16 Telluric Currents: The Natural Environment and Interactions with Man-made Systems

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INTRODUCTION

Telluric currents consist of both the natural electric currents flowing within the Earth, including the oceans, and the electric currents originating from man-made systems. Telluric currents could also be considered to include geodynamo currents, i.e., the electric currents that are presumed to flow in the Earth's core and are responsible for the generation of the "permanent" geomagnetic field. This review excludes geodynamo considerations from its purview.

There has been an evolution (see Appendix) in the terminology in the English-language scientific literature related to telluric currents. A common former term used for telluric currents has been "Earth currents," a term that was widely used by Chapman and Bartels (1940) in their classic work, whereas Price (1967) preferred "telluric currents." A difference between the two terms can be recognized in reading historical papers: an impression is obtained that Earth's currents was the name applied to the natural currents (or, more properly, voltages) that are measured between two electrodes which are grounded at some distance apart. Independent of the cause, the observed current was termed an Earth's current. It later became evident that electric currents also flow in seawater. Therefore, the term telluric currents can be interpreted to include currents flowing both within the solid Earth and within the seas and oceans. However, we note that Earth currents and ocean currents do not form independent electric-current systems. On the contrary, leakage currents exist between continental areas and oceans (see, e.g., references in Gregori and Lanzerotti, 1982; Jones, 1983). In the early French and Italian scientific literature on the subject, however, the term telluric (derived from the Latin *tellus*, for Earth) was always used (e.g., Blavier, 1884; Battelli, 1888; Moureaux, 1896).

The fundamental causes of telluric currents are now believed to be understood. They are produced either through electromagnetic induction by the time-varying, external-origin geomagnetic field or whenever a conducting body (such as seawater) moves (because of tides or other reason) across the Earth's permanent magnetic field. Both causes produce telluric currents, which, in turn, produce magnetic fields of their own—fields that add to the external origin geomagnetic field and produce a feedback on the ionosphere current system (a feedback that, however, is negligible; see, e.g., Malin, 1970).

The complexities associated with telluric currents arise from the complexities in the external sources and in the conductivity structure of the Earth itself. Such complexities have led earlier workers to make statements such as "the simple laws of electromagnetic induction do