Magnetic characterization of ghost rocks from the Sterkfontein cave (South Africa): are iron oxides linked to biological activity?

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The Sterkfontein caves system in the Cradle of Humankind (South Africa) is a karstic environment resulting from a ghost-rock karstification process that developed in the Malmani dolomite formation presenting interlayered more resistant chert layers (Bruxelles, 2017). This process of karstification occurs under low hydrodynamic conditions leaving in place a residual highly porous altered rock, which preserves the structure of the initial bedrock, and which is called “ghost rock”. Due to its high porosity and in the presence of water, ghost-rocks can represent a potential habitat for microorganisms, ubiquitous on and in Earth, with metabolisms mainly relying on dissolution or precipitation processes of minerals. Thus some secondary mineralizations of manganese and iron oxides, found associated to microorganisms in cave systems, could have a biological origin (Banerjee and Joshi, 2012). To better characterize the alteration phases and understand the process of karstification and the potential role of microorganisms and biofilms, samples including dolomitic bedrock, cherts and ghost-rocks were collected at the Sterkfontein cave system. We report here magnetic properties of powdered samples (low-field susceptibility, hysteresis parameters, saturation magnetization and MPMS measurements). In parallel to these magnetic measurements, XRD analyses, FTIR spectroscopic analyses and microscopic observations (SEM) have been realized in order to better characterize the mineralogy of bedrock and secondary phases and to better constrain the alteration processes. We observe that the ghost-rock is mostly composed of quartz and oxides. The magnetic phases detected are mainly hematite and goethite, precipitated on the quartz grain boundaries. These first observations could be explained by a total dissolution of the main bedrock (dolomite) and a partial chemical alteration and mechanical erosion of cherts. To go further, an additional microbial ecology study in the cave system is needed to better constrain the role of microorganisms in the precipitation of oxides detected.
