Journal of African Earth Sciences 110 (2015) 135–149

Contents lists available at ScienceDirect

Journal of African Earth Sciences

journal homepage: www.elsevier.com/locate/jafrearsci

Taphonomy and sedimentology of an echinoderm obrution bed in the Lower Devonian Voorstehoek Formation (Bokkeveld Group, Cape Supergroup) of South Africa

Mhairi Reid, Emese M. Bordy *, Wendy Taylor

Department of Geological Sciences, University of Cape Town, Cape Town, South Africa

ARTICLE INFO

Article history:
Received 2 January 2015
Received in revised form 15 April 2015
Accepted 16 April 2015
Available online 19 June 2015

Keywords:
Taphonomy
Lower Devonian obrution bed
Malvinokaffric
Ophiuroid–stylophoran assemblage
SW Gondwana
3D microCT scanning

ABSTRACT

The Lower Devonian Voorstehoek Formation is a lithostratigraphic unit within the Ceres Subgroup of the Bokkeveld Group (Cape Supergroup) in South Africa comprised of essentially mudstones and siltstones. This fossiliferous unit contains typical cool to cold water benthic biota (e.g., brachiopods, trilobites, crinoids) from the Malvinokaffric Realm of SW Gondwana, however, to date, not only the taphonomy of Voorstehoek invertebrates is understudied, but in general those of the Early Devonian marine communities of this Realm. The palaeontological and sedimentological features of the Emsian Voorstehoek Formation suggest that deposition took place in a shallow marine environment within the storm-influenced, proximal part of an offshore transition zone. 3D microCT scanning of this obrution bed allows us to report, for the first time from South Africa, on the co-occurrence of fully-articulated remains of both ophiuroids and stylophorans within the same sedimentary layer. Taphonomic analyses of this ophiuroid–stylophoran assemblage suggest a marine obrution deposit, which formed due to the rapid burial of the benthic community during high-energy storms, smothered both autochthonous and allochthonous taxa. This uniquely preserved, mixed ophiuroid–stylophoran assemblage provides a taphonomic window into the marine ecosystems of the Early Devonian, including the structure of a benthic community within the Malvinokaffric Realm of SW Gondwana.

1. Introduction

The Devonian Bokkeveld Group of South Africa comprises invertebrate fossil assemblages that belong to the unique cool to cold water, high latitude Malvinokaffric Realm, a biogeographic term first introduced by Richter (1941) and originally used to denote the highly endemic, benthic marine, Devonian invertebrate faunas of the Southern Hemisphere. Initially defined based on the distribution of endemic Devonian trilobites and brachiopods (Clarke, 1913; Richter and Richter, 1942; Boucot et al., 1969; Eldredge and Ormiston, 1979), this polar latitude biogeographic unit now encompasses the Early Palaeozoic (Late Ordovician to Middle Devonian (Eifelian)) invertebrate fossil assemblages of south-western Gondwana (i.e., South America, southern Africa, Falkland Islands, Antarctica; see inset in Fig. 1) – Boucot, 1985, 1988; Melo, 1988). Generally, the Malvinokaffric Realm is characterised by a low-diversity fauna with abundant conulariids and hyolithids and the absence of certain major groups such as stromatoporoids, conodonts, nautiloids, and graptolites and almost no thermophilic reef-building corals or bryozoans (Oliver, 1980; Bigey, 1985; Boucot, 1985, 1988; Hiller and Theron, 1988; Meyerhoff et al., 1996).

The Malvinokaffric biota of the Bokkeveld Group comprises both highly endemic species (e.g., certain bivalves and brachiopods) as well as several shared taxon (e.g., *Australospirifer* sp., *Australocoelia* sp., *Burmeisteria* sp.) that are also found in the Devonian of the Falkland Islands and southern parts of South America (Ponta Grossa Formation in the Parana Basin – e.g., Reed, 1906; Clarke, 1913; Richter and Richter, 1942; Melo, 1988; Almond et al., 1996; Boucot, 1999). The fossiliferous nature of the Lower Devonian Bokkeveld Group was first recorded in 1830 and onwards (e.g., Grisbrook, 1830; Thom, 1830; Bain, 1856; Salter, 1856) and in comprehensive reviews by Reed (1925), Theron (1972) and Oosthuizen (1984). Furthermore, the Lower Bokkeveld stylophorans were described by Rennie (1936) and revised in detail Ruta and Theron (1997). Additionally, Jell and Theron (1999) provided an extensive revision of the Bokkeveld crinoids, blastoids and asterozoans.

* Corresponding author at: Department of Geological Sciences, University of Cape Town, Private Bag X3, Rondebosch, 7701, Cape Town, South Africa.
E-mail address: emese.bordy@uct.ac.za (E.M. Bordy).
URL: http://www.geology.uct.ac.za/emese/bordy (E.M. Bordy).

http://dx.doi.org/10.1016/j.jafrearsci.2015.04.009
1464-343X/

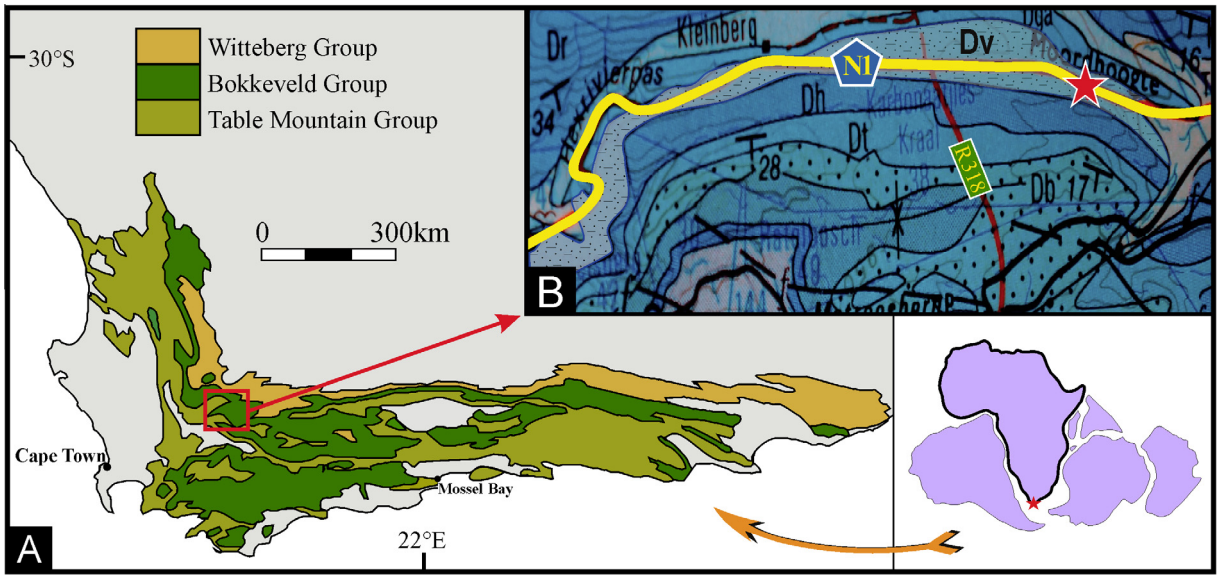

Fig. 1. (A) Simplified geological map of the Cape Supergroup in South Africa showing the approximate location (red square) of the study area within the Cape Fold Belt, ~145 km NE of Cape Town (figure redrawn and modified from Theron and Loock, 1988). Inset shows Africa's position within Gondwana. (B) Extract from 1:250,000 geological map sheet of Worcester 3319 (Council for Geoscience, Pretoria) showing the approximate location (red star) of the study area, along the N1 national road (yellow line) in the Western Cape Province (South Africa). Dv refers to the outcrop area of the Devonian Voorstehoek Formation. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

The unique preservation of Bokkeveld invertebrate assemblages has often been associated with obrution beds (Hiller and Theron, 1988) which are deposits attributed to sudden smothering of benthic communities by rapidly deposited sediments and provide useful "snapshots" of offshore marine communities before burial. The Bokkeveld obrution beds contain fully-articulated echinoderms, well-preserved crinoid calyces, arms and stems (Gydo Formation – Fig. 2), as well as exquisitely preserved bryozoans, complete trilobites and adult to immature ophiuroids (Waboomberg Formation – Hiller and Theron, 1988; Jell and Theron, 1999). Furthermore, well-preserved ophiuroids (brittlestars) and stylophorans, a group of extinct free-living echinoderms, were also reported from the obrution beds of the Voorstehoek and Waboomberg Formations (Fig. 2 – Ruta and Theron, 1997; Jell and Theron, 1999), but abundant, fully-articulated remains of both ophiuroids and stylophorans within the same beds have not been formally described from the Devonian of South Africa.

In this preliminary report we describe a well-preserved ophiuroid–stylophoran burial assemblage in a thin, fossiliferous obrution bed from the Lower Devonian (Emsian ~ 400 ma)

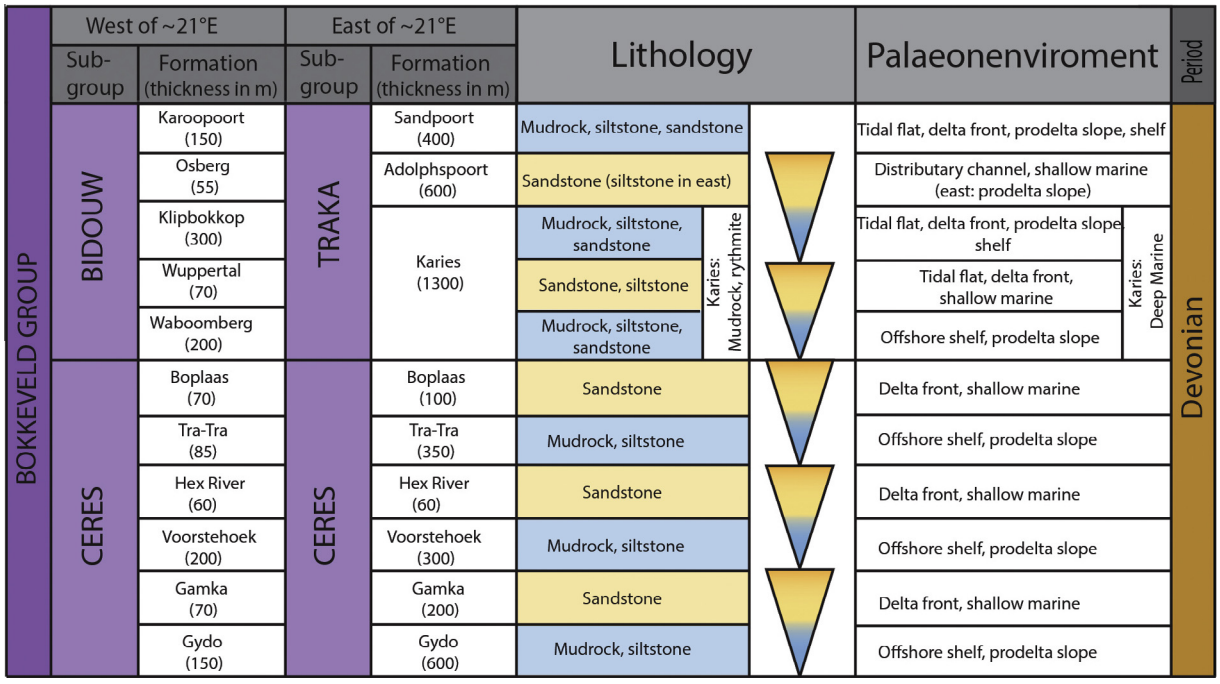

Fig. 2. Stratigraphy of the Devonian Bokkeveld Group. Triangles indicate large-scale, upward-coarsening cycles, which represent shallowing upwards successions. Note that the age of the Voorstehoek Formation is Emsian (~400 Ma old; figure redrawn and modified from Thamm and Johnson, 2006).