High pressure investigation of Xe-compounds relevant for the Earth

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The background of this abstract is the missing Xe problem in the atmospheres of the Earth and Mars and the perspective to resolve it by synthesizing Xe-compounds with terrestrial materials. Evidence for the stability of both xenon silicate and xenon clathrate phases at deep crustal pressures and temperatures will be presented The experiments have been conducted using diamond anvil cell techniques combined with laser heating. Loaded samples were water or α-cristobalite with Xe as a pressure medium.

Xe-H_2O system:

Structure I xenon clathrate was observed to be stable up to 1.8 GPa at which pressure it transforms to a new Xe-clathrate phase stable up to 2.5 GPa before breaking down to ice VII plus solid xenon. The bulk modulus and structure of both phases were determined: 9(±1) GPa for Xe-clathrate A with structure I (cubic) and 45(±5) GPa for Xe-clathrate B (tetragonal)..

Xe-SiO_2 system:

α-cristobalite transforms to β-cristobalite above 270°C, which possesses large cavities and a high degree of crystallographic disorder and provides favorable conditions for hosting Xe. Indeed, after laser heating at 1500-1700°C and 1.2 GPa, Raman spectra show three intense peaks in the low frequency region, attesting the formation of a new silicate phase in the presence of Xe. This phase is not temperature quenchable but transforms back to a mixture of mostly quartz plus a minor phase. This second phase is stable up to 2.1 GPa and its x-ray diffraction pattern could be indexed by a cubic structure with a=8.03 Å, similar to ethylene glycol-silicalite, a silica clathrate. Indeed, molecular dynamics simulations predict a clathrate-like environment of heavy rare gases in liquid silica, which would imply that the underlying solid phase is indeed a Xe-silica clathrate. Electron microprobe analyses of the recovered DAC samples gave Xe concentrations of up to 4 wt%. Our results on the Xe-SiO_2 system are preliminary and open many perspectives for studying Xe-bearing compounds relevant for the solid earth.

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Ion Microprobe Dating of Dinosaur Tooth: Implications for High-Level Lead Exposure

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Direct dating of fossilized teeth was first successfully completed by Sano and Terada using the ion microprobe ^{238}U-^{206}Pb isochron method. This technique was subsequently extended to a total Pb/U isochron method of a Carboniferous conodont. These results have convincingly shown that the U-Pb isotopic systems of fossil apatite can yield credible age data with reasonable precision. The purpose of this study was to apply the ion microprobe U-Pb dating of a tooth from a Cretaceous dinosaur and to indicate the mechanism to produce the elemental fractionation of U from Pb at the hundred µm size.

The sample analyzed is a fragment of a fossilized tooth of a carnivores dinosaur (Allosauroids, Theropoda, Saurischia) which was derived from the Lower Cretaceous Hasandong Formation in the middle part of the Singdong group from the Gyeongsang basin, southeastern Korea. Twelve spots on a single fragment of the fossil dentine yielded a ^{238}U-^{206}Pb* isochron age of 117±18 Ma and a Tera-Wasserburg concordia intercept age of 115.1±9.3 Ma in a ^{238}U/^{206}Pb-^{207}Pb/^{206}Pb-^{204}Pb/^{206}Pb diagram. These ages provide a constraint on the depositional age of the fossil in its host Hasandong Formation as Early Aptian. It is well documented that living animal teeth does not uptake U, Th and REE. These elements may be enriched in the tooth during late diagenetic processes There are positive correlations between U content and minor chemical components such as FeO and Al_2O_3 in the sample suggesting progress of diagenetic process. On the other hand, the uptake mechanism of Pb in teeth and/or bone may be different from that of U. It is well known that Pb enters the body primarily via ingestion and secondarily through inhalation. Pb then contaminates the blood and various organs are affected. In the present sample, common Pb (estimated by ^{204}Pb) abundance was huge, up to 2400 ppm at relatively pure apatite site where shale-normalized rare earth element (REE) abundance pattern indicates less altered signature. Such common Pb was incorporated in the tooth at least before the remains were deposited and probably suggests Pb poisoning of the dinosaur by a high level-exposure.