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Microfossils from the late Mesoproterozoic – early Neoproterozoic Atar/El Mreïti Group, Taoudeni Basin, Mauritania, northwestern Africa

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ABSTRACT

The well-preserved Meso-Neoproterozoic shallow marine succession of the Atar/El Mreïti Group, in the Taoudeni Basin, Mauritania, offers a unique opportunity to investigate the mid-Proterozoic eukaryotic record in Western Africa. Previous investigations focused on stromatolites, biomarkers, chemostratigraphy and palaeoredox conditions. However, only a very modest diversity of organic-walled microfossils (acritarchs) has been documented. Here, we present a new, exquisitely well-preserved and morphologically diverse assemblage of organic-walled microfossils from three cores drilled through the Atar/El Mreïti Group. A total of 48 distinct entities including 11 unambiguous eukaryotes (ornamented and process-bearing acritarchs), and 37 taxonomically unresolved taxa (including 9 possible eukaryotes, 6 probable prokaryotes, and 22 other prokaryotic or eukaryotic taxa) were observed. Black shales preserve locally abundant fragments of organic-rich laminae interpreted as benthic microbial mats. We also document one of the oldest records of *Leiosphaeridia kulgunica*, a species showing a circular opening interpreted as a sophisticated circular excystment structure (a pylome), and one of the oldest records of *Trachyhystrichosphaera aimika* and *T. botula*, two distinctive process-bearing acritarchs present in well-dated 1.1 Ga formations at the base of the succession. The general assemblage composition and the presence of three possible index fossils (*A. tetragonala*, *S. segmentata* and *T. aimika*) support a late Mesoproterozoic to early Neoproterozoic (Tonian) age for the Atar/El Mreïti Group, consistent with published lithostratigraphy, chemostratigraphy and geochronology. This study provides the first evidence for a moderately diverse eukaryotic life, at least 1.1 billion years ago in Western Africa. Comparison with coeval worldwide assemblages indicates that a broadly similar microbial biosphere inhabited (generally redox-stratified) oceans, placing better time constraints on early eukaryote palaeogeography and biostratigraphy.

1. Introduction

Mid-Proterozoic organic-walled microfossil assemblages seem to be broadly similar worldwide, despite some differences possibly related to redox conditions (e.g. Sergeev et al., 2016), facies preservation, sample preparation, lack of recent detailed taxonomic revision, or sampling bias; but similarities may suggest oceanic connections between most basins. However, global comparisons are not possible while in some areas of the Proterozoic world, such as the West African Craton (WAC), the microfossil record is still poorly documented. Previous palaeobiological investigations of the Taoudeni Basin, in northwest Africa (Fig. 1), have mainly focused on stromatolites (Bertrand-Sarfati and Moussine-Pouchkine, 1985, 1988; Kah et al., 2009) and more recently on biomarkers (Blumenberg et al., 2012; Gueneli et al., 2012, 2015), but there has been limited discussion on microfossils, mostly on unornamented ubiquitous and poorly diverse acritarchs (Amard, 1986; Ivanovskaya et al., 1980; Lottaroli et al., 2009; Blumenberg et al., 2012).

In contrast, extensive work has focused on the Taoudeni Basin sedimentology (Lahondère et al., 2003; Kah et al., 2012), geochronology (Clauer, 1976, 1981; Clauer et al., 1982; Clauer and Deynoux, 1987; Rooney et al., 2010), chemostratigraphy (Kah et al., 2012; Gilleaudeau and Kah, 2013a), and palaeoredox

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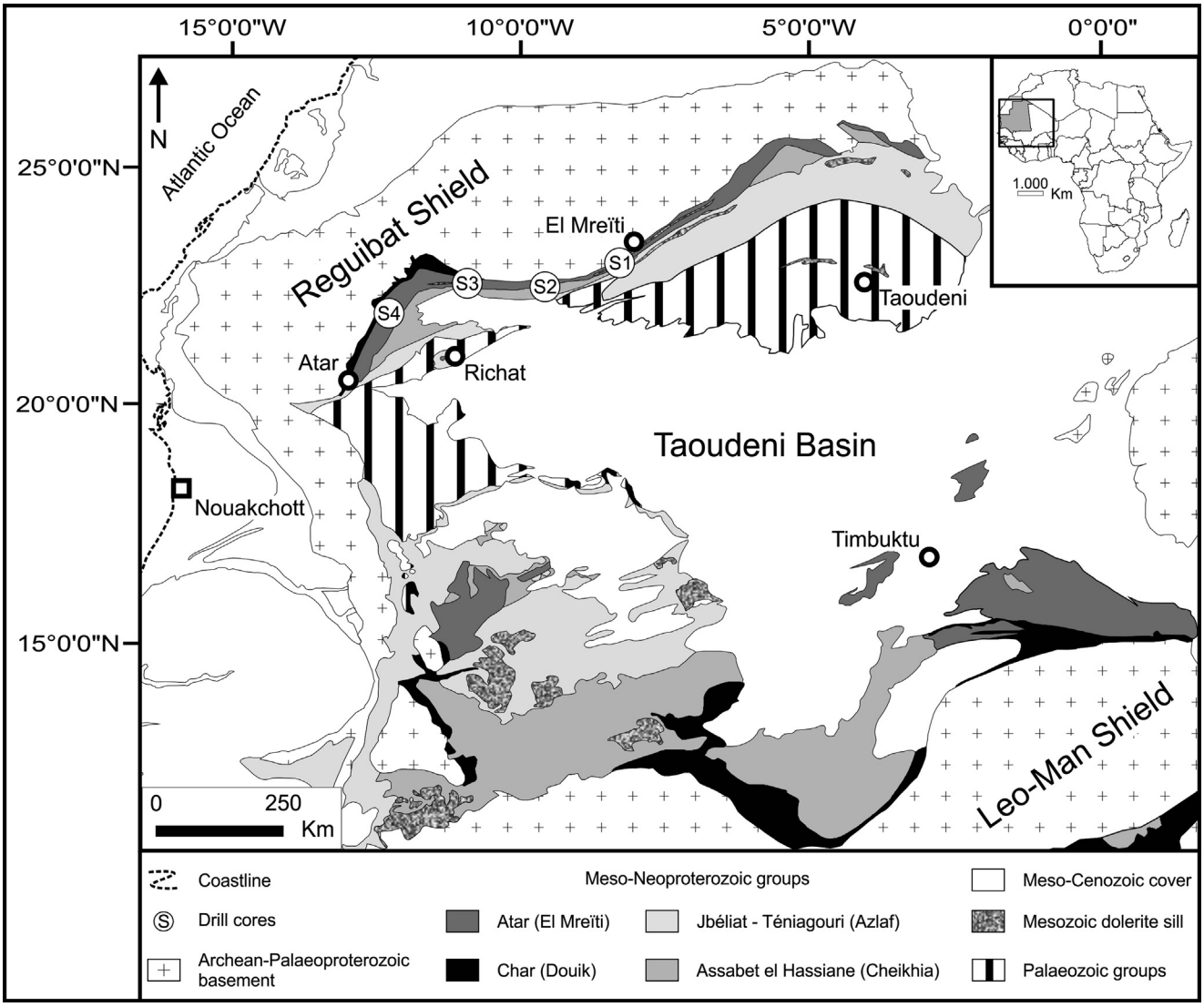

Fig. 1. Simplified geology of the Taoudeni Basin. Modified from BEICIP (1981). Data from TOTAL (pers. comm., 2005). Locator map indicates Mauritania (in grey) in Africa and the studied area (rectangle) described on the main map.

conditions (Gilleaudeau and Kah, 2013b; Gilleaudeau and Kah, 2015). Relatively new Re-Os geochronologic dating (Rooney et al., 2010) and chemostratigraphy (Fairchild et al., 1990; Teal and Kah, 2005; Kah et al., 2009, 2012) suggest a late Mesoproterozoic (~1.2–1.1 Ga) age for the stratigraphically lower deposits of the Atar/El Mreïti Group in the Taoudeni Basin (Fig. 2).

Here we report on a new diverse assemblage of organic-walled microfossils preserved in late Mesoproterozoic-early Neoproterozoic shales of the Atar/El Mreïti Group in the Taoudeni Basin, Mauritania. The Mesoproterozoic-Neoproterozoic transition is increasingly recognized as a key interval in both planetary and eukaryotic evolution. The discovery of a number of unambiguously eukaryotic fossils, in addition to taxa unassigned to a particular domain, improves their known stratigraphic and palaeogeographic distribution and more broadly, the pattern or timing of early eukaryotic diversification and evolution.

2. Geological setting of the Taoudeni Basin

The Taoudeni Basin (Fig. 1), northwest Africa, is the largest Proterozoic and Palaeozoic sedimentary basin (intracratonic platform) in Africa (>1,750,000 km^2), and extends from Mauritania to northern Mali and Western Algeria (Lahondère et al., 2003; Gilleaudeau and Kah, 2013a, 2013b, 2015). This large depression in the continental platform contains kilometer-thick sedimentary deposits (up to 1300 m) of gently dipping (<1°), unmetamorphosed and undeformed Proterozoic to Palaeozoic strata, which are overlain in the basin's centre by a thin Meso-Cenozoic cover. The Proterozoic and Phanerozoic strata unconformably overlie an Archean-Palaeoproterozoic basement (Lahondère et al., 2003; Rooney et al., 2010; Kah et al., 2012; Gilleaudeau and Kah, 2013a, 2013b, 2015).

In total, four Megasequences or Supergroups bound by craton-scale unconformities are recognized (Trompette, 1973; Trompette and Carozzi, 1994; Deynoux et al., 2006). Supergroup 1 (this study) or Hodh (Fig. 2) rests upon the metamorphic and granitic basement (Lahondère et al., 2003). The type section for the Taoudeni Basin was previously described in the Adrar region of the Mauritanian section, in the western part of the basin (Trompette, 1973). Supergroup 1 is divided into three unconformable groups (Lahondère et al., 2003), which correlate between the Adrar region and the north-central edge of the basin (in the Hank and Khatt areas). The Char Group in the Adrar region corresponds to the Douik Group in the north-central region, the Atar Group to the El Mreïti