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A Quaternary paleolake in a sinkhole at Cassis (SE France) : a geomorphology and geophysical study

C. Romey (1), P. Rochette (1), C. Vella (1), B. Arfib (2), C. Champollion (3), P. Dussouillez (1), D. Hermitte (1), and J-C. Parisot (1)

(1) CEREGE, Europole de l'Arbois BP80, 13554 Aix-en-Provence Cedex 3, France, (2) Laboratoire de Géologie des Systèmes et Réservoirs carbonatés, Aix Marseille-Université, Place Victor Hugo, 13331 Marseille Cedex 3, France , (3) Laboratoire Géosciences, Université Montpellier II, Place Bataillon, Montpellier, France

The Lower Provence and the Massif des Calanques, near Marseille, are a key area in understanding the mechanisms of evolution of the Mediterranean climate and the study of human impact on the local environment during the Quaternary. However, a continuous continental record of paleoenvironment in coastal Provence was not previously available. Looking for such a record, we discovered in a coastal alluvial plain a small paleolake filling a sinkhole that occurred in a marl sequence topping pure limestones at an altitude of 80 m, and a distance to the sea of 2 km. The sinkhole is close to the outlet of a small catchment area of about 8 km^2. Limestone is massive but much fractured and therefore suitable for the development of karst. The drilling sedimentary sequence of 50 meters is mainly resulting from the weathering of Cretaceous marls. It consists of 5 meters of oxidized brown clay deposit which covers 45 meters of laminated lacustrine gray clay with sandy past. Cretaceous marls are at the base of the sequence. The presence of marls pebbles in the last meters of the sequence reflects the collapse of the sinkhole. The lacustrine clay was probably deposed during stages isotope 2 to 4 (48 ± 3 ka C14 date at 23 meters depth), whereas brown clay deposit was interpreted as Holocene paleosol.
Combination of surface observation, drilling and geophysical studies (gravimetry and Electrical Resistivity Tomography) allows to constraint the geometry of the paleo-polje that formed during glacial period. Lake diameter was likely of the order of 200 m. It evolved from a deep lake to a swamp (probably Holocene, dating in progress) and it was drained in roman times for agriculture.
Locally, this discovery has implications for the understanding of karst processes and water resources. The relationship between the sinkhole, rooted at circa 100 m below surface according to gravimetric modeling and the underground karstic river of Bestouan is strongly suggested by underwater exploration and hydrogeologic investigations.