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Plants Impact on Soil: Rhizospheric and Seasonal Changes

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In the forested ecosystems, soil minerals weathering is one of the most important sources of nutrients with the atmospheric deposits. This weathering is yet not well known and not easily quantifiable. It is controlled by different parameters like soil solution pH, mineral composition but also by biological activity in the soil. The plants ability to uptake their nutrients directly inside the mineral and to increase mineral weathering has been already demonstrated in in vitro studies (Drever, 1994; Hinsinger et al., 1992). Nevertheless, in the literature, we can find only a few in situ studies about the impact of the plants on soil minerals weathering. In order to show this impact in situ, we tried to characterize differences between rhizospheric and bulk soil. Because the rhizosphere is the contact zone between the roots and the soil. Here is concentrated the major part of the soil biological activity. We wanted to know if the soil minerals could record seasonal rhizospheric changes. For this experiment, we made two sampling campaigns, one in march (dormancy) and the other in June (growing period) in a 40 years old Douglas fir stand in the Vauxrenard forest (France). Each campaign was constituted by 30 sampling points clearly defined with a cross-ruling. We sampled three soils types (B : bulk, R : rhizospheric soil, extracted by shaking the roots after drying at 30 ºC in an oven and RI:rhizospheric soil more attached to the roots, extracted by brushing), in three horizons (0-5 cm, 5-15 cm, 15-30 cm). Each sample was sieved to 200µm in order to eliminate all the possible distortion between bulk and rhizospheric samples and all the small pieces of roots. We made two studies with these samples:a physico-chemical one and a mineralogical one. First we measured the pH, carbon rate, cation exchange capacity (CEC, extraction with NH_4Cl and KCl and cation concentration in solution measure with ICP-AES), exchange acidity and different treatments like extraction with sodium tricitrate (Tamura, 1957) to extract Al and Fe from the interlayer zone. Then, we prepared 16 middle samples (one for each season, depth and fraction from every 30 sampling points). In these samples we separated granulometric fractions (Robert , Tessier, 1974) and with the clay fraction we made a mineralogical study using an X-ray diffractometer Siemens D5000. In these experiments we showed differences between rhizospheric and bulk soil according three effects:season, depth and fraction. We have seen pH increase up to 0.2 units in the rhizosphere. Important variations in the nutrients concentrations in the different types of soil has also been showed. For example, K concentration value increased from 3 $mmolc.kg^{-1}$ in the bulk soil up to 15 $mmolc.kg^{-1}$ in the rhizospheric soil. At the same time, Ca and Mg concentration decrease in the rhizospheric soil. From the mineralogical study we demonstrated the ability of the mineral to record short term variations like seasonal variations. We showed a transformation from vermiculite to illite in June and also between the surface and the deeper horizons. The hydroxylation rate of the vermiculite also show important variations. In June, there are more interlayer aluminium hydroxide than in march in the vermiculite structure, but these interlayered cations are easier to extract. In march, the situation is exactly the contrary : less HIV (hydroxi interlayered vermiculite) but it is more difficult to extract these interlayered cation from the vermiculite. All the observations made by XRD were confirmed with the results of the tricitrate extraction.

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