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Elemental composition of soils developed on volcanic materials of Isla Santa Cruz (Galápagos Islands)

Rodríguez Flores (1), R., Ferro Vázquez (1), C., Stoops (2), G., Martínez Cortizas, A (1)

(1) Dept. Edafología y Química Agrícola, Facultad de Biología, Campus Sur s/n, Santiago de Compostela, Spain, (2) Laboratorium voor Mineralogie, Petrologie en Micropedologie, Geologisch Instituut, Universiteit Gent, Krijgslaan 281, S8 B-9000 GENT België

Seventeen soil profiles were sampled in the south of Santa Cruz Island (Galapagos Islands); six in the surroundings of Bella Vista (BV), seven along a catena to Crocker Mountain (CM) to the north and four along a catena to the Camote volcano (CT) NE of Bella Vista. BV soils are developed on olivine basalts; CM soils on basaltic tephras and slope deposits; and CT soils on basaltic tephras. The sampling was also representative of three of the bioclimatic belts of the area: the transition zone (situated between the arid coastal area and the more humid higher areas)(TZ, 100-240m a.s.l.; includes BV soils and the lower elevation profile of each catena); the *Scalesia* zone (SZ, 240-400 m a.s.l.; 4 soils); and the brown zone (BZ, 400-500 m a.s.l.; 5 soils). The fine earth fraction of soil horizons (56 samples) was analysed for C, N and H using a LECO TruSpec CHN analyser, and by XRF for Mg, Al, Si, P, S, Cl, K, Ca, Ti, Cr, Mn, Fe, Ni, Cu, Zn, Ga, As, Se, Br, Rb, Sr, Y, Zr, Pb and Nb.

Correlation and cluster analysis indicated that elements form five main groups: 1) biophyllic and organically bound elements (C, N, S, H, P and Br); 2) largely immobile elements (Ti, Fe, Pb, Ga and Nb); 3) other metallic elements (Mn, Cu, Zn, K and Rb); 4) mobile elements in andic soils (Si and Sr) and Ni; and 5) Y and Zr. ANOVA analysis of the C horizons grouped by parent material showed that BV soils have lower concentrations of elements of group 1 and higher of elements of group 4 than CM and CT soils, indicating there are not large differences in elemental composition between parent materials and that the main differences observed may be related to the incorporation of organic matter and degree of weathering. ANOVA analysis of A horizons grouped by bioclimatic zone showed that soils of the TZ have significantly

lower concentrations of C, N, H, S, P, Br, Ti, Fe and Ga, but higher concentrations of Si, K, Ca, Cr, Mn, Ni, Cu, Zn, Rb and Sr than soils of the SZ and BZ. Soils of the BZ have higher contents of Ti, Cr, Fe and Ga, and lower of H, P, Ca, Cu, Br and Sr than soils of the SZ.

In principal components analysis four factors were needed to explain a 77% of the variance. For factor 1 (28%) elements of the Si group showed negative and those of the Ti group positive loadings: the Si group is associated to soils from the TZ, while the Ti group with the soils from SZ and BZ, which suggests a decrease in Si and increase in immobile elements with altitude and thus an increasing degree of weathering. Factor 2 (22%) scores increase from the superficial to the subsuperficial horizons, and relate to the decreasing content of organic matter and biocycling from the A (high C, N, H, S, P, Ca and Br) to the mineral horizons (high Ti, Fe, Zr). The other two factors accounted for a 17% and a 10% of the variance respectively, and are also both related to vertical soil differentiation. But F3 is more intense in the TZ (involving higher concentrations of elements of the Mn group in the superficial horizons), while F4 scores indicate a more pronounced differentiation in soils from the SZ and BZ (involving decreasing Si and Cr and increasing Al, Y and Zr with depth). These results indicate that the accumulation of organic matter and the degree of weathering and pedogenesis, that control elemental composition in these volcanic soils, are largely influenced by the changing bioclimatic conditions with altitude. This is also supported by the Al_{OX}/total Al ratio, which is very low in the TZ (0.08 ± 0.03) and increases up to 0.9 in the BZ, and by the negative correlation shown by this ratio and the total Si content -indicative of large Si depletion in the more weathered soils.