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Geochemical soil baseline values in north-eastern Brazil – vital requirement for pollution studies

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Global geochemical baselines are a major requirement to resolve numerous questions such as the evaluation of anthropogenic pollution, the location of natural resources, and the identification of health problems. Indeed, data concerning the spatial heterogeneity of the Earth′s surface are incomplete and biased towards the northern hemisphere and to polluted sites. The BraSol-2010 project was initiated to establish a reliable database on soil geochemistry in Brazil. A large-scale geochemical sampling took place in north-eastern Brazil in 2008 at 111 sites, covering an area of 1.7 Mio km^2. Samples were taken from organic soil layer (ORG), topsoil (TOP, 0-20 cm) and subsoil (BOT, 30-50 cm), avoiding obvious anthropogenic anomalies (e.g., settlements, industrial areas). First results of the geochemical analysis of TOP and BOT samples by wavelength dispersive X-ray fluorescence spectrometer are presented here. Total concentrations of 37 elements (Ag, Al, As, Ba, Bi, Br, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, K, La, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, S, Si, Sn, Sr, Ti, U, V, W, Y, Zn, Zr) were determined. Elements with more than 50% of values below the lower limit of quantification were excluded from further statistical analyses. In general, soils in north-eastern Brazil are depleted in most elements compared to the world average, but are enriched in Zr, Si, and Ce, a typical weathering effect. Compared with tropical soils (laterites) in Australia, the Brazilian soils are enriched in Al, Ce, Mg, Ti, Y, and Zr. The topsoils show enrichment in Ca and Cu relative to Australian laterites. The comparison of TOP and BOT samples reveals an enrichment of most plant nutrients (Ca, Cu, Mg, Mn, P, S) and Na, and an depletion of Al, Ce, Cr, Fe, Sr, Ti, V, and Y in the TOP samples. The elements Ba, K, Si, and Zr show comparable concentrations in TOP and BOT (TOP/BOT ratio between 0.95 and 1.05). Various elements are highly correlated (significant Spearman rank correlation coefficient $\geq$ 0.9) between TOP and BOT samples (Al, Ba, Ca, Cr, Fe, K, Mg, Mn, Na, Sr, Ti, V). Even Ce with the lowest Spearman rank correlation coefficient (0.6) has a significant medium correlation between TOP and BOT material. Cluster analysis (log10 transformed, standardized concentrations, Ward′s method with squared Euclidean distance measure, 4 clusters) revealed almost the same clusters for TOP and BOT just differing in the allocation of S. The first cluster comprises Al, Cr, Fe, P, S (for BOT in the second group), Ti, and V. The second cluster was made up of Ba, Ca, K, Mg, Mn, Na, Sr, and Y. Cerium and Zr formed the third and Cu and Si the forth cluster. Similar processes affecting the geochemical composition are assumed to be relevant for the top- and subsoil. After the first analyses lithology, soil type and biome seem to be the most influencing variables for the geochemical composition of TOP and BOT soils in north-eastern Brazil.