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Geomagnetic Paleointensity Variations as a Cheap, High-Resolution Geochronometer for Recent Mid-Ocean Ridge Processes

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The sequence of geomagnetic field reversals is widely used to date events younger than 160 Ma, with a resolution of a million years. In oceanic domains, Vine and Matthews (1963) magnetic anomalies have been successfully used for more than 35 years. The major limitation of this chronometer is its low temporal resolution, especially for the recent times: the youngest polarity reversal, between Brunhes normal and Matuyama reversed periods, is dated ~800 ka. Studies of pelagic sedimentary cores have shown the existence of consistent variations of the geomagnetic field intensity within this period. If accurately dated, these variations may refine the magnetic geochronometer to a much higher resolution of 10-100 ka. Recent studies have demonstrated that the "tiny wiggles" of lower amplitude and shorter wavelength superimposed to the Vine and Matthews anomalies are of geomagnetic origin and correspond to the paleointensity variations identified on sediment cores. Using a large set of magnetic data acquired in 1996 on the Mid-Atlantic Ridge at 21°N (surface and submersible magnetic anomalies, natural remanent magnetization and absolute paleointensities measured on samples), we have shown that the oceanic crust confidently records the geomagnetic intensity variations. It was unfortunately impossible to date the samples, made of basalt too depleted in K2O and in trace elements required by the various methods of radiochronology. In 2000 we have collected a similar data set at the Central Indian Ridge axis at 19°S (surface, deep-tow, and submersible magnetic anomalies, natural remanent magnetization and absolute paleointensities measured on samples). This area offers the advantages of 1) a faster spreading rate, and therefore a higher temporal resolution of the geomagnetic signal, and 2) the presence of moderately enriched basalt as a consequence of the interaction of the ridge with the nearby Reunion hotspot, making possible radiochronologic dating. Our first evaluation of the data confirms the quality of the oceanic crust as a recorder of the geomagnetic variations. Future work in the framework of Project GIMNAUT include 1) the processing and interpretation of the available magnetic signals to obtain a detailed sequence of the geomagnetic fluctuations for the last 800 ka; 2) the dating of collected samples with different radiochronologic methods such as K-Ar and Ar-Ar for samples older than 100-150 ka and 230Th-238U for samples aged between 300-10 ka; and 3) the calibration of the geomagnetic intensity variation sequence as a high resolution geochronometer for the last 800 ka. Such a magnetic geochronometer would present an obvious interest for mid-ocean ridge studies, because of its low cost and simplicity of operation: it would only require the addition of a deep-sea magnetometer onto existing means of investigation such as submersibles, ROVs or AUVs. Beyond this application, this magnetic geochronometer could also be used for accurate dating of pelagic sedimentary sequences, through the analysis of relative paleointensities on cores, or of continental or island volcanic flows, through the determination of absolute paleointensities by the Thellier-Thellier method.

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