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A High Resolution $(^{231}Pa/^{230}Th)_{xs,0}$ Profile from the Western Pacific Warm Pool over the Last Five Isotopic Stages

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The equatorial western Pacific, often referred as the Western Pacific Warm Pool (WPWP), is characterized by sea surface temperatures of 28ºC, which are among the highest of the world oceans. Its influence on the Earth climate has been recently recognized, as well as the need to understand long term variations of primary production at low latitudes (e.g. Thunell et al., 1994).

The paleoceanographic record of the WPWP is poorly documented. To remedy this situation and better understand this regions contribution to climate dynamics, we have measured the activity ratio of ^{231}Pa excess to ^{230}Th excess in core MD 97-2138 from the WPWP (1^0 42^1N, 146^0 24^1E, 1900 m water depth). The measurements have been decay corrected to the time of deposition: $(^{231}Pa/^{230}Th)_{xs,0}$. Uranium is homogeneously distributed in the ocean because of its long residence time and the absence of strong biolimiting processes. Thus, ^{231}Pa ($t_{1/2}$ = 32.5 ky) and ^{230}Th ($t_{1/2}$ = 72.5 ky) are uniformly produced in the water column, from uranium decay, at a constant activity ratio of 0.093, referred hereafter as production ratio. Both nuclides are extremely particle reactive resulting in water column residence times of 20-40 years for ^{230}Th and 150-200 years for ^{231}Pa. This difference in particle reactivity leads to a fractionation between ^{230}Th and ^{231}Pa. Therefore, ^{230}Th is almost totally scavenged from the water column by the vertical particle flux, whereas ^{231}Pa can be laterally advected or transported along the conveyor belt because of its lower particle affinity. Consequently ^{231}Pa is preferentially removed in high particle flux regions, resulting in $(^{231}Pa/^{230}Th)_{xs,0} > 0.093$ in sediments. We have analyzed 36 samples on the single-collector, magnetic sector, Finnigan MAT Element ICP-MS at Woods Hole Oceanographic Institution. These measurements provide a high-resolution record from present to the end of isotopic stage 5.

We found that the $(^{231}Pa/^{230}Th)_{xs,0}$ ratios in the studied area are always above or equal to the production ratio, except for the latest 4,500 years and one point in the latest part of isotopic stage 2. The contrasts between glacial and interglacial periods are sharp. During the Last Glacial Maximum and the early stage of deglaciation, $(^{231}Pa/^{230}Th)_{xs,0}$ approaches the production ratio. $(^{231}Pa/^{230}Th)_{xs,0}$ then increases abruptly to reach a maximum (0.135-0.154) during the beginning of the Holocene. High values (0.15-0.17) are also found at the end of isotopic stage 5. High $(^{231}Pa/^{230}Th)_{xs,0}$ are often interpreted as reflecting periods of high particle flux or high productivity (e.g. Kumar et al., 1993). Lower resolution cores from the Pacific margins, interpreted as reflecting boundary scavenging (Lao et al., 1992), show trends similar to our core. However, the large amplitudes found in the WPWP have not been observed in other regions of the Pacific.

The $(^{231}Pa/^{230}Th)_{xs,0}$ trends we have seen are also similar to those found in the Southern Ocean, suggesting that they may reflect changes in global ocean circulation. In the Atlantic, $(^{231}Pa/^{230}Th)_{xs,0}$ are systematically below the production ratio, due to the export of ^{231}Pa as a result of thermohaline circulation (Yu et al., 1996). Much of this exported ^{231}Pa is scavenged in the opal belt of the southern ocean. However, the similarity between our $(^{231}Pa/^{230}Th)_{xs,0}$ profile and the variations observed in the southern ocean, for the last two isotopic stages, suggests that some ^{231}Pa may also be exported farther on the conveyor belt, into the Pacific, to be removed in the WPWP.

Confirming this view will require that we clearly distinguish the effect of global circulation from more localized effects resulting from changes in productivity in response to phenomenon like monsoons (Kawahata, 1999), local current pattern, or thermocline height. We are now analyzing additional equatorial Pacific cores and conducting a modeling study in order to distinguish local phenomenon from global scale processes.

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