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A novel method for stable isotope measurement of gaseous elemental mercury

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Here, we introduce a new methodology developed for highly precise stable mercury isotope ratio (δHg) analysis: the sampling method collecting sufficient amount of gaseous elemental mercury (GEM) from air within 24 h or less and the extraction method effectively converting the collected GEM to Hg^{2+} in less than 10 mL of acidified solution.

A big gold-amalgam trap (BAuT), which has approximately 11 times larger inner diameter of the tube and more gold-amalgam granular than a conventional gold-amalgam trap, was designed for quick and effective sampling of GEM in a short time period. A 24-h sampling demonstrated that the collection efficiency was higher than 99.9% under the flow rate of 55 LPM. Prior to the extraction the collected GEM by BAuT was pre-concentrated to a conventional gold-amalgam trap to reduce the dead volume.

The GEM pre-concentrated was transferred into a four side sealed 2L Tedler bag with a PTFE stopcock by heating the gold-amalgam trap to 600 ºC for ~ 4 min under the 0.5 LPM flow of Hg-free air. Prior to this transfer 5mL of 0.5~40% (v/v) reversed aqua resia or RAR (hydrochloric acid: nitric acid = 1:2) was pre-introduced into the bag. The bag with GEM and RAR was left for the conversion of GEM into the stable state in the solution (i.e., Hg^{2+}). The solution recovered was then analyzed by multi collector-ICP-MS for the Hg concentration and δHg.

Results with a standard reference material showed that the recovery from the test with 10% RAR and the extraction duration of 8 days was the highest, 97%, with the 5% of recovery for the residual GEM in the gas-phase. The δHg analysis for five isotope ratios exhibited that the accuracy was between 0.01 and 0.3 ‰. Results from the analytical tests of ambient GEM using this methodology will be discussed.