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Physical and chemical characterization in degraded soils by tin mining

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Abstract

The Amazon ecosystem is suffering an accelerated process of environmental degradation for the vegetation retreat by the introduction of agricultural projects or the disordered exploration mineral and wood. The present work had as objective evaluates the differences which happened after the activity tin mining in an area of the Amazon forest. The samples were collected, superficially, along a line with: high forest, low forest, plows, reject dry and reject sandy, in each situation there were collected 5 samples, which worked as repetitions, in a total of 35 samples. In the collected samples physical analyses were accomplished: texture, soil's density and particles and mechanical resistance to penetration and chemical elements: pH (CaCl2); organic matter, P, K, Ca, Mg, Al, CEC and BS. The results showed that the process of tin extraction promoted significant alterations in the soil's properties studied. Parameters as the organic matter, P, the soil and particle's density were the most altered by the process of suppression of the original vegetation and extraction of the tin. In that way, when it intends to implant recovery projects in those areas, the soil's recovery should be prioritised for the success of the enterprise and the different degraded situations should be worked in different ways.

1 Introduction

The Amazon ecosystem has been suffering an accelerated process of environmental degradation by the vegetation removal, for the accomplishment of agricultural projects or for the disordered mineral and wood exploration. That process, begun in the 60 decade, has been more active in the recent years, with the elimination of great portions of the primary forest, not very acquaintance of the botanical point of view. In this sense, several works have being published alerting for the environmental risks that can appear with the destruction of these formations (LISBON, 1989; SALOMÃO, 1988; FEARNSIDE, 1989, 1991).

On the other hand, those areas are extremely rich in biological and mineral resources and, for that reason, wake up the economic interests not only for our Country but for the whole world community. Being Brazil a country in development, it is evident that the rational exploration of the minerals becomes necessary to promote economic increments in the country. Thus, a controlled exploration and rationalization of the mineral resources of the Amazon area becomes acceptable, since the degraded areas provoked by these activities become appropriately recovered.

The surface mining is, in general, an activity that can provoke a quite intense environmental degradation, which tends to a strong disturbing effect in the landscape because it requests the removal of the vegetation, of the soil and of the rocks that are above the mineral deposits. Thus, it demands a constant concern in the sense associating it to a program of recovery of the area. (Fontes, 1991).

The present work had for objective to evaluate the physical and chemical properties along a line, consisting of high forest, short forest, mine pit, dry tailings and humid tailings, seeking to characterize the differences that happened after the activity tin mining in an area of Amazon forest. That work serves as subsidy for future activities of recovery of those areas, once soil where the recovery processes will be implanted is know it is essential for the success of the enterprise to tell the alterations that happened in tropical soils by mining seen in Raij et al. (1991).

2 Material and Methods

Soil Collection: Soil samples were collected from five different sites on the tin mines spoil in Rondônia, Brazil.

Samples 1-5: high forest

Sample 6-10: short forest

Sample 11-15: mine pit (mine 1)

Sample 16-20: dry tailings (mine 2)

Samples 21-25: humid tailings (mine 3)

In each place were collected five samples (twenty five in total) (Figure 1).

1.

2. Points of collected

The results were analyzed being applied a variance analysis and the test F at 5% of probability. Physical parameters were analyzed: granulometric, soil's and particle's density in soils samples collected with a bottom ring

The air dried soil were submitted to chemical analyses, being determined: pH ($CaCl_2$); organic matter by oxidation for the $H_2SO_4^-$; phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg) contents, extracted by the resin of ionic change; aluminum (Al) extracted by KCl 1N; cation exchange capacity (CEC) and base saturation (BS), were obtained by calculation. A description detailed of the analytic methods used can be seen in Raij et al. (1991).

3 Results and discussion

The results obtained for the pH (Table 1) showed acid soils in all the studied situations, even so with significant differences among the forest soil, came with larger acidity, proceeded by the short forest and for the different degraded situations, that didn't differ significantly to each other. According to Smyth (1996) the predominance of acid soils in firm earth, places the acidity and the aluminum toxicity among the most frequent restrictions in Amazon's soil. The results indicated that, probably, the existent organic matter in the soil forest and the processes involved in the extraction of the mineral, wash and separation of the material, they promoted those differences.

1. Chemical soil characteristics

Sample	Characteristics								
	pH	OM	P	K	Ca	Mg	H+Al	CEC	S
	$CaCl_2$	$d.dm^{-3}$	$mg.dm^{-3}$	$Mmol_c/dm^3$					%
high forest	3,8a *	32a	4,9a	0,83ab	5,1a	1a	80,9a	8,1a	8
short forest	4,1b	28,6a	3,9a	1,06a	9,5a	1a	67,7b	17,7b	1
mine pit	4,4c	2,4b	1b	0,38b	4,4a	2a	20,4c	28,2	2
dry tailings	4,6c	3b	1,8c	0,38b	4,4a	2a	14,6c	21,6	2
humid tailings	4,4c	5b	1,6c	0,38b	2,8a	2a	16,8c	20,4	2

Sample	Characteristics				
	Sand	Lime	Clay	Soil Density	Particle Density
	%			g/cm_3	
high forest	42,9a	23,5a	39,8a	1,05a	2,5a
short forest	39,1ab	19,8ab	38,7a	1,15a	2,52a
mine pit	26,8a	14,4bc	58,8b	1,47b	2,61b
dry tailings	72,6c	11,6c	15,8c	1,33ac	2,67c
humid tailings	66,8c	14,8c	18,4c	1,12a	2,67c

*- In each column, numbers followed by the same letter are not significantly different at the 0.05 levels according to Turkey's

1. Physical soil characteristics

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The values of organic matter (Table 1), as expected, presented superior plenty values in the forest in relation to the other situations, by virtue of the own process of extraction of the mineral that involves the suppression of the original vegetation, the wash and separation of the collected material. Long et al. (2000) making a study in the contents of C-organic and N-total in areas of forest close to Porto Velho, proceeded by the pasture introduction, they observed a gradual fall in the texts of those passing of the first for the second studied situation, agreeing with the results obtained by Moraes (1991) who observed that, in general, the values of organic matter were quite vulnerable to the cultivation on account of being concentrated in the superficial layer of the soil. Few results were found in mining areas being more common studies obtained in agricultural areas.

Phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg) contents, can be found in Table 1. P contents came bass in all the studied situations, being the largest values found in the forest situations, differing significantly from the other studied situations. According to Falesi (1976) available P in the superficial layer of the soil drops drastically with the time after the establishment of agricultural activities as the pasture. The Ca and Mg contents didn't show significant differences among the studied situations, while the K presented superior values in the forest.

In relation to SB, S, CEC and H+Al (Table 1), we can observe that the smallest values of CEC happened in the high forest and short forest situations differing significantly from the other studied situations, similar result was observed for SB, while the values of S didn't differ in the different studied situations. H+Al revealed significant differences among the studied situations, however largest values was observed in the soil under high forest and short forest, indicating that they are very acid and can present Al toxicity, similar results were observed by Long et al. (2000) in Rondônia´s soils.

In relation of the sand, lime and clay percentages (Table 2) we can observe there were significant differences among the studied sites and the high forest, the short forest and the pit mine presented elevated texts of clay and lime, while in the tailings it was sandier. Espíndola et al. (2000) it was observed a great variation textural, in lands degraded by the tin extraction in Rondônia, being sandier in the "head" and loamier in

the slope areas. We can observe like this that the different situations generated by the process of tin extraction: pit mine and tailings should be approached in a differentiated way in a recovery project.

The soil and particle's density contents (Table 2) presented significant differences among the deferential studied situations being the smallest values found in the samples collected under high forest and short forest, that it probably suffered influence of the largest texts of organic matter found in these situations, as we can observe in Table 1.

4 Conclusion

The results showed that the process of tin extraction promoted significant alterations in the properties of the soils studied. Parameters as organic matter, phosphorus, soil and particle's density were the most altered by the process of suppression of the original vegetation and mineral extraction. In that way, upon intending to implant projects of recovery of those areas, the recovery of the soil should be prioritized for the success of the enterprise and the different degraded situations should be worked in a differentiated way.

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