RECENT ADVANCES IN DETERMINING ABSOLUTE AND RELATIVE PALEOINTENSITY VARIATIONS OF THE GEOMAGNETIC FIELD

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For the past 30 yr, the focus in paleomagnetism has been on the direction of the paleomagnetic vector rather than on its intensity. The reason for this "two-dimensional" view of a three-dimensional quantity is that determination of the paleointensity is inherently more complex, more difficult, and less reliable than determination of the paleomagnetic direction. This situation may be changing as new techniques and new instrumentation are brought to bear on these problems.

For determinations of the absolute paleointensity of the geomagnetic field, the standard methodology has, for many years, been the Thellier-Thellier double heating experiment. This approach can be used with material that carries a thermal remanent magnetization, such as lava flows, hearths and pottery. Unfortunately, the Thellier-Thellier experiment is very time-consuming, and the percentage of samples that give unsatisfactory results can be quite high. As a result, the database of absolute paleointensity determinations is still relatively small. Recently, several research groups have tried to develop mineral magnetic screening criteria for identifying, in advance, those samples that were likely to produce satisfactory results in the Thellier-Thellier experiment. Although this work promises to increase the success rate for absolute paleointensity determinations, it does not address another important problem, namely, the available material seldom represents a continuous sampling of the geomagnetic field through time. This problem is particularly acute for studies involving lava flows but it can also arise when archaeological materials are involved.

Sediments, on the other hand, offer the possibility of a continuous record of geomagnetic intensity variations. For sediments, however, the intensity of magnetization depends on the intensity of the geomagnetic field at the time the magnetization was acquired and on several other factors, including the concentration and grain size of the magnetic carriers. Many years ago it was proposed that the relative intensity of the geomagnetic field intensity could be determined with a normalization based on the intensity of a laboratory-induced magnetization. It was soon recognized that too much variation in the size or concentration of the magnetic grains could be a problem, and various selection criteria were proposed. In recent years, a globally consistent picture of relative paleointensity variations is beginning to emerge, at least for the last 250,000 yr. In addition, there has been the intriguing suggestion that variations in relative paleointensity over the past four million years are linked to polarity transitions. However, there is still disagreement about the interpretation of significant spatial and temporal variations that are seen in relative paleointensity records over both time scales. In addition, it is not clear whether the absolute and relative paleointensity records are mutually consistent.

With regard to the determination of production rates of cosmogenic nuclides, it is important to recognize that both absolute and relative paleointensity determinations are not easy to make nor simple to interpret, and that the inherent problems and complexities could lead to problems in calculations based upon them. On the other hand, the most important observation may be that geomagnetic intensities during the past 10,000 yr have been somewhat higher than the average for the past 250,000 yr. If this conclusion is correct, then temporal and spatial variations that are present over the longer time interval could have had a relatively minor influence on production rates.