

Paleointensity Determination on Neoproterozoic Dikes within the Vodlozerskii Terrane of the Karelian Craton

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Abstract—The results of paleomagnetic studies and paleointensity determinations from two Neoproterozoic Shala dikes with an age of ~2504 Ma, located within the Vodlozerskii terrane of the Karelian craton, are presented. The characteristic components of primary magnetization with shallow inclinations $I = -5.7$ and 1.9 are revealed; the reliability of the determinations is supported by two contact tests. High paleointensity values are obtained by the Thellier–Coe and Wilson techniques. The calculated values of the virtual dipole moment (11.5 and 13.8) $\times 10^{22}$ A m² are noticeably higher than the present value of 7.8×10^{22} A m². Our results, in combination with the previous data presented in the world database, support the hypothesized existence of a period of high paleointensity in the Late Archaean–Early Proterozoic.

Keywords: Neoproterozoic dikes, Karelian craton, paleodirections, paleointensity, Thellier technique

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INTRODUCTION

The Precambrian period which spans the interval from the emergence of the earliest rocks with an age of more than 3500 Ma to the beginning of the Phanerozoic (~541 Ma ago) occupies ~85% of the lifetime of the Earth in its geological history. Correspondingly, the Precambrian accommodated all the main formation stages of the Earth as a planet, including the emergence of its magnetic field. The main characteristic of the geomagnetic field observed on the surface of the Earth (geometry, intensity, reversals and their frequency) reflect the deep geodynamical processes, and the paleomagnetic studies that explore the evolution of these parameters with time are one of the sources of information about these processes.

A challenging problem in the work with such ancient rocks lies in proving the preservation of the primary components of natural remanent magnetization (NRM) acquired by the rock at the time of its formation. This requirement is a necessary condition of the reliability of the obtained results, and the difficulty of fulfilling it is the main cause of the paucity of the published data concerning the value of the Precambrian magnetic field. Indeed, of the more than 4000 determinations currently contained in the world database on paleointensity (<http://www.brk.adm.yar.ru/palmag/database.html> and

<http://earth.liv.ac.uk/pint/>) there are only 200 results (~5%) for the Precambrian. This leaves no doubt about the topicality of the paleomagnetic studies of the Precambrian rocks, including those aimed at estimating the intensity of the geomagnetic field in the Precambrian.

Below, we present the data on paleointensity determination from two gabbro-norite dikes with an age of ~2504 Ma; i.e., they were formed close to the Archaean–Proterozoic boundary.

GEOLOGICAL CHARACTERISTIC AND AGE OF THE STUDIED OBJECTS

The Archaean Karelian craton was formed by the collision of five terranes—Vodlozerskii, Central Karelian, Kianta, Iisalmi, and Ranua—about 2.7 Ga ago (Slabunov et al., 2006). The basement of the Karelian craton (3.5–3.2 Ga) is a granite-greenstone domain formed by a complicated combination of Archaean and Paleoproterozoic rocks. The main part of the craton is composed of tonalite–trondhjemite–granodiorite association (TTG) older than 3.0 Ga. For the granite-gneisses of this association, one of the most ancient age estimates over the Karelian craton (3540 ± 90 Ma) is obtained (*Rannii...*, 2005).