

Nitrogen and hydrogen isotopic compositions of the Martian meteorite ALH84001

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Nitrogen and hydrogen isotopic compositions of ALH84001 were measured. The highest $\delta^{15}\text{N}$ value is 418 permil which is much higher than the previously reported values for this meteorite. It is actually the highest value ever reported for martian meteorites. The highest δD value obtained for the carbonate in ALH84001 is 1344 permil which is also higher than previously reported values, though it is smaller than the values for the other martian meteorites. It is concluded that a significant fraction of the martian atmosphere had escaped in by 4 billion years ago.

Some studies suggest that the isotopic compositions of volatile elements in ALH84001 are not very anomalous. A nitrogen isotopic composition ($\delta^{15}\text{N} = 46$ permil) is reported by Murty and Mohapatra and inferred that the martian atmospheric nitrogen at 4 billion years ago was isotopically lighter than that in the present atmosphere. As to the hydrogen isotopic compositions, $\delta\text{D} = 783$ permil was reported by a stepped heating study and much lower values were reported by a SIMS study. These values are lower than those in other martian meteorites and it was inferred that the hydrogen isotopic composition of the early Mars was lighter than that of the present Mars.

We made our own measurements of nitrogen and hydrogen isotopic composition to see if the isotopic compositions have evolved throughout the Martian history, or it evolved very early in the martian history and has not changed much in the latter half of the history.

The nitrogen isotopic composition was measured by stepped combustion and the hydrogen isotopic composition of carbonates was measured by SIMS. The $\delta^{15}\text{N}$ is 418 permil after cosmogenic correction. This is much heavier than the previously reported values for this meteorite, and is the highest value ever reported for the Martian meteorites. The highest $\delta\text{D} = 1344$ permil which is also much higher than the previously reported value for carbonates in this meteorite. The present martian atmospheric δD value is estimated to be close to 4000 permil and similar values have been reported for some martian meteorites. Compared with these values, the hydrogen in ALH84001 is isotopically light. Yet, when considered together with the nitrogen isotopic composition, it can be said that the isotopic compositions of H and N are significantly heavier than the inferred initial isotopic compositions and hence it is suggested that a large fraction of the martian atmosphere has escaped very early in the history of the Mars.