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Endo-tracers in Tight-rock Geothermal: Back to Single-well Engineering?

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Abstract

Deep-geothermal realm typifying by petrothermal, 'aquifer-like' EGS, ... may run into apory. Once having drilled down to approximate target depth, reliable categorizing would be needed before drilling further, to enable us decide about stimulation strategy and well-path deviation. But we get to know whether our guess was right only after stimulation with its subsequent hydraulic and fluid turnover testing was completed, evaluated, analyzed. E. g., quite some drillings in Malm 'aquifers' beneath the Molasse basin were typified as 'unsuccessful' ('*unfündig*') and therefore abandoned, though 'petrothermal' (Moeck et al. 2015, …, 2018) might fit much better – which, however, would have required a different well-path orientation and wellbore completion, different legal steps and participatory decision-making, …. For most EGS candidates so far (Horstberg, Gr.Schönebeck, KTB, Bad rach, Soultz-sous-Forêts, St.Gallen, Espoo), 'breed' could only be told *post festum*, and tracer data (where available) indicated a time-dependent, and spatially heterogeneous superposition of 'petro' and 'aquifer-like' contributions. Growing emphasis on avoiding human-felt seismicity imposes operational changes to stimulation protocols – altering stimulation outcome in ways that additionally blur the 'petro'-/'aquifer-like' frontier. On the other hand, technical rationality imposes a rather inflexible design for HDR multi-frac EGS: first drill to the final 'bottom of well', then perform a 'backward' sequence of stimulation stages; else, disproportionately high costs would incur for packer-penetrator devices, alongside with significantly increased risk of technological failure. The major issue persisting about this "*back-to-the-future*" concept of Jung (2013) concerns the *ability to define a second well's trajectory that rules out any risk of thermal short-cut, while maximizing the 'inter-well' effective multi-frac area* – facing the complexity of multi-frac geometry incurred by 'wing cracks' (Jung 2013) and by sequentially frac-induced 'stress shadow' (Zeeb/Konietzky 2015). Even if this intricate geometry gets accurately mapped by microseismic monitoring, and its hydraulic parameters reliably inverted from pressure signals, its *thermally-effective aperture distribution remains unknown*. As a workaround, we consider the option of *single-well 'push-then-pull' operation* for HDR-based EGS anew (as had originally been endeavoured by Jung/Tischner 2002ff for the GeneSys well), now in guise of a multi-frac operated 'from opposite ends' *in tandem*. Furthermore, 'softening' the stimulation process (Zang / Zimmermann 2016ff, Kwiatek / Martínez-Garzón 2017ff) also turns out to increase (owing to cyclic injection and outflow++) the diagnostic value of endo-tracers, and their ability to tell 'petro'/'aquifer-like' contributions apart.