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A new stability test for high-resolution palaeomagnetic data

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Assessing the reliability of palaeomagnetic directions is a long-standing problem: how can it be determined that a set of measured palaeomagnetic directions truly records primary geomagnetic field directions, rather than being produced by one of the other processes which can affect rock magnetizations? One approach is to use rock magnetic analysis to establish that the rock should be capable of retaining a palaeofield direction. A complementary approach is the use of field tests of paleomagnetic stability, which analyse the palaeomagnetic directions themselves in the context of their position in the section or core. Perhaps the best known is the reversals test, which determines whether the mean direction computed from the normal-polarity sites is antiparallel to the mean direction for the reversed-polarity sites. Only a small number of stability tests have been devised, and none are universally applicable. We describe a new addition to this arsenal.

Our proposed stability test, the secular continuity test, is applicable to data with sufficient temporal resolution to reflect geomagnetic secular variation. The secular variation of the geomagnetic field direction varies in a continuous manner, and statistical tests can be used to determine whether a sequence of measured directions is consistent with such behaviour. If a set of measured directions passes the continuity test, it indicates that they are reliable records of the geomagnetic field direction, since none of the other processes which impart remanence are known to vary in this way. A failed continuity test may merely indicate that the sampling interval was too large to capture variation at secular timescales. If, however, the sampling interval is known (from other constraints) to be short enough, a failed continuity test shows that the palaeomagnetic directions are unreliable due to unstable magnetizations, secondary overprints, or other confounding factors.

The continuity test is implemented as a simple procedural algorithm, using bootstrap statistical techniques to estimate the probability that a supplied data set has a secular component; the test can thus be applied at a chosen confidence interval. We describe the implementation of the test, and demonstrate its application to synthetic and real data.