



Maps of multi-elemental enrichment indices in soils and stream sediments from Santiago Island, Cape Verde

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The archipelago of Cape Verde is located in the Macaronesia region, on eastern Atlantic, about 500 km west of the coast of Senegal (west African). The Santiago island is the largest of the archipelago, covering an area of 991 km² and reaching an altitude of 1392 m. It is the most populated island of the archipelago, with more than 50% concentrated in the Cidade da Praia metropolitan area. The climate is arid, but with torrential rains (July to September). Santiago is characterized by very high hills separated by valleys with almost vertical margins and large flat areas in the coastal zones. Santiago Island is composed mainly by volcanic rocks, such as alkaline basaltic and basaltic rocks, phonolites, carbonatites and pyroclastes (breccia, lapilli and tuffs). The pyroclastes and carbonatites have reduced importance, the lavas occupy most of the island. Some phaneritic rocks occur in small areas, sedimentary rocks also occupy small areas and metamorphic rocks are very rare and are associated to contact metamorphism. The definition of background values and enrichment indices of soils and stream sediments is very important to comprehend the extent of polluted areas in countries like Cape Verde, where intervention limits for soils were not yet established. In this work we present maps of multi-elemental enrichment indices of some potential harmful elements (As, Ba, Co, Cr, Cu, Ni, Pb, V and Zn), based on background levels of soil and stream sediments samples collected over the Santiago island at a density of approximately 1 sample per 3 km². These maps are compared with a simplified soil map and the geological map. Most metal contamination in the surface environment is associated with a cocktail of contaminants rather than one single metal. The aim of this study is to discriminate between background and enrichment levels, either these have natural or anthropogenic sources.

The geochemical survey was conducted following the guidelines of the International Project IGCP 259 at the sampling stage, sample preparation, analysis, data treatment and mapping. Analysis were performed in the fraction < 2 mm. The color maps, plotted together with dot maps, based on 249 and 337 soil and stream sediment samples, respectively, were obtained by kriging using a variogram model adjusted for each multi-elemental index. The diameter of dot, as well as the color scale (in soil maps), were classified in 8 classes, according to percentiles: [minimum -P10]; [P10-P25]; [P25-P50]; [P50-P75]; [P75-P90]; [P90-P95]; [P95-P97.5]; [P97.5-maximum]. The number of classes and the color scales were chosen to demonstrate the existence of any sites enriched in each index calculated.

The multi-elemental enrichment indices are useful to evaluate the degree of combinations metal contamination. Enrichment index values similar to 1 indicate that the metals are at levels considered as the background and are not dangerous to the environmental. An enrichment index over than 1 indicates that, on average, element concentrations are above the reference level, and any element enrichment can be from anthropogenic inputs or natural geological sources. Either in soils and stream sediments, areas with $EI \sim 1$ correspond to the Pico da Antónia geological formation (basaltic-basanite lavas), while the remaining areas show levels of EI ranging between 1 and 2.64, reflecting a slight enrichment in these elements. The distribution of these metals in the Santiago island is mainly controlled by bedrock geochemistry than by anthropogenic inputs or by pedology.