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Investigating a hydrothermal venting scenario at the Bahariya Oasis, Western Desert, Egypt

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The Bahariya depression (BD) (or Bahariya Oasis) is located in the Egyptian Western desert about 300 km SW of Cairo. The depression stretches for approximately 90 km along a NE-SW direction. The BD is known since Roman times for its thermal springs. Hot fluids were still emitted at the surface in the late 70ies before agricultural development caused the deepening of the groundwater table. Today, hot fluids are found at shallow depths and extracted for thermal bathing and farming.

The oldest exposed rocks cropping out in the BD are of Early Cenomanian age and mainly consist of sandstones and claystones. Magmatic formations are also found in the BD and crop out as isolated basaltic formations. The most prominent tectonic feature dissecting the whole area is a NE-SW trending strike-slip fault system along which the depression developed. Satellite images reveal that large part of the BD area is characterised by concentric features (similar in shape to impact craters) that increase in number approaching the fault zone.

A cross section of these features resembles to flattened crater-like structures (up to 10 m in height) with steeper external flanks and a gently dipping internal zone. Their average diameter is about 100 m. However, some of the largest features may reach nearly 400 m in diameter. We performed CO_2 and CH4 soil gas flux measurements completing profiles across the structures finding a higher concentration of CO_2 approaching the center. No significant CH4 flux variations were observed through the profiles. The central zone of one structure was targeted for detailed investigations. The samples recovered are characterised by the presence of halite-cemented breccias. XRD and semi-quantitative SEM analysis indicate the presence of mineral phases typical of hydrothermal circulation. In particular, some of the K-feldspars analyzed show a Ba-rich core with outer rims with no Ba content. One of the K-feldspar phases is sanidine and does not appear as an overgrowth but it is a primary phase. Quartz is often rimmed by a phyllosilicate phase of the montmorillonite group, grew probably during the final phases of hydrothermal circulation. We also identified a Zn-Al-F-silicate, that we speculate may be hemimorphite, a typical low-T phase occurring in hydrothermal environments. In addition, zircon, rutile, quartz and microcline are easily recognized and halite, brushite, bornite and diopside are detected by XRD analysis. Considering the textural relationship between the minerals it can be inferred that the Ba-bearing K-feldspar was the first phase to crystallize while the euhedral sanidine grew afterwards. SEM images indicate the textural evidence of channeling implying that high-T fluids were flushing the system and inducing the precipitation of the minerals. The paragenesis and the petrographic structures of the identified mineralogical assemblages indicate circulation of high temperature fluids flushed from these vents towards the surface. This evidence is consistent with large-scale field observations and with a scenario envisaging the paleo-venting system focusing hydrothermal fluids at localities near the faulted zone.