Rend. Online Soc. Geol. It., Vol. 16 (2011), 19-20, 1 fig.

Geomorphological settings and tufa models in Algibre flexure (Algarve, Portugal)

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KEY WORDS: *tufa, travertine, karst, Algarve, Portugal.*

INTRODUCTION

Percolating water through organically enriched soil, raises the water pCO_2 promoting an increase in carbonates dissolution. Following subaerial exposure, the water-atmosphere interaction, leads to an oversaturation of water $CaCO_3$ and precipitation (PENTECOST, 2005; CHAFTEZ & FOLK, 1984). This precipitation can be inorganic, biologic or both (PEDLEY, 2009). The tufa facies presented in this work, follow GUERREIRO *et alii* (2010) and PEDLEY (1990) and the accumulation models follow PEDLEY (2009).

In Central and Western Algarve over de Mesozoic limestone substrate, there are many tufa outcrops, with main outcrops occurring along the streams of Alte, Mercês, Cadouço, Rio Seco and Asseca.

Algarve is the southernmost Portuguese region in the Iberian range, developed in three main geomorphological settings (FEIO, 1952). In the north, the mountainous area is mainly composed by Carboniferous schist and greywacke, and a Late Cretaceous intrusive massif in the west. In the south, develops the meridional Meso-Cenozoic Algarve basin, composed by the Triassic and Jurassic lithologies known as Barrocal with Cretaceous and Cenozoic sediments and the Littoral with Cenozoic topographically lower and eroded by the shore realm.

HYDROLOGICAL SYSTEM

The Algibre flexure is the main geomorphological feature in the area, where the karst is well developed as aquifer's recharge area (ALMEIDA, 1985). The highest hills (350 to 380 m) are bare and soddy karst plain areas, where surface runoff is very low (e.g. Cabeça Gorda and Rocha). Lower colluvial areas have also low runoff conditions, because most are also low gradients (< 3°) and some have dolines and sinks (e.g. Campina dos Galegos or Rossinas).

Discharge areas are located on the North and the South, but in different settings. Discharge to Mercês basin (North) is controlled by impermeable Triassic lithologies along high gradient slopes. All springs are intermittent and discharge is linked to the Mediterranean climate wet season.

In the South, the discharge occurs along low gradient streams like Cadouço or São Lourenço. Different discharge settings result in different deposition systems as suggested in PEDLEY (2009).

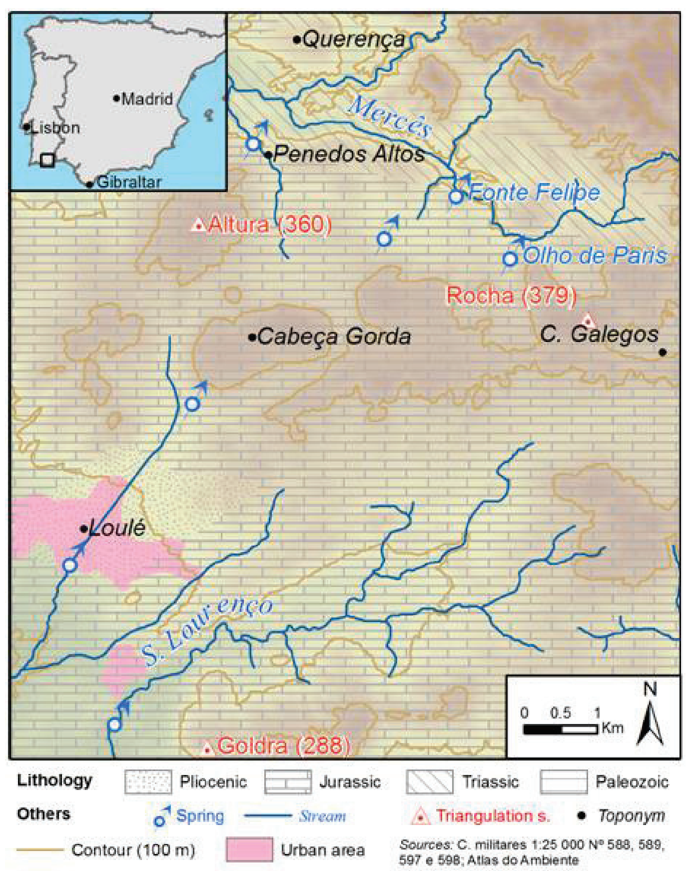

Fig. 1 – Location map of the study area

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PERCHED SPRINGLINE TUFA

Springs in the Mercês basin are commonly perched and in low runoff karst, enhancing the development of perched springline model, where Pedley (1990) suggested proximal and distal deposits. Mature proximal deposits have wedge morphology with fan-shape, shaping low gradient terrace with a slow braided flow, sometimes with some ponds. In this area only the Olho de Paris can be classified as mature, with a 300 m long and wide, one small pond next to spring and many channels that spread from the old anthropic bank.

High gradient at downstream edge enhance the sedimentation on cascades, producing moss curtains (subvertical moss laminar bioherm) intercalated by other bioherms and phytoclastic tufa on small pools and short low gradient channels where the upper macrophytes detritus (stems, fruits and leaves) accumulate leading to the development of tufa microdams and decimeter pools. Due to the high permeability in these systems, sometimes dissolution structures are present (Ordoñez & García del Cura, 1983). Decimeter scale holes in Penedos A. are covered by syngenetic speleothems and flowstones, however, there could have been a former hollow in the waterfall deposits now partially destroyed.

Distal deposits in the above mentioned model are mainly composed by phytoclastic tufa and locally bioherm tufa developed on channels. However, in this model low gradient alluvial deposits exist downstream. Not only Olho de Paris but also Penedos Altos outcrops are followed by important stream sediments fed by the turbidite formations in the surrounding mountainous areas, with the high energy flow destroying the most recently deposited tufa. There are few situations where gravel and cobble is strongly cemented on modern stream, as in the case of the downstream of Olho de Paris or some strata from ancient accumulations.

There are other incrusting springs in the area, but the low discharge related to the geomorphological or hydrogeological settings prevent the outcrops maintenance.

FLUVIAL TUFA

In the southern low-gradient streams, fluvial models develop. The main modern features in the area are the waterfalls up to 5 m and channels, where the main facies are macrophytes, moss and other lamellar bioherm tufa and oncoids.

This is an intermediate model for braided fluvial model and barrage model, where valleys are incised but incipient discharge associated to the Mediterranean climate and small aquifer produce a cascade model. In the studied case lakes are absent and few small pools exist due to the low sedimentation.

The São Lourenço stream outcrop is developed in a valley floor struggle, where ancient pebble conglomerates with massive carbonate cement are horizontally followed by curtain moss and algae laminar tufas and some low energy pool deposits.

Despite the modern deposition, both valleys are currently incised in older tufa deposits which are present on river banks and terraces. The ancient structures show the same facies associations as the modern ones, with some tufa clasts and unconformities interlayered in some sequences of sedimentation.

CONCLUSION

Algibre flexure is the main geomorphological structure in the area, which include the recharge area feeding the springs on the northern and southern slopes.

Geomorphological conditions result in distinct tufa structures, especially when considering slopes gradient. In the northern high gradient slopes, perched springline models are predominant. In low gradient streams like Cadouço and São Lourenço, deposits along the streams can occur. However, in this situation we don't know lacustrine deposits like other Mediterranean outcrops despite the presence of modern and ancient waterfalls or just stream deposits.

Spring regime with long discharges allows the development of bigger and more suitable structures to model the systems, especially when discharge extends to the warmer months like May or June.

Acknowledgements

Work financed by Fundação para a Ciência e Tecnologia Ph.D. grant SFRH/BD/62323/2009.

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