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Composition of Deep Groundwaters
Problems and Solutions for the Operation of Geothermal Installations

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1. INTRODUCTION

The composition of (thermal) deep water, unadapted pumping conditions and pumping equipment, i.e. inapplicable pipes and treatment facilities, are responsible for various problems according to the exploitation of deep-water resources for balneological and geothermal applications. To guarantee the success of a long-term exploitation of a geothermal drilling a fundamental knowledge of the system enclosing chemical and physical interactions is of particular importance. Besides the for a sustainable utilization mandatory parameters such as temperature, pH-value, redox-conditions, chloride and sulphide contents, also parameters like gas content, microbiological conditions as well as the evaluation of the geothermal processes and the examination of the vulnerability of the resource by using isotope-physical investigations play an important role.

2. PHYSICO-CHEMICAL PROCESSES

A key point for the sustainable and long-term utilization is the investigation of corrosion processes and the characterization of formation of deposits in the geothermal system (Table 1). Corrosion and deposits are mainly influenced by the solubility of iron, the state of sulphur compounds and the ratio of the carbonate equilibrium, the gas content and the temperature.

Table 1: Overview of physico-chemical processes and their implication on the system

Process	Implication	Deposition
Degassing Change of the pH-value	Disturbance of the carbonate equilibrium	Precipitation of carbonate
Temperature reduction	Reduction of sulphate	Formation of pyrite Precipitation of silicate
Leakage, influx of air	Oxidation of hydrocarbons	Formation of biofilms

2. THE ROLE OF DISSOLVED GASSES

Another compound, which can have an influence on such systems, is methane. The origin of it has to be clarified and its behavior as reductive in deep water has to be assessed geochemically. Therefore, also the formation of biofilms has to be taken into account as well.

After completion of a drilling and of the installation of the associated equipment a monitoring program is mandatory which takes all the factors mentioned above into account?

In many boreholes the gas content of thermal water depicts specific problems. Therefore gas-physical investigations and modeling turn out to be an important tool for the sustainable utilization of a geothermal installation. In addition the extraction of gas can be of an important economic aspect for CO_2-rich ground waters (Fig. 1).

Carbon dioxide is one of many different factors, which can influence the solubility of dissolved constituents. Each of these factors has to be considered for the planning of distinct parts of the installation.

3. CONCLUSION

Summarizing, a monitoring and controlling program for geothermal installations has to be adjusted taking all important boundary conditions into account. Such a program has to be based on the understanding of the possible chemical, microbiological and physical processes in the geothermal cycle.

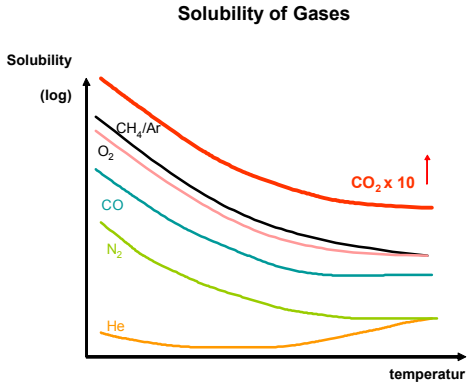

Figure 1: Temperature-dependent solubility of gases .