Special section

U. Schmucker (†2008): Electromagnetic induction studies with long-periodic geomagnetic variations in Europe - I. Theory and methods of data analysis

Preface

Ulrich Schmucker was one of the formative scientists in the field of electromagnetic induction studies of the Earth. His work is documented in various fundamental contributions published in international journals and in countless contributions to the „Blaue Bände“(„Blue Volumes“) proceedings of the German EMTF (Elektromagnetische Tiefenforschung) working group. The main focus of Schmucker's work has been on the use of geomagnetic observatory data to infer the electrical conductivity within the upper mantle. Electromagnetic induction studies with long-period geomagnetic data rely on an inhomogeneous source field, as opposed to magnetotellurics, where the source field is commonly considered a plane wave.

An important limitation of this kind of induction studies has for long time been the assumption of a one-dimensional Earth. This simplifying assumption facilitates estimates of the source field geometry from global observations, which in turn is prerequisite to infer electrical conductivity within the Earth. The electromagnetic induction problem of a complex source in a three-dimensional Earth is still far from a satisfactory solution.

In this manuscript, Ulrich Schmucker removes the constraint about one-dimensionality by introducing a multivariate transfer function relation, which includes a tensor C-response. This formulation is the basis for the study of lateral heterogeneities within the mantle. The work described in Part I comprises the underlying theory and contains examples for the observatories FUR (Fürstenfeldbruck) and WNG (Wingst). Part II had been devoted to the application; this second part, although at least in parts completed, is unfortunately lost. It should be noted, that a previous contribution to the „Blaue Bände“ (Schmucker U., 2003. Horizontal spatial gradient sounding and geomagnetic depth sounding in the period range of daily variations) already outlines the idea and some results presented in this work.

In addition to the novelties introduced in this work, the paper carefully reviews existing methods of geomagnetic depth sounding. Ulrich Schmucker begins his manuscript with the following statement: *The theoretical foundations of the various methods of magneto-variational sounding (MVS) are developed from first principles*. In fact, the paper can serve as an excellent starting point to familiarize with the problem of geomagnetic depth sounding, while leading the reader to the latest and future concepts of data analysis for the purpose of studying the deep substructure. Besides the progress presented in the work, the completeness of the manuscript makes the paper particularly valuable and is one of the main reasons to make it now accessible to a broader readership.

Ulrich Schmucker made an attempt to publish the manuscript; it was however considered too long to become published in a science journal. Sadly, Ulrich Schmucker passed away before he had decided how to proceed with his work and the manuscript. It was then Peter Weidelt who proposed to take the lead to revise the manuscript in order to publish the work *posthum*. Sadly, Peter Weidelt could not even start to work on the revision, as he tragically passed away a few days after the Ulrich Schmucker memorial colloquium that was held at Neustadt an der Weinstrasse in 2009.

After this series of sad occurrences, the manuscript was kept in paper copy by colleagues and co-workers of Ulrich Schmucker but no new efforts were undertaken to revise and to publish the work.

In 2016, the EMTF working group decided to publish the paper in its original form as part of the „Blaue Bände“ i.e. without any revisions that could alter the comprehensive character of the work, and to make it accessible to the community. Since the digital version of the manuscript was not recovered, the text, including all formulas, figures and tables were digitized and typeset. Ute Weckmann and Danielle Tölg have accomplished this tremendous work, and Laura Maria Schmidt has proof-read the result. We are very grateful to all of them!

We trust that Ulrich would have agreed with the publication of his original manuscript in the „Blaue Bände“. We believe that the work will be of great use and interest to people working in the field of geomagnetic depth sounding and in related fields, and we hope that the manuscript will also renew the interest of the German EM community in the broader topic of geomagnetic depth sounding.

Michael Becken and Henri Brasse
Münster and Berlin, im Februar 2018