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Inclination Shallowing in the Permian/Triassic Boundary Sedimentary Sections of the Middle Volga Region in Light of the New Paleomagnetic Data

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Abstract—One of the key challenges which are traditionally encountered in studying the paleomagnetism of terrigenous sedimentary strata is the necessity to allow for the effect of shallowing of paleomagnetic inclinations which takes place under the compaction of the sediment at the early stages of diagenesis and most clearly manifests itself in the case of midlatitude sedimentation. Traditionally, estimating the coefficient of inclination flattening (f) implies routine re-deposition experiments and studying their magnetic anisotropy (Kodama, 2012), which is not possible in every standard paleomagnetic laboratory. The Elongation–Inclination (E–I) statistical method for estimating the coefficient of inclination shallowing, which was recently suggested in (Tauxe and Kent, 2004), does not require the investigation of the rock material in a specially equipped laboratory but toughens the requirements on the paleomagnetic data and, primarily, regarding the volume of the data, which significantly restricts the possibilities of the post factum estimation and correction for inclination shallowing. In this work, we present the results of the paleomagnetic reinvestigation of the Puchezh and Zhukov ravine (ravine) reference sections of the Upper Permian and Lower Triassic rocks in the Middle Volga region. The obtained paleomagnetic data allowed us to estimate the coefficient of inclination shallowing f by the E–I method: for both sections, it is $f = 0.9$. This method was also used by us for the paleomagnetic data that were previously obtained for the Permian–Triassic rocks of the Monastyrskii ravine (Monastirskoje) section (Gialanella et al., 1997), where the inclination shallowing coefficient was estimated at $f = 0.6$.

Keywords: paleomagnetism, inclination shallowing, Permian, Triassic, Elongation–Inclination method, secular variations

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INTRODUCTION

The effect of paleomagnetic inclination shallowing in the sedimentary rocks has been known for a long time; however, it is most frequently thought of when something goes wrong with the interpretation of the obtained data. The situation with the global inconsistency of the paleomagnetic and geological data at the Permian–Triassic (*P-Tr*) boundary for Laurussia and Gondwana, which in its time resulted in the appearance of two alternative paleotectonic reconstructions of Pangaea (Domeier et al., 2012), is a striking example. We frequently come across the inclination shallowing effect being mentioned in the works devoted to testing the hypothesis of the central axial dipole for the Paleozoic/Mesozoic boundary, where this phenomenon is considered as one of the probable causes of the systematic difference of the coeval paleomagnetic poles of the Siberian and East European platforms (Veselovskiy and Pavlov, 2006; Bazhenov and Shatsillo, 2010).

It was recently convincingly demonstrated (Domeier et al., 2012) that the allowance for the effect of inclination shallowing in the paleomagnetic data obtained over the sedimentary rocks promotes an efficient solution of the Pangaea reconstruction problem, whereas even the presence of insignificant inclination shallowing (5–10%, $f = 0.9$) in the Permian/Triassic sediments of Europe makes the distinction between the average *P*–*Tr* paleomagnetic poles of Siberia and the East European platforms statistically insignificant (Veselovskiy and Pavlov, 2006; Bazhenov and Shatsillo, 2010). Thus, the allowance and subsequent correction of the paleomagnetic data for the effect of inclination shallowing is highly important for the paleotectonic reconstructions and for studying the past configuration of the Earth's magnetic field.

However, until recently the procedure of estimating the coefficient of inclination shallowing for a particular sedimentary section required lithological and