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Alkaline lake systems with stromatolitic shorelines in the Ediacaran volcanosedimentary Ouarzazate Supergroup, Anti-Atlas, Morocco

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ABSTRACT

In the Zenaga and Saghro inliers of the Anti-Atlas, Morocco, the Ediacaran Ouarzazate volcanosedimentary Supergroup preserves a record of the complex interplay between effusion of lava floods and explosive volcanic activity from numerous separate volcanic centres. Volcanic units consist of basaltic and andesitic, lava flows and subvolcanic sills and dikes, and dacitic/rhyolitic ignimbrites and tuffs that represent a post-collisional, high-K calc-alkaline magmatism.

Volcanic events are separated by erosive and low-angle unconformities (related to regional tilting), which mark significant hiatii in the timing of deposition and are locally marked by carbonate production in palaeoweathered lowlands. Infill of scattered, decametre-scale, carbonate-bearing troughs, less than 1 km across, started with the dominantly local derivation of weathered and eroded lava debris, followed by the migration of scattered subaqueous bottomset and foreset structures, and final nucleation of carbonate productivity. Microbial mats developed along the shorelines of these ponds. When bathymetry increased the stromatolites developed domal to columnar morphologies that coalesced laterally to form metre-thick biostromes. The lack of evidence for significant fluvial and deltaic deposits suggests that the streams that entered the ponds were intermittent and thus not a significant source of water. It appears that groundwater, rather than surface water, was the dominant source of water to sustain the ephemeral ponds in the low-lying weathered palaeodepressions preserved in the Ouarzazate Supergroup.

Fluids passing through the surrounding volcanic landscape and the volcanic ashes interbedded within the lacustrine infill supplied silica-enriched fluids, giving the ponds the characteristics of alkaline lake systems. Their lacustrine affinity is supported by the subaerial character of many of the volcanic products that surround them. REE composition of partly silicified, dolomitized and undolomitized stromatolites is entirely consistent with freshwater (lacustrine) or shallow lagoonal (with a strong freshwater input) depositional settings, but they also display a strong contamination from the rhyolitic tuffs that overly them.

1. Introduction

In the Atlas Mountains, Morocco, the northern limit of the West African craton is situated along the Anti-Atlas major fault (AAMF in Fig. 1), where two ophiolitic complexes are preserved (Saquaque et al., 1989; El Boukhari et al., 1992), whereas the South Atlas fault (SAF) marks the northern limit of the Eburnean (*ca.* 2 Ga) outcrops of the craton (Ennih and Liégeois, 2008). Soon after the Pan-African collision and suturing (680–660 Ma), extensive post-orogenic uplift and subsequent collapse led to an extensional regime that resulted in the formation of faulted molasse troughs into which the thick volcanosedimentary succession of the Ouarzazate Supergroup was deposited (Thomas et al., 2002). Deposition of the supergroup, which covers more than 60 000 km^2 throughout the entire Anti-Atlas orogen (Thomas et al., 2004), was the result of explosive volcanic activity and rapid clastic sedimentation from numerous separate volcanic centres, associated with active rift faults. Volcanic and subvolcanic (granitic plutons, dike swarms, and rhyolitic caldera complexes) rocks of the whole Ouarzazate Supergroup have yielded a range of dates from 610 to 550 Ma (Thomas et al., 2004; Gasquet et al., 2005).

Among the numerous volcanic, volcaniclastic, and epiclastic facies that characterize the Ouarzazate Supergroup little attention

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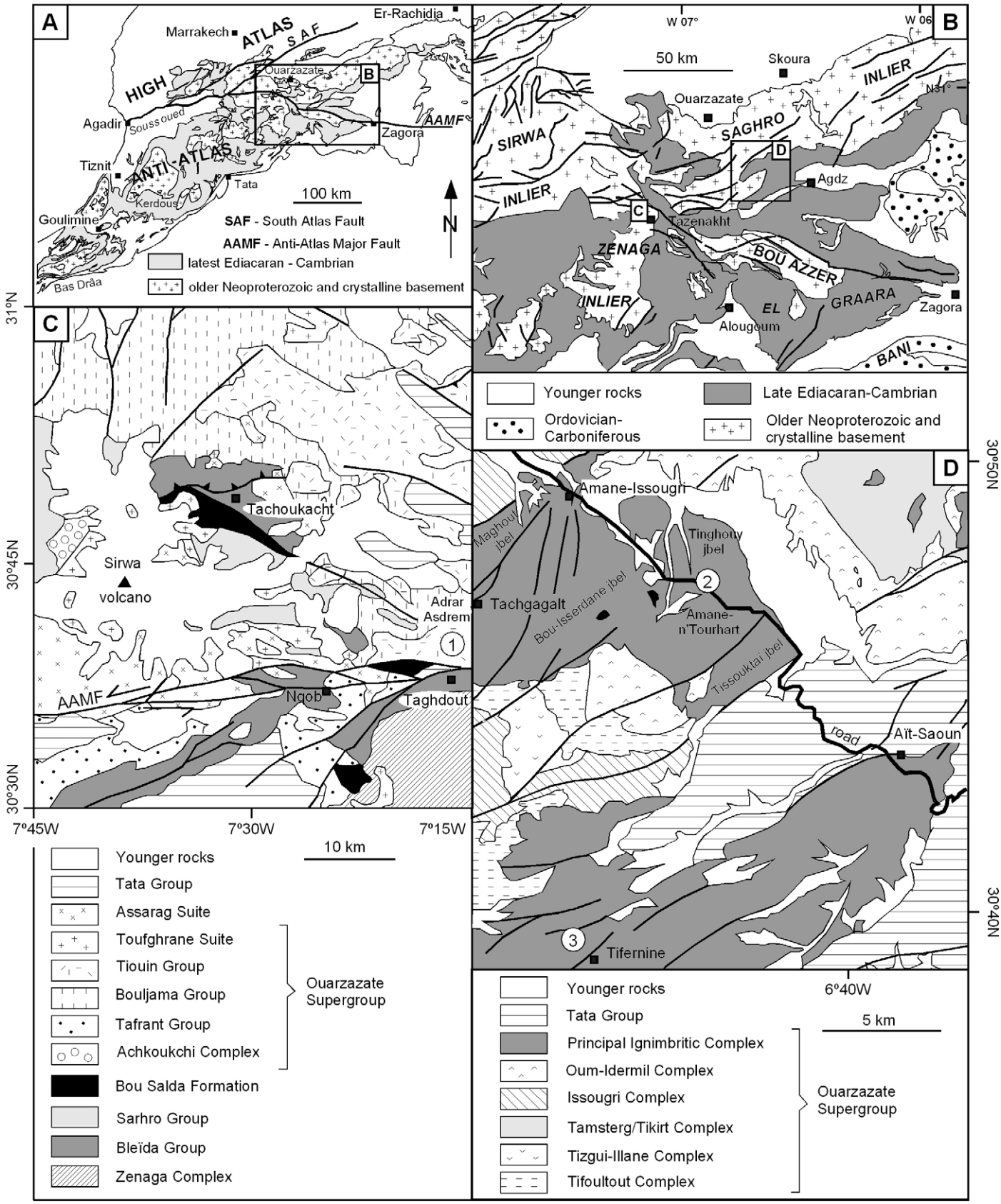

Fig. 1. A. Major geological units of the High Atlas and Anti-Atlas. B. Setting of the Zenaga and Saghro inliers in the central Anti-Atlas (modified from Service Géologique du Maroc, 1970). C. Geological map of the eastern Sirwa and northern Zenaga inliers, showing the setting of Adrar Asdrem (1), where the first study area is located (modified from Thomas et al., 2002). D. Geological map of the western Saghro inlier with location of Amane-n'Tourhart (2) and Tifernine (3) study areas (modified from Service Géologique du Maroc, 1970).