

In situ continuous monitoring of soil solution chemistry

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A multiparametric probe designed for oceanographic measurement in sea water is used for the first time to monitor changes of physical and chemical parameters in soil solution (temperature, pressure, conductivity, dissolved oxygen, pH and Eh) with time. The acquisition of data is automated and requires no maintenance during several weeks.

Sensors and probe

The probe used in this study is the Eco-mem probe from Meerestechnik-elektronik[®], equipped optionally with six sensors: a pressure transducer, a temperature sensor, a conductivity cell, a dissolved oxygen sensor, a glass electrode (Ingold[®]) for pH and a Pt electrode (Ingold[®]) for Eh measurements. In addition, the probe is equipped with a stirrer, in order to homogenize the volume of the solution and to reduce oxygen depletion in front of the oxygen sensor's membrane. All these sensors are verified and calibrated in the laboratory just before the installation *in situ*. No intervention is required for maintenance later, though a drift of the sensors is not a priori excluded. The ranges of measurement and the precisions observed are the same as obtained in the laboratory with the same sensors. The software Eco-mem[®] is used to program the acquisition of data with a portable computer and to collect the data at will. The duration of each series of measurement, their frequency, and the switch of the stirrer are thus programmed. Alternatively, one can store only some averages or initiate the measurements only when a predefined threshold is exceeded. The probe autonomy, around several weeks, is influenced by two factors: - the storage capacity of data in the internal memory of the probe (216 kbytes extensible) - the battery of the probe.

Field installation

The probe is put in a PVC pipe about 80 cm length and 12 cm inner diameter. The lower extremity is open and holes are drilled to ease the entry and the circulation of soil water in the cell of the pipe where

the measurement is performed. To avoid the penetration of large particles, the PVC pipe is wrapped in a synthetic and inert cloth. Precautions are taken to avoid preferential outflow and to isolate thoroughly the measurement cell from the atmosphere. The probe is completed with tubings to sample soil solution precisely in the measurement cell. The chemical composition is analysed for the major cations, anions and dissolved silica, and a possible drift of the sensors is controlled by analysing the same parameters, with the exception of pressure. The samples are preserved from the air and from the light to maintain the redox conditions. Iron II is immediately complexed *in situ* with DPKBH and the optical density of the complex formed is measured at 660 nm with a spectrophotometer in the laboratory following the procedure by Jaffrezic (1997).

The measurements are collected at 50 cm depth in a gley soil, developed just over a granitic saprolite under beech forest at Fougères (Ille et Vilaine) where green rusts were previously found (Trolard *et al.*, 1996; 1997) and where Eh and pH variations were shown to be correlated with dissolved Fe(II) dynamics at equilibrium with these mixed Fe(II)-Fe(III) oxides (Maître, 1991; Génin *et al.*, 1998).

Results

As an example, the pH and Eh variations observed during an intense rainy event are shown in Fig. 1. These two parameters show well defined variations, though the kinetics are different: the effect of rain on the pH is a quick drop and a stabilization near pH = 5.4 after which the variations are not important, which suggests that this system is well buffered. The redox potential is not affected immediately by rain. We do not observe stabilizations at some steady value but rapid variations.

These first results show the interest of *in situ* measurement of the chemical parameters in hydro-morphic soils, in the saturated zone, to follow the geochemical reactions. Kinetic information can thus be gained directly in the field.

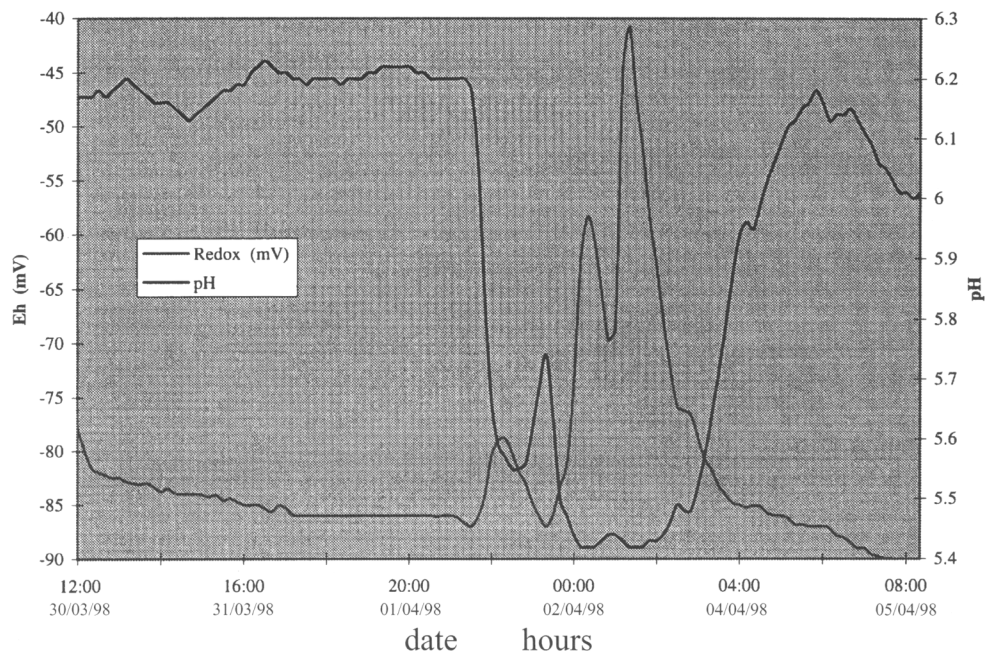


FIG. 1. Eh and pH variations vs time. Eh is corrected to reference temperature (25°C).

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