Thursday, March 16, 2006
HESS Building • 5430 Westheimer, Houston
Social 5:30 p.m.
Cost: $25
Reservations: Call or email Dale Bird, by noon Tuesday, March 14, 2006
281-463-3816 or dale@birdgeo.com (email is preferred)

*by **John Ferguson***
University of Texas at Dallas

The 4-D Gravity Method and Water Flood Surveillance at Prudhoe Bay, Alaska

It has long been recognized that repeated gravity surveys could be used to track changes in either elevation or mass distribution in the Earth. The technology to effectively track mass distribution changes resulting in μGal level signals over long periods of time has matured in recent years. The Prudhoe Bay, Alaska, water flood surveillance project has hastened that development and set a new standard for the conduct of time lapse or 4-D gravity surveys. This talk will review the history of the Prudhoe Bay efforts and some of the milestones achieved along the way.

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The Prudhoe Bay reservoir water flood is the largest ever undertaken and is intended to repressurize the gas cap and maintain declining production over a period of decades. It is difficult to monitor the progress of the water due to a lack of wellbores located in the gas cap. The 4-D seismic method will also be used, but it is limited by expense and permafrost. In 1993 Jerry Brady and Don Walcott, then at ARCO Alaska, started to consider the application of repeated surface and borehole microgravity surveys to monitor the water flood.

The University of Texas at Dallas (UTD) became involved in a theoretical investigation of the possibility of gravity surveillance. An inversion procedure was formulated and tested on synthetic gravity data based on reservoir simulations. Various 4-D gravity noise scenarios were proposed and the resolution of the method determined. At about the same time (1994), a program of field experiments was initiated to refine procedures for actually obtaining the type of data required for the modeling. It soon became clear that the state of the art would require some extension to achieve that goal.

In successive field experiments, conducted in the Arctic winter, microgravity measurement techniques (both relative and absolute gravity meters) and geodetic measurements using the Global Positioning System were refined. The noise levels to be expected in the 4-D gravity data were characterized and a long-term monitoring program was planned, involving about 300 stations. In 2002 a full-scale baseline survey was conducted and late in that year water injection commenced. Repeat surveys were conducted in 2003 and 2005, and a third survey is planned for this year.

The 4-D data over the 2002 to 2005 interval has been modeled and the water flood has been detected. Model results resemble predictions from reservoir simulations but are also producing unexpected results that should help the reservoir engineers understand the actual situation in the ground. The methodologies and standards developed for this project are now being used to plan surveys in other areas. ■

Biographical Sketch

John Ferguson has been a member of The University of Texas at Dallas geosciences faculty since 1982 and is currently the Department Chairman. He was awarded a PhD degree in geophysics from Southern Methodist University and previously obtained an MS in geophysics from the University of North Carolina and a BS in physics from Wofford College. He was a founding member of the SAGE Geophysical Field Course, which won the American Geophysical Union's Excellence in Geophysical Education Award in 1999 and has now been taught for 23 consecutive years. Research interests span seismology, potential fields, mathematical geology, signal processing and numerical modeling. In addition to projects involving 4-D microgravity in Alaska and New Mexico, Dr. Ferguson is active in the application of near-surface geophysics and high-resolution seismic methods to archaeology.