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Mioara Manda

The Magnetic Declination

A History of the Compass

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*For YOU and my wonderful readers!
This book could be an inspiration to anyone,
but especially to Elise, Rachel, Ténael,
Tristan, Matéï...*

Preface

The Earth's magnetic field is used for probing the Earth's lithosphere and deep interior, and understanding solar-terrestrial relationships; it is also a tool for navigation, directional drilling, geological studies and mineral exploration. Also known as the "geomagnetic field", it shields our habitat from the direct influences of the solar wind. During strong geomagnetic storms, that magnetic shield is pushed Earth-ward under the influence of the high-speed solar wind. Satellite failures, problems in telecommunication and radio transmission or even regional power outages are often identified as consequences of these events. To map the geomagnetic field and both its spatial and temporal variations, it is essential not only to improve our understanding of the different processes producing it but also to increase the predictability of the field evolution. Data from ground observatories, special surveys over land and sea, and more recently from satellites must be jointly used to achieve these goals. But it is also important to go back in time... and this journey is offered here, via the magnetic declination.

From the outset, we need to underline that the book mainly focuses on magnetic declination, as one of the magnetic field components. *Magnetic declination* is defined as the angle between the magnetic north and the true north, being positive when the angle measured is east of true north and negative when west. In what follows, the term *declination* is also used; however, it must not be confused with the same term employed in astronomy and defined as the angular distance to locate a point on the celestial sphere in the equatorial coordinate system. Let's also note that, in the field of navigation, the difference between the true north and magnetic north is called *variation*, a characteristic common to all vessels—at a given position and given time. *Deviation* is a magnetic property unique to the vessel itself, describing the effect of different magnetic fields created by the vessel's own equipment such as batteries, large iron-rich objects, engine, speakers, VHF radios, etc.

The origin of this book is somehow linked to my French career which started at the French National Magnetic Observatory, Chambon-la-Fort[^]. Prior to the establishment of observatories and elaboration of an absolute method to measure the magnetic field intensity by Gauss in the 1830s, magnetic observations were made, amongst others, by mariners engaged in merchant and naval shipping. These measurements

are mainly magnetic declination measurements and they extend the global history back to the beginning of the sixteenth century. To discover and analyse ancient magnetic measurements has been a part of my work. Ancient books and maps, old French Navy measurements and instruments have provided me with a unique way to gather magnetic field measurements in Western Europe, over the last centuries, with a sustained work on declination and inclination series for Paris, London, Munich and Bucharest.

Thus, the book aims to describe in a comprehensible way the efforts made over centuries in measuring and understanding the magnetic declination. The book also highlights some important characteristics of the Earth's magnetic field determined thanks to the declination measurements. Some applications and societal implications are also underlined. The book is structured as follows.

The short Part I provides introductory information about the geomagnetic field, mainly with respect to its definitions and sources. Part II is dedicated to the beginning of magnetism, as illustrated in poetry and philosophical writings. The relevance of different attempts to measure this magnetic field component, at different times and locations, is underlined. Part III focuses on the magnetic declination—from the age of sail to the first modern observations. This part offers a tour across centuries, featuring the first maps which include magnetic information. The next important period for understanding the magnetic declination covers the time span from the first continuous observations to the satellite era, and this is addressed in Part IV. The magnetic declination is closely linked to some specific phenomena. To understand them, a selection of maps over the last century is presented in Part V. This is followed by some consideration on spatial and temporal variations of the declination, such as the westward drift and geomagnetic jerks. A special chapter of this Part focuses on geomagnetic and magnetic poles. The book concludes with some thoughts about the magnetic declination of the spacecraft era.

This book would not have been possible without the doors open to the history of science by many of my colleagues, in France, Germany, Great Britain, Romania, so, to some extent, this book is a true community product. Even though I have not mentioned them individually, I extend my warm thanks to each of them.

I am also immensely grateful to institutions which have allowed me to allocate time for searching ancient books, catalogues and maps in many European libraries. I want to acknowledge those who have made my professional life such a pleasure: Benoît Langlais, Monika Korte, Vincent Lesur, Niels Olsen, Erwan Thébault, Georgios Balasis, Aude Chambodut, Mathias Holschneider, Jean-Louis Le Mouél, Maria Alexandra Pais, Nicolas Gillet, Giuliana Verbanac, Michel Diamant, Ingo Wardinski, Dominique Jault, Mike Purucker, Anca Isac, Susan MacMillan, Isabelle Panet, Martin Rother, to name a few.

Petra van Steenbergen and Margaret Deignan were kind enough to invite me to consider publishing this book with Springer. Toby Clark deserves special words of appreciation as he brought a sense of required proportion to all our conversations and read early drafts. I would like to express my special appreciation and thanks to Elena Voj for her diligent reading of this book and her increasing interest in Earth's

magnetism! Finally, I am deeply indebted to Ram Prasad Chandrasekar and Satish Ambikanithi for their wonderful editorial support and guidance.

Last but not least, I want to thank my friends and my family for tolerating my timeless retreats in my home office. I would like to thank my daughters, Anamaria and Raluca, for their presence throughout my life, without whom I would not be who I am. Finally, I must express my very profound gratitude to Daniel, my husband, for providing me with unfailing support and continuous encouragement. Thank you.

Paris, France
May 2022

Mioara Manda

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