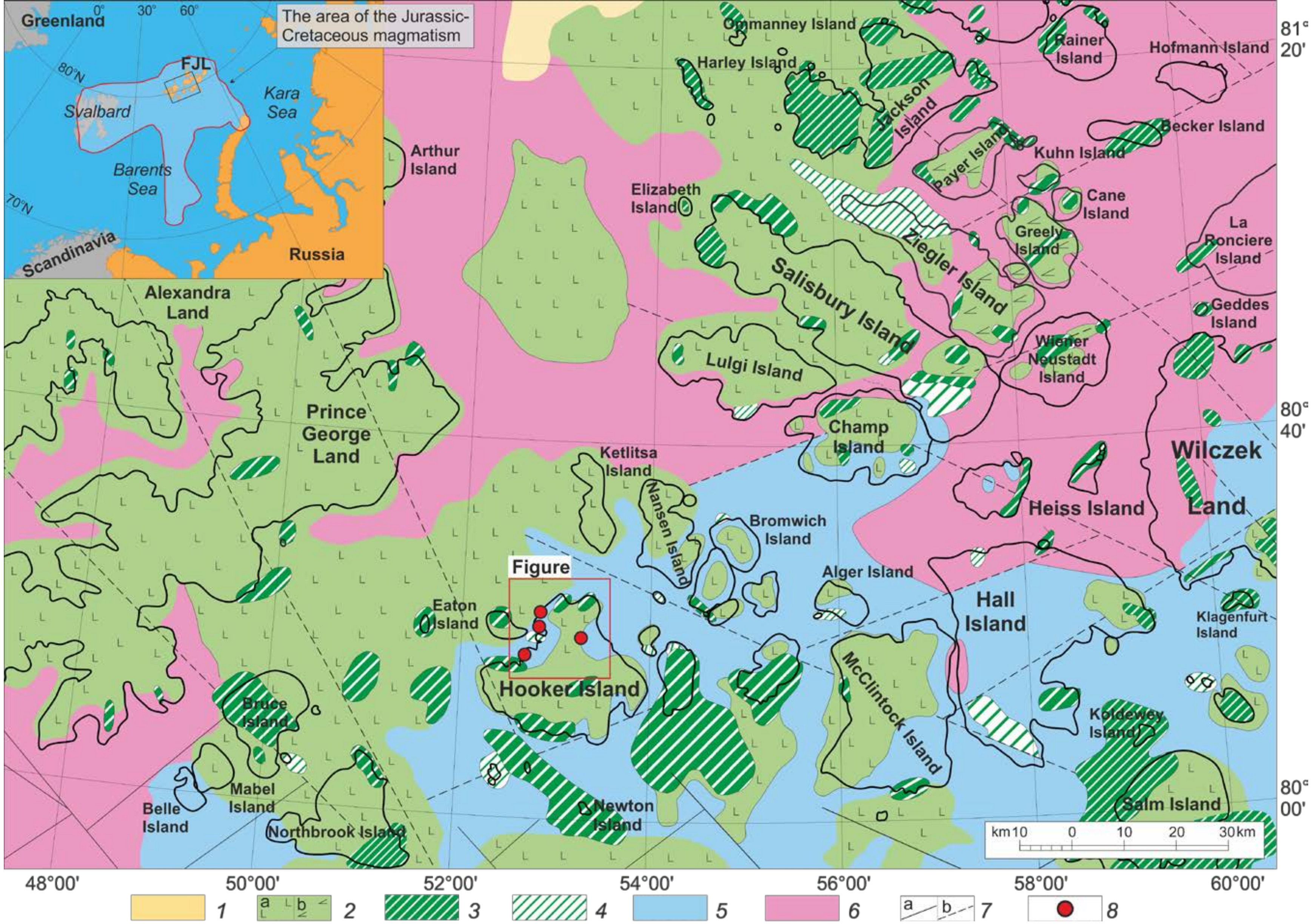
The first definition of paleointensity in the Early Cretaceous basalts from the Franz Josef Land

Evgeniy Vinogradov, Andrey Eliseev, Dmitriy Metelkin, Victor Abashev, Valery Vernikovsky, and Nikolay Mikhaltsov

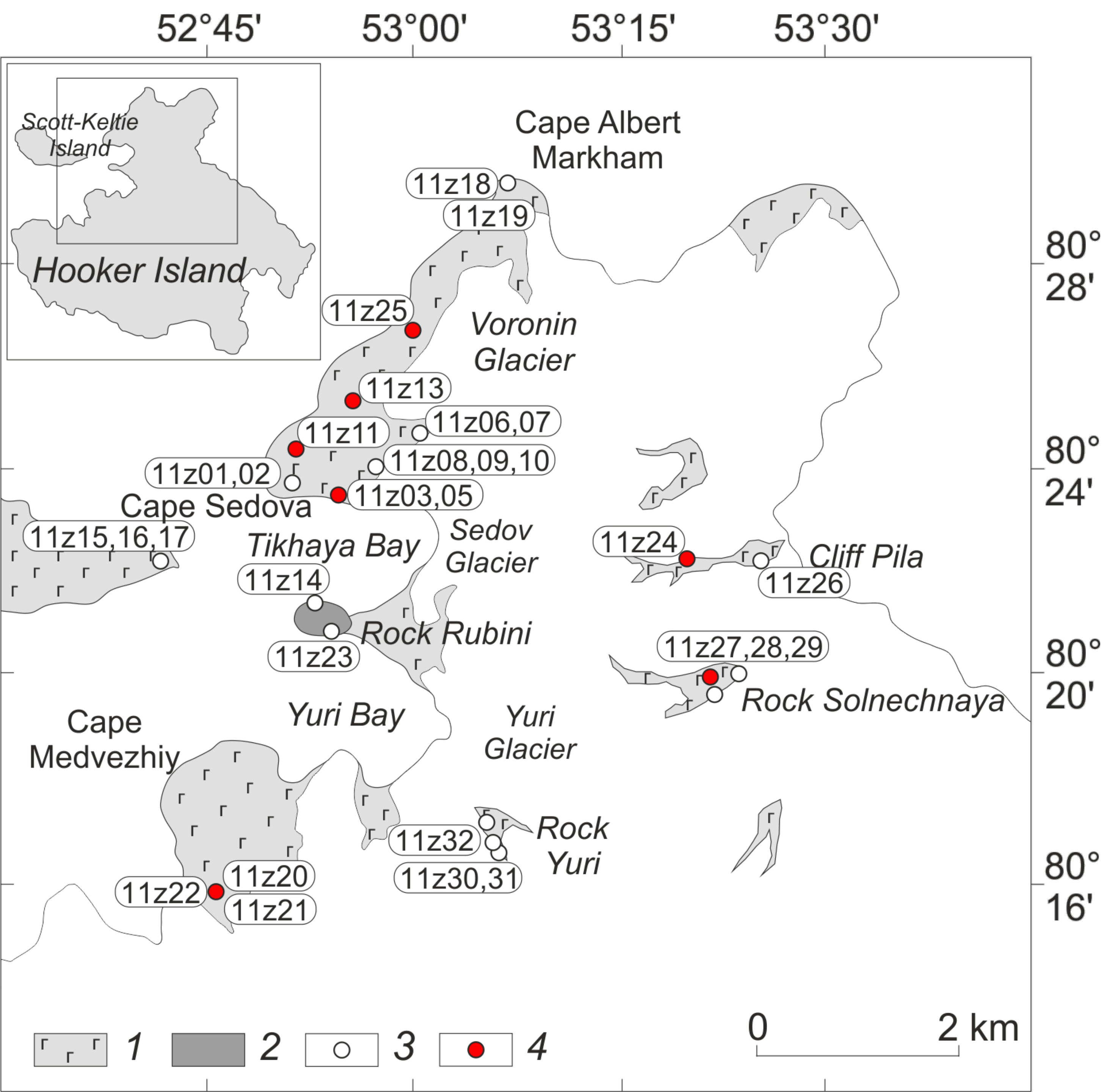
Novosibirsk State University, Novosibirsk, Russian Federation (ev.vinogradov94@gmail.com)

Institute of Petroleum Geology and Geophysics A.A. Trofimuka of the Siberian Branch of the Russian Academy of Sciences, Novosibirsk, Russian Federation



Schematic geological map of the studied Franz Josef Land Archipelago area, after (State Geological Map..., 2006) (revised).

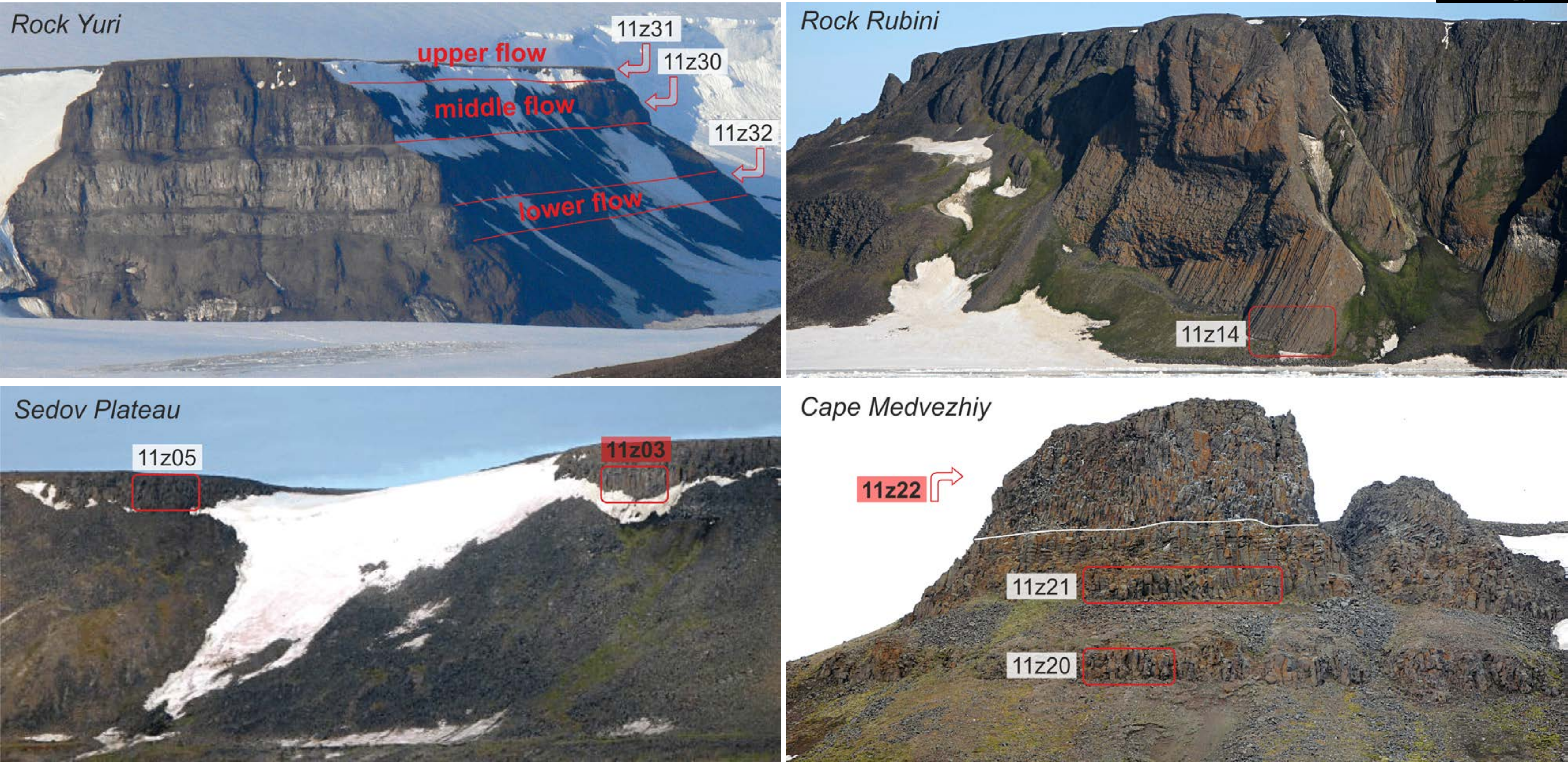
The red line in the inset delineates a tentative area of basaltoid magmatism distribution in the Barents Sea LIP, after (Polteau et al., 2016). 1 - Oligocene–Pliocene deposits (siltstones, clays); 2–4 - Early Cretaceous trap complex: 2 - tuffs and basalt flows (a) and andesibasalts (b), 3 - hypabyssal complex (dikes, sills, laccolites) gabbro, gabbro-diorites, gabbro-dolerites, dolerites and monzonites, 4 - vent facies holding extrusive bodies (stocks and nekks) of basalts, andesibasalts; 5 - Jurassic deposits (mudstones, siltstones, sands, sandstones); 6 - Triassic deposits (sands, sandstones, clays, mudstones, siltstones); 7 - faults: established (a) and inferred (b); 8 - paleomagnetic and rock-magnetic sampling sites.



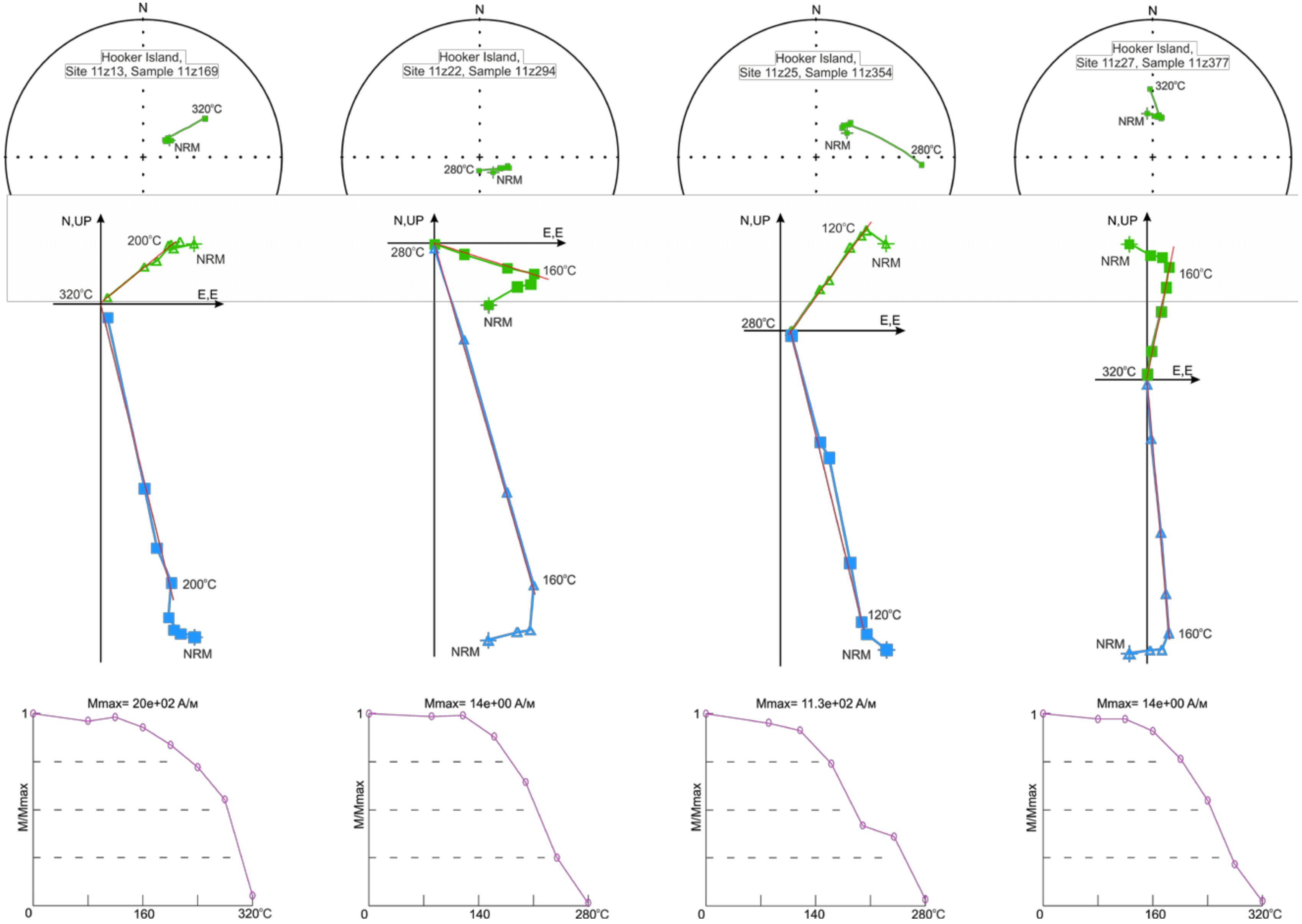
The geological structure of the northern part of Hooker Island.

Sheme of geological structure: 1 – Jurassic-Early Cretaceous basalts and dolerites; 2 – Stock of the Rock Rubini; 3 – locations of the sampling sites for paleomagnetic investigations with indication of the number; 4 – locations of the sampling sites for paleointensity analysis with indication of the number.

- The analysis of the entire set of geochronological data, taking into account information about magnetic polarity, indicates that the interval of active magmatism occurs at the end of the Barremian – Aptian and corresponds to the beginning of the Cretaceous Normal Superchron (C34n), **about 125 Ma**. (Abashev et al., 2020)
- Early Cretaceous age is confirmed by the first U-Pb datings of sills from wells. Nagurskaya well (Alexandra Land) and Severanaya well (Graham Bell Island), the age of zircons in which is 122.2 ± 1.1 and 122.7 ± 0.3 Ma, respectively (Corfu et al., 2013).

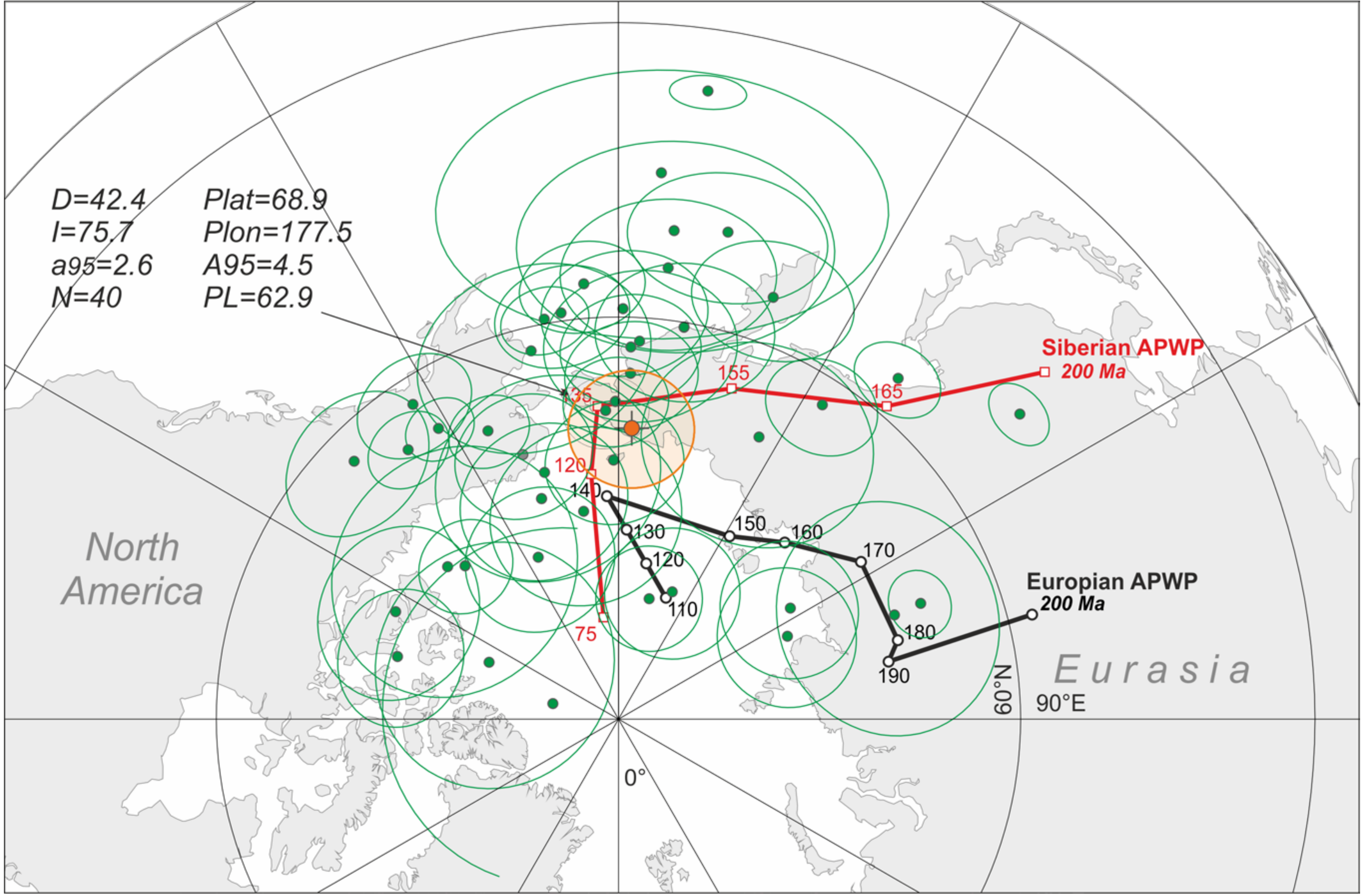


Field photos of the studied outcrops (photo by N. Mikhaltsov and M. Ivanov): volcanic complexes of the Tikhaya Bay, East part of the Cape Sedov, volcanic complexes in the South part of the Cape Medvezhiy, volcanic complexes of the Rock Yuri, Stock of the Rock Rubini.

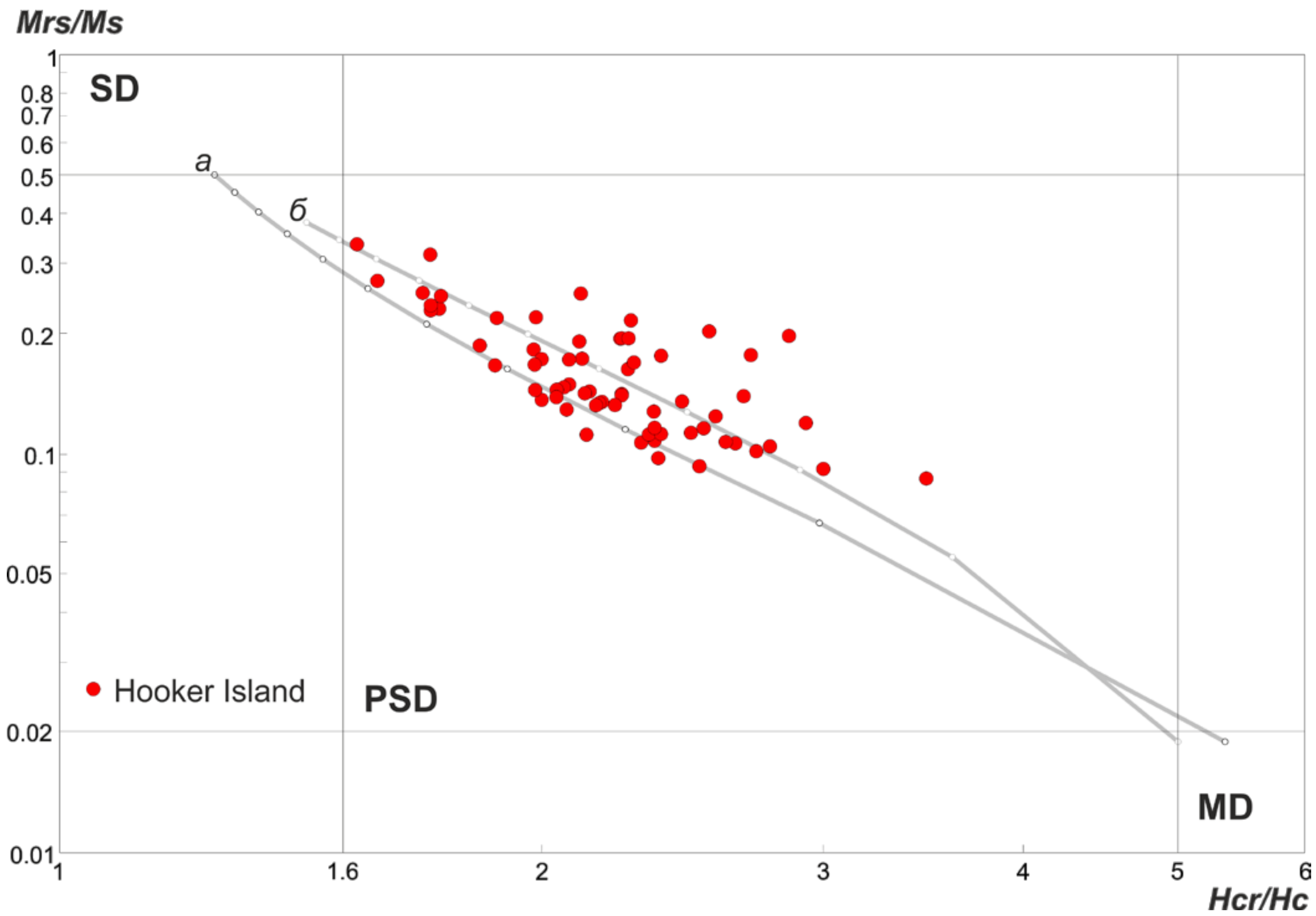


Typical examples of vector end-point diagrams, equal area projections, and demagnetization behavior of the samples from magmatic complexes of the Franz Josef Land Archipelago, Hooker Island.

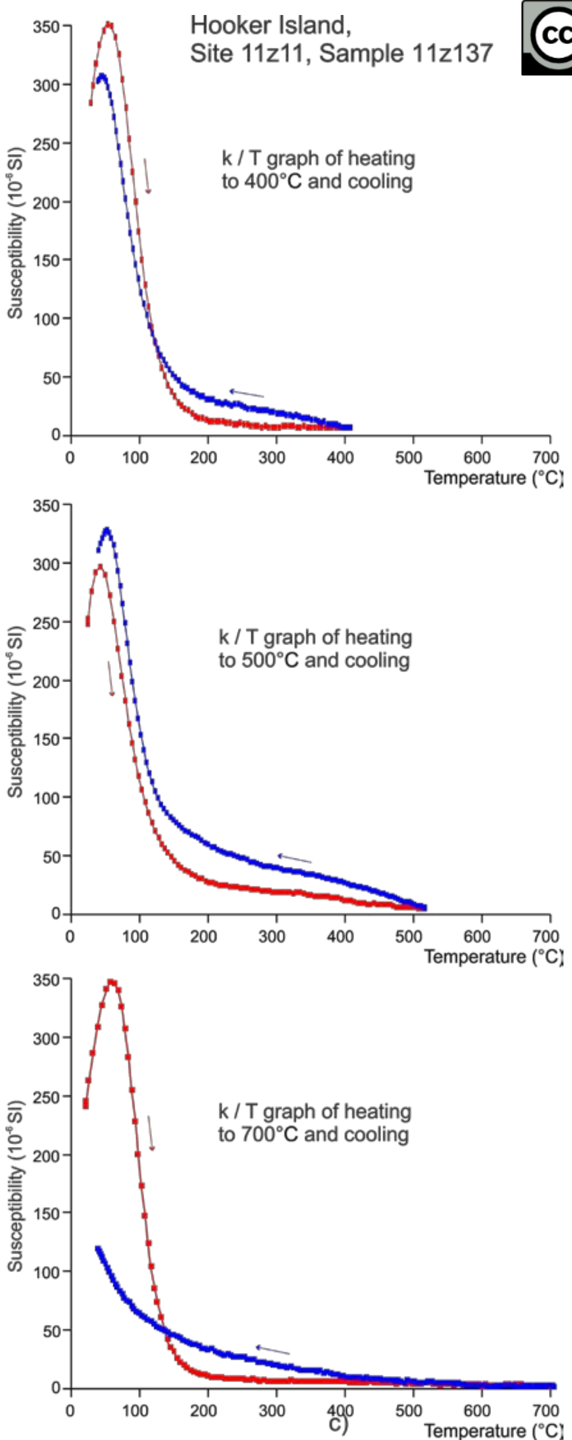
The demagnetization intervals of the characteristic component were also used to determine the paleostresses in these samples. The average temperature of full demagnetization is about 300° C.



The paleomagnetic pole is located at Plat=68.9, Plon=177.5; a corresponding statistical characteristic of pole: N=40, K=26.2, S=15.9, A95=4.5, PaleoLat=62.9. Statistic from 45 VGPs and a wide age range provide reliable averaging of secular geomagnetic variations. The magnitude of the angular dispersion of the paleomagnetic pole of 15.9 that practically coincides with the value predicted for paleolatitude 62.9 by the value S = 19 and is limited by the limit 10 < S < 20, which is also an indicator of the correct averaging of the secular variation. The coordinates for the calculated paleomagnetic pole taking into account confidence ovals do not differ from the corresponding path segment of the APWP of Europe and Siberia.

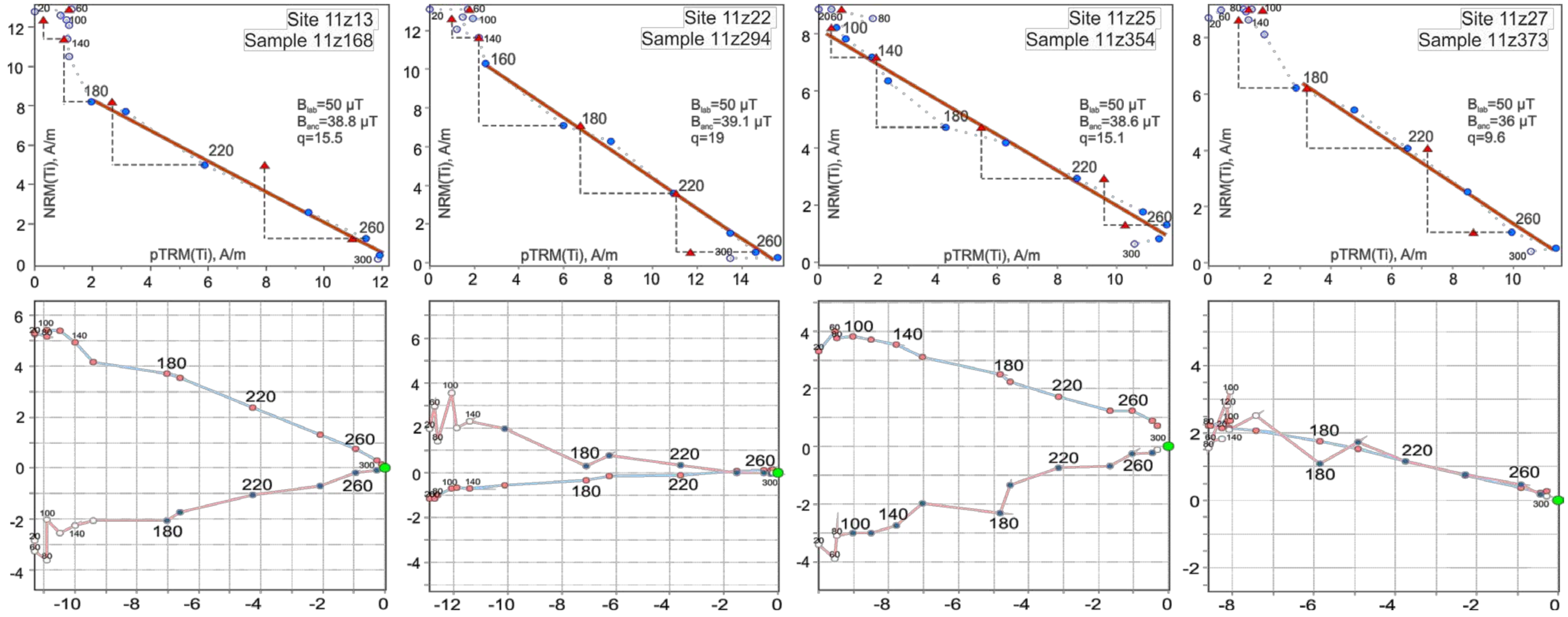


Day-plot for the FJL samples (Day et al., 1977). SD single domain; PSD pseudo-single domain; MD multidomain; Mrs saturation remanence; Ms saturation magnetization; Hc coercivity field; and Hcr coercivity of remanence. Gray lines show SD-MD mixture models from Dunlop (2002).



The rock magnetic analysis results thus allow to infer that the studied FJL flood basalts are dominated by small grains of primary magmatic or single-phase-oxidized during cooling titanomagnetite rocks.

Magnetic susceptibility versus temperature curves of basaltics showing irreversible mineralogical changes during laboratory heating above 500°C and cooling. Red and blue lines show heating and cooling cycles, respectively.



The determinations of the absolute values of paleointensity were obtained by the Thellier-Coe method with the implementation of the procedure "check-points". The Banc values for site 11z13 are 35.4 ± 1.7 μT, 11z22: 32.7 ± 4.9 μT, 11z25: 32.8 ± 3.9 μT, 11z27: 35.4 ± 2.3 μT which is noticeably lower than the current magnetic field at the sampling point ≈55 μT. The corresponding VDM is 4.8 ± 0.2 × 10^{22} Am^2, with the current value of VDM ≈8 × 10^{22} Am^2.

Conclusions:

We present the first definition of paleointesity of the Earth's magnetic field that were obtained in the Early Cretaceous igneous rocks from the Franz Josef Land archipelago (Hooker Island). An assessment of the domain structure of ferrimagnets using the Day plot diagram shows that the carriers of the natural remanent magnetization are pseudo-single-domain grains of titanomagnetites with varying Ti-content. Magnetic remanence was unblocked in temperatures of ≈300 °C.

For four basalt flows, the values of the intensity of the ancient magnetic field were determined, the corresponding VDMs is 4.8-5 ± 0.2 × 10^{22} Am^2, with the current value of VDM ≈8 × 10^{22} Am^2. Numerous basalt flows are well studied by paleomagnetic and rockmagnetic methods, together with a large number of geochronological definitions, this makes basalts from the Franz Josef Land promising for obtaining new qualitative determinations of paleointensity in the Early Cretaceous time.

References:

Abashev V.V., Metelkin D.V., Vernikovsky V.A., et al. The Early Cretaceous age of basalts from Franz Josef Land Archipelago: correspondence of new 40Ar/39Ar and paleomagnetic data // Doklady of the RAS. 2020. in print.

Corfu F, Polteau S., Planke S., et al. U-Pb geochronology of Cretaceous magmatism on Svalbard and Franz Josef Land, Barents Sea Large Igneous Province // Geol. Mag. 150 (6). 2013. P. 1127 - 1135.

Metelkin, D.V., Vernikovsky, V.A., Kazansky, A.Yu. Tectonic evolution of the Siberian paleocontinent from the Neoproterozoic to Late Mesozoic: paleomagnetic record and reconstructions // Russian Geology and Geophysics. 2012. V.53 P. 675–688.

Polteau S., Hendriks B.W.H., Planke S., et al. The Early Cretaceous Barents Sea Sill Complex: Distribution, 40Ar/39Ar geochronology, and implications for carbon gas formation // Palaeogeography, Palaeoclimatology, Palaeoecology. 2016. V. 441. P. 83-95.

Torsvik, T.H., Van der Voo, R., Preeden, U., et al. Phanerozoic polar wander, paleogeography and dynamics // Earth Sci. Rev. 2012. V.114. P. 325–368.

Acknowledgments:

This work was supported by the RSF (project no. 19-17-00091) and the RFBR (project nos. 18-35-00273, 18-05-70035)