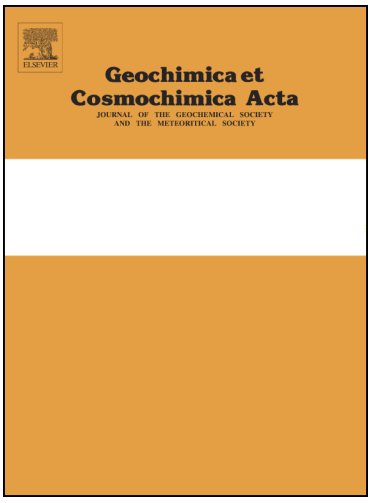

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Differential metamorphic effects on nitrogen isotopes in kerogen extracts and bulk rocks

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Abstract

The last decade has seen a steady rise in the number of publications on nitrogen isotopes in sedimentary rocks, which have become an established tool for investigating the evolution of life and environmental conditions. Nitrogen is contained in sedimentary rocks in two different phases: bound to kerogen or substituted in potassic minerals (mostly K-bearing phyllosilicates and feldspars). Isotopic measurements and interpretations typically focus either on kerogen extracts alone or on bulk rocks that include both phases. The community is split about which sample type more accurately captures the original composition of the biomass. To address this question, we combined nitrogen isotopes and carbon-to-nitrogen ratios with carbon-to-hydrogen ratios which act as an independent proxy for metamorphic alteration. Our results reveal that metamorphism drives kerogen-bound nitrogen isotopically lighter while silicate-bound nitrogen becomes heavier. For rocks up to greenschist facies, the isotopic effect of this internal partitioning (up to 3-4‰) is larger than the isotopic effect of metamorphic nitrogen loss from the system (up to 1-2‰). The opposite may be true for higher metamorphic grades. We conclude that for low-grade sedimentary rocks with more than 60% of their total nitrogen residing in the silicate phase the primary isotopic composition of the biomass is best approximated by the bulk rock measurement, whereas for high-grade rocks the kerogen extract may be the more accurate proxy. The isotopic difference between nitrogen phases can thus serve as a rough indicator of the degree of metamorphic alteration.