A laboratory approach for seismic data interpretation: the borehole Humilly-2 (France)

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A. Introduction

- Reservoir-characterization of geothermal systems, integrating multiscale seismic data, is key to predicting reservoir-performance. In a joint project by the Canton of Geneva and SIG (Services Industriels de Genève), a geothermal exploration program GeoGerme 2020 integrate the subsurface geological and geophysical data and evaluate the potential of geothermal energy production in the Geneva basin.
- This area is located in the westernmost part of Swiss Molasse Basin, where the “case history” for the ongoing study consists of five main ayerylized pairs of the Swiss Molasse basin. These pairs have been indicated in literature as potential reservoirs for deep CO2 sequestration.
- One of our main goals is to quantify the effect of porosity, mineral composition and micro-textural characteristics, such as banding and layering of minerals in sedimentary rocks, on their seismic properties. The final aim is to offer a key to interpret the seismic reflectivity zones identified in the seismic survey (Gorin et al., 1993) and to identify a calibration key for borehole logging data where no coring was performed.

B. Geological Constraints

- High-resolution stratigraphic maps and sub-sampled quantitative mineralogical compositions identification are assessed using a combination of back-scattered electron values, energy-dependent X-ray spectra, and X-ray count rates (GEMSCAN) at University of Geneva.

C. Methods

- We bored three mutually orthogonal plugs: one in the vertical Z direction, parallel to the logging direction and two in the horizontal plane at 90° between each other (in the so-called X and Y directions). The experiments were performed under hydrostatic pressure.
- P- and S-wave velocities were measured using pulse transmission technique (Birch 1961) at 1 MHz resonance frequency.

D. Results

- The seismic velocities were calculated at 40 MHz using Rayleigh waves and plotted against porosity. The Vp/Vs ratio are dependent not only on the porosity but also on the large scale data for the velocity-porosity relationship, but also on the constituent minerals.

E. Conclusion

- The highest values of the seismic velocity and density were measured in Muschelkalk, therefore, those rocks might give nice to good reflectors. For contact with almost all the other lithologies.
- The reflection coefficients calculated for the lithostratigraphic sequence in Humilly borehole show possible good reflectors at:
  - The top of Muschelkalk, or the top of Kupfer (with the caveat that we used samples from different boreholes or time due to absence of Kupfer samples in Humilly borehole).
  - A good reflector can also be the contact between Sundsteinen and Muschelkalk.