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Observing the magnetic world: when measurements precede theory

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In 1269 Peter Peregrinus of Maricourt published "Epistola Petri Peregrini de Maricourt ad Sygerum de Foucaucourt, militem, de magnete" (Letter of Peter Peregrinus of Maricourt to Sygerus of Foucaucourt, Soldier, on the Magnet). In doing so he was the first author to explain how to identify the poles of the compasses and describe the laws of magnetic attraction and repulsion. Although his analysis was based on definite experiences, he clearly provided the first existent written account of the polarity of magnets. Even though that Peregrinus attributed the Earth's magnetism to the action of celestial poles, his concepts developed some 750 years paved the way to our understanding of the geomagnetic field.

Over centuries, the convergence of many different approaches has led to considerable progress in our understanding of the geomagnetic field characteristics and properties. The usefulness of magnetic field charts for navigation has resulted in the compilation of the longest series of quantitative measurements in the history of science, over nearly five centuries. During the last two centuries geomagnetic ground data have been obtained from either magnetic observatories providing continuous measurements or from other kind of observations providing punctual measurements. At that time these data were the main sources of information on geomagnetic field spatial and temporal variations. A radical shift takes place in the late '70, with the launch of the very first satellite carrying a vector magnetometer to measure the full magnetic field. The state-of-the-art has dramatically changed over the last decades due to measurements obtained from the Oersted, CHAMP, SAC-C satellites, and mostly with the recent Swarm mission.

In this lecture I provide an overview of our present knowledge and understanding of Earth's magnetic field, covering both, commonly accepted and some of the more controversial aspects. I aim to underline how geomagnetic field observations have been crucial in developing new insights and new theories, with a special emphasis given on the temporal variations of the core field, on timescales of months to a few hundred years and to the secular variation impulses. A few aspects of the Earth's deep and shallow processes grasped by the magnetic field are also presented, in closest relation with some other geophysical data.