The possibility of Climatic Changes during Geomagnetic Reversals

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Introduction

The earth's magnetic field has repeatedly alternated normal and reversed polarity through out the history. Althogh there is no satisfactory theory for such reversals, it is generally accepted that the dipole field intensity decreases to less than 20% of its normal normal value for a few thousand years during the change in direction. As a result, it has been suggested that the flux of galactic and solar cosmic rays with high energy into the Earth's atmosphere remarkably increases due to the great reduction of the shielding effect by the geomagnetic field, and then could have influences on climatic processes.

Harrison and Prospero (1974) suggested that during reversals of the Earth's magnetic field, the increase in cosmogenic rays into the atmosphere causes ion-induced nucleation and, hence, enhanced formation of clouds, resulting in profound changes in the climate.

This possible climatic changes include the decrease of atmospheric temperature as well as increase of precipitation.The possibility was supported by Svensmark and Friis-Chistensen (1997) and Marsh and Svensmark (2000). They indicated a strong correlation between the cosmic ray flux and the global cloud cover on the basis of observation by satellites.In particular,the latter addressed that such a relationship was found only in the lower parts of troposphere below 3200m, but not in a higher part. These recent researches enhance the possibility that the increase of cosmic rays during geomagnetic reversals causes climatic changes.

However,little has been known about the study investigating the possibility.This is probably due to the difficulty of collecting historical samples, such as sediments,

showing a past evidence with a reliable time-resolution and also the difficulty of analysing samples and data.

Since 1990,joint international research on long historical changes of climates using very long sediment core from Lake Baikal had started.This project has been provided an important chance to collect excellent

sediment samples for our research purpose since 1996. Using Lake Baikal sediment samples recorded geomagnetic reversals, we have attempted to investigate the

possibility that the reversals have effects on environmental conditions such as atmospheric temperature, precipitation, primary production of the lake and so on. We report here the results obtained so far.

Sample and Methods

In 1998, a 600m long sediment core (BDP98) was drilled from Academician Ridge in the boundary between northern and southern basin of Lake Baikal. From this core, each 1m long sediment layer recording the two latest geomagnetic reversals, Brunhes/Matuyama Boundary (780KyrBP) and Upper Jaramillo Event (990KyrBP) was taken and divided in every 1cm layer.

We tried to use cosmogenic Be-10 as an indicator to elucidate the period of time when the cosmic ray flux to atmosphere increased in association with the reversals.

Information of environmental changes was obtained from the distributions of various organic molecules such as alkane,fatty acid and sterol,in the sediments.

Outline of Results

The results have been summarized as follow:

1) Based on the Be-10 vertical distribution obtained,it was difficult to elucidate the period of time when the flux of cosmic rays to atmosphere increased in association with the reversals.

2) It was demonstrated that very similar climatic and environmental changes occurred in the vicinity of both two geomagnetic reversals.The major change was a remarkable increase of precipitation, followed by clear succession of the flora around the lake from steppe to forest.

Although we still do not have a solid evidence indicative of the relationship between the above climatic and environmental changes and the geomagnetic reversals,the results are strongly suggesting the possibility of the relationship.