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Long-term variations in the paleomagnetic field

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Variations in Earth's magnetic field due to internal processes occur on a broad range of timescales, ranging from months to billions of years. While most variations are often attributed to stochastic processes in the core, long-term variations, >10 Ma, have been hypothesized to reflect influences beyond outer core dynamics. One hypothesis is that these long-term variations reflect the influence of mantle forcing, bound to changes in heat flow at the core mantle boundary. It has also been hypothesized that long-term variations reflect the influence of planetary thermal evolution. While it is expected that both the mantle and the thermal evolution of the planet influence the outer core, the question that remains is whether the influence of these entities would result in changes detectable at Earth's surface. To help assess this hypothesis we have two key tools at our disposal: paleomagnetic data and numerical geodynamo models. If long-term variations can be properly identified in paleomagnetic records, and corroborated by geodynamo models, together they can provide a means for studying changes in the deep interior over the course of Earth history. Unfortunately, long-term trends in Earth's magnetic field behaviour can be difficult to ascertain due to complexities associated with poor/uneven spatial and temporal coverage, and reliability assessment. These issues are particularly pertinent for records of ancient magnetic field strength (or paleointensity), which is arguably one of the hardest aspects of Earth's ancient magnetic field to constrain. For example, a recent compilation of Precambrian paleointensity estimates has been interpreted to indicate that Earth's magnetic field strength increased in the Mesoproterozoic, hypothesized to mark the onset of inner core nucleation. However, it has been suggested that this interpreted Mesoproterozoic increase is due to the inclusion of unreliable data. In this presentation, I will provide an overview of the current understanding of the long-term magnetic field behavior from paleomagnetic data and its geodynamic implications. This will include a discussion of the difficulties in assessing these trends, and our recent work attempting to overcome these barriers to verify long term variations in the paleomagnetic field, particularly focusing on records of paleointensity.