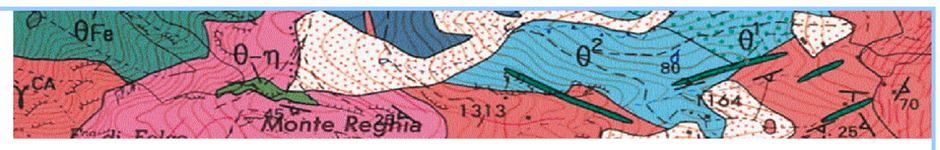
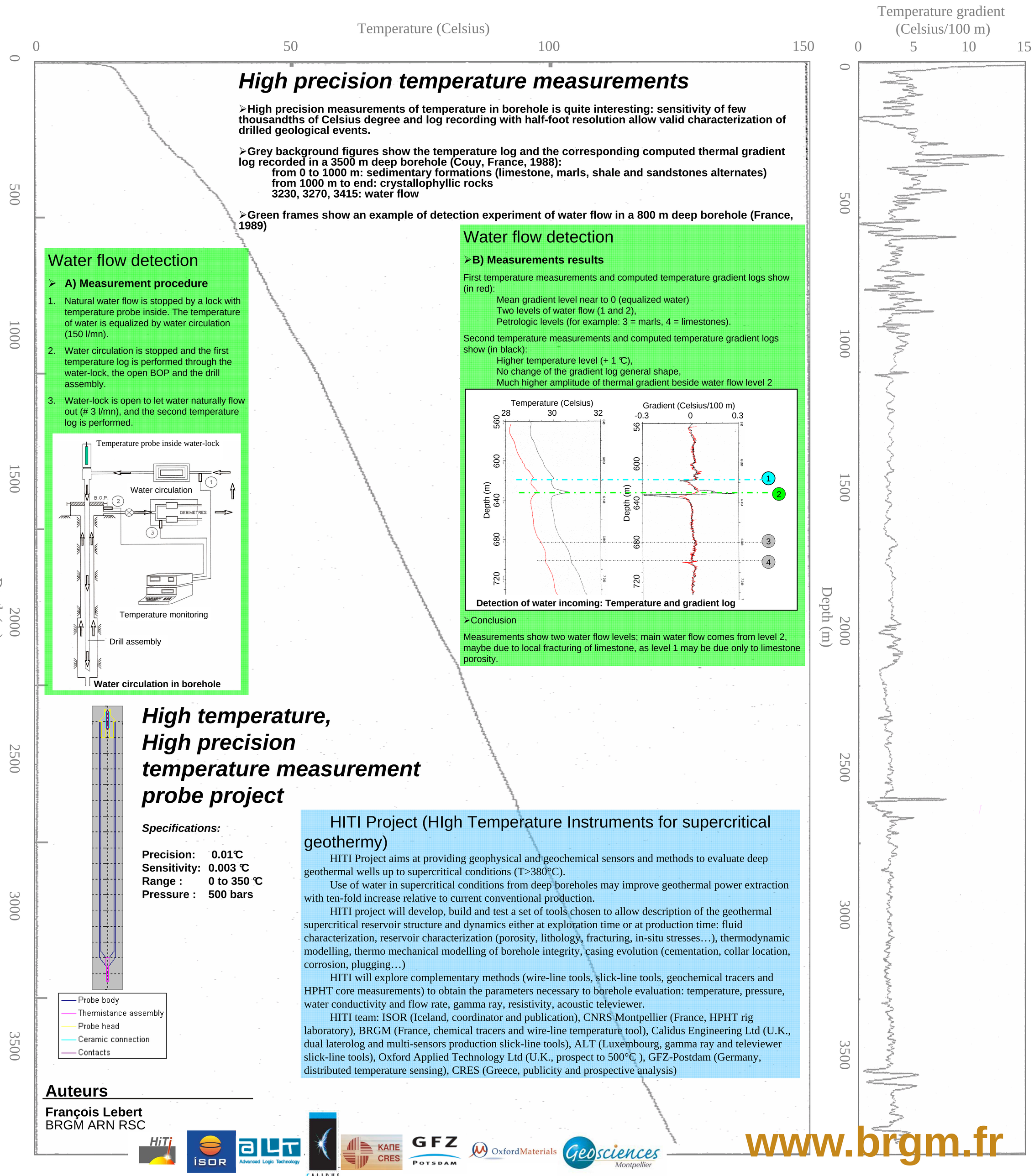
Géosciences pour une Terre durable

brgm



High temperature, high precision, temperature measurement probe

High precision temperature tools allow accurate temperature logs to be performed and geological events to be characterized in geothermal wells. In the framework of the European HITI project, BRGM will transfer his experience from low temperature domain (0-130 ℃) t o high temperature domain (up to 320 ℃)



High precision temperature measurements

➢**High precision measurements of temperature in borehole is quite interesting: sensitivity of few thousandths of Celsius degree and log recording with half-foot resolution allow valid characterization of drilled geological events.**

➢**Grey background figures show the temperature log and the corresponding computed thermal gradient log recorded in a 3500 m deep borehole (Couy, France, 1988):**
from 0 to 1000 m: sedimentary formations (limestone, marls, shale and sandstones alternates)
from 1000 m to end: crystallophyllic rocks
3230, 3270, 3415: water flow

➢**Green frames show an example of detection experiment of water flow in a 800 m deep borehole (France, 1989)**

Water flow detection

➢ **A) Measurement procedure**

1. Natural water flow is stopped by a lock with temperature probe inside. The temperature of water is equalized by water circulation (150 l/mn).
2. Water circulation is stopped and the first temperature log is performed through the water-lock, the open BOP and the drill assembly.
3. Water-lock is open to let water naturally flow out (# 3 l/mn), and the second temperature log is performed.

Water circulation in borehole

Water flow detection

➢**B) Measurements results**

First temperature measurements and computed temperature gradient logs show (in red):
Mean gradient level near to 0 (equalized water)
Two levels of water flow (1 and 2),
Petrologic levels (for example: 3 = marls, 4 = limestones).

Second temperature measurements and computed temperature gradient logs show (in black):
Higher temperature level (+ 1 ℃),
No change of the gradient log general shape,
Much higher amplitude of thermal gradient beside water flow level 2

Detection of water incoming: Temperature and gradient log

➢Conclusion

Measurements show two water flow levels; main water flow comes from level 2, maybe due to local fracturing of limestone, as level 1 may be due only to limestone porosity.

High temperature, High precision temperature measurement probe project

Specifications:

Precision: 0.01℃
Sensitivity: 0.003 ℃
Range : 0 to 350 ℃
Pressure : 500 bars

HITI Project (HIgh Temperature Instruments for supercritical geothermy)

HITI Project aims at providing geophysical and geochemical sensors and methods to evaluate deep geothermal wells up to supercritical conditions (T>380°C).

Use of water in supercritical conditions from deep boreholes may improve geothermal power extraction with ten-fold increase relative to current conventional production.

HITI project will develop, build and test a set of tools chosen to allow description of the geothermal supercritical reservoir structure and dynamics either at exploration time or at production time: fluid characterization, reservoir characterization (porosity, lithology, fracturing, in-situ stresses…), thermodynamic modelling, thermo mechanical modelling of borehole integrity, casing evolution (cementation, collar location, corrosion, plugging…)

HITI will explore complementary methods (wire-line tools, slick-line tools, geochemical tracers and HPHT core measurements) to obtain the parameters necessary to borehole evaluation: temperature, pressure, water conductivity and flow rate, gamma ray, resistivity, acoustic televiewer.

HITI team: ISOR (Iceland, coordinator and publication), CNRS Montpellier (France, HPHT rig laboratory), BRGM (France, chemical tracers and wire-line temperature tool), Calidus Engineering Ltd (U.K., dual laterolog and multi-sensors production slick-line tools), ALT (Luxembourg, gamma ray and televiewer slick-line tools), Oxford Applied Technology Ltd (U.K., prospect to 500°C), GFZ-Postdam (Germany, distributed temperature sensing), CRES (Greece, publicity and prospective analysis)

Auteurs

François Lebert
BRGM ARN RSC

www.brgm.fr