HOW MUCH XENON IN SHALES?
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Several years ago it was reported that the heavy noble gases are selectively enriched in shales and that some shales contain more Xe than even the most gas-rich meteorites [1]. It was suggested that the anomalously low Xe/Kr ratio in air would increase to approximately the value observed in chondrites if the noble gases in shales were added to those in air [1]. The trapping of noble gases in sediments may also play a role in determining the atmospheric abundance pattern of these elements for other terrestrial planets [2], especially if the surface temperature is low, e.g., Mars.

Average concentrations of $^{132}$Xe = 2.46 x $10^{-8}$ ccSTP/g and 2.67 x $10^{-8}$ cc STP/g were reported in the initial study of noble gases in several samples of the Fig Tree and Mt. Vernon shales, respectively [1]. A later analysis of noble gases in Fig Tree shale yielded a $^{132}$Xe concentration of 0.15 x $10^{-8}$ cc STP/g [3], but $^{132}$Xe concentrations of 2.1 x $10^{-8}$ cc STP/g and 13.2 x $10^{-8}$ cc STP/g were reported in two samples of shale from Kuruman, Cape Province, South Africa [3]. However, a more recent report on noble gases in a variety of shales gives $^{132}$Xe concentrations of only (0.004-0.569) x $10^{-8}$ cc STP/g and notes that the data do not support the suggestion that the Xe deficiency in air can be made up by the Xe inventory of sedimentary rocks [4]. It was reported that the samples analyzed in this latest study were "heated overnight to -150°C under vacuum during preliminary extraction system preparation" [4].

We have investigated the effects of sample heating prior to the collection of gases for analysis in accounting for the 3 order of magnitude variation in the Xe contents of terrestrial shales. The results of our analyses confirm the high Xe concentrations initially reported in Fig Tree shale [1].

Gases were extracted from samples of Fig Tree shale that had been exposed to a variety of preheating procedures. Stepwise heating was used for gas extraction. The 200°C fraction of gases released from a sample previously heated to 150±5°C for 12.00 hrs contained only 9% of the Kr and 19% of the Xe that was released from another sample that had not been preheated. However,
the total Kr and Xe concentrations of the preheated sample were 73% and 83%, respectively, of those in the sample that had not been preheated. Thus carefully controlled preheating of this shale to 150°C for 12 hrs cannot account for the wide range of Xe concentrations reported in shales.

The results of our stepwise heating experiments on Fig Tree shale revealed that 83% of the Kr and 57% of the Xe were released at extraction temperatures of $T < 400°C$. Thus, the loss of an appreciable fraction of these two heavy noble gases from Fig Tree shale might occur if the preheating temperature exceeded 150°C.

The fraction of Xe lost during preheating might also be expected to depend on the nature of the sample and the Xe sites. Kuroda and coworkers have reported that 74% of the total $^{132}$Xe content of Wausau granite was released at an extraction temperature of 200°C [5] and that 84% of the total $^{132}$Xe content of thucholite was released at an extraction temperature of 250°C [6]. It is therefore premature to interpret the low Xe contents of the recent study on shales [4] as evidence that the terrestial noble gas inventory contains an exotic depletion of Xe, particularly at a time when so little is known about the fraction of Xe lost when the samples were preheated.

REFERENCES: