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Behaviour of Mg isotopes during chemical weathering in the Han River, South Korea

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Magnesium (Mg) isotopes can be useful for directly constraining the sources of riverine Mg, but the dominant controls on riverine Mg isotope ratios are still uncertain. Here, we report Mg isotope ratios for river waters, experimental leachates and digestions, bulk rocks, and fertilizers in the Han River (HR), South Korea. The HR is composed of two lithologically distinct tributaries: the North Han River (NHR) that flows over only silicate rocks, and the South Han River (SHR) that flows over carbonate rocks in the upper part. The lithological differences between the NHR and SHR are reflected in major ion, $^{87}Sr/^{86}Sr$, and $\delta^{26}Mg$ geochemistry. In particular, the NHR has lower major ion concentrations but higher $^{87}Sr/^{86}Sr$ ratios and $\delta^{26}Mg$ values than the SHR. Simple mass balances and mixing equations indicate that if the riverine $\delta^{26}Mg$ values in the HR system are mainly controlled by conservative mixing between silicate and carbonate weathering, the average carbonate end-member $\delta^{26}Mg$ value should be unlikely lower than what are measured in this study. Although multiple process-related fractionations occur in the HR system, the enrichment of ^{24}Mg in the NHR could be mostly controlled by either fractionation or mixing between isotopically distinct reservoirs, such as minerals or fractions (labile and structural Mg), during dissolution, while the little depletion of ^{24}Mg in the SHR could be likely due to the input of groundwater with lower $\delta^{26}Mg$ value rather than fractionation. However, it is difficult to identify the contribution of anthropogenic inputs to riverine $\delta^{26}Mg$ because their effects are little. This study suggests that the potential of Mg isotopes for constraining Mg sources in a lithologically varied river basin can be enhanced with a better understanding of process-related fractionation.