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Palaeogeography, Palaeoclimatology, Palaeoecology 215 (2004) 173–177

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Discussion

Upper Cretaceous stable carbon isotope stratigraphy of terrestrial organic matter from Sakhalin, Russian Far East: a proxy for the isotopic composition of paleoatmospheric CO₂

by T. Hasegawa et al.—Discussion

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Received 11 February 2004; received in revised form 24 June 2004; accepted 3 September 2004

Abstract

[Hasegawa, T., Pratt, L.M., Maeda, H., Shigeta, Y., Okamoto, T., Kase, T., Uemura, K., 2003. Upper Cretaceous stable carbon isotope stratigraphy of terrestrial organic matter from Sakhalin, Russian Far East: a proxy for the isotopic composition of paleoatmospheric CO₂. *Palaeogeogr. Palaeoclimatol. Palaeocol.* 189, 97–115] present highly interesting patterns in stable carbon isotopic ratios based on terrestrial organic matter from Cenomanian–Maastrichtian successions in Sakhalin Island and try to match these with carbonate carbon curves from other parts of the world. Although we agree that this approach is useful and do not doubt their methods or isotopic fluctuation results, we worry about the lack of any detailed stratigraphic scheme in the paper. Our main arguments: (1) Hasegawa et al. do not show Cenomanian/Turonian stage boundary positions in the Naiba section precisely, and, as a result, it seems that the positive spike shown at this boundary might not equate with this level but relate to the upper of two Cenomanian spikes established in Japan; (2) the definition of Turonian/Coniacian boundary is also imprecise and it is difficult to understand at what level in the Naiba section they place this boundary. As a result, it seems that the positive spike which has been shown near the middle of the Coniacian could correspond to the T–C boundary; (3) the imprecise interpretation of the Campanian/Maastrichtian boundary also causes the assumption that the negative spike, which Hasegawa et al. equate with the C–M boundary could be correspond to middle of upper Maastrichtian in the Naiba section.

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Keywords: Sakhalin; Upper Cretaceous; Biostratigraphy; Carbon stable isotopes

1. Introduction

Hasegawa et al. (2003) present highly interesting patterns in stable carbon isotopic ratios based on terrestrial organic matter from Cenomanian–Maastrichtian successions in Sakhalin Island, especially

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et al. (2003) state that they adopt all stratigraphic interpretations from Kodama et al. (2002), which combine data on three sections (Seim, Krasnoyarka and Naiba) in Sakhalin, and Toshimitsu et al. (1995), which mainly concern the Hokkaido sections. It appears that they (p. 99) also accept data presented by Salnikov and Tikhomolov (1987), which incidentally is Chapter 3 in Poyarkova (1987), who edited this volume. Note, however, that Kodama et al. (2002, Table 1) proposed their own stratigraphic subdivision, which does not correspond completely to units introduced in the Poyarkova (1987) volume. This also means that stage boundaries of these two papers do not coincide in some cases, as here shown in Fig. 1, which is based on their biostratigraphic interpretations (see pp. 99–101).

2. Our arguments

2.1. The Cenomanian–Turonian boundary

The positive spike at the Cenomanian–Turonian boundary is placed in a ‘zone lacking macrofossils’ (Hasegawa et al., 2003, Fig. 2) and this ‘zone’ is shown to be ca. 500 m thick. However, Zonova (in Poyarkova, 1987, the authors refer to that work) recorded Cenomanian inoceramids from beds 50 m below the lowest Turonian inoceramids from the black mudstones of member 3 of the Bykov Formation. Later, Zonova et al. (1993) and Zonova and Yazykova (1998) published Turonian faunas from the black mudstones of member 3. Thus, the zone lacking macrofossils does exist at this level, but its thickness is ca. 50 m. It can be traced from northeast Russia through Sakhalin (our observations) to New Zealand (James Crampton, pers. comm.). In our view, the positive spike shown at the Cenomanian–Turonian boundary might not equate with this level but relate to the upper of two Cenomanian spikes established in Japan (Hasegawa, 1997; Hasegawa et al., 2003, Fig. 5). If we look carefully at their Fig. 3 with results from the rivers Kemo and Shadrinka, and follow our own results (Poyarkova, 1987; Zonova et al., 1993; Zonova and Yazykova, 1998), the latter interpretation becomes more probable. We place the Cenomanian–Turonian boundary (on Fig. 1) at the base of member 3 of the Bykov Formation,

which correlates with a level within lithostratigraphic unit B1 in Kodama et al. (2002). These authors do not show stage boundary positions in the Naiba section precisely; they write (p. 101) that, ‘Macrofossils were not recovered from the overlying clayey siltstone in the lower part of the Bykov Formation (zone lacking macrofossils in Fig. 2)’. The next note of age-indicative fossils is to *Inoceramus hobetsensis* and *Romaniceras yubarense*, which they state are, ‘...indicatives of the Middle Turonian in the Far Eastern realm...’ These data, however, are not sufficiently precise to allow a boundary interpretation.

2.2. The Turonian–Coniacian boundary

The positive spike at the Turonian–Coniacian boundary is important because it is difficult to establish this boundary using faunal assemblages and it is barely recognised on lithological criteria. That is why correlation with the positive spike recorded in the Western Interior (USA) could be important (Hayes et al., 1989). The definition of this boundary in Hasegawa et al. (2003) is so imprecise that it is difficult to understand at what level in the Naiba section they place this boundary (for example, in the scheme supplied by Kodama et al., 2002). As a result, it seems to us that the positive spike which Hasegawa et al. (2003) show near the middle of the Coniacian could correspond to the T–C boundary if we follow the biostratigraphy of Kodama et al. (2002) and Zonova and Yazykova (1998). Kodama et al. (2002) place this boundary in the lower portion of unit B3 and correlate it with the lower part of member 6 of the Bykov Formation. We place this boundary approximately at the same level (Fig. 1). Hasegawa et al. note (p. 101) abundant *Inoceramus uwajimensis* (which is an important index species) ‘in the upper middle part of the Bykov Formation’. This is not sufficient to allow precise correlation and placement of the boundary. It would have been much better to show the lower occurrence of *Inoceramus uwajimensis* and precisely illustrate the correlations with schemes in Kodama et al. (2000).

2.3. The Campanian

In our view, the criteria for the lower boundary of the Campanian are the lower occurrences of *Inocer-*

amus nagoi and *Anapachydiscus* (*Neopachydiscus*) *naumanni*, which appear in the lower portion of member 10 of the Bykov Formation (Zonova et al., 1993; Yazykova, 1996, 2002; Yazykova et al., 2002). The basal part of the Krasnoyarka Formation encompasses the boundary between the lower and upper Campanian (Yazykova et al., 2002). Hasegawa et al. (2003, p. 101) note that ‘The succeeding bedded sandstone is extremely rich in *Sphenoceramus schmidti*, a diagnostic species of the Lower Campanian’. It appears from this that they are referring to member 3 of the Krasnoyarka Formation (Poyarkova, 1987; Zonova et al., 1993, Fig. 1). Note, however, that this member is a very good marker level with radially ribbed inoceramids, plus *Pachydiscus* (*P.*) aff. *egertoni* and *Saghalinites cala* (Yazykova, 1996, 2002; Yazykova et al., 2002), which are age-diagnostic species of the Upper Campanian. Moreover, Sokolov (1915) first established *Schmidticeramus*, which subsequent studies (Zonova et al., 1993) have shown to be a distinct genus-level taxon based on features of ligament structure in particular.

For three sections in Sakhalin, Kodama et al. (2000, Fig. 4) equated the base of the Campanian with the base of magneto—Chron 33r, and Hasegawa et al. (2003, Fig. 4) adopt that view. This differs from the situation in Japan where this boundary is placed at the base of or within Chron 34 (Toshimitsu et al., 1995; Toshimitsu and Kikawa, 1997). In addition, there is recent evidence (Hancock and Gale, 1996, p. 107) that in southern England the base of Chron 33r is within the upper Santonian.

2.4. The Campanian–Maastrichtian and Cretaceous–Paleogene

From the biostratigraphic interpretations by Hasegawa et al. (2003, p. 101), it appears that this boundary was placed within the uppermost portion of member 4 (Krasnoyarka Formation), as done by Kodama et al. (2002), who correlate their units K3 and K4 with members 4 and 5, respectively. Kodama et al. (2002) equate K5 and K6 with members 6 and 7 (Fig. 1). As a consequence, Kodama et al. and Hasegawa et al. note that ammonites and inoceramids are missing from the upper Maastrichtian in

Sakhalin. However, Yazykova (1994) presented a highly diverse assemblage of Maastrichtian ammonites in perfect preservation from Sakhalin. In Poyarkova (1987), members 6 and 7 (Krasnoyarka Fm.) (see Fig. 1) were named Sinegorsk Beds, which were later elevated to the formation rank (Zonova et al., 1993), and yield Danian foraminifera, radiolarians and non-inoceramid bivalves. That would explain the absence of ammonites noted by Kodama et al. (2002) and Hasegawa et al. (2003) in this part of the succession.

It also appears to us that the negative spike in South Atlantic (middle of upper Maastrichtian) shown in Fig. 5 of Hasegawa et al. (2003) could well be correlated with a similar drop in the Naiba section, which Hasegawa et al. equate with the Campanian–Maastrichtian boundary.

If we were to have the opportunity of correlating our results on litho-, bio- and event stratigraphy, the comparison of carbon isotope profiles between the Naiba River valley, Japan, the South Atlantic, England, Italy and the Western Interior of USA as shown in Fig. 5 in Hasegawa et al. (2003) could look much more convincing and effective.

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