Unravelling electrical structure of the mantle with ionospheric, magnetospheric and oceanic electromagnetic sources

Alexander Grayver
[1]Institute of Geophysics, ETH Zürich, agrayver@ethz.ch

SUMMARY

This review presents the progress made in the last decade in the mantle studies with natural electromagnetic (EM) induction sources, which span periods from seconds to years and have diverse origins. These mechanisms produce field variations that can sense Earth's electrical structure at different scales in a depth range from the crust to the lower mantle. The last decade has seen substantial progress in different areas related to the methods, data collection and numerical modelling of EM phenomena. Specifically, new methods on handling complex ionospheric and magnetospheric sources were proposed, accompanied by more efficient forward and inverse modelling tools that allow us to combine several sources and constrain electrical conductivity on multiple scales simultaneously. Further, the launch of Swarm satellites in 2013 with extremely successful operation have marked a new era in the field of large-scale EM induction, presenting a set of new opportunities. These developments were backed by continuing new lab measurements of electrical conductivity for mantle minerals at temperatures and pressures that are closer to the actual conditions expected in the mantle. The latter enabled more accurate quantitative estimates of water content and temperature in the mantle. In parallel, crust and mantle conductivity models along with developed modelling techniques have become an integral part of geomagnetic field and geomagnetically induced current (GIC) modelling workflows.

Keywords: global induction, mantle conductivity, inversion, water content