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Hot and Saline Spring Behaviour in the Taupo Volcanic Zone and the North-East German Basin

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Hot springs occur in geothermal regions worldwide, and often have important economic or cultural values which can be threatened by geothermal developments. In this paper we describe models of hot springs in the Taupo Volcanic Zone (TVZ) in New Zealand, and of saline springs in the Northeast German Basin (NEGB). In New Zealand, the operation of the Wairakei geothermal power station in the 1950's and early 1960's lead to the collapse of the thermal area known as 'Geyser Valley', and more recently, the spring and Geyser activity in Rotorua was threatened by the widespread and uncontrolled drawoff of geothermal water for domestic use. Similarly, in the NEGB, discharge of saline springs poses serious challenges for groundwater management for agricultural and domestic use, having additional implications for future geothermal energy projects.

Despite their obviously very different nature the springs in NEGB and TVZ do have some common characteristics: they both feed fluid to the surface from deeper (geothermal) aquifers through embedded hydrogeological heterogeneities (e.g. fracture systems, erosional gaps and unconformities in the internal stratigraphic sequence), and data shows that they both exhibit irregular flowrates, temperatures and chemistries. Currently used models of hot/saline springs do not show these types of behaviour and offer no understanding of the mechanisms of variability in either setting, or indeed the nature of the connections to deeper aquifers.

In this paper we present early results from a study aimed at identifying the most important physical mechanisms governing the dynamics of these systems. We use the simulation code NaCl-Tough2 (Kissling, 2005a,b) to accurately represent the thermodynamics of fluids in both systems. Though relatively simplistic in terms of the modelled geometry these models provide new important insights into the variability of the observed flow dynamics as well as in their causative processes at depths.

The results obtained so far nicely demonstrate that the observed spring variability in both settings may be regarded as a surface manifestation of instabilities in the thermal and flow dynamics which originates at greater depths in the aquifer systems. Structural heterogeneities like faults or domains of enhanced permeability at intermediate depth levels provides preferential connections between the deep and shallow flow systems leading to a structurally controlled localization of their occurrence.

References

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