Hydrogeological and geochemical characterisation of a mantled evaporite karst based on hydrogeochemical data

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The dissolution of soluble minerals present in sediments and rocks due to the action of groundwater flow may cause the subsidence of the overlying material and eventually the settlement of the ground surface with the formation of sinkholes. Very frequently the anthropogenic activities (mainly irrigation and agricultural practices) activate or accelerate the processes involved in the generation of sinkholes, favouring its development.

In this study, the hydrochemical features of the Ebro valley mantled evaporite karst in Zaragoza city area (NE Spain) are investigated in order to shed light on the functioning of the interconneted karst and alluvial aquifers and to identify the hydrogeological and hydrochemical processes and factors involved in sinkhole genesis. The surroundings of Zaragoza city are probably the area in Europe where subsidence due to evaporite karstification has a greater socio-economic impact.

With these aims, a review of the hydrochemical information contained in the public database maintained by the Ebro Waters Authority was done. Moreover, several hydrochemical field sampling campaigns were carried out and their results were interpreted with the assistance of classical ion-ion plots, statistical calculations and geochemical modelling.

The preliminary results obtained in the study suggest that the main feature controlling the hydrology and hydrochemistry in the studied area is the fluctuation of water levels and compositions seasonally caused by irrigation. Other important factors are: (1) halite and calcium sulfate dissolution, (2) differences in the chemical composition of the irrigation waters upstream and downstream Zaragoza, as clearly observed in small sinkhole lakes, and (3) local focused discharge of more saline waters from the evaporite aquifer into the overlying alluvial aquifer.

Pyroxenite xenoliths from Cenozoic alkaline basalts, Bohemian Massif

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The Cenozoic alkaline basalts from the Bohemian Massif contain abundant mantle xenoliths. They predominantly spinel lherzolites and harzburgites, but also rare wehrlites, olivine-bearing clinopyroxenites and websterites. Mantle peridotite (lherzolite-harzburgite) from Kozákov volcano (Lusatian fault, NE Bohemia) and Lutynia (SW Poland) show similar evolution – melt extraction followed by basaltic melt cryptic metasomatism [1,2]. Nevertheless, position of pyroxenites in these scenarios remains unknown.

We studied pyroxenites from Dobkovičky, Kuzov (both in Ohře/Eger graben), Kozákov and Lutynia. The studied xenoliths have different textures. While olivine/spinel-bearing clinopyroxenite from Kozákov has equigranular texture with common orthopyroxene exsolution lamellae within clinopyroxene grains, Dobkovičky clinopyroxenite show cumulate texture with large clinopyroxene grains and orthopyroxene present only on their grain boundaries. Olivine-bearing websterite from Kuzov has equigranular texture while Lutynia spinel-bearing clinopyroxenite-websterite has cumulate (clinopyroxene with orthopyroxene lamellae) texture with spinel symplectite. The pyroxenites from Kozákov, Dobkovičky and Lutynia yield a range of two-pyroxene equilibration temperatures from 820 to 900° C. In contrast, Kuzov websterite has higher equilibrium temperature of 1050° C. The #Mg numbers of clinopyroxene and orthopyroxene from Kozákov and Lutynia vary from 91.3 to 92.8 and 90.0 to 90.7, respectively and therefore fall within the same range as reported for peridotite [1,2]. Clinopyroxene from Kozákov pyroxenite show LREE enrichment suggesting its formation from basaltic melt derived in spinel-bearing peridotite stability field. Dobkovičky clinopyroxenite show lower #Mg (89.4 and 86.4, respectively). Taking into the account this low value and its texture, it is likely that represents cumulate from the host basalt.

[1] Ackerman *et al*. (2007) *Journal of Petrology* **48**, 2235-2260. [2] Matusiak-Malek *et al*. (2010) *Lithos* **117**, 49-60.