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New data on structural-geomorphological and petro-paleomagnetic investigations of Kandalaksha Bay Islands in the White Sea

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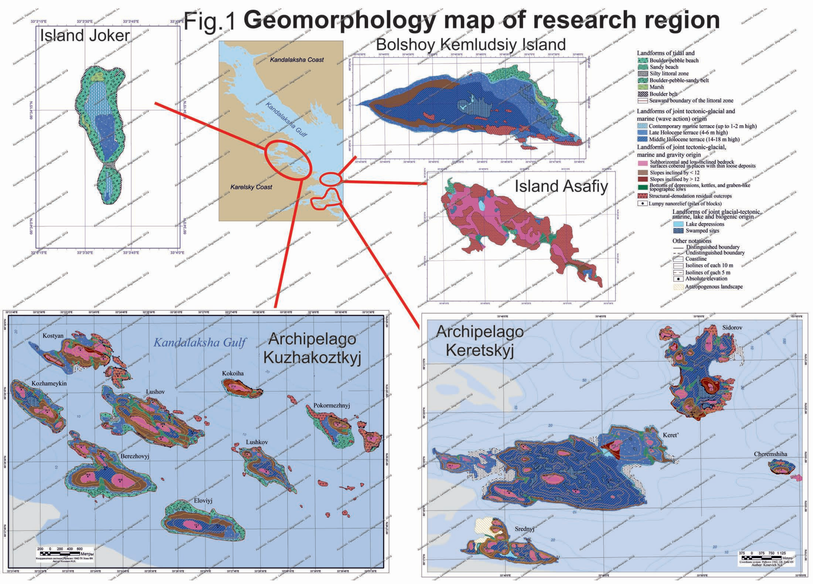
Region of research

White Sea is the main islands' region of Russia characterized by the predominance of a great number of small islands. For the most part they are locates along the west coast of Karelskiy, Kandalakshkiy and Pomorskiy coasts. In Onega and Kandalaksha Bays. In a lot of places the islands are so numerous that scarryes tyoe coasts represent the lake-like of water and land. They are the eastern part of the Kem scarryes, Soroca Bay, etc. Besides big and small islands there are countless numbers of small barren stonebanks, korgs, stones, etc.

The relief of all investigated islands is represented by forms created by the following combinations of processes (Fig.1): 1) glacial-tectonic and marine wave processes; 2) tidal and wind effected phenomena; 3) glacial-tectonic, marine and gravity processes, and 4) glacial-tectonic, marine, lake and biogenic processes. Tectonic rising plays the main role in the islands relief formation. During the land rising above the sea level, its area and height increases leading therefore to the relief complication.

Fig.1 **Geomorphology map of research region**



There are soft rocks somewhere among the crustal rocks on the studied Islands. They are mainly Holocene marine sediments or seaworn diamicton (Fig.3).

In the field work in 2018 we selected soft rocks in pits into plastic boxes to measure the magnetic properties of rocks (anisotropy of magnetic susceptibility (AMS) and thermomagnetic analysis to determine the composition of the magnetic fraction). Bulk magnetic susceptibility (km) ranges from 78.6E-6 to 1525E-6. Anisotropy degree (P) ranges from 1.8 % to 4.1 % (Fig.3).

Ellipsoids are predominantly oblate. This character of distribution of AMS is typical for sedimentary rocks (Tarling, 1993). At the same time in some specimens (waypoints J, U, ON) the maximum axis is directed in the North-West direction, which may indicate the direction of the paleoflow. This is especially evident in ellipsoids oblate-triaxial (shape parameter T=0,2-0,3). Less reliable directions have a shape parameter greater than 0.5. These are the directions of the Northern strike.

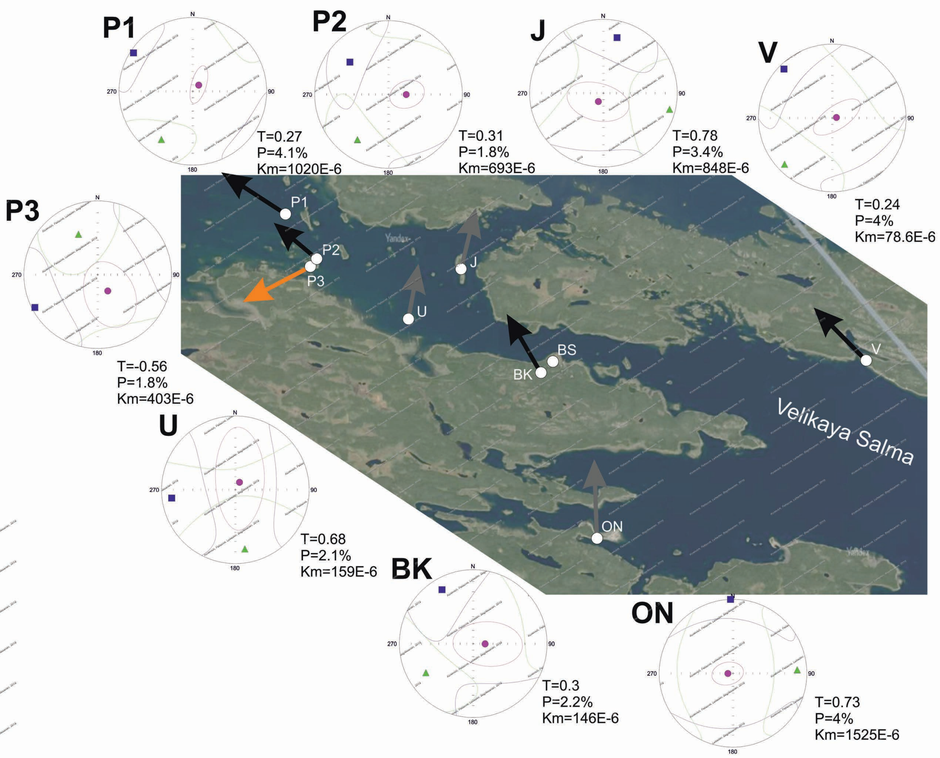


Fig. 2. Satellite image with waypoints. Stereoplots shows mean directions of main axes of AMS with confidence angles for each point. K1 – max axe, K2 – intermediate and K3 – min axes. Km – average bulk susceptibility, P – mean anisotropy degree, T – value of shape parameter. Arrows shows plunge of max axe on map, that we interpret as flow direction. Orange arrow – from point with T<0 and high authenticity, black – with 0<T<0.5 and moderate authenticity, grey – with T>0.5 and low authenticity.

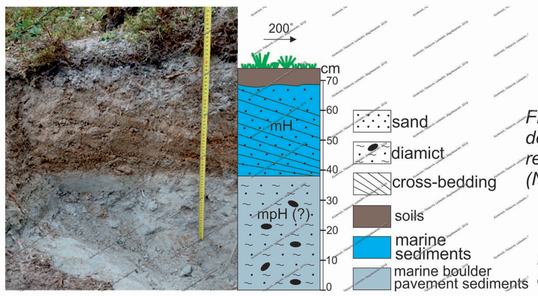


Fig. 3. Section of Quaternary sediments on the island Ipanchiniha

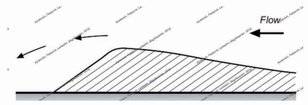


Fig. 4 The patterns of cross-beds are determined by the shape of the bedforms resulting from different flow conditions (Nichols, 2009).

The North-Western paleoflow's direction could be formed as a result of the weak movement of the water flow in a low altitude area (Fig.4). This area could be formed immediately after the deglaciation of the last Fennoscandian glacier and before the beginning of isostatic uplift in the glaciation center.

There are also a number of limitations. First of all, in this region there is signs of the block structure, which is reflected in the different speeds of movements of the individual blocks (Baranskaya, 2015). Therefore, we cannot interpret all objects in the same way and ignore the block structure. Secondly, we do not know the exact age of the sediments, and this affects the altitude of the area during sedimentation.

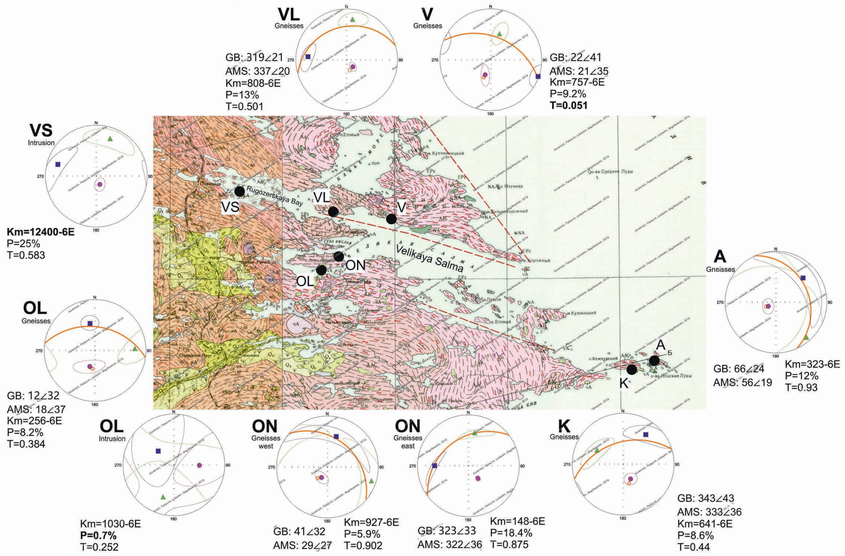


Fig. 4. Geological map GGK-200 1:200000 with waypoints. Stereoplots shows mean directions of main axes of AMS with confidence angles for each point. K1 – max axe, K2 – intermediate and K3 – min axes. Orange great circle and pole shows mean directions of gneissic banding. GB – azimuth and dip of gneissic banding, AMS – azimuth and dip of magnetic foliation, Km – average bulk susceptibility, P – mean anisotropy degree, T – value of shape parameter.

We took samples from hard rocks from 7 waypoints (Fig.4). There are 5 from gneisses (V, VL, A, K, ON), 1 from gneisses and mafic intrusion (OL) and 1 whole from mafic intrusion (VS). We take 10-30 samples from each point. Most of all waypoints have bulk magnetic susceptibility between 5E-6 – 1E-3 SI. This large scatter related with variable petrology of gneisses. Degree of anisotropy have moderate values mean is 9%. Many of waypoints have oblate magnetic fabric. And in gneisses we established strong correlation between gneissic banding and magnetic foliation of AMS.

Two intrusions, that we sampled, have different values of AMS. Intrusion at the Visokiy island (VS), have the highest values of bulk susceptibility (8-20E-3 SI), highest degree of susceptibility and oblate magnetic fabric like gneisses. In another intrusion at the Olenevskiy island (OL) we observe another type of AMS. Bulk susceptibility like in country gneisses, but anisotropy degree is very low. We think that, this is 2 generations of intrusions. We think so, because >9% degree anisotropy in gneisses and in intrusion of Visokiy island can be connected with regional metamorphic event that have vast propagation in Belomorian Belt. But on the Olenevsky island we didn't observe this degree, so that we think that it formed before regional metamorphic event. It can have earlier age of formation.

Conclusions:

The White Sea water area is very young, being located in the region of last continental ice sheet. The Kandalaksha Gulf is one of the regions that rise most intensively. That is why the islands relief evolution occurs notably here.

Intensive tectonic rise caused disappearance of numerous coast parts of Kandalaksha Gulf. For example, on the southern bank of the Great Salma Strait the small island occupied by the marine terrace up to 4 m high joints the Kindo peninsula by the low-lying bridge. Calculation of tectonic elevating speed allows estimating of coastal islands age of the south coast of Kandalaksha Gulf. We traced the sequence of the islands relief formation studying the islands of all investigated archipelagoes.

Tectonic rising plays the leading role in the islands relief formation. During the land rising above the sea level, its area and height increases, and therefore the relief becomes more complex. The islands relief forms due to the impact of gravity processes, abrasion and accumulative activity of the sea, and biogenic processes.