Local characters in the stable isotopic records of laminated tufa in Japan, reflecting the underground features.

Masako Hori[1]; Akihiro Kano[2]

[1] Earth and Planetary Systems Sci., Hiroshima Univ; [2] Earth and Planetary Sys. Sci., Hiroshima Univ

INTRODUCTION

Tufas are freshwater carbonates commonly formed in limestone areas of temperate to tropical climates. They often have annual lamination, and are ideal high-resolution archives of terrestrial climates. Stable isotopic analysis were carried out for the two Japanese tufa from Shirokawa (Ehime Prefecture) and Nimi (Okayama Prefecture), showing fairly regular sine curves in both of the results of oxygen and carbon isotopes, which are significantly correlated each other. Its oxygen isotopic values result from relatively stable value of water, and indicate the isotopic fractionation depending to water temperature. On the contrary, seasonal change of carbon isotopic values are basically inherited from seasonal change in the values of springwater DIC, and similarly controlled by two temperature-controlled processes in underground. 1) Soil CO_2 productivity and 2) gas exchange by natural ventilation. The stable isotopic characters can be variable depending to climatic and hydrological settings. To evaluate this, we measured additional two specimens of Nagaya (Okayama Prefecture) in temperate climate and Muiga (Miyako Island, Okinawa Prefecture) in subtropical climate.

RESULT AND DISCUSSION

11-years high-resolution record from Nagaya shows the regular change of carbon isotopic ratios and the less regular change of oxygen isotopic ratios. Irregular curve of the ratios of oxygen stable isotopes is commonly recognized in summer records and its amplitude reaches 1 permil. It was explained by summer heavy rainfalls with lower ratios of oxygen isotopes, which were recognized by continuous monitoring of that in water. Regular curve of the ratios of carbon isotopes is recognized to be own to the constant ventilation effect. Gas exchange and deposition underground decrease the isotopic ratios in summer, and expand the amplitude up to 4 permil. Stable groundwater level allows the gradual changes of the seasonal ventilation, and brings the regular curve of carbon isotopic ratios. The larger seasonal amplitude of spring water temperature, together with the geological structure, suggests a small water mass in limestone aquifer in Nagaya.

The subtropical tufa from Muiga records 15-years isotopic curves. The oxygen isotopic values exhibit regular cyclic change consistently correlated with the annual lamination pattern of the specimen. The small amplitude in the change of oxygen isotopic ratios likely results from a small seasonal variation in subtropical temperature. The change of carbon isotopic ratios is not in a cyclic manner, and the values are clearly higher (by 2-3 permil) than the previously reported tufas from the temperate Japanese mainland. Vegetation here, which is dominated by C4-type sugar corn, largely contributes the high ratios of carbon isotopes in the tufa. The weaker correlation between excursions of carbon and oxygen stable isotopes in the Muiga tufa suggests that the small annual temperature variation reduces the seasonal amplitude of soil CO_2 productivity and the ventilation. Instability of the degassing and depositing effect might be explained by the physical property of the underground system such as passive gas exchange which can be important because frequent fault conduits and porous lithology characterize the limestone.

The high-resolution isotopic record of laminated tufas should be interpreted carefully, although it informs the climate and hydrological settings of the locality. Shirokawa Model is an ideal case and can be typically applied to a temperate setting associated with underground system having a large water storage and stable respiration by natural ventilation. Some of the tufas deposited in a temperate climate, such as Nagaya, recorded fairly regular change of carbon isotopic ratios that is used for high-resolution time scale in stead of that of oxygen stable isotopes.