Isotopic composition of nitrogen in ‘phase-Q’

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Abstract

An acid residue from the Dhajala meteorite which carries the noble gas component of the pure Q-phase, has been analyzed for nitrogen and noble gases by step-wise heating pyrolysis. From Ne data we derive \( \frac{20}{22}Q = 10.48 \pm 0.15 \). A nitrogen content of 48 ppm with \( \delta^{15}N = -15\% \) in all temperature fractions except for a small fraction (0.26%) of N in 1200°C with \( \delta^{15}N = -55\% \) has been observed. The sharp fall in the \( \delta^{15}N \) for the 1200°C fraction, in all likelihood, is due to the signature of microdiamonds in Dhajala. We calculate an abundance of ~30 ppb for microdiamonds in Dhajala. The uniform \( \delta^{15}N \) of ~15% in all other temperature fractions is interpreted as the isotopic composition of nitrogen in phase-Q. The peak release of nitrogen occurs at 1400°C, while for the noble gases, the peak release occurs at 1200°C, indicating that nitrogen is more tightly bound in phase-Q as compared to the noble gases.

Keywords: Dhajala Meteorite; N-15/N-14; noble gases; pyrolysis

1. Introduction

A major fraction of the primordial noble gases in chondritic meteorites are located in a small carbonaceous phase which is resistant to HF/HCl attack [1]. Further treatment of this carbonaceous phase with oxidizing acids such as HNO₃ leads to loss of the isotopically normal ‘planetary gases’, without appreciable mass loss, which has led to the suggestion that the phase-Q that is hosting the noble gases is a set of adsorption sites in the carbonaceous phase rather than a true phase [1-4]. Carbonaceous, enstatite and ordinary chondrites all have the phase-Q as a principal carrier of the trapped noble gases. This phase exhibits the same noble gas elemental and isotopic ratios [5-7] in all these meteorites. More refined in situ acid etching experiments [8,9] have been very successful in isolating and analysing the composition of phase Q noble gases in a pure form. The HF/HCl-resistant carbonaceous phase from chondrites loses its Q component on treatment with oxidizing acids and only retains the exotic noble gas components of mostly extra solar origin (viz. Xe-HL, Xe-S, Ne-A2, Ne-E, etc.) [7,10,11]. The abundance of the exotic noble gases, as well as the Q gases, decreases with the increasing metamorphic grade of the chondrites [12,7]. The Dhajala meteorite has been petrologically classified to belong to the metamorphic grade H3.8, based on TL sensitivity [13]. It has been shown that the abundance of exotic noble gas components is negligible in the case of Dhajala meteorite [7] and for all practical purposes the HF/HCl residue of Dhajala is considered to host a pure component of Q noble gases.

The Q component from different chondrite groups

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