The origin of atmospheric particles (PM10) in the air of Paris: A multi-isotopic approach

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The origin of airborne particles in the urban atmosphere is still subject to debate, as classical methods showed their limits. To appraise the respective contributions of each type of aerosol sources, this study proposes a pioneer method based on a multi-isotope approach (carbon, nitrogen, lead and strontium systematics). We isotopically characterize both the organic and inorganic phases of PM10 from pollution sources exhausts and in the atmosphere of Paris.

The systematic multi-isotope characterization of the main pollution sources (i.e. road traffic, heating sources and waste incinerator) identifies each one of them by distinctive isotope signatures. Diesel emissions, in particular, display $\delta^{13}C$ significantly different from the other types of sources.

In the first twenty meters above the ground, results from ambient air samples show the predominance of road traffic as the principal vector of the organic phase (among which diesel engines play a major role), while industry is the main source of the inorganic phase. Both strontium and lead also show that under specific meteorological conditions, a non-negligible part of the PM10 may originate from natural sources outside the city.

These first results indicate that the use of stable and radiogenic isotopes as tracers of aerosols in the atmosphere is conclusive, and open a large field of isotopic research in the domain of atmospheric pollution.

Simultaneous magnesium isotope and aluminum abundance measurements using laser ablation multiple-collector ICPMS

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Some of the naturally occurring magnesium isotope variation is due to decay of ^{26}Al. The short half-life of 0.69 Myrs makes ^{26}Al-^{26}Mg an ideal chronometer to date processes in the solar nebula. The presents of excess ^{26}Mg from the decay of ^{26}Al in the early solar system has already been discovered in the seventies [e.g. 1,2]. However, most of the evidence for ^{26}Al has been derived from Type B calcium and aluminum rich inclusions (CAIs) which contain large anorthite crystals with high $^{26}Al/^{24}Mg$. In these CAIs excess ^{26}Mg up to several percent is detectable with TIMS and SIMS techniques. The ^{26}Al content of other CAI types and chondrules are less well known because the precision of SIMS and TIMS techniques is insufficient for most other minerals. Here we report magnesium isotope and $^{26}Al/^{24}Mg$ ratios for minerals from terrestrial and meteoritic samples using Nu-1700 a new large geometry high resolution multiple-collector ICPMS. With the Nu-1700 molecular interferences such as C_2^+, CN^+, or doubly charged ^{48}Ca can be resolved from magnesium isotopes. To date an average $^{26}Mg/^{24}Mg$ of 0.139424±8 (2σ SE) has been obtained for NIST SRM-980. Instrumental and natural mass-dependent fractionation have been corrected by using an exponential law assuming a $^{25}Mg/^{24}Mg = 0.12663$ [3]. In situ $^{26}Mg/^{24}Mg$ ratios for NIST SRM 610 by laser ablation are identical providing evidence that double charged ^{48}Ca is resolved from ^{24}Mg even at $Ca/Mg \approx 300$. This normalized $^{26}Mg/^{24}Mg$ obtained at high mass resolution ($m/\Delta m \approx 2500$) is significantly different from the value of 0.139563±41 measured on a NuPlasma at a mass resolution of $m/\Delta m \approx 500$ [4]. With the precision for internally corrected $^{26}Mg/^{24}Mg$ on Nu1700 initial $^{26}Al/^{27}Al = 5 * 10^{-5}$ can be detected in minerals with $^{27}Al/^{24}Mg \geq 0.5$. First analyses of olivines, pyroxenes and melilites in chondrules of Allende with $^{27}Al/^{24}Mg \leq 5$ did not detect any excess ^{26}Mg. This provides evidence that last equilibration of these chondrules took place a minimum of 2 Myrs after CAIs formed assuming homogeneous distribution of ^{26}Al in the early solar system.

References

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