Creating a cloud environment for a virtual rock core model*

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As a part of the X International Youth Scientific and Practical School "High Performance Computing on GRID", the work of the project team was presented. The context of the project is mathematical, computational and cognitive challenges in the Digital Rock Modeling (DRM)[1-3]. DRM implies using virtual or reconstructed digitized pore space and mineral matrix of natural rock to numerical simulating various physical processes in this digital object to obtain such macroscopic rock properties as permeability and porosity, to analyze reservoir characterization. The project is focused on following key issues:

- Efficient digital rock models and methods for extraction of rocks macroscopic properties from it;
- Image processing and associative reconstruction;
- Machine learning for model tuning;
- Open rock modeling infrastructure;
- High-Performance computing in modeling, simulation, visualization and data analysis.

The focus of the project is well-aligned with trends in Digital Rock Analysis and e-Core technology, that promise to address challenges of integration of intelligent data analysis into digital rock modeling to accurately and efficiently predict oil and gas reservoir characteristics using high-performance computing technology. To achieve these goals, the following methods are used.

- Molecular dynamics simulations using HPC for 3D rock microstructure construction and fluids permeability estimation.
- Brute-force search accompanied by HPC for model simulations is used to train multilayer neural network to identify the correspondence between model parameters and geophysical survey and well logs data.

Having enough data from geophysical survey reports, adequate rock model and using artificial intelligence methods it can be possible to predict oil and gas reservoirs behaviors.

The first stage of the project devoted to design and creation of a cloud service to provide the user interface for conducting numerical experiments with a digital rock model using the resources of the NArFU computing cluster. We use SageMath containers to provide access to modeling platform along Platform as a Service cloud computing model and implement virtual workplace with Eclipce to get clients work environment within Desktop as a Service model. We use Open Science Framework for integration with public platforms of dissemination of results. Among other tools, the following set is used: Singularity, SageMath, Eclipce, Python, OpenStack.

Main outputs of the project are prototype of the intelligent infrastructure for digital rock modeling with several capabilities, intelligent data acquisition and assimilation for the model, and verification of obtained from the model macroscopic properties.

References

1. Belozerov I., Berezovsky V., Gubaydullin M., Yur'ev A.. Digital Core Modelling for Clastic Oil and Gas Reservoir. Journal of Physics: Conference Series; 2018.. DOI: 10.1088/1742-6596/1015/3/032016
2. Berezovsky, V., Belozerov I., Gubaydullin M. G., Yur'ev A.. Numerical and Laboratory Examinations for Digital Rock Modeling for Clastic Oil and Gas Reservoirs.". 17th International Confer-

1 The project was impemented within the framework of the X International Youth Scientific and Practical School "High Performance Computing on GRID", NArFU, Arkhangelsk. All models has been simulated used NArFU HPC facilities.

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3. Berezovsky, V., Gubaydullin M., Yur'ev A., Belozerov I. Examination of Clastic Oil and Gas Reservoir Rock Permeability Modeling by Molecular Dynamics Simulation using High-Performance Computing. Communications in Computer and Information Science. Vol. 965. 2019 DOI:10.1007/978-3-030-05807-4_18.