How Can Petrophysics Support Geothermal Exploration?

- General Remarks
- Specifics for Geothermal Applications
- Recommendations

E. Spangenberg, S. Raab, D. Bruhn

GFZ Potsdam

Exploration

allows to extract information of geological relevance

Geophysics

Distribution of Measurable Physical Properties in the Subsurface

Interpretation

- Pressure and Temperature
- Composition of the Pore Fill
- Porosity and Type of Pores
- Texture and Structure
- Mineralogical Composition

Distribution of Lithologies, Porosities, Pore Fills, etc.

Geological Model or Reservoir Model

Knowledge of the dependencies of physical properties on: ← *Petrophysics*

Petrophysics for Geothermal Application – A Challenge for Experimentalists

Simulation of in situ conditions in the laboratory is characterized by confining and pore pressure controlled experiments under ***high*** temperatures.

Requirements and Problems

- Special materials
- Special design of internal set up

- Longer experimental time
- Higher failure probability

- Higher costs

Possible Subjects of Investigation

- Dependence of physical rock properties on temperature
- Production stimulated fluid rock interactions under high temperature
  Assessment of long term behaviour of the reservoir
- Phase transitions in the reservoir

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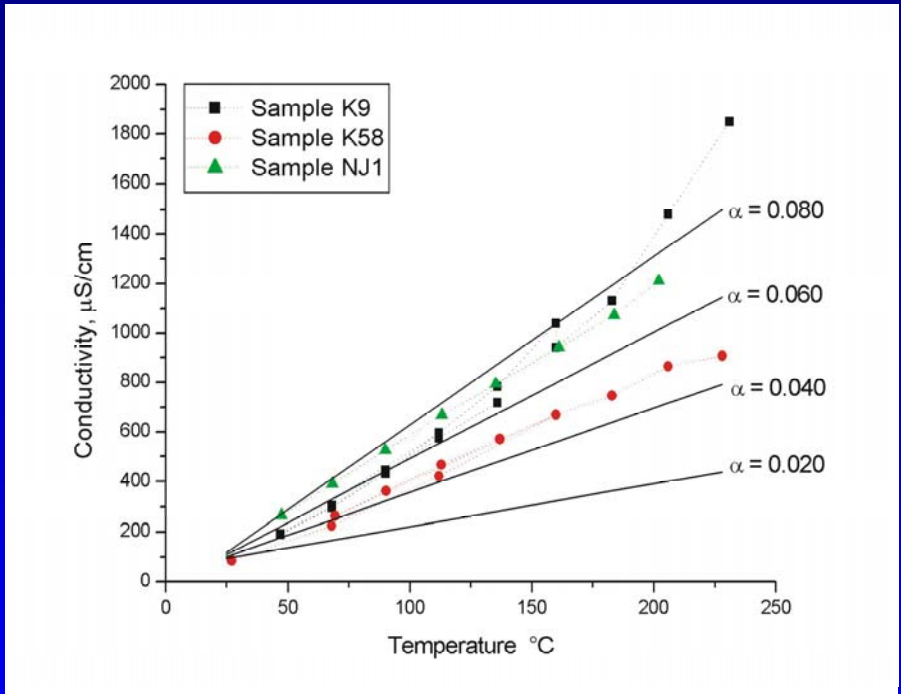
Examples

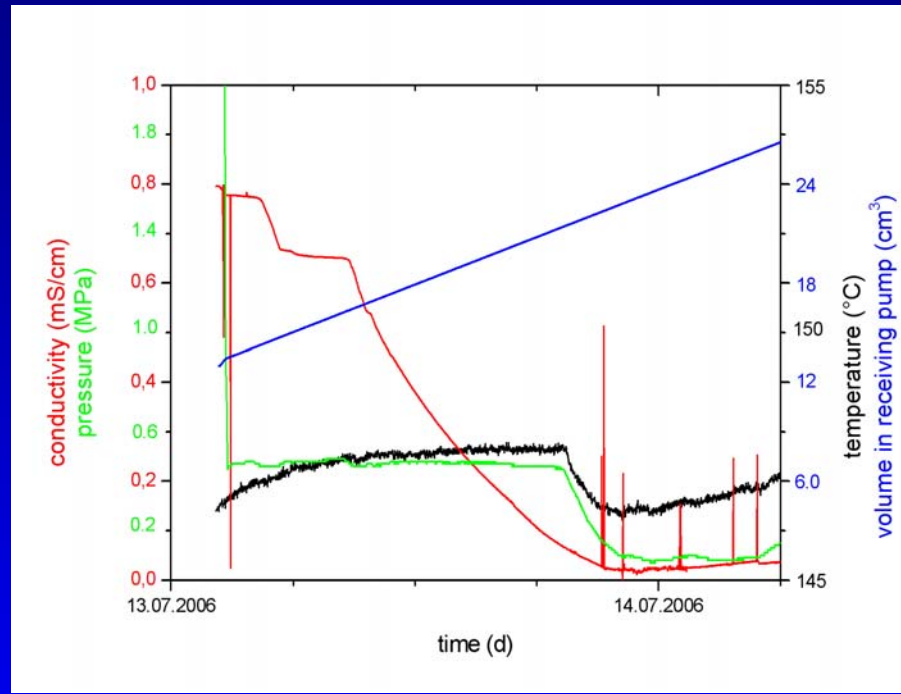
Temperature Dependence



Kulenkampff et al., 2005

Basalt: Krafla, Nesjavellir

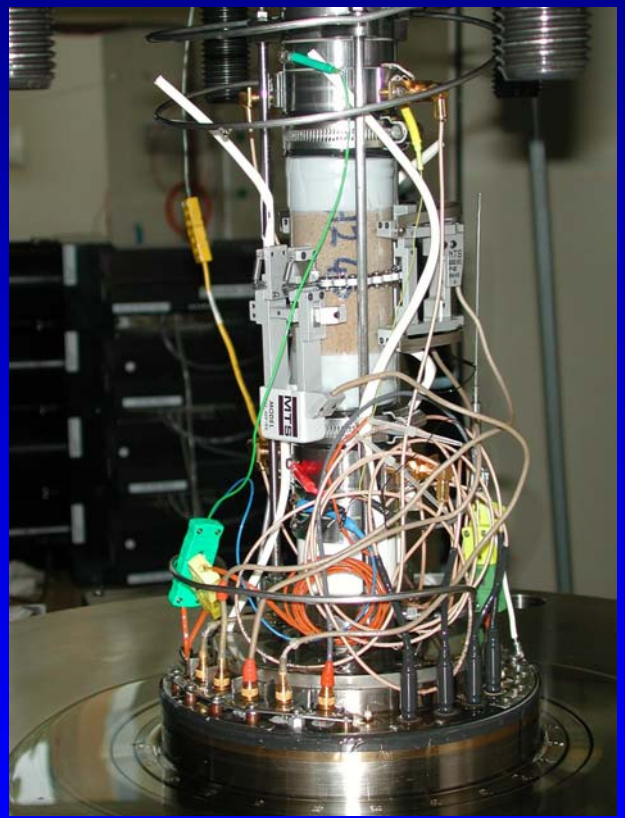
Influence of "boiling pore water"

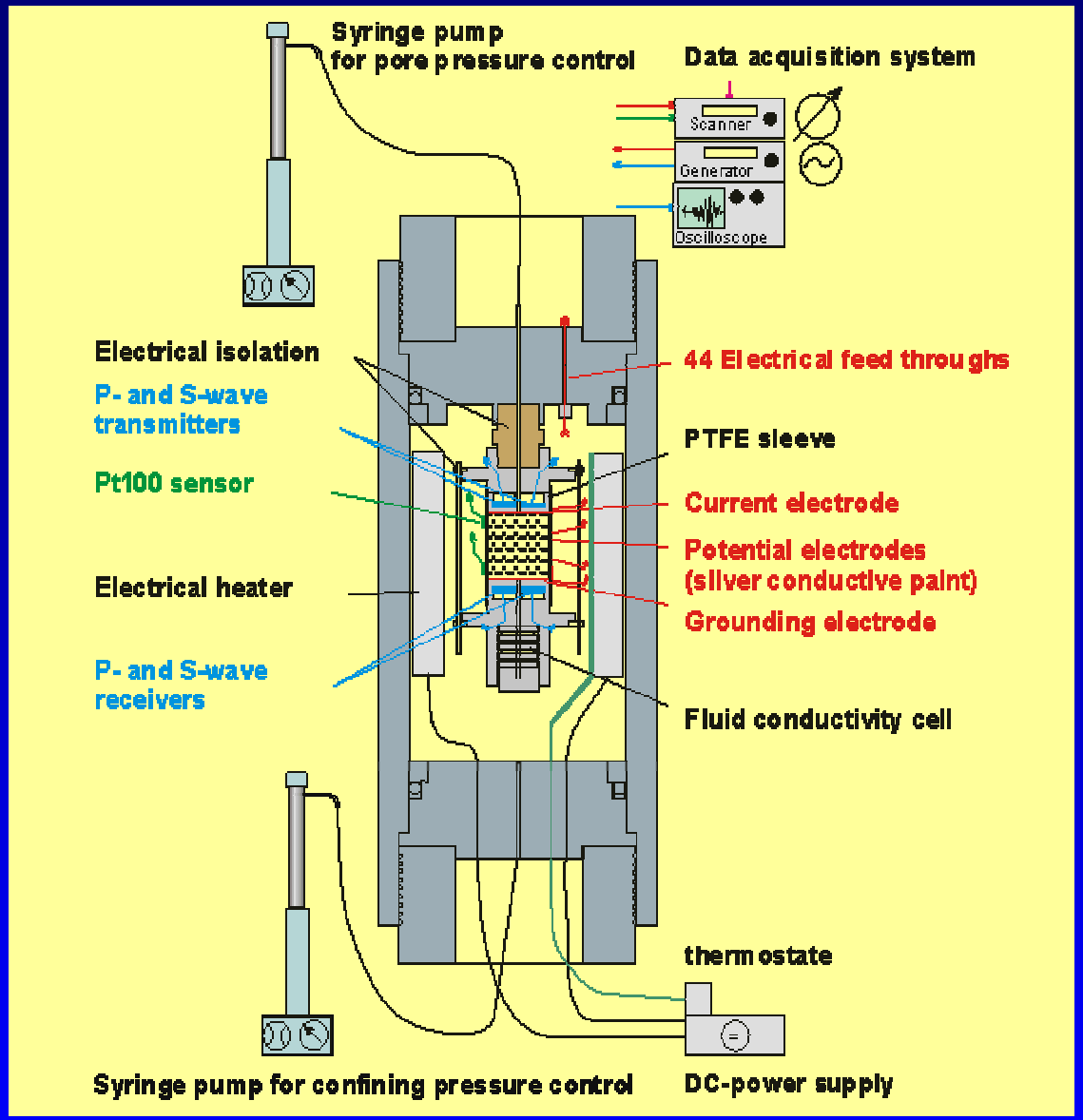


L.H. Kristinsdóttir et al., 2006

Hyaloclastite: Hengill

•State of the Art





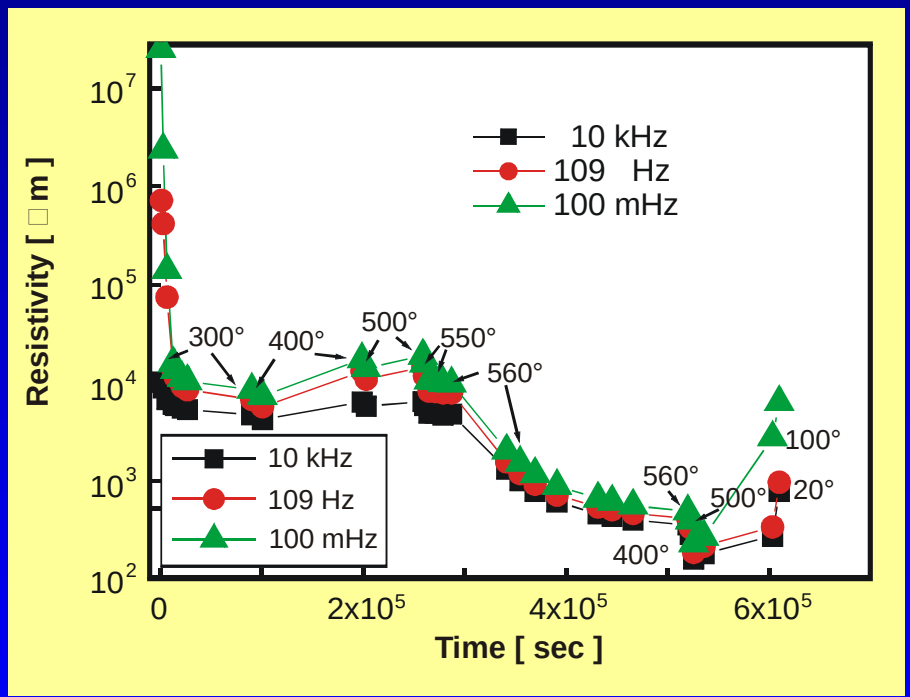
Advantages - Limitations

- Reusable internal set up
- Standardized samples and sample preparation
- Measurement of different properties in on experiment

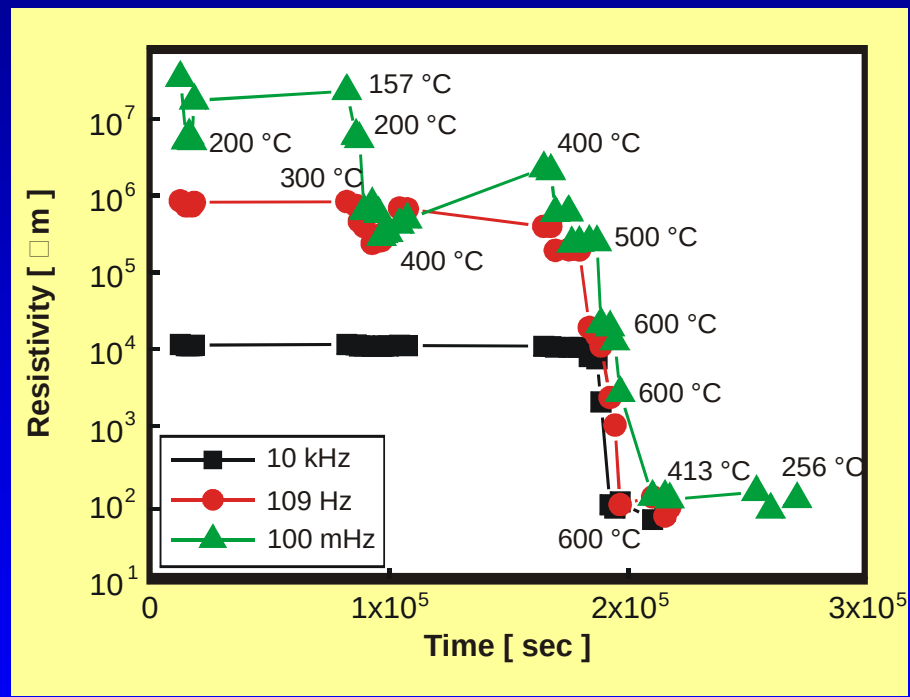
- Shrinkable tubing – FEP, PFA (Fluoropolymers) 250-300°C
- Polymers – PTFE, PEEK 250-300°C
- Seals – Viton, PTFE 250-300°C
- Piezoceramics – sonic transducers Curie temperature up to 300°C

Dehydration of Serpentinite

Fast Dehydration

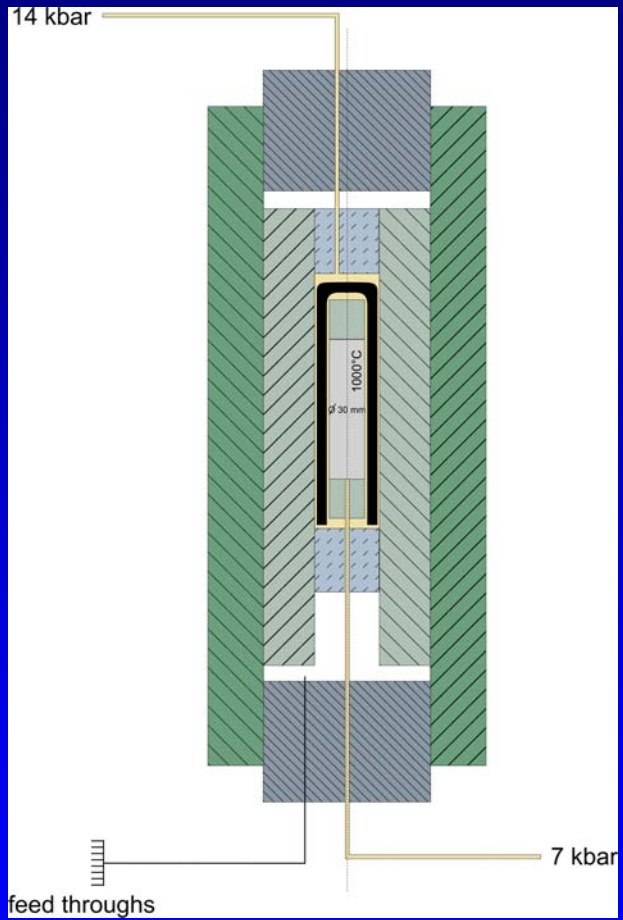


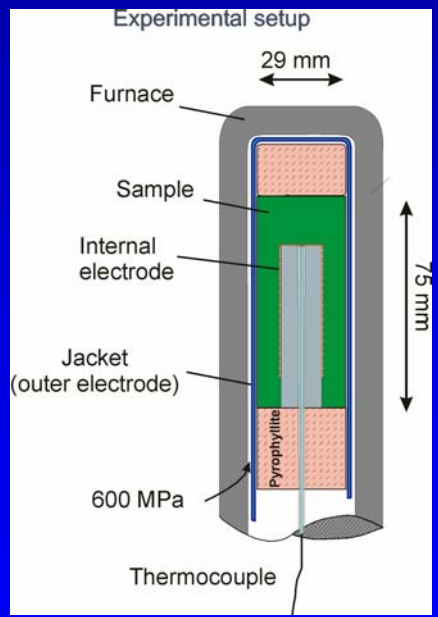
Slow Dehydration



Bruhn et al., 2005

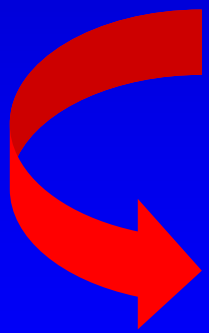
“The Next Generation”





Higher temperatures require:

- sample protection against confining pressure medium by a metal jacket
- to avoid chemical reactions between the pore fluid and the jacket is has to be chemically inert (gold, platinum)
- high temperature gradients within the pressure vessel
  - high temperature in the centre where the sample is placed
  - low temperature at the closers to protect seals and some temperature sensible parts (piezoceramic transducers)
- special design of the internal set up
- special preparation techniques
- the parts in the hot zone of the set up are “one way components”



- Do not underestimate the effort, time, and costs for experiments under high temperature!

Recommendation

If a problem is identified that requires petrophysical experiments within a geothermal Project it is important to:

- define the objective of the investigation clearly
- design an experimental set up for exact this objective
- budget sufficient
  - lead time for the construction and test of the experimental set up,
  - men power for the design, set up, test, preparation, and measurement
  - money