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Estimating SGD flux in the Pingtung Plain coastal area by using Radon and Radium isotopes

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In the past two decades, submarine groundwater discharge (SGD) has been recognized as an important pathway to transport material into coastal area. Our study area is located at Pingtung Plain which is the second largest plain in Taiwan with three major rivers, including Gaoping, Donggang and Linbian Rivers, flow through the plain. The Gaoping River, which has the largest drainage area, flows throughout the central part of the plain. The Pingtung Plain composed by four aquifers in different depths (0, 50, 100, and 200 m) and each layer extends to coastal area. Groundwater is an important water resource for local agriculture and aquaculture. However, the long-term over-pumping induced subsidence problem makes salinization at some coastal area. Some previous studies pointed out the SGD accounts for 80% or more of the mass of freshwater in Fangshan coast, depends on salinity and stable isotopes research.

In this study, the radioactive tracers, Radon (^{222}Rn, $T_{1/2}$=3.8 d) and short-lived Ra isotopes (^{223}Ra, $T_{1/2}$=11.4 d & ^{224}Ra, $T_{1/2}$=3.6 d) are used in tracing SGD off the Pingtung Plain. During 2013 to 2014, the terrestrial water samples were collected from Gaoping, Donggang, Linbian Rivers and springs in different seasons. We also conducted two coastal waters cruises by using R/V Ocean Researcher 3 (OR3-1768 and 1799 cruises in May and September 2014). Continuous ^{222}Rn was measured by RAD7 equipped with RAD-AQUA system and large volume (20 L) seawater samples were collected by CTD/Rosette water sampler with Niskin sterile bottles. Water samples were flow through Mn-fiber (flow rate $<$ 1 LPM) to concentrate the Ra isotopes, and counted via RaDeCC system.

In spatial variation, our result shows the excess ^{224}Ra in the downstream of Gaoping River (2.39 dpm 100L^{-1}) is higher than upstream (1.09 dpm 100L^{-1}). It indicates the groundwater input may play an important role at the downstream of Gaoping River. For temporal variation, excess ^{224}Ra in the Gaoping River are higher in wet season (May-August) than dry season (Nov-Feb). Furthermore, in some drainage area which groundwater recharged by shallow aquifer, the ^{222}Rn and excess ^{224}Ra will diluted by large rainfall in August. The analysis results from coastal waters shows the activities of radium isotopes in surface water are higher than bottom water. Compare with the data collected from Pingtung Plain, the radon and radium isotopes activities are also higher in wet season (OR3-1799 in Sep 2014). The highest excess ^{224}Ra value (2.90 dpm 100L^{-1}) is located at the offshore of Linbian River and it is much higher than the value in the Linbian River (0.54 dpm 100L^{-1}, salinity 0.2‰) which collected in August 2014.