

# **Comparative review of geochemical and exploitation data from fifteen geothermal operations in the Paris area for deep understanding and solving corrosion and scaling troubles**

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## **Abstract**

More than 50 geothermal operations (GOs) in France are exploiting low-enthalpy geothermal fluids (GF) of the Dogger aquifer in the Paris Basin. The GOs are generally made up of two wells (production-injection, both are about 1,800 m deep), and of surface installations. The GFs flow assisted by an immersed pump through the carbon steel (CS) casings to the surface without releasing their gases, and, after flowing through heat-exchangers, are re-injected into the same aquifer. GOs experience has shown that, in well casings, there are several CS corrosion and deposits of iron sulfides, when a high sulfide content was present initially in the GFs or acquired later by bacterial sulfate-reduction (BSR). Since 1990, progressively, the doublets were treated, using a well-bottom treatment tube, with various organic corrosion inhibitors (OCI), which have enabled GOs to eliminate most of their corrosion/scaling problems. However, new problems are now arising on some sites. In order to understand and control them, we present a comparative review of all the data obtained during several years from 15<sup>th</sup> GOs, from various anoxic and acidic GFs with varying degrees of mineralization and gases and different exploitation conditions. All GFs are treated by different OCI under different dosages. The corrosion rates (CR) were measured by both mass losses of CS samples exposed to the GF and electrochemical instantaneous methods. GF flowrate (m<sup>3</sup>/h) are correlated to sulfide, inhibitor and suspended matter contents and to CR. Solid matter gone up under different conditions, characterized mainly by XRD and SEM/XPS, gives aquifer particles (mainly pyrite, silica) and neo-formed minerals (mackinawite, pyrrhotite). Based on compositions of the GFs sampled at the surface, saturation indices (SI) for the relevant minerals are calculated by Phreeqc geochemical code. The simulations predict a constant super-saturation of all GFs with respect to pyrite. Mackinawite and pyrrhotite are, for most of GFs, undersaturated or very close to thermodynamic equilibrium, except for a few GFs, which show positive SI for these

two minerals, indicating potential precipitation. Only few of treated GFs present problems, because of their varying exploitation conditions.