Origin of the collapse sinkholes of the Boukadir region (Chelif-Algeria)

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Algeria offers a large variation of karstic landscapes (Collignon, 1991). This study focuses on the Messinian carbonate platform outcropping in the northern piedmont of Ouarsenis mountains and extending below the Chelif plain. Boukadir has not been classified as an Algerian karstic area. In June, 1988, in the region of Boukadir, northwestern Algeria, a large collapse sinkhole of 60 m in diameter and 35 m deep in the Chelif plain and it broke the national road RN4. This collapse sinkhole suggests that there were large underground cavities under the Quaternary alluvium, at an altitude near or lower than the present sea level. In the piedmont, there is another large collapse sinkhole perched high up called "Bir el Djeneb". Our aim, is to analyse the processes that lead to the formation of these sinkholes, using geological, speleological, and geomorphological data.

The Ouarsenis piedmont is made up of 3 main geological units. The basal Tortonian to Messinian blue marls are overlain by a 70 m thick bioclastic carbonate unit, and thereupon by 80 m of homogeneous Lithothamnium carbonate packstones (Neurdin- Trescartes, 1992; Moulana et al., 2021). A drill hole S1 was made in the Chelif plain, and it reveals that the same carbonates outcrop at 61 m depth under the plain. The cross-section based on 6 mechanical drill cores (Scet-Argi, 1985) parallel to the piedmont (Fig.1.a), highlight a 70 m deep incision in the carbonate at the level of the present river Oued Taflout, filled by a basal 35 m thick light brown clay unit with some gravels, then by a 30 m thick alluvium composed pebbles and gravels. The speleological analyses are based on Birebent (1947) evidenced five caves. The most considerable karstic feature is Bir Djeneb, a cylindrical pit about 20 m in diameter and 63 m deep, located 5.5 km SW of Boukadir. It is dug mostly in unconsolidated sediments with carbonates outcropping at its base (Fig. 1. b). Geomorphological analyses show a well-developed hydrological network on the carbonate piedmont, the lack of sinkholes and poljes, an important fracture/fault network and the occurrence of shelter caves at different levels attesting from the progressive incision of the drainage network.

The results show that an atypical karst with very minimal present-day surface weathering and deep active karstification. The development of a surface calcrete enhanced surface flow and the development of the hydrological network. The carbonate facies and pervasive vertical factures still favours a diffuse infiltration, which reduced localized dissolution and flow, and preventes the development of large caves. The endokarst is poorly developed whereas the epikarst is prevalent and characterized by shelter caves. The large voids deep below the present-day base-level are inferred to be a paleokarst related to the Messinian Salinity Crisis who lowered the Mediterranean Sea level. However, the link of Bir Djeneb with the MSC, is not evident. The genetic relation of the two holes thus remains problematic.

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Figures

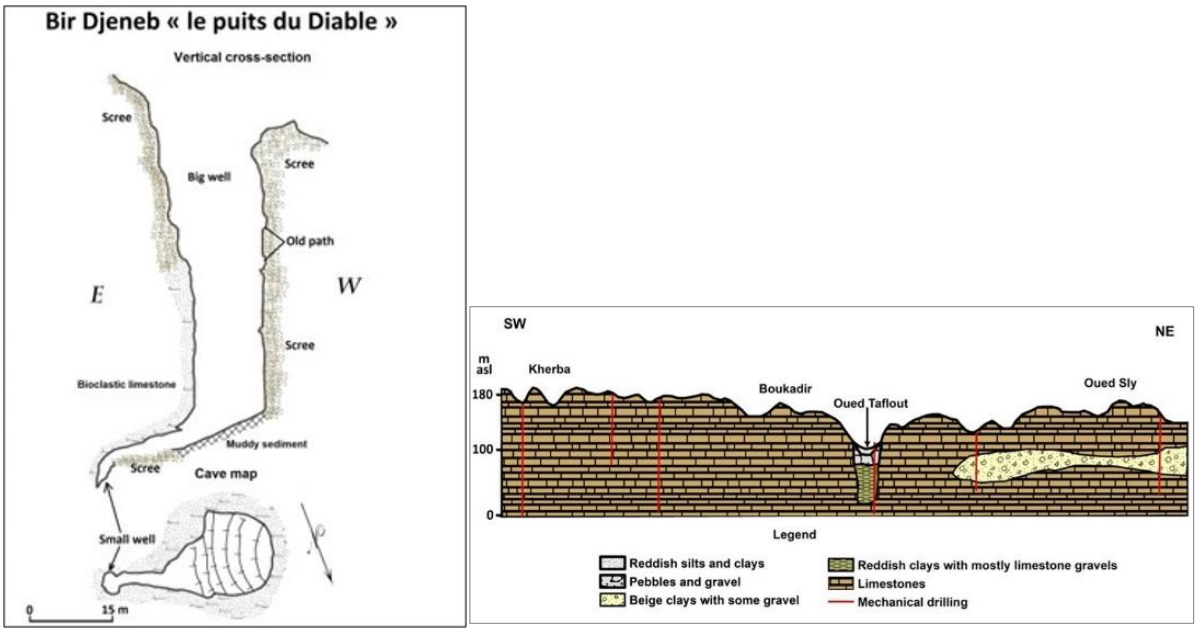

Figure 1. a. Map and cross-section of Bir Djeneb cave, northern Ouarsenis piedmont; after BIREBENT, 1947, modified. **b.** Reinterpreted geological cross-section based on 6 mechanical drill cores parallel to the piedmont and across Oued Taflout (Scet-Argi, 1985). The section shows a ~ 70 m deep Messinian incision at the location of Oued Taflout filled first by ~40 m of clay and then by coarser alluvial deposits.