SIS Software Bulletin in Caspian Region

SIS Astana / Kazakhstan / Q1 2017

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In this issue we will announce the winner of our SIS New Year contest!
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April 28	OFM Interface - Application Programming
May 18	Petrel automation: workflow examples for reservoir engineers
May 26	PIPESIM – Perforation design
June 9	Practical examples of automatic workflows and reports creation in Petrel
Upcoming Trainings in 2017	
Apr 3-7	Petrel Geophysics
Apr 10-14	Petrel Reservoir Engineering
May 15-19	Petrel Fundamentals and Petrel Geology
May 22-26	Formation Evaluation with Quanti.Elan
May 29 – June 2	Compositional Reservoir Simulation with ECLIPSE and PVTi
June 5-9	PIPESIM Fundamentals & Artificial Lift Design and

* Preliminary Schedule, minor changes are possible during the year
** See the full schedule from http://sis.slb.ru/sis_in_central_asia/

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Litho Scanner high-definition spectroscopy service

Duman Issayev
Petrophysicist

The increasing complexity of reservoirs demands an accurate understanding of formation composition and mineralogy. Data from the Litho Scanner high-definition spectroscopy service allows to derive detailed complex reservoir property.
Application for detailed quantitative mineralogy in complex lithologies:

- ✓ Ca, Fe, Mg, and S for carbonate lithology
- ✓ Al, Fe, and Si for siliciclastic lithology
- ✓ Al, Ca, Fe, K, and Si for unconventional reservoirs
- ✓ Total organic carbon (TOC) log for lithology and salinityindependent hydrocarbon saturation

The science of spectroscopy

The neutrons emitted by the PNG of the Litho Scanner tool induce the emission of gamma rays from the formation via two primary interactions: *inelastic scattering* and *thermal neutron capture.* Each of these interactions produces gamma rays with a specific set of characteristic energies.

Fig. 1. The Litho Scanner tool's LaBr3:Ce detector is coupled to a high-temperature spectroscopy photomultiplier, producing signals that are integrated, digitized, and processed by a high-performance pulse-height analyzer.

The analyzer determines the pulse height (proportional to energy) of each detected gamma ray and accumulates pulse-height histograms (spectra) that tally counts versus pulse height.
Spectra are acquired during and after each neutron burst, which enables separation of the inelastic and capture gamma rays. Each spectrum is decomposed into a linear combination of standard spectra from individual elements.

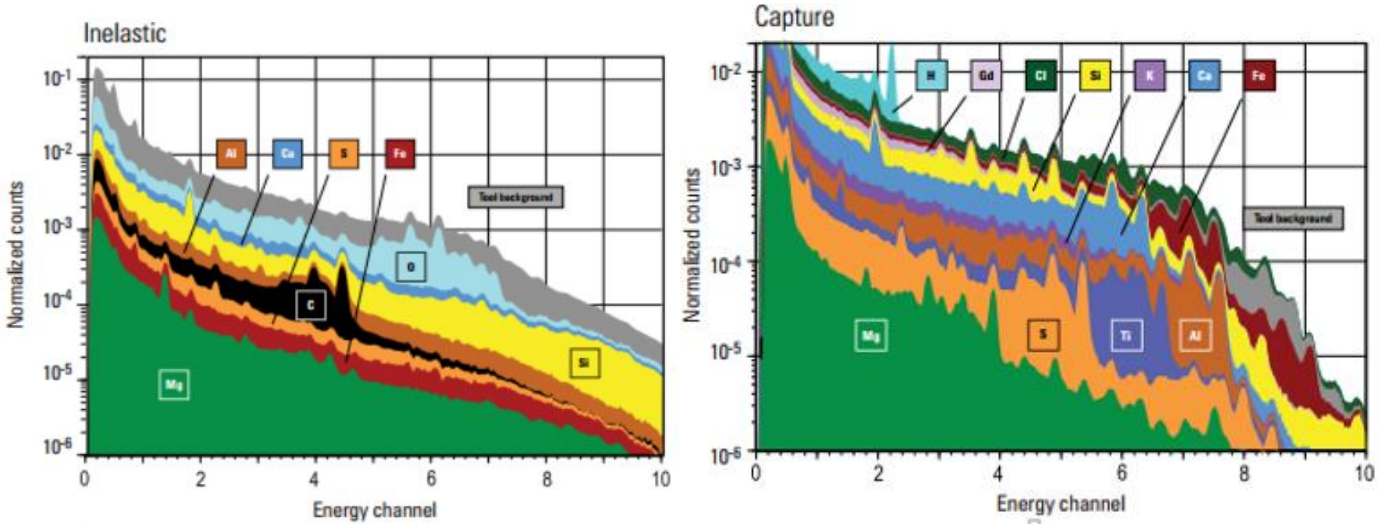


Fig. 3 and 4. Spectra of inelastic and capture gamma rays.

The coefficients of the linear combination of the standard spectra are converted to elemental weight fractions via a modified geochemical oxides closure model or by using an inversion approach.

Two methods are available to generate mineralogy and lithologic fractions from the elemental concentration logs. One is sequential SpectroLith* processing, which is based on the derivation of empirical relationships between elemental concentrations and mineral concentrations. The other is by using an iterative inversion technique, such as the Techlog* Quanti multicomponent inversion ELAN* module.

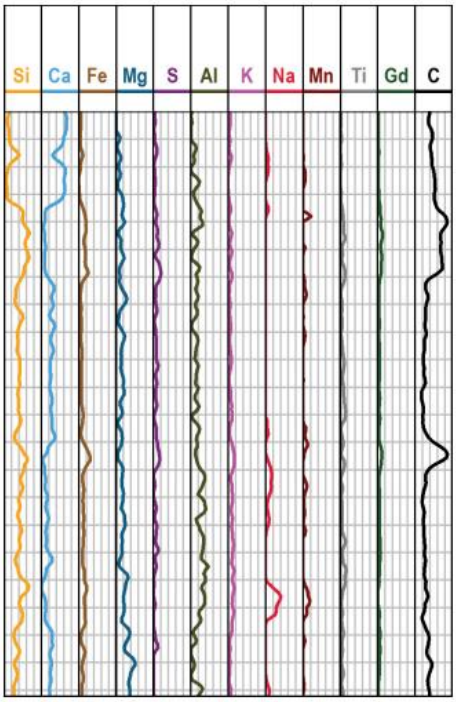


Fig. 5.The individual spectral yields are then converted to elemental weight fractions presented as logs.

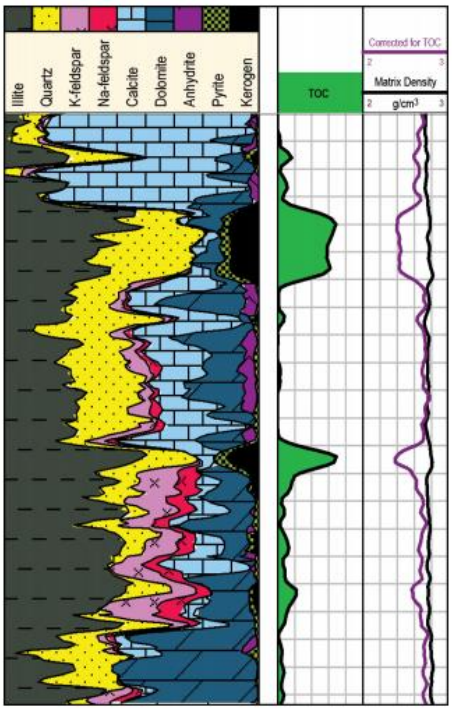


Fig. 6. Interpretation of the elementary weight fractions determines mineralogy, matrix properties, and TOC.

The measure of minerals

The inelastic scattering measurement made with the Litho Scanner tool is of particular interest because of its sensitivity to C, Mg and other elements.

Application for carbonates:

- Magnesium: comparison of the inelastic and capture yields of Mg for mutual consistency increases the precision and accuracy of the measurement by determining the weighted average of the dry-weight Mg obtained from both spectra. In carbonates, Mg can be used to accurately differentiate calcite from dolomite at standard wireline logging speeds. Dolomite creation in carbonates is the result of the long chain system realization, which consists of the solution filtration and the subsequent dissolution and desalination, what is followed by the crystalline modification. These processes often provide the secondary porosity in carbonates. Hereby, calcite and dolomite differentiation avails to classify lithofacies and highlight production intervals with the best properties. This problem has a big relevance in the Caspian region, where the carbonate reservoirs has a vast majority. The improved S measurement also supports the quantification of anhydrite from calcite.

Application for siliciclastic:

- Two other elemental measurements of significance are K and Al. The direct measurement of Al is used to quantify clay volume. Final answers of each element concentration from the neutron-pulse spectroscopy measurement permits to make a robust petrophysical models and evaluate influence of separated lithological type to porosity calculation.

Application for TOC determination:

- Carbon: From common association factors for carbonate minerals, the amount of inorganic carbon present can be quantified and subtracted from the total inelastic measurement of C to compute TOC and kerogen contents for shale gas plays. The S measurement is also of use in organic-rich shales to determine pyrite content.

Until quite recently TOC volume calculation was defined from the numbers of complex interpretation steps, requiring combination of log measurements and laboratory study as well. Such uncontrolled variety of interpretation results affects to the precision of the reservoir properties. The difference between the total carbon and the carbon in carbonate structure is the TOC, independent of the environment and the reservoir, and presented as a continuous log available at the wellsite.
Therefore it's available to derive quantitative TOC without preparing complex models that requires existence of repeated calculations using log data and laboratory study.
Litho Scanner service data is the part of the essential data set for sedimentary basin and hydrocarbon system model creation. Forming an integrated digital geological model, which is suitable for subsequent oil-and-gas content estimation of the territory, serve as a reliable tool for the reserves increment.

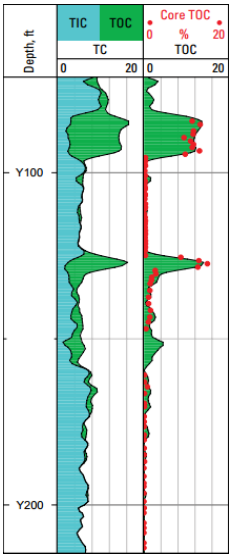


Fig. 8. The summary for TOC is derived by the following equation:
Carbon concentration – Carbonate associated carbons = Total organic carbon

Accurate porosity and kerogen volume from Litho Scanner lithology, TOC, and matrix density

An accurate matrix density is required to compute the correct porosity from a bulk density measurement. However, the grain density determined from the elements does not account for kerogen in the rock, which makes it heavier than the grain density obtained from core, as shown in Track 2 of the bottom log. The TOC (Track 1) was used to correct the grain density computed from the elements to provide significantly better agreement with the core-measured grain density (Track 2). The corrected grain density is based entirely on the Litho Scanner measurements, so it is obtained as a standalone, single-tool output. Total porosity calculated using bulk density and the matrix density corrected for organic carbon shows much better agreement with the core porosity measurements (Track 5) compared with the uncorrected porosity in Track 4.

Therefore, mineralogy obtained from the elemental concentration has a good match with the mineralogy from core analysis. Appliance of petrophysical models will help to avoid a unconformity of the parameters related to the different vertical resolution of log data.

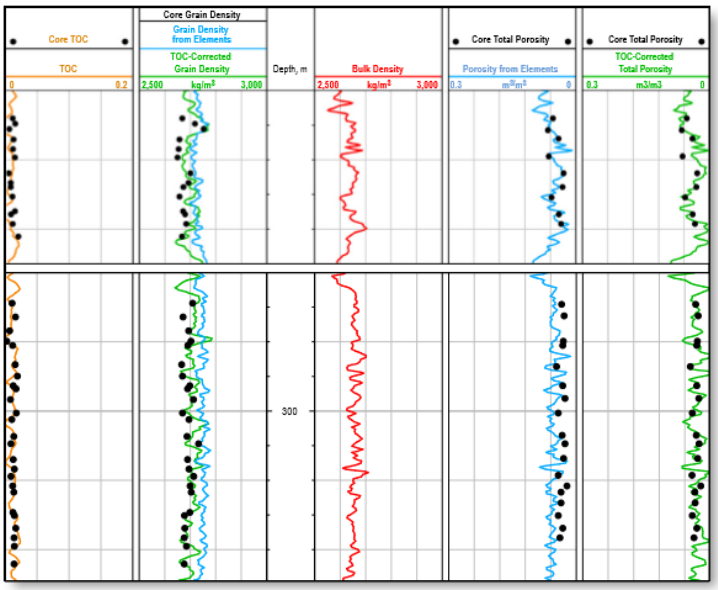


Fig. 9. Litho Scanner matrix density corrected for organic carbon content (Track 2) and the resulting porosity (Track 5) are in much better agreement with core measurements than the uncorrected density (Track 2) and porosity (Track 4).

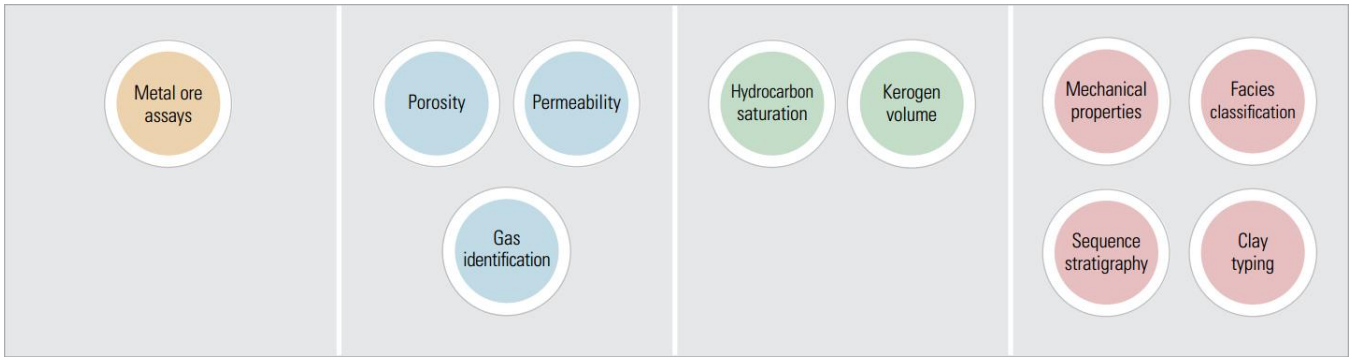


Fig. 10. Accurate mineralogy and lithology determined from Litho Scanner spectrography measurements contribute extensively to petrophysical analysis for improved decision making.

Advanced workover modeling tools using 3D models

Bagdad Amangaliyev
Reservoir Engineer

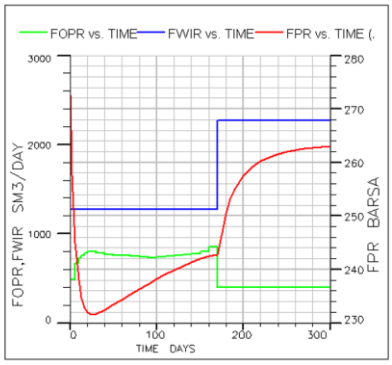
Based on standard packages of simulation, ECLIPSE provides a number of tools for modeling the effects associated with workovers:

- **Automated producer-to-injector conversion**

In the process of field development planning some production wells might be required to be converted to the injection wells after a certain period of time. The following ECLIPSE keywords can be used to simulate such type of tasks:

- UDQ keyword to specify user defined vectors;
- ACTIONX keyword for defining a set of actions to be implemented when certain conditions are triggered.

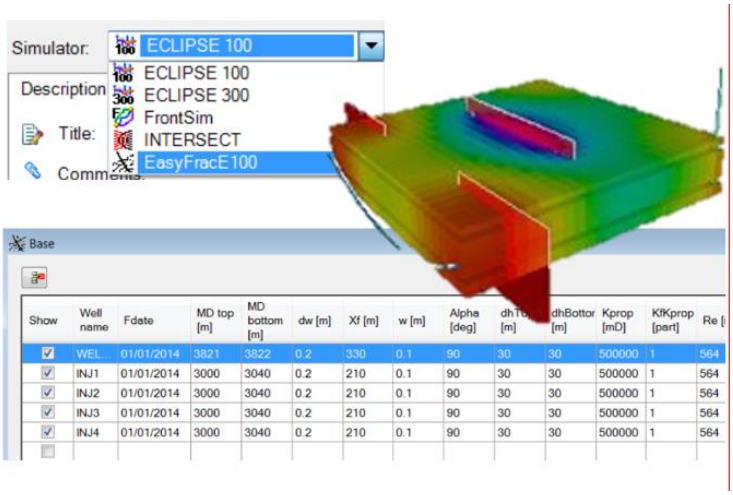
```
UDQ
ASSIGN WUTIME 0 /
/
ACTIONX
CALC 100000 1 /
WSTAT 'P*' = 1 /  -- producing
/
UDQ
DEFINE WUTIME WUTIME UADD (TIMESTEP * (WSTAT 'P*' == 1)) /
/
ENDACTIO
ACTIONX
SWITCH 100000 1 /
WUTIME 'P*' >= 165 AND /
WSTAT 'P*'  <  2  / -- not yet converted
 /
WCONINJE
'?' 'WATER' 'OPEN' 'BHP'  1000 1*  400 /
/
ENDACTIO
```



ACTION family keywords allow more flexible control over actions performed under certain conditions, whereas UDQ helps to add new vectors so that to calculate quantities that are not in the standard set of available summary vectors. These tools allow modeling such problems as automatic change of well control, automatic re-perforation, etc.

- **Hydraulic fracture modeling**

The EasyFrac module is designed to simulate the effect of fracturing (including auto-fracturing) on large models. The fracture is modeled by creating in the formation additional well connections. Calculations are faster than alternative modeling methods, since this algorithm does not change the grid. At the same time, the accuracy of computations is comparable to the detailed model. It is possible to import and export fracture parameters in a tabular form, as well as simulate the reduction of the fracturing effect with time.



- **Near wellbore modeling**

In the 2014 version of ECLIPSE, a new keyword, CSKIN, was added to dynamically change the connection skin-factor. It is possible to use custom arguments (UDA) inside the keyword, which can be calculated dynamically (UDQ, UDT). The combination of the new keyword with the user-defined values allows one to simulate the gradual change in permeability in the vicinity of the wellbore, whether it is an increase in permeability (for example, washout of the drilling mud penetrated into the near wellbore region) or its decrease (for example, reduction of the acid treatment effect, reduction of the fracturing effect). There are also other tools for modeling the change in the productivity of the well (WPIMULT), reducing the injectivity through scale deposition (SCDPTAB), etc.

The above methods of modeling the workover provide a much more realistic behavior of the simulation model of the reservoir and increase its predictability.

PIPESIM: PVT fluid properties modeling

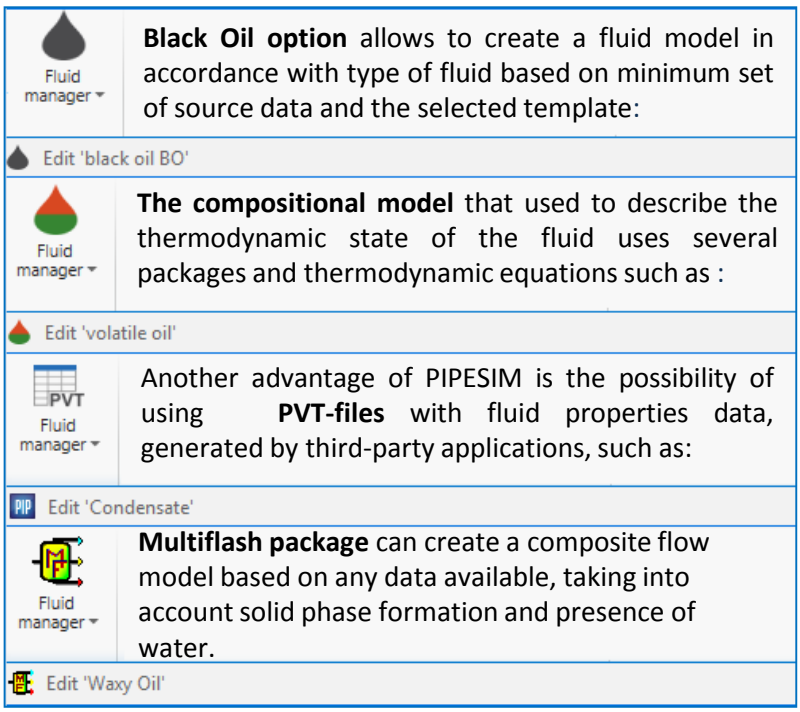
Andrey Tsoy
Production Engineer

All design decisions in production and fluid transportation in oil & gas industry are based on prediction of phase behavior of the fluid in different Pressure-Temperature conditions. One of the most important parts in the modeling workflow is the fluid phase behavior modelling. PIPESIM software package allows to create a composite fluid model for any type of fluid from heavy oil to dry gas, based on any amount of data available.

For phase behavior modeling it is necessary to know the fluid composition and physical properties of each component in the composition. Depending on available set of data users can make a choice from a wide range of PVT modeling options:

- ✓ **Black Oil Option;**
- ✓ **Compositional model ;**
- ✓ **PVT - files, generated by third-party applications;**
- ✓ **Multiflash package.**

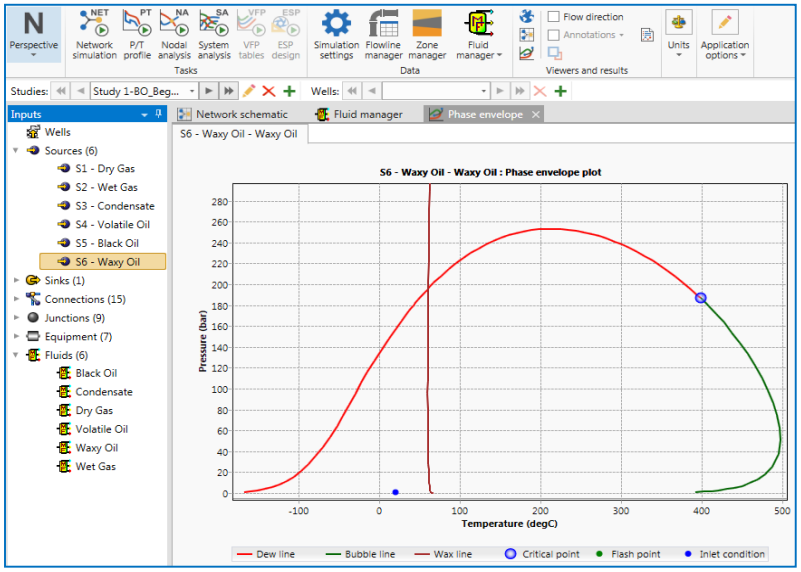
Multiflash is also used to create the required files for OLGA and it's additional modules (.tab, .wax, .hyd files). Thus, the use of Multiflash PVT technology **provides a consistent fluid modelling solution between PIPESIM and OLGA.**



Multiflash – Fluid Characterisation

The goal of the procedure of determining the fluid characteristics in Multiflash is a fluid model optimized and simplified with respect to available experimental data :

- ✓ It is possible to use results of single stage separation in the form of a separate composition of gas and liquid with GOR specified
- ✓ it possible to use TBP or ASTM D86 data curves
- ✓ It is allow to use gas chromatography data up to C80 and higher;
- ✓ it possible to use component-fractional composition data;
- ✓ Black Oil model for minimum set of source data.



It is possible to use additional data about water and solid phase content, for example wax and asphaltene distribution (SARA analysis and etc.)

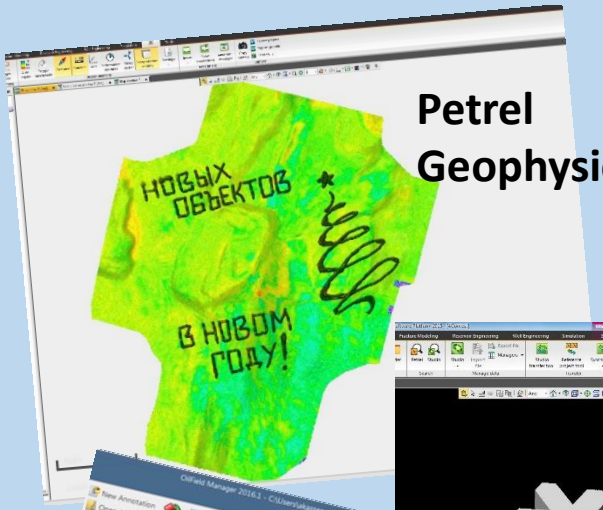
SIS New Year contest winner!

Last issue we announced our New Year Contest and asked all of you to use your imagination and create something holiday related using any Schlumberger software.

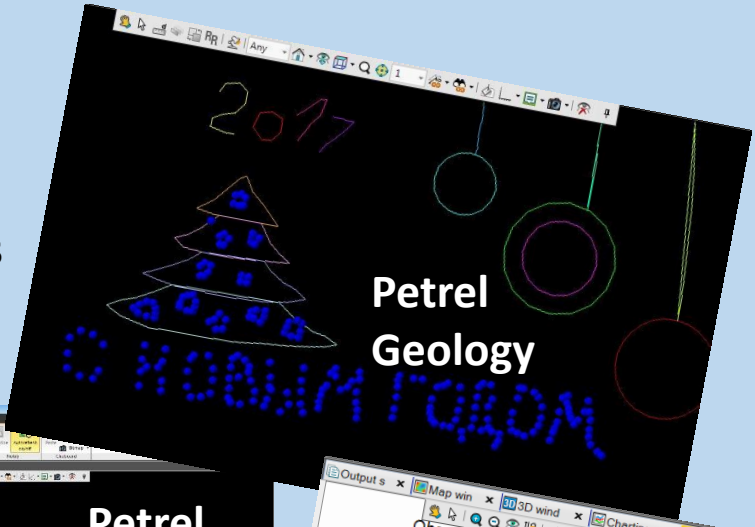
Thank you all for participating!

Our congratulations to winners:
Abzal Kenesary *from Urikhtau Operating*
Assel Ospanova *from Maersk Oil*
And ***Guldana Alimzhanova*** *from KMG SRI*

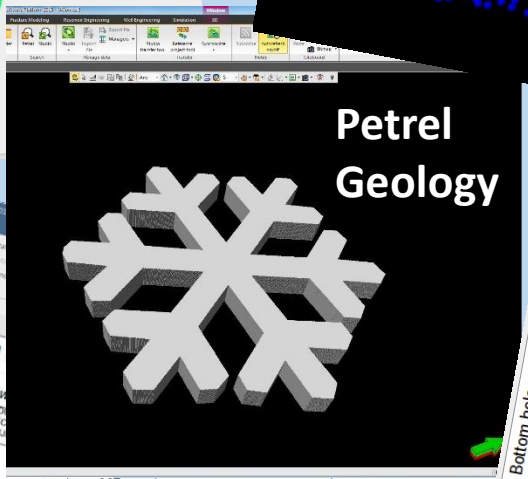
We will contact you soon and send you your prizes!



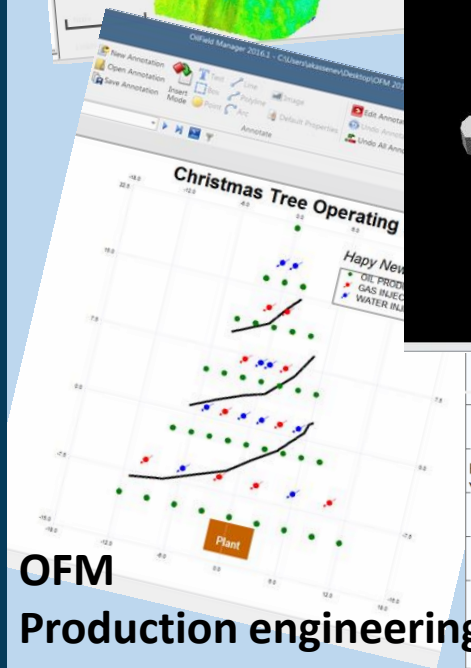
Petrel Geophysics



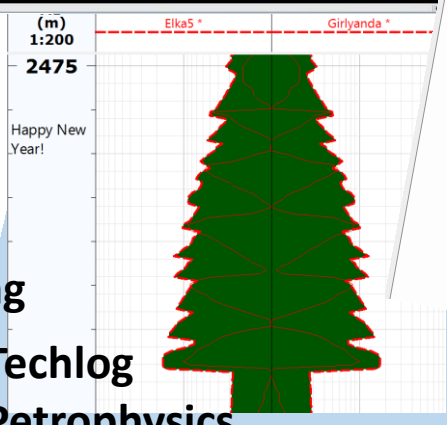
Petrel Geology



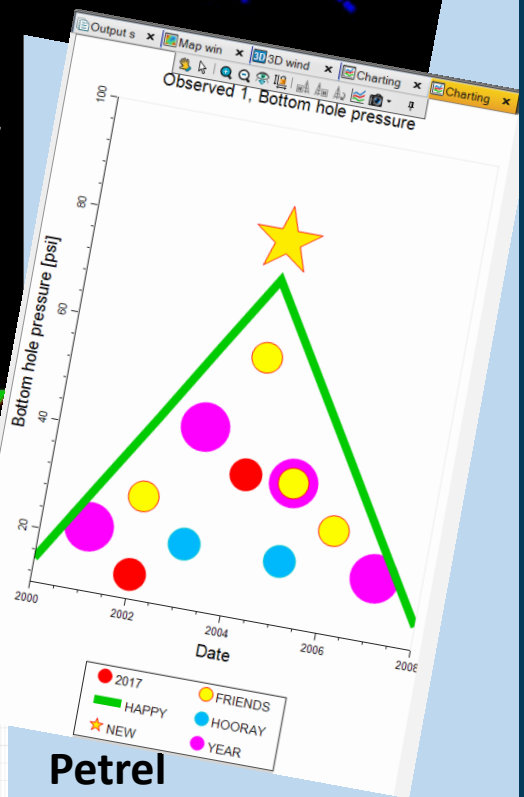
Petrel Geology



OFM Production engineering



Techlog Petrophysics



Petrel Reservoir Engineering