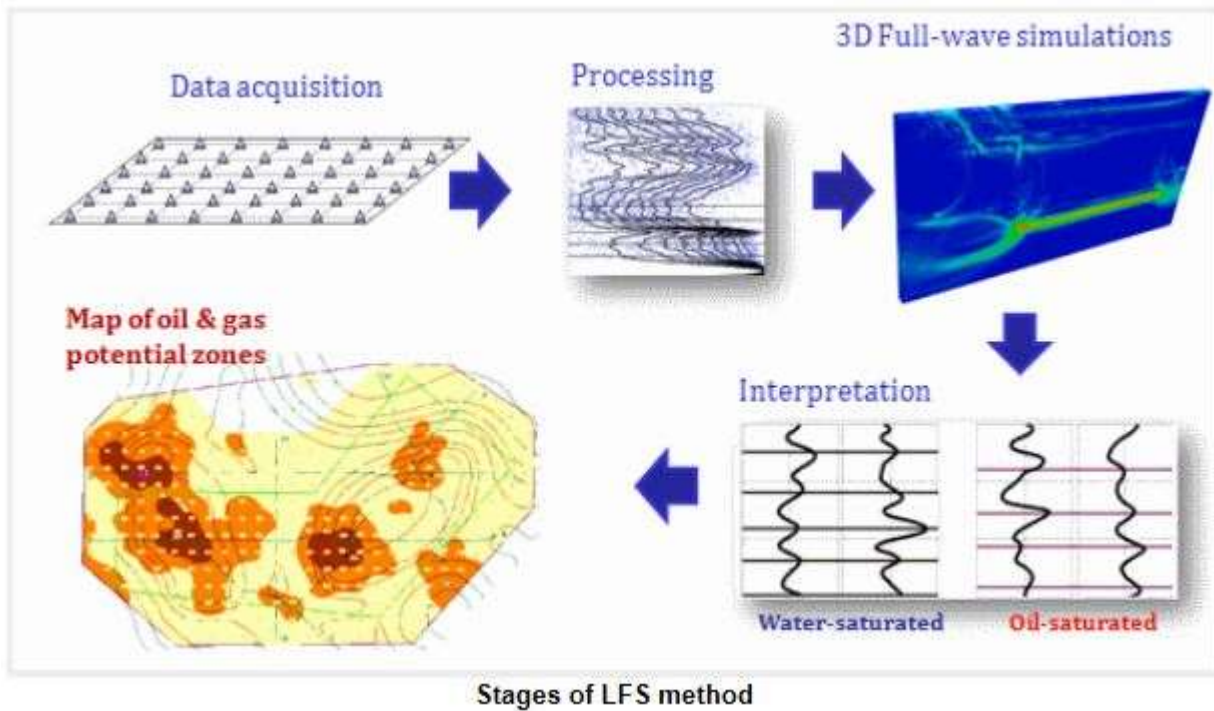


**R-sensors' seismometers used for low-frequency seismic sounding**



**Background**

Low-Frequency Seismic Sounding (LFS) is an environmentally friendly technology for oil & gas seismic exploration. The LFS technology, used by [the Gradient company](#), is based on the analysis of spectral characteristics of natural seismic background noise in a low-frequency (1 – 10 Hz) range.

The LFS method can be successfully applied for:

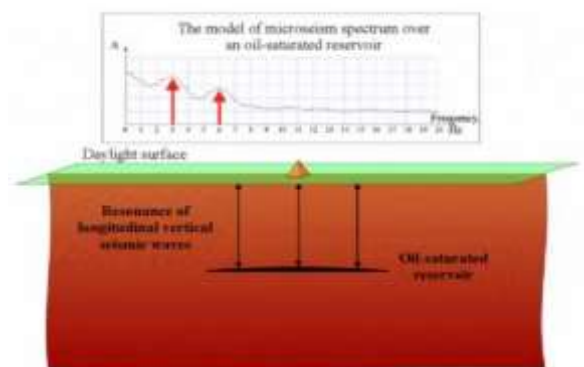
- Oil & gas seismic exploration at remote locations;
- Delineation of oil & gas fields;
- Optimization of seismic exploration and drilling.

The LFS method is based on mechanics of fluid-saturated, fractured and porous media. Oil & gas saturated reservoirs show themselves as anomalous objects in terms of reflection and attenuation of low frequency seismic waves.

**Challenge**

Data acquisition, data processing and interpretation are the key stages of the LFS method.

Data acquisition is made on a regular 250x250 m grid and is conducted by means of seismic data loggers and high-sensitivity low-frequency seismometers.



*The model of microseism spectrum over an oil-saturated reservoir*

## Solution

For over 10 years, Gradient has been using **high-sensitivity low-frequency broadband seismometers** CME-4111-LT manufactured by R-sensors. These seismometers feature high sensitivity of 4.000 V/(m/sec), bandwidth from 0.1 Hz, inclination tilt of  $\pm 15^\circ$ , operation temperature of  $-40\dots+55^\circ\text{C}$  (a low-temperature model), easiness in transportation and in field deployment.

As a result, the LFS method allows providing the following advantages to the customer:

- Maps of oil & gas accumulation zones;
- Identification of oil & gas accumulation boundaries;
- Recommendations for further optimization for exploration.

With the help of this method, the efficiency of oil-saturation forecast can go up as high as 85%.

It can be notably achieved with an environmentally friendly and cost-effective technology - without explosives, chemicals or drilling.

## Results

Gazprom, Lukoil, Tatneft, TNK-BP, Rosneft and other oil & gas companies have been using the LFS method at their license areas in Tatarstan, Udmurtia, Kalmykia, Komi, Perm, Astrakhan, Samara, Orenburg, Tumen regions of Russia. 96 wells were drilled, 82 wells out of them confirmed the forecast – the efficiency of the oil-saturation forecast reached 85%.

LUKOIL, a big Russian oil & gas company, conducted oil seismic exploration at its Nozhovka license area of the Perm region, central Russia.

The results gained by the LFS method was considered for drilling and the oil-saturation forecast was confirmed as follows: while drilling the well in 2013, industrial oil inflows of up to 20 tons per day were found out.

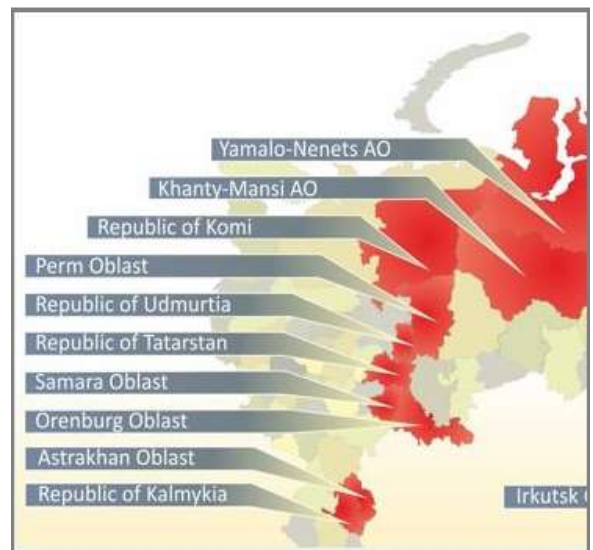
TATNEFT, a well-known Russian oil company, has been using the LFS method for over 10 years by now. 26 grids of over 370 sq. km were studied and explorative drilling showed a very high efficiency of the method.

In Tatarstan (Russia), 59 wells were drilled and 50 out of them confirmed the forecast. The LFS key advantages marked by the company's management are cost-effectiveness, mobility, ecology, applications in remote and isolated locations (settlements, sanitary protection zones, etc.).

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*Seismometer CME-4111-LT  
(a low temperature model)*



*Geography of the LFS applications*