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Inferences on physico-chemical conditions and gas-water interaction by new quantitative approaches: The case of Panarea (Italy)

A. CARACAUSI[1], M. DITTA[1], F. ITALIANO[1], M. LONGO[1], R. MAUGERI[1], P.M. NUCCIO[2], A. PAONITA[1] AND A. RIZZO[1]

[1] Istituto Nazionale di Geofisica e Vulcanologia – Sezione di Palermo, Via Ugo La Malfa 153, 90145 Palermo, Italy
[2] Dipartimento Chimica e Fisica della Terra ed Applicazioni, Via Archirafi 36, 90123 Palermo, Italy (paonita@pa.ingv.it)

We have developed two new quantitative approaches to calculate temperatures in hydrothermal reservoirs by using the CO_2-CH_4-CO-H_2 gaseous system and to model selective dissolution of CO_2-H_2S-N_2-CH_4-He-Ne mixtures in fresh and/or air saturated seawater. The anomalous outgassing starting November 2003 from the submarine exhalative system offshore Panarea island (Italy), was the occasion to apply such approaches to the extensive collection of volcanic gases.

Gas geothermometry suggest the presence of a deep geothermal system at temperature up to 350°C and about 12 mol% CO_2 in the vapor, which feeds the submarine emissions. Based on the fractional dissolution model, the rising geothermal vapor interacts with air-saturated seawater at low depths, dissolving 30-40% CO_2 and even more H_2S, modifying the pH of the aqueous solution and stripping the dissolved atmospheric volatiles (N_2, Ne). Interaction of the liquid phase of the thermal fluids with country rocks, as well extensive mixing with seawater, have been also recognized and quantified.

The measured output of hydrothermal fluids from Panarea exhalative field [1] accounts for the involvement of volatiles from an active degassing magma, nonetheless the climax of the investigated phenomenon is probably overcome and the system is new tending towards a steady-state. Our quantitative approaches allow us to monitor the geochemical indicators of the geothermal physico-chemical conditions and their potential evolution towards phreatic events or massive gas releases, which certainly are the main hazards to be expected in the area. The event at Panarea has in fact highlighted how hydrothermal systems can exhibit dramatic and sudden changes of their physico-chemical conditions and rate of fluid release, as a response to variable activity of feeding magmatic systems.

References

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All acid waters are not equal: Biological differences between Yellowstone's acid waters and acid mine waters

D.K. NORDSTRÖM

U.S. Geological Survey, 3215 Marine St., Suite E-127, Boulder, CO 80303 USA (dkn@usgs.gov)

During investigations of acid waters, both thermal and non-thermal, at Yellowstone National Park, fly larvae were discovered to reproduce in waters with pH values between 2 and 3. Complex organisms such as these have never been found in acid mine waters of identical pH.

In Brimstone Basin, Yellowstone, large quantities of elemental sulfur are oxidizing in an altered terrain where no thermal activity exists today and the drainage waters are of ambient temperature. The main drainages are Alluvium Creek and a tributary of Columbine Creek with waters having pH values of 2-3. Thousands of fly larvae were discovered in Alluvium Creek water of pH = 2.05. These larvae were later identified by morphology as belonging to the family *Diptera: Ephydridae*, probably genus *Ephydra*, an organism known to be adaptable to extreme ranges in water composition. The species *Ephydra thermophilia* has been described [1] for thermal springs and their survival through the winter depends on geothermal heat. Because there is no heat at Brimstone Basin, it is not known how they survive the winter.

In Norris Geyser Basin, Yellowstone, active fly larvae were found in a small spring with pH = 2.87, temperatures of 30-40ºC, and a concentration of As of 5.4 mg/L. These larvae were later identified as *Diptera: Stratiomyidae* or "soldier fly." Soldier fly larvae have been found in several warm acid drainages at Norris by Park naturalists.

Acid mine waters of the same pH have never been observed to contain fly larvae. The most complex life forms in acid mine waters have been ciliates and rotifers living at pH 2-3 in the presence of abundant organic material from rotting mine timbers and microbial growth [2]. The main difference in the chemistry of Yellowstone's acid waters and that of typical acid mine waters is the near absence of any trace elements (typically < 10 ppb for Cu or Zn and < 0.1 ppb for Cd). Also H^+ is the main cation in the Yellowstone waters whereas Fe and Al are the main cations in acid mine waters of pH 2-3. It appears that the presence of absence of transition metals is the main chemical property that determines the possibility for growth of aquatic invertebrates.

References

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