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Oligocene lacustrine tuff facies, Abu Treifeya, Cairo-Suez Road, Egypt

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ABSTRACT

Field investigations in the Abu Treifeya area, Cairo-Suez District, revealed the presence of Oligocene lacustrine volcaniclastic deposits of lacustrine sequences associated with an Oligocene rift regime. The present study represents a new record of lacustrine zeolite deposits associated with saponite clay minerals contained within reworked clastic vitric tuffs. The different lithofacies associations of these clastic sequences are identified and described: volcaniclastic sedimentary facies represent episodic volcaniclastic reworking, redistribution and redeposition in a lacustrine environment and these deposits are subdivided into proximal and medial facies. Zeolite and smectite minerals are mainly found as authigenic crystals formed in vugs or crusts due to the reaction of volcanic glasses with saline–alkaline water or as alteration products of feldspars. The presence of abundant smectite (saponite) may be attributed to a warm climate, with alternating humid and dry conditions characterised by the existence of kaolinite. Reddish iron-rich paleosols record periods of non-deposition intercalated with the volcaniclastic tuff sequence.

1. Introduction

Phanerozoic volcanism in Egypt occurred mainly along rejuvenated fracture systems that originated in the late Precambrian (El-Shazly, 1977). Alkaline volcanic complexes related to this Phanerozoic activity were emplaced along a rejuvenated Pan African fracture (De Gruyter and Vogel, 1981; Meneisy, 1986). Explosive volcanism can introduce large volumes of primary pyroclastic clasts to various sedimentary settings including terrestrial and/or marine environments (Manville, 2001; Palmer and Shawkey, 2001 and Manville et al., 2009) where they can be remobilised, reworked and redeposited by debris flows, hyperconcentrated flows, normal stream flows and catastrophic avalanche processes (Manville et al., 2009).

Generally the volcaniclastic deposits have different lithologies and sedimentary characters, showing large lateral and vertical variations reflecting the magma fragmentation style and the primary or reworking transport mode of the pyroclasts in various sedimentary environments from subaerial to subaqueous (Manville et al., 2009).

Volcaniclastic deposits produced by ancient volcanism can be compared with recent active ones supported by direct observations (Major et al., 2000; Scolamacchia et al., 2006; Németh et al., 2009), emphasising the periodicity of eruptions and the influx of the pyroclastic detritus and describing and interpreting proximal–distal facies changes (Manville, 2002; Manville and Wilson, 2004; Kataoka, 2005; Martin and Neméth, 2005; Vazquez and Ort, 2006).

Recent field investigation in the Gebel Abu Treifeya area (Fig. 1) revealed the presence of lacustrine proximal-medial volcaniclastic sequences composed dominantly of analcime and saponite clay minerals (similar sequences were recorded elsewhere e.g. Crowe and Fisher, 1973; Abdel Motelib et al., 2014). Distal facies are probably buried under the Quaternary sediments along Wadi El Kiheiliya. This is obviously clear due to the presence of coarse siliciclastic deposits (conglomerate and sandstone) along with fine mudstone facies. Depositional processes are discussed based on the composition, textures, sedimentary structures, pedogenic characteristics, organic materials, geometry, paleocurrent indicators, lateral and vertical changes of the different units.

2. Geological setting

Gebel Abu Treifeya represents a major horst block of Middle to Upper Eocene limestone (Barakat et al., 1972) (Fig. 1). The Oligocene basalts and associated zeolitic tuffs are observed at the foot of the limestone block along Wadi El Kiheiliya and Wadi Um Thibua (Figs. 2a and 2b). Based on field aspects, Abou Seda (2005) divided the Oligocene basaltic rocks into 4 phases:

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Phase 1: Basalt boulders in old terraces as effusions along fissures with extensive zeolite.
Phase 2: Doleritic dykes with nodular spheroidal appearance.
Phase 3: Cinder cone-forming extensive explosive volcanic phase with semi-ring structured lava flows capping older zeolitic lava flow units.
Phase 4: Fresh dolerite dykes along reactivated older NW faults.

Other basaltic lava flows of Oligocene age along fault planes were recorded and described in the Cairo-Suez district (Shukri, 1953; Shukri and El Ayouty, 1956).

The present work recognised volcaniclastic deposits (Fig. 2b). Unit Z1 of the lacustrine sequence is rich in analcime and clay minerals and is equivalent to Phase 1 of Abou Seda (2005). Further detailed investigations of other sections of basalts and volcaniclastic-related rocks, namely (Z2, Z3, Z4 and Z5) are in progress by the authors.

Generally, the lithofacies variation of pyroclastic deposits is the results of processes associated with the magma fragmentation, pyroclasts transportation and sedimentation as well as the processes that acted after their deposition through various secondary processes such as reworking and redeposition. Lithofacies may also vary according to the interactions of tectonism, volcanicity, non-volcanic detritus and climatic variations (Blair, 1987; Ryang and Chough, 1997; Paredes et al., 2007). These variations are reflected in differences in particle shapes, sizes and composition; where the previously mentioned factors affect the components during erosion, transportation and deposition. The studied lithofacies are here differentiated into:

A. Proximal alluvial conglomerate and breccia facies.
B. Medial lacustrine conglomerate-sandstone and mudstone facies.

These lithofacies are inferred to represent accumulations in fluvio-lacustrine environments. The presence of massive mudstone (mud rock) can be taken as a key marker to distinguish the alternating fluvio-lacustrine deposits (Palmer and Shawkey, 2001). Field description of each lithofacies and interpretations will be presented in the following paragraphs.

(A) The proximal alluvial conglomerate and breccia facies

The exposed outcrop of this facies is about 2 m high (the bottom is unexposed) and c. 50 m long, showing a ramp structure (Fig. 2b), and is bounded to the north and south by NW–SE trending faults that elevate the whole block as a horst. Neighbouring medial facies are overlain by younger basalt blocks (Figs. 3a and 3b). The exposure consists of angular to subangular blocks with different compositions including pre-Oligocene boulders of basalt, sandstone and carbonate rocks (Fig. 3c). The fragments, of all sizes, are dumped together showing a poorly sorted character (diamictite) reflecting a high velocity water current (Abdel Motelib et al., 2014), or a mobilised mixture of ash-rich debris flowing down slope on the ramp structure (i.e. Wadi fill deposits). This diamictite generally grades vertically and laterally into coarse sandstone with load casts and scour fill structures. The lower part of the outcrop is clast-supported and is identified as a coarse- grained debris flow whereas the upper surface shows signs of scouring and reworking. The upper part of the proximal facies is mainly a debris-flow deposit, massive and poorly sorted.

Interpretation:

Highly fragmented erupted materials around volcanoes can be remobilised forming successions of reworked volcano-sedimentary deposits (Capra et al., 2004). Destabilisation events such as tectonic activity, gravity slides or even heavy rain storms, can trigger the sliding of the fragmental debris flow as subaerial-subaqueous debris flow forming a lahar (Johnson and Rodine, 1984). The studied deposits represent lahars in general not debris avalanches, as the latter commonly contain mega-clasts of the same composition or stratigraphically related material resulting from fragmentation of larger clasts during transportation (Pierson, 2005a).

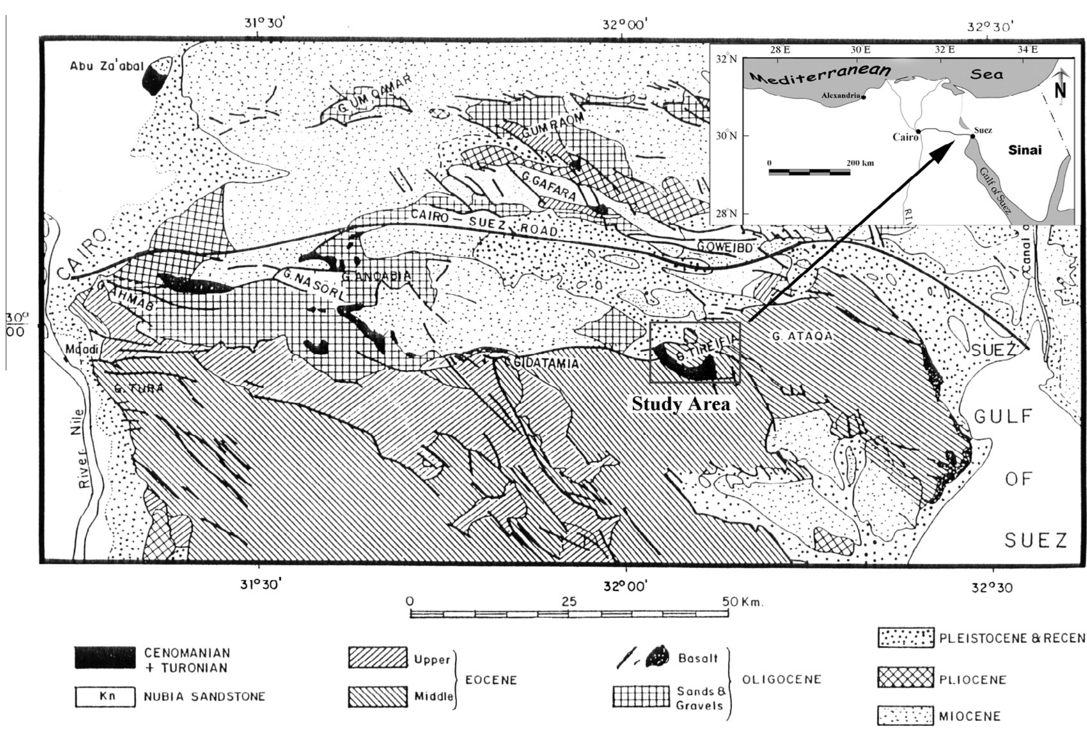

Fig. 1. Geological map of Cairo Suez Road (after Said, 1990) and study area.