

Orientation of in-situ horizontal stress in Outokumpu, Finland

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The main aim of the Outokumpu deep drilling project was to determine the geological nature of strong seismic reflectors at 2-2.5 km depth (e.g. *Kukkonen 2011*). It was conducted within the International continental drilling program (ICDP).

The objectives of this study are to (1) constrain the orientation of maximum horizontal stress by mapping the occurrence of stress-induced deformation features using two sets of borehole televiewer data, which were collected six years apart, in 2006 and 2011; and (2) investigate whether any time dependent deformation of the borehole wall has occurred (creep).

Stress concentrations are formed at the borehole wall when rock is removed by drilling. Two types of stress-induced features exists (e.g. *Tingay et al. 2008*): (1) Borehole breakouts that form parallel to the orientation of minimum horizontal stress if the stress concentration exceeds the compressional rock strength; and (2) Drilling-induced fractures (DIF) that form parallel to the orientation of maximum horizontal stress if the stress concentration exceeds the tensile rock strength. Few opportunities exist for studying time-dependent borehole deformation.

BHTV data were collected from 260 m to 1900 m in 2006. In 2011 logging was repeated at 160-235 m and 950-1900 m. Preliminary results of the first data set indicate that stress-induced features (and core dinking) start to form 1800 m depth, with roughly N-S orientation of maximum horizontal stress to the magnetic north.

References:

Kukkonen, I. T. (ed.) 2011. Outokumpu Deep Drilling Project 2003–2010. Geol. Surv. Fin., *Spec. Publ.* 51: 252 pp.

Tingay M., J. Reinecker, B. Müller 2008. Borehole breakout and drilling-induced fracture analysis from image logs. World Stress Map Guidelines: Image logs. Available at : http://dc-app3-14.gfz-potsdam.de/pub/guidelines/WSM_analysis_guideline_breakout_image.pdf. (5 Nov. 2015).