Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

PEM08-07 会場:411 時間:5 月 1 日 17:45-18:00

星雲遭遇による白亜紀末の大量絶滅
End-Cretaceous mass extinction driven by the encounter with a dark cloud

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We found that a significant positive broad component of iridium in a pelagic deep sea sediment core (886C) around an iridium peak by asteroid impact corresponds at the K-Pg boundary. The 886C is core sample was taken by the Ocean Drilling Program (ODP) in the central portion of the North Pacific. This site has been in Pelagic from the End-Cretaceous periods. The accumulation rate is 0.5 m Myr^{-1}. Kyte et al., (1995) measured iridium density in the 886C core of 0.75-72.2 m which corresponds of ~80 Ma from the present. In this data, there is one sharp peak around 65.5 m correspond at K-Pg boundary. In addition, we found that there are broad components across ~20 m above the back ground which have some sharp peak component. The Ir value of the broad component which is about dozen times of back ground. This broad component is difficult to be explained by the materials on the surface of the Earth, and requires the contribution from the iridium-rich extraterrestrial materials, such as CI chondrite. And it is difficult to explain the broad component by diffusion and bioturbation of an iridium peak by asteroid impact. Platinum-group-element such as Pt, Re and Ir are redistributed by changes in sedimentary redox condition. However such change can probably account for many of small $<$10 cm (Colodner et al., 1992) and the mean global depth of marine bioturbation was calculated to be 9.8$\pm$4.5 cm (Boudreau, 1994). And also an evidence of bioturbation was not found from lithofacies (Proc. ODP, Init. Repts., 145).

We consider that the broad component can be caused by an encounter of the solar system with a dark cloud with a size of ~100 pc and the central density of over 2000 protons/cc in the galactic disk and estimated that the flux of exosolar material began ~73 Ma and has run through ~8 Myr. By the Kataoka's "Nebula Winter model" (Kataoka 2013), dark cloud can lead to an environmental catastrophe to the Earth from a few kiloannum to megaannum. The dark cloud encounter enhances a flux of cosmic dust particles and cosmic rays which lead to global cooling and destruction of the ozone layer.

The solid particles from the dark cloud accrete on the Earth and in the stratosphere, stay for a several months; their sunshield effect is as large as -9.3 W m^{-2}. The climate cooling in the End-Cretaceous period is also suggested by the variations of stable isotope rations in oxygen and strontium (Brian and Huber, 1990; Barrera and Savin, 1999; Li and Keller, 1998). Any photosynthetic plants had heavy damaged, and loss of biodiversity began to the top of food chain.

The mass extinction at K-Pg boundary, which is widely thought to be caused by an impact of an asteroid (e. g., Schulte et al., 2010). However, a complete extinction of level of family by asteroid impact seems rather difficult. First, a severe environment turn-over would finish few years after impact, the solid particles and sulphate launched by the asteroid impact was settled down for only few month (troposphere) to few years (stratosphere) and negative radiative forcing became negligible after a few years from the impact (Pierazzo, 2001).The number of individuals would recover completely after the environmental catastrophe was over, if a few percent of individuals of one species survived.

Second, in spite of there were similar impacts without catastrophic on the Earth, for example, Alamo, Woodleigh, and Popigai crater, there are no evidences of association for extinction. However, because the encounter with the dark cloud perturbs the orbit of asteroid or comet by its gravitational potential and may lead an asteroid or comet shower, the asteroid impact at K-Pg may be one of the consequences of the dark cloud. For a certainly, only an asteroid impact cannot involve mass extinction, however may be role cruncher. The multiple impact and volcanism in a short period of time (Keller, 2005) may have been caused by encounter the dark nebula and attendant cosmic ray, respectively.

キーワード: 星雲の冬, 暗黒星雲, 大量絶滅, 白亜紀末, K-Pg 境界, 国際深海掘削計画
Keywords: Nebula Winter, dark cloud, mass extinction, End-Cretaceous, K-Pg boundary, Ocean Drilling Program