UNDERSTANDING THE INITIAL Xe ISOTOPE COMPOSITION OF THE TERRESTRIAL ATMOSPHERE AND THE COMPOSITIONAL VARIATION OF METEORITES

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Introduction: It has been long noted that the noble gas composition of the atmosphere is not primordial, as the non-radiogenic isotopic compositions are heavily fractionated with respect to both solar and chondritic compositions [1]. Xenon, with nine isotopes, plays a crucial role in atmospheric evolution models, as it carries information on the physical processes that produced mass fractionation. In principle, the Xe isotope composition of the atmosphere can identify likely sources of noble gases and volatiles of the early atmosphere, and may put chronometric constraints on early atmosphere formation.

In order to match the non-radiogenic Xe isotope composition to the solar wind (SW) values, backward modeling by [2] resulted an initial atmosphere Xe isotopic composition (U-Xenon) that is depleted in the heaviest two isotopes (^{134}Xe and ^{136}Xe), even with respect to the composition of the SW. This makes both the planetary (Q) and SW compositions unlikely precursors of our atmosphere.

Additionally, Takeoka [3] used meteorite data to infer the existence of a primitive solar-system Xe component that is depleted in the heaviest Xe isotopes, similarly to U-Xe. His approach explains the compositional variation of basaltic achondrite data as a mixture between a primitive component and mostly Pu-fission derived Xe. The principal variation of the carbonaceous chondrite data would lie between the same primitive solar system Xe and an isotopically heavy Xe-HL component, that is found in presolar diamond grains.

Recent studies, however, have shown that all types of chondrites have a similar trapped component (Q) [4,5,6]. Observed heavy Xe isotope variation in primitive meteorites may be explained by addition of ancient products of nucleosynthetic processes (pure s-component, and two heavy nucleosynthetic components: Xe-s, Xe-r and Xe-h) preserved in presolar grains [7].

Discussion: Here we show more recent heavy Xe data on achondrites [8], and carbonaceous, ordinary and enstatite chondrites [9-27] (Fig. 1). The correlation line intersection may define a a primitive Solar System Xe isotope composition. Although there is scatter in the data, error weighted linear fits are consistent with Q or air as trapped components, and do not require a common source depleted in the heaviest Xe nuclides, i.e. U-Xe.
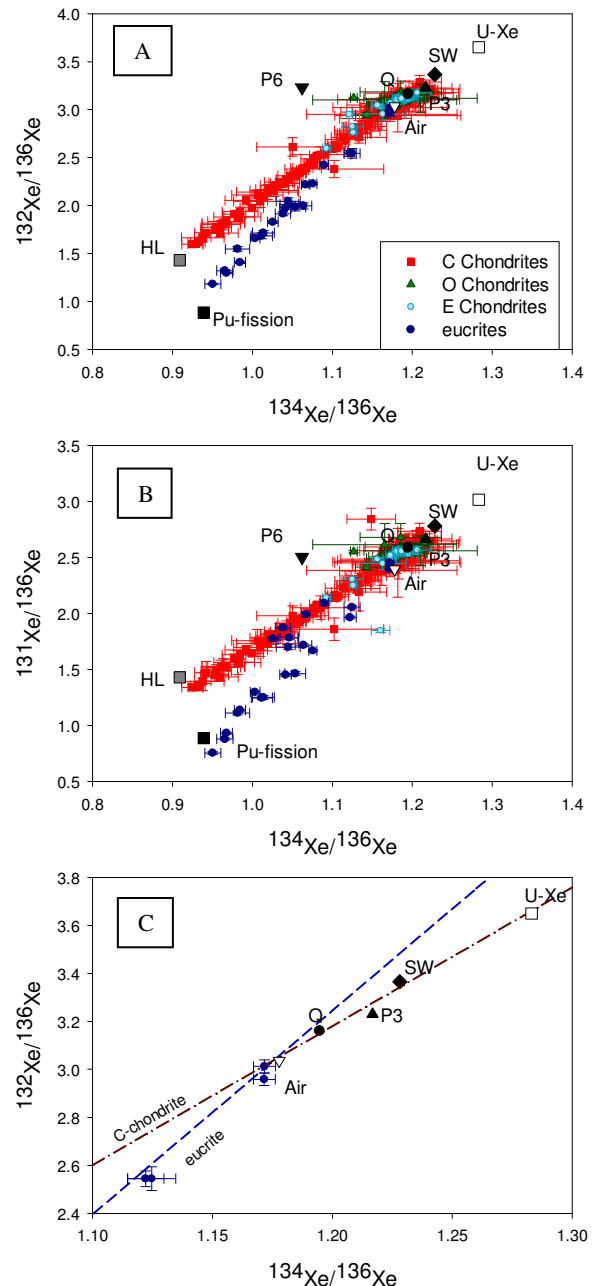

Figure 1. Heavy Xe isotope variation in meteorites. The composition of the SW, Earth's atmosphere, U-Xenon, Pu-fission , the planetary component Q, and components defined by pre-solar grains (P3, P6, HL) are also indicated. **A-B.** Xe data of eucrites [8] is plotted against an extended dataset of carbonaceaous chondrites, ordinary chondrites and enstatite

chondrites [9-27]. **C**. The correlation line intersection defined by error weighted least square fits on eucrites and carbonaceous chondrites.

We re-examine the exotic composition of the modern atmosphere in order to infer the possible source(s) of terrestrial noble gases. Although nucleosynthetic anomalies are preserved in presolar grains, as shown in available meteoritic data, we investigate whether mass fractionation applied to a modified planetary (Q) or solar composition by the addition of recently determined nucleosynthetic component(s) [7] is sufficient to derive the precursor of our atmosphere.

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