FLUID PRODUCTION CONDITIONS MANIFESTED IN MINERAL PRECIPITATES FROM GEOTHERMAL POWER PLANTS

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Fluid circulation and fluid-solid interaction are critical constituents during sustainable and renewable geothermal energy production (heat, electricity) and gas storage (H_2, CO_2, CH_4). The occurrence and extent of unwanted processes (scaling, corrosion, plugging) depends on the prevailing natural and technical environmental and fluid production conditions. Differentiated aqueous solutions and gases streaming in subsurface reservoir rocks and boreholes as well as surface infrastructure (pipelines, heat exchangers) lead to successive mineral precipitation and material alteration. This includes mineral (scale) deposits, corrosion products, cements in pore spaces, veins in fractures as well as altered rock and construction materials. Production conditions and potential mineral formation vary across the fluid flow route and with time.

The unwanted mineral precipitates (carbonates, sulfides, sulfates) are originating from the thermal fluid and constitute a chemical-sedimentary archive evolving continuously and/or episodically. Applying some forensic approach ("Scaling Forensics") an advanced process understanding emerges from the solid deposits. This is based on a steadily growing set of laboratory analytical methods targeting mineralogical, petrographic, chemical, and isotopic compositions. The reconstruction of relevant processes involves the interpretation of indicative minerals and inclusions, crystal growth mechanisms, chemical tracers, and the role of specific interfaces, substrate effects and microbial contributions. Distinct phases and sections of the fluid circuit can further be interrelated by computer based numerical modeling.

Considering novel geochemical tracers, "clumped isotopes" (multiply-substituted isotopologues) in solids (scale deposits, rocks) and gases, hold a highly attractive potential as geothermometer, fluid provenance and evolution tracer and for kinetic effects related to mineral precipitation. In particular, carbonate scales reflecting a broad range of physicochemical growth conditions are promising materials for the evaluation and calibration of the new isotopic tool.