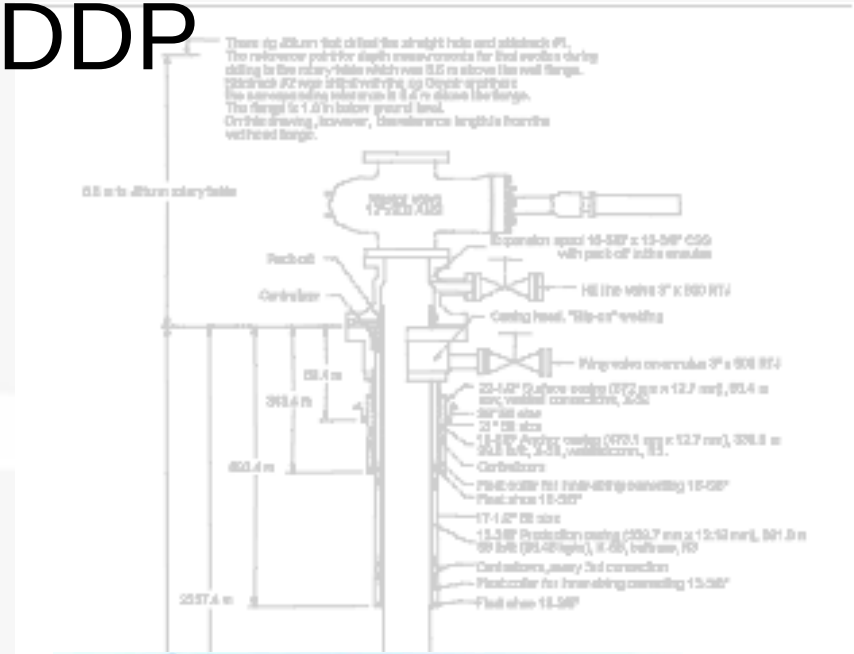
HITI – HIgh Temperature Instruments for supercritical geothermal reservoir characterization and exploitation

-European project HITI, STREP

Kick-off meeting at GFZ, Potsdam, Jan 2007

HITI and IDDP

The main **objective** of the HITI project is to **develop sensors and methods to accurately determine the existing conditions of the reservoir and fluids in-situ at the base of a deep geothermal system** in Iceland



Partners

HIgh Temperature Instruments for supercritical geothermal reservoir characterization and exploitation

1 ÍSOR Iceland
2 CNRS Montpellier France
3 BRGM France
4 Calidus Engineering Ltd. U.K
5 ALT, Luxembourg
6 Oxford Applied Technology U.K.
7 GFZ-Potsdam Germany
8 CRES Greece

Submitted in Dec. 2004

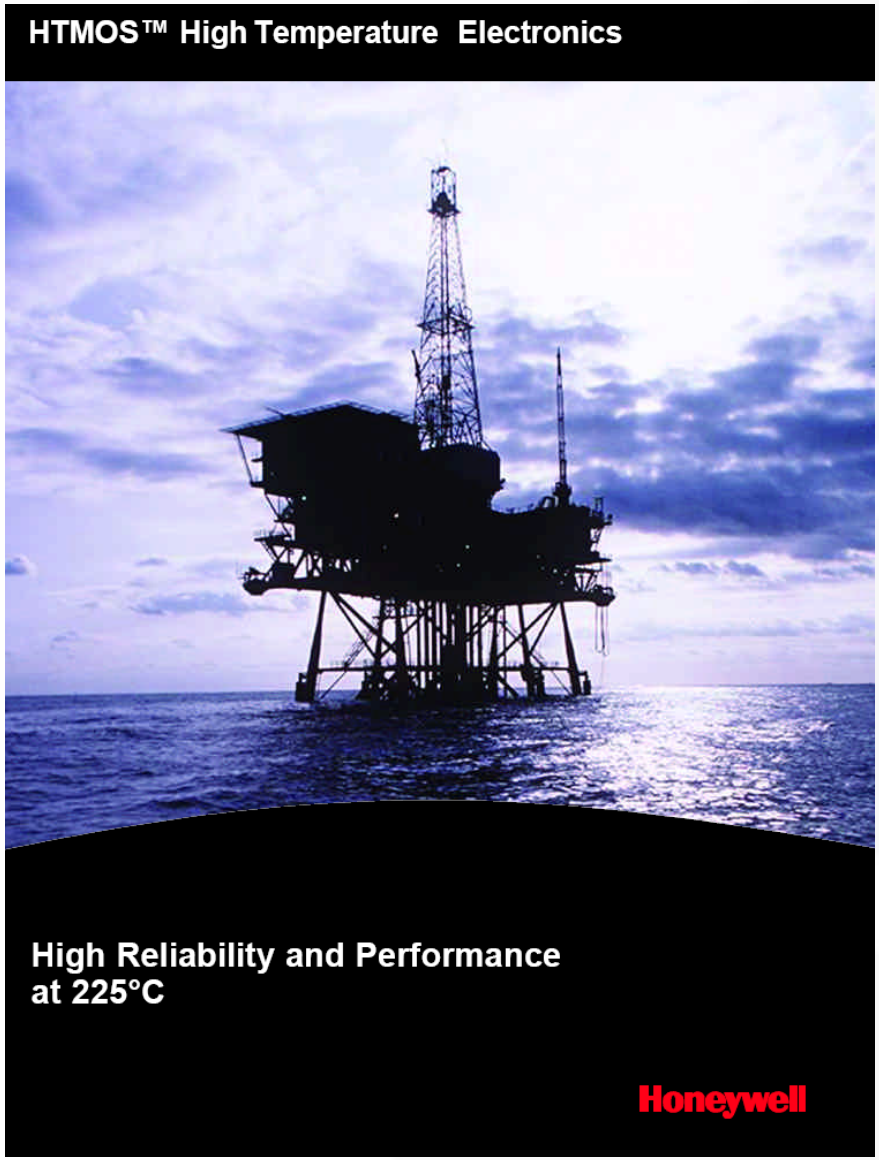
Main objectives

Developing downhole instruments capable of tolerating temperatures **over 300 °C, and preferably up to 500 °C**.

- develop and field test downhole instruments and methods tolerating temperatures above current limits. These instruments include: temperature, pressure, fluid and rock electrical resistivity, natural gamma radiation, televiewer acoustic images, pH, casing collar locator, casing monitoring, fluid flow, chemical temperature sensing and organic tracers,
- adapt an existing HPHT (High Pressure, High Temperature) laboratory facility to the measurement of electrical resistivity at appropriate reservoir conditions and varying fluid nature,
- validate the new instruments from the analysis of downhole data and samples (either core or fluid) from field tests in either hot existing wells, or the new IDDP hole.

Tool/method deliverables

1. MultiSensor, PLT400, 400°C
2. High temperature wireline T sensor
3. Gamma ray (GR) detector, 300 °C
4. Dual Laterolog (DLL), 300 °C
5. Televiewer with casing thickness evaluation to 300°C and cement monitoring
6. Distributed temperature sensing
7. HPHT rig 600°C laboratory
8. Na-Li temperature evaluation to 500°C
9. Organic tracers to 350°C



Complete oxide isolation of all transistors

TiW barrier layer on all metals and contacts

Variable width oxide trench

Twin well technology

CrSi thin film resistors available
N+poly to N+silicon linear capacitor

0.8 micron 5 volt digital capability

Designed for 50,000 hours of 225°C operation

Final test at 225°C ambient

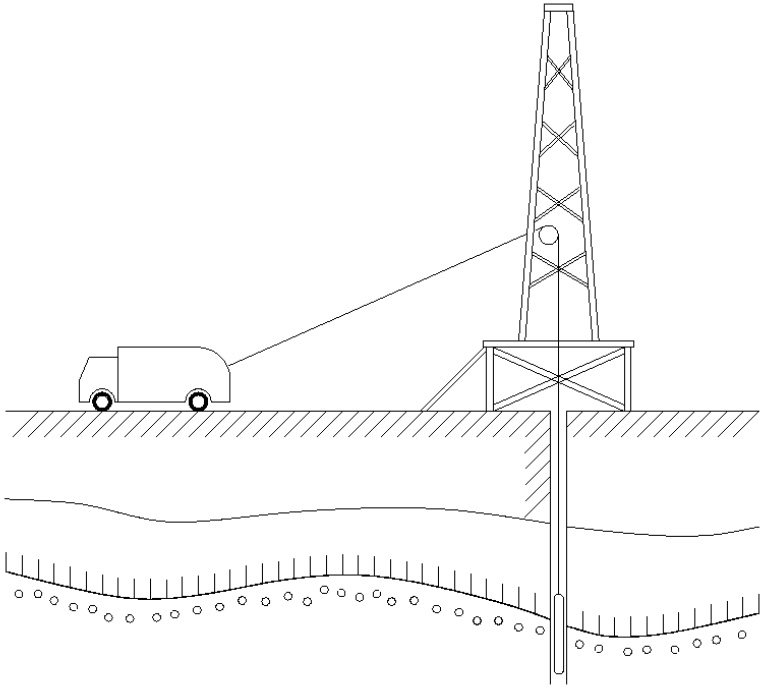
Burn-in at 250°C

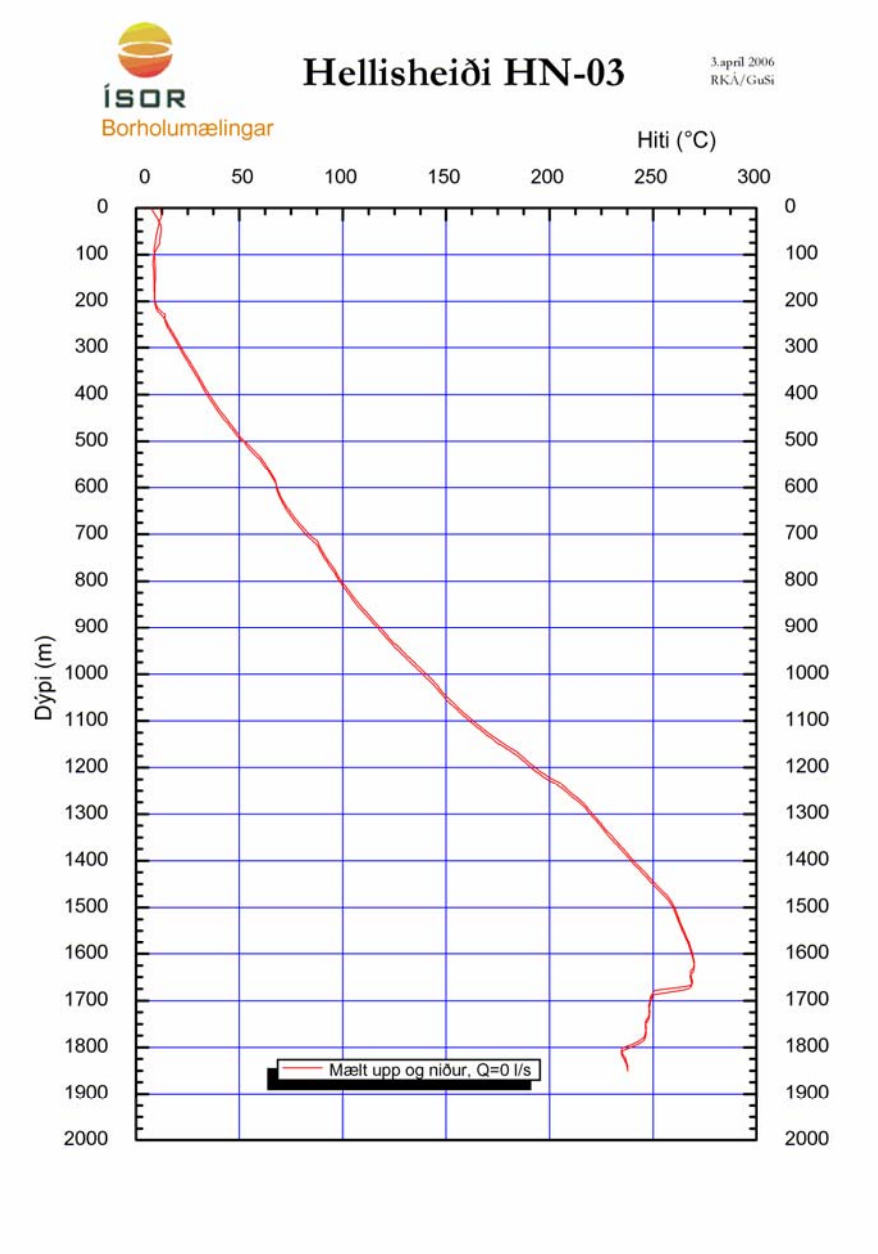
400°C Memory tools, temperature, pressure, flow, casing collar and conductivity

350 °C Pressure / Temperature / flow

Comparison: Kuster K10, 350°C (4h)

The act of logging





320 °C wireline temperature sensor

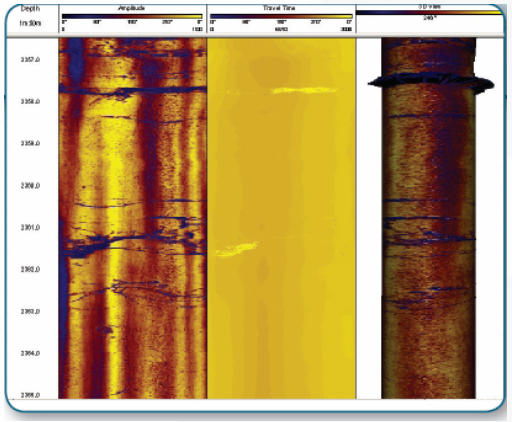
Comparison: Kuster, 177°C, 114 MPa

Comparable ISOR gauges do not exceed 140-150°C

Dual Laterolog (DLL), 320 °C

Resistivity logs have proven to be very useful to analyse fundamental formation properties relating to geothermal exploration.

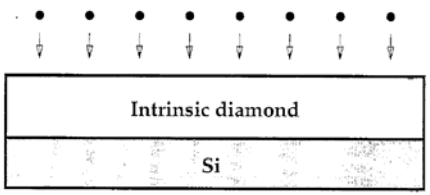
Televiewer with casing thickness evaluation to 300°C and cement quality beyond casing



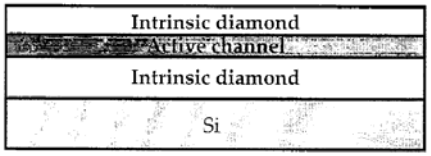
Advanced Logic Technology

Diamonds replacing silicon in integrated circuits?

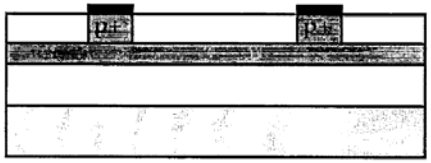
A buffer layer of intrinsic diamond was grown on a Si substrate. Boron was then implanted to form the active channel.



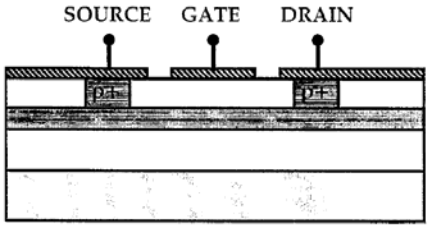
The insulating gate was formed by depositing intrinsic diamond.



Ohmic source and drain contacts were formed by boron implantation and deposition of Ti-Ag-Au.

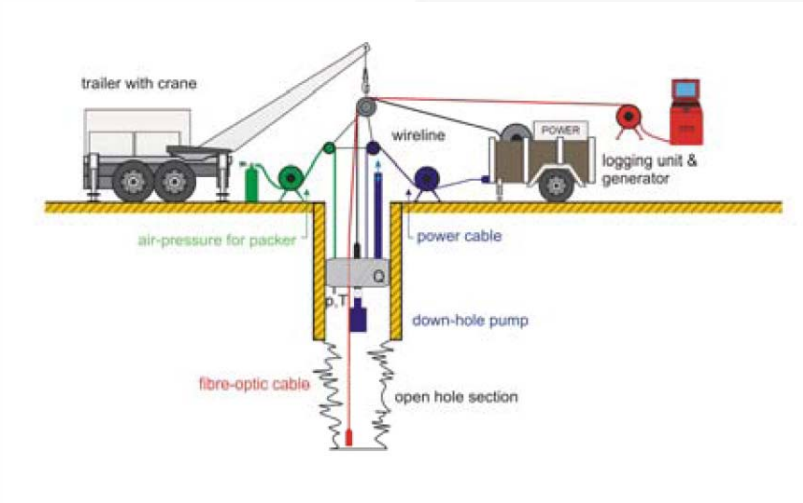


The completed device. Gold was deposited to contact the gate, source, and drain regions.



OxfordMaterials

Distributed temperature sensing, 300°C



DTS: Temperature measured instantaneously and simultaniously in the whole well using laser and fibre optic cable.

Groß Schönebeck°: 143°C, 4.2 km

HPHT 600°C laboratory

CENTRE NATIONAL
DE LA RECHERCHE
SCIENTIFIQUE

Measure electrical resistivity at 600 °C, 200 MPa and varying fluid nature.

Organic tracers to 350°C and Li analysis

To estimate the reservoir temperature from chemical analyses performed on fluid samples collected either in-situ or at surface. Isotopic Li analyses, performed by ICP-MS/MC on high temperature fluid samples for the first time, are proposed to ameliorate the knowledge of this geothermometer and to confirm the nature of the reservoir rocks in contact with the geothermal fluid. To use organic compounds (sulfonate naphthalene family) to carry out tracer tests in high temperature geothermal wells (up to 350°C) in order to detect possible hydraulic connections between wells and to estimate the reservoir capacity (storativity) and the fluid flow rate.

Status: In force.....

- EU funding is 2.5M€
- Project kicks off in January 2007: NOW
- Opportunity for the geothermal exploration industry and research communities, e.g. high- temperature electronics, geosciences, instrument design and measuring techniques