

Microstructure and fluid state within an Icelandic geothermal reservoir from inversion of tomography data

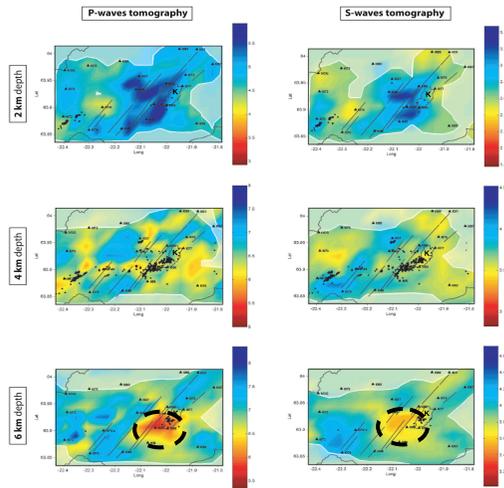
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Abstract

The inversion of seismic data in terms of physical properties and fluid flow is a **challenging issue**. We develop an effective medium model for estimating **crack parameters** and **fluid state** beneath the Reykjanes Peninsula. Locally beneath the anomaly area located by tomography the crack density increases with depth. This is consistent with the presence of a **deep reservoir with supercritical fluids under pressure**.

1. Tomography data and theoretical approach



Kleifarvatn anomaly at 6 km depth: velocity decrease stronger for P-waves (15 %) than for S-waves

Effective Medium model including pores and cracks

$$V_{P,S}^{th} = f(\rho, \Phi_{cr}, K_f)$$

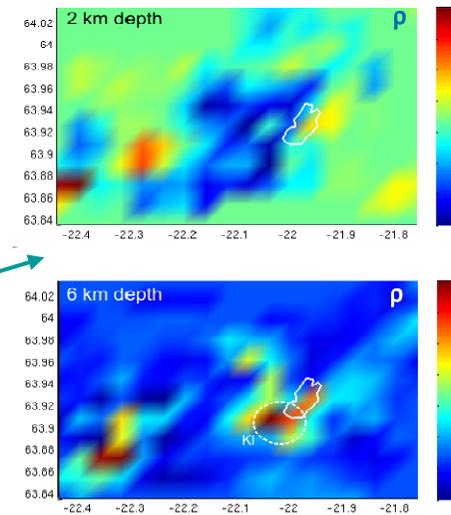
Minimization of an objective function

$$J = \frac{1}{2} \sum_i (V_i^m - V_i^{th})^2$$

Saturating fluid : SC and liquid (Reuss average on K_f)

$$\frac{1}{K_f} = \frac{R}{K_f^{liq}} + \frac{1-R}{K_f^{SC}}$$

2. Crack density ρ beneath the Reykjanes Peninsula



> Is there a **gaseous** or **SC** fluid in depth beneath the Kleifarvatn area ?

Outside active hydrothermal areas : decreasing of the crack density

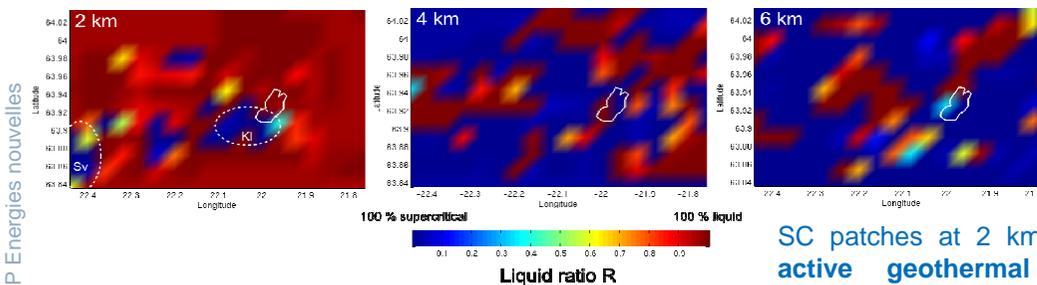
→ crack closure due to **overburden** ?

→ secondary **filling** of cracks ?

Locally beneath SW Keifarvatn : slight increasing of the crack density

→ **SC reservoir** under pressure triggering off hydrofracturation ?

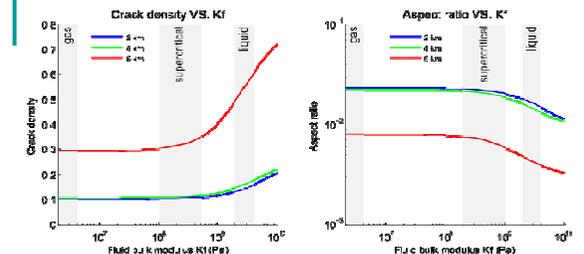
3. Fluid state and implications on the crustal parameters



Most of the Icelandic crust is saturated with **liquid** at 2 km depth and with **SC** phase at 6 km depth.

SC patches at 2 km depth correspond to the most **active geothermal** areas located on surface (Kleifarvatn and Svarstengi for instance).

A significant difference between the **shallow crust** (2 and 4 km depth) and **deeper crust** (6 km depth) is visible locally beneath the Kleifarvatn area.



Conclusions and Outlooks

We have shown that elastic wave velocities recorded at a large scale can be processed as **local** variations in **microstructure** and **fluid state**. Effective medium modeling appears to be very useful to constrain such field data and provides **efficient tools** to invert the **seismic responses** of a reservoir.