Variation of ^{239,240}Pu in coral and its response to climate system in South China Sea

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With the acceleration of climate change, understanding the behavior of the anthropogenic radioactive substances–particularly their responses to climate system–become critical for assessing their transport, transfer and impact on the ecosystems. However, this remains underexplored, particularly in the South China Sea (SCS), where radioactivity is derived from both close-in fallout of Pacific Proving Ground (PPG) and global fallout. Additionally, this region is quite sensitive to climate change. A coral core collected from Xisha Island, SCS was initially analyzed for high radiotoxic ^{239,240}Pu. Approximately 72–84% of plutonium in coral originated from close-in fallout of PPG through ocean current compared to the direct global fallout. But ^{239,240}Pu concentration still remains in background levels and does not show a significant radiation risk. After 1980, a distinct pattern emerged characterized by "higher" concentration but "lower" ^{240}Pu/^{239}Pu atom ratio compared to the levels in the open west Pacific. This is primarily attributed to the seasonal upwelling of subsurface seawater on the continental shelf of SCS, driven by prevailing southwest monsoon. Significantly elevated ^{239,240}Pu concentrations were observed during typical ENSO years–1983, 1988 and 1997. This is due to the elevated temperature, coral bleaching and the expulsion of symbiotic zooxanthellae. After expulsion, zooxanthellae containing higher ^{239,240}Pu compared to skeleton rapidly die, and their debris directly deposited onto the coral skeleton, in contrast to the metabolic way of ^{239,240}Pu during normal years. This finding offers critical insights into ecosystem protection in SCS amid the global changes and potential threat of nuclear contamination.

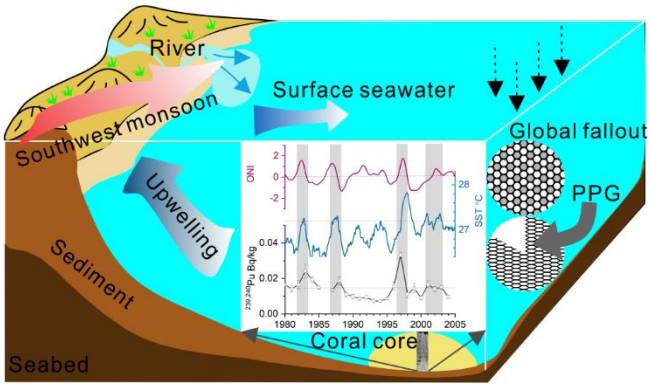

Fig. 1 Temporal variation of ^{239,240}Pu concentrations in the Xisha coral after 1980, in comparison with ONI index and SST