xenon in the meteorite is apparently a mixture of radiogenic and "ambient" xenon, which the meteorite absorbed from its environment (Fish and Goles, 1962). To determine the amount of radiogenic Xe^{129}, the ambient component must be subtracted, which requires a knowledge of its isotopic composition. Second, the iodine in ordinary chondrites appears to reside in several mineralogically different sites (Goles and Anders, 1962; Reynolds, 1963). The Xe^{129} seems to be associated only with the iodine in the more retentive sites, perhaps because the Xe^{129} from the less retentive sites was lost sometime before the fall of the meteorite. Decay intervals should therefore be based only upon the iodine "correlated" with xenon, rather than the total iodine content of the meteorite.

Fish and Goles (1962) have developed an ingenious method for eliminating both of these difficulties. By graphical analysis of the gas-release pattern of neutron-irradiated meteorites, they obtain both the decay interval of the meteorite and the Xe^{129}/Xe^{132} ratio of ambient xenon. This method has been applied to only three meteorites thus far (Table 6). The older results, based on total iodine, are also listed. Though obviously less reliable, they still reveal some important trends.

TABLE 6

I^{129}-XE^{129} DECAY INTERVALS

Meteorite	*Class**	*Decay Interval calculated from:*		*Average K-Ar age[††] AE*	*Average (U, Th) — He age[††] AE*
		*Total I** m. y.*	*"Correlated" I[†] m. y.*		
Abee	E	47	51.5 ± 2	4.71 ± 0.28	3.62 ± 0.64
Indarch	E	77		4.29 ± 0.26	3.77 ± 0.94
St. Marks	E	52		*3.78*	*2.45*
Beardsley	B	254		4.30 ± 0.18	3.70 ± 0.65
Richardton	B	97	51.5 ± 2	4.27 ± 0.08	3.77 ± 0.67
Bruderheim	H	107	34.3 ± 6	1.81 ± 0.07	1.27 ± 0.11
Renazzo	?	—	66 ± 6	3.8 ±	
Murray	K	≥ 128		*1.58 — 2.51*	
Sardis (troilite)	O	238			

* E = enstatite chondrite, B = bronzite chondrite, H = hypersthene chondrite, K = carbonaceous chondrite, O = coarse octahedrite.

** See Anders (1963a) for references. The original values were reduced by 16 m. y. to make them consistent with Reynolds' values in the next column, which are based upon $(I^{129}/I^{127})_0 = 1.25 \times 10^{-3}$. The value for Beardsley is based on the most recent xenon measurement (Reynolds, 1963).

[†] From Reynolds (1963), and Reynolds and Turner (1964). Apart from the general uncertainty of ± 55 m. y. (see text) the first three values in this column are afflicted with an additional error of ± 17 m. y., which is, however, constant for these three meteorites. Thus the difference between Bruderheim and the other meteorites is significant, but the difference between Renazzo, Abee, and Richardton is not.

[††] See Anders (1963a) for the original values and references. In the calculation of averages, errors of ± 6 and ± 25% were assumed for the individual K–Ar and U — He ages (Kirsten *et al.*, 1963). Values printed in italics seem to be low owing to diffusion losses during exposure.

Allowing for an uncertainty of ±60 m.y. in the absolute values of the decay intervals, we can draw the following conclusions.

1. The enstatite chondrite Abee had cooled to a low enough temperature to retain Xe^{129} some 50 ± 60 m.y. after t_0.

2. The friable bronzite chondrite Richardton also began to retain Xe^{129} about 50 ± 60 m.y. after t_0, but the more highly recrystallized Beardsley did not begin to retain Xe^{129} until some 100–200 m.y. later. This points to an origin in a deeper location or a larger body.

3. Within the stated error limits the primitive chondrite Renazzo has the same decay interval as Abee and Richardton. However, it also contains a loosely-bound Xe^{129} component, which is not present in the other meteorites.

4. The hypersthene chondrite Bruderheim started to retain Xe^{129} some 17 m.y. earlier than did Abee and Richardton.

5. The carbonaceous chondrite Murray seems to contain little or no radiogenic Xe^{129}, but since carbonaceous chondrites are known to lose gases more readily than do ordinary chondrites (STAUFFER, 1961a), and generally have low gas-retention ages, no definite conclusions about their cooling times can be drawn from the present data.

6. The iron meteorite Sardis apparently began to retain Xe^{129} some 100–200 m.y. later than most chondrites. Again, this suggests an origin in a deeper location or a larger body, although this conclusion is less certain for a dense iron than for a porous chondrite (see below).

3.23. INTERPRETATION OF GAS-RETENTION AGES

The two principal views on the origin of chondrites are: that they come from the interior of small-to-medium-sized bodies, or from the surface of a larger body. In the former case, the gas retention ages can provide valuable clues to the size of the body, since its interior temperature is a sensitive function of radius (Figure 5).* This is not true of the surface temperature, and we must therefore confine our discussion to small bodies. This is not intended to prejudice the issue, however. The size of the parent bodies will be discussed in Section 4.2 and 4.3.

For a quantitative interpretation we must know T' and T'' for He^4, Ar^{40} and Xe^{129}. The first attempt to extract detailed information about the former environment of meteorites from the K–Ar dates was made by GOLES *et al.* (1960). On the basis of the then available laboratory data on the diffusion of Ar^{40}, they estimated $T'_{Ar} \approx -80$ °C, and concluded that the parent bodies of the chondrites must have been $\leqslant 250$ km in radius. Recent work by FECHTIG *et al.* (1963) has shown, however, that the diffusion data must be corrected for the preferential degassing of small grains.

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* Any such deductions involve the tacit assumption that the measured samples represent a reasonably good average of the body as a whole, and not just its surface regions. This assumption is probably justified, inasmuch as the meteorites dated by the K–Ar and U–He methods include a number of metamorphosed specimens, whose textures, porosity, and magnetic anisotropy suggest extensive recrystallization at high temperatures. Although the meteorites dated by the I–Xe method are far fewer in number, they also include a strongly metamorphosed and a chemically differentiated specimen (Beardsley and Sardis).