Seismic Interpretation: 'Computers Can't Replace Geologists'

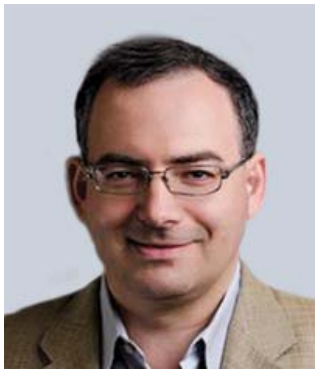
March 2016 | By David Brown

Computers have taken on more and more of the load in seismic interpretation.

But advances in computational seismology and the use of seismic attributes won't remove the geologist from the equation.

"Our task is to help the geologists do their interpretation," said Sergey Fomel. "We cannot always replace geological insight with what we extract from the data."

Fomel has a joint appointment at the University of Texas at Austin.



Sergey Fomel

As a member of the faculty, he serves as Wallace E. Pratt professor of geophysics in the university's Jackson School of Geosciences.

He's also a researcher in the school's Bureau of Economic Geology (BEG) for the Texas Consortium for Computational Seismology, a joint initiative of BEG and the UT Center for Numerical Analysis at the Institute for Computational Engineering and Science.

In the latter role, he sees the latest trends in computer-assisted seismic interpretation and use of seismic attributes.

Current Trends Aren't Necessarily New Trends

Not that he thinks all the trends are cutting-edge.

Some of those developments "are, in my opinion, not new developments," he said.

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Progress sometimes involves perfecting approaches that were developed in the past. Still, new advances in computer-assisted interpretation have taken place in just the most recent two years.

Fomel sees these as some of the current trends:

- Automating Seismic Interpretation: The interpretation process "typically involves a lot of manual activity, which is sometimes important activity because it requires geological insight. But it also can be tedious," Fomel noted.
- Advances in Picking Horizons and Identifying Features: "There are some new exciting algorithms where we can pick more than a human interpreter possibly could," he said.
- Better Implementation of Concepts: "Some of those involve highlighting discontinuities and measuring curvatures in the seismic horizon," he said.

A Wide Umbrella

Fomel earned his doctorate in geophysics from Stanford University after working at the Russian Institute of Geophysics and the Lawrence Berkeley National Laboratory.

He received the J. Clarence Karcher Award from the Society of Exploration Geophysicists in 2001 and the Conrad Schlumberger Award from the European Association of Geoscientists and Engineers in 2011.

A quick review of the titles of some recent papers co-authored by Fomel shows the wide-ranging nature of today's research in computational seismology and seismic attributes:

- "Viscoacoustic modeling and imaging using low-rank approximation."
- "Seislet-based morphological component analysis using scale-dependent exponential shrinkage."
- "Random noise attenuation using local signal-and-noise orthogonalization."
- "A fast algorithm for 3-D azimuthally anisotropic velocity scan."
- "A robust approach to time-to-depth conversion and interval velocity estimation from time migration in the presence of lateral velocity variations."
- "Source-receiver two-way wave extrapolation for pre-stack exploding-reflector modeling and migration."

Computational seismology adds the computer as a tool to assist geoscientists who analyze and interpret seismic data. "We deal with computation of various types. Traditionally in seismic, more of the resources are spent on imaging," Fomel said. "The other side of it is doing seismic data analysis as it relates to interpretation."

Current research challenges cited by the computing consortium include estimating seismic velocities by using full waveform information, identifying most-accurate and most-efficient

imaging algorithms while controlling the trade-off between accuracy and efficiency, and assisting the seismic interpreter by automating common interpretation tasks.

Automating manual tasks is an especially meaningful problem, but it can be a tricky one, according to Fomel. He said hand-work in seismic interpretation can be so repetitive it becomes a health hazard.

The Human Factor

At the same time, hands-on interpretation allows geoscientists to bring personal knowledge and experience to the task.

"We need to bridge the gap between manual interpretation, which brings in the geological insight and computational seismology," he said.

Fomel cited the example of 3-D seismic interpretation of salt bodies in the Gulf of Mexico.

Computer programs and inexperienced interpreters faced with a choice can easily pick a false bottom for salt, but geoscientists who have worked in the Gulf will more often make the correct choice.

"They can tell from their experience which is more likely," he said.

Another challenge for computer-assisted interpretation is combining seismic data with information from well logs and other sources. That's a decades-old issue, but new developments in exploration and production make it a timely problem, Fomel observed.

"It is especially true today because the scale that's of interest in unconventional resources and nonconventional reservoirs is smaller than what we can detect in usual seismic," he said.

Seismic interpreters use computers to help identify subtle features, another important area of study. Fomel has conducted research into what he calls "predictive painting," or using a numerical algorithm for automatic spreading of information in 3-D seismic volumes according to the local structure of seismic events.

"In time-frequency analysis we also are developing new methods. This is important, again, in recognizing subtle features," he said.

Seismic attributes are extracted or derived from seismic data and commonly used to enhance understanding, for a better geological or geophysical interpretation. The most commonly used attribute is seismic amplitude.

Advances in identifying, quantifying and utilizing seismic attributes continue, Fomel said, but the industry's uptake of new developments can be slow.

"A lot of interpreters still have some mistrust of attributes, so they don't understand how

attributes can help them," he noted.

Seismic imaging no doubt continues to receive the biggest share of investment in seismic computing. But Fomel has noticed an increasing interest in computational seismology, in tools for seismic data analysis.

"We see more companies putting money into computational tools," he said. "I see it as a new trend, but some companies are doing it."

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