Comp. by: DShiva Date:14/2/07 Time:15:55:17 Stage:First Proof File Path://spiina1001z/womat/production/
PRODENV/0000000005/0000001725/0000000022/000000A293.3D Proof by: QC by:

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JESUITS, ROLE IN GEOMAGNETISM

The Jesuits are members of a religious order of the Catholic Church, the Society of Jesus, founded in 1540 by Ignatius of Loyola. From 1548, when Jesuits established their first college, their educational work expanded rapidly and in the 18th century, in Europe alone, there were 645 colleges and universities and others in Asia and America. As an innovation in these colleges, special attention was given to teaching of mathematics, astronomy, and the natural sciences. This tradition has been continued in modern times in the many Jesuit colleges and universities and this tradition thus spread throughout the world. Jesuits' interest in geomagnetism derived from teaching in these colleges and universities. In many of these colleges and universities observatories were established, where astronomical and geophysical observations were made (Udías, 2003). Missionary work in Asia, Africa, and America, where scientific observations were also made and some observatories established, was another factor in the role of Jesuits in geomagnetism. In this work we must distinguish two periods. The first, from 1540 to 1773, ended with the suppression of the Jesuit order. The second began in 1814 with its restoration and lasts to our times.

Early work on magnetism

Terrestrial magnetism attracted Jesuits' attention from very early times (Vregille, 1905). José de Acosta, a missionary in America, in 1590 described the variation of the magnetic declination across the Atlantic and the places where its value was zero, one of them at the Azores islands. His work is quoted by *William Gilbert* (*q.v.*). In 1629, Nicolò Cabbeo (1586–1650) was the first Jesuit to write a book dedicated to magnetism, *Philosophia Magnetica*, where he collected all that was known in his time, together with his own experiments and observations. Some of his work is based on that of a previous Jesuit Leonardo Garzoni (1567–1592), professor at the college of Venice, who could well be the first Jesuit interested in such matters. Cabbeo was opposed to Gilbert on the origin of terrestrial magnetism. The best-known early work on magnetism by a Jesuit is that of *Athanasius Kircher* (1601–1680) (*q.v.*), *Magnes sive de arte magnetica*, published in 1641. Martin Martini (1614–1661), who sent many magnetic observations from China to Kircher, proposed to him in 1640 to draw a map with lines for the magnetic declination. Had his suggestion been followed this would have been the first magnetic chart (before that of *Edmund Halley* (*q.v.*)).

A curious work is that of Jacques Grandami (1588–1672), *Nova demonstratio inmobilitatis terrae petita ex virtute magnetica* (1645), in which, in order to defend the geocentric system, he tried to show that the Earth does not rotate because of its magnetic field. Among the best observations made in China are those of Antoine Gaubil (1689–1759), who mentioned that the line of zero declination has with time a movement from east to west. His observations and those of other Jesuits in China were published in France in three volumes between 1729 and 1732. In 1727, Nicolas Sarrabat (1698–1739) published *Nouvelle hypothèse sur les variations de l'aiguille aimantée*, which was given an award by the Académie des Sciences of Paris. In 1769, Maximilian Hell (1720–1792), director of the observatory in Vienna, made observations of the magnetic declination during his journey to the island of Vardö in Lapland, at a latitude of 70° N, where he observed the transit of Venus over the solar disk.

Magnetic observatories

The Jesuit order was suppressed in 1773 and restored in 1814. From this time work on geomagnetism was taken up again at the new Jesuit observatories (Udías, 2000, 2003). A total of 72 observatories were founded throughout the world. Magnetic stations were installed in 15 of them: five in Europe, one in North America, four in Central and South America, and five in Asia, Africa, and the Middle East. Some of those magnetic stations in Europe were among the first to be in operation. Observatories in Central and South America, Asia, and Africa provided for some time the only magnetic observations in those regions. Details of these observatories can be found in Udías (2003). At present, most of them have been either closed or transferred to other administration.

The first of these observatories was established in 1824 at the Collegio Romano (Rome). There, in 1858, Angelo Secchi (1818–1878) began magnetic observations, using a set of magnetometers, a declinometer, and an inclinometer. He studied the characteristics of the periodic variations of the different components of the magnetic field and tried to relate magnetic variations with solar activity, considering the Sun to be a giant magnet at a great distance. Relations between geomagnetism and solar activity were to become a favorite subject among Jesuits. In the same year, 1858, magnetic observations begun at Stonyhurst College Observatory (Great Britain). Stephen J. Perry (1833–1889, Figure J1) began his work on geomagnetism, carrying out three magnetic surveys: two in France in 1868 and 1869 and the third in Belgium in 1871 (Cortie, 1890). In each of these surveys, at each station, careful measurements were made of the horizontal component of the magnetic field, magnetic declination, and inclination or dip (Perry, 1870). In Belgium, Perry found large magnetic anomalies related to coal mines. In order to study the relation

Figure J1 Stephen J. Perry (1833–1889), Director of Stonyhurst Observatory.

between solar and terrestrial magnetic activity, which was still a controversial subject, Perry at Stonyhurst began a series of observations of sunspots, faculae, and prominences in 1881. For this purpose he installed direct-vision spectroscopes and photographic-grating spectrometers and made large drawings of the solar disk (27 cm diameter). Perry collaborated with *Edward Sabine* (*q.v.*) in this work. Perry participated in several scientific expeditions. The most important was to Kerguelen Island in 1874 to observe the transit of Venus; there he carried out a very comprehensive program of magnetic observations. His project of collecting and comparing all his magnetic and solar observations was never completed due to his untimely death during a scientific expedition to the Lesser Antilles to observe a solar eclipse. In 1874 he was elected a Fellow of the Royal Society for his work in terrestrial magnetism. Perry's successor Walter Sidgreaves (1837–1919) completed the work and showed the correlation between magnetic storms and the maxima of sunspots (Sidgreaves, 1899–1901). The continuous magnetic observations from 1858 to 1974 at Stonyhurst may be one of the longest series at the same site.

Solar–terrestrial relations were also the main subject of Haynald Observatory, founded in 1879 by Jesuits in Kalocsa (Hungary). Between 1885 and 1917, Gyula Fényi (1845–1927) carried out a long program of magnetic and solar observations. He concentrated his efforts on the study of sunspots and prominences, making detailed observations (about 40000 of them) and proposing some interesting, for that time, new ideas about their nature. Magnetic observations began in 1879.

The Manila Observatory (Philippines) was founded by Spanish Jesuits in 1865. Martín Juan (1850–1888) was trained in geomagnetism by Perry in Stonyhurst. Juan brought new magnetic instruments to Manila where he took charge of the magnetic section in 1887. In 1888, he carried out a magnetic field survey on various islands of the archipelago. His death did not allow him to finish the work; this was done in 1893 by Ricardo Cirera (1864–1932), who extended the survey to the coasts of China and Japan (Cirera, 1893).

In the observatory of Zikawei, founded in 1872 near Shanghai, magnetic instruments for absolute measurements and variations were installed in 1877; instruments were moved to two nearby sites, first Lukiapang in 1908 and then Zose in 1933. Results were published in nine volumes between 1908 and 1932 (*Études sur le magnetisme terrestre*, pp. 1–39). Joseph de Moidrey (1858–1936) carried out some early work on the secular variation in the Far East region (de Moidrey and Lou, 1932). These observations continued until 1950 when Jesuits were expelled from China by the Communist government.

Figure J2 Ebro Observatory, Roquetas, Tarragona, Spain.

After returning to Spain, Cirera founded in 1904 the Observatorio del Ebro, Roquetas (Tarragona; Figure J2), dedicated specifically to the study of the relations of solar activity and terrestrial magnetism and electricity. The observatory was equipped from the beginning with the most up-to-date instrumentation for this purpose and has kept updating its instrumentation since then. Luis Rodés (1881–1939) studied the influence of various forms of solar activity, mainly sunspots and prominences on the terrestrial magnetic and electric fields (Rodés, 1927). After the Spanish civil war, work was resumed by Antonio Romañá (1900–1981) and José O. Cardús (1914–). Since 1958, Ebro has been the base of the International Association of Geomagnetism and Aeronomy *(IAGA)* (*q.v.*) Commission for rapid magnetic variations. Romañá and Cardús held office in IAGA for many years.

Maintaining magnetic observatories in Africa was a difficult task, which Jesuits undertook early. One of the earliest observatories was established in 1889 in Antananarive, Madagascar. Continuous magnetic observations were made until 1967 when the observatory was transferred to the University of Madagascar. A magnetic station was established in the observatory founded in 1903 in Bulawayo, Zimbabwe. Edmund Goetz (1865–1933), its director for 23 years, in 1909 and 1914 carried out two magnetic field surveys, the first with a profile from Broken Hill (Kabwe, Zambia) to the "Star of the Congo Mine" (Congo) and the second in Barotseland (Zambia) covering a distance of more than 200 miles from Kazungula to Lealui (Goetz, 1920). The third observatory was a state observatory entrusted to and directed by Jesuits in Ethiopia. This observatory arose from a recommendation of the Scientific Committee of the International Geophysical Year in 1955 for a magnetic station near the magnetic equator. The station was established in Addis Ababa in 1958 and directed by Pierre Gouin (1917–) for 20 years. Gouin with the collaboration of Pierre Noel Mayaud (1923–), a Jesuit working at the Institute de Physique du Globe in Paris, studied temporal magnetic variations and magnetic storms. Mayaud participated in French expeditions to the Antarctica, studied the magnetic activity in the polar regions and worked mainly on the nature and practical use of geomagnetic indices (Mayaud, 1980). Early magnetic observations were also made by Jesuits in Central and South America. These observations began in 1862 in Belen Observatory (Havana, Cuba) and continued to about 1920. In Puebla (Mexico), magnetic observations were made between 1877 and 1914.

Summary

As an important part of their scientific tradition Jesuits dedicated much of their efforts to the study of terrestrial magnetism. Jesuits' dedication to science can be explained by their peculiar spirituality, which unites prayer and work and finds no activity too secular be turned into prayer. Teaching mathematics and observing the magnetic field of the Earth or of the Sun are activities, as has been shown, that a Jesuit finds perfectly compatible with his religious vocation and through which he can find God in his life. Early work on magnetism was carried out in the 17th and 18th centuries. Jesuit missionaries during those centuries carried out magnetic observations, which were analyzed and published in Europe. Modern work was done through the establishment of observatories. In at least 15 of these observatories magnetic observations were made. Jesuits contributed to the earliest magnetic observations in Africa, Asia, and Central and South America.

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Bibliography

Cirera, R., 1893. *El magnetismo terrestre en Filipinas.* Manila: Observatorio de Manila, 160 pp.

Cortie, A.L., 1890. *Father Perry, F.R.S.: The Jesuit Astronomer.* London: Catholic Truth Society, 113 pp.

Goetz, E., 1920. Magnetic observations in Rhodesia. *Transactions of the Royal Society of South Africa*, **8**(4): 297–302.

Mayaud, P.N., 1980. *Derivation, Meaning, and Use of Geomagnetic Indices.* Geophysical Monograph 22. Washington, D.C.: American Geophysical Union.

Moidrey, J. de and Lou, F. 1932. Variation séculaire des éléments magnétiques en extreme orient. *Études sur le magnetisme terrestre 39, Observatoire de Zikawei*, **9**: 1–21.

Perry, S., 1870. Magnetic survey of the west of France in 1868. *Philosophical Transactions Royal Society of London*, **160**: 33–50.

Rodés, L., 1927. Some new remarks on the cause and propagation of magnetic storms. *Terrestrial Magnetism and Atmospheric Electricity*, **32**: 127–131.

Sidgreaves, W., 1899–1901. On the connection between solar spots and Earth magnetic storms. *Memoirs of the Royal Astronomical Society*, **54**: 85–96.

Udías, A., 2000. Observatories of the Society of Jesus, 1814–1998. *Archivum Historicum Societatis Iesu*, **69**: 151–178.

Udías, A., 2003. *Searching the Heavens and the Earth: The History of Jesuit Observatories.* Dordrecht: Kluwer Academic, 369 pp.

Vregille, P. de, 1905. Les jésuites et l'étude du magnétisme terrestre. *Études*, **104**: 492–511.

Cross-references

Geomagnetism, History of
Gilbert, William (1544–1603)
Halley, Edmond (1656–1742)
IAGA, International Association of Geomagnetism and Aeronomy
Kircher, Athanasius (1602–1680)
Observatories, Overview
Sabine, Edward (1788–1883)

http://www.springer.com/978-1-4020-3992-8

Encyclopedia of Geomagnetism and Paleomagnetism
Gubbins, D.; Herrero-Bervera, E. (Eds.)
2007, XXVI, 1054 p. 718 illus., 50 illus. in color.,
Hardcover
ISBN: 978-1-4020-3992-8