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Influence of orientation errors associated with the use of a magnetic compass on the accuracy of determining the position of the paleomagnetic pole and the amplitude of paleosecular variations

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Abstract. The use of a magnetic compass in paleomagnetic studies of highly magnetic rocks (for instance, basalts) can lead to large errors in the orientation of paleomagnetic samples. On the other hand, alternative methods of orientation are relatively time-consuming, and in the case of using a solar compass, they also require sunny weather – a condition that is rarely met, especially when sampling at high and subpolar latitudes. This often leads to the fact that researchers in their work rely on the results of magnetic compass measurements, while assuming that the resulting errors are of a random nature and, with sufficiently good statistics, are averaged. In this study, numerical modeling is performed, which allows us to verify this assumption and assess how much orientation errors associated with the use of a magnetic compass can affect the final results of paleomagnetic studies, such as determining the position of the paleomagnetic pole and the amplitude of ancient geomagnetic variations. As a result of the work performed , it is shown that: 1) the amplitudes of paleosecular variations and the positions of paleomagnetic poles are weakly sensitive to moderate and even relatively large errors in the orientation of paleomagnetic samples associated with the use of a magnetic compass; 2) very large errors in the orientation of samples lead to a significant increase within-site scatter of paleomagnetic directions, which makes it possible to detect and exclude the corresponding sites with a large (for instance >15°) value of the α95; 3) the influence of distortions associated with the use of a magnetic compass on the accuracy of determining the position of the paleomagnetic pole and the amplitude of ancient geomagnetic variations depends on latitude. At near-equatorial latitudes, this effect is maximal, at medium latitudes – minimal. 4) With a systematic error in the orientation of paleomagnetic samples within the site, the largest deviations of Sb values and paleomagnetic poles are observed in the range of latitudes up to 60°; at higher latitudes, these deviations become insignificant.

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