Description of applied rock-magnetic and palaeomagnetic procedures

The rock magnetic and palaeomagnetic investigations were conducted at the Laboratory of Palaeomagnetism, Institute of Geophysics Polish Academy of Sciences (IGF PAS). From each of 104 oriented palaeomagnetic samples up to 5 cylindrical cores, 2.5 cm in diameter and 2.2 cm in length were drilled for anisotropy of magnetic susceptibility (AMS) and demagnetization experiments. From each site additional cylindrical cores, 0.6 cm in diameter and 0.8 cm in length were drilled for SIRM (saturation isothermal remanent magnetization) experiments and VSM (vibrating sample magnetometer) rock magnetic investigations.

Ferromagnetic minerals were identified in the course of the following investigations:

1. The isothermal remanent magnetization (IRM) curves were obtained and hysteresis loops parameters were defined using Molspin Ltd, UK vibrating sample magnetometer VSM (0.6 x 0.8 cm cylindrical specimens of amphibolites) and Princeton Measurements Corporation MicroMag 2900 Series alternating gradient magnetometer - AGM (irregular specimens up to 0.2 cm in diameter of metacarbonates, carbonates and tillites) in maximum field 1T.

2. Within amphibolites evaluation of maximum unblocking temperatures ($T_{ub\ max}$) of ferromagnetic minerals was based on SIRM decay curves (procedure after Kądziałko-Hofmokl & Kruczyk, 1976). Small cylindrical specimens 0.6 x 0.8 cm were magnetized in a 7 T field using an MMPM–10 (Magnetic Measurements pulse magnetizer, Great Britain). The specimens were subsequently heated twice in the furnace combined with a spinner magnetometer up to 700ºC in field-free space. On the first demagnetization curve, ferromagnetic carriers of natural remanent magnetization (NRM) were identified. On the second it was possible to identify ferromagnetic minerals which were formed within the specimens in the course of first heating.

3. Within metacarbonates, carbonates and tillites identification of $T_{ub\ max}$ was conducted by a three-component IRM analysis (Lowrie 1990). Specimens of 2.5 x 2.2 cm in size (a minimum of 1 specimen from each site) were magnetized in 3 perpendicular axes in fields of 3T, 0.4T and 0.12 T using an MMPM-10 pulse magnetizer. The specimens were then subjected to a gradual stepwise demagnetization up to 680ºC in a field-free magnetic furnace MMTD1 (Magnetic Measurements thermal demagnetizer, Great Britain). After each of the

demagnetization steps magnetic signals of the specimens were measured using a superconducting quantum interface device (SQUID), 2G Enterprise model 755, US.

The magnetic susceptibility and AMS were measured on the AGICO MFK1−FA, susceptibility bridge. Specimens were subjected to the alternating field (AF) and thermal demagnetization procedures. Thermal demagnetization appeared to be the most effective method of extracting characteristic remanent magnetization (ChRM) components. Specimens were thermally demagnetized in steps up to 680ºC in MMTD1 furnace and after each heating step their residual magnetic field was measured using SQUID. In the course of the demagnetization process, the susceptibility of the specimens was controlled to note changes in the magnetic mineralogy of the samples during heating. A total number of 286 2.5 x 2.2 cm specimens were subjected to AMS and demagnetization experiments.

AMS ellipsoids were calculated using ANISOFT 42 software (Chadima & Jelinek 2009). Palaeomagnetic components and mean site directions were calculated using REMASOFT 3.0 software (Chadima & Hrouda 2009), which employs principal component analysis (PCA) after Kirschvink (1980) and Fisher (1953) statistics. The palaeomagnetic components were calculated on the orthogonal Zijderveld diagrams as a direction of the best fit line to a minimum of three points, with a maximum angular standard deviation (ASD) of 10º. This should be stressed however that the majority of components were calculated with higher precision (60% of directions was defined with max. ASD = 6º, 80% - max. ASD = 8º). Mean site directions that did not pass the modified criteria of Van der Voo (1993) – $\kappa>10$, $\alpha 95\%<16º$, were rejected from further considerations. Additional great circles procedures (Halls 1976; McFadden & McElhinny 1988) were applied to samples from selected sites. Tectonic corrections of the obtained palaeomagnetic components were tested using SPHERISTAT 3.2.1. software. The fold tests procedures - syn-tilting Fisher analysis and inclination only test of Enkin & Watson (1996) were performed using Enkin's (1994) program. Palaeogeographic simulations were performed using GMAP 2012 software (Torsvik *et al.* 2012). The reference Phanerozoic palaeopole paths of Baltica and Laurentia were derived from integral libraries of GMAP 2012.

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