# The old and the new in seismic inversion

**Dr. Brian Russell**
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## Abstract

Inversion involves the extraction of information about the subsurface geology from a set of geophysical measurements. It is one of the most difficult geophysical methods to implement since our measurements are limited and the earth is extremely complex. There are many different inversion methods and my talk will focus on one specific approach: the inversion of seismic amplitude data to extract the velocities and densities of the earth's subsurface. I will discuss the history of this method and then show some exciting new developments.

The earliest approach to inversion assumed that the seismic section is a frequency-limited set of reflection coefficients which can be recursively inverted to extract the impedance (the product of velocity and density) of the subsurface. Since most seismic data are recorded as compressional, or P-wave, data, this meant that the velocity component would be P-wave velocity. There are several limitations with this method. First, the low-frequency component is missing and must be estimated elsewhere. Second, the final seismic section is an average of a number of seismic traces recorded at various source to receiver distances, or offsets, and thus does not represent true reflectivity.

To overcome the second problem, the AVO (Amplitude Versus Offset) method was developed in the 1980s, in which an estimate of the elastic properties of the earth (which includes shear, or S-wave, data) could be obtained from the offset data. This allowed us to estimate the fluids within our reservoirs. Most recently, inversion and AVO have been combined to give a better estimate of the P-wave velocity, S-wave

velocity and density. We can then estimate secondary parameters such as the porosity, sand content and water saturation of a hydrocarbon reservoir.

This talk will stress the physical principles behind each of the inversion methods, and illustrate them with real data examples from the Western Canadian sedimentary basin and the Gulf of Mexico.

## Biography

Dr. Brian Russell started his career as an exploration geophysicist with Chevron in 1976, and worked for Chevron subsidiaries in both Calgary and Houston. He then worked for both Teknica Resource Development Ltd. and Veritas Seismic Ltd. in Calgary before co-founding Hampson-Russell Software Ltd. in 1987 with Dan Hampson. Hampson-Russell develops and markets seismic software which is used by oil and oil service companies throughout the world. Since 2002, Hampson-Russell has been a fully owned subsidiary of VeritasDGC Inc. Brian is currently Vice President of Veritas Hampson-Russell and is actively involved in both geophysical research and training. He is also an Adjunct Professor in the Department of Geology and Geophysics at the University of Calgary and is active with CREWES (the Consortium for Research in Elastic Wave Exploration Seismology).

Brian was President of the CSEG in 1991, received the CSEG Meritorious Service Award in 1995, the CSEG medal in 1999, and CSEG Honorary Membership in 2001. He served as chairman of The Leading Edge editorial board in 1995, technical co-chairman of the 1996 SEG annual meeting in Denver, and as President of SEG in 1998. In 1996, Brian and Dan Hampson were jointly awarded the SEG Enterprise Award, and in 2005 Brian received Life Membership from SEG.

Brian has presented numerous technical papers at geophysical conferences around the world, including the SEG, EAGE, CSEG and ASEG conferences. His papers have been published in Geophysics, The Leading Edge, Exploration Geophysics and The Journal of Petroleum Geology. His book “Introduction to seismic inversion methods”, based on course notes from an SEG Continuing Education course, was published by the Society of Exploration Geophysicists in 1988.

Brian holds a B.Sc. in Geophysics from the University of Saskatchewan, a M.Sc. in Geophysics from the Durham University, U.K., and a Ph.D. in Geophysics from the University of Calgary. He is registered as a Professional Geophysicist in Alberta.