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Cretaceous–Tertiary boundary problem on shallow carbonate platform: Carbon and oxygen excursions, biota and microfacies at the K/T boundary sections Dolenja Vas and Sopada in SW Slovenia, Adria CP

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Abstract

The transition of Maastrichtian to Danian in SW Slovenia was studied in two shallow marine carbonate successions. Apart from the extinction of some biota, the K/T boundary is reflected also in carbonate isotopic composition and in geochemistry. The K/T boundary is characterized by 20 cm to 1 m thick sedimentary breccia of intertidal origin. Extreme depletion in the $\delta^{13}C$ content (up to −8‰) was found in Dolenja Vas section just at this boundary. It related to global climatic changes caused by impact of extraterrestrial body followed by the destruction and combustion of terrestrial plants. Slight enrichment in $\delta^{13}C$ content (up to 2‰) is evident at Danian/Selandian boundary too.

Keywords: K/T boundary; Shallow marine limestone; Carbon and oxygen isotopes; Microfacies; Adria CP; Slovenia

1. Introduction

The transition from Cretaceous to Tertiary 65.5 Ma ago is one of the most interesting and well documented events in the Earth's history. Besides the extinction of a great number of biota (Gartner and Mc Guirk, 1979; Russell, 1979; Smith, 1982; Kaufmann, 1986; Keller, 1988; Gallagher, 1991; Ivanov and Stoykova, 1994; Rögl et al., 1996; Tambareau et al., 1997; Arz et al., 2004), a general climatic cooling (Thierstein, 1982; Hsü et al., 1982; Crowley and North, 1988), enrichment with Ir and other elements (Alvarez et al., 1980; Smith and Hertogen, 1980; Ganapathy, 1980; Kyte et al., 1980; Orth et al., 1981; Alvarez et al., 1984; Schimmelman and DeNiro, 1984; Alvarez and Montanari, 1985; Preisinger et al., 1986; Brooks et al., 1986; Schmitz et al., 1988; Crocket et al., 1988; Graup and Spettel, 1989; Zhou et al., 1991), a decrease in $\delta^{13}C$ marine carbonates and that of organic matter (Letolle and Renard, 1980; Schimmelman and DeNiro, 1984; Zachos and Arthur, 1986; Magaritz, 1989; Kump, 1991; Meyers, 1992; Ivany and Salawitch, 1993), are evident as well.

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Several possible explanations for these global perturbation events have been proposed. High concentrations of Ir and other siderophile elements in marine sediments at the K/T boundary have been explained by the impact of a large extraterrestrial object on Yucatan (Alvarez et al., 1980; Kyte et al., 1980; Alvarez et al., 1982; O'Keefe and Ahrens, 1982; Alvarez et al., 1984; Alvarez, 1987; Picard, 2004; Keller et al., 2004; Steinnesbeck et al., 2004). The observation of Ir anomaly in contemporaneous terrestrial sediments not only in Europe but also in other continents (Orth et al., 1981; Ganapathy et al., 1981; Hansen, 1984; Brooks et al., 1986) added weight to the impact hypothesis in that it provided evidence for a global geochemical disturbance at that time (Schimmelman and DeNiro, 1984; Barrera and Keller, 1990; Meyers, 1992; Rodriguez et al., 2004). Additional support for the impact theory has come from the shocked quartz grains from boundary clays containing iridium anomalies in different places in Europe (F.i. Padriciano near Trieste — Gregorič et al., 1998), in a core from the north-central Pacific Ocean, at the K/T boundary in New Zealand (Bohor et al., 1984) and in many other places.

The SW part of Slovenia, known as the classical Karst region, was a part of a huge Adria–Dinaric carbonate platform during Late Cretaceous and Early Paleocene time (Herak, 1986, 1989; Buser, 1989; Jurkovšek et al., 1996a; Vlahović et al., 2002, 2005). In this area the K/T boundary is exposed in several sections and developed in a shallow marine carbonate facies (Fig. 1). Lithological development like this is unique in the whole Mediterranean region, where deep water clay or flysch developments are typical. Section Dolenja Vas is the most completely documented (Drobne et al., 1987, 1988, 1989; Drobne and Ogorelec, 1991; Pleničar et al., 1992; Drobne et al., 1995; Dolenec et al., 1995; Ogorelec et al., 1995; Drobne et al., 1996a,b; Jurkovšek et al., 1996a), while some other sections, such as Sopada near Sežana (Pugliese et al., 1995; Jurkovšek et al., 1996a), Slivje and Kozina (Delvalle and Buser, 1990) and Čebulovica (Ogorelec et al., 2001) are also stratigraphically and sedimentologically well documented.

General geological properties of the Slovenian part of the Karst region were presented in Pavlovec (1963); Buser (1968); Drobne (1977); Hottinger and Drobne (1980); Buser and Radoičić (1987); Pavlovec et al. (1989); Jurkovšek et al. (1996b); Otoničar and Košir (1998); Hottinger and Drobne (1998); biota by Stache (1889); Pleničar et al. (1992); Drobne et al. (1995); Pugliese et al. (1995); Drobne et al. (1996a,b); Barattolo (1998); Turnšek and Drobne (1998); Košir (2004); Turnšek and Košir (2004); while abiotic characteristics of the K/T boundary sections by Dolenec et al. (1995); Hansen et al. (1995); Ogorelec et al. (1995); Marton et al. (1995); Hansen and Toft (1996) and Palinkaš et al. (1996) and tectonical position by Placer (1998); Poljak (2000) and Premru (2005).

In the Vipava valley and Goriška Brda, north from the Trieste–Komen carbonate platform a deep sedimentary basin in which flysch, partly also "scaglia" (Podsabotin beds) were deposited, existed during the Late Cretaceous and Paleocene (Drobne and Pavšič, 1991; Dolenec and Pavšič, 1995).

The aim of this paper is to test by means of isotope study the asteroid hypothesis of terminal Cretaceous extinction at the K/T boundary in the carbonate sequence of the shallow littoral platform, at two localities in NW part of the Adria carbonate platform — Sopada and Dolenja Vas as support to mentioned biota and abiota data.

Here we supply the isotopic analyses of transition beds across the Cretaceous/Tertiary boundary in the shallow carbonate platform of the NW part of the Adria carbonate platform — AdCP.

The rarity of such K/T transitions on shallow carbonate platform was confirmed by W. Alvarez' interest. He and coworkers visited the K/T boundary at Dolenja Vas soon after the discovery of enhanced iridium contents at the boundary in the Gubbio section (Alvarez et al., 1982). In Slovenia followed afterward a systematic research of biota in abiota. The first publication on the K/T boundary at Dolenja Vas dates to 1987 (Drobne et al., 1987, 1988, 1989, 1994).

At personal wish of W. Alvarez in 1996 the international workshop "The role of Impact Processes in the Geological and Biological Evolution of Planet Earth" was organized at Postojna, where members from 16 countries took participation. For this event 6 K/T transitions were documented in the Dolenja Vas section and also the entire sequence of Paleocene beds from Lower Danian to Upper Thanetian as well as classic scaglia and flysch beds of Goriška Brda and Vipava valley margins (Postojna 1996, Drobne et al. (eds.), 236 pp). At this event also a monography with geologic map of Slovenian Karst in scale 1:50,000 was published (Jurkovšek et al., 1996a,b).

The mentioned sections in NW part of Adria CP are the only discovered and documented sections on AdCP by now (Vlahović et al., 2005). The Paleocene shallow marine limestones appear with smaller or larger gaps also in eastern Hercegovina (Drobne et al., 2000; Trutin et al., 2000; Jelaska et al., 2003; Ćosović et al., 2006) and in the Montenegrin littoral (Pavić, 1970; Leppig, 1988).