

LATE QUATERNARY PLUVIAL PHASES IN SEMIARID NORTHEASTERN BRAZIL RECORDED BY SPELEOTHEMS

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RESUMO

Períodos de maior umidade no nordeste semi-árido brasileiro foram determinados através de datação de fases de crescimento de espeleotemas por $^{230}\text{Th}/^{234}\text{U}$ via espectrometria de massa. O crescimento de espeleotemas tende a ser interrompido durante períodos de aridez como na presente fase interglacial. Portanto, intervalos de deposição de espeleotemas necessariamente indicam épocas em que as taxas de precipitação eram superiores às atuais. A maior parte dos espeleotemas foi depositada rapidamente durante intervalos relativamente curtos relacionados a Eventos Heinrich e estadiais no Hemisfério Norte. Estes, por sua vez, coincidem com intervalos de fraca monção de verão na China. Fases pluviais são também coincidentes com períodos de alta insolação a 10°S do verão austral. Estes dados podem indicar uma “teleconecção” climática entre os trópicos e as regiões de média e alta latitude.

ABSTRACT

Phases of increased humidity in presently semi-arid northeastern Brazil were inferred through mass spectrometric ^{230}Th high-precision dating of speleothem growth phases. Because speleothems may cease growing during dry periods such as the present interglacial, growth phases correlate with times of higher than present rainfall rates. Most speleothems grew rapidly during relatively short intervals correlated with Heinrich Events and stadials in the northern Hemisphere, which in turn are coincident with intervals of weak summer monsoon in China. Pluvial phases are also coincident with higher-insolation at 10°S during the austral summer. This data may indicate a climatic teleconnection between the tropics and mid-to-high latitudes.

Key words: speleothems, $^{230}\text{Th}/^{234}\text{U}$ dating, heinrich events, semi-arid northeastern Brazil, palaeoclimate

INTRODUCTION

Tropical precipitation variations remain largely unknown during glacial periods. Contrary to the conventional views of increased aridity during these times, fossils and geomorphologic evidence from northeastern Brazil indicate much wetter climates and possible tropical rainforest expansion in the past. Unfortunately, these lines of evidence are rarely well-dated. In arid and semiarid regions, speleothems may cease to grow during dry intervals of climate and thus have the potential to provide constraints on past pluvial periods, provided their ages of growth can be accurately determined using U-series dating techniques.

METHODS, RESULTS AND DISCUSSION

Speleothem samples were collected from semiarid northern Bahia state. All stalagmites are composed of pristine and compact calcite crystals. Distinct growth phases were sub-sampled for ^{230}Th dating with mass spectroscopic techniques.

Age determinations on the speleothems show that samples grew during glacial periods. In addition, several samples grew rapidly during relatively short intervals that coincide with intervals of weak summer monsoon in China (Wang et al., 2001; Yuan et al., 2002), which in turn have been correlated with the timing of cold and dry stadials in Greenland ice core records, such as Heinrich events H1, H4, and H6. This may indicate a climatic teleconnection between the tropics and mid-to-high latitudes. Currently, dry anomalies in northeastern Brazil

are observed to be closely related to negative SST anomalies in the Southern Tropical Atlantic. This may cause stronger southeast trade winds and thus, a northward displacement of the annual mean position of the ITCZ. Abrupt precipitation changes in this region may be due to the southward shift of the ITCZ associated with the overturning of thermohaline circulation. These circulation changes may drag tropical Atlantic warm water to the south, switching the tropical SST mode and then weakening the southeasterly wind strength.

Synchronicity between these Brazilian pluvial phases and periods of relatively weak East Asian summer monsoon (recorded in Chinese speleothems) illustrates the significant role the tropics play in these abrupt climate variations. Pluvial phases are also coincident with higher insolation at 10°S during the austral summer. This association suggests that insolation may contribute to the southward shift of the ITCZ and enhanced precipitation in northeastern Brazil.

CONCLUSIONS

Stalagmites from caves in semiarid northeastern Brazil were analyzed to constrain paleopluvial phases. Short growth intervals show millennial-scale climate changes that coincide with intervals of weakened East Asian summer monsoon, which can be correlated to stadial periods in Greenland. In addition, it is possible that local summer insolation plays a role. Both enhanced continental heating and oceanic circulation overturning

may cause a southward shift of the ITCZ, resulting in higher precipitation over northeastern Brazil.

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