Paleomagnetism of the Kola Peninsula's dykes, NE Fennoscandia: the review

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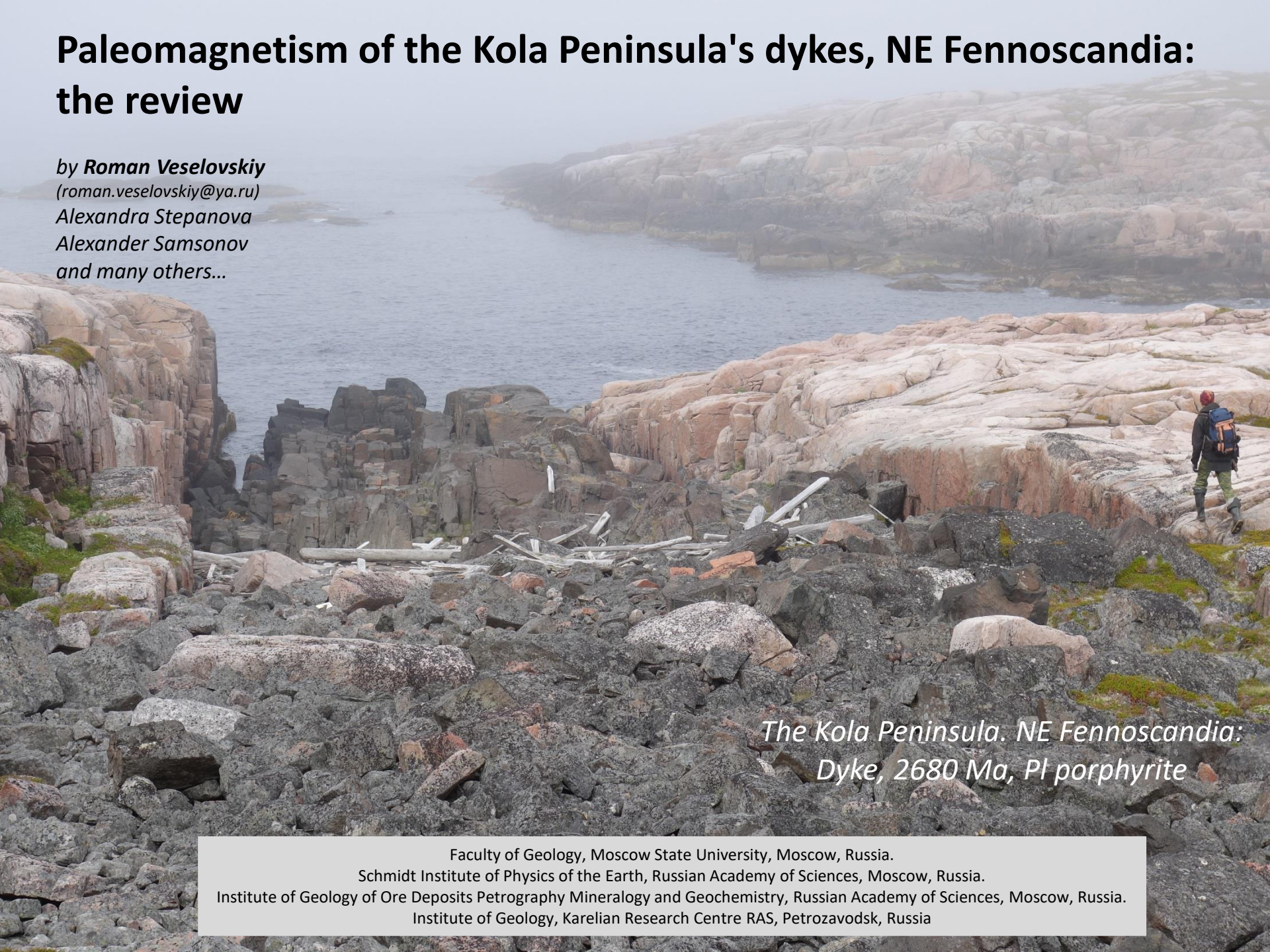
and many others…



The Kola Peninsula. NE Fennoscandia: Dyke, 2680 Ma, Pl porphyrite

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Dyke

Granites and gneisses (AR)

General goal of our collaborative research is finding the place of the Murmansk craton in the Neoarchean and Paleoproterozoic paleotectonic reconstructions. To get this, paleomagnetism, geochronology and geochemistry of about 140 dykes along the NE coast of the Kola Peninsula were studied during 2016-2019 field seasons…

Methods

Paleomagnetic Lab of the Institute of Physics of the Earth RAS, Moscow

Paleomagnetism: 8-60 (15 in average) samples were taken from each dyke and its host rock; each sample is cut on 2 sister-specimens (for thermal and AF demagnetization); SQUID SRM with built-in AF-demagnetizer and MMTD-80, installed in shielded room, are used; PCA analysis is the only method for getting NRM component.

Rock magnetism: 2-3 specimens from each dyke are studied for hysteresis parameters and thermomagnetic properties; anisotropy of MS for each sample is measured; Scanning electron microscopy is using for the most interesting and typical specimens.

Studied objects

100 km
scale

Murmansk

Barents Sea

We have found 5 episodes of dyke magmatism on the Kola Peninsula:

Dykes 2680 Ma

Dykes 2505 Ma

Dykes 1980-2060 Ma

Dykes and sills 1860 Ma

Dykes 400-360 Ma

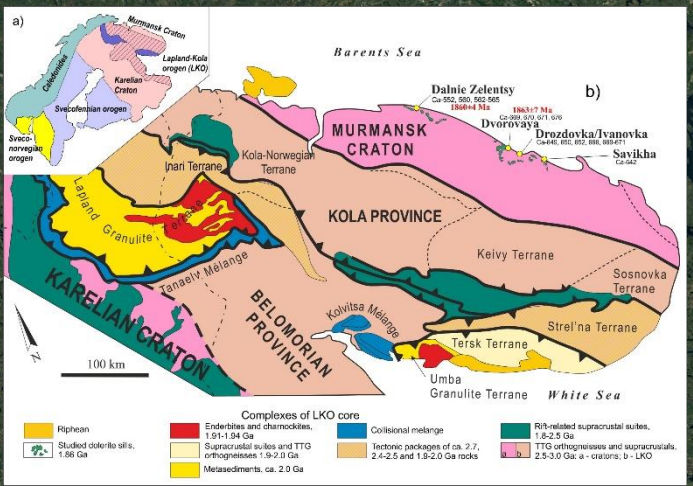
Grey dykes – unknown age

Murmansk craton

Karelia

Apatity

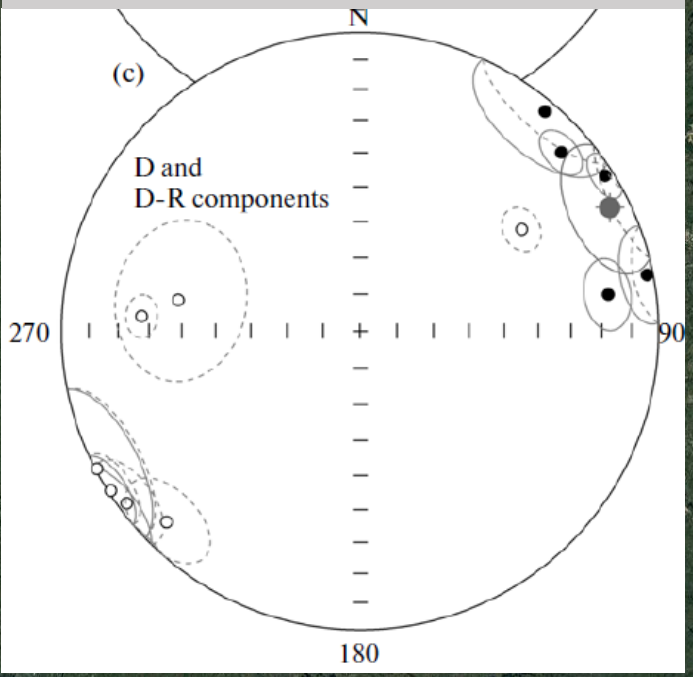
Kola Peninsula



White Sea

Devonian dykes (440-360 Ma)

Typical paleomagnetic record of Devonian dykes:

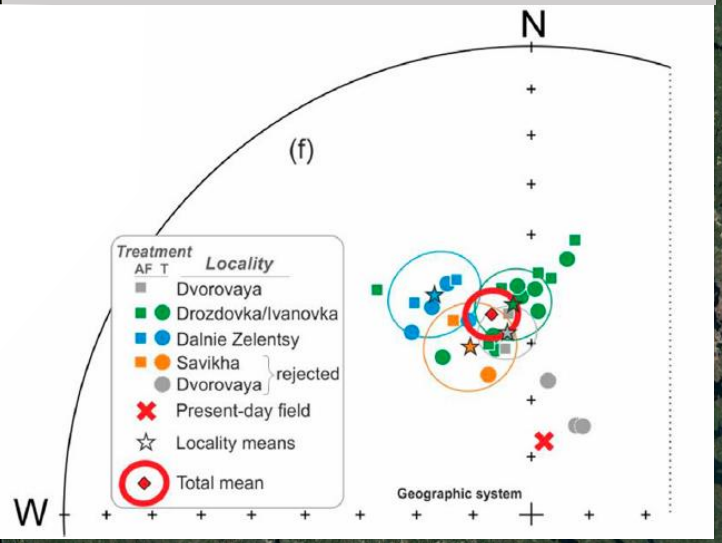


The data on paleomagnetism and geochronology of Devonian dykes are partially presented in:

1) Veselovskiy R.V., Mikhail L. Bazhenov, Andrey A. Arzamastsev. Paleomagnetism of Devonian dykes in the northern Kola Peninsula and its bearing on the apparent polar wander path of Baltica in the Precambrian // Tectonophysics. 2016. V.675. P.91–102. DOI:10.1016/j.tecto.2016.03.014
2) Veselovskiy R.V., A.A. Arzamastsev, L.I. Demina, A. V. Travin, S.B. Botsyun. Paleomagnetism, Geochronology, and Magnetic Mineralogy of Devonian Dikes from the Kola Alkaline Province (NE Fennoscandian Shield) // Izvestiya, Physics of the Solid Earth. 2013. Vol. 49. No. 4. PP. 526–547. 10.1134/S106935131303018X

1860 Ma dykes and sills

Typical paleomagnetic record of 1860 Ma intrusions:

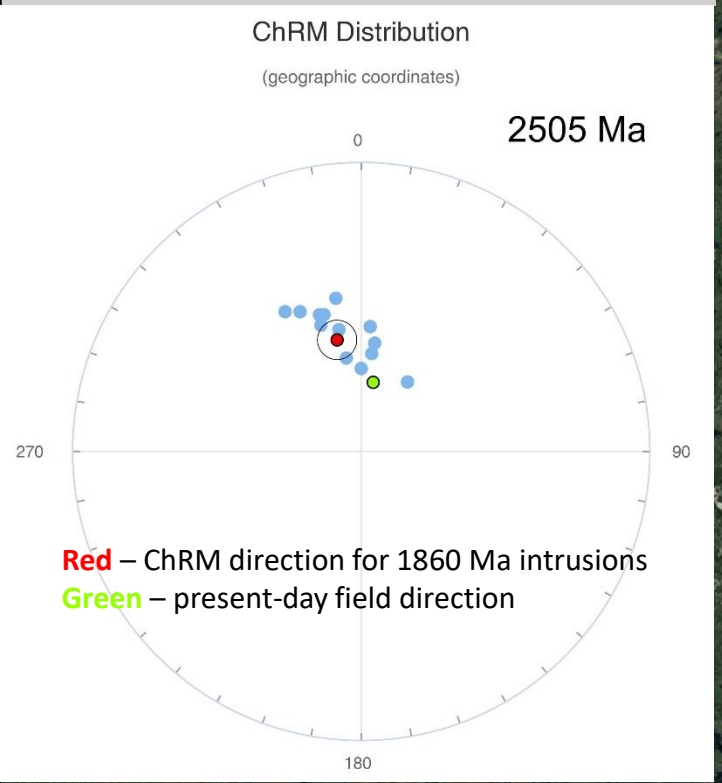


The data on paleomagnetism and geochronology of 1860 Ma dykes and sills are presented in:

1) Veselovskiy Roman, Alexander Samsonov, Alexandra Stepanova, Ekaterina Salnikova, Yulia Larionova, Alexey Travin, Andrey Arzamastsev, Svetlana Egorova, Kseniya Erofeeva, Maria Stifeeva, Valentina Shcherbakova, Valeriy Shcherbakov, Grigoriy Zhidkov, Vladimir Zakharov. 1.86 Ga Key Paleomagnetic Pole from the Murmansk craton intrusions – Eastern Murman Sill Province, NE Fennoscandia: multidisciplinary approach and paleotectonic applications // Precambrian Research. 2019. 324. P. 126-145. DOI: https://doi.org/10.1016/j.precamres.2019.01.017

2505 Ma dykes

Typical paleomagnetic record of 2505 Ma dykes:

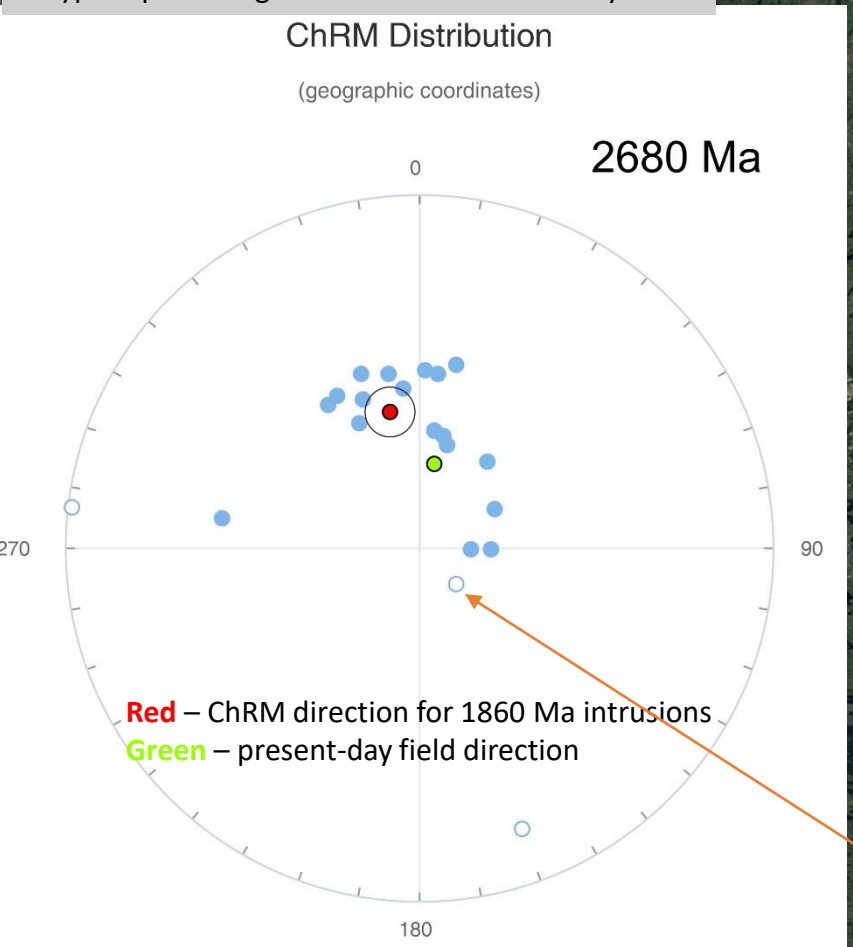


Red – ChRM direction for 1860 Ma intrusions
Green – present-day field direction

The ChRM directions from 2505 Ma dykes are not distinguish from the present-day geomagnetic field direction and the mean ChRM direction from 1860 Ma. We have to conclude, that all 2505 Ma dykes were remagnetized ca. 1860 Ma.

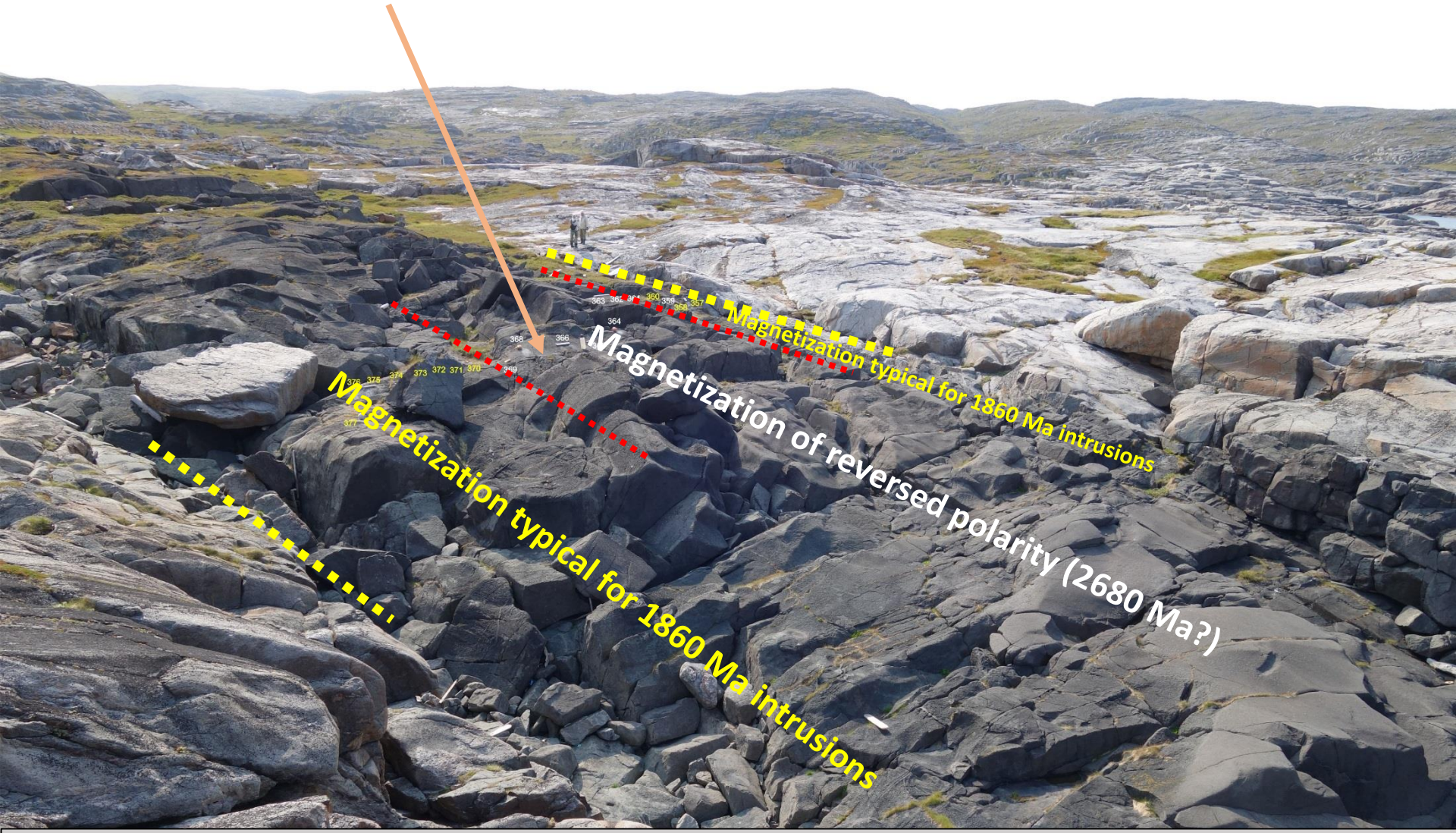
2680 Ma dykes

Typical paleomagnetic record of 2680 Ma dykes:



The ChRM directions from 2680 Ma dykes, in some cases, are close to the present-day geomagnetic field direction and the mean ChRM direction from 1860 Ma. We have to conclude, that some of 2680 Ma dykes were remagnetized ca. 1860 Ma. But few dykes have distinct ChRM directions, even reversed. We have studied one of these dykes in detail…

Central part: U-Pb, ID-TIMS, baddeleyite: 2680±2 Ma; Ar/Ar (phlogopite): 1922±19 Ma

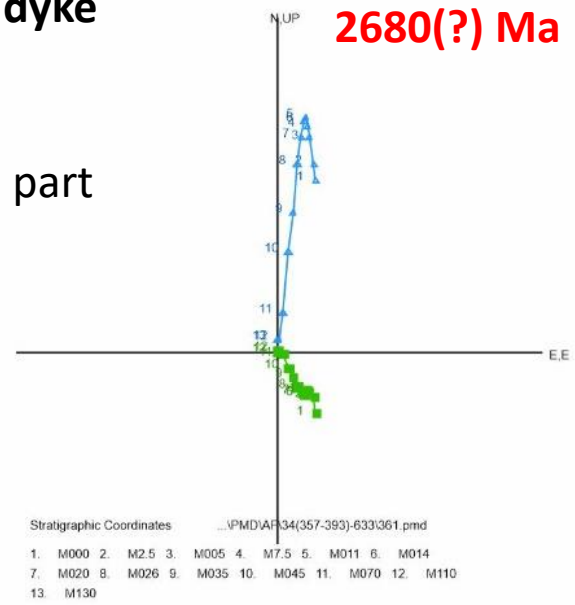


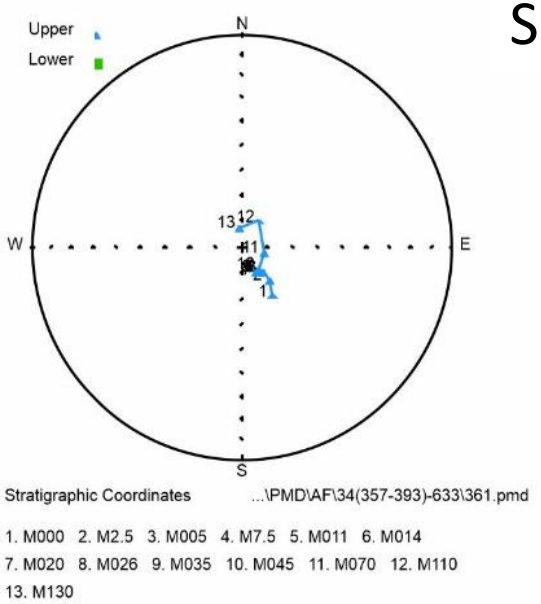
The rocks of marginal parts of the dyke have the same ChRM directions as from 1860 Ma intrusions. Central part of the dyke has previously unknown ChRM of reversed polarity (see next slide)…

Paleomagnetism of 2680 Ma dyke

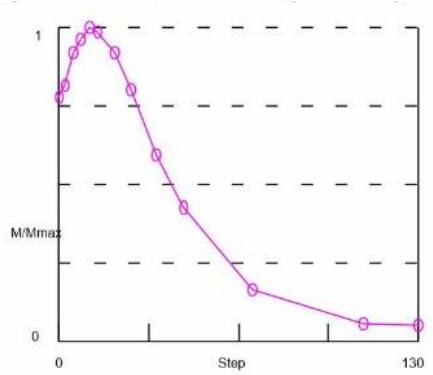
2680(?) Ma

Central part



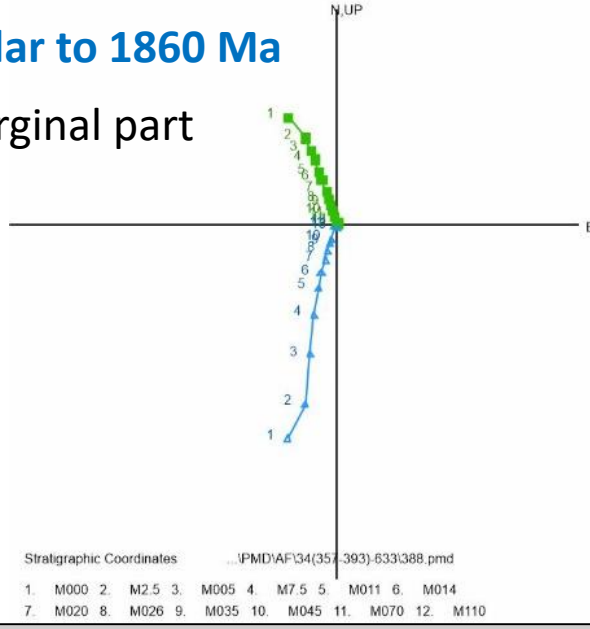


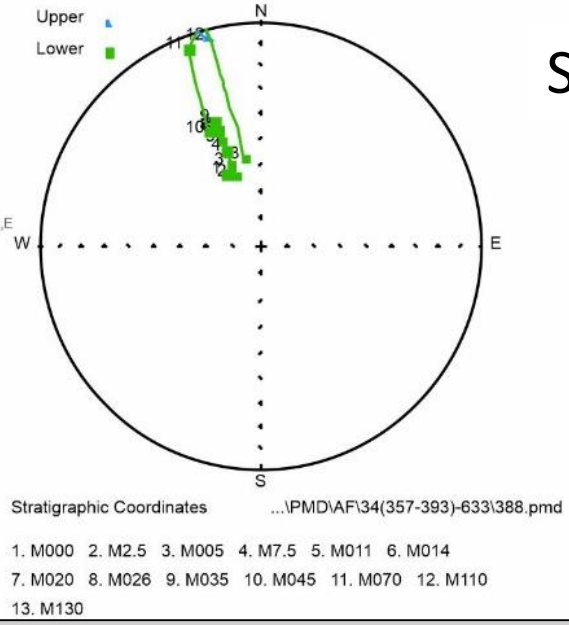
Sample 361 (633)



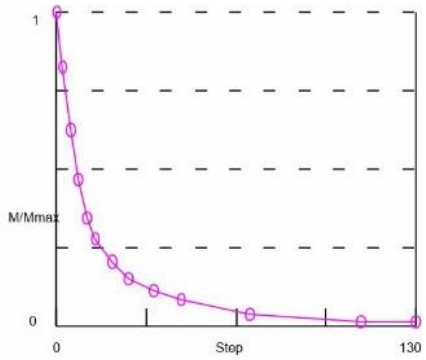
Similar to 1860 Ma

Marginal part



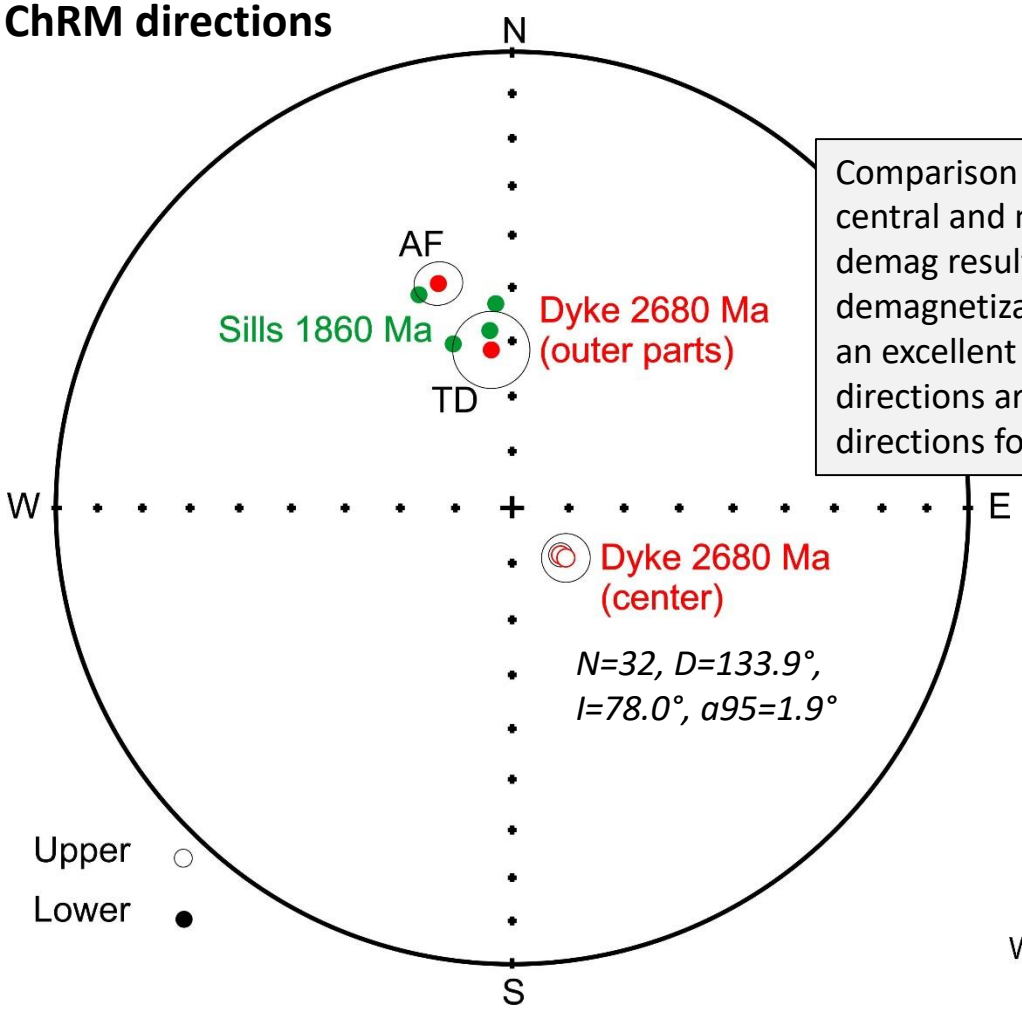


Sample 388 (633)

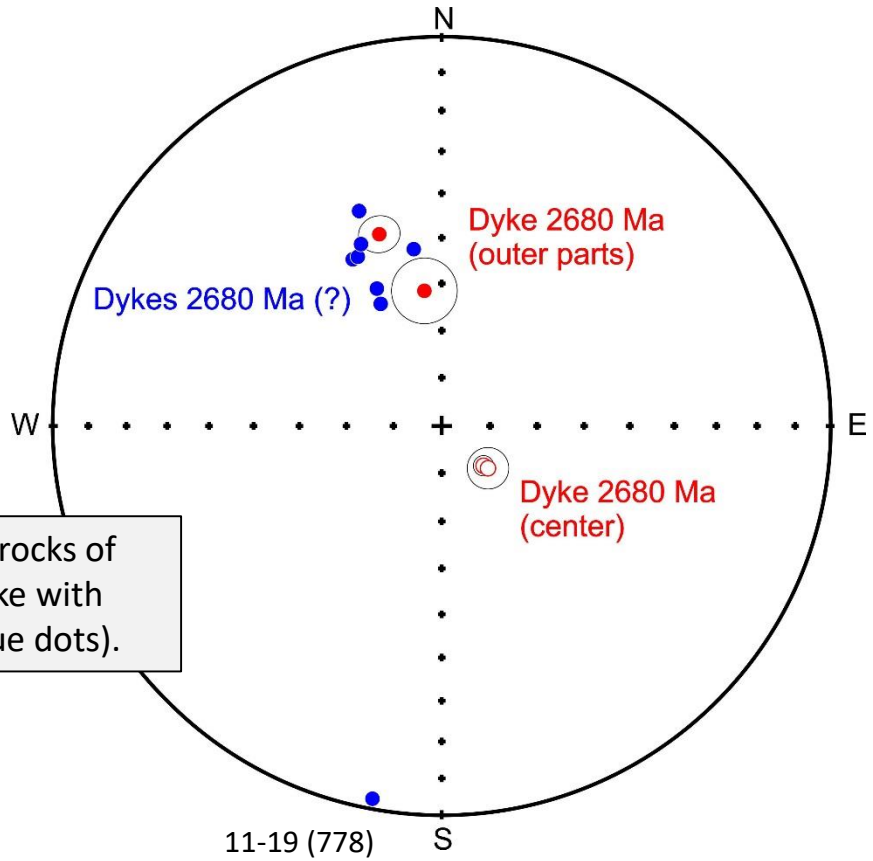


Comparison of the paleomagnetic record from the rocks of central and marginal parts of the 2680 Ma dyke (AF-demag).

ChRM directions

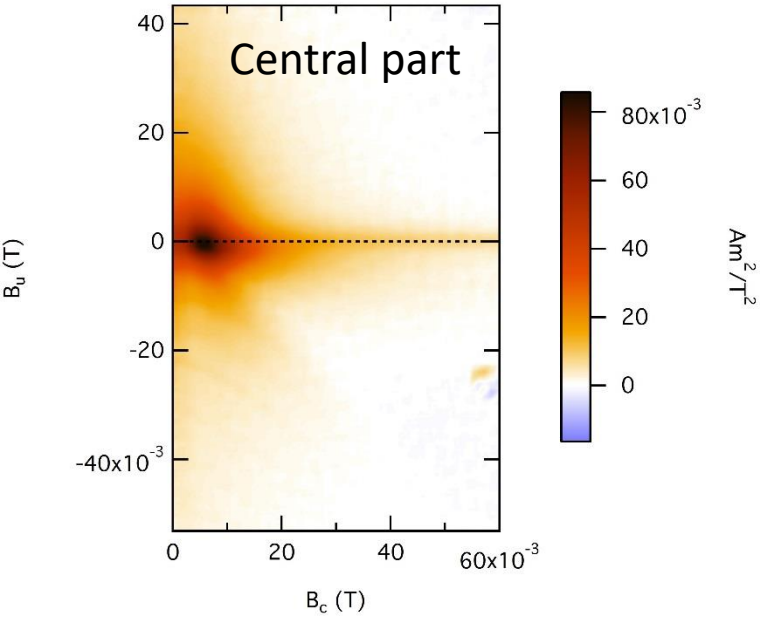


Comparison of the ChRM directions from the rocks of central and marginal parts of the 2680 Ma dyke. AF-demag results are in a good agreement with thermal demagnetization ones for outer (marginal) parts and in an excellent agreement for central part. ChRM directions are in comparison with mean ChRM directions for 1860 Ma intrusions (green dots).



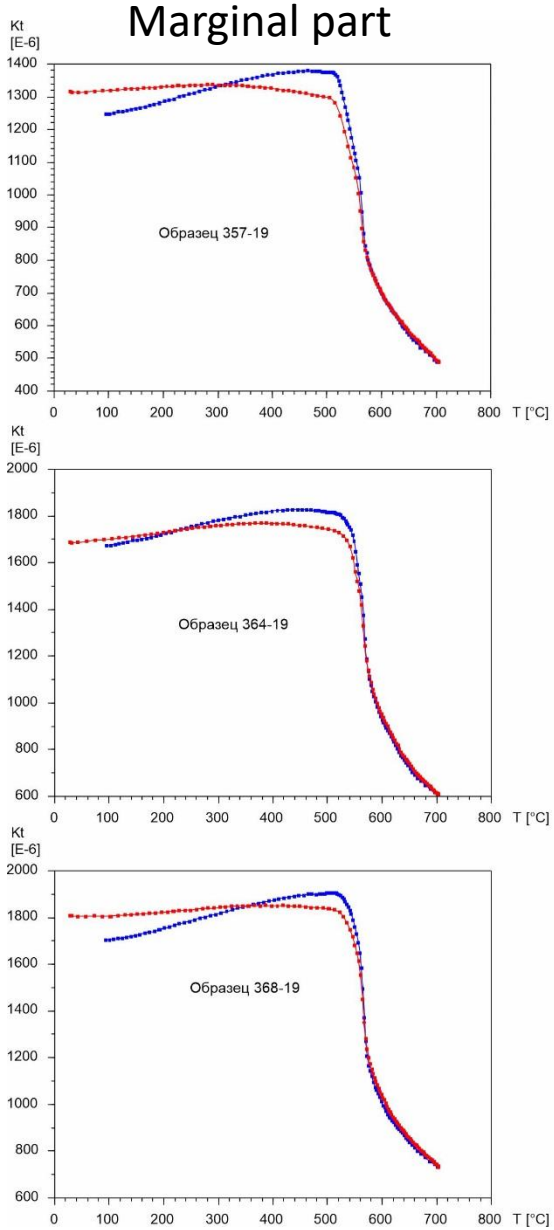
Comparison of the ChRM directions from the rocks of central and marginal parts of the 2680 Ma dyke with ChRM directions for other 2680 Ma dykes (blue dots).

Rock magnetism of 2680 Ma dyke

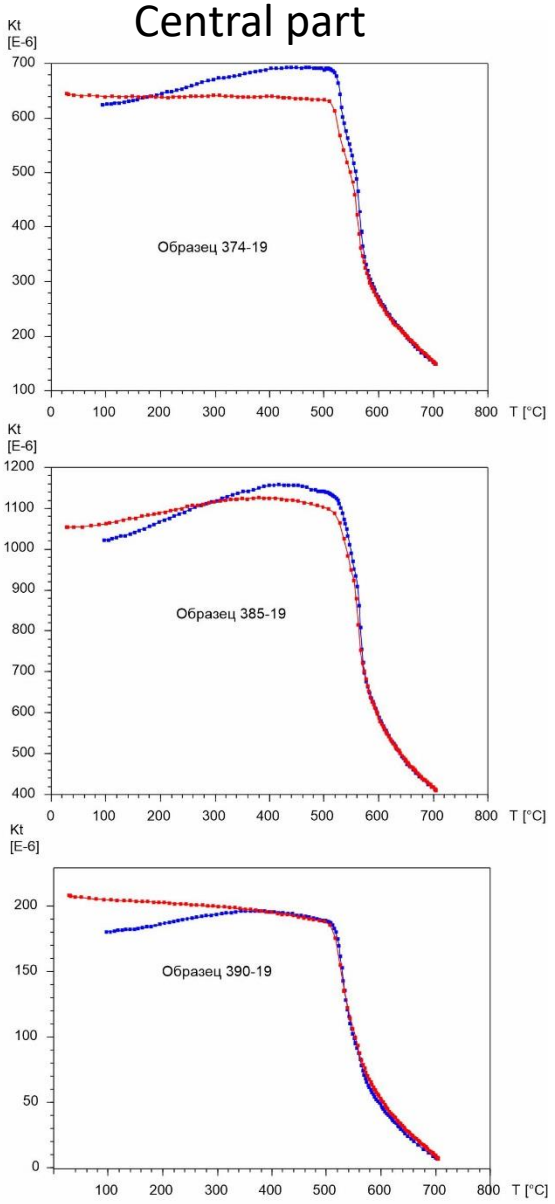


FORC diagram and thermal dependence of magnetic susceptibility curves for the 2680 Ma dyke rocks. There is no obvious difference between magnetic properties of rocks from central and marginal parts of the dyke. All rocks contain magnetite as the main carrier of ChRM.

Marginal part

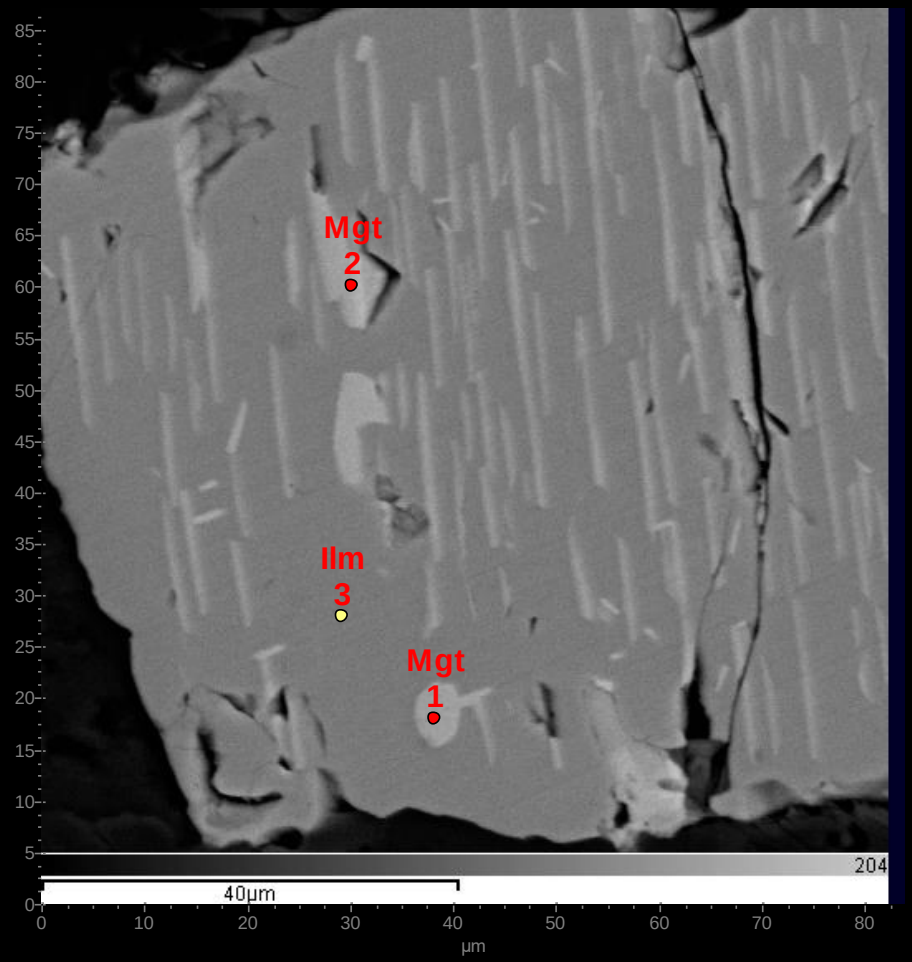


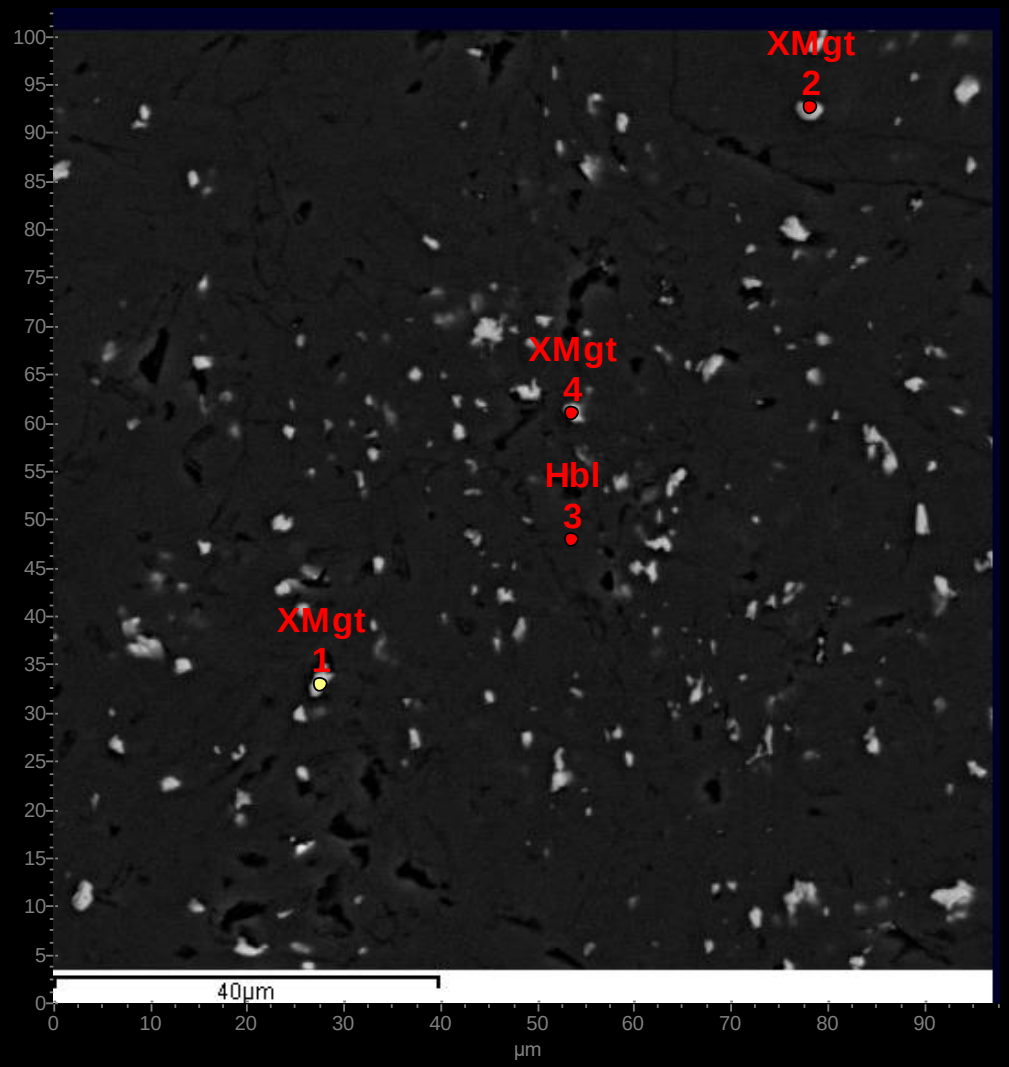
Central part



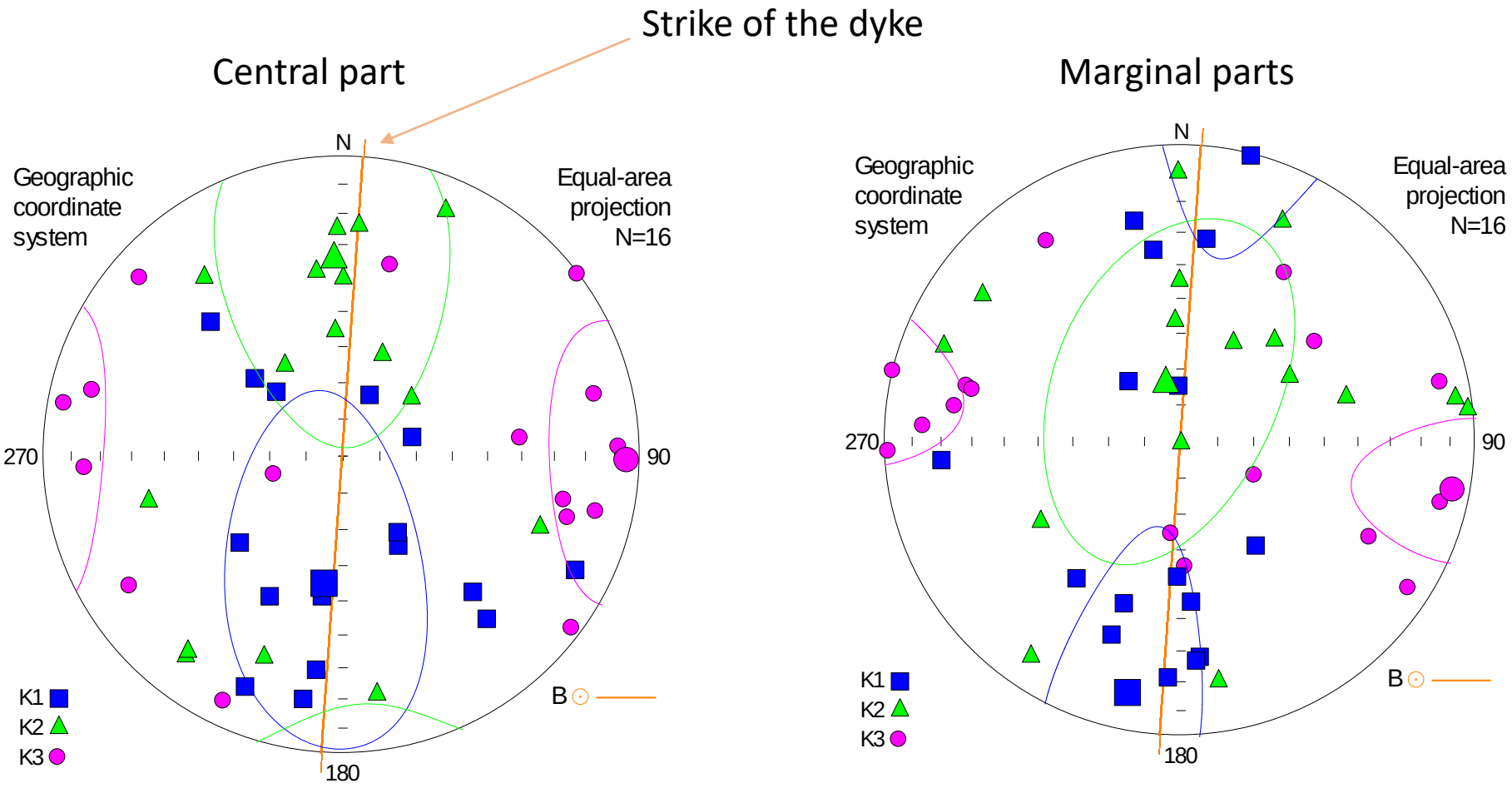
SEM observations

Both types of rocks (from central and marginal parts of the dyke) contain dispersed magnetite (on the right) and magnetite lamellae (on the bottom).





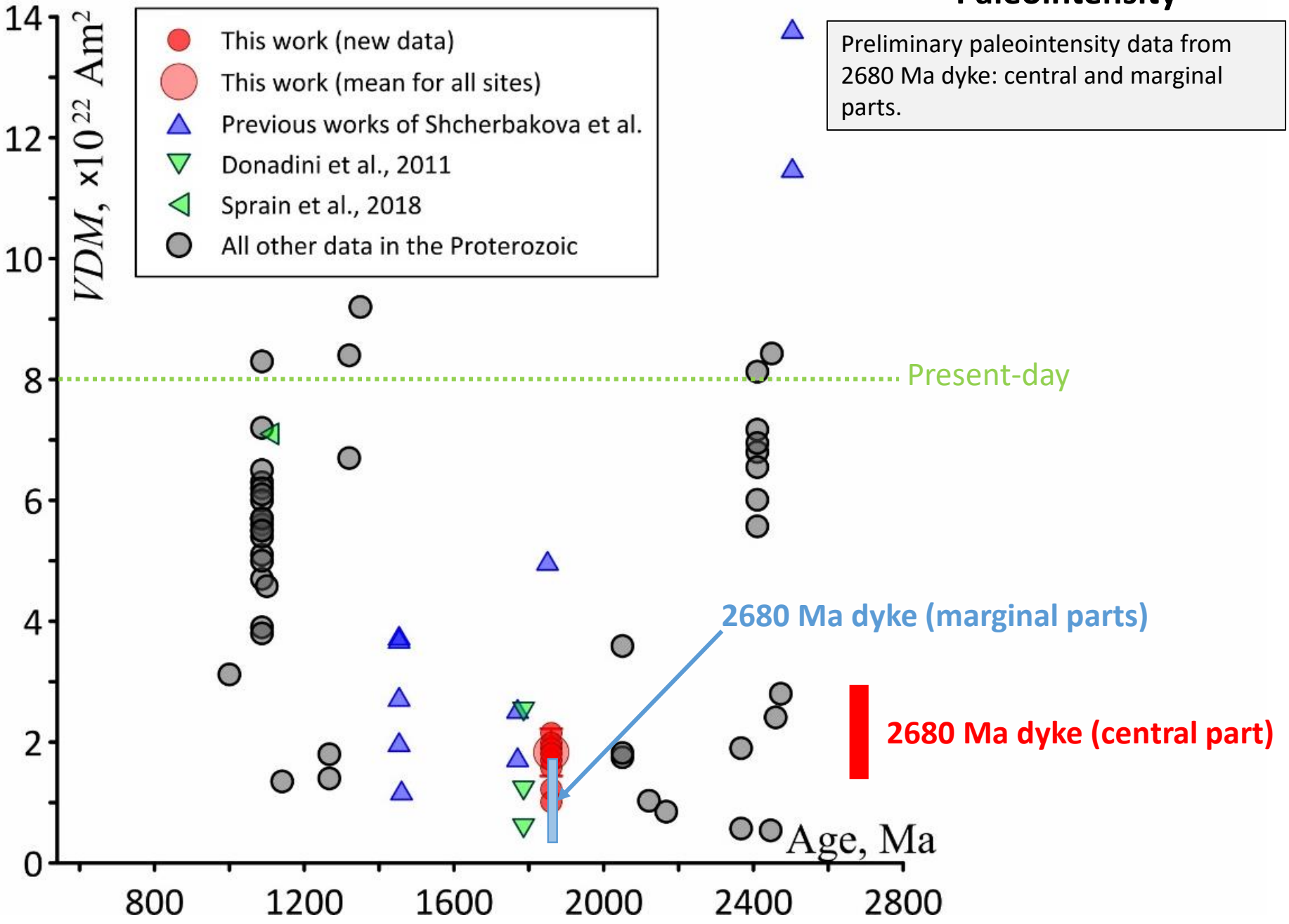
Anisotropy of magnetic susceptibility of 2680 Ma dyke



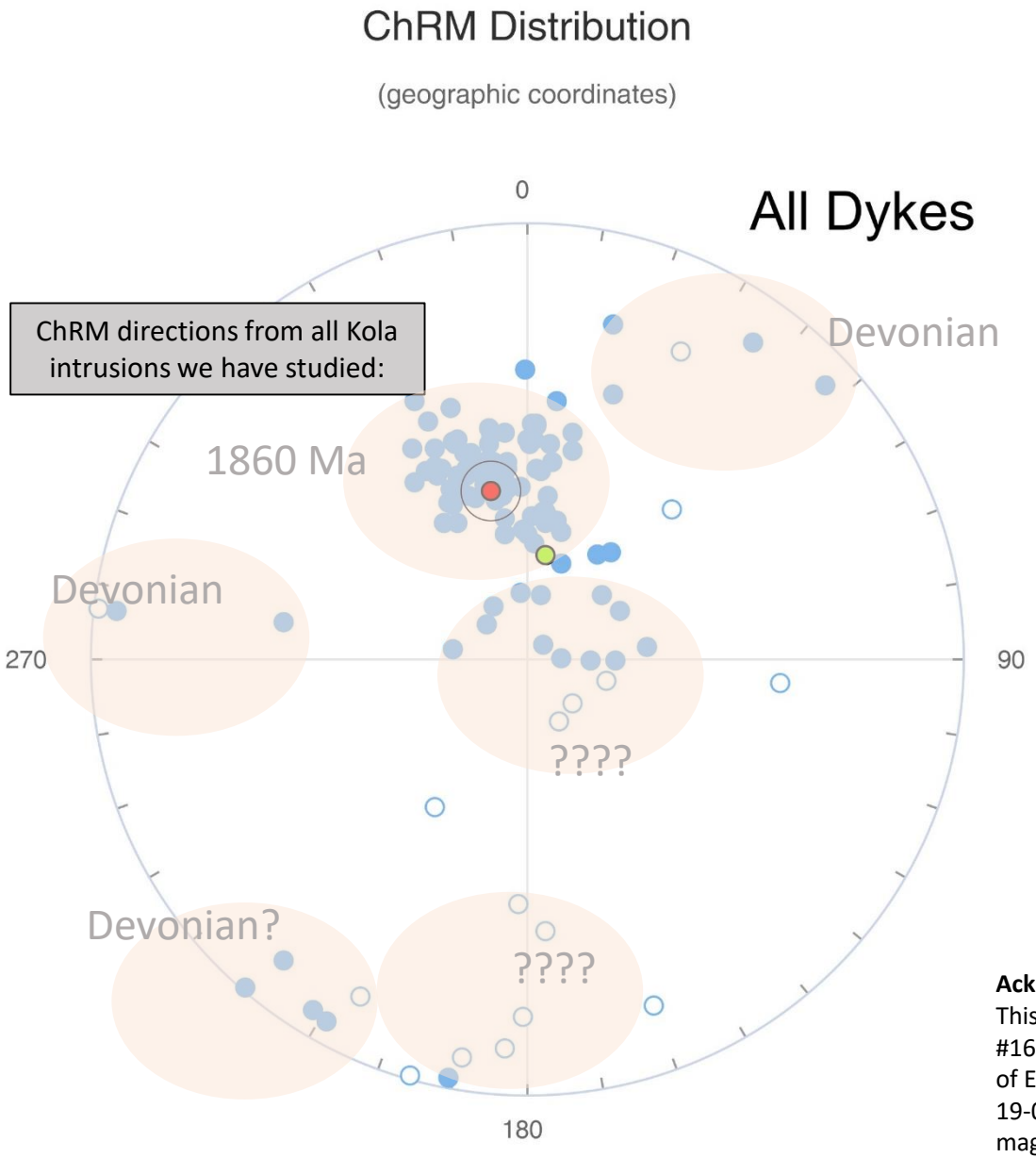
Magnetic texture looks to be primary in both types of rocks – from central and marginal parts of the dyke.

Paleointensity

Preliminary paleointensity data from 2680 Ma dyke: central and marginal parts.



All studied Kola Peninsula dykes



Red – ChRM direction for 1860 Ma intrusions
Green – present-day field direction

Conclusion:

We have to conclude, that almost all Neoarchean (2680 and 2505 Ma) dykes of the Kola Peninsula were totally remagnetized ca. 1860 Ma. The nature of this remagnetization event remains controversial. There are few reasons to believe that magnetic record of some Neoarchean dykes survive this remagnetization event; to prove this we have to increase the number of studied objects. But it's very difficult to achieve, because we have studied almost all of accessible dykes on the NE Kola Peninsula. Moreover, the most difficult task is to prove the age of ChRM of these dykes in the situation, when baked contact test doesn't work as it has been shown for all dykes, studied for this purpose.

Acknowledgements
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Stay healthy and safe!

From the Kola Peninsula…