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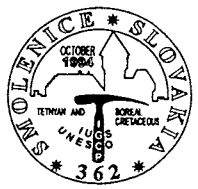
INTERACTIONS BETWEEN THE PROTO-PACIFIC, TETHYAN-BOREAL REGIONS IN THE CRETACEOUS



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Abstract: In order to understand interactions between the proto-Pacific and the Tethyan Boreal Cretaceous regions, which are the fields of research of the IGCP Project No. 362 and IGCP Project No. 350, a few approaches have been proposed as to inter-regional correlation, analysis of the Cretaceous superplume event, tectonic features, basin developments, and paleoceanography.

Key words: proto-Pacific, Tethys, Boreal, superplume, plume tectonics, strike-slip fault, event analysis, paleoenvironment.

Introduction

When we consider the Cretaceous System of the world, geological interactions between the proto-Pacific and the Tethyan-Boreal regions are most important, because these areas covered a great part of the marine realm at that time. This allows thorough investigation of the global environmental changes in the Cretaceous by integrating the geological and paleontological evaluations of marine sediments and biota from those regions.

In order to present hints and clues for better understanding of the global Cretaceous environmental change, I would like to poin out some topics of interest common to both the projects IGCP Project No. 362 and IGCP Project No. 350, which have been generated from work conducted on the Cretaceous in the Pacific region.

Inter-regional correlation

In the attempt to identify the synchroneity of various geological and biological events, precise stratigraphic correlation is the most basic and crucial work for the success of both the projects IGCP 362 and 350.

As the Japanese Islands are fortunately located at the transition between the Tethyan and Boreal regions off the eastern continental margin of Eurasia and the paleo-margin between the land and the sea, Cretaceous deposits in this area provide effective information on the correlation between marine and nonmarine as well as between the proto-Pacific and the Tethys-Boreal regions.

Numerous stratigraphic standard schemes for the Cretaceous of the Japanese Islands allow inter-regional and intra-regional correlations; these schemes involve, among others, macrofauna (e.g. Matsukawa & Obata 1992; Toshimitsu et al. 1995), microfauna (e.g. Takayanagi & Matsumoto 1981; Yasuda 1986; Taketani 1995) and microflora (Okada et al. 1987). Furthermore, magnetostratigraphic studies are now being introduced (Kodama et al. 1994; Toshimitsu et al. 1995).

Event analysis related to the Cretaceous superplume

Large igneous provinces covered not only the western Pacific and eastern Tethys during the Cretaceous (Tarduno et al. 1991; Coffin & Eldholm 1993a, b), but also a 7,000 km long and up to 2,000 km wide land area at the East Asia continental margin during the Late Mesozoic to Early Cenozoic (Takahashi 1983). Magmatism in the Pacific and Tethyan oceans were basaltic while those at the continental margins were granitic and felsic or andesitic. Many of these igneous edifices were once regarded as sunken microcontinents or fragments of Pacifica (Nur & Ben-Avraham 1977, 1983). The space-time distribution of these magmatic events was great.

This fact can be explained by the plume tectonic theory (Maruyama 1994) that at present there are hot superplumes rising from the core-mantle boundary beneath the South Pacific, the Atlantic and Africa and a large stack of subducted slabs of cold oceanic plates at the depth of 670 km beneath Central Asia, and in the Cretaceous Period there were stronger activities of superplumes beneath the South Pacific, Africa and the Atlantic. These superplumes played a major role to produce the large igneous provinces mainly in the Pacific and Tethyan regions (Coffin & Eldholm 1993a, b) as well as for rifting the Atlantic Ocean.

As I have emphasized elsewhere, this extraordinary active magmatism must have caused substantial environmental change during the Cretaceous (Okada 1994, 1995). According to Tarduno et al. (1991) the large igneous provinces in the western Pacific and eastern Tethys were formed very rapidly, in less than 3 million years during the Albian. Also, it is important to identify the synchroneity of these magmatic events between and within the oceans.

Tectonic features and basin developments

By the beginning of the Cretaceous, a general outline of land and ocean realms had been established in the Circum-Pacific

margin (Zonenshain et al. 1987). One of the most striking tectonic features at the eastern margin of the Asian continent is the NNE-SSW trending strike-slip faults, most of which originated in Late Jurassic to Early Cretaceous (Chen & Qin 1989; Xu et al. 1989; Zhou et al. 1989; Natal'in 1993; Okada & Sakai 1993). These faults were critical in controlling a majority of Cretaceous sedimentary basins in this region (Okada & Sakai 1993).

A similar large-scale strike-slip fault system is also found along the San Andreas Fault in southern and central California on the opposite side of the Pacific (Park 1988). In this area, many mesh-like strike-slip faults are developed subparallel to the principal San Andreas Fault accompanied by many small but deep sedimentary basins (Crowell 1979). These structures were ascribed to oblique convergence between the main proto-Pacific Plate and the Eurasia Plate and between the proto-Pacific Plate and the North American Plate (Silver & Smith 1983). However, the scale of the strike-slip fault system is much larger on the west side of the Pacific than on the east side.

On the eastern Asian continent, sedimentary basins are classified into two major types: those associated with strike-slip faults, e.g. many basins in Southwest Japan and the Keonsong Basin in South Korea (Okada & Sakai 1993), and second, the large-scale depressions developed within the Precambrian craton like the Ordos, Sichuan and Tarim Basins in China and Khorat Basin in Thailand (Liu 1986).

To compare patterns in the basin development in the Tethys and Boreal regions with those in the eastern Asian region is important for understanding regional features of tectonic and sedimentary environments during the Cretaceous.

Paleoceanography and paleoenvironments

There were two major bioprovinces in the northern hemisphere in the Mesozoic time: the Tethyan and Boreal realms. The paleoceanography in the Pacific region has been investigated through the analyses of various biotas; for example, ammonites and other molluscs by Matsumoto (1980), Obata & Matsukawa (1988), Matsukawa et al. (1993); radiolarians by Matsuoka (1992); planktonic and benthic foraminifers by Maiya (1985), Saito et al. (1995), Kaiho et al. (1993), Kaiho & Saito (1994); dinoflagellate cysts by Kurita (1995); ostracods by Ishizaki & Kaiho (1990).

Matsukawa et al. (1993) outlined paleoceanic current systems in the western margin of the proto-Pacific during the Barremian time, suggesting that an Arctic current reached the central part of the inner side of the Japanese Islands. A warm current flowed along the oceanic side of the Islands.

Oceanic anoxic events are being studied intensively by Hirano (1994, 1995) on the Cenomanian/Turonian boundary of the Yezo Supergroup in Hokkaido and on the Albian in Shikoku, Japan, by Maeda et al. (1987). Future works has to concentrate on the oceanic anoxic events between the Tethyan-Boreal and proto-Pacific regions.

Concluding remarks

It is reasonably considered that many geological phenomena during the Cretaceous were related to superplume volcanic events. Therefore, event-like phenomena should be analyzed and be correlated with each other between the Tethyan-Boreal and proto-Pacific regions.

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