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国立大学法人
島根大学

エスチュアリー研究センター

137th Estuaries Open Seminar 第137回 汽水域懇談会

Climate records derived from stable isotope time series of cactus spines, a calibration study

サボテンの棘の同位体分析による気候記録の解析

日時: 2018年 8月9日(木) 17:00-18:00, 9th August (Thu), 2018

場所: エスチュアリー研究センター

2階セミナー室, Seminar Room 2F, EsReC

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As the giant cactus *Carnegiea gigantea* (saguaro) grows, it adds new tissue and spines at the apex of the central column. Because the spines grow only from the center of the apex and then move off to the side as more tissue is added, they are arranged in a perfect time series down the side of the plant. These spine time series can span more than 100 years and the dead woody spine tissue holds a chemical record of the water balance, water stress, photosynthetic activity, and seasonal variability in aridity. Our project is working to understand the controls on the isotope geochemistry of columnar cactus spines and their potential as climate recorders in regions where trees and tree-ring records are absent, and instrumental records are sparse. To relate a calendar age to spine geochemical records one can use the post-1964 decay of the ^{14}C bomb-spike (created by nuclear weapons testing in the atmosphere) to identify the growth year of individual spines. Combining one or two ^{14}C ages with saguaro growth curves allows a year-by-year chronology to be assigned to the isotope record. Prior to 1964, ^{14}C data is very difficult to use, and annual cycles in $\delta^{13}\text{C}$ values can be used to count years moving back in time. Note, however, that only part of the year is recorded in spines – spine growth is limited to the monsoon season, about 4 months out of the year.

The oxygen isotope ratio in spines records the isotopic composition of water at the apex of the plant. The isotopic composition of this water is a balance of new rain water taken up by the plant and the cumulative water loss by evaporation through the skin of the plant. Rain water is taken up directly as an input with a $\delta^{18}\text{O}$ value of approximately -8 ‰. Water is lost through the stoma when they open to take in CO_2 , a process that involves a large fractionation associated with evaporative losses. So waters in the upper portion of the plant are highly enriched in ^{18}O , with values in the +10 to +20 ‰ range. The water gain in saguaros due to winter rains is devoted mostly to flower and fruit production. Monsoon rain water uptake is mostly applied to growth of the plant. The plant's water balance is reflected in the isotopic composition of the spines and can be used as a record of total precipitation during the year.



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