Xe-Q IN LODRANITES AND A HINT FOR Xe-L. FRO90011 ANOTHER LODRANITE?
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The Lodran achondrite contains about one-quarter metallic Fe/Ni, two-thirds olivine and pyroxene, some troilite, plus minor phases [1, 2]. In a previous study [3] we demonstrated that Lodran and three other lodranites – LEW88280, Yamato-791491, and MAC88177 – yield the same cosmic-ray exposure age of a few million years, suggesting that they originate from the same parent body. In the present work we show that the mineral phases of Lodran contain large concentrations of planetary-type but no solar-type trapped noble gases. Surprisingly, the highest concentrations were observed in the Fe/Ni-phase (e.g. 1520 x 10^{-12} cm^3 STP/g ^{132}Xe). A large fraction of the trapped gas is released between 1200°C and 1400°C. The Xe isotopic pattern is similar to that of Xe-Q [4, 5]. The 1400°C fraction of the Fe/Ni-phase shows excesses of ^{124}Xe, ^{126}Xe, and ^{128}Xe similar to Xe-L (pre-solar Xe enriched in the light isotopes) that has, until now, only been observed in combination with Xe-H (pre-solar Xe enriched in the heavy isotopes) [6].

A 900 mg sample of Lodran was separated by handpicking into five phases - Fe/Ni, FeS, olivine, pyroxene, and Cr_2O_3. He, Ne, and Ar isotopes were measured in all phases, and Kr and Xe in a bulk sample and Fe/Ni. Bulk samples of LEW88280, Y-791491, and MAC88177 were also analyzed, the latter two only for He, Ne, and Ar. The cosmogenic, radiogenic, and fissiogenic components will be published later. Here we present the results for the trapped component. The concentrations are given in Table 1.

Although Lodran is a differentiated meteorite, its planetary-type trapped gas concentrations are high; they are in the range of those of type 3 ordinary chondrites. It is very unusual that the Fe/Ni-phase contains the highest amounts of trapped gases of all mineral phases (Table 1). The other three lodranites contain less trapped gases than Lodran. Fig. 1 demonstrates that the elemental abundance pattern is quite similar for the different mineral phases and resembles that for C3 chondrites.

The isotopic composition of trapped Ne and Ar could not be derived due to the very low concentrations. Trapped Kr shows the isotopic signature of Kr-Q [5]. Fig. 2 displays the isotopic pattern of trapped Xe in the 1200°C and 1400°C fraction of bulk Lodran and of the Fe/Ni-phase, normalized to solar wind Xe (BEOC 12001 [7]). The data points represent the measured values. As discussed below, the contributions of cosmogenic and fissogenic Xe are negligibly small. The concentrations of the target elements for cosmic-ray produced Xe in Lodran are low: 0.17 ppm Ba and 0.141 ppm La [8]. For a cosmic-ray exposure age of 3 Ma [3] we calculate a ratio $^{126}Xe_c/^{126}Xe_{total}$ of less than 0.0008. The U concentration of lodranites is unknown, but it can be estimated based on a K concentration of 13 ppm [8] and a K/U concentration ratio of 2 x 10^4 (ureilites). We obtain 0.65 ppb U and, for 4.55 AE, 0.002 x 10^{-12} cm^3 STP $^{136}Xe_f$. However, the major progenitor of fission Xe in achondrites is ^{244}Pu. Its abundance 4.55 AE ago was derived from 0.227 ppm Nd in Lodran [8] and a ratio ^{136}Xe (Pu-fission)/Nd in Angra dos Reis of 1.0 x 10^{-12} cm^3 STP per g and ppm Nd [9] resulting in 0.23 x 10^{-12} cm^3 STP/g ^{136}Xe (Pu-fission). Compared with the observed concentration of trapped ^{136}Xe of 410 x 10^{-12} cm^3 STP/g (Table 1) the fission Xe contribution is negligibly small. Radiogenic Xe from ^{129}I decay might be responsible for a slight enrichment of the ^{129}Xe abundance in the Xe isotope pattern in Fig. 2.

Inspection of Fig. 2 shows that bulk Lodran is depleted by about 7% in ^{124}Xe and ^{126}Xe relative to solar Xe. The 1200°C fraction of the Fe/Ni-phase yields a Xe isotopic pattern almost identical to that of Xe-Q [4, 5]. The 1400°C fraction of Fe/Ni contains 370 x 10^{-12} cm^3 STP/g ^{132}Xe. The Xe pattern can be interpreted to indicate an addition of Xe-L, with perhaps some of Xe-S [10], as ^{128}Xe and ^{132}Xe are enhanced. Xe-H that is highly enriched in ^{134}Xe and ^{136}Xe is absent in the 1400°C fraction. The Xe isotopic abundances of bulk LEW88280 are similar to those observed in bulk Lodran. We now plan to continue the Kr and Xe analyses of pyroxene, olivine, FeS, and Cr_2O_3, to search for the Xe-L carrier.

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Table 1. Trapped noble gases in lodranites

		^{20}Ne	^{36}Ar	^{84}Kr	^{132}Xe
		10^{-8} cm³ STP/g		10^{-12} cm³ STP/g	
Lodran	Fe/Ni	0.40	31.7	1700	1470
	FeS	0.62	28.9	-	-
	Bulk	0.30	21.9	1430	1330
	Cr_2O_3	3.6	20.7	-	-
	Px	0.24	8.2	-	-
	Ol	0.23	4.0	-	-
LEW 88280	Bulk	0.08	5.0	280	220
Y-791491	Bulk	0.03	0.45	-	-
MAC88177	Bulk	0.03	0.08	-	-
FRO90011	Bulk	0.1	1.07	-	-

Errors (2σ): 10-20%.

Table 2. He, Ne, and Ar in lodranites and FRO90011 (10^{-8} cm³ STP/g)

	^{3}He	^{4}He	^{20}Ne	^{21}Ne	^{22}Ne	^{36}Ar	^{38}Ar	^{40}Ar
Lodran	11.0	48.2	1.38	1.19	1.39	22.2	4.57	60.1
LEW88280	8.8	46.7	0.94	0.88	1.09	5.2	1.25	85.8
Y-791491	10.2	322	1.35	1.34	1.63	0.68	0.29	664
MAC88177	0.78	7.1	1.40	1.31	1.68	0.23	0.13	46
FRO90011	9.6	831	1.48	1.44	1.73	1.16	0.34	518
For comparison								
Acapulco [11]	11.6	12600	2.26	1.71	2.10	4.34	1.06	4212

Errors (2σ): 3-5%

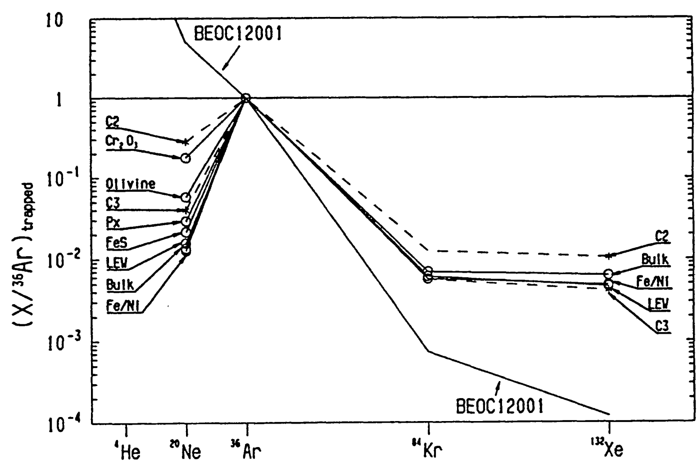

Fig. 1 Abundance pattern of the trapped noble gases normalized to ^{36}Ar = 1 in samples from Lodran (bulk, Fe/Ni, FeS, pyroxene, olivine, and Cr_2O_3) and in bulk LEW88280 (LEW). C2, C3, and BEOC12001 abundances are shown for comparison.

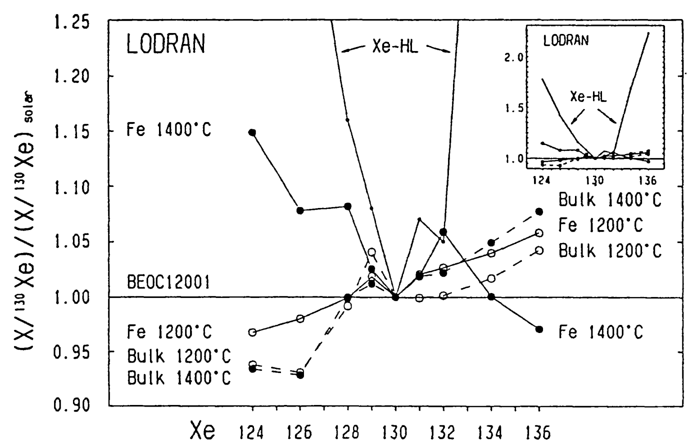

Fig. 2 Pattern of the Xe isotope ratios in temperature fractions of a bulk sample and the Fe/Ni-phase (Fe) of Lodran normalized to solar Xe isotope ratios (BEOC12001). The pattern for Xe-HL [6] is shown for comparison. Errors (2σ): for ^{124}Xe and ^{126}Xe about 8%, for the other isotopes about 5%.