

V INTERNATIONAL SYMPOSIUM ON KARST

MALAGA, SPAIN 14TH - 16TH OCTOBER 2014

Annual meeting of IGCP 598 Project of UNESCO

INTRA-SYMPOSIUM FIELD TRIP 3

Evaporite karst - Fuente Piedra and
Archidona wetlands

15TH October 2014



Intra-symposium field trip to evaporite karst areas: Fuente de Piedra and Archidona wetlands

Key features

Departure: Wednesday 15th October (8.30 am) from Malaga city (Hotel Malaga Palacio)

Return: Same day 15th October (7:30 pm approx.)

Number of places: 50 (maximum), by rigorous order of inscription

Registration deadline: 1st September 2014

Price: included in registration fee (both trip and lunch)

General description

The intra-conference field trip 3 will be held the 15th October 2014, during the celebration of the 5th International Symposium on Karst (ISKA), coinciding with other intra-symposium field trips. Guided by hydrogeologists from the Centre of Hydrogeology of the University of Malaga (CEHIUMA) and from the University of Granada, the participants will have the opportunity to visit some of the most interesting Andalusian wetland areas associated with evaporitic karst aquifers:

- Fuente de Piedra wetland
- Archidona wetlands and Los Hoyos evaporitic karst aquifer



Aereal view of Fuente de Piedra lagoon



Archidona wetlands (Grande wetland area)

The main goals of this excursion are to present the geological-hydrogeological context of some wetlands related to evaporitic karst aquifers in this part of the Mediterranean. During the field trip, assistants will also visit an area where evaporitic karst geomorphology is especially significant: Los Hoyos area, which shows one of the most spectacular evaporite karstic landscapes in Spain.

In Andalusia (southern Spain), a wide extension of terrain constituted fundamentally by clays and evaporite rocks (gypsum and salt) exists, including other lithologic blocks. All these materials, termed Chaotic Subbetic Complexes (CSC), appear highly deformed and brecciated, with an internal disorganized and chaotic structure. Traditionally, low permeability has been assumed for these formations. Nevertheless, the presence of evaporitic rocks increases the porosity and permeability constituting an aquifer by dissolution/karstification processes. As a consequence, unstable karst conduits and cavities have been originated giving place to collapse and subsidence phenomena, sinkholes and surface depressions; which are favorable places for wetlands formation.



View of Chaotic Subbetic Complexes (CSC)

The lithological heterogeneity and the geological processes related to endorreic areas formation confer to the CSC materials a certain hydrogeological complexity, with groundwater flows of different length, to different scales, from recharge areas (diffuse infiltration and concentrated recharge via sinkholes) to discharge zones: wetlands and springs (generally located in riverbeds). Thus, wetlands and springs placed at lower altitudes are associated with large (regional) groundwater flows, of greater residence time within the aquifer, and they normally drain highly salinity waters. Wetlands located in these contexts, such as Fuente de Piedra wetland, turn into discharge places of groundwater (discharge wetlands), where the period of seasonal flood is generally prolonged or even permanent. On the contrary, if phreatic groundwater level remains below the bottom of wetlands, these constitute a recharge component in the water balance of the aquifer (recharge wetlands); they are generally ephemeral and with low salinity water. Finally, wetland areas located in an intermediate position between recharge and discharge zones (transit wetlands) do not constitute the last

destination of groundwater flows, but rather those go towards other wetlands and springs situated at lower altitudes. The last is the hydrogeological context of Archidona wetlands.

Provisional list of stops

- ✓ **Fuente de Piedra wetland:** the first stop of the field trip will be in this endorreic area of 153 km² situated on the Atlantic-Mediterranean divide. Concretely, Fuente de Piedra is the largest “lake” in Andalusia (13 km²) and one of the largest salt lakes in Spain. In conditions of maximum storage the water rarely exceeds 2 m in depth, whereas it is usually drying out in summer. The Fuente de Piedra lagoon is included in the Ramsar International Convention, which was ratified by Spain in 1982. It is a continental, karstic wetland that lies over evaporitic rocks and contains saline water of a sodium chloride facies. The common salt that is precipitated was exploited commercially until relatively recent times.

Within the lake, there are various elements forming hummocks, of varying shapes and sizes, which are remains of the infrastructure created for extracting salt. These structures include groynes that are now used by nesting pink flamingos (*phoenicopterus ruber roseus*); the area, thus, is ecologically valuable and has been declared a Nature Reserve. This category represents the highest level of protection in Spain against transformation or alteration.

The endorreic basin of Fuente de Piedra is a depression formed by progressive sinking of the terrain, which in turn is the result of the dissolution and collapse of the evaporitic materials that developed during the Triassic and which underlie all the materials in the area. In addition to the karstification of the substrate, this process was also subject to the groundwater flows towards the lake, which contributed to the dissolution of the evaporitic materials affected by these flows and, thus, to the definitive establishment of an endorreic basin.



Fuente de Piedra lagoon during high flooding condition (above), and in dry condition (bottom).



- ✓ **Archidona wetlands and Los Hoyos evaporitic karst aquifer:** After lunch, a small trip will be done to visit the Archidona wetlands (Grande and Chica). Both wetlands must be considered as a part of a larger geological, geomorphologic and hydrological context, which includes the totality of Los Hoyos diapiric structure, a CSC outcrop of 20 km² that extends between the provinces of Malaga and Granada.



Panoramic view of Los Hoyos area

Over the diapiric structure a singular karst landscape has developed, characterized by the presence of a high number of dolines (showing different typology), small closed endorreic areas, springs, etc. Most of dolines are distributed in the central part of Los Hoyos area due to the presence of gypsum in the nucleus of the diapir. Altitude of doline basements is higher at southern and eastern zones whereas is lower in the western part, where Archidona wetlands are located.

Recharge in Los Hoyos karst aquifer takes place by infiltration of rainwater on aforementioned endorreic areas, while discharge occurs fundamentally via springs, located nearby wetlands. The main spring (Molino de los Aguileras) has an estimated mean discharge of 15 L/s. Nevertheless, the most spectacular hydrogeological manifestations of this system are Grande and Chica wetlands, which occupy dolines whose basements are permanent or occasional below phreatic surface. Each of them has an approximate surface of 7 ha. Grande



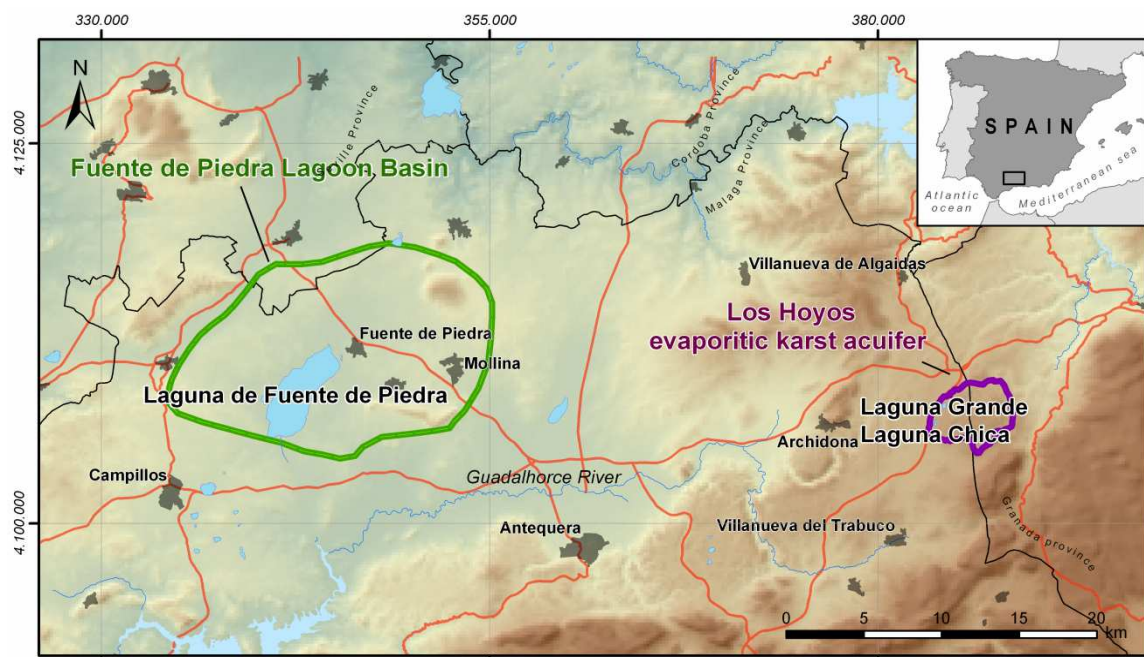
Chica wetland during low flooding condition (above) and during high flooding condition (bottom).

reaches a maximum depth of 13 m, whereas Chica, less deep, has a kidney-shaped form and, in low water conditions, two water bodies separated by the central sector of the wetland appear. In addition to these two principal wetlands, in Los Hoyos area other dolines exist that only remain flooded during few months after exceptionally rainfall events. Under these meteorological conditions, phreatic surface go up, reaching the doline basement and flooding it.



Grande wetlands in winter

Location map



Pictures by Centre of Hydrogeology of the University of Malaga.