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Analysis of the Devonian paleomagnetic direction distribution in the Minusa basin

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There have been several lengthy periods in the Earth's history when the geometry of the geomagnetic field may have differed from the central axial dipole model. One such problematic interval is the Devonian period [1, 2], for which the array of available paleomagnetic data suggests a significantly more complex structure of the geomagnetic field. In this report we present initial results of a comprehensive analysis of the current database for Devonian rocks, including our own new paleomagnetic data.

Based on our own collection of 568 samples collected from 63 sites and already available data [1], we studied the distribution of paleomagnetic directions within Early–Middle Devonian dolerites and basalts of the Minusa Basin. The studied paleomagnetic record varies not only between different magmatic bodies but also within each outcrop, making it difficult to determine the predominant direction at a given sampling point. The distribution of paleomagnetic directions often appears chaotic, making it even more difficult to identify a clear pattern. Among the sampling points where we were able to analyze the data, we identified 9 clusters of paleomagnetic directions. We hypothesized that the different components that are fixed in the rocks of this period are due to a decreased contribution from the primary dipole component, which is related to the strength of the Earth's magnetic field [2]. This decrease in field strength may have led to an increase in magnetic anomalies, which contributed to the overall magnetic signal observed in the rocks.

According to the fold tests, all clusters predate folding. Two clusters (S and N) are antipodal, the reversal test is positive ($\gamma/\gamma c$ = 5.61/11.89; class C [3]. The calculated paleopole (Plat = -11.5; Plong = 107.3) is close to the expected Devonian directions for Siberia [4]. Thus, we believe that the S and N directions correspond to the central axial dipole and can be used for paleotectonic reconstructions. The paleopoles calculated for the other seven clusters differ significantly from the expected Devonian and younger directions for the study area [4]; they are currently not suitable for solving tectonic problems. Despite the difficulty in interpreting the nature of the clusters, combining the S-cluster with the north geographical pole (Euler pole: Lat = 0, Long = 197.3, angle = -101.5) positions the clusters close to world gravitational anomalies, which, in turn, correlate with world magnetic anomalies [5]. Thus, the observed correlation between paleomagnetic clusters and global anomalies is difficult to explain. However, it is possible that, during "low-field" times, when the contribution of the primary dipole component was reduced, other sources of magnetization, such as anomalous sources, could also have played an important role in the process of obtaining magnetization.

References

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