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Platinum group elements in automobile catalysts: characterization, sources and environmental mobility

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The platinum group elements (PGE) comprise Ru, Rh, Pd, Os, Ir, and Pt. The PGE are extremely siderophile and most of the elements were during the Earth differentiation partitioned into the core. The average natural concentration of PGE in Earth's crust is low and range of 0.X – X0 μg kg-1. During the magmatic process the PGE are strongly partitioned into sulphides and Ni minerals. The distribution of PGE and increase of their emissions in the environment are mostly related to the use of automobile catalyst (AC) in car engines (in USA since 1975, in Europe since 1986). The ACs consist of a honeycomb support (made from -Al2O3 or cordierite with trace element admixtures – mostly lanthanides and Zr) coated with Pt, Pd and Rh in different ratios. While AC for gasoline engines contain a mixture of Pt-Pd-Rh or Pd-Rh, AC for diesel engines are composed only of Pt. New and aged AC of gasoline and diesel engines, AC standard reference materials, tunnel dust from Prague and tunnel dust reference materials were studied using scanning electron microscopy, electron microanalyses, X-ray diffraction and chemical analyses using inductively coupled plasma mass spectrometry.
The studied ACs differ in phase and elemental composition and PGE contents. The matrix of the gasoline AC is composed of Al, Zr, Ce, Ba oxides with Rh, Pd and Pt coatings. The support of diesel AC is composed of Mg, Al, Fe, Ti and Ca silicates with Pt coatings. Aged gasoline AC exhibit higher Mg, Mn, Zn and Pb contents compared to the new AC. Aged diesel AC differs in higher Zn and Ba contents compared to the new one. Both aged and new AC does not differ in total PGE contents. Leaching experiments were done with AC, real samples of tunnel dusts and reference materials with inorganic (Cl-, HPO42-) and organic (low and high molecular weight) complexing solutions. The solubility experiments indicate that PGE mobilization from ACs is dependent on particle type, time and complexing medium.