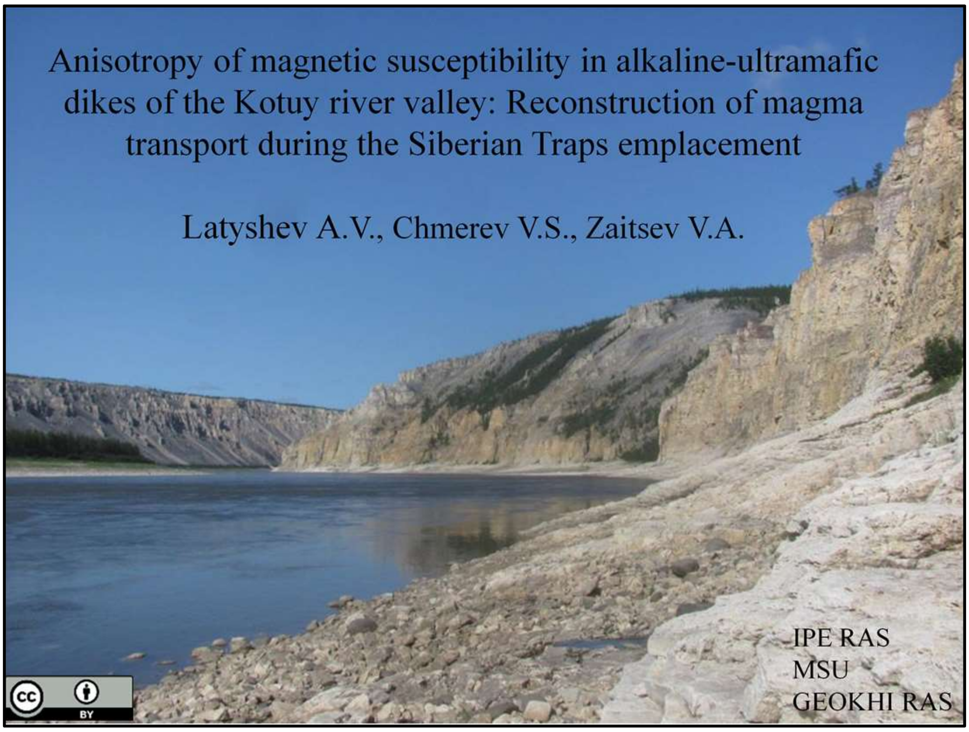
Anisotropy of magnetic susceptibility in alkaline-ultramafic dikes of the Kotuy river valley: Reconstruction of magma transport during the Siberian Traps emplacement
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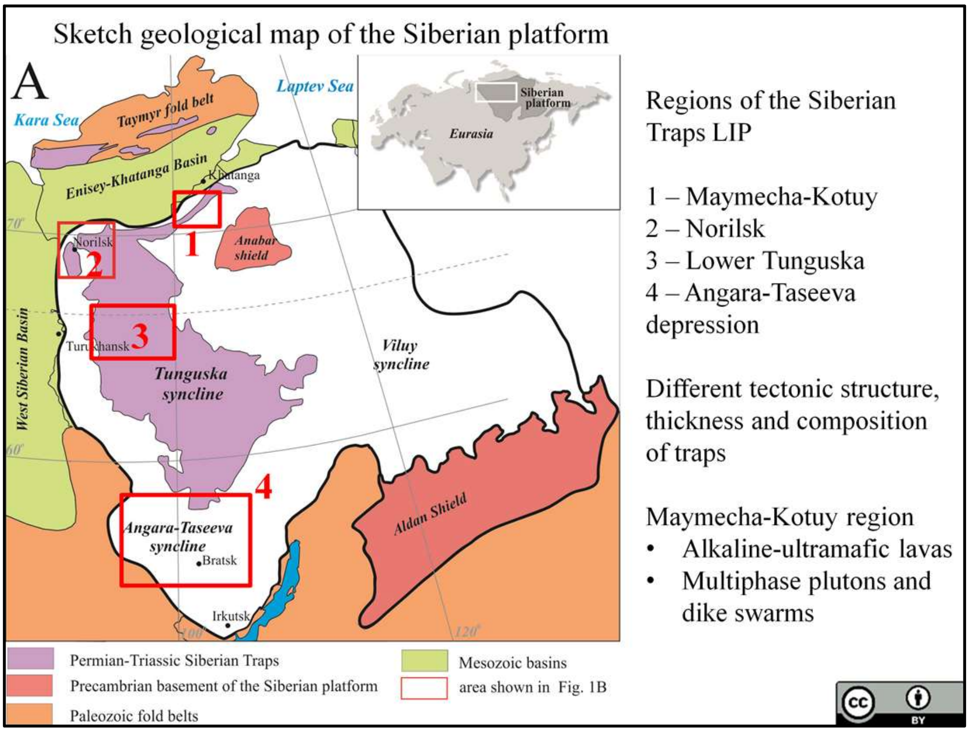
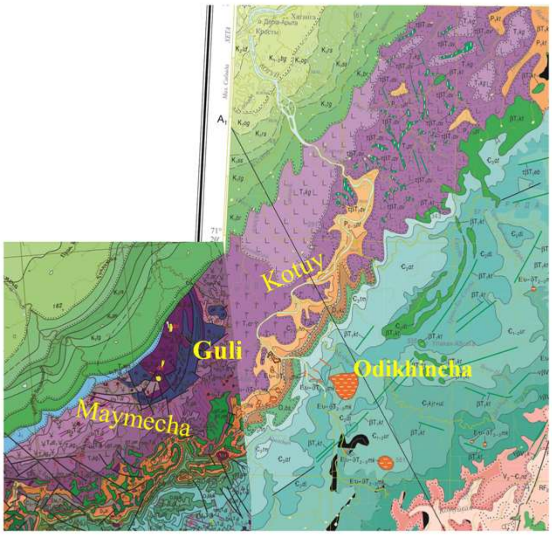
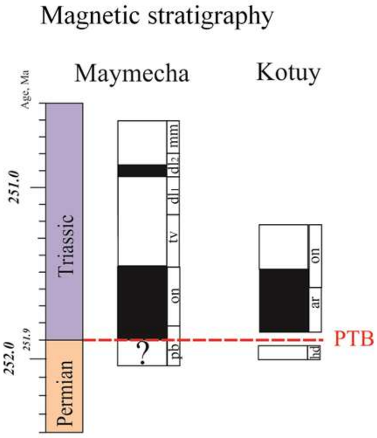


Here we present the preliminary results of the study of anisotropy of magnetic susceptibility in the Permian-Triassic dikes of the Kotuy river valley. These dikes are located in the marginal part of the Siberian Traps Large Igneous Province (LIP_, the Maymecha-Kotuy region This investigation continues our paleomagnetic and rock-magnetic study of the Siberian LIPs. The main goals were:

1. To reconstruct the main directions of the magma transport during the emplacement of dikes, based on AMS measurements and structural data;
2. To determine the location of the main magmatic centers and magma feeder zones;
3. To compare the magma transport patterns within different parts of the Siberian LIP;
4. To correlate the studied intrusions with the volcanic section of Maymecha-Kotuy.

Geological map of the Maymecha-Kotuy region



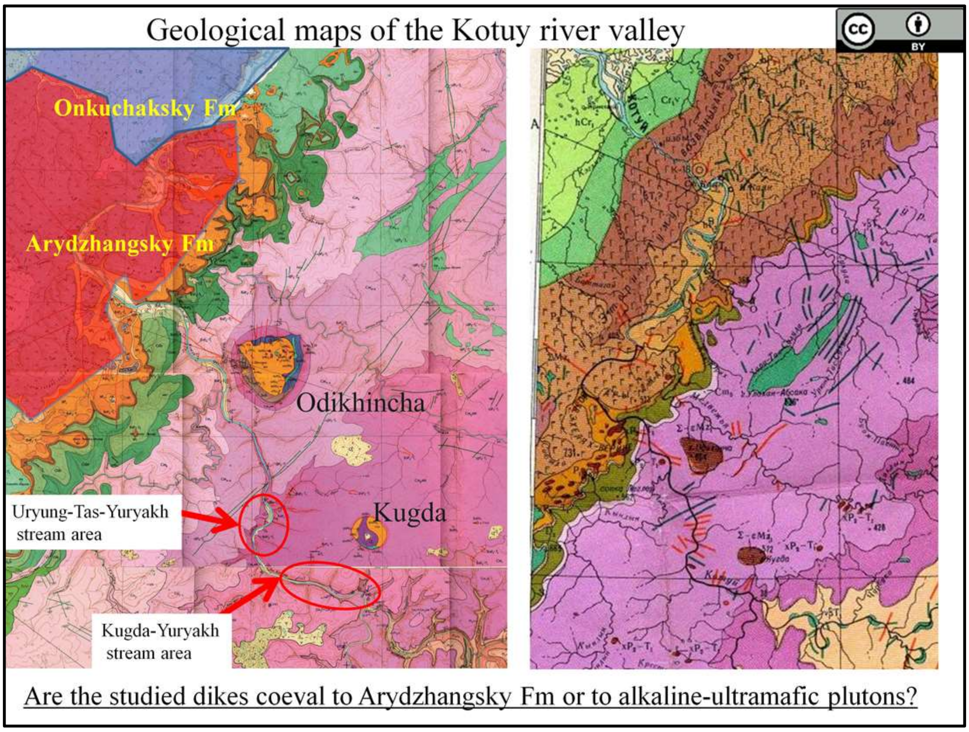


- Diversity of volcanic sections;
- Large area of dike complexes;
- Alkaline-ultramafic and tholeiitic lavas;

Maymecha-Kotuy region is the unique area within the Siberian LIP, due to predominance of alkaline and ultramafic rocks over tholeiitic basalts, which comprise the main volume of the rest of LIP. In general, two types of volcanic sections are distinguished within this region:

1) the Maymecha river valley;
2) the Kotuy river valley.

Also, the huge area is covered by dike swarms an multiple alkaline and ultramafic plutons (Guli, Odikhincha, Kugda etc.).



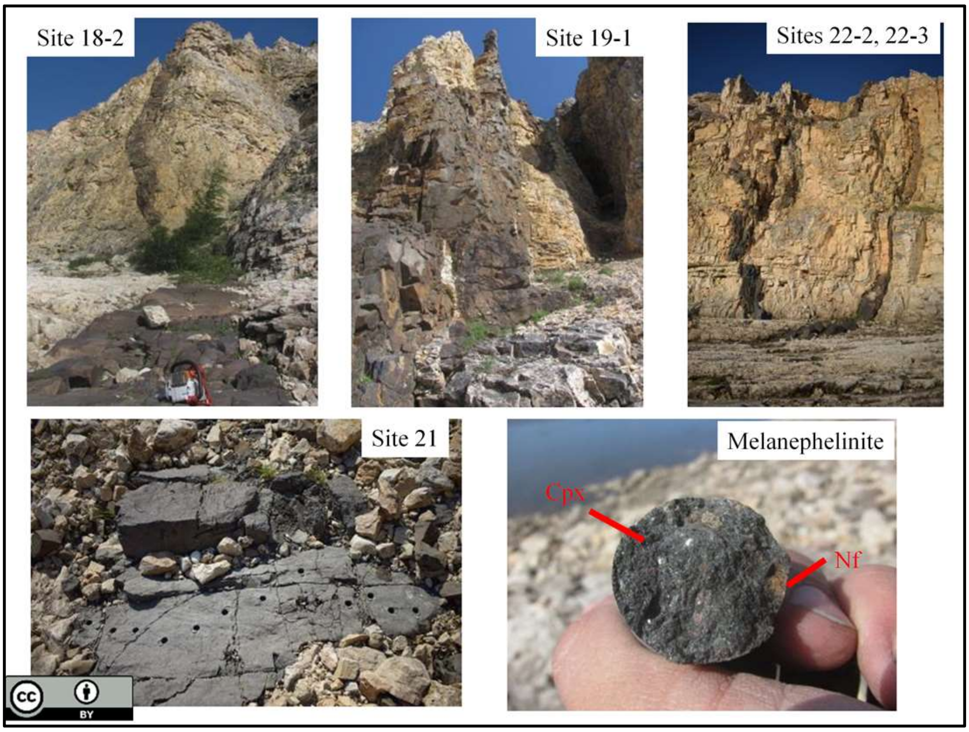
In the Kotuy river valley, two stages of volcanic activity occurred:

1. Alkaline ultramafic lavas and tuffs of the Arydzhangsky Fm, spread in the limited area.
2. Tholeiitic basalts of the Onkuchaksky Fm, forming the stripe along the margin of the Siberian platform and close in composition to the main volume of LIP.

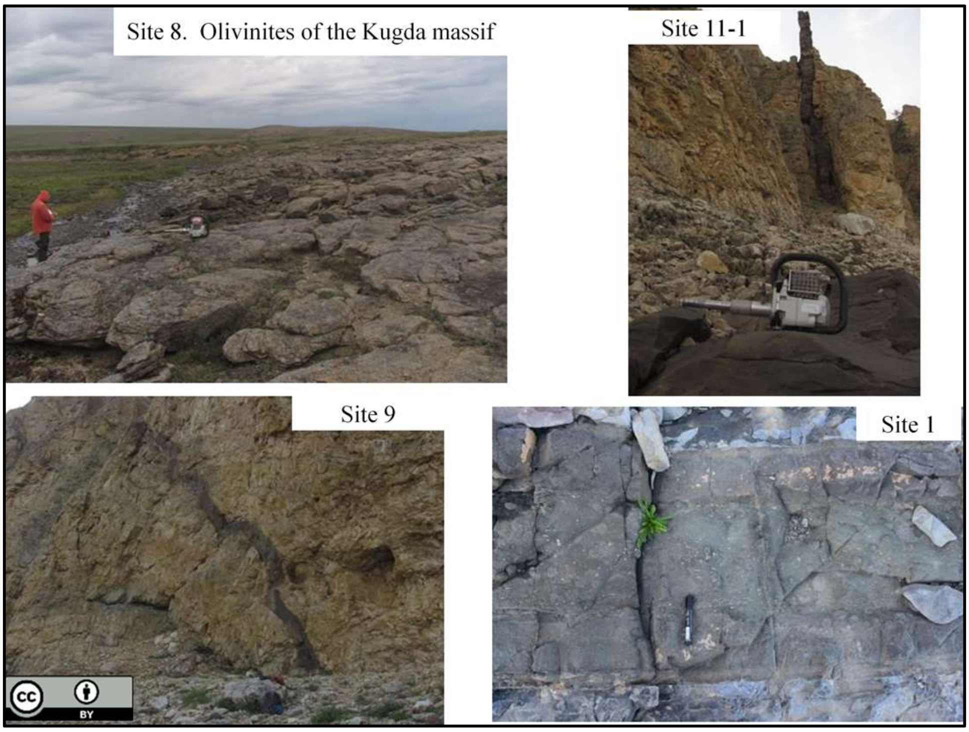
Large multiphase plutons (Odikhincha, Kugda) are considered to terminate the magmatic activity in this region (Kamo et al., 2003), though it is not clear.

Age of dike swarms and their correlation with lavas is not established as well. In the right geological map, this dikes are shown as radial systems, suggesting that they are related to alkaline-ultramafic plutons. However, based on their composition, they can be correlated with the Arydzhangsky Fm.

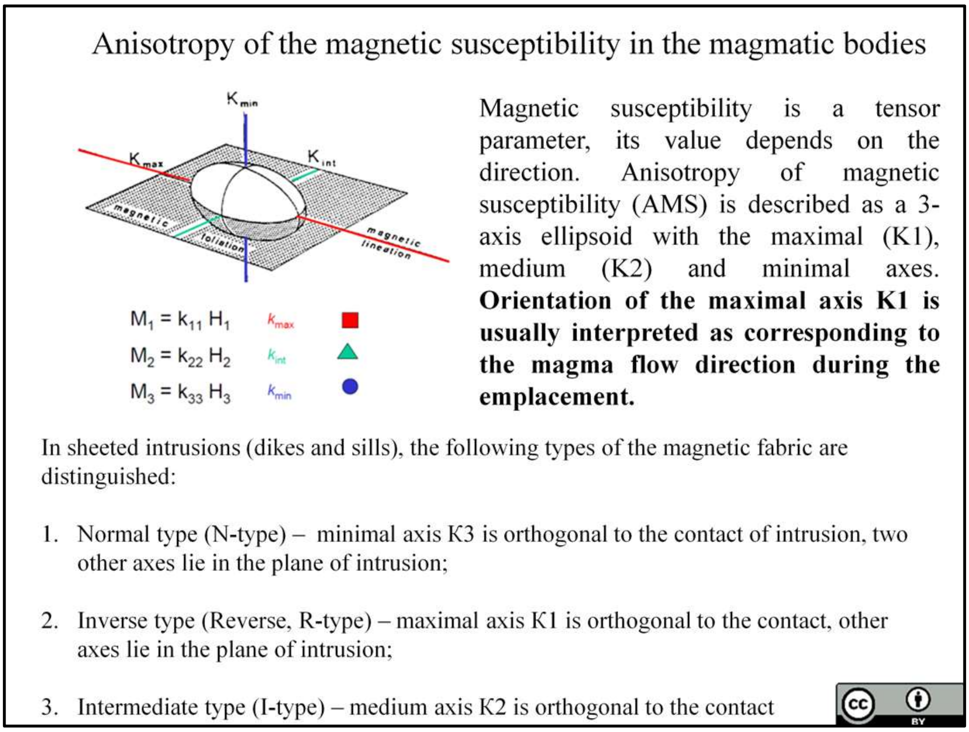
Last year we sampled more than 50 dikes along the Kotuy river valley. Here we present the first results from two areas: 1) Uryung-Tas-Yuryuakh stream; 2) Kugda-Yuryakh stream; and some data for the Kugda massif.



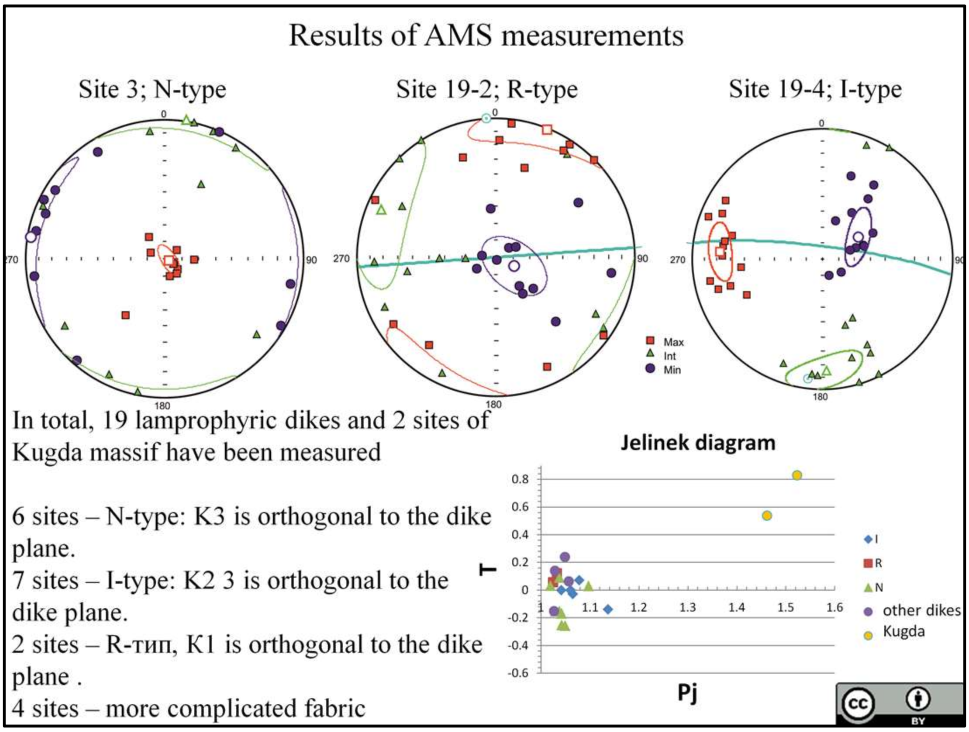
The studied dikes are steep sheets of 0.5 – 2.5 m, cutting the Cambrian dolomites of the Siberian platform cover. Dikes are composed of very specific alkaline-ultramafic rocks (melanephelinites, augitites etc.), similar to the Arydzhangsky Fm. Almost all dikes consist of many jointing segments (sites 18, 22). When possible, we collected oriented samples along the profile through the dike (site 21).



Some dikes have a complicated morphology (site 9) or demonstrate the distinct layering even within thin bodies (site 1).
Also, we sampled olivinites of the central part of Kugda massif (site 8) in two sites.



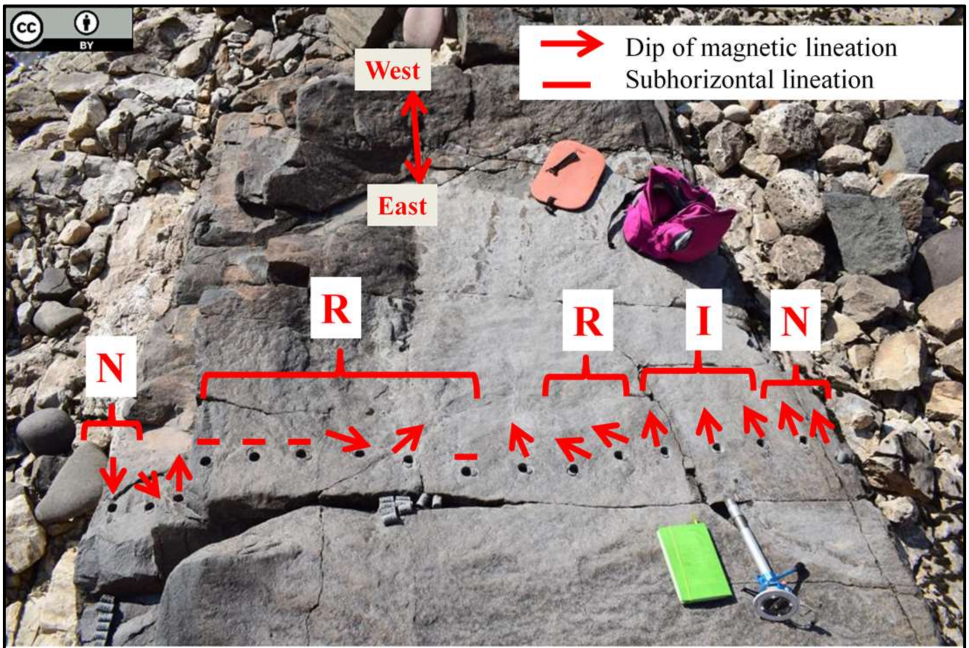
Our approach is based on the hypothesis that anisotropy of magnetic susceptibility in sheet-like intrusions can record the magma flow fabric (e.g. Ernst and Baragar, 1992; Tarling and Hrouda, 1993). In the case of so-called “normal” magnetic fabric (N-type), it is possible to reconstruct the magma flow direction.



At this moment, we have obtained results from 19 dikes and 2 sites of Kugda olivinites.

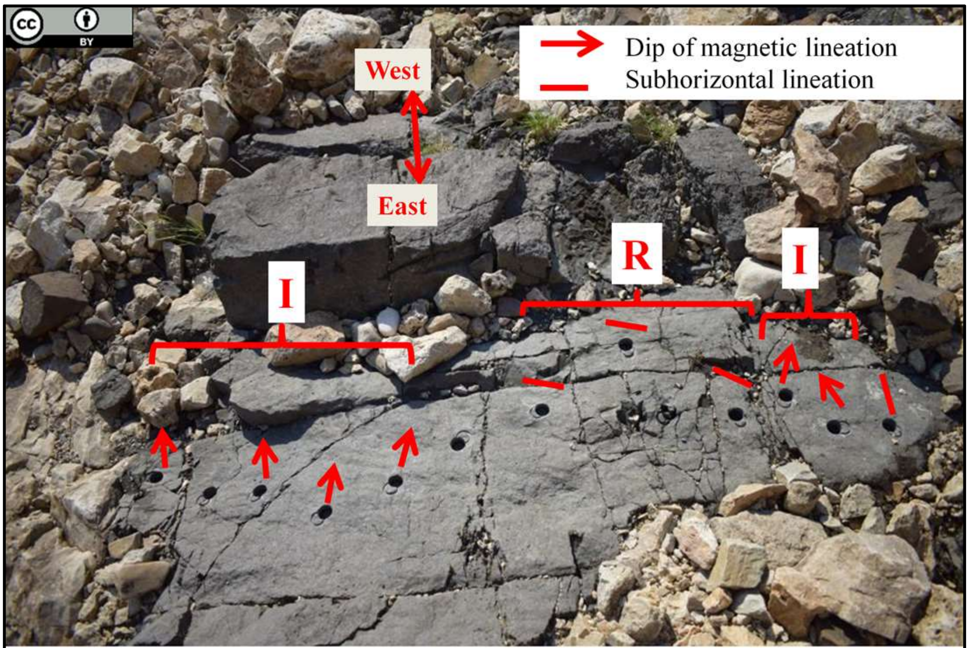
Magnetic fabric, recorded in the studied dikes, is widely variable. All main types of AMS ellipsoid were identified. The intermediate (I-type) magnetic fabric is the most widely distributed (medium axis K2 is orthogonal to the dike plane). Also, N-type of magnetic fabric is identified in 6 dikes (K3 is orthogonal to the dike plane).

The corrected degree of anisotropy (Pj at Jelinek diagram, (Jelinek, 1981)) in dikes usually does not exceed 1.05, typical of the mafic intrusions with the primary magmatic magnetic fabric. In some sites this parameter reaches 1.1 (mainly I-type dikes). The only exceptions are Kugda olivinites with the highest Pj and clearly oblate shape of AMS ellipsoid (T>0)



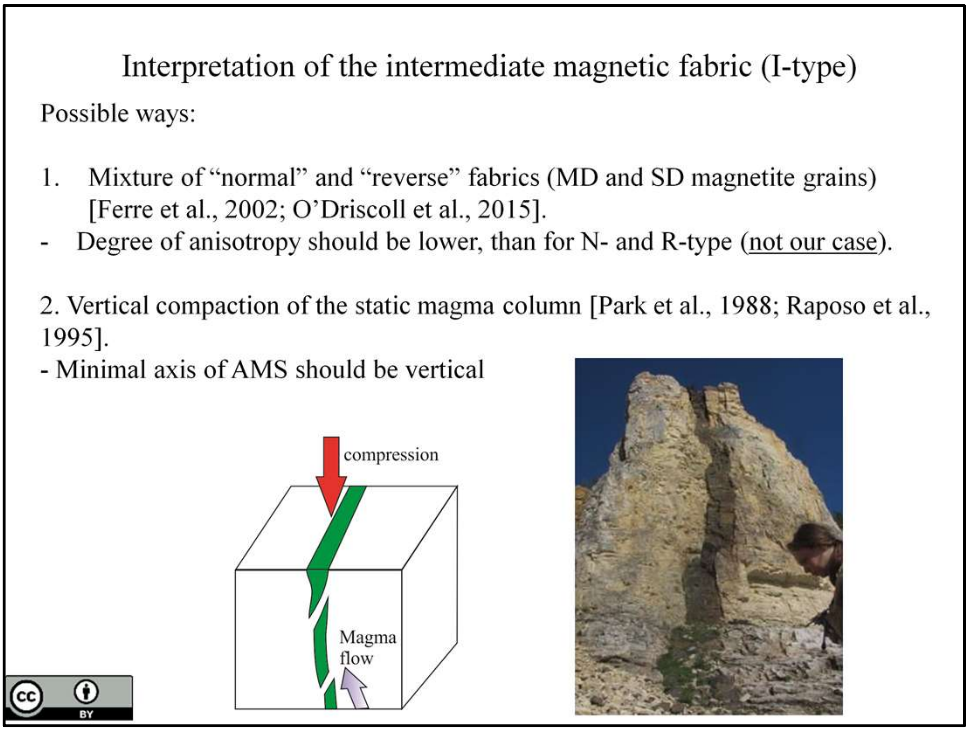
Variations of magnetic lineation through the section of dike 19-1

Here are some examples of the complicated magnetic fabric, when the orientation of AMS axes varies through the dike section. For this site, marginal parts demonstrate the N-type with the maximal axis K1 (magnetic lineation) shallowly plunging to the west. The central part of this dike shows the R-type of magnetic fabric, with the K1 axis orthogonal to the dike plane. Since the marginal zones of dikes cool faster, all flow fabrics are better expressed near the contact zones, and we can reconstruct the direction of magma flow. In this case, the dike emplacement took place during the lateral magma transport from W to E.

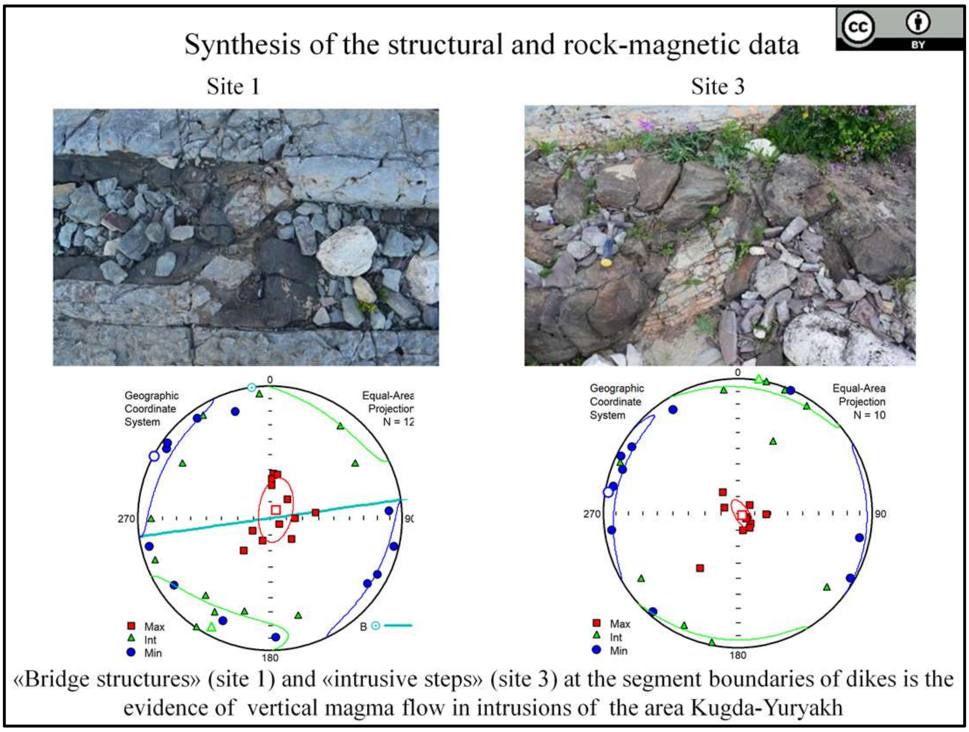


Variations of magnetic lineation through the section of dike 21

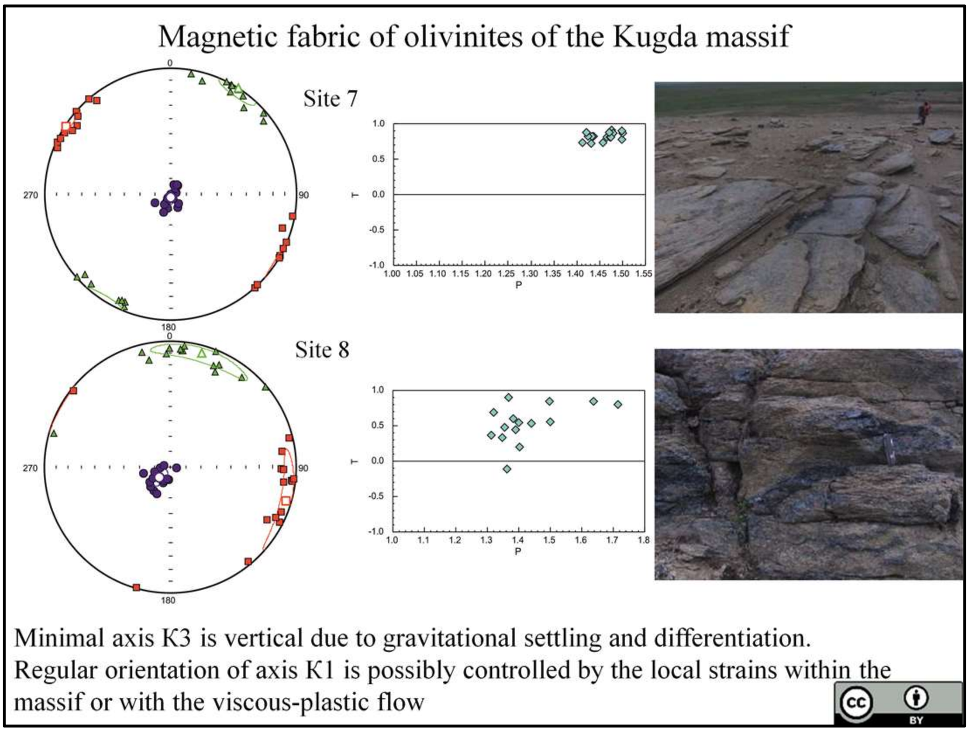
For this site, one can see the similar distribution of axes, but poorly expressed. Nevertheless, magnetic lineation (K1 axis) along the dike contacts shallowly plunges to west, indicating the lateral magma transport from W to E. In general, similar results were obtained from most dikes of the Uryung-Tas-Yuryakh area.



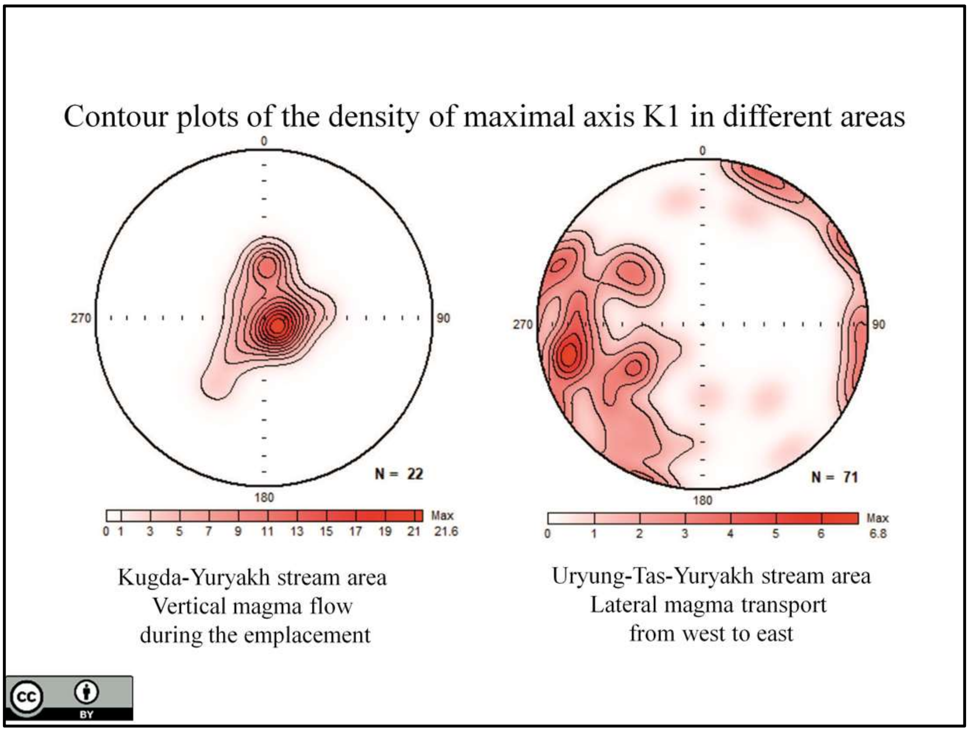
Since the intermediate magnetic fabric is the most widely distributed in the studied dikes, its origin must be explained.
Our way of interpretation is the vertical compaction of the static magma column after the emplacement in the setting of horizontal extension. In this case, K3 axis of AMS should be vertical, while the K1 axis has to be subhorizontal and corresponds to the magma flow lineation.



When possible, we used the structural data along with rock-magnetic. Many dikes demonstrate very typical features, like intrusive steps or bridge structures near the segment jointing, providing the tools for the magma flow reconstruction. In the presented images from the Kugda-Yuryakh stream area, these structural features indicate the vertical magma flow. Analysis of AMS yields similar results (magnetic lineation is vertical).

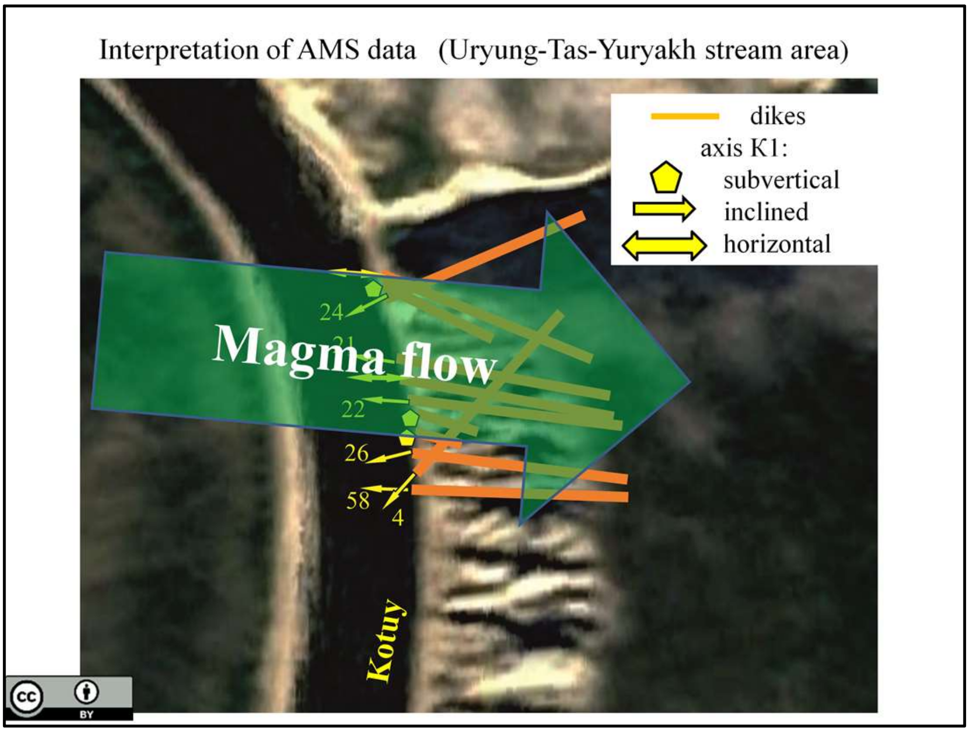


Magnetic fabric of the Kugda olivinites is originated from the gravitational settling and differentiation (K3 axis is subvertical, magnetic foliation is horizontal).
In site 7, all ellipsoid axes are tightly grouped, as well as anisotropy parameters (T, Pj). In site 7, axes orientation and values of T and Pj are more scattered, probably, due to post-magmatic magnetite veins.



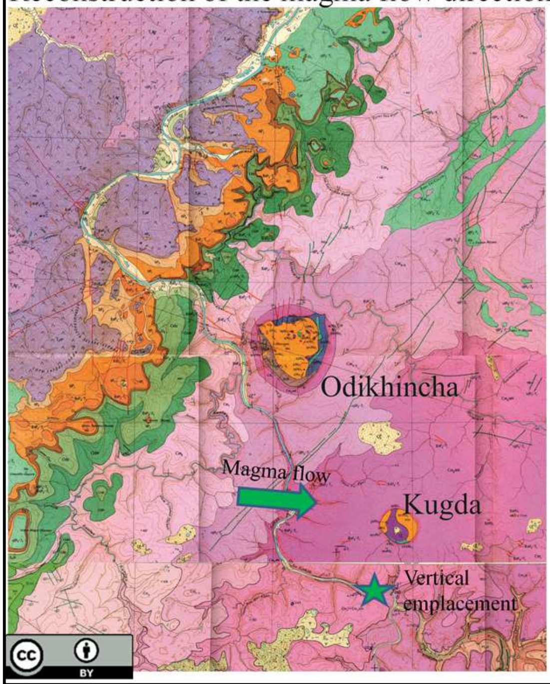
Contour plots of the magnetic lineation distribution within two areas allows us to reconstruct the dominating directions of magma flow:

1. In the area of Kugda-Yuryakh stream vertical magma flow was predominate during the emplacement.
2. In the area of Uryung-Tas-Yuruakh stream, lateral magma flow from west to east controlled the magma emplacement. However, several local centers are distinguished at the plot.



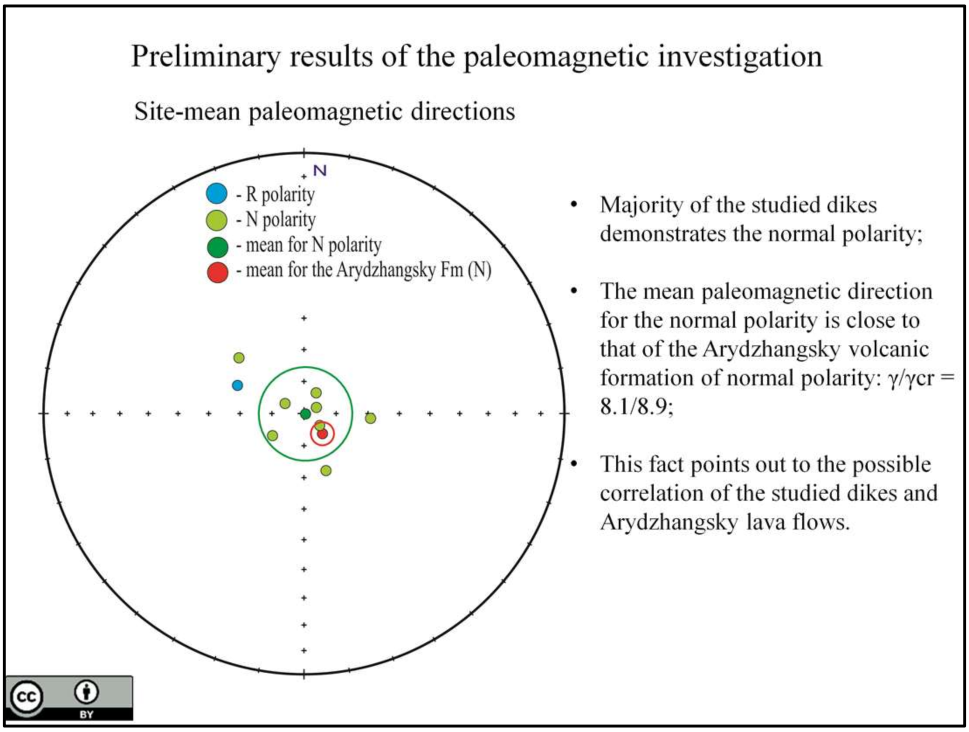
Interpretation of the AMS data from the Uryung-Tas-Yuryakh stream area shows that the local magma feeding zone was situated westward from the Kotuy river valley

Reconstruction of the magma flow direction in the studied dikes



- Studied dikes are not related to the emplacement of Kugda massif;
- The magma feeding channel for the dikes of Uryung-Tas-Yuryakh area was located westward from the Kotuy river;
- Dikes of Kugda-Yuruakh area were formed as a result of the vertical magma intruding;
- Based on the composition of dikes, we suppose that they are coeval to Arydzhangsky Fm.

Thus, we identified the contrasting magma flow patterns for the emplacement of dikes in two areas. At least, dikes of Uryung-Tas-Yuryakh area are not directly related to the formation of nearby Kugda massif. Based on the composition of dikes, we suppose that they are coeval to Arydzhangsky Fm



Preliminary results of the paleomagnetic investigation show that most dikes were emplaced during the normal polarity interval, and their paleomagnetic directions are similar to those of the Arydzhangsky lavas, within the confidence circles. This fact can be another argument in favor of the correlation of the studied dikes and Arydzhangsky Fm. Then, the area of Arydzhangsky magmatic stage manifestation could be much wider than volcanic area preserved now.

Conclusions

1. During the emplacement of Uryung-Tas-Yuryakh dikes, lateral magma transport was predominant; the local magma feeding zone was located westward from the Kotuy river valley and does not related to any large massif.

2. Dikes of the Kugda-Yuruakh area were formed as a result of the vertical magma flow..

3. Magnetic fabric of I-types is identified in the essential part of dikes. It can be explained by the vertical compaction of the static magma column after the emplacement in the horizontal extension setting. In this case, magma flow direction can be reconstructed for these sites.

4. Based on the petrographic and paleomagnetic data, the studied dikes are probably coeval to the Arydzhangsky Formation. Thus, the area of Arydzhangsky magmatic stage manifestation could be much wider than volcanic area preserved till now.


Thank you!
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