essential for determining the continuous change in the Earth's magnetic field over decades, which reflects dynamic processes in the Earth's core and core-mantle interactions. For this purpose, we extend our observations to geological time scales using special techniques for interpreting magnetic records preserved in archaeological objects, sediments, and rocks. With these records, it is possible to establish that our planet had a magnetic field for at least 3 billion years, and that the polarity of this field reverses every 0.1-1 million years. The last reversal occurred 780 000 years ago. The intensity of the Earth's field and the position of the magnetic poles are highly variable; for example, the magnetic declination in Austria (i.e. the magnetic North pole direction as indicated by a compass) changed by almost 20° over the last 200 years.

The geomagnetic field provides an effective shield against radiation from the sun and variations of its intensity are suspected to influence the structure of the higher atmosphere and therefore also climate. Furthermore, some migratory animals, as well as a special kind of bacteria, use the geomagnetic field for orientation purposes. Our Department is actively involved in these new research areas.



Geomagnetic field model (arrows) during the last reversal 780 000 years ago.

The Earth's gravity field is another important parameter for studying the internal structure of our planet, given its sensitivity to deep mass redistribution, which also alters the length of day by small amounts. Such effects are for instance observed after large earthquakes. Combined high-precision gravity measurements are performed at the Conrad Observatory in Lower Austria in collaboration with the University of Vienna and the Federal Bureau for Metrology and Geodesy.

Our main activities can be summarized as follows:

- Permanent observation of the geomagnetic field
- Geomagnetic survey of Austria and annual publication of declination maps
- Gravity measurements
- Active research in all aspects relating to the geomagnetic field and gravity potential

Superconducting gravimeter (in blue) at the Conrad Observatory

Absolute field measurement in Krimml (Salzburg), during the last geomagnetic survey in 1998.

Applied Geophysics

Environmental issues have always been an area of interest for the ZAMG. One area of expertise deals with the detection of waste deposits and ground water pollution and even war relicts.
In an alpine country such as Austria, the undulating topography poses additional dangers and challenges, such as forecasting rock conditions and the stability of slopes ahead of tunnelling operations, thus providing essential safety information for slope, rock and dam stabilization as well as optimizing tunnelling progress. These activities ensure the operation of infrastructures such as motorways, railways but also hospitals, telecommunication services, power connections and water supplies. This is a wide field which can be supported by geophysical investigations.

Survey in Carnuntum in Lower Austria

Neolithic circular ditch structure (dates back 5.000 years before present) in Lower Austria

Measurements in Pompeji near Naples in Italy

Archaeological research relies more and more on geophysical investigations. The methods of Archeo Prospections® utilize non-destructive methods based on georadar and electric resistivity measurements. The principle can be compared with scanning the subsurface without disturbing it. These measurements can be quickly conducted and the potential of archaeological sites can be judged, thus streamlining the planning of excavations and permitting cost-effective work. These measurements were employed numerous times not only in Austria but also abroad with great success. Most interesting were the surveys in Turkey/Ephesos, Italy/Pompeji, Portugal, Ireland, Romania, Syria, Bhutan, and last but not least in Austria, where the majority of all neolithic circular ditch structures of our celtic forebears in Lower and Upper Austria could be detected. Hallstatt, where ancient miners recovered salt, adds to this record, as well as Carnuntum - the roman military and civilian outpost near Vienna – and the most prominent silver mine in Europe in Schwaz in Tyrol, from which a former Emperor of Austria drew his capital. Traces of numerous other historic settlements have also been found.

Field surveys may utilize several geophysical techniques, such as

- Ground-penetrating radar (GPR)
- Resistivity measurements
- Magnetic measurements
- Seismic profiles

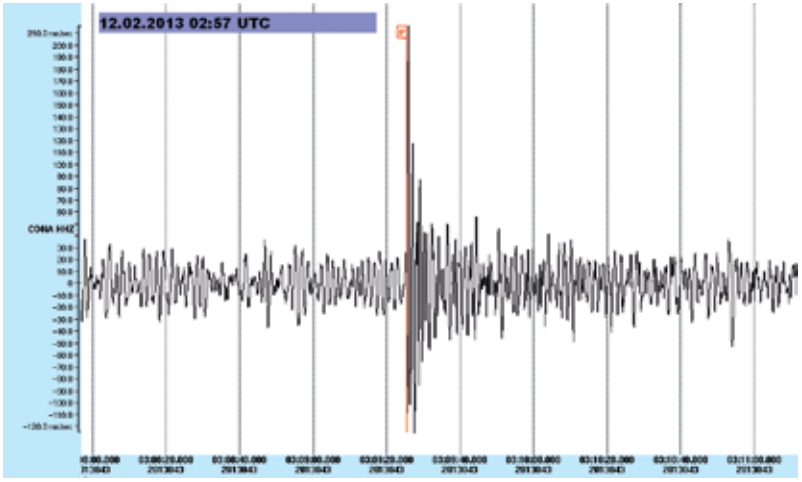
The Conrad Observatory

The Observatory is a geophysical Observatory for monitoring important physical parameters of our planet. Amongst these are earthquakes, changes in gravity and mass distribution, geomagnetic field variations, geodetic parameters, atmospheric waves and meteorological data. Observatories such as the Conrad Observatory are characterized by long-term recording in largely stable measurement conditions.
The Observatory is named after the Austrian geophysicist Victor Conrad (1876 - 1962), who worked for many years at the Central Institute for Meteorology and Geodynamics in Vienna, Austria. It is located 50 km southwest of Vienna, in a nature reserve on the Trafelberg just 1000 m above sea level. It can be reached from Vienna by car within 2 hours.
The Observatory is almost entirely underground and guarantees, among other things, constant temperature for all applied techniques. The range of supported measurement techniques, instrumentation and layout of the underground facilities at the Conrad Observatory represents a unique research and development location for earth scientists of all disciplines.
Conrad Observatory includes two main facilities: the seismo-gravimetric Observatory (SGO) and the geomagnetic Observatory (GMO).

Winter impression at the Conrad Observatory.

The National Data Centre and International Co-operation

Austria hosts the Comprehensive Test Ban Treaty Organization (CTBTO) with the aim to monitor nuclear tests worldwide. The ZAMG serves as the National Data Centre on behalf of the Austrian Ministries of European and International Affairs and Science and Research of Austria.
The observations include seismic detections of nuclear tests, transport modelling of nuclear particles and infrasound detections. The Conrad Observatory has already hosted testing and training courses for these tasks. This scientific monitoring helps to interpret even non-nuclear sources, as long as they generate significantly strong signals, which can be detected by instruments sensitive enough.
In addition, international recording systems become more and more important. These days complicated systems, whose data could only exchanged partially, can now be used by a much broader scientific community. Therefore, the Department exchanges seismic and magnetic records with our neighbours - and beyond – at an instance.
This co-operative sharing is cost-neutral, enhances research and improves the analysis for civil protection purposes.



Seismogram of the announced nuclear test in North Korea in 2013. The signal was recorded not only at the Conrad Observatory, but also at all other seismic broadband stations in Austria.

ZAMG – Zentralanstalt für Meteorologie und Geodynamik

1190 Vienna, Hohe Warte 38
phone: +43 1 36026 2502
email: seismo@zamg.ac.at
www.zamg.ac.at

Geophysical Department:
Wolfgang Lenhardt
email: wolfgang.lenhardt@zamg.ac.at
phone: +43 1 36026 2501

Seismology:
Yan Jia
email: yan.jia@zamg.ac.at
phone: +43 1 36026 2523

Geomagnetism and Gravity:
Ramon Egli
email: ramon.egli@zamg.ac.at
phone: +43 1 36026 2503

Applied Geophysics:
Sirri Seren
email: sirri.seren@zamg.ac.at
phone: +43 1 36026 2506

Instrumentation:
Rudolf Steiner
email: rudolf.steiner@zamg.ac.at
phone: +43 1 36026 2520

Conrad Observatory:
Roman Leonhardt
email: roman.leonhardt@zamg.ac.at
phone: +43 1 36026 2507

ZAMG
Zentralanstalt für
Meteorologie und
Geodynamik