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# SECTION NEWS

## Updating the Map of Earth's Surface Conductance

Studying the Earth's deep conductivity structures, important for developing our understanding of the dynamics of the Earth, is complicated due to effects of the shallow conductive structures on the electromagnetic (EM) responses for periods larger than hours. The results of the deep EM soundings can be heavily distorted by the surface shell conductance, which varies from fractions of siemens (S) inland to up to tens thousand of siemens in the oceans. Thus, separating the effects caused by those variations and by deep conductivity structures is an important step during interpretation of the data.

This article reports on efforts to overcome these difficulties by providing high-resolution, global maps of the Earth's surface shell conductivity structure, from which deep conductivity can be interpolated. Using fine-scale regional surface schemes of conductance for the shallow structures (S-maps) overlain and compiled into broader spatial maps, scientists will be able to use data products from these efforts to accomplish research goals of the currently running USArray (http://www.emscope.org) and for the planned Euro-Array (http://www.euroarray.org), projects that aim in part to regionally map the conductivity structures at upper and middle mantle depths by using magnetotelluric (MT) and magnetovariation (MV) methods.

Changes in the outer part of the Earth's magnetic field, usually caused by interactions between the solar wind and the ionosphere and magnetosphere, induces an electric 'telluric' field in the Earth, and the strength of the telluric field is dependent on the conductivity (resistivity) of the medium. In the MT method, observing the magnetic and electric fields simultaneously, and determining their ratios at varying periods, allows for the derivation of the conductivity distribution with depth. A similar process for determination of conductivity is used in the MV method, but just from magnetic components of the field.

Measuring conductivity is a useful tool for distinguishing different rock types, and measurements of the Earth's subsurface conductivity can shed light on structural geology. The research described here seeks to characterize mantle inhomogeneity against the background of known surface shell conductance distribution for the European region. This study reveals a number of problems that must be overcome in order to collect reliable mantle soundings, and it highlights the necessity of improving of S-maps.

*Improving S-maps*

The most straightforward way to separate deep conductivity from surface shell conductivity is to numerically simulate EM fields in the frame of the Earth's layered model, incorporating a surface conducting shell that consists of contributions from the sea water and from sediments (see Figure 1). Obviously, the accuracy of such a modeling depends essentially on the accuracy of the global S-maps used.

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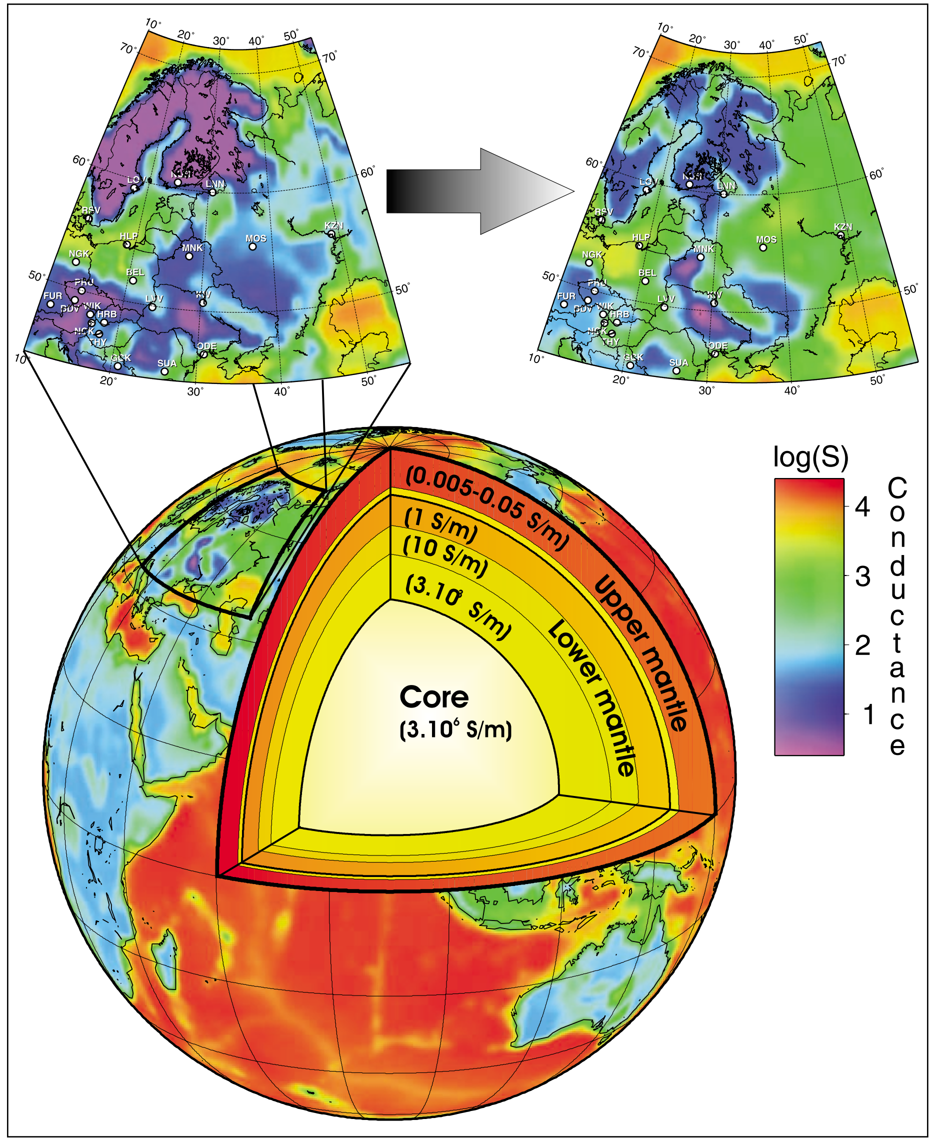


*Fig. 1. The current global surface S-map with a global conductivity distribution of the Earth's interior and extracted S-map for the European region. The initial S-map is obtained from sediment thicknesses (left) and the new corrected S-map is obtained by MT soundings in situ (right). Sediment thicknesses are from* Laske and Masters *[1997].*

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The modern global S-maps are mainly based on the bathymetry, and global sediment thicknesses (on land as well as under water) given by *Laske and Masters* [1997]. Additionally, improvement in the oceanic conductance data recently was achieved, taking into account the salinity, temperature and pressure of the sea water [cf. *Manoj et al.*, 2006]. However, the methods used to create these global S-maps seem to be insufficient do to the ambiguity introduced by applying heuristic procedures to convert sediment thicknesses into conductance values [cf. *Everett et al.*, 2003].

One way to improve the global S-map on the continents is to merge the existing regional S-maps that have been compiled all over the world for many years. These regional S-maps often have better resolution and, most probably, higher reliability since they use a priori information, for example, the shallow seismic and gravity investigations, or electrical and EM prospecting [cf. *Harinarayana and Naganjaneyulu*, 2003]. The authors of this article started updating the global S-map on the continents by incorporating the existing regional S-maps, and welcome the contribution of regional conductance data in any form for subsequent correction of the global S-map. The data can be sent to article lead author Ján Vozár (geofSmap@savba.sk), Geophysical Institute, Bratislava, Slovak Republic. The modeling results for the regions of interest with the updated global S-map will be available on request.

GEOMAGNETISM & PALEOMAGNETISM

*Modeling EM Responses With a New Regional S-map*

In a demonstration of the distorting effect of the nonuniform conductance distribution on EM responses in the European region, the layered model of the Earth shown in Figure 1, which incorporates a thin spherical shell, was used with updated regional conductance for northern, central, and eastern Europe. This S-map was compiled with spatial resolution of 1° × 1° as part of two projects: Baltic Electromagnetic Array Research (BEAR) [*Korja et al.*, 2001] and Central Europe Mantle Geoelectrical Structure (CEMES) [*Semenov et al.*, 2003]. The new regional S-maps are shown in Figure 1. Induction equations have been solved numerically according to the three-dimensional scheme by *Kuvshinov et al.* [2005].

Figure 2 presents examples of the theoretically calculated apparent resistivity and impedance phase values for the MT and magnetovariational geomagnetic deep soundings (GDS) methods at periods of 0.25 days (more results are available at ftp://gpi.savba.sk/Smap). The two methods respond in different ways to the near-surface inhomogeneities, and moreover, the MT responses depend on the field polarization. The distortions of the apparent resistivity obtained by the MT method are much higher than the impedance phases, as expected. The apparent resistivity values obtained for the GDS method (apart from the MT responses) are less sensitive to the surface conductance variations than the MT method. Note that the inconsistency between the two methods due to the lateral variability of the conductance decreases as the period increases.

These modeling results show that effects caused by surface shell conductance inhomogeneities are significant and can be predicted with required detail and accuracy if the reliable conductance maps are available. Once these high-resolution S-maps have been made, it then would soon be possible to model deep conductivity structures by subtracting shallow components from the overall signal. Hopefully, this would lead to a better understanding of mantle evolution and plate tectonics.

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CEMES Experimental Team [*Semenov et al.*, 2003] members from the following institutions participated in the preparation of the S-map of central and eastern Europe: Institute of Geophysics, Warsaw, Poland; Geophysical Institute, Prague, Czech Republic; Institute of Geological Sciences, Minsk, Belarus; Geodetic and Geophysical Research Institute, Sopron, Hungary; Geological Survey of Romania, Bucharest; Geophysical Institute, Bratislava, Slovakia; Institute of Geophysics, Kiev, Ukraine; and State University of Moscow, Russia. Thanks are due to the Polish Committee of Scientific Research, which has supported the investigations through grants 6P04D-01220 and 2P04D-02329, and to the Centre on Geophysical Methods and Observations for Sustainable Development, Warsaw, Poland, which has supported the joint work of the authors. Additionally, C. Manoj thanks V. P. Dimri, National Geophysical Research Institute, Hyderabad, India, for permission to publish this article. J. Vozár is grateful to Vedecká Grantová Agentúra (VEGA) for support of this work through grant number 02/6045/26.

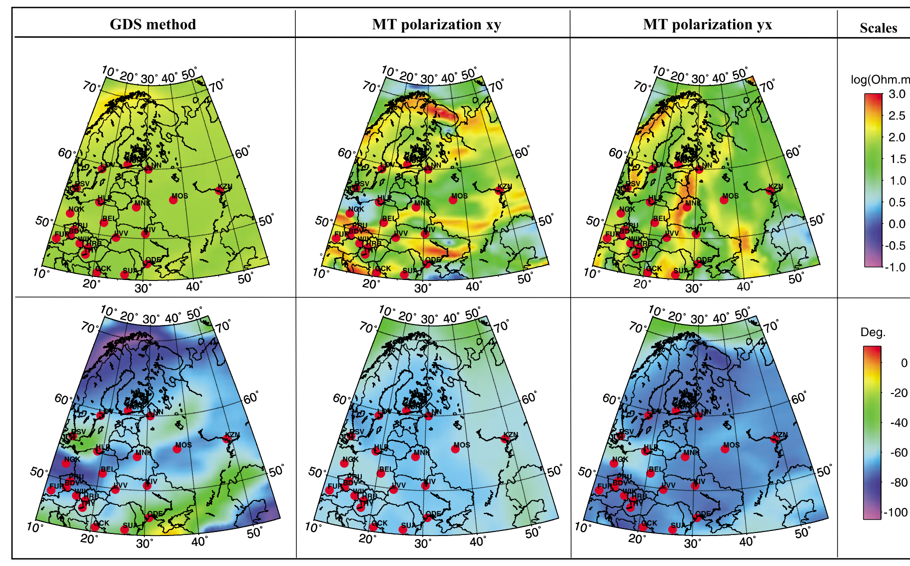


*Fig. 2. (top) The apparent resistivities and (bottom) phases of impedances modeled for the Europe region by (left) the GDS and (center and right) MT methods (for two polarizations). The period is 0.25 days.*

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