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Forecasting high resolution variations in deep geothermal wells based on low resolution measurements utilizing virtual sensors

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Multiple operators use geothermal wells in Lower Bavaria and Upper Austria for balneological (medical and wellness) applications and for energy and/or heat mining purposes. These applications depend heavily on the well's hydrochemical and geophysical stability (mineralization, pressure, temperature).

At the moment, wells are submitted to inspection once a year, which includes the analysis of ions, pH, pressure, temperature etc. These „offline“ analyses, while covering a large set of parameters, obviously fail to show intra-annual variability within the measured parameters. On the other hand, some geothermal wells are being monitored quasi-continually. These „online“ sensors, however, only cover a small set of selected parameters, such as electric conductivity, temperature and pressure.

This study aims at forecasting hydrochemical and physical stability based on annual measurements by assessing the degree of intra-annual variability covered or neglected by the yearly measurements. The results are required for a sound assessment of possible adverse effects of other exploration activities and short term variations of the withdrawal rates reflecting the demand for heat, energy and/or spa water. To do this, we followed the concept of virtual sensors and their correlation to detailed yearly measurements.

We found that, while annual measurements, when taken approximately in the same season of the year, do match the data sampled online quite well, intra-annual variability at the examined wells was quite strong for some parameters and not represented by the offline data. Thus, annual data can be used to make predictions regarding long-term variability. In order to forecast intra-annual variability, higher temporal resolution is necessary. While not a replacement for the detailed analyses, the virtual sensors presented here provide a robust method to trigger further actions.