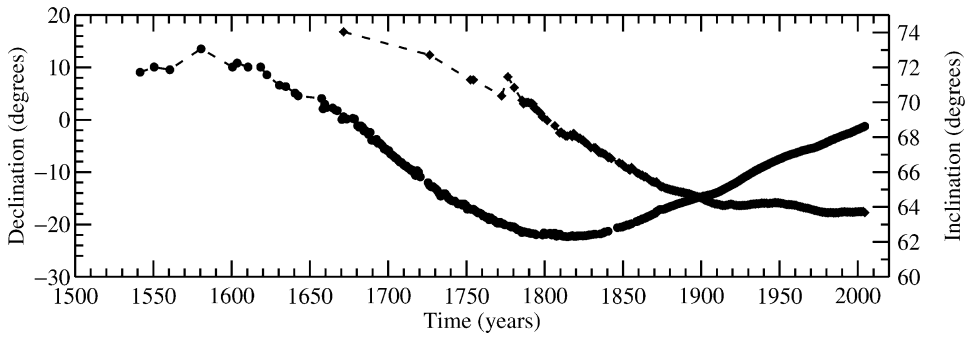

Figure O8 Annual means of declination (full circles, left axis) and inclination (full diamonds, right axis) adjusted to the Chambon la Forêt Observatory.

Table O1 Observatories operating with assistance from BCMT, in 2004

Code	Name	Latitude (°)	Longitude (°)	Altitude (m)	Start-date
AAE	Addis Ababa	9.030	38.765	2442	1958
AMS	Martin de Vivies	−37.833	77.567	48	1981
BNG	Bangui	4.437	18.565	395	1952
BOX	Borok	58.030	38.972	137	1977
CLF	Chambon la Foret	48.024	2.260	145	1936
CZT	Port Alfred	−46.433	51.867	155	1974
DRV	Dumont Durville	−66.665	140.007	30	1957
KOU	Kourou	5.100	307.400	10	1996
LZH	Lanzhou	36.083	103.850	1560	1959
MBO	Mbour	14.392	343.042	10	1952
PAF	Port Aux Francais	−49.350	70.220	15	1957
PHU	Phutuy	21.033	105.967	5	1978
PPT	Papeete	−17.550	210.380	342	1968
QSB	Qsaybeh	35.645	33.870	525	2000
TAM	Tamanrasset	22.800	5.530	1395	1932
TAN	Antananarivo	−18.920	47.550	1375	1890

full absolute control, providing 1-min magnetic field values measured by a vector magnetometer, and an optional scalar magnetometer, all with a resolution of 0.1 nT (see *Observatories, instrumentation*). More details about the instruments used through time are given in Bitterly *et al*. (1999).

All of these observatories are operated according to the principles and conditions necessary and desirable for maintaining a service of rapid magnetic observatory data exchange. The daily data quality control, the weekly absolute measurements, and the definitive data processing are done according to INTERMAGNET standards (see *Observatories, INTERMAGNET*). The observatory data are used for many specific uses, from characterizing the magnetic activity to modeling magnetic field contributions (see *Observatories, overview*).

Mioara Mandea

Bibliography

Alexandrescu, M., Courtillot, V., and Le Mouël, J.-L., 1996. Geomagnetic field direction in Paris since the mid-XVIth century. *Physics of the Earth and Planetary Interiors*, **98**: 321–360.

Bitterly, J., Mandea Alexandrescu, M., Schott, J.-J., and Vassal, J., 1999. Contribution de la France à l'observation cu champ magnétique terrestre. In B *Comité National Français de Géodésie et Géophysique, Rapport Quadriennal 1995–1998.* Toulouse, pp. 145–158.

Cross-references

Observatories, Instrumentation
Observatories, INTERMAGNET
Observatories, Overview

OBSERVATORIES, PROGRAM IN USA

The Geomagnetism Program of the US Geological Survey has, for over a century now, monitored the Earth's magnetic field through a network of magnetic observatories and conducted scientific analysis on the data collected. The program traces its origins to the Reorganization Act of 1843, in which Congress authorized the creation of a coastal survey agency, as part of the Treasury Department, that was responsible for, among other things, geomagnetic surveys. The 19th century saw the establishment of relatively short-lived magnetic stations, as well as the production of declination maps for the United

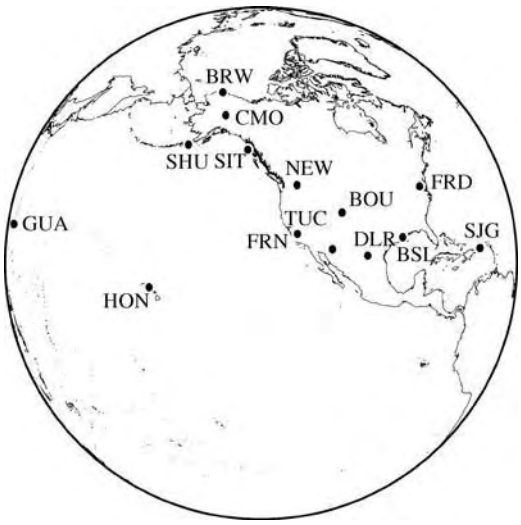

Figure O9 The geographic distribution of USGS geomagnetic observatories, identified by their three-letter IAGA codes.

States and territories. With the purchase of Alaska, coastal surveys became an increasingly higher priority, and in 1889 the Coast and Geodetic Survey, with a Division of Terrestrial Magnetism, was established. The first essentially permanent geomagnetic observatories were established under the Division's leadership of Dr. *Louis A. Bauer* and Dr. John A. Fleming: Cheltenham Maryland Observatory was established in 1900, subsequently moved to the Fredericksburg site in 1956; Sitka Alaska Observatory was established in 1901 and that of Honolulu Hawaii in 1902. Soon after these observatories became operational, it was found that the Sitka and Honolulu magnetometers were also sensitive to local earthquakes, and so seismometers were installed at the sites. In part, because of this colocation of instruments, the magnetic and seismological programs in the Coast and Geodetic Survey were united in 1925 under the Division of Geomagnetism and Seismology. Over the years, the Geomagnetism Program has evolved in response to the needs of the United States and in response to changes in the nation's various federal agencies. In 1903 the Coast and Geodetic Survey was transferred to the newly organized Department of Commerce, and in 1970 the survey became part of the National Oceanic and Atmospheric Administration (NOAA). In 1973, the US Geological Survey of the Department of the Interior assumed responsibility for the nation's Geomagnetism and Seismology programs.

Today, Geomagnetism is one of four programs, in addition to the National Earthquake Hazards, the Global Seismic Network, and the Landslides Programs, represented by the USGS Central Region Geohazards Team in Golden, Colorado. Unlike the Earthquake Hazards Program, which supports many different projects, based primarily in Menlo Park and in Golden, the National Geomagnetism Program is a self-contained entity within the USGS and the team. A major part of the program is concerned with operating and maintaining magnetic observatories located in the United States and its territories (see Figure O9). The observatories, which have modern digital acquisition systems, are designed to produce long time series of stable magnetometer data having high accuracy and resolution. The observatory data are collected, transported, and can be disseminated in near-real time. The program has made a considerable investment in computing technology to enable efficient processing and management of data. By necessity, the network, and everything associated with handling the data, is technologically elaborate; it consists of many finely tuned components, each of which need to be operated in careful synchronization. The USGS observatories form an important part of the INTERMAGNET network, within which the USGS has an important leadership role. The USGS Geomagnetism Program, working in cooperation with other Federal Government departments and bureaus, most particularly the NOAAs Space Environment Center and the US Air Force Weather Agency, is an integral part of the Federal Government's National Space Weather Program. Further details about the USGS Geomagnetism Program are available at http://geomag.usgs.gov

Jeffrey J. Love and J.B. Townshend

Cross-references

Bauer, Louis Agricola (1865–1932)
Fleming, John Adam (1877–1956)
IGRF, International Geomagnetic Reference Field
Observatories, Automation
Observatories, INTERMAGNET
Observatories, Overview

OBSERVATORIES IN ANTARCTICA

Some historical landmarks

The history of magnetic measurements in Antarctica and the surrounding oceans can be traced back to the expeditions looking for the South Magnetic Pole (see Fogg, 1992 for a review). Until the turn of the 19th/20th century, all measurements were performed at sea, on ships including *Gauss* (E. Drygalski expedition, 1901–1903) and *Discovery* (first R.F. Scott expedition, 1901–1904), both being equipped with a magnetic observatory (Lüdecke, 2003). The first confirmed landing (although certainly not really the first one), can be credited to C. Borchgrevink's expedition (1893–1895), whose party reached Cape Adare and made some magnetic measurements there (Fogg, 1992). If we define the Antarctic region as that being south of 60° S the longest span of data is that collected at the observatory of Orcadas del Sur (South Orkneys, IAGA code ORC). This observatory was founded by R.C. Mossman in 1903 during the expedition led by W.S. Bruce, 1902–1904, (Moneta, 1951). Many annual means of the magnetic elements are available from this observatory from 1905 up to now. Other early observatories had a rather short or intermittent life, for example, Hut Point (Discovery Bay) set up by the first R.F. Scott expedition (1902–1903), Cape Evans (1911–1912) opened during the tragic second expedition headed by R.F. Scott, Cape Denison (1912–1913) opened by D. Mawson, and Little America (ran intermittently at various locations from 1929 to 1958). Things changed after World War II. It seems that P.N. Mayaud pioneered this new era with the observatory of Port Martin built in 1951 (Mayaud, 1953). Unfortunately, the station burned down 2 years later. Neither the first International Polar Year (1882–1883), which came too early for Antarctica, nor the second IPY (1932–1933) that was launched during an economically depressed time gave to scientific activities in Antarctica. However, the first gave Geophysical Year (1957–1958) boosted the opening of several observatories increasing the total number from around 4 to 14. All of the observatories recorded field variations on analog photographic magnetograms according to common practice in use before the advent of digital records in the 1970s. The first reported digital records were performed at Dumont d'Urville in 1969.

Situation at the beginning of the 21st century

At present, more or less permanent sites may be divided into three types: standard observatories with or without regular absolute measurements, unmanned magnetometer chains devoted to external field studies, and repeat stations, the latter two being beyond the scope of this review. According to J.L. Rasson (2001), there are a total of 44 observatories in the region with data for various time spans.