MANTLE ELECTRICAL CONDUCTIVITY AND GEOMAGNETIC JERKS: DATA ANALYSIS, FORWARD AND INVERSE PROBLEMS

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The electrical conductivity of the Earth's mantle has been a subject of much debate in the last few years. Induction studies agree mainly in the first 1000 km of the mantle, however in the lower mantle the conductivity is still very uncertain. Geomagnetic jerks involve abrupt temporal changes in the secular variation of Earth's magnetic field and are believed to be due to motions in the fluid core. We modeled the secular variation, around the time of a jerk, by two straight-line segments; their intersection defines the jerk occurrence time and the difference between the two slopes defines the jerk amplitude. We detected global jerks occurring at 1969, 1978, and 1991 that show different time arrivals at the surface of the order of 3 years. We analysed the hypothesis that the electrical conducting mantle generates such jerk differential delays. We developed the forward approach to this problem where a 1D mantle conductivity model acts as linear, causal and time-invariant filter. In the forward problem, we have demonstrated exactly how different emergence times can occur at the Earth's surface. However, in order to constrain some information about the electrical conductivity of the mantle one needs to solve the inverse problem. We used Velímský and Martinec's [2005] approach to solve exactly the diffusion equation for 1D mantle models to calculate the Impulse Response Functions (IRFs). The 1-D mantle conductivity model of Kuvshinov & Olsen (2006) was adopted up to 700 km depth and below that four simulations were performed with electrical conductivities varying from 1000 S/m to 0.4 S/m for one, two and three layers models. The results showed to be consistent with similar patterns of low misfit values for a lower mantle about 1 S/m and allowing a broad variation for the D". The amplitude of most low misfit models indicates differential delays on the order of 0.1 yr and by our data analysis the differential delays are on the order of 1.5 yr. However, the patterns early/late for differential delays of the minimum misfit models are in a good agreement with the results found in the data analysis of the Y component of the 1969 jerk.

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