Petrogenesis of the Polish AMCG massifs based on detailed mineralogical, geochemical and isotopic studies of parental jotunite rocks.

Massif-type anorthosites and associated granites are known from almost all Precambrian cratons as AMCG (anorthosite-mangerite-charnockite-granite) suite. The tight link between this magmatic AMCG suite and Proterozoic time (c. 1.9-0.9 Ga) suggests that formation of the AMCG complexes reflects a specific state in Earth's history and provide a possibility to study processes on lower crustal-upper mantle boundary.

The Suwałki Anorthosite Massif (SAM) and the Sejny gabro-norite-anorthosite intrusion are located in the NE Poland in western part of the East European Craton, which is covered by younger platform sediments. The recognition of deep basement structures is possible only through the interpretation of geophysical data and from direct petrological studies of drill cores. These two intrusions and related granites belong to the wider, c. 1.5 Ga, magmatic terrane called the Mazury Complex (AMCG suite), which makes the SAM and the Sejny Intrusion perfect objects for studies on the genesis and evolution of the AMCG suite.

The origin of anorthosites has been a long-standing point of the debate in petrology for over 100 years. There are a number of views on the origin of anorthosite massifs and AMCG formation. One of the models places magma of the jotunitic composition (dioritoide enriched in Fe, Ti and P) as parental to all associated rocks of the AMCG suite. The lack of accurate data for jotunites from Polish anorthosite massifs is therefore a problem for evaluating the truth of this hypothesis.

Jotunite rocks, which will be the subject of this project, are common components of the SAM and the Sejny Intrusion and were found in several boreholes. Jotunites show characteristic fine-grained textures of chilled type melts, which suggest a later injection of hot jotunitic magma into mafic rocks. They are made up of plagioclases, pyroxenes, Fe-Ti oxides (magnetite and ilmenite), apatite crystals and traces of biotite or amphiboles. Zircon and baddeleyite are accessory minerals.

The aim of the research will be an identification and detailed analyzing of jotunitic rocks in boreholes, from the Suwałki Massif and the Sejny Intrusion. The project assumes several research hypotheses.
1. Jotunitic melts derived from lower-crust, not from upper-mantle.
2. Magma of jotunitic composition is parental for anorthosite and other rocks associated in AMCG suite.
3. Jotunites from Sejny Intrusion (based on chemical composition) have features of more primitive type and jotunites from SAM, enriched in Fe, Ti and P, show compositions characteristic rather for evolved type. This feature was stressed earlier but samples do not come from all boreholes drilled in Suwałki Massif. Perhaps jotunites from a distinct part of the massif have different features.
4. Differences in the chemical composition of jotunitic magma are the result of extra processes.

The above goals will be achieved thanks to several analytical methods. The Detailed petrographic description of previously collected sampless will be the starting point for further research. Then, based on the chemical composition investigations of selected minerals, e.g. from the pyroxene group, it will be possible to determine the temperature and pressure prevailing at the time of their crystallization, which allows to determine the depth of the rock formation. The application of the novel dating method allows to determine the age of crystallization of these rocks based on the U, Th and Pb content ratios in very resistant to weathering, both chemical and physical, zircon grains. Zircon is a mineral crystallizing at high temperatures (around 900˚C), which means that its dating indicates the time of setting up the igneous pluton, rather than its cooling. The Lu-Hf isotopic method, made on zircon grains, thanks to the specific behaviour of these elements in various environments, allows to obtain information about the source of magma, from which anorthosites and other rocks of AMCG suite were crystallized. It can indicate whether the magma was contaminated by different material. It is equally important to determine the chemical composition of whole-rock samples. This type of research allows to make conclusions about nature of rocks. The obtained results will be the starting point for petrological modelling.

Results of the project may become an important contribution to understanding the formation and evolution of massive-type anorthosites, especially Polish ones.