Dr. Mikhail Baykulov
Geophysicist
Addax Petroleum Ltd / Geneva Branch
Route de Malagnou 101
1224 Chêne-Bougeries
Switzerland
mikhail.baykulov@addaxpetroleum.com

Evaluation of the PhD thesis "**Joint Detection, Location and Source Mechanism Determination of Microseismic Events**", submitted by Denis V. Anikiev, Saint Petersburg State University, 2015.

The thesis of Denis Anikiev presents innovative methods of microseismic monitoring that is a type of passive seismic or, more generally, seismology. The key issue in seismology/passive seismic is that the location (hypocenters) and timing of sources generating seismic waves are unknown, and have to be estimated.

The main objective of the presented research is determination of hypocenters of microseismic events resulting from hydraulic fracturing in real wells, in **an automatic and, ultimately, real-time mode**. The main principal difference to the existing studies is that the proposed workflow considers phase/polarity change of seismic events, which pretends to increase the stability of event detection. The method is benchmarked vs. conventional manual event detection, with the latter usually considered to be the most accurate.

It would be beneficial for the benchmark of the results to see application of the method to synthetic data, which was not part of this work, but I believe is presented in the author's publications. The spatial misfits between manually and automatically detected seismic events were mainly in the vertical (depth) direction, and were corrected by changing the velocity model, which must be known a-priory. Analysis of synthetic data with the ideal velocity model would provide a reliable comparison between manual and automatic methods, and would show which results are closer to the actual hypocenters.

Another suggestion, for the future studies, is to apply the proposed method on active seismic data from exploration seismology. The algorithm can be used to detect diffraction events that naturally originate from faults or discontinuities in the rock volumes. Fault imaging remains challenging task in complex geological areas, and could be improved by diffraction detection and, consequently, stacking.

Results of the submitted thesis, author's papers in various scientific journals, presentations made at international conferences in 2006-2015, and collaborations with other scientists worldwide prove that Denis Anikiev achieved great results in his research. Successful tests on real data suggest that the algorithm can be directly applied in passive seismic monitoring, and can generate technological and financial benefits.

Personally, I wish Denis to successfully defend the thesis. Knowing Denis as a motivated, accurate and target-oriented researcher, I am sure he will have great achievements in his future studies and work.

Mikhail Baykulov
Geneva, 01.10.2015