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Impact of industrial activity near urban area on dating of groundwater with sulfur hexafluoride (SF6)

Kazuyoshi Asai[1*]

[1]Geo Science Laboratory Inc.

Sulfur hexafluoride (SF6) is known as one of the effective tracer for estimating age of young groundwater. SF6 is a colorless, odorless, nonflammable, nontoxic, stable gas with excellent electrical insulating and arc-quenching properties. Significant industrial production of SF6 began in the 1960s, and then the SF6 atmospheric mixing ratio has rapidly increased from 0.03 parts per trillion (pptv) in 1970 to 6.9 pptv in 2009, reflecting the long life time of SF6 (3200 y) in the atmosphere. The dating method using SF6 is based on the rapid increase (6% per year) of SF6 air concentration past 40 years, so that the dating range of SF6 is from 1970 to modern, and the SF6 method is particularly useful in dating very young (post-1993) groundwater. Considering the relatively high velocity of groundwater circulation in Japan, the SF6 method is expected to be powerful tool in estimating the residence time of young groundwater in Japan, however, the SF6 method has received very little application in dating groundwater in Japan, due to the paucity of SF6 data.
On the other hand, the dating of young groundwater with SF6, in some cases, can be complicated by natural terrigenic sources, such as from some diagenetic, igneous and volcanic fluids, and by addition of local excess anthropogenic sources of SF6 from industrial activity near urban area. Japan is a world leading industrialized country. Therefore, the additional SF6 from local industrial activity become key factor in application of SF6 dating method to young groundwater in Japan. The present study aims to evaluate the validity of SF6 method in estimating the residence time of young groundwater in Japan. For this purpose, we measured SF6 concentration in air, pond, spring and groundwater sampled from Nagoya city in Aichi prefecture. Based on these data, we will discuss the impact of industrial activity on dating young groundwater with SF6 near urban area.

Keywords: sulfur hexafluoride (SF6), young groundwater, age dating of groundwater, urban area