FLUID-MINERAL EQUILIBRIA IN A HYDROTHERMAL SYSTEM, ROOSEVELT HOT
SPRINGS, UTAH

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The distribution of alteration minerals has been used extensively to
predict temperature and fluid chemistry associated with hydrothermal
systems. The availability of fluids and drill cuttings from the active
hydrothermal system at Roosevelt Hot Springs allows a quantitative
comparison between alteration mineralogy observed and mineral
equilibrium calculated for the coexisting reservoir fluid.

The composition of the deep reservoir fluid at Roosevelt Hot
Springs, calculated from analyses of liquid and steam fractions, is
NaCl in character with 9900 ppm T.D.S. At 250°C and pressures
corresponding to liquid-vapor equilibrium of H_2O, pH=5.6, PCO_2=14 atm,
log PO_2 is between -35 and -38 atm, PH_2S=.023 atm, and log activity
ratios are K^+/H^+=3.3, Ca^{++}/H^{+2}=-0.5 and Mg^{++}/H^{+2}=-3.9. The maximum
reservoir fluid temperature is estimated to be 278°C.

Theoretical alteration mineral assemblages in equilibrium with the
deep reservoir fluid at 150°, 200°, 250° and 300°C in the system Na_2O-
K_2O-CaO-MgO-FeO-Fe_2O_3-Al_2O_3-H_4SiO_4-H_2O-H_2S-CO_2-HCl were calculated and
compared with alteration assemblages described by Ballantyne (1978,
1980), Parry (1978) and Rohrs and Parry (1978) from producing geo-
thermal wells. Minerals theoretically in equilibrium with the cal-
culated reservoir fluid at >250°C include sericite, K-feldspar, quartz,
calcite, pyrite, and hematite. This assemblage corresponds with
observed higher-temperature (>225°C) alteration assemblage in the
deeper parts of the producing wells. The presence of montmorillonite
and mixed-layer clays with the above assemblage observed at temper-
atures <225°C corresponds with minerals predicted to be in equilibrium
with the fluid below 250°C.

Hg AND As SOIL GEOCHEMISTRY AS A TECHNIQUE FOR MAPPING PERMEABLE STRUCTURES OVER A HOT-WATER GEOTHERMAL SYSTEM

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A multielement soil geochemical technique has been developed to map fault distributions over active geothermal systems. At the Roosevelt Hot Springs KGRA, Utah, nearly 550 soil samples on a 500 ft. grid spacing covering approximately 4 square miles were collected and analyzed for Hg and As using, respectively, gold film and colorimetric techniques. Hg concentrations within the survey area range from 10 to 5,300 ppb with a local threshold value of 58 ppb; As concentrations range from <1 to 41 ppm with a local threshold value of 6 ppm (Bamford, Christensen, and Capuano, in prep.).

Geochemical anomalies occur in a series of closely spaced NE and NW-trending zones that parallel the major fault directions within the geothermal field (Nielson et al., 1978). Portions of these anomalies, not associated with mapped faults, are believed to reflect concealed faults within the alluvium. Zones of high permeability characterized by extreme enrichment of Hg and As and, in places, hot spring deposits, typically occur at the intersections of these NE and NW structural trends. The distribution of Hg and As suggests that faults are more widespread in the alluvial covered portions of the geothermal field than have previously been mapped and that the intersection of NE and NW-trending structures are of fundamental importance to near-surface fluid flow.

The results of this study suggest that soil geochemistry can be used to map faults that lack surface expressions but have hydrologic importance to the reservoir, and can therefore be an effective geothermal exploration tool, particularly in areas with alluvial cover.

An Overview of the Chemical Aspects of Mineral-Solution Interaction in
Leach Systems.

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The reaction of ore and its host rock with lixiviants results in a
complex series of recrystallization, solution and deposition reactions. The
end products of this interaction depend on many factors, the major ones being
temperature and pressure, solution composition, mineralogy, time of interaction,
rate of solution flow, and permeability of the rock. The successful development
of any leaching operation depends on quantitatively predicting the nature and
rates of numerous chemical reactions.

This overview summarizes the progress made to date in areas critical to
the understanding of chemical interactions in leach systems. These areas
include: electrolyte solution models, gas equilibria, heterogeneous mineral-
solution equilibria and kinetics, oxidation-reduction kinetics, and adsorption
and ion exchange phenomena. Future research directions needed to fill gaps in
our data base and upgrade existing computer models are also discussed.

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