Palaeogeography, Palaeoclimatology, Palaeoecology 409 (2014) 301–319

Contents lists available at ScienceDirect

Palaeogeography, Palaeoclimatology, Palaeoecology

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

Sedimentation in the Tethyan pelagic realm during the Cenomanian: Monotonous settling or active redistribution?

G. Gambacorta [a,*], R. Bersezio [a,b], E. Erba [a]

[a] Dipartimento di Scienze della Terra "A. Desio", Universitá di Milano, Via Mangiagalli 34, Milan 20133, Italy
[b] CNR-IDPA, Via Mangiagalli 34, Milan 20133, Italy

ARTICLE INFO

Article history:
Received 23 December 2013
Received in revised form 5 May 2014
Accepted 7 May 2014
Available online 22 May 2014

Keywords:
Bottom currents
Calcareous pelagic contourites
Cenomanian
OAE
Pelagic environment
Scaglia

ABSTRACT

Sea bottom processes of the pelagic realm are still not completely understood and represent an intriguing subject. This paper focuses on the relationships between "normal" settling processes, redistribution of sediments and oceanographic parameters in a pelagic setting, during the Cenomanian. Five key Tethyian localities in the Cenomanian Umbria-Marche and Belluno Basins have been studied in order to understand the interplay among sea bottom processes that acted on the sea floor. The dataset consists of the mm-scale sedimentological description of the sections complemented by microfacies analysis on selected samples. Different sedimentological indications, such as presence of intraclasts, lined forams, pervasive plane-parallel lamination, suggest a continuous reworking under action of bottom-currents with varying intensity and direction. All the identified facies are here illustrated in detail and organized in a comprehensive schematic facies framework, the "facies matrix", that leads to recognize two depositional facies suites: the "settling dominated" and the "traction current dominated", under different oxygenation conditions. Our results suggest that settling of biogenic and inorganic particles represents the main source of pelagic sediments, but not the unique depositional process: under the action of sea-bottom currents of different intensity, sediments are continuously redistributed on the sea floor. All the collected evidences contribute to the proposal of a comprehensive depositional model for these reworked and redistributed fine-grained sediments, that represent true calcareous pelagic contourites. The model suggests that the identified traction-related facies can be used as a proxy for bottom current intensity and, indirectly, as an indicator of changing ventilation regimes at the sea floor through time.

1. Introduction

Carbonate pelagic sediments are interpreted as deposited mainly by monotonous and continuous settling of biogenic particles through time with a minor shale input from either volcaniclastic activity (e.g. Klein, 1975), river discharge (e.g. Hemming et al., 1998), eolian dust (e.g. Pratt and King, 1986) or even hydrothermal activity (e.g. Jarvis et al., 2001) and eventually differently degraded and/or modified organic matter (Hüneke and Rüdiger, 2011). Together with planktonic foraminifera, and usually sparse benthic foraminifera, calcareous nannoplankton represents the vast majority of the carbonate fraction providing the clay-size micrite (micarb) of pelagic oozes (Premoli Silva et al., 1999; Turpin et al., 2012). The siliceous organisms are mainly represented by radiolaria, diatoms and silicoflagellates. The transfer of these fine-grained biota and minor fine-grained clastics from surface water masses to the seafloor originates the calcareous oozes, that can be eventually replaced by siliceous oozes under specific paleoceanographic conditions. Likewise, chalk or pelagic limestone sequences are normally regarded as the result of a monotonous homogenized succession of biogenic particles settled throughout the water column and differently lithified during burial diagenesis. Pelagic sedimentation is mostly controlled by productivity, dissolution and dilution rates (Berger, 1974; Scholle et al., 1983; Hüneke and Mulder, 2011). The resulting pelagic lithofacies are controlled also by current reworking, bioturbation and diagenesis. Among all these controls, this paper focuses on the relevance of sea-floor current redistribution, trying to provide the sedimentological evidence of redistribution of ooze particles and soft mud-chips by sea-bottom currents.

Starting from the pioneering paper of Stow and Lowell (1979), many authors have studied sea-bottom currents and their effects both in siliciclastic and carbonate environments, ranging from tropical to glacial climatic conditions (e.g. Nowell and Hollister, 1985; McCave et al., 1988; Faugéres and Stow, 1993, 2008, 1999; Shanmungam et al., 1993; Stow and Faugéres, 1993; Gao et al., 1998; Mienert, 1998; Stoker et al., 1998; Stow et al., 1998, 2002a; Maldonado and Nelson, 1999; Wynn and Stow, 2000; Rebesco and Stow, 2001; Shanmungam, 2003, 2006, 2008; Viana and Rebesco, 2007). Many papers describe calcareous muddy and silty contourites as well as siliceous bioclastic contourites (e.g. Stow et al., 1998; Hüneke and Stow, 2008; Stow and Faugéres, 2008). As defined by Stow et al. (2002b) "contourites are the sediments deposited by or significantly affected by the action of bottom currents".

* Corresponding author. Tel.: + 39 02503 15530.
E-mail addresses: gabriele.gambacorta@unimi.it (G. Gambacorta), riccardo.bersezio@unimi.it (R. Bersezio), elisabetta.erba@unimi.it (E. Erba).

http://dx.doi.org/10.1016/j.palaeo.2014.05.011
0031-0182/

This process being semi-permanent, it also affects the hemipelagic and pelagic settling (Stow and Faugéres, 2008) and might have a huge impact on the continuous redistribution of pelagic sediments on the sea floor.

The goals of this paper are to: 1) illustrate the importance of current reworking in fossil pelagic sediments; 2) recognize the evidence of reworking intensity recorded by peculiar sedimentary signatures; 3) propose a comprehensive facies model for the combination of passive settling and reworking/redistribution processes of oozes by sea-bottom currents.

To achieve these goals we have studied the fine-grained pelagic facies association of the Cenomanian "Scaglia" of two Tethyan basins in Italy in five test sections. Widespread pelagic sedimentation characterized the southern Tethyan margin during the Cretaceous. Therefore, some well-known Tethyan sections from the Italian basins provide good case-histories to study the deep-sea processes, during time intervals of paleoceanographic stability as well as relative to periods of paleoenvironmental stress. Specifically, the late Albian–Cenomanian interval was a time of intermittent major carbon cycle perturbations. Three positive excursions in the stable carbon isotope content are recognized at global scale: the so called Pialli or Breistoffer Event corresponding to the Oceanic Anoxic Event 1d (Wilson and Norris, 2001; Leckie et al., 2002), the Middle Cenomanian Event (MCE) (Coccioni and Galeotti, 2001, 2003) and the Oceanic Anoxic Event 2 (see Jenkyns, 2010 for a synthesis). The most spectacular sedimentary expression of OAE2 is the Bonarelli Level (Bonarelli, 1891), a bituminous radiolaria-rich interval that testifies to widespread anoxic conditions in the oceans during the latest Cenomanian (Schlanger and Jenkyns, 1976; Arthur et al., 1990; Bralower et al., 1993; Jenkyns, 2010).

2. Case histories and methods

Five key-sections from two Tethyan Cretaceous basins in Italy represent the study sites (Fig. 1): Furlo (Beaudoin et al., 1996; Turgeon and Brumsack, 2006; Mitchell et al., 2008; Turgeon and Creaser, 2008; Lanci et al., 2010), Contessa (Monechi and Parisi, 1989; Coccioni and Galeotti, 2003), Monte Petrano (Giorgioni et al., 2012) and Le Brecce (Tiraboschi et al., 2009) sections in the Umbria–Marche Basin, and the Cismon section in the Belluno Basin (Bosellini et al., 1978; Channell et al., 1979a; Bellanca et al., 1996). The latest Albian to earliest Turonian time interval has been studied at these sites. The schematic stratigraphy of the five studied sections is presented in Fig. 1. The partial overlap between the sections permits tight comparisons in the upper part of the Cenomanian succession.

Four sections belong to the Umbria–Marche Basin (Fig. 1):

1) The Furlo measured sequence is 30 m thick and outcrops in a dismissed quarry located 25 km south-east of Urbino. 2) The Contessa section in the Vispi Quarry is about 2 km away from Gubbio (Monechi and Parisi, 1989). The outcrop is close to the coring site of the Gubbio 2 borehole (Tsikos et al., 2004; Turgeon and Brumsack, 2006). The interval of interest is 29 m thick. To integrate the field data, we studied the Gubbio 2 core that recovered a 40.05 m long section (Fig. 1). The Gubbio 2 core was re-described in high

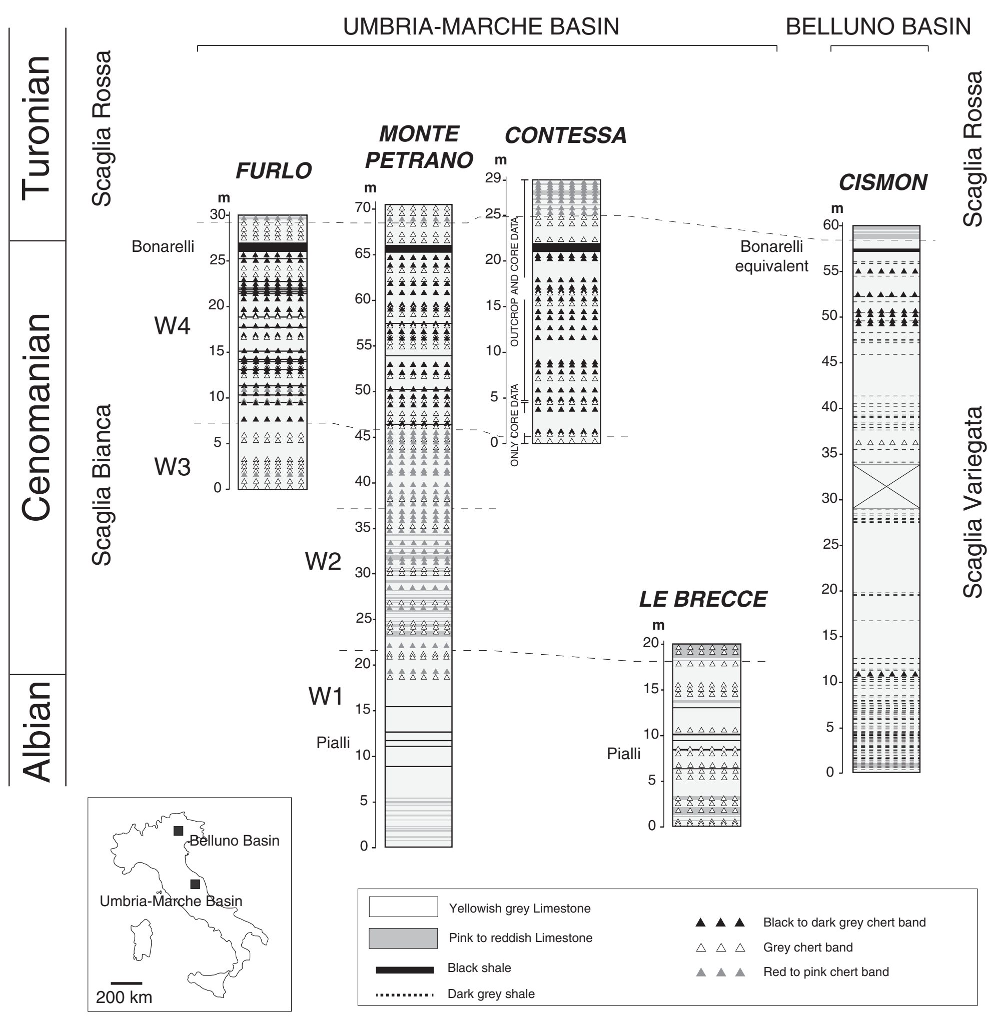

Fig. 1. Stratigraphy of the studied sections within the Umbria–Marche and Belluno Basins.