The subduction origin of mantle nitrogen

COLIN GOLDBLATT[1] AND KEVIN ZANHLE[2]

[1]Space Science and Astrobiology Division, NASA Ames Research Center, MS 245-3, CA 94035 (colin.goldblatt@nasa.gov)
[2]Space Science and Astrobiology Division, NASA Ames Research Center, MS 245-3, CA 94035 (kevin.j.zahnle@nasa.gov)

Mantle nitrogen correlates strongly with radiogenic ^{40}Ar but not primordial ^{36}Ar: $N_2/^{40}Ar$ ~ 80 over several orders of magnitude in concentration, whereas $N_2/^{36}Ar$ varies by orders of magnitude. ^{40}Ar is the decay product of ^{40}K, so with an estimate of the K content of the mantle one can calculate that the mantle nitrogen inventory is $1.9 \pm 1.5 \times 10^{20}$ mol N_2 ($5.4 \pm \times 10^{18}$ kg), equivalent to 1.4 times the present atmospheric nitrogen inventory.

A key point is that the lack of correlation between N and primordial ^{36}Ar means that mantle N is not primordial. By contrast, the strong correlation with radiogenic ^{40}Ar indicates that the main source of the mantle's nitrogen is NH_4^+ substituted for K^+. Because K is incompatible with the solid phase of the mantle and fractionates to crustal rocks, this implies that the mantle's N is from subducted crust. Consequently, a history of monotonic volatile depletion of the mantle can be excluded.

Presently, the net transfer of nitrogen to the mantle at subduction zones (input to the trench minus arc volcanic output) is 3.3×10^8 kg N yr^{-1}. This flux was likely much larger in the past, when the deep ocean was anoxic and NH_4^+ concentrations were much higher than today. NH_4^+ incorporate into altered oceanic crust during early hydrothermal alteration, so much more would incorporate under the high NH_4^+, high heat flow and fast spreading rate regime of the Archean. Also, less sedimentary NH_4^+ be lost in diagenesis. Consequently, the atmosphere—mantle balance of nitrogen is likely to have changed over Earth history. An higher atmospheric nitrogen inventory would have enhanced greenhouse warming, contributing to the resolution of the Faint Young Sun paradox [1].

That the nitrogen in the mantle arrived by subduction, and therefore was once in the atmosphere is clear. When this transfer took place is not yet clear. Can noble gas systematics shed further light on this?

[1] Goldblatt, Claire, Lenton, Matthews, Watson & Zahnle (2009) *Nature Geosci*. **2**, 891–896. doi, 10.1038/ngeo692.

Single-particle characterization of Saharan dust events at an urban site in Freiburg, Germany

E. GOLDENBERG[1]*, R. GIERÉ[1], B. GROBÉTY[2], V.DIETZE[3], P. STILLE[4], U. KAMINSKI[3] AND C. NEURURER[2]

[1]Department of Geosciences, University of Freiburg, Albertstrasse 23b, D-79104 Freiburg, Germany (*correspondence: Ella.goldenberg@minpet.uni-freiburg.de, Reto.giere@minpet.uni-freiburg.de)
[2]Department of Geosciences, University Fribourg. Chemin du Musee 6, 1700 Fribourg, Switzerland
[3]German Meteorological Service, Air Quality Department, Stefan-Meier-Strasse 4, D-79104 Freiburg, Germany
[4]Ecole et Observatoire des Sciences de la Terre, Université de Strasbourg, rue Blessig 1, 67084 Strasbourg, France

During 2008, Saharan dust reached southern Germany during several events, increasing significantly the weekly levels of particulate matter. The aim of this study was to characterize these dust events by using aerosol samples collected at an urban site in Freiburg, Germany. These samples were compared to non-event conditions at the same site. Using a standardized, rain-protected passive sampler (Sigma-2), airborne particles >2.5μm were collected on transparent adhesive collection plates. Computer-controlled single-particle optical microscopy (IAS) was used to determine size and optical density of individual particles, allowing for distinction between anthropogenic (opaque), geogenic (transparent mineral dust), and biogenic particles, as well as for calculation of mass concentrations. Additionally, chemical composition, geometry and morphology were determined using scanning electron microscopy (SEM), combined with energy-dispersive X-ray (EDX) spectroscopy and automated single-particle analysis (Genesis, EDAX). Particles were classified according to size and composition, whereby geogenic particles were further subdivided into several mineralogical groups. By combining IAS with SEM-EDX single-particle-analysis there will be a high chance for a successful differentiation between particles of local origin and particles transported over long distances. This differentiation of the morphological and optical properties as well as chemical composition will be an improvement for a better distinction between Saharan and Non-Saharan dust events.