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THE UNIVERSITY of WISCONSIN MADISON

Special Department of Physics Colloquium

Thursday, September 24, 2009 • 4:00 P.M. • 2103 Chamberlin Hall

cookies & coffee served at 3:30 p.m

Time-lapse seismic monitoring of reservoir deformation

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Host: Balantekin

Seismic imaging is a technology used worldwide by the oil industry to look into the subsurface and determine underground structures and their potential for oil and gas production. Time-lapse seismic monitoring is a relatively new technology that consists of carefully repeating a seismic image months to years after production starts and looking for changes that indicate where production did or did not occur to help guide future operations.

Production of oil and gas is often accompanied by a large reduction in the reservoir fluid pressure that in some cases leads to compaction as large as several meters. The deformation of the reservoir layers is coupled to the adjacent rocks and leads to changes in the stress and strain fields that extend a great distance away from the reservoir. Time-lapse seismic measurements through these rocks show large variations that are useful for monitoring the distribution of deformation within the reservoir.

The compaction induces seismic velocity changes that are observed on many different wave types including conventional P-P reflection seismic, P-S mode converted seismic, and surface waves such as the Scholte wave and refracted compressional waves. Using geomechanical models that predict changes in stress and strain fields within the earth we can start to understand the factors that control the changes in seismic velocities. We find that simple non-linear relationships between velocity and strain produce forward models that match many of our observations.

About the Author

Paul Hatchell earned his PhD with Prof. Kirk Mcvoy studying scattering theory in Nuclear Physics. He also enjoyed working with Prof. Baha Balantekin on solar neutrino physics. Paul joined Shell in 1989 and has worked on many research projects ranging from measuring shear-wave anisotropy in deep boreholes to understanding seismic wave propagation through lateral velocity variations, and developing seafloor deformation monitoring sensors in 1000 m of water. Paul has worked at several locations during his 20-year career with Shell spending four years in New Orleans pursuing exploration (identified and drilled the “Lombardi” and “Starr” gas fields) and eight year’s in Shell’s research center in the Netherlands. Paul’s current role is geophysical advisor with the areal monitoring team at Shell’s Bellaire Technology Center in Houston.