

**Project 90104**  
**3-D Seismic Experimentation and Advanced Processing/Inversion**  
**Development for Investigations of the Shallow Subsurface**

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**RESULTS TO DATE:** Under ER63662, 3-D Seismic Experimentation and Advanced Processing/Inversion Development for Investigations of the Shallow Subsurface, we have completed a number of subprojects associated with the Hill Air Force Base (HAFB) high resolution 3-D reflection/tomography dataset.

D. Dana completed her PhD research on this dataset, producing a 3D depth migrated and interpreted image volume (Dana, 2003). The depth migrated images map the paleochannel in which the tri-chloroethene DNAPLs are trapped reasonably well, but shows some variations in the signal level through the volume. Dana interpreted the image volume as showing a number of shallow faults in the top of the clay layer that acts as an aquitard for this system. The faults offset the top of the clay layer, and may be related to slumping in the sediments. If the faults penetrate the entire clay layer, the faults could act as a conduit to permit DNAPLs to escape from the containment zone constructed around the site by the Air Force. As this is a potentially important finding we are re-examining the dataset as described below.

F. Gao completed his PhD research on waveform tomography (Gao, 2004). Included in this thesis is application of acoustic waveform tomography to the inline 2D sections of the HAFB high resolution dataset. Gao has derived a velocity map that outlines the channel and velocity heterogeneity within it. The velocity field is highly heterogeneous, with variations of almost an order of magnitude in the Gao has also produced a paper about to be submitted to Geophysics (Gao et al., 2004).

An incoming PhD student, G. Fradelizio is reprocessing the 3D reflection dataset focusing on advanced velocity analysis for developing a depth migration velocity model. Fradelizio is also trying a number of signal conditioning algorithms to improve signal to noise in the dataset before depth migration. Fradelizio will also depth migrate the dataset using the velocity model produced by Gao.

We are researching different shear wave sources for another study at HAFB in spring 2005. While in Berlin in spring 2004 (at no cost to DOE), Levander met with a German shallow seismics research group from the University of Kiel Institute of Geophysics with experience in S-wave recording. They routinely use methods we are contemplating employing at HAFB. Several PhD level German researchers have volunteered to participate in our S-wave survey.

**DELIVERABLES:** Dana, D., 2004, Near-Surface Seismic Reflection Investigations at a Groundwater Contamination Site, PhD thesis, Rice University, Houston, TX 154 pages.

Gao, F., 2004, Waveform Tomography and its Application at a Groundwater Contamination Site, PhD thesis, Rice University, Houston, TX 152 pages.

Gao, F., A. Levander, G. Pratt, C. Zelt and S. Ham, 2005, High-resolution Waveform Tomography at a Ground Water Contamination site: VSP Dataset, submitted to Geophysics.

R. G. Pratt, Fuchun Gao, Colin Zelt and Alan Levander, 2002, The limits and complementary nature of traveltimes and waveform tomography (expanded abstract). International Conference of Sub-basalt imaging: Exploiting the full wavefield, Cambridge, England.

F. Gao, A. Levander, R.G. Pratt, and S. Morton, 2004, Velocity analysis by waveform tomography: a few examples, Society of Exploration Geophysicists Expanded Abstracts, 74th Annual Meeting, Denver Co.

High resolution seismic investigations at a groundwater contamination site, Lamont Doherty Earth Observatory of Columbia University, September 2003.

High resolution seismic investigations at a groundwater contamination site, Schlumberger Research Lab, Ridgefield CT, September 2003.

F. Gao, F., A. Levander, G. Pratt, C.A. Zelt, S. Ham, Waveform tomography applied to the high resolution HAFB dataset, Geophysical Research Abstracts, 5, EGS-AGU-EUG Joint Meeting, Nice, France, April 2003, EAE03-A-11971.

A. Azaria, C.A. Zelt, A. Levander, High resolution seismic mapping at a groundwater contamination site: 3-D traveltimes tomography of refraction data, Geophysical Research Abstracts, 5, EGS-AGU-EUG Joint Meeting, Nice, France, April 2003, EAE03-A-13292.

D. Dana, Levander, A., S. Danbom, C.A. Zelt, 2003, High resolution seismic mapping at a groundwater contamination site: 3-D reflection data, Geophysical Research Abstracts, 5, EGS-AGU-EUG Joint Meeting, Nice, France, April 2003, EAE03-A-12726.