Geochemical and geophysical coupling study of the karstic aquifer between Saïs Basin and the Causses of the Middle Atlas (Morocco). Fez-Meknès area

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The population growth in the region of Fez-Meknès (1.6 Million), accentuated by the increasing number of wells for agriculture, and by the increasing aridity in recent years, poses the problem of controlling water of sufficient quality and quantity over time.

This fractured karstic Basin mainly composed of Liassic dolomitic limestones overlying Triassic basalts, shales and evaporites, is the main drinking water supply in the region. The karstic reservoir presents a decline in its chemical quality and ponctually some turbidity problems.

To better understand this system and the interactions between different aquifers and aquitards, we conducted coupling study on:

i) geochemistry (major and minor elements, $\delta^{18}O$, δD and ^{222}Rn) of the main springs of Liassic and Triassic origin that could be connected each other and with the major spring of Bittit;

ii) electromagnetic multi-scale tomography for separating draining faults from not draining faults (geological structure).

The geochemistry of water during the three surveys in 2009 and 2010 shows a major Liassic origin for Bittit, Ribaa, Aguemguam, Amansayarmine, Bou Youssef and El Hajeb springs, and a major Triassic origin for El Mir, Sbaa 2, Maarouf1 and Maarouf2 springs. Radon 222 (T=3.85days) has highlighted the existence of areas of rapid exchange between waters of Liassic aquifers characterized by low Radon activity (3500 Bq/m^3) and waters of Triassic aquitards characterized by a high Radon activity (> 12000 Bq/m^3). The transit time from the Triassic aquifer is less than two weeks. Analyses of $\delta^{18}O$ versus δD show only a slight excess of Deuterium, this characterizes a local recharge of the groundwater.

Geophysical measurements of resistivity and conductivity show anomalies in the direction of Bittit and perpendicularly to the Causses, confirming the presence of a preferential drainage where Liassic waters of high quality mix with those in contact with the Triassic aquitard.

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Natural ferrihydrite: Impact of structure and composition on redox cycling

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Synthetic ferrihydrite (Fh) is typically used in laboratory studies and in the field, to a lesser extent, as a model compound for natural Fh in terms of understanding its sorption capacity, reactivity, stability, and dissolution and transformation behavior. All are properties that make naturally occuring Fh one of the most important natural Fe (III) oxyhydroxides in geochemical systems undergoing biogeochemical cycling of iron and redox-active contaminant metals such as U.Although much is known about synthetic Fh, recent research by our group calls into questions its relevance to natural systems. Many past studies have suggested that natural Fh often contains a suite of impurities (e.g. Zn^{2+}, Cr^{3+}, Al^{3+}, silicate, phosphate, organic carbon complexes) that can range widely depending on the conditions of Fh formation. It is less clear, however, how impurities impact the bulk and surface structure of Fh and its reactivity and stability. Our recent work [1] on natural Fh formed in an acid mine drainage system demonstrated that impurities, mainly Al, Si, and natural organic matter, increased structural disorder and decreased average particle size. Such details are important as they are likely to have significant impact on the biogeochemical reactivity of Fh.

While our picture of synthetic Fh structure continues to improve, little is known about the individual and cumulative effects of structural disorder (e.g. lattice strain and cationic vacancies), size, and composition on electron transfer processes occurring in Fh under reducing conditions. Processes related to the Fe (II)-induced reductive transformation are important, for example, because of the potential for environmental contaminants such as uranium to be directly incorporated in Fh transformation products. Our current work aims to better understand the links between the structure/composition and biogeochemical reactivity for both natural Fh and synthetic analogues to natural samples.

[1] Cismasu *et al*. (2011) *Comptes Rendus Geosci*. In press.