Sedimentary Geology 216 (2009) 117–124

Contents lists available at ScienceDirect

Sedimentary Geology

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

High-resolution isotope stratigraphy of the Devonian–Carboniferous boundary in the Namur–Dinant Basin, Belgium

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ARTICLE INFO

Article history:
Received 16 September 2008
Received in revised form 3 February 2009
Accepted 2 March 2009

Keywords:
Chemostratigraphy
Devonian–Carboniferous boundary
Namur–Dinant Basin
Belgium

ABSTRACT

The Devonian–Carboniferous (D–C) boundary sequence of the Namur–Dinant Basin in southern Belgium consists of marine platform carbonates. Global biostratigraphic correlation of the boundary has been a dilemma due to the absence of index conodont zones. Despite the scarcity of brachiopods, we managed to sample twenty-five calcitic shells from boundary beds at the Royseux-Gare section, to reconstruct biochemostratigraphic profiles of oxygen-, carbon- and strontium-isotopes for correlations with established global counterparts. The $\delta^{18}O$ and $\delta^{13}C$ values of the well-preserved shells range from −7.8 to −6.3‰ VPDB (−7.2 ± 0.4, $n = 25$) and from +1.1 to +2.4‰ VPDB (1.8 ± 0.3, $n = 25$), respectively. The shells also yielded $^{87}Sr/^{86}Sr$ ratios between 0.708185 and 0.708297. The Royseux isotope signatures are within the ranges documented for the global D–C boundary but their isotope profiles, however, show no significant shifts or excursions. Evaluation of the Royseux isotope profiles and correlation with their global counterparts may suggest a stratigraphic hiatus approximately from the middle *Siphonodella praesulcata* to the lower *Siphonodella sulcata* zones on the global D–C boundary conodont biostratigraphic scheme, while corresponding to the Hangenberg Event in Belgium.

1. Introduction

Geochemical studies have proven that well-preserved carbonates retain their primary stable-isotope and trace-element signatures that can be reliably utilized to study the paleo-environmental conditions (climate and oceanography) and construct high-resolution correlations of sequences from different depositional settings (e.g. Azmy et al., 1998, 1999; Veizer et al., 1999; Brand et al., 2004). This is an efficient technique particularly for sequences that have poor biostratigraphic resolution such as is the case of the Carboniferous–Devonian boundary (D–C) in the Namur–Dinant Basin of Belgium, where a stratigraphic hiatus spans the boundary (Paproth and Streel, 1984; van Steenwinkel, 1990). Brachiopod shells are among the ideal materials for geochemical investigation since they occur, although rarely, in the marine sequence of the current study and their low-Mg calcite, in many cases, retains the encrypted primary geochemical signatures in equilibrium with ambient seawater (cf. Veizer et al., 1999). Despite the scarcity of brachiopods in the investigated sequence, the sampled shells exhibit a high degree of preservation.

The main objectives of the current study are:

(1) to present biochemostratigraphic trends (C-, O-, and Sr-isotopes) for the Devonian–Carboniferous boundary sequence in the Namur–Dinant Basin using preserved brachiopods,
(2) to compare the biochemostratigraphic data from the Namur–Dinant Basin with those from the Devonian–Carboniferous GSSP trend of La Serre in the Montagne Noire (France) and other auxiliary sequences for possible refined global chemocorrelation.

2. Study area and stratigraphic dilemma

The Devonian–Carboniferous (D–C) sequence of southern Belgium occurs in the northwestern part of the Rheno–Hercynian Fold Belt (Hance et al., 2001) and during deposition was a part of the Namur–Dinant Basin (Fig. 1). The sequence spans the Devonian (Strunian)–Carboniferous (Tournaisian) boundary and consists, from base to top, of two main formations: (1) the Etroeungt Limestone and its lateral equivalent the Comblain-au-Pont Formation, and (2) the Hastière Formation (Paproth et al., 1983; Hance and Poty, 2006). The current study is focused on the boundary section at the Royseux-Gare, which is located in the Condroz sedimentation area (Figs. 1 and 2).

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doi:10.1016/j.sedgeo.2009.03.002

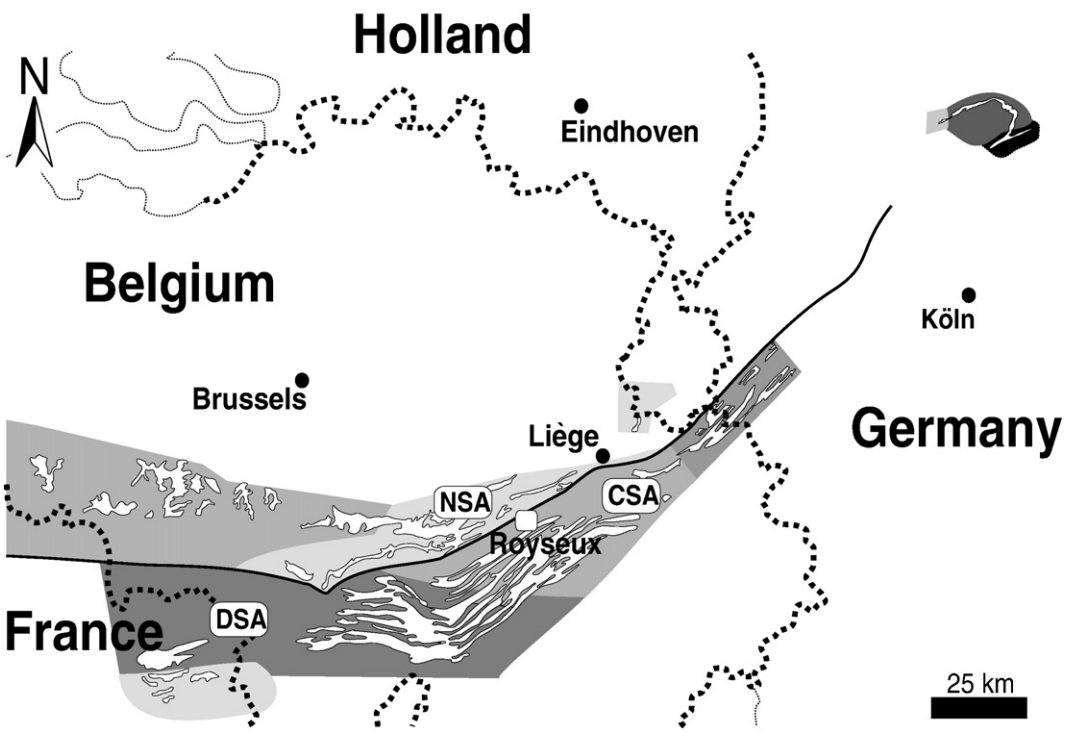

Fig. 1. Map of the study area showing the location of the investigated Royseux-Gare section and distribution of the Uppermost Devonian (Strunian) and Lower Carboniferous deposits in the Namur–Dinant Basin of southern Belgium. DSA, Dinant; NSA, Namur; and CSA, Condroz.

The D–C boundary is defined by the entry of the conodont *Siphonodella sulcata* in the lineage of *Siphonodella praesulcata* to *S. sulcata* in a section at La Serre, France (Paproth et al., 1991). Unfortunately, these conodonts are never found in the rather shallow carbonate platform facies of the Franco-Belgian Basin that includes the study area, where the oldest record of siphonodellid conodonts (*Siphonodella duplicata*)

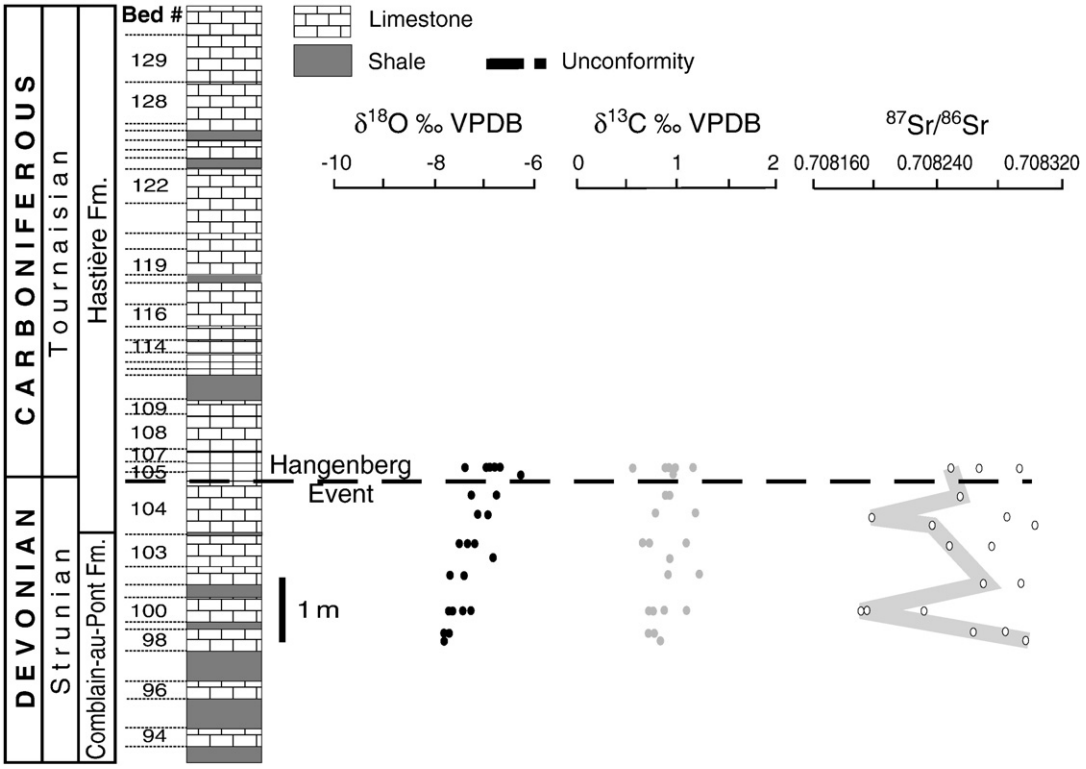

Fig. 2. Schematic diagram showing the stratigraphic log of the investigated Royseux-Gare section, including the Comblain-au-Pont (Etroeungt Limestone) and the Hastière formations, and the carbon-, oxygen- and strontium-isotope profiles. Grey line on the Sr-isotope graph represents the pattern of least radiogenic values.