

Lateritic sheet air

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Lateritic sheet air has been first tested for O₂, CO₂, CO, and CH₄ concentrations. The tests were performed at a bauxite deposit situated in northwest Guinea. The deposit area includes step-like hills (mesas) and their gentle slopes with altitudes 260 to 180 m.

The gas concentrations were measured in 35 auger holes intersecting the local ground water table (depths 10 to 15 m) and belonging to exploration profiles crossing several relief and geological zones.

The dynamics of gas exchange between laterites and atmosphere was monitored in a number of profiles with two-hour periodicity. Gas concentrations were measured by a gas analyzer OLDHAM COM2100 with sensors for CO₂ (sensitivity 0.1 vol. %), O₂ (sensitivity 0.1 vol. %), CO (sensitivity 1 ppm), and CH₄ (sensitivity 10 ppm). The air monitoring was made for the whole length of each borehole.

It is found that O₂ concentration decreases with depth from 20.8% at borehole collar to 5% at the ground water table, with CO₂ concentration increasing simultaneously from 0.1 to 10%. The uppermost 3- to 4-m interval represents the zone of intense gas exchange between the laterites and the Earth's atmosphere, with a gentle change gradient of the gas concentrations. On the contrary, the underlying 2- to 3-m interval shows a jumping change gradient of the gas concentrations. Deeper, down to the ground water table, the gas concentrations remain almost constant. Thickness of the zone of intense gas exchange is decreasing in daytime and increasing at night. Rains cause its abrupt increase. However, these fluctuations are not accompanied by any considerable changes in O₂ and CO₂ concentrations at the ground water table.

High CO (20-300 ppm) is most typical of boreholes drilled on slopes. Its concentration is gradually increasing to maximum value at the middle of vertical profile and then is decreasing with depth to the half-peak. CH₄ peaks (10-20 ppm) coincide with CO peaks.

The gas distribution data of boreholes allow the conclusion that the vaporization scale in lateritic sheets is considerable. The gaseous dynamics of boreholes allows the assumption that CO₂ and CO are produced by the reaction between the organic compounds present in lateritic sheets and the free oxygen transported from the Earth's atmosphere into the lateritic sheets with rainwater

X-ray views of the defect structure and chemistry of environmental nanoparticles

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Major goals of environmental science are to control mobility of toxic elements and to remediate contaminated soils, sediments, and subsurface waters. These goals cannot be met without first having in hand a fundamental understanding of the elemental composition, defect structure, and surface properties of environmental nanoparticles. Key problems are their low dimensionality, short-range order and high density of defects, the multiplicity of reactive surface sites and bonding mechanisms of impurities, and the partitioning of elements into coexisting organic and inorganic phases. In most cases, the information sought can be obtained by application of synergistic synchrotron-based X-ray techniques, including microfluorescence (micro-SRFX), microdiffraction (micro-XRD), high-energy scattering (HEXS), and microspectroscopy (micro-EXAFS), as well as data modelling with meaningful structure models. In this approach, micro-SRFX is used to map trace contaminants among coexisting constituents in a natural matrix, thus determining their distribution and relative abundance with unrivalled sensitivity. Then, micro-XRD, complemented by powder XRD and HEXS, is employed to identify nanocrystalline minerals and, more importantly, to determine the nature of structural and chemical defects (stacking faults, cationic and anionic vacancies and occupancies, site occupation of impurities, stoichiometry) through modelling of their scattering properties. Finally, micro-EXAFS gives the uptake and complexation mechanism of trace contaminants by individual constituents. Since the distribution of trace elements is heterogeneous on nanometer to micrometer length scales and nanoparticles are generally aggregated in environmental systems, the combination of these three microscopic techniques provides just the tools needed to scrutinize the nature and fundamental properties of environmental matter. This new kind of hybridization of experimental and modelling approaches to the characterization of natural nanoparticles will be illustrated with examples that show its potential for expanding our knowledge in environmental science.