Study on natural iodine isotope system

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Iodine isotopes (stable ^{127}I and long-lived radioactive ^{129}I with half-life 15.7 million year) in natural environment have potentially various applications, utilizing as a dating tool or an index of comic-ray intensity variation with millions to 10-million-year time scale. For these purposes, iodine isotope system in natural environment should be understood comprehensively. Important issues are:

1. Iodine dynamics in the environment.
   Inventories of iodine in various sites and transition among them should be elucidated.

2. ^{129}I sources and assimilation of the iodine dynamic system.
   Production rate of ^{129}I by the cosmic ray and ^{238}U spontaneous fission and how well is the produced ^{129}I is mixed with the ambient iodine should be evaluated. This is related to the equilibrium ^{129}I/^{127}I ratio. Does the globally equilibrium ^{129}I/^{127}I ratio exist like radiocarbon?

There has been long debate on the initial (equilibrium) ^{129}I/^{127}I ratio in the earth environment. Originally the value of 1.5E-12 was proposed by U. Fehn [1] and J. Moran [2] and it has been used for the starting ratio for dating. However the age determined by iodine isotopic ratio is frequently discrepant with the geologic age (The isotopic age is always much larger than the geologic age). More mysterious is that many iodine-rich old fluid samples associated with large caron reservoir (hydrate or natural gas) show always 1.5~2E-13 of ^{129}I/^{127}I. For this issue we once proposed the initial isotopic ratio of 2E-13 [3] from the data of deep seawater with which the isotopic age and geologic age were consistent in many cases.

Recently we considered another possibility. The Fehn and Moran value 1.5E-12 was determined by the marine sediment core whereas our value 2E-13 was by deep sea. In the marine sediments ^{129}I produced by the spontaneous fission of ^{238}U should make higher ^{129}I/^{127}I ratio because ^{238}U concentration is much higher in the crust than in the sea water. If the exchange of iodine between sediments and sea water is significantly slow, apparent different equilibrium values of isotopic ratios could exist simultaneously in seawater and sediments.

Though there are lack of many parameters, e.g., uranium concentration in sediments, iodine exchange rate between sites, etc., we found that certain combination of parameters could explain the simultaneous two apparent equilibrium states. To improve the consideration, more quantitative observational data are needed.

References

[1] U. Fehn, et al., Science, **289**, 2332 (2000).
[2] J. Moran, et al., Chemical Geology, **152**, 193 (1998).
[3] H. Matsuzaki, et al., NIM, **B463**, 55 (2020).