Tracing Groundwater Dynamics on Yoron Island (Amami Islands) Using Radiocarbon

*Shoko Hirabayashi[1], Yusuke Yokoyama[1], Naoto Fukuyo[2], Toshihiro Miyajima[1]

1. Atmosphere and Ocean Research Institute, The University of Tokyo , 2. Hosei University

Groundwater is especially important for small islands without major rivers, such as low-latitude Pacific islands formed by coral reefs, including the Ryukyu and Amami Islands. Carbonate islands composed of sandy or gravel deposits overlying coral reef platforms present unique challenges for water resource management. To enhance both regional and global understanding of groundwater behavior, it is essential to improve our knowledge of spatial and temporal groundwater movement through integrated hydrogeological, geochemical, and isotopic analyses.
Oxygen isotopes and ionic composition diagrams (e.g., key diagrams) are commonly used tracers or proxies to investigate groundwater dynamics. Stable oxygen isotopes ($\delta^{18}O$) are frequently applied to characterize seasonal isotopic variations in groundwater and to estimate recharge and discharge sources. However, according to Tsujino et al. (2024), interpretations based solely on $\delta^{18}O$ are limited in their ability to draw definitive conclusions regarding groundwater flow paths, residence times, or quantitative mixing processes. In contrast, radiocarbon (^{14}C) serves as a more reliable tracer for groundwater flow because its dynamic range is much larger than that of $\delta^{18}O$.
In this study, we investigate groundwater dynamics on Yoron Island, a small carbonate island within the Amami Archipelago, to validate the methodology proposed by Tsujino et al. (2024). Due to the absence of surface water bodies such as rivers, the island relies entirely on groundwater for its domestic water supply, raising concerns about long-term sustainability and potential water shortages. Previous studies conducted groundwater level monitoring and remote sensing analyses using Landsat (Segawa, 2004; Kuraoka et al., 2009), suggesting that groundwater occurs almost independently within fault-bounded blocks. However, a comprehensive understanding of the island-scale groundwater system remains limited.
In this study, groundwater samples were collected from 19 sites during the summers of 2022, 2023, and 2025, and the winters of 2023 and 2025. We measured ^{14}C and stable water isotopes. The spatial distribution of ^{14}C concentrations first allows classification into three fault-bounded groups, consistent with previous studies. Even within the same fault-bounded group, samples can be further subdivided into smaller groups, likely reflecting differences in groundwater residence time. In this presentation, we will demonstrate how spatial variations in ^{14}C concentrations across the island can be clearly visualized and discuss how radiocarbon serves as a robust tracer for groundwater flow, even on a small carbonate island.

Keywords: Groundwater, Radiocarbon , Oxygen isotope

