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T. Wonik
Leibniz Institute for Applied Geophysics, thomas.wonik@liag-hannover.de

T. Grelle
Leibniz Institute for Applied Geophysics

D. Handwerger
TerraTek (Schlumberger)

R. D. Jarrard
University of Utah

A. McKee
Raytheon Polar Services Corporation

See next page for additional authors

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Authors
T. Wonik, T. Grelle, D. Handwerger, R. D. Jarrard, A. McKee, T. Patterson, T. Paulsen, S. Pierdominici, D. R. Schmitt, H. Schröder, M. Speece, T. Wilson, and ANDRILL-SMS Science Team

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Downhole Measurements in the AND-2A Borehole, ANDRILL Southern McMurdo Sound Project, Antarctica

T. Wonik[1*], T. Grelle[1], D. Handwerger[2], R.D. Jarrard[3], A. McKee[4], T. Patterson[5], T. Paulsen[6], S. Pierdominici[7], D.R. Schmitt[8], H. Schröder[1], M. Speece[5], T. Wilson[9], & the ANDRILL-SMS Science Team[10]

[1] Leibniz Institute for Applied Geophysics, 30655 Hannover - Germany
[2] TerraTek (Schlumberger), Salt Lake City, UT 84104 - USA
[3] Dept. of Geology and Geophysics, Univ. of Utah, Salt Lake City, UT 84112 - USA
[4] Raytheon Polar Services Corporation, Centennial, CO 80112-3938 - USA
[5] Montana Tech, 1300 West Park Street, Butte, MT 59701 - USA
[6] Dept. of Geology, Univ. of Wisconsin at Oshkosh, Oshkosh, WI 54901-8649 - USA
[7] Ist. Nazionale di Geofisica e Vulcanología, Rome 00143 - Italy
[8] Inst. for Geophysical Research, Dept. of Physics, Univ. of Alberta, Edmonton, Alberta, T6G 2G7 - Canada
[9] School of Earth Sciences, The Ohio State University, Columbus, OH 43210-1522 - USA
[10] http://andrill.org/projects/sms/team.html

**Corresponding author* (thomas.wonik@liag-hannover.de)

Abstract – Under the framework of the ANDRILL Southern McMurdo Sound (SMS) Project successful downhole experiments were conducted in the 1138.54 metre (m)-deep AND-2A borehole. Wireline logs successfully recorded were: magnetic susceptibility, spectral gamma ray, sonic velocity, borehole televiewer, neutron porosity, density, calliper, geochemistry, temperature and dipmeter. A resistivity tool and its backup both failed to operate, thus resistivity data were not collected. Due to hole conditions, logs were collected in several passes from the total depth at ~1138 metres below sea floor (mbsf) to ~230 mbsf, except for some intervals that were either inaccessible due to bridging or were shielded by the drill string. Furthermore, a Vertical Seismic Profile (VSP) was created from ~1000 mbsf up to the sea floor. The first hydraulic fracturing stress measurements in Antarctica were conducted in the interval 1000-1138 mbsf. This extensive data set will allow the SMS Science Team to reach some of the ambitious objectives of the SMS Project. Valuable contributions can be expected for the following topics: cyclicity and climate change, heat flux and fluid flow, seismic stratigraphy in the Victoria Land Basin, and structure and state of the modern crustal stress field.

INTRODUCTION

The main goal of the ANDRILL Southern McMurdo Sound (SMS) Project is to establish the history of Neogene Antarctic ice sheet variation and long-term climate evolution. Harwood et al. (2005) describe the major scientific objective in the following way: "The recovery of middle Miocene Antarctic stratigraphic sequences is required to evaluate the history derived from global proxy records that invoke a change from a warm climatic optimum (~ 14 Ma) and the formation of a quasi-permanent ice sheet on East Antarctica." The 1138.54 m-deep AND-2A drillhole sampled a sequence of strata identified on seismic lines and inferred to represent an early Miocene through middle Miocene sequence of seismic units that expand basinward and are overlain disconformably by Pliocene and Pleistocene strata. This borehole penetrated strata that mostly lie stratigraphically above the lower Miocene section recovered at the top of the sequence drilled by the Cape Roberts Project (CRP) (17 – 34 Ma; Davey et al., 2001). Furthermore, this core overlaps by several hundred metres with the ANDRILL McMurdo Ice Shelf (MIS) Project borehole AND-1B core, which consists of sediments as old as 14 Ma, providing a composite sequence of strata aged from 34 Ma to Recent for the McMurdo Sound region.

Downhole experiments from Antarctica are still a rarity. Most downhole logging has been performed from drill ships, under the framework of the Deep Sea Drilling Project (DSDP) and the Ocean Drilling Program (ODP). In the McMurdo Sound region, only the CIROS-1 borehole (Cenozoic Investigation of the Western Ross Sea), the two Cape Roberts Project (CRP) boreholes (CRP-2 and CRP-3) and the ANDRILL AND-1B borehole had been previously downhole logged (Harwood et al., 2005). All mentioned drillholes are situated on the south-western margin of the Victoria Land Basin, the westernmost of four north-south trending basins formed by extensional rifting of the Ross Sea region. The CIROS-1 hole (Barrett, 1989) was drilled in 1986 and was located about 15 kilometres (km) away from the AND-2A borehole. It reached a total depth (TD) of *c.* 700 m and recovered sediments as old as 37 Ma. Only a limited downhole logging program was conducted (White, 1989). More than 100 km north of the SMS drill site, the CRP boreholes were drilled in 1997 - 1999. The age of the drilled

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