

Ultralow geomagnetic paleointensity at ~2 Ga of Paleoproterozoic igneous rocks from the Ukrainian Shield

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New determinations of paleointensity of the Ukrainian Shield Paleoproterozoic rocks aged 1980–2040 Ma are presented. The Ukrainian Shield is the exposed crust of a large Palaeoproterozoic protocraton and consists of metamorphic and igneous rocks.

Sample selection, palaeomagnetic studies and rock age determination were carried out by Ukrainian geophysicists. The samples were collected in two different regions of the Ukrainian Shield at two sites — Novoukrainka (“NU”, 48.3733N, 31.4930E) and Novaya Rudnya (“DE”, 50.1783N, 28.3320E). NU is the Novoukrainka intrusive massif in the southern part of the Ingul Domain of the Ukrainian Shield, formed by gabbro-monzonite rocks, zircon U-Pb age is 2035 ± 10 Ma. DE is the Buky massif, Northwestern (Volyn) Domain of the Ukrainian Shield, monzonite rocks, zircon U-Pb age is 1987 ± 14 Ma.

The samples were demagnetized by temperature and an alternating field, characteristic components (ChRM) were isolated, and paleodirections were determined. For the NU site: $D = 46.5^\circ$; $I = 36.4^\circ$; $k = 33$; $\alpha_{95} = 7^\circ$ (based on 14 samples); for DE site: $D = 40.6^\circ$; $I = 38.8^\circ$; $k = 59$; $\alpha_{95} = 5.7^\circ$ (based on 12 samples) [1]. The paleomagnetic poles calculated from these sites [1] are in good agreement with previously obtained data for Ukrainian Shield rocks of this age [2].

Determination of paleointensity and accompanying studies of rock properties were carried out in GO “Borok” IPE RAS. Two methods were used to determine paleointensity — Thellier (with the pTRM-check-points procedure) and Wilson. The thermal stability of rocks, the domain structure of magnetic grains were studied, X-ray diffraction analysis and micrographs are made. The rocks are thermostable. Carriers of the characteristic remanent magnetization are single- and small pseudosingle-domain magnetite grains. The reliability criteria are met by 3 determinations of paleointensity on the NU rocks and 18 (21 with duplicates) on the DE rocks. The average values of paleointensity are extremely low: $3.3 \pm 1.3 \mu\text{T}$ (NU) and $4.3 \pm 0.8 \mu\text{T}$ (DE), the corresponding VDM values are $0.73 \times 10^{22} \text{ Am}^2$ (NU) and $0.93 \times 10^{22} \text{ Am}^2$ (DE). The results obtained are consistent with the few determinations of VDM of similar age presented in the world paleointensity database, and indicate an extremely low field strength in the Paleoproterozoic in the period 2040–1980 Ma, an order of magnitude lower than VDM in the Cenozoic ($\sim 8 \times 10^{22} \text{ Am}^2$). This work was supported by the State program GO “Borok” IPE RAS number FMWU-2022-0026.

[1] S. Cherkes, V. Bakhmutov, I. Poliachenko, O. Mytrokhyn, V. Shpyra, and V. Yakukhno, Palaeomagnetism of the Palaeoproterozoic rocks of the ~2 Ga Novoukrainka and Buky massifs of the Ukrainian Shield, 17th International Conference Monitoring of Geological Processes and Ecological Condition of the Environment, European Association of Geoscientists & Engineers, 2023, V. 2023, p. 1, <https://doi.org/10.3997/2214-4609.2023520199>

[2] S.-Å. Elming, L. Shumlyanskyy, S. Kravchenko, P. Layer, and U. Söderlund, Proterozoic Basic dykes in the Ukrainian Shield: A palaeomagnetic, geochronologic and geochemical study — The accretion of the Ukrainian Shield to Fennoscandia, *Precambrian Research* 178(1) (2010) 119.