



OTC 17957

## Measuring Temperature and Pressure with the Temperature Two Pressure (T2P) Probe in the Ursa Basin, Gulf of Mexico: Development of a New Pressure and Temperature Probe for the IODP

P.B. Flemings, Pennsylvania State U.; J. Germaine, MIT; H. Long, Pennsylvania State U.; B. Dugan, Rice U.; D. Sawyer, Pennsylvania State U.; J. H. Behrmann, Albert-Ludwigs-U. Freiburg; and C. John, Texas A&M U. and Shipboard Scientific Party

Copyright 2006, Offshore Technology Conference

This paper was prepared for presentation at the 2006 Offshore Technology Conference held in Houston, Texas, U.S.A., 1-4 May 2006.

This paper was selected for presentation by an OTC Program Committee following review of information contained in an abstract submitted by the author(s). Contents of the paper, as presented, have not been reviewed by the Offshore Technology Conference and are subject to correction by the author(s). The material, as presented, does not necessarily reflect any position of the Offshore Technology Conference, its officers, or members. Papers presented at OTC are subject to publication review by Sponsor Society Committees of the Offshore Technology Conference. Electronic reproduction, distribution, or storage of any part of this paper for commercial purposes without the written consent of the Offshore Technology Conference is prohibited. Permission to reproduce in print is restricted to an abstract of not more than 300 words; illustrations may not be copied. The abstract must contain conspicuous acknowledgment of where and by whom the paper was presented. Write Librarian, OTC, P.O. Box 833836, Richardson, TX 75083-3836, U.S.A., fax 01-972-952-9435.

### Abstract

We developed the Temperature 2 Pressure probe (T2P) to measure in-situ pore pressure and temperature in sediments at the base of the borehole. Tool development began in 2003, it was land-tested in 2004, and it was deployed on the IODP's *Joides Resolution* drillship in June 2005 on IODP Expedition 308. During Expedition 308, we measured temperature and pressure in mudstones up to 300 meters below mudline. The T2P has a narrow tip that contains a pressure and temperature sensor; a second pressure sensor is located at the larger diameter shaft behind the narrow tip. The design allows for rapid measurement of pressure and temperature in low-permeability sediments. The T2P is deployed by wireline through the drill string. It is pushed into the formation by the drillstring and then the drillstring is raised to decouple the probe from ship heave. The probe is left in place to allow for dissipation of temperature and pressure toward in-situ conditions and then is withdrawn from the borehole. We describe one deployment at 200 meters below the seafloor at Site U1322 in the Ursa Basin (Mississippi Canyon Block 855). Pore pressures induced by the probe did not dissipate to in-situ pressure by the end of deployment (60 minutes) and the in-situ pressure is extrapolated. Overpressure is 0.64 times the vertical hydrostatic effective stress.

### Introduction

Penetrometers induce a pressure pulse as they are inserted into sediments. The induced pore pressure and its subsequent dissipation are constrained by the sediment's strength and its coefficient of consolidation. The magnitude of the induced pressure is used to estimate the shear modulus of the sediments.<sup>1</sup> In-situ pressure and the coefficient of

consolidation can be inferred from the rate of pressure dissipation profile.<sup>1 2</sup>

The Davis-Villinger Temperature/Pressure Probe (DVTTP)<sup>3 4</sup>, and Fugro-McLellan's tapered Piezoprobe<sup>5 6</sup> are pore pressure penetrometers deployed within boreholes. The DVTTP measures in-situ pressure and temperature. However, its diameter is large and as a result it takes a very long time for the induced pressure to dissipate to in-situ conditions in marine mudstones.<sup>7</sup> The Piezoprobe has a much narrower diameter and has been more successful in measuring mudstone pressure; however, it does not measure formation temperature.

We developed the T2P (Temperature-Two-Pressure) probe. Its modular design allows the use of multiple tip geometries and it measures both pressure and temperature at the tip. It also measures pressure at the shaft in order to utilize a theoretically predicted approach to predict in-situ pressure from partial dissipation data.<sup>6</sup> Tool development began in 2003. The T2P was deployed on land in 2004 and it was deployed on the IODP's *Joides Resolution* drillship in 2005.<sup>8</sup> We describe the T2P and describe results from one deployment on IODP Expedition 308.

### Instrument

The T2P was designed to meet very specific goals. The primary objectives were to provide pore pressure measurements at two locations on one device corresponding to different penetrometer diameters and to provide a measurement of in situ temperature. Given the fact that this would require a tapered geometry, it was desirable to reduce the smaller diameter as much as practical and create a sharp contrast between the two diameters. A step-geometry was preferable to a continuous taper based on prior research concerning interpretation of the measurements. An extensive set of numerical analyses were performed to guide the decision making process. Parameters of primary concern were the diameter of the tip, the shaft to tip diameter ratio, the length of the tip, and the transition angle between the two diameters. The parametric study was complimented with a stress analysis of the instrument and connections. The final geometry is discussed below.