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Geochemical exploration of geothermal systems: applications and limits of solute geothermometers

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Hydrothermal systems are characterized by multiphase processes, which are responsible for heat transfer and complex chemical reactions involving the surrounding rocks. In active hydrothermal systems, hosted in volcanic, metamorphic or sedimentary settings, the geochemical study of thermal waters is crucial to understanding the features of the geothermal reservoir. In the last decades, a growing number of works have focused on the study of thermal waters with the final aim of evaluating deep temperature of geothermal systems. Solute geothermometers represent one of the major tools for the exploration of the subsurface geothermal resource as well as to estimate deep water temperatures and rock-water equilibrium at deep conditions.
In Giggenbach (1988), the thermal-water composition is used to classify groups of water and their origin, and to prove if water-rock equilibrium (i.e the equilibrium of a thermodynamically stable mineral phase with water) is attained (Giggenbach 1981). Under equilibrium conditions, water-rock interaction implies the simultaneous existence of dissolution, precipitation and exchange processes under given temperature, pressure and salinity conditions. If the equilibrium is attained, geo-thermometers can provide a realistic evaluation of the temperature. Alternatively, if the equilibrium is only partially attained or other processes are involved (e.g. seawater, cold brines, connate waters), interpretation of temperatures obtained from geothermometry equations requires to be critically evaluated in order to avoid over-interpretation of the analytical results. Details of methods and some application examples will be discussed.