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Textured organic surfaces associated with the Ediacara biota in South Australia

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ABSTRACT

The Ediacaran Period takes its name from the fossils of the Ediacara biota, which represent the first appearance of large and diverse assemblages of organisms in the fossil record. Although the global record of these distinctive body fossils is now well known, a previously unrecognized megascopic organic record of textured organic surfaces (TOS) occurs in the Ediacara biota. However, TOS is also a feature over a wider range of paleoenvironmental settings, where body fossils are unknown, in Ediacaran siliciclastic successions that have been studied in Australia, Namibia and western North America.

Paleoecological analysis of successive bedding planes of strata from the late Ediacaran Rawnsley Quartzite in the Flinders Ranges of South Australia, reveals that TOS represent the most common organic features in bedding-surface assemblages of the Ediacara biota. The TOS consist of preserved, patterned assemblages of textured organic mats, fibers and simple tubular body fossils. Complex Ediacara body fossils while striking for their distinctive body plans, and dominating some of the beds, are relatively minor components of combined overall surface area. Many elements of TOS have previously been miss-diagnosed as trace fossils, which are in practice limited to two or at most three morphotypes that indicate the presence of Bilateria. Although TOS represent a simpler grade of organismic construction than discrete and more complex Ediacara body fossils, they were preserved in a similar manner. Marked variability in all components of the biota between successive surfaces suggests that Ediacara ecologies fluctuated at short intervals despite an apparently consistent sedimentary regime.

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1. Introduction

The Ediacara biota contains the oldest diverse macroscopic fossils, and provides a critically important, if highly contested, picture of Neoproterozoic ecology. The prevailing view is that the Ediacara biota is comprised of body fossils ranging from millimeters to over 1 m in length that fall into discrete structural types, along with a diverse variety of trace fossils made by animals up to 2 cm in diameter. This view is the result of a focus on the collection and analysis of single specimens, and is important partly because the trace fossils are presently the only uncontested evidence of Ediacaran bilaterians. Previous studies of Ediacara assemblage paleoecology (e.g. Grazhdankin and Ivantsov,

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1996; Gehling et al., 2000; Grazhdankin and Seilacher, 2002; Clapham et al., 2003), while important, have not surveyed the entire biogenic record and did not have of the advantage of exposure of sequential beds. In order to assess all aspects of the record available, we selected exposures of Ediacara fossil beds where sequential excavation of fossil beds could be performed. This enabled successive samples of benthic communities to be studied with emphasis on assessing all the biological evidence on each surface including background textures, discrete body fossils, trace fossils, orientations, clustering and taphonomic effects.

Our study of other Ediacaran formations, both in Australia and in siliciclastic successions in Namibia and western North America, while more superficial, suggests that diverse arrays of textured organic surfaces (TOS), not including discrete body fossils, described from Australia also occur globally. TOS refer to macroscopic bed-surface textures, including megascopic organisms that occur in large numbers on bedding surfaces, rather than internal grain relationships and textures produced by microbial organisms alone. Thus TOS represent a subset of microbially induced sedimentary structures (MISS) (Noffke et al., 1996, 2001, 2002), which are grounded in actualistic studies of microbially mediated sedimentary structures, both micro- and macroscopic. In particular, MISS include laminations that represent microbial mats (Hagadorn and Bottjer, 1997; Bottjer et al., 2000), filaments and associated grain relationships that cannot be observed in sedimentary rocks with a strong diagenetic overprint, such as found in the Ediacaran siliciclastic sediments of South Australia.

2. Stratigraphy

In the central Flinders Ranges of South Australia, the earliest well accepted fossils of the Ediacara biota, in the form of *Palaeopascichnus* and a few disc, frond and spicular arrays (Jenkins, 1985; Haines, 2000), occur in the upper part of the Wonoka Formation (Fig. 1). The fossiliferous Ediacara Member of the Rawnsley Quartzite (Pound Subgroup) (Fig. 1) lies 200–600 m below a basal Cambrian disconformity (Gehling, 2000). These fossil beds were deposited as transported storm-sands that inundated normally low energy benthic environments on prograding deltas (Gehling, 2000). They vary from stacked event sands deposited in channels near fair-weather wave base, to thinly-bedded sands and silts deposited as waning storm surges below storm wave base. The Ediacara Member varies from 5–150 m thick on the basin margins, up to a maximum of 300 m thick in incised valleys and in more distal sections. The fossiliferous facies are repeated in four of five parasequences within the Ediacara Member (Gehling, 2000) involving varied facies associations of fossils, but with no clear evidence of a significant change in overall composition of the biota between levels.

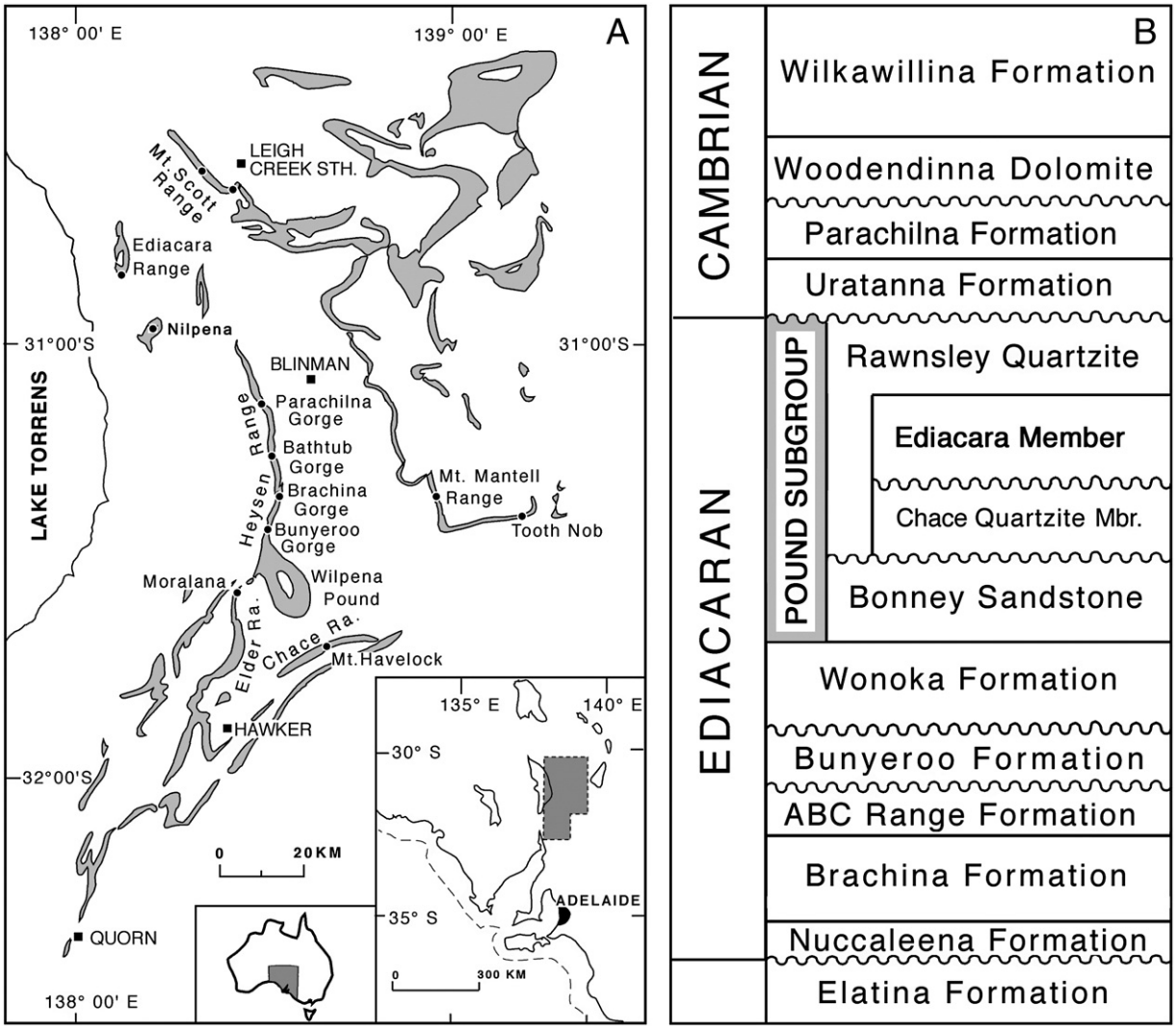

Fig. 1. A. Location of the Flinders Ranges, South Australia, with the distribution of the Pound Subgroup (Bonney Sandstone and Rawnsley Quartzite), bearing the most prominent fossil horizons of the Ediacara biota. B. Ediacaran and Early Cambrian stratigraphy of the Flinders Ranges.