# Crustal noble gases anomaly associated main fault movement with aftershock the Northeast Japan Great Earthquake at 2011 and fault movements, insights from high-velocity friction experiment

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Noble gases have unique characteristics that they are rarely combined with other chemicals as their very stable nature. Because its main reservoir is the atmosphere, their isotopic composition is well defined and believed to be uniform all over the world being insensitive to disturbance from anthropogenic and/or natural emission of geologically trapped noble gases in the earth interior. Based on our friction experiment, however, detectable amount of noble gases emitted accompanied with a fault motion even using mafic specimen sparsely containing K-rich minerals. [1], [2] After the extreme Northeast Japan Earthquake occurred on March 11, 2011, extraordinary increase of seismic activity as numerous aftershocks e.g. over 4000 felt earthquakes in four months, which may be a source of non-atmospheric component preserved in the earth interior.

In the model fault experiment using gabbroid, Ar was degassed at the " first fusion" prior to the steady state motion generating silicate melt. [1],[2] In this study, a granite was used for the starting material, of which age of 77.2~ 87.1 Ma [3], [4] in order to much realistic condition for the experiment as the assemblage of the continental crust. Accordingly, the specimen contained abundant radiogenic Ar-40 decayed from K-40 in K-rich minerals. Ar was clearly emitted with more amounts after only 5 seconds sliding than that with the gabbroid sliding. Also, the timing of melting depended on the variety of the atmospheres of the experiment; e.g. moist-air, dry-air, pure He or pure Ar, respectively. These results suggest that the dissipation of friction-induced heat depends on the mass numbers of the ambient gases. If so, in the case that a sedimentary rock containing much higher potassium is in contact with a fault plane, emission of $^{40}Ar$ may be faster and much intense during the fault motion. Thus, the liberation of volatiles, believed to be detected in some large earthquakes, may be controlled by ambient condition of the fault.

As the observation, we widely collected atmosphere samples all over Japan from Hokkaido, Honshu (the main island Japan) and Kyusyu. The atmospheres have been sampled into vacuumed containers, Isotube@, at each sampling site in several times to evaluate time-series changes. The elemental and isotopic compositions of the samples were analyzed mainly by quadrupole residual gas analyzers (RGA-200, SRS Co.) and partly confirmed by sector-type mass spectrometers (GVI-5400, GV instruments). In the duplicated analyses of the selected a few samples, the measured elemental and isotopic compositions were consistent within analytical uncertainties.

The relative elemental abundances were changed at least in heavier noble gases. Ar was enriched to pre-3.11 Earthquake atmospheres. It might be contributed by emission of crustal Ar at aftershocks and deformation as well as the main fault movement. In addition, frictional melting was supposed to occur at >M5 earthquakes as reported by [5]. These altered atmospheric Ar isotopic composition in Eastern Japan area were observed until typhoon season.

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