Geophysical Research Abstracts
Vol. 12, EGU2010-6558, 2010
EGU General Assembly 2010

Contribution of rock fragments to soil fertility

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Research in plant-soil interactions has focused on the role played by the finest particles, but much less attention has been devoted to quantify the contribution of rock fragments. While the coarse soil fraction is known to affect soil physical properties, such as bulk density, porosity, water infiltration and storage, its contribution to the biogeochemical cycle is neglected. In particular in plant nutrition studies, only the fine fraction (< 2 mm) of soils is sampled and analysed while the coarse fraction (> 2 mm) is considered chemically inert. However, several recent studies have showed that rock fragments contribute significantly to nutrient content and the cation exchange capacity of soils. Considering that stony soils cover about 30% of the surface soils of Western Europe, and 60% in the Mediterranean area, new data on the potential contribution of rock fragments to soil fertility may give new insights that will re-evaluate their role in models on biogeochemical cycling.

We attempt to study nutrient availability differents types of rock fragments, and started with five types of pebbles: oolitic limestone, marly limestone, lithographic limestone, chert, and flint. Pebbles were collected in topsoils, brushed thoroughly, and dried before chemical analyses. Exchangeable cations (Ca, Mg, and K) were extracted after immersion of whole pebbles in an ammonium acetate solution (1M) under agitation for 48h. We had previously established the kinetic of extraction over 6 days (after 1, 3.5, 7, 24, 48, 72 and 144 h) and showed that a plateau was reached at 48h, and with a good repeatability.

The pattern of release differed among the three studied exchangeable cations, and among pebbles of different origin. The capacity of pebbles to release exchangeable calcium and magnesium was in the following decreasing order: lithographic limestone = marly limestone > oolitic limestone » chert > flint. As expected, the greatest difference was found between limestones and the two other types. Indeed limestones, compared to chert and flint, contained 20 times higher exchangeable Ca (2.3 g Ca/kg for limestones compared to 0.08 and 0.03 g Ca/kg for chert and flint) and 7 to 10 times higher Mg (19.3g Mg/kg for limestones compared to 2.7 and 1.7 g Mg/kg for chert and flint). Potassium showed a completely different trend with the highest exchangeable K found for chert and marly limestone, intermediate levels for lithographic limestone and flint, and lowest levels for oolitic limestone.

In addition, whatever the pebble origin, calcium was the element the most released. Limestones released more Mg than K, and chert and flint more K than Mg. Further, released exchangeable Ca and Mg were closely related to the dry mass of pebbles, but exchangeable K was not.
As mentioned above, much more cations were extracted from limestones compared to chert and flint. Besides, chert released twice as much as flint for the three cations.

Finally, the fertilisation potential of these pebbles and especially limestones is far to be negligible. For instance, the exchangeable Ca, Mg and K released from lithographic pebbles represent respectively about 50%, 20% and 10% of those released from the surrounding fine earth.

These results confirm the potential contribution of rock fragments to soil fertility. Furthermore, important

differences in exchangeable cations in relation to their origin were measured. Further analyses are being carried out on pebbles from other origins and on available phosphorus. We believe that this work is a first step towards a better understanding of the role of rock fragments in plant-soil relationships.