



Working Report 2007-13

Optical Imaging of Borehole PR10 at Olkiluoto 2006

Anna-Maria Tarvainen

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Suomen Malmi Oy

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The conclusions and viewpoints presented in the report
are those of author(s) and do not necessarily
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ABSTRACT

Optical imaging of borehole PR10 at Olkiluoto 2006

29.1.2007

Anna-Maria Tarvainen, Suomen Malmi Oy

Suomen Malmi Oy carried out optical imaging of borehole PR10 at Olkiluoto site in Eurajoki during December 2006. The survey is a part of Posiva Oy's detailed investigation program for the final disposal of spent nuclear fuel. The assignment included the field work and the data processing. This report describes the field operation, the equipment as well as the processing procedures and shows the obtained results and their quality. The raw and processed data are delivered digitally in WellCAD and PDF format.

Key words: Geophysics, borehole logging, structural geology, nuclear waste disposal

TIIVISTELMÄ

Kairanreiän PR10 optinen kuvantaminen Olkiluodossa vuonna 2006

29.1.2007

Anna-Maria Tarvainen, Suomen Malmi Oy

Suomen Malmi Oy teki geofysikaalisia mittauksia porareikässä PR10 Olkiluodon tutkimusalueella joulukuussa 2006. Työ tehtiin Posiva Oy:n tilauksesta osana yksityiskohtaisia kallioperätutkimuksia käytetyn polttoaineen loppusijoitusta varten. Toimeksiantoon kuuluivat kenttätyöt ja aineiston prosessointi. Raportissa on kuvattu kenttätöiden kulku, käytetty kalusto ja tehdyt korjaukset sekä esitetty tulosten laatu. Tulokset on toimitettu tilaajalle digitaalisesti WellCAD- ja PDF-muotoisina tiedostoina.

Avainsanat: Geofysiikka, reikämittaukset, rakennegeologia, ydinjätteen loppusijoitus

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Abstract

Tiivistelmä

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1 INTRODUCTION

In 1999, Posiva Oy filed an application for a policy decision from the council of state for a construction permit to build a final disposal facility for spent fuel at the Olkiluoto area in the Eurajoki municipality. In December 2000, the Council of State made a positive policy decision and in May 2001, the Parliament ratified the decision. The policy makes it possible to concentrate the research activities at Olkiluoto.

Suomen Malmi Oy (Smoy) carried out optical imaging of borehole OL-PR10 for Posiva Oy in December 2006 according to the purchase order 9162/06/TUAH. Optical imaging contributes to fracture detection as well as further description of the crystalline bedrock at Olkiluoto Site.

The field surveys were coordinated by geophysical foreman Antero Saukko. Data processing and reporting was conducted by Anna-Maria Tarvainen. This report describes the field operation and the data processing. The quality of the results is shortly analysed and the data presented in the Appendices.

2 EQUIPMENT AND METHODS

Optical imaging was carried out in borehole OL-PH10 using Advanced Logic Technology's (ALT) OBI-40 optical televiewer which is property of Smoy. OBI-40 is a high-resolution optical borehole imagery for wells and boreholes. The tool is used for fracture detection and evaluation, lithological interpretation etc.

OBI-40 creates a 360 degree image of borehole wall by using a CCD camera and a prism. Orientation measurement is controlled with a 3-axes magnetometer and 3 accelerometers. This makes possible to measure borehole azimuth and dip and create an accurate orientation of the image.

1000 meter cable is operated by a motorised winch. The depth measurement is triggered by pulses of sensitive depth encoder, installed on a pulley wheel. The cable is marked with 10 m intervals for controlling the depth measurement to adjust any cable slip and stretch.

Tool diameter of OBI-40 is 42 mm. Tool maximum azimuthal resolution is 720 pixels and vertical resolution is 0.5 mm. Survey rate is 12 – 20 cm/min. Smoy has prepared special centralisers for 120 mm boreholes. The probe and logging control unit are also presented in Appendix 2.

3 FIELD WORK

The field work was carried out within 2 working days, 15th and 16th December 2006. The total survey amount was approximately 230 meters. The borehole specifications are listed in Table 1.

Table1: Specifications of the boreholes surveyed.

	Diameter (mm)	Azimuth	Dip	Length (m)
OL-PH10	120,00	318	-89	253.00 m
	Coordinates	X	Y	Z
		6 792 167.10	1 525 949.88	8.18

4 DATA PROCESSING AND RESULTS

The data processing of borehole OL-PH10 included initial dept matching and image correction.

The quality of the image was controlled during survey by taking samples of the image and applying histogram analysis. Also the vertical resolution was checked using captured images. The survey was never left unsupervised. The overlapping of data between recorded intervals was ensured by rerunning of the last 0.5 m of each recording.

Initial depth match is based on 10 m cable mark control of depth pulse encoder data. Locations of rock type contacts and fractures in core are normally used in final depth matching, but because of a lack of this data it was not possible to perform finer scale depth correction like presented on Posiva's working report 2004-43 (Lahti, 2004a). The images were produced to depth matched and oriented to high side presentations including 3-D image.

The optical televiewer images are presented on the Appendix on CD and an example of the image log is shown in Appendix 1. All images are saved as Well CAD and PDF documents to a CD as an appendix of this report. Images can be reviewed with Well CAD Reader/Software and Adobe Reader/ Acrobat software.

5 CONCLUSIONS

The total survey amount of borehole OL-PH10 was approximately 230 m and the surveys were concluded within December 2006. The processed and interpreted data is delivered to the Client in digital format. The draft report was compiled in January 2006. The quality of the data widely achieves the required level.

References

ALT 2001. WellCAD user's guide for version 3.0. Advanced Logic Technologies, Luxembourg, 831 p.

Lahti, M & Heikkinen, E. 2004. Geophysical borehole logging of the borehole PH1 in Olkiluoto, Eurajoki 2004. Posiva Oy. Working report 2004-43. 30 p.

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Lahti, M., Tammenmaa J. & Hassinen P. 2001. Kairanreikien OL-KR13 ja OL-KR14 geofysikaaliset reikämittaukset Eurajoen Olkiluodossa vuonna 2001 (Geophysical borehole logging of the boreholes OL-KR13 and OL-KR14 in Olkiluoto, Eurajoki, 2001). Työraportti 2001-30. Posiva Oy, 136 p.

Lahti, M., Tammenmaa, J. & Hassinen, P. 2003. Geophysical logging of boreholes OL-KR19, OL-KR19b, OL-K20, OL-KR20b, OL-KR22, OL-KR22b and OL-KR8 continuation at Olkiluoto, Eurajoki 2002. Posiva Oy. 176 p. Working report 2003-05.

Appendices

Appendix 1: An example of a borehole image

Appendix 2: Tool technical information: Optical televiewer OBI40

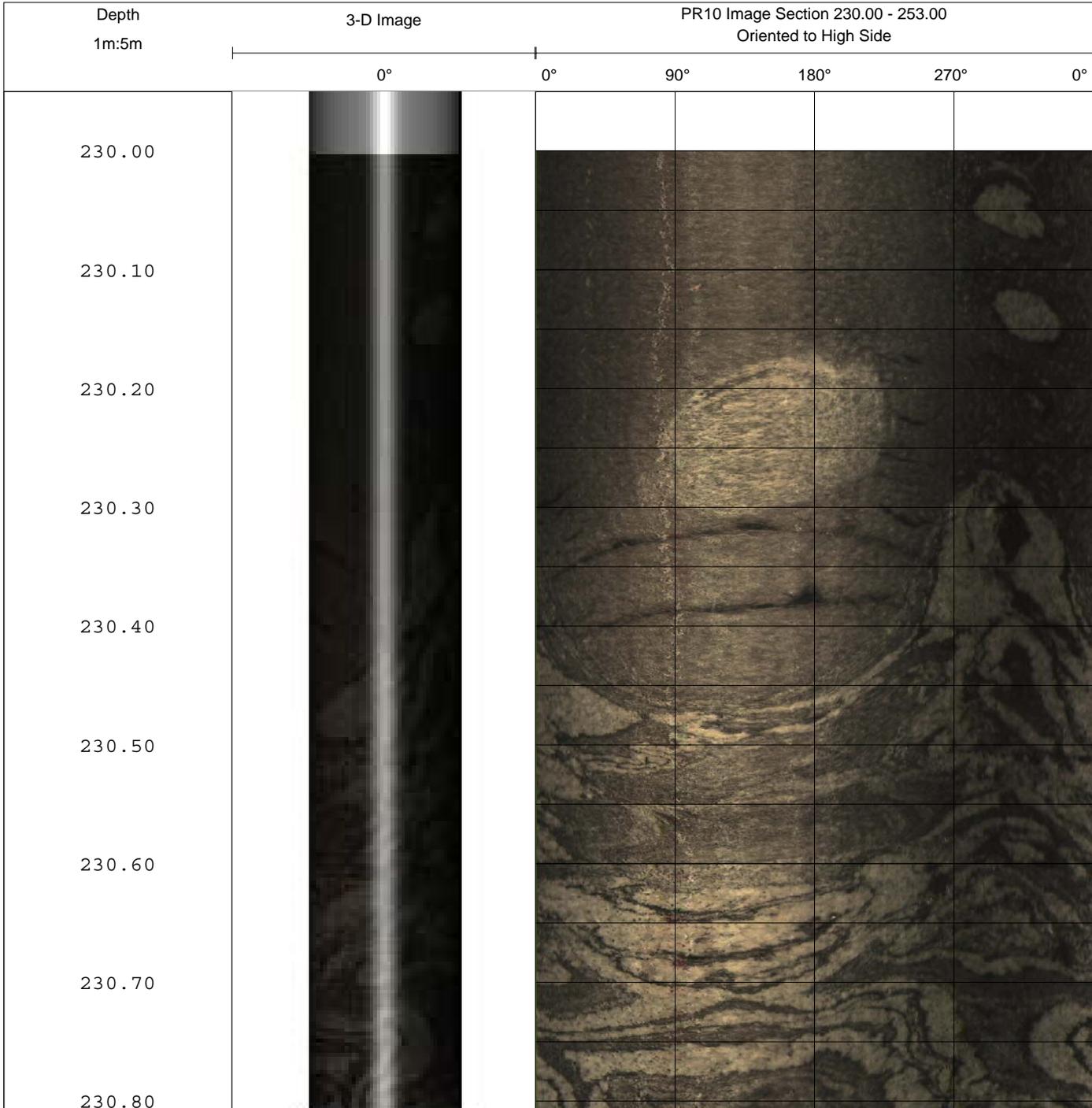
CD: Results



Borehole Imaging

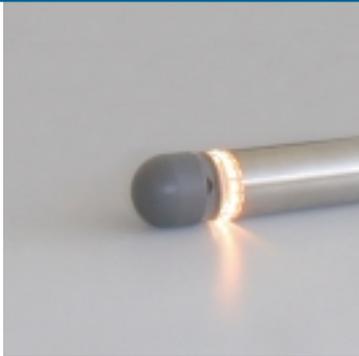
Suomen Malmi Oy
 P.O. Box 10
 FI-02921 ESPOO
 +358 9 8524 010
 www.smoy.fi

Client: Posiva Oy	Hole no: PR10	Ø: 120 mm	Surveyed by: AS, LH
Site: Olkiluoto	X: 6792167.10	Length: 253	Survey date: 15.12.06
Project no: 9162/06/TUAH	Y: 1525949.88	Azimuth: 318	Reported by: AT
	Z: 8.17	Dip: -89	Report date: 29.01.07



OBI 40

slimhole optical televiewer

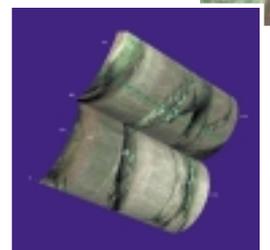
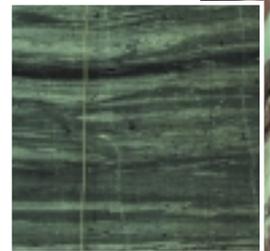
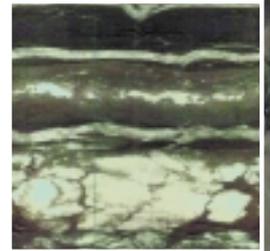


The tool generates a continuous oriented 360° image of the borehole wall using an optical imaging system. (downhole CCD camera which views a image of the borehole wall in a prism). The tool includes a orientation device consisting of a precision 3 axis magnetometer and 3 accelerometers thus allowing accurate borehole deviation data to be obtained during the same logging run (accurate and precise orientation of the image).

Optical and acoustic televiewer data are complimentary tools especially when the purpose of the survey is structural analysis.

A common data display option is the projection on a virtual core that can be rotated and viewed from any orientation. Actually, an optical televiewer image will complement and even replace coring survey and its associated problem of core recovery and orientation.

The optical televiewer is fully downhole digital and can be run on any standard wireline (mono, four-conductor, seven-conductor). Resolution is user definable (up to 0.5mm vertical resolution and 720 pixels azimuthal resolution)



OBI 40

slimhole optical televiewer



Applications:

The purpose of the optical imaging tool is to provide detailed, oriented, structural information. Possible applications are :

- fracture detection and evaluation
- detection of thin beds
- bedding dip
- lithological characterization
- casing inspection

Technical specifications

Diameter	40mm
Length	approx. 1.7m
Weight	approx 7 kgs
Max temp	50°C
Max pressure	200 bars
Borehole diameter	1 3/4" to 24" depending on borehole conditions
Logging speed	variable function of resolution and wireline

Cable:

Cable type	mono, four-conductor, seven-conductor
Digital data transmission	up to 500 Kbps depending on wireline, realtime compressed
Compatibility	ALTlogger- ALT-Abox- Mount Sopris MgXII (limited to 41 Kbps)

sensor:

Sensor type	downhole DSP based digital CCD camera
Optics	plain polycarbonate conic prism system
Azimuthal resolution	user definable 90/180/360 or 720 pixels /360°
Vertical resolution	user definable, depth or time sampling rate
Color resolution	24 bit RGB value
White balance:	automatic or user adjustable
Aperture & Shutter	automatic or user adjustable
Special functions	User configurable real time digital edge enhancing User configurable ultra low light condition mode
Orientation	3 axis magnetometer and 3 accelerometers.
Inclination accuracy	0.5 degree
Azimuth accuracy:	1.0 degree

Logging parameters:

- 360° RGB orientated optical image
- Borehole azimuth and dip
- Tool internal Temperature

The specifications are not contractual and are subject to modification without notice.