

## Chemical Aspects of Production from Sedimentary Geothermal Systems

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### ABSTRACT

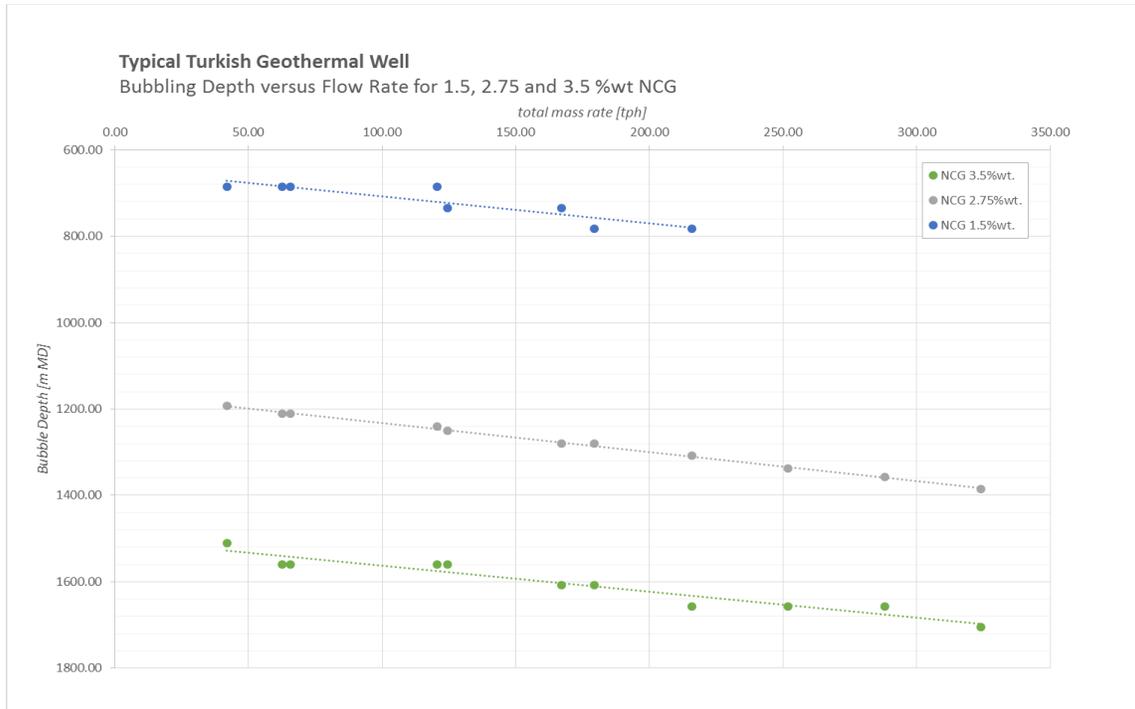
The chemistry of geothermal fluids is derived from the source fluids, water±gas, and interaction with rocks at a given temperature and ratio of water and rock. Fluids from sedimentary and metamorphic hosted geothermal systems differ from volcanic and magmatic geothermal systems. While the source fluid in almost all geothermal systems is meteoric water (or sometimes sea water), primary differences in geothermal fluids are generated by the sedimentary host-rock mineralogy. The lack of influx of volcanic or magmatic gas and variations in the degree of water/rock interaction also produce differences in fluid chemistry of sedimentary geothermal systems relative to volcanic and magmatic systems.

While volcanic and magmatic systems are typically hosted by volcanic or intrusive igneous rocks, sedimentary systems often include carbonates, fluvial, alluvial and lacustrine deposits ± evaporates. These differences can produce geothermal fluids with higher carbon dioxide (CO<sub>2</sub>) concentrations and/or higher total dissolved solids (TDS) exemplified by two end-members of sedimentary-hosted geothermal systems: the high CO<sub>2</sub>-low TDS systems of the Menderes and Gediz grabens of Turkey (Aksoy et al., 2015; Haizlip et al., 2012; Haizlip et al., 2013) or the high TDS-low CO<sub>2</sub> geothermal systems in the Salton Sea in California (e.g., Lipmann et al., 1999).

High (>1% dissolved) CO<sub>2</sub> in geothermal reservoir fluids produces high-pressure, gas-driven geothermal systems. When the systems are produced, the CO<sub>2</sub> causes relatively deep two-phase conditions or boiling, requiring deep delivery of carbonate scale inhibitor and limiting pumping. When the CO<sub>2</sub> partitions into the vapor phase, it is removed from the reservoir and discharged to the atmosphere. Recharge (either from re-injected brine or meteoric water) is relatively low in CO<sub>2</sub>. Without re-equilibration of recharge, reservoir CO<sub>2</sub> concentrations could decline if recharge mixes with reservoir fluids in the production zone. Producing these geothermal systems requires designing a two-phase production system that can handle high CO<sub>2</sub> concentrations in the vapor phase (e.g., no pumping of wells and gas management in the power plant), scale mitigation for carbonates, injection management to minimize reservoir pressure decline, and management of CO<sub>2</sub> emissions.

The high TDS observed in the Salton Sea produces complex scaling and corrosion in both the production and injection wells. Scales include iron silicate (amorphous silica and iron oxides), amorphous silica and other metal oxides and sulfides and salt. Managing the corrosion and scaling in production wells, removing silica from brine before injection, and managing the high dissolved solids in injection wells are all required to maintain production.

The technological solutions to producing geothermal fluids with the extreme chemistry of these two types of sedimentary-hosted geothermal systems may encourage additional geothermal development of sedimentary-hosted geothermal systems with complex chemistry.



**Figure 1: Wellbore simulations of mass flow rate versus the depth of gas break-out pressure or bubble point; pressure required to maintain gas in solution or to maintain reservoir conditions as a single liquid. Simulations using a typical wellbore construction, reservoir temperature of 175°C, average reservoir pressure at three levels of CO<sub>2</sub> in reservoir liquid: 1.5% (blue dots), 2.75% (grey dots) and 3.5% (green dots).**

## REFERENCES

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