Magnetic measurements at Naples in the XIX century

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Abstract
Measurements of elements of the Earth's magnetic field started in Naples in 1837 by the Astronomical Observatory. Declination and inclination daily averages were regularly published from 1840. In 1839 Macedonio Melloni was called in Naples by the Bourbon Government and asked to found an observatory to carry out regular measurements of geomagnetic elements and meteorological parameters. The observatory was built on Mt. Vesuvius and completed in 1848, but it started to operate only in 1852. Magnetic measurements were carried out in the following years, rather discontinuously, by Luigi Palmieri.

Key words *geomagnetism – history – observatories*

The development of geomagnetism in Naples is closely bound to the foundation of the «Osservatorio Vesuviano», even if, during the last century, most of the measurements of geomagnetic elements were in fact carried out by other institutions. The original name of the first observatory built on a volcano was in fact «Reale Osservatorio Meteorologico Vesuviano». One may wonder why no mention was made of volcanology. The answer is simple: because the observatory was founded with the main purpose of carrying out periodical or, possibly, continuous measurements of the main elements of the Earth's magnetic field, and in XIX century geomagnetism was part of meteorology.

As often occurs, geomagnetic measurements were not performed for more than about twenty years of the 150 year lifetime of the observatory, which was to become an observatory devoted to the study of Mt. Vesuvius, *i.e.* a volcanological observatory.

It all began in 1837, when King Ferdinand II of Bourbon visited Paris with a delegation which included Ernesto Capocci, Director of the Royal Astronomical Observatory, and Nicola Santangelo, Ministry of the Interior and Public Education. There they met Macedonio Melloni, one of the prominent physicists of the time, who was in Paris as a political refugee from the Grand Duchy of Parma. Melloni was renowned for his research on radiant heat, and he had conducted some meteorological research in Parma. Melloni was impressed by the interest in science shown by the Neapolitan government and, shortly after the visit, wrote the King offering his services as professor of physics. François Arago, director of the Observatoire de Paris and secretary of the Académie des Sciénces, and Alexander von

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Humboldt, a geophysicist, member of a very influential Prussian family, backed his offer, writing directly the King praising the scientific merits of Melloni (Gasparini *et al.*, 1992). None of the letters mention any observatory and only the capability of Melloni as a physicist is emphasized. Both Santangelo and Capocci were very eager to have in Naples a physicist of the value of Melloni. On March 4, 1839, Santangelo wrote the King a letter proposing that Melloni should be entrusted to organize a Conservatory of Arts and Crafts and, he adds: «it would be extremely necessary to found in Naples a meteorological institute similar to those existing in England and in Russia, particularly nowadays that the Earth's magnetism occupies the minds of those who study the physics of the globe».

The foundation of a meteorological observatory had to be a lower priority task. It was probably suggested by Ernesto Capocci because his coworkers at «Osservatorio Astronomico» were at that time carrying out measurements of magnetic declination and inclination. He had found that the eruption of January 1839 caused a long term decrease of the magnetic declination at the Astronomical Observatory (Capocci, 1839, 1840).

These were crucial times for the knowledge of the geomagnetic field. K.F. Gauss published his General Theory of the Earth's magnetism in 1838. It was largely based on the measurements made all over the world by Alexander von Humboldt, and on the maps by Christopher Hansteen and others. The magnetic elements which were measured at that time were declination and inclination. The total intensity of the geomagnetic field was determined measuring the period of needle oscillation which is proportional to the product of the intensity of the horizontal component and the magnetic moment of the needle. As the two terms could not be separated, the horizontal intensities were relative to a reference station. Von Humboldt used Berlin, Sabine used Paris, Hansteen used Christiania (the modern Oslo). The total field intensity was obtained by dividing the horizontal intensity by the cosine of the dip angle. Shortly afterwards similar instruments were developed by Lamont in the United States and Hansteen in Norway.

The existence of strong irregular variations of the magnetic field (magnetic storms) and of irregular daily variations had been observed by Alexander von Humboldt and by many other scientists measuring the magnetic field. The need to establish magnetic observatories to study these variations worldwide was clear. A magnetic observatory was set up in Berlin in 1828. Alexander von Humboldt was very active in fostering the establishment of magnetic observatories in several countries and by the 1830's pratically every major town had a meteorological observatory measuring the magnetic field. In 1834 a meeting was held in Göttingen where some rules for measuring the magnetic elements were given. As continuous measurements by graphical methods were expensive and many observatories could not afford them, eight 44 h long periods were selected in one year during which magnetic declination and inclination were measured every hour.

In 1837 the Astronomical Observatory of Naples was equipped with declination and inclination compasses and with a Gauss instrument for the measurement of the total field, which was not set up at least until 1843, because it was impossible to find a quiet place around the Observatory (Capocci, 1840; Del Re, 1843). Monthly averages of declination from 1840 to 1848 and of inclination from 1840 to 1844 (fig. 1a,b and table I) were published by Chistoni (1887) who reports Cristiano Enrico Federico Peters as the man who actually carried the measurements out.

We have recalculated monthly averages from the original data. They generally agree with those reported by Chistoni (1887), who reported seconds as decimals, with the exception of the year 1840. Our monthly averages for this year are one minute lower than Chistoni's ones. De Gasparis (1884) and Chistoni (1887) report that the magnetic measurements were actually carried out by Peters. De Gasparis (1884) writes that «the magnetic observations were started in 1840 with the old Gauss magnetometers and were recently restarted with the new instruments». Capocci (1840) and Del Re (1843) refers that the Gauss magne-

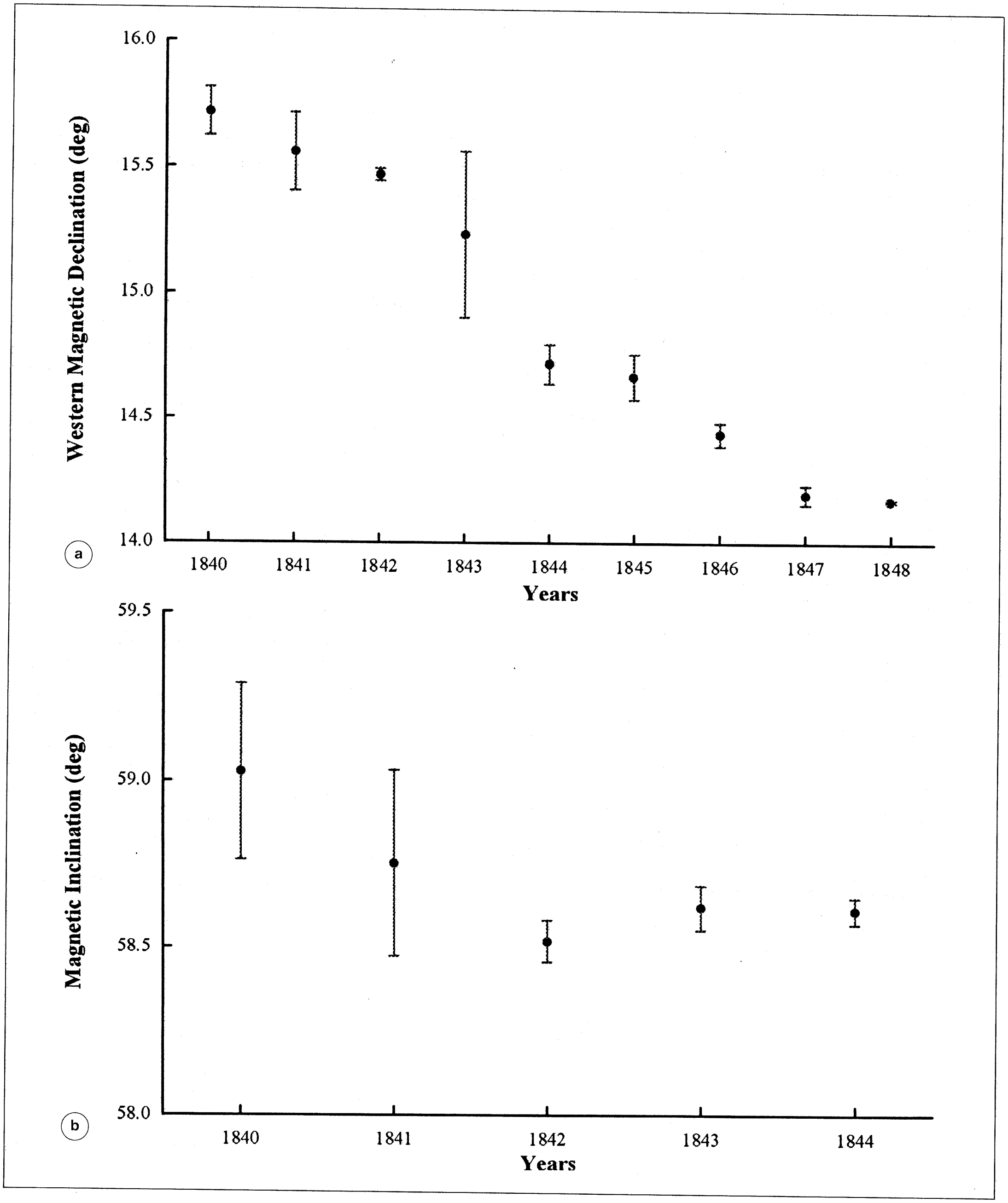

Fig. 1a,b. Yearly averages of magnetic declination (1840-1848) and inclination (1840-1844) respectively. The yearly averages and the standard deviations have been computed from the monthly tables of meteorological observations carried out by the Astronomical Observatory and published in *Annali Civili del Regno delle Due Sicilie* (1840-1847) and *Rendiconti della Reale Accademia delle Scienze* (1841-1848).

Table I. An example of a meteorological table with daily and monthly means. Published by the «Osservatorio Astronomico» in *Rendiconti della Reale Accademia delle Scienze* (1842). Magnetic data are entered under the column *ago magnetico* (magnetic needle).

Osservazioni meteorologiche fatte nel Real Osservatorio di Napoli (1) *nel mese di febbrajo dell'anno 1842.*

Fasi della Luna	Giorni	Barometro 9 mat.	Barometro 3 ser.	Term. R. att. al B. 9 m.	Term. R. att. al B. 3 s.	Term. R. all'om. al nascere del sole	Term-igr. all'omb. 2 h sera asc.	Term-igr. all'omb. 2 h sera bagn.	Ago magnetico Declinazione	Ago magnetico Inclinaz.	Quantità della pioggia	Vento all'osserv. pr m.	Vento all'osserv. d.m.	Stato del cielo prima mez.	Stato del cielo dopo mez.	Stato del cielo notte
		p. l.	p. l.	°	°	°	°	°			c					
	1	27 6,7	27 7,3	6,8	7,0	1,9	6,8	6,1	15° 28′10″	58° 27′	0,000	NE	NE	ser. nuv.	se.nu.va.	se.nu.va.
☾	2	— 8,6	— 8,5	7,0	7,0	0,7	7,2	4,0	30.40	28	0,000	NE	NE	se.nu.va.	ser.calig.	se.calig.
	3	— 10,7	— 10,7	6,3	7,0	— 0,8	6,8	4,0	29.55	—	1,028	NE	N	ser.bello	ser.calig.	ser.nuv.
	4	— 10,3	— 10,1	6,3	6,8	— 0,9	6,4	3,5	29.00	25	0,000	NNE	N	ser.bello	ser.	ser.
	5	— 10,3	— 10,2	6,2	6,9	— 0,5	8,0	6,1	28.10	25	0,000	NE	NE	ser.bello	se.nu.va.	nu.se.va.
	6	— 10,7	— 10,3	6,0	6,9	1,0	7,6	6,2	28.50	28	0,000	N	NE	ser.q.nu.	ser. vel.	ser.vel.
	7	— 10,6	— 10,5	6,2	7,0	— 0,4	6,8	5,2	30.15	25	0,000	NE	ENE	ser.	ser.q.nu.	se.nu.bia
	8	— 10,7	— 10,3	6,0	7,0	— 1,5	7,2	4,8	29.00	28	0,000	NNO	NE	ser.p.nu.	ser.calig.	ser.nuv.
	9	— 11,1	— 11,2	6,2	6,6	— 0,9	6,9	4,7	27.00	30	0,000	NNO	NNE	nuv.var.	nuv.var.	nuv.var.
●	10	28 0,3	28 0,4	6,2	7,2	0,0	8,7	5,6	28.00	25	0,000	NNE	NE	ser.bello	ser.calig.	ser.calig.
	11	— 2,2	— 2,5	6,6	7,3	0,1	9,1	5,6	29.35	—	0,000	NE	ENE	ser.bello	ser.	ser.
	12	— 3,5	— 3,5	6,7	7,8	1,0	10,4	5,9	29.55	28	0,000	NNO	—	ser.	ser.	nu.se.ca.
	13	— 3,1	— 2,7	7,0	8,6	2,0	10,4	7,9	27.30	—	0,000	NO	SE	ser.	ser.calig.	ser.
	14	— 1,5	— 1,1	7,2	8,1	1,4	10,0	7,6	28.10	25	0,000	NO	SO	se.nu.va.	ser.calig.	se.calig.
	15	— 0,3	— 0,0	7,0	8,0	1,5	9,6	6,0	27.50	25	0,000	N	ENE	ser.p.nu.	ser.p.nu.	ser.p.nu.
	16	— 1,2	— 1,3	7,0	8,0	1,1	9,6	5,6	28.50	25	0,000	NE	NE	ser.bello	ser.calig.	ser.
	17	— 1,4	— 1,1	7,0	7,9	0,1	9,5	6,3	30.50	30	0,000	N	SSO	ser.	ser.calig.	se.nu.va.
☽	18	— 0,7	— 0,3	7,0	7,6	— 0,9	8,8	8,3	29.10	25	0,000	NE	NE	ser.p nu.	ser.p.nu.	ser.calig.
	19	— 0,3	— 0,1	7,0	8,0	1,0	10,7	6,4	29.10	—	0,000	NNO	NE	ser.	ser.	ser.calig.
	20	— 0,4	— 0,2	7,0	8,5	2,2	10,6	7,6	30.00	—	0,000	N	SSE	ser.	ser.calig.	ser.
	21	— 0,2	27 11,6	8,0	8,7	2,0	10,6	8,8	29.10	25	0,000	ONO	SSO	ser.	nu.va.se.	se.nu.va.
	22	27 10,7	— 10,2	8,0	8,8	1,5	12,8	10,8	28.50	23	0,000	NO	SO	se.nu.va.	se.nu.va.	nu.va.se.
	23	— 10,3	— 10,0	8,3	9,0	1,9	12,7	10,1	29.00	—	0,000	SSO	SO	se.nu.va.	se.nu.va.	se.nu.va.
	24	— 7,8	— 5,7	8,2	9,0	2,4	9,9	7,6	32.10	—	0,000	SE	SSE	ser.bello	nuv.var.	nuv.var.
○	25	— 2.5	— 2,2	8,4	9,0	3,2	11,1	10,0	28.10	—	1,139	ENE	ENE	nuv.var.	nuv.var.	nuv.var.
	26	— 5,8	— 5,7	8,4	8,9	2,9	10,4	9,2	27.05	—	0,000	NE	S	ser.bello	nuv.var.	nuv. var.
	27	— 5,7	— 6,0	8,2	8,9	2,9	8,7	7,9	28.50	30	0,264	NNO	N	nu.p.ser.	nu.p.ser.	nuv.
	28	— 10,7	— 10,7	8,2	9,1	2,0	11,2	7,6	30 20	25	0,042	N	SO	ser.calig.	se.calig.	nu.se.cal
	Medî	27 10,80	27 10,59	7,09	7,86	0,96	9,23	6,76	15. 29. 3	58.26,4	2,473					

(1) 460 piedi sul livello del mare: Lat. 40°52′: Long. 11°. 55 all' est di Parigi.

tometer, which was acquired by the observatory in 1837 was not operational for the lack of a suitable place. The measurements were carried out with the Gambey inclinometer. This instrument was also used on Mt. Etna in 1842 by Del Re, Peters and Waltershausen. In fact the values of inclinations from December 7, 1842 to January 4, 1843 are missing in the tables issued by the Astronomical Observatory. This is the period when Leopoldo Del Re was on leave of absence to Catania to perform the measurements on Mt. Etna.

From 1847, magnetic declination and inclination started to be measured also by the Royal Navy. The comparison with the measurements made at the Astronomical Observatory shows that the Royal Navy declinations are systematically almost two degrees higher. This discrepancy is not justified by the different locations of the measurement sites.

The aim of «Osservatorio Meteorologico Vesuviano» is clearly stated also in the inaugural address which Macedonio Melloni delivered in 1845, at the VII meeting of the Italian scientists, when the construction of the building was still underway.

He states that: «Nobody ignores that one of the innermost secrets of Nature is the mystery of volcanic eruptions. Till now they have given more pages to history and poetry than useful hints to science, such as the findings of the changes they produce to the properties of the atmosphere and to the electric and magnetic forces. Here is the idea of selecting a volcanic mountain as the site for an observatory» (Melloni, 1846).

This task was strongly recalled by the President of the Academy of Sciences of Naples sixteen years later, at the opening of the first meeting of the year: «After so many years of struggle, we now have the Osservatorio Meteorologico Vesuviano. This was built with the aim of researching and recognizing whether and how much the volcano affects certain meteors... Science is still waiting for an answer from «Osservatorio Vesuviano». Does Vesuvius have any effect on magnetic declination?» (Costa, 1861).

Melloni, on his trip to Paris and London, bought several meteorological instruments as well as a Lamont instrument to measure the magnetic elements, some electrometers, etc. They can be seen in the hall of the new building of the Vesuvius Observatory. There is evidence in several documents that he asked for a special room to be built to set up the magnetic instruments. This room was not ready when the Observatory building was delivered to him in March 1848.

However, two months later a violent insurrection occurred in Naples, which was repressed by the Army. A period of strong repression followed and Melloni and Capocci were dismissed from their offices because they were believed to be involved in the insurrections. Melloni delivered the instruments he had bought to the Institute of Physics of the University and the Observatory was completely forsaken. It looks as if it had been condemned together with its director. The Bourbon Government lost interest in it and even considered selling it to turn it into a hotel (Pinto, 1896).

In 1852 Luigi Palmieri, at that time professor of Philosophy at the University of Naples and an active researcher in geophysics and volcanology, asked the government for permission to install the instruments Melloni had purchased.

The permission was granted, but only a few instruments, including the Lamont variation magnetometer and the Peltier atmospheric electrometer, were carried back to the Observatory. After the sudden death of Melloni in 1854, Palmieri accepted the position of director of the Observatory. He started to measure atmospheric electricity, one of his main research interests at that time (Palmieri, 1853). The magnetic observations were sporadic, due to a lack of assistants and suitable space. However, he suspected the imminent start of the Vesuvius eruption of May 1855, because of an unusual unrest of the Lamont needles which he observed from the last days of April (Guarini *et al.*, 1855).

After the above quoted remark of the President of the Academy of Sciences of Naples, in 1861, Palmieri reported at the meeting of the Academy of Sciences some measurements of declination and inclination he had performed in August and September 1860. He showed the existence of a correlation of periodic noises (magnetic storms or «orages magnetiques») with the phases of the moon (Palmieri, 1861). He published another short paper on the correspondence between displacements of magnetic needles and increasing sunspots during the solar eclipse of July 1860 (Palmieri, 1862a,b).

Then Palmieri concentrated on his studies of electricity and seismology (since 1859 he had constructed his electromagnetic seismograph) and only ten years later did he inform the Academy of some new magnetic observations made during the aurora borealis of October 1870 and the solar eclipse of December 1870 (Palmieri, 1870, 1871).

In 1888 Palmieri wrote his last paper on magnetism entitled: «Actions of earthquakes, volcanic eruptions and thunderbolts on magnetized needles», wherein he summarizes the results of more than thirty years of incontinuous but careful magnetic observations, confirming the probable influence of volcanic activity on the local magnetic field (Palmieri, 1888).

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