Oral | Symbol S (Solid Earth Sciences) | S-GL Geology

[S-GL42_29AM2]Geochronology and Isotope Geology

Convener:*Takahiro Tagami(Graduate School of Science, Kyoto University), Yuji Sano(Division of Ocean and Earth Systems, Atmosphere and Ocean Research Institute, University of Tokyo), Chair:Yuji Sano(Division of Ocean and Earth Systems, Atmosphere and Ocean Research Institute, University of Tokyo), Takahiro Tagami(Graduate School of Science, Kyoto University)

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Reliable reconstruction of geohistory is of primary importance to better envision the present and future of the Earth. Geochronology and isotope geology play major roles in the reconstruction. This session offers an opportunity to present the results of fundamental studies, including the developments / improvements of analytical methods and age calibration, as well as applications to the Earth and planetary materials. We particularly focus on: (1) radiometric dating, bio-stratigraphy, magneto-stratigraphy and stable isotopic time series that provide the age information, (2) radioisotopes and stable isotopes widely employed for analyzing the Earth and planetary systems and (3) hypothesis and numerical modeling that utilize / assimilate the age and isotopic data. We also welcome contributions that integrate a variety of relevant disciplines.

12:25 PM - 12:40 PM

△[SGL42-P01_PG]Ultrahigh-sensitive simultaneous determination of halogens and noble gases by an extension of Ar-Ar and I-Xe methods

3-min talk in an oral session

*Hirochika SUMINO[1], Masahiro KOBAYASHI[1], Takehiko SAITO[1], Keisuke NAGAO[1], Chiaki TOYAMA[2], Yasuyuki MURAMATSU[2] (1.Geochemical Research Center, Graduate School of Science, University of Tokyo, 2.Department of Chemistry, Gakushuin University)

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Noble gas isotope ratios in various geochemical components in the Earth are significantly different, making them useful tracers to constrain origin of volatiles in the mantle. The development of noble gas mass spectrometry during the last two decades has enabled us to detect less than 10000 noble gas atoms (e.g., [1]). An extension of Ar-Ar and I-Xe dating methods allows us to simultaneously determine trace amounts of noble gases, halogens, K, Ca, Ba, and U by use of ultrahigh-sensitive noble gas mass spectrometry on neutron-irradiated samples. This method has several advantages: (i) detection limits for halogens are three or four orders of magnitude lower than those of other conventional analytical methods, (ii) several components of different origin can be distinguished based on their relations with specific noble gas isotopes such as mantle-derived ^{3}He and by using various noble gas extraction methods such as laser microprobe [2], and (iii) in-situ production of radiogenic noble gas isotopes (such as ^{4}He and ^{40}Ar) after the entrapment of the noble gas component of interest in the sample can be corrected by the simultaneous determined their parent elements, such as U and K, when the age of the entrapment is known or can be assumed. We have developed a new noble gas mass spectrometric system for this method based on an Ar-Ar and I-Xe dating system [3]. Accuracy and precision of our method were examined by analyzing GSJ and USGS reference materials, their original rocks, and scapolite standards [4] and by comparing the halogen data with those obtained with ion chromatography and ICP-MS followed by pyrohydrolysis extraction [5]. By using this method, we analyzed halogens and noble gases in exhumed mantle wedge peridotites and eclogites from the Sanbagawa-metamorphic belt, southwest Japan and

those in mantle-derived xenoliths from Kamchatka and N. Philippines, in all of which relicts of slab-derived water are contained as hydrous mineral/fluid inclusions. The striking similarities of the observed noble gas and halogen compositions with marine pore fluids [6,7] challenge a popular concept, in which the water flux into the mantle wedge is controlled only by hydrous minerals in altered oceanic crust and sediment (e.g., [8]). On the other hand, halogen ratios of olivines in lavas from the northern Izu-Ogasawara arc [9] indicate insignificant contribution to the mantle wedge of pore fluid-derived halogens. This implies a relatively small amount of the pore water subduction fluids would be released from the Izu slab at a sub-arc depth resulting in further subduction to great depths in the mantle, possibly resulting in the seawater-like heavy noble gas composition of the convecting mantle [10].Based on the relation with ^{129}Xe produced from decay of short-lived nuclide ^{129}I during stepwise heating noble-gas extraction of the Allende and Shallowater meteorites, intrinsic I and U to the meteorites were distinguished from those of terrestrial contamination origin.These results demonstrate that simultaneous determinations of noble gases, halogens, K, Ca, Ba, and U in mantle-derived rocks and meteorites provide important information about their origins. [1] Sumino et al. (2001) J. Mass Spectrom. Soc. Jpn. 49, 61-68. [2] Sumino et al. (2008) J. Volcanol. Geotherm. Res. 175, 189-207. [3] Ebisawa et al. (2004) J. Mass Spectrom. Soc. Jpn. 52, 219-229. [4] Kendrick (2012) Chem. Geol. 292-293, 116-126. [5] Muramatsu &Wedepohl (1998) Chem. Geol. 147, 201-216. [6] Sumino et al. (2010) Earth Planet. Sci. Lett. 294, 163-172. [7] Kobayashi et al. (2013) Mineral. Mag. 77, 1484. [8] Schmidt &Poli (1998) Earth Planet. Sci. Lett. 163, 361-379. [9] Sumino et al. (2013) Mineral. Mag. 77, 2285. [10] Holland &Ballentine (2006) Nature 441, 186-191.