## Geomagnetic Observatories and Magnetic Surveys

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Observatories are one of the most important elements in geophysical research. The simultaneous involvement of world-wide continuous long-term observational structures devoted to geophysical data aquisition is the most important source for the investigation of time invariant and transient physical properties of the Earth. Geomagnetic observatories are part of this heritage: they record the variations of the Earth's magnetic field with a view to the exploration of our globe and its environment in the broadest sense.

During the International Geophysical Year (IGY, 1957/58) the main presently working Italian geomagnetic observatory of L'Aquila was established near the village of Preturo about ten kilometres north-west of L'Aquila city in the Central Apennines. Here continuous recording of the geomagnetic elements H and Z (horizontal and vertical intensities), D (declination) and F (total field) have been made since the IGY. At the present time a set of Ruska variographs with normal sensitivity and with a time scale of 20 cm/h is used; a digital recording system consisting of an automatically recording proton vector magnetometer has been systematically used also; a third independent automatic set with digital output from a three axis fluxgate magnetometer and a proton precession magnetometer (derived from an AMOS MKIII with a new data acquisition system) has been routinely employed to check and integrate the other recording systems.

As a regular procedure also in the last few years absolute measurements have been made about three times a week in order to compute base-line values for all the recording systems; these mesurements are carried out by means of magnetic theodolites (magnet suspension and fluxgate) and a vector proton precession magnetometer. The publication of a monthly K-indices and rapid variation bulletin, a four-monthly publication of 0200 UT absolute instantaneous element values, for a reciprocal check among the European geomagnetic observatory network, and finally the complete traditional Yearbook containing all hourly mean values, ensure the dissemination of the L'Aquila observatory data. The major effort during the last four years has been devoted to the modernization of all observatory operations and to the updating of the recording equipment; the improvement of some instruments, in particular the DI-flux, a Zeiss theodolite, a fluxgate sensor and control ensamble, has also been made.

The second Italian magnetic observatory located in Northern Italy near the city of Trento is Castello Tesino where a completely automatic system consisting of a proton precession magnetometer (similar to that at L'Aquila) is working. A monthly inspection made by specialized technicians provides absolute level control by means of absolute magnetic

measurements and data retrieval; absolute measurements are also here made by means of a proton precession magnetometer and a magnetic theodolite. In Fig. 1 the geomagnetic field trend at L'Aquila from 1960 to 1993 is shown. For Castello Tesino Observatory also the publication of the Yearbook permits the dissemination of its data. All data from the two observatories are sent out also in digital form (hourly means and subsets) to WDCs.

In Sicily a photographic paper variograph, working in Gibilmanna, close to Palermo, has been regularly active during the past few years. This observatory is severely affected by artificial noise, and is mainly used to monitor the daily variation during magnetic survey operations in southern Italy.

Magnetic repeat station measurements are made specifically to determine the absolute value of the geomagnetic field at a particular location and, by means of subsequent reoccupations, the secular variation (annual change) of the geomagnetic field. In Italy magnetic surveys, some of which date back as far as the XVII century, have been performed for declination, inclination and, later, also for the horizontal intensity. The retrieval of ancient magnetic measurements and their study has been the object of some very interesting research in recent years. A complete description of the early history of measurements of the Earth's magnetic field in Italy, is now available in the Italian Historical Geomagnetic Catalogue recently published by the ING.

Modern magnetic surveying activity is now carried out for the updating of the new National Network and is performed by the ING in cooperation with the Istituto Geografico Militare Italiano (IGMI). Between 1989 and 1992 the two Institutes measured the declination (D), inclination (I) and the total intensity (F) of the Earth's Magnetic Field at 116 repeat stations distributed over the Italian territory. The network is similar to that used for the 1985.0 survey but now also includes new stations established on the Pontine Islands, the Egadi Islands, and the Island of Lampedusa. All data from field measurements have been reduced to 1990.0. The field equipment used during the survey included the following magnetic and geodetic instrumentation: 1) a nuclear precession magnetometer for the total intensity F; 2) a fluxgate theodolite for measurements of inclination and declination; 3) a gyroscopic theodolite for the determination of geographic North.

High precision measurements made in the seventies on a second order network of more than 2500 data points allowed the complete magnetic mapping of Italy; the results of the latest occupation of the repeat station network were used also to update all these measurements. The new maps describing the field updated to 1990.0 have been drawn with automatic contouring programs (Fig. 2).

A normal field, regarded as a reference that allows the detection of localized crustal magnetic anomalies by computing differences between it and the measured field, was computed at 1990.0. We chose for this purpose an analytical expression consisting of a second-degree polynomial in latitude and longitude.

Once this field is deduced maps of the crustal anomalies can be made (this was first done for the Italian land area for 1979.0). Since it is required that the reference magnetic field reflects only the contribution from the Earth's core (main field), the simple model described above (in this case for 1990.0) was compared with the International Geomagnetic Reference Field (IGRF 1990, see "Geomagnetic Field Modelling"); an attempt to combine the advantages of global models like the IGRF and those of a polynomial normal field was also made. This comparison shows maximum differences of ± 25 nT all across Italy. Such an uncertainty in the reference field is not very significant when it is considered that the crustal anomaly averaged over the whole planet is about 200 nT.

Field operations for the 1995.0 updating of the whole national repeat station network started in 1993 and are continuing in order to complete field operations by 1995.

In 1994 a new national geomagnetic network of repeat stations for F, H, Z, and D was established in cooperation with Albanian colleagues; the observed magnetic field elements from all these repeat stations were referred to 1994.7

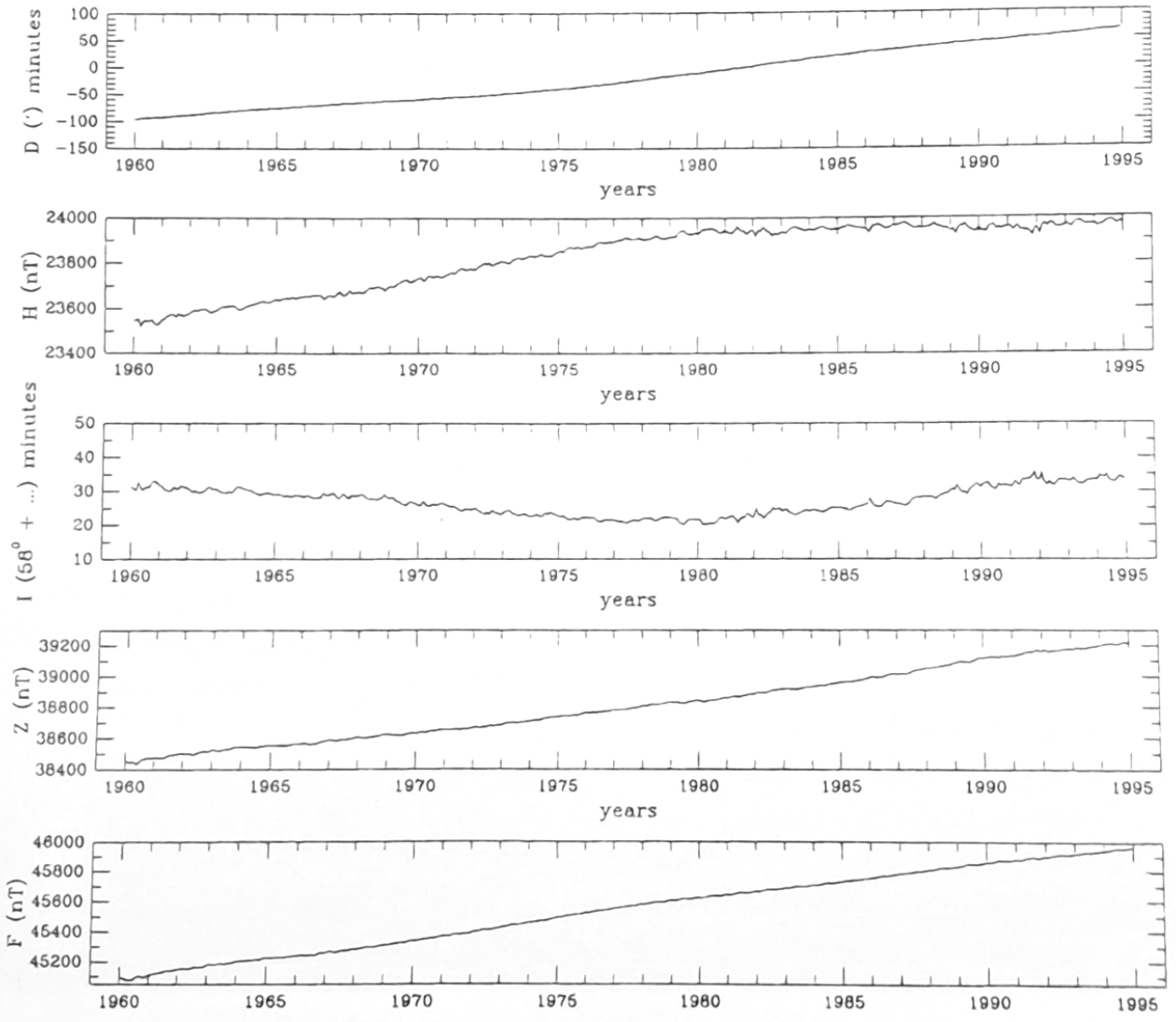


**Fig. 1.** Geomagnetic field elements trend at L'Aquila, Italy (1960-1993).

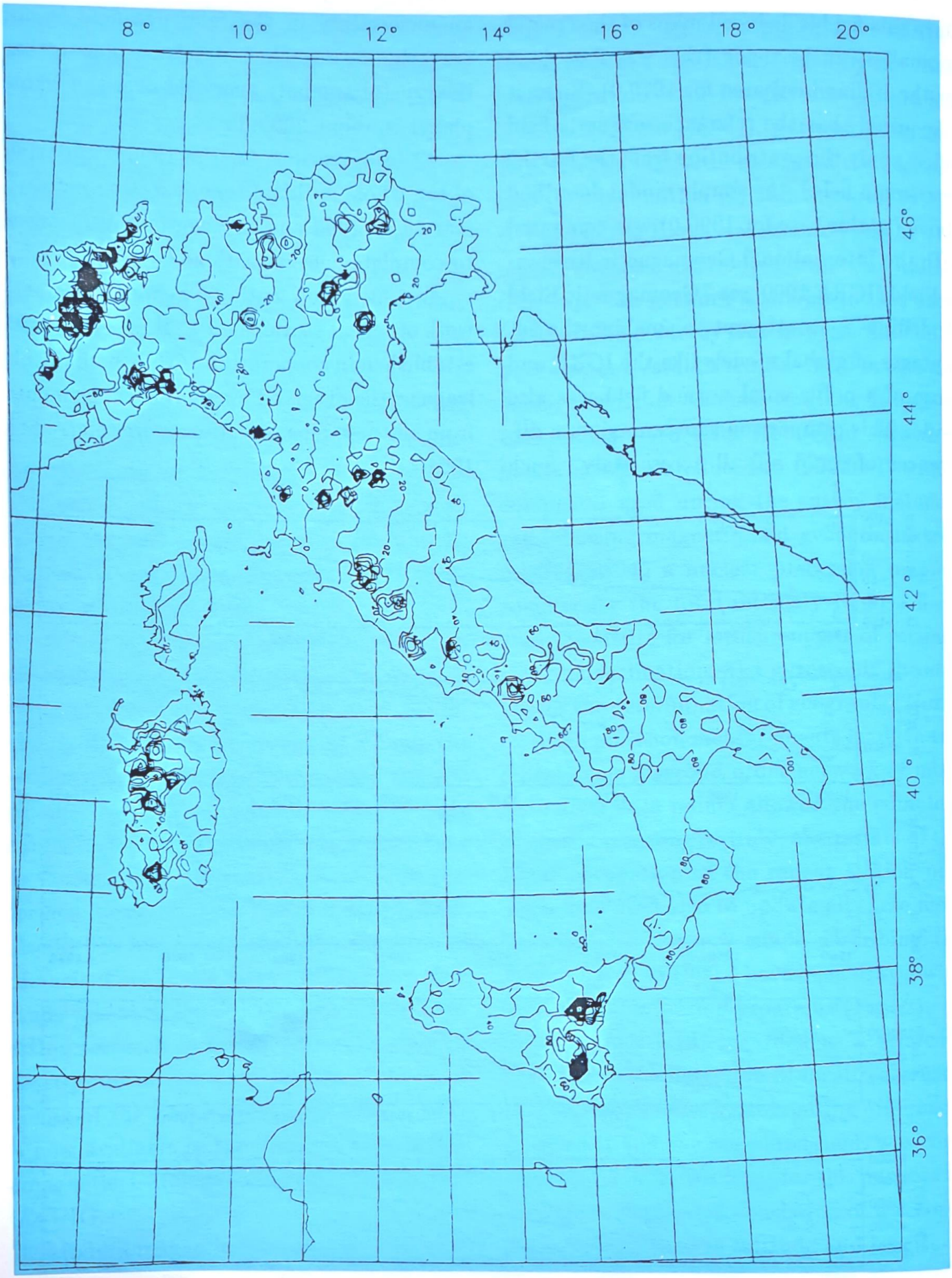


**Fig. 2.** Geomagnetic Field Map of Italy: Declination at 1990.0. Values are expressed in minutes.