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Magnetic observatory data - unique input for probing the Earth's mantle

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Geomagnetic fluctuations originating in the exterior of the Earth are the cause of electromagnetic induction phenomena in its interior. Using the relation between inducing (external) and induced (internal) field variations over periods ranging from several hundred sec and longer, we can infer the electrical conductivity distribution within the Earth's mantle. The field penetration depth (or the skin depth) approximately controls the depth of investigation. Electrical conductivity of materials composing the Earth's mantle highly depends on temperature, abundance of conducting materials such as fluids or melts, content of hydrogen in the lattice of minerals. Since these physical conditions are known to control the dynamic property, the knowledge of conductivity distribution is useful for understanding the deep mantle dynamics.

In the past, such a study began with an estimation of the mean value of the mantle conductivity. Then a number of attempts have been made to obtain one-dimensional profile of the mantle conductivity as a function of depth. Recently, efforts have been carried out to image the heterogeneous mantle conductivity in three-dimensions by inverting data from a number of magnetic observatories or observation stations. This presentation shows an overview of scientific results obtained in the past and the current status and possible future perspectives. Especially, it is emphasized that exploring down to the bottom of the lower mantle is still a difficult task, even when analyzing long time series provided by a few "one-century old" magnetic observatories in the world, as Kakioka celebrates nowadays.

Keywords: magnetic observatory, structure of the Earth, electrical conductivity, geomagnetic field variations, mantle