

E-20-G75
#1

Final Report for Period: 06/2001 - 05/2003

Submitted on: 09/08/2003

Principal Investigator: Rix, Glenn J.

Award ID: 0107400

Organization: GA Tech Res Corp - GIT

Title:

Coring and Geophysical Logging of a Deep Well in the Mississippi Embayment

Project Participants

Senior Personnel

Name: Rix, Glenn

Worked for more than 160 Hours: Yes

Contribution to Project:

Post-doc

Graduate Student

Undergraduate Student

Technician, Programmer

Other Participant

Research Experience for Undergraduates

Organizational Partners

University of Memphis

The Center for Earthquake Research and Information at the University of Memphis identified the Wilson 2-14 drilling site in Keiser, Arkansas, coordinated with the drilling engineer, and provided student assistants to help log the well.

U.S. Geological Survey

Mr. Mike Bradley from the Nashville office of USGS located the MLGW #236 site and coordinated the drilling and well logging.

Memphis Light, Gas, and Water

Memphis Light, Gas and Water provided access to their well, designated as MLGW #236, for the purposes of performing geophysical well logging.

Embayment Oil LLC

Embayment Oil LLC provided access to the Wilson 2-14 well in Keiser, AR.

Mid-America Earthquake Center

The Mid-America Earthquake Center provided funding to supplement this award that allowed a complete suite of geophysical tests to be performed at the MLGW #236 well in suburban Memphis, TN.

Reeves Wireline, Inc.

Reeves Wireline, Inc. provided geophysical logging services at a discounted cost to allow the logging to be performed within the budget of the project.

Baker Atlas, Inc.

Baker Atlas, Inc. provided geophysical logging services at a discounted cost to allow the logging to be performed within the budget of the project.

Other Collaborators or Contacts

Results obtained from the geophysical logs were shared and discussed with Dr. Walter J. Silva of Pacific Engineering and Analysis, Inc. and Dr. Bob Youngs of Geomatrix Consultants, Inc. for the purpose of developing reference shear wave velocity profiles for the Upper Mississippi Embayment.

Activities and Findings

Research and Education Activities:

In Fall 2000, the PI, working in collaboration with personnel from the Center for Earthquake Research and Information (CERI) at the University of Memphis, learned of a planned 915-m deep exploratory well for hydrocarbons near Keiser, Arkansas. The well was designated as Wilson 2-14. The PI and CERI entered into a dialogue with the drilling partners, who were receptive to the idea that the well could also be used for scientific purposes. In mid-December, 2000, drilling commenced and geophysical logging and sampling were planned to allow direct measurements of dynamic soil properties in the soils comprising the Upper Mississippi Embayment. At the first sampling depth of 176 m, coring of the soft sediments was attempted by Baker Hughes INTEQ, a geophysical service company. The core was unsuccessful (i.e., no recovery) due to the use of a water-based drilling fluid and lack of control over fluid pressures in the well. Attempts at subsequent planned cores at depths of 280 m and 670 m were abandoned because of (a) Baker Hughes INTEQ estimated a low probability of success, (b) concerns about possible sample disturbance, and (3) concerns expressed by the drilling engineer about the time required for coring. The PI decided to conserve funds for future use in other wells. Following completion of the well to a depth of 890 m, conventional geophysical logging was performed by Reeves Wireline Services, Inc. including sonic, saturated mass density, sandstone density porosity, and sandstone neutron porosity logs. Shear wave logging was attempted but was not successful to a failure of the logging tool.

In May 2002, another well was identified by the PI in collaboration with personnel from the U.S. Geological Survey office in Nashville, TN. The well as being drilled to a planned depth of 436 m in suburban Memphis, TN by Memphis Light, Gas, and Water (MLGW) for the purpose of developing an additional water supply for the Memphis area. MLGW was also receptive to the idea of using the well, designated as MLGW #236, for scientific purposes. Using residual funds, the PI contracted with Baker Atlas, Inc. to perform shear wave logging in the completed well using their Multipole Array Acoustilog (XMAC) technology. The logging was successfully performed on May 24, 2002.

Findings:

Despite the failure of the shear wave logging tool at the Wilson 2-14 well, valuable results have been obtained by using the measured sonic, density, and porosity logs to infer a shear wave velocity profile based on Gassman's equations. The resulting shear wave velocity profile provides important information that has reduced the uncertainty of site response calculations in the Upper Mississippi Embayment. Furthermore, the well penetrated a short distance into the Paleozoic-age limestone. Sonic measurements in the limestone provided valuable information about the impedance contrast at the interface between the soft sediments and limestone that controls resonance phenomenon in the Embayment.

The direct measurement of a detailed shear wave velocity to a depth of 436 m in the MLGW #236 well is the first such deep measurement that the PI is aware of in the Upper Mississippi Embayment. An added bonus is that the measurement was performed in close proximity to a major urban area (Memphis). Information derived from the shear wave velocity profile has helped constrain estimates of site response in the Memphis area during future seismic events.

Training and Development:

The use of geophysical logging tools developed for the oil and gas industry in this project has helped familiarize and promote the use of these tools in geotechnical engineering.

Outreach Activities:

Journal Publications

Rix, G.J., "Shear Wave Velocity Profile of Unconsolidated Sediments in the Upper Mississippi Embayment from Geophysical Logs", *Seismological Research Letters*, p. , vol. , (). Submitted

Books or Other One-time PublicationsWeb/Internet SiteOther Specific ProductsContributions**Contributions within Discipline:**

The direct measurement of the shear wave velocity profile at significant depths near a large, urban center (Memphis, TN) at the MLGS #236 well is the first such measurement that the PI is aware of. In addition, the inferred shear wave velocity profile at the Wilson 2-14 well penetrates the full depth of the Upper Mississippi Embayment at that location. Taken together, the two profiles have substantially reduced the uncertainty associated with dynamic soil properties in the Embayment, which in turn has allowed improved estimates of site response in the deep, unconsolidated deposits.

The use of advanced geophysical logging technologies developed for oil and gas exploration in geotechnical engineering should help promote their acceptance and use for other applications and projects.

Contributions to Other Disciplines:

Although related, the improved knowledge of dynamic soil properties in the Embayment has allowed seismologists to better understand the filtering effects of the deep soil column on ground motions. This permits a clearer picture of earthquake source processes.

Contributions to Human Resource Development:

Students from the University of Memphis who assisted with acquiring well log information at the Wilson 2-14 well had an opportunity to observe well drilling technologies and geophysical logging.

Contributions to Resources for Research and Education:**Contributions Beyond Science and Engineering:**Categories for which nothing is reported:

Activities and Findings: Any Outreach Activities

Any Book

Any Web/Internet Site

Any Product

Contributions: To Any Resources for Research and Education

Contributions: To Any Beyond Science and Engineering