Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

APE34-P01 Room:Convention Hall Time:May 20 18:15-19:30

Reconstruction of atmospheric CO2 and O2 concentrations during the last 100 million years based on a model

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Reconstruction of atmospheric carbon dioxide (CO2) and oxygen (O2) concentrations in the past is a key to understand the evolution of environments and life. Accumulating geological and geochemical data with accurate chronology enable us to consider the dynamics of atmospheric composition and its controlling mechanisms. The paleo-atmospheric CO2 and O2 concentrations have been discussed from proxies and theoretical modeling with geological and geochemical data.

One of these models, GEOCARBSULF (Berner, 2006, GCA) is a standard which studies changes of atmospheric CO2 and O2 over Phanerozoic time (for 542 million years). In the model, various geochemical processes, such as chemical weathering of minerals and CO2 degassing via volcanisms and metamorphism are considered, and geological and geochemical data are given for every 10 million years as boundary conditions.

The reconstructed evolution of climate and atmospheric composition are broadly consistent with geological and geochemical data. However the reconstructed atmospheric CO2 in the last 150 million years are evidently different from compiled CO2 proxy data such as stomata, phytoplankton, paleosols and liverworts. For instance, GEOCARBSULF overestimates the atmospheric CO2 before 100 Ma. The difference between the results from the theoretical model and from the CO2 proxies may be partly because of low time resolution data of carbon and sulfur isotopes of seawater, and of other boundary conditions, and also because of effects of the processes GEOCARBSULF does not considered.

In this study, we will focus on the reconstruction of atmospheric CO2 and O2 changes during the Cretaceous and Cenozoic time (over the last 145 million years), with a modified GEOCARBSULF model and high time resolution data of carbon and sulfur isotopes, including effects of processes, such as eruptions of large igneous provinces, emergence of foraminifera during the Jurassic, and so on.

Keywords: carbon dioxide, oxygen, reconstruction, Mesozoic, Cenozoic, GEOCARBSULF