Climate evolution in the Southeast Indian Ocean during the Miocene

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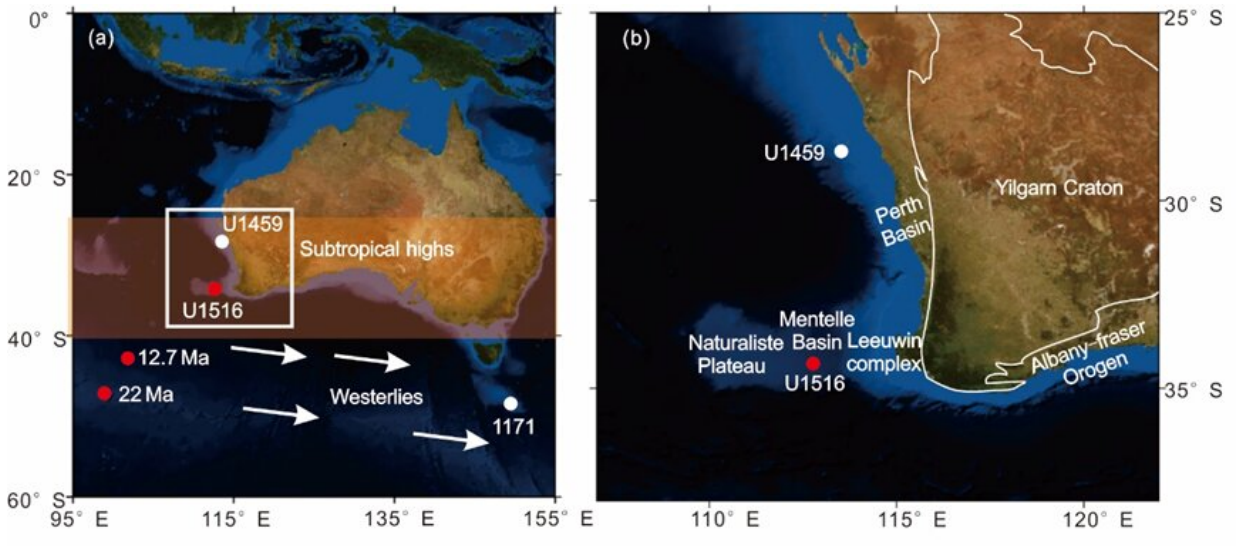

Site location and geological background off the southwest coast of Australia. The red dots are the locations of Site U1516 since the Miocene which is their research site. Credit: Science China Press

The Miocene, 23 to 5 million years ago, was an important period for the formation of the Antarctic ice sheets (AIS). The mid-latitudes in the southern hemisphere are the area where the westerlies prevailed and the climate there is sensitive to the volume changes of the AIS. Recently, the research team led by Prof. Li Tiegang from the Institute of Oceanology of the Chinese Academy of Sciences (IOCAS) has reconstructed the Miocene climatic evolution in the southeast Indian Ocean. This history

builds an important bridge between the evolution of the westerlies and AIS. This study was published in *Science China Earth Science*.

In the context of global warming with rising atmospheric carbon dioxide (CO_2) levels and melting polar ice, reconstruction of paleoclimatic and paleoenvironmental history during past periods when the Earth's climate system changed dramatically is significant for understanding climate mechanism and thus improving predictions of the future. At present, deep-sea sediments provide scientists with an ideal perspective to decode paleoclimatic and paleo-environmental history.

In 2017, the International Ocean Discovery Program (IODP) drilled deep-sea sediment cores from the Mentelle Basin in the southeast Indian Ocean. Scientists from the Institute of Oceanology of the Chinese Academy of Sciences (IOCAS) combined the analysis of the siliciclastic mass accumulation rate, grain size, clay minerals, and elemental composition of the sediments to reconstruct the paleoclimatic evolution in the middle latitudes of the southern hemisphere.

Due to the northward drift of the Australian plate since the Cenozoic, the Mentelle basin and Australia were closer to Antarctica in the Miocene than it is now. At the same time, the westerlies have been prevailing in the middle latitudes of the southern hemisphere and playing an important role in the precipitation of southwest Australia. That makes the Mentelle basin an ideal target area for studying the interaction among the cryosphere (e.g., AIS fluctuations), hydrosphere (e.g., the hydrography of South Ocean), and lithosphere (e.g., Australia plate drift and continental weathering), and atmosphere (e.g., mid-latitude westerlies).

The research results show that the amount of terrigenous material transported from southwest Australia to the ocean increased significantly, and the contribution of the fluvial component was more

than that of the aeolian dust component 13 million years ago. Scientists consider that it became wetter and the continental chemical weathering became stronger in southwest Australia after the late middle Miocene.

It's also found that this significant climate transition of Australia occurred right after the permanent formation of AIS with the dramatic decline of deep-sea temperatures and remarkable expansion in zonal and meridian sea surface temperature gradients. Meanwhile, the South Asian monsoon system enhanced abruptly. These consistent changes might indicate the transmission of Antarctic signals along the ocean and atmosphere to lower latitudes.

In the future, this research team will combine Nd isotopes of seawater to study the impact of AIS expansion on ocean circulation in the Indian Ocean. This research will be of great significance for the study of the climatic effects of ice sheet changes in the process of global warming.

More information: Tianqi Sun et al, Climate evolution of southwest Australia in the Miocene and its main controlling factors, *Science China Earth Sciences* (2022). DOI: 10.1007/s11430-021-9904-y

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