Contribution ID: **658** Type: **Verbal**

Sedimentary record of plutonium in the North Yellow Sea and response to catchment environment of inflow rivers

Tuesday, 15 May 2018 11:45 (15 minutes)

239Pu (T1/2=24110 yr) and 240Pu (T1/2=6563 yr), because of their high chemical toxicity, long half-lives and high particle affinity, are not only good indicators for radioactive pollution but also useful geochemical tracers for better understanding a variety of marine processes. Pu isotopes have been intensively studied in the East China Sea to investigate their source terms, transport, scavenging and deposition processes in the past years. However, studies regarding Pu isotopes in the Yellow Sea especially the North Yellow Sea are very limited. The North Yellow Sea is adjacent to the Bohai Bay and surrounded by the Liaodong Peninsula, Shandong Peninsula and Korean Peninsula. The coastal areas of the NYS are densely populated areas, where are very close to North Korea. Nuclear activities including NWTs in North Korea have caused a great concern on the radiation exposure to the public in the past years. The Hongyanhe nuclear power plant (NPP) with 4 units located in Dalian (39.792°N, 121.475°E) on the Liaodong Peninsula has already being in operation from 20th September 2016. In addition, there are plans to build 4 more NPPs in China's three northeast provinces. Potential releases of radioactive materials including Pu from NPPs to the surrounding environment and the consequences are also a major concern of the local inhabitants and the authorities.
This work, for the first time, reports sedimentary records of 239Pu and 240Pu in the northern North Yellow Sea in order to elucidate their source terms and deposition process as well as the response to human activities in watersheds of inflow rivers. The results of 240Pu /239Pu atom ratios in all sediment samples indicates that plutonium in the northern North Yellow Sea was mainly originated from the global atmospheric fallout, without any significant contributions from nuclear weapons testing in the North Korea in the past few years, the Fukushima accident in 2011, as well as the Pacific Proving Ground (PPG) sourced Pu. The observed large variation in the spatial distribution of Pu isotopes in the study area was mainly attributed to the re-suspension and transportation of fine sediments influenced by the coastal currents. From the depth profiles of 239+240Pu activities with easily observed onset fallout levels (1952) and fallout peaks (1963) in the two sediment cores, 239+240Pu was found to be a useful time marker for studying the modern sedimentary process in the northern North Yellow Sea. The riverine Pu was quantified to contribute 15-27% to the total global fallout Pu inventory in the study area, much lower than that in the Yangtze River estuary (77-80%), indicating a better soil conservation in the northeast China compared to the Yangtze River's drainage basin. Riverine input Pu increased after 1980s in the sampling sites reflected the increased soil erosion degree caused by the land use and cover change due to the increased human activities in the northeast China.

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Session Classification: RER 1

Track Classification: Radionuclides in the Environment, Radioecology