

Scientific registration no : 1412
Symposium no : 15
Presentation : poster

Soil - relief relationships in the região Cacaueira da Bahia - Brazil

Relations sols-relief dans la région de Cacaueira da Bahia - Brésil

RÊGO Maria José Marinho do

Av. Cardeal da Silva, no. 555, apto. 103, Federação, CEP.: 40.220-140 Salvador- BA. Brasil., e-mail: maze@ufba.br

INTRODUCTION

Studies concerned with the landforms, the weathering, and sedimentation processes, are important tools for a complete understanding of the formation and distribution of soils. The geomorphogeny as well as the pedogenesis (soil formation) are, to some extent, determined by the same factors such as climate, time and lithology. Despite the common origin of soils and reliefs, the intensity and velocity of the phenomena that act on their formation are different.

This study investigated the relationships between soils and the geomorphic surfaces during the Tertiary and Quaternary Periods, in sites located within a vast area of coastal lands in the State of Bahia - the so-called Region Cacaueira da Bahia. This Region is mainly used for the cocoa culture which is of great interest to the economy of the State. Therefore, soils and landscapes were analysed allowing the re-construction of the mayor events that carved the relief and caused the formation and distribution of the several types of soils found within the study area.

MATERIALS AND METHODS

The area chosen (39° 00' to 39° 30'W and 14° 00' to 15° 00'S) is totally within the Region Cacaueira da Bahia (Fig. 1). The study area is essentially composed by granulitic rocks (Archaean) represented by piroxene-granulites and basic granulites. Also, intrusive rocks of the Meso-Proterozoic (diabases, gabbros, syenites and diorites) occur between the cities of Itabuna and Uruçuca, being known as the of Sienitos of Itabuna. The Region Cacaueira da Bahia is characterised by a peculiar climatic regime. The study area presents a total annual rainfall between 1500 and 2200 mm with the highest discharges occurring near to the coast. The rains fall during the whole year increasing during the autumn-winter period. The mean annual temperature varies from 23° to 25° C. The

percentage air humidity is high, being always > 80%. The study area is totally located within the Ecosystem called by Floresta Perenefólia Higrófila.

The study involved intensive field observations and the collection of 10 soil profiles. The physical and chemical analyses of the soil samples were performed by the Instituto Agronomico de Campinas (IAC) and the Instituto de Geociências da Universidade Federal da Bahia (UFBA). The characterisation of the clay fraction was obtained according to the TDA and X-ray diffraction techniques.

RESULTS AND DISCUSSIONS

LANDFORMS

The taxonomy applied in this study is that adopted by the Projeto Radambrasil (1981) that is based on the following categories (Domain, Area, and Geomorphological Unit). Thus, the study area is divided into two Geomorphological Domains according to that classification: They are: the Domain of Inter-Plateaux Depressions and the Domain of Crystalline Plateaux. The first Domain is represented by the Depression of Itabuna (Fig. 2) that corresponds to the planation surface that had its evolution due to the alternation of the weathering processes and denudation. It presents very little altered rocks truncated by the process of planation that fleshed the relief. The open valleys show flat floor with debris. The lowlands are flooded because the ground water is near to the surface. The landforms are dominated by convex hill slopes and flat summits. The declines vary from 3 to 25%, prevailing those ranging from 5 to 10%. The summits are essentially lower than 100 m. The Depression of Itabuna opens towards the coast, normally occupying the areas corresponding to the Sienites of Itabuna. It is clear in the area the action of an intense and superficial erosion. Such erosion seems to have its origin caused by oscillations in the base level of the Rio Cachoeira, (King, 1956).

The second Domain is represented by the Crystalline Plateaux, known in the area as the Lowered Plateau Region. This is lowered in relation to another Region located at west (Uplifted Plateau), presenting summits < 300 m and summits that can reach up to 1000 m. The tectonic control in the area is evidenced through the direction of the drainage net and summit lines accompanying the fractures and flaws, both in the direction SSO-NNE. The area is submitted to an intense dissection propitiated by the humid tropical climate that occurs there. In the Lowered Plateau Region, two Geomorphological Units are found: the Pre-Littoral Mountains and Massifs and the Pre-Littoral Low Plateaux (Fig. 2). The first Unit comprises mountainous reliefs presenting plane areas. The lowered spaces are < 100 m while some summits can reach up to 1000 m giving a high degree of amplitude. The area is dominated by landforms showing differential dissection patterns with a marked influence of the structure. In general, the hills have convex tops and concave-convex slopes. Slopes totally convex are limited to hills of lower altitudes. The Pre-Littoral Low Plateaux Unit has altitudes between 100 and 200 m presenting an uniform relief. The erosion had intensely dissected the greatly altered granulite. The resulting forms were described as landforms of homogeneous dissection, that is, independent of the structural control. This structural control can be only evidenced through a few tributaries of the Rio de Contas, whose valleys were adapted to the

structure. The thick weathering mantle that is seen over the whole Unit is covered by a yellowish-red colluvial material which the thickness varies from 1 to 2 m.

THE SOILS

The area is dominated by soils of the following classes (Fig. 3): Latossolos (Udox), Podzólicos Vermelho-Amarelo (Udalf), and Cambissolos (Tropept). Three profiles of Latossolos were studied. They presented different grades of development and are characterized by yellowish-brown colours in the solum, and reddish colours in the alteration horizons. They are very developed soils which texture is always very clayey having an impoverishment of clay in the A horizon. Chemically, they are soils showing low-base saturation and acid pH. The CEC, when calculated for 1Kg of clay, varies from 4 to 7 cmol in the Bw horizon. The clay mineralogy is composed by kaolinite, goethite and gibbsite.

Five profiles of Podzólicos Vermelho-Amarelo were studied. They are moderately deep (solum depth ranging from 85 to 120 cm), but not very developed. These soils have coarse materials (alterable minerals) in the solum showing brownish colours in the A horizon and yellowish-red colours in the Bt horizon. The texture in the Bt horizon varies from clayey to very clayey. These soils do not present evidences of illuvial clay. They have a base saturation > 50% and acid pH. The clay mineralogy shows essentially the presence of kaolinite associated with goethite. Also, varying amounts of biotite, interstratified minerals, vermiculites and esmectites are present in these soils, particularly in the alteration horizons.

The study of Cambissolos was carried out on soils formed from in-place parent materials (Cambissolo Eutrófico) and from partially transported materials (Cambissolo Distrófico). Both present the sequence ABiC. These soils present coarse fraction and the texture varies from sandy clay loam to clay. The pH is acid in the Cambissolo Distrófico, and moderately acid in the Cambissolo Eutrófico. The clay mineralogy of the Cambissolo Distrófico is represented by kaolinite and small amounts of esmectites, clorites, goethite and gibbsite. The clay composition of the Cambissolo Eutrófico is given by kaolinite, vermiculite, biotite-vermiculite interstratified and goethite.

SOIL-RELIEF RELATIONSHIPS

The study area is characterized by two mayor groups of soils. The first group is represented by Latossolos showing varying evolution grades and is located in the Pre-Littoral Low Plateaux. The second group is characterized by two classes of soils: the Podzólicos and Cambissolos. The placement of these two classes in a single group is justified by the grade of evolution of these soils which show a recent genesis. In general, they are associated to the Geomorphological Units of the Pre-Littoral Mountains and Massifs and the Depression of Itabuna.

In the Tertiary Period, during the Eogene, it was formed a vast peneplained surface that occupied the whole central-oriental part of the State of Bahia where the study area is included. This surface was previously denominated of South American Surface (King, 1956) and Eogene Surface (Tricart & Silva, 1968). During the Miocene Period, the

whole area was affected by high levels of humidity causing deep alteration and dissection of the relief (Tricart & Silva, 1968). These changes in the environmental conditions were likely to be responsible for the formation of the Depression of Itabuna. During the Neogene new phases of dissection and planation occurred allowing to the deposition of the transported materials in the Pre-Littoral Low Plateaux. Following this deposition process, a phase of genesis of Latossolos was started lasting until the beginning of the Pleistocene Period (Projeto Radambrasil, 1981). In the Latossolos studied, there was little evidence of colluvial material covering the weathering mantle. Some indication of colluvial material, however, was found on the residual weathering mantle. This indication is supported by a higher content of magnetite in the A & B horizons of these soils when compared with the BC & C horizons. The enrichment of magnetite in the A & B horizons may suggest the transportation of materials such as colluvium.

The Quaternary Period was marked by important climatic changes related to the glaciations that caused fluctuations in the base levels and in the eustatic movements. The landform in the study area was quite affected by the events that took place during the Plio-Pleistocene Period. This Period was marked by cycles of erosion that degraded the landform during the driest periods while permitting incisions during the most humid periods. After the formation of the Latossolos, the Pre-Littoral Low Plateaux area suffered an increasing in the gradient caused by the continental uplift allowing the incision of the valleys and a deep dissection in this surface. This dissection process was responsible for the formation of Latossolos showing different grades of evolution. The most developed soils occupy the summits where the colluvial cover is well preserved, therefore, being thicker. The less developed soils are located near to the drainage net. Since these colluvial deposits do not present great thickness, the BC and C horizons are always formed from material altered *in situ*. Consequently, deep soils of high development grade are normally found in this Geomorphological Unit. The clay fraction contents of the Latossolos are high. The ratio silt/clay, used as an indicator of the weathering degree, suggests a high grade of evolution of the soil profiles. These soils were submitted to leaching processes that caused acid pH and an exchange complex poor in basic cations (Rêgo, 1990).

During the Plio- Pleistocene Period, there was the formation of the Pre-Littoral Mountains and Massifs Unit. This Unit was submitted to successive cycles of alteration, dessection and erosion that allowed the removal of the alteration mantle and soils caused by the action of concentrated rains (Tricart, 1959). This removal occurred through an important drainage net formed by the rivers Almada and Cachoeira that flow through the Depression of Itabuna. Up north, the tributaries of the right margin of the Rio de Contas were responsible for draining the material that composed the alteration mantle. Therefore, these factors promoted the recent soil formation in both Geomorphological Units, the Pre-Littoral Mountains and Massifs and the Depression of Itabuna.

Despite the humid climate without dry periods that occurs nowadays in the area, the exposure time of the rock to the alteration processes and soil formation was not enough to form soils showing a high development grade. The soils formed (Podzólicos and Cambissolos) show moderate grade of development. They still present alterable minerals in the sand fraction such as mica, piroxene, and feldspar. Also, they show coarse fraction

and a poor degree of organisation. The exchange complex of these soils is classified as eutrophic. The secondary paragenesis is more complex than that shown by Latossolos, with mineralogical species typically found in environments rich in cations such as silice and bases (Rêgo et al, 1997). The Cambissolos occurring in the Depression of Itabuna as well as in the Pre-Littoral Mountains and Massifs had two origins according to the parental material: 1 - the soils were formed from granulitic rocks altered *in situ* normally occupying the highest places of the relief; 2 - the soils were developed on a thin layer of transported material occupying the lower areas of the relief.

CONCLUSIONS

In the light of these results it may be concluded that the carving of different geomorphic surfaces at the end of the Tertiary Period and during the Quaternary Period, particularly during the Pleistocene, played a pivotal role in the formation and distribution of the several types of soils found in the study area.

REFERENCES

- EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA - 1977 - Serviço Nacional de Levantamento e Conservação de Solos, Rio de Janeiro, RJ. Levantamento exploratório - reconhecimento de solos do Estado da Bahia: margem direita do Rio São Francisco. Recife, 738 p. (Bol. Tec. 52, v. 1).
- KING, L. C. - 1956 - A geomorfologia do Brasil Oriental. Ver. Bras. Geogr., 18 (2): 147-265.
- PROJETO RADAMBRASIL - 1981 - Levantamento dos recursos naturais. Folha SD. 24 - Salvador, MME, Rio de Janeiro, 622 p.
- RÊGO, M. J. M. - 1990 - Alteração e pedogênese em rochas granulíticas na Região Cacaueira da Bahia. Tese de Doutorado. Universidade de São Paulo. 187 p.
- RÊGO, M. J. M.; BARBOSA, R. M.; NOVIKOFF, A - 1997 - Mineralogia e geoquímica de dois solos desenvolvidos sobre rochas alcalinas na Região Cacaueira da Bahia. Actas X Semana de Geoquímica/ IV Congresso de Geoquímica dos Países de Língua Portuguesa. Braga - Portugal. p. 307 - 310.
- TRICART, J. (1959) - Divisão morfoclimática do Brasil Atlântico Central. Boletim Paulista de Geografia, São Paulo. Assoc. dos Geóg. Bras., (31):3 - 44.
- TRICART, J. & SILVA, T. C. - 1968 - Estudo de geomorfologia da Bahia e Sergipe. Salvador. Fundação para o desenvolvimento da Ciência na Bahia/Imprensa Oficial da Bahia. 167 p.

Keywords : soil-relief relationships, Brazil

Mots clés : relations sols-relief, Brésil



Fig. 1 - Location of study



PEDOLOGICAL DOMAINS

-  Latossolos (Udox)
-  Podzolicos Vermelho-Amarelo (Udalf)
-  Cambissolos (Tropel)
-  Other Soils

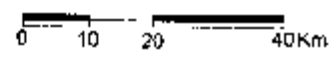


Fig. 3 - Pedological map of the study area
EMBRAPA (1977) - Simplified

GEOMORPHOLOGICAL UNITS





-  Littoral Plaines
-  Pre-Littoral Mountains and Massifs
-  Depression of Itabuna
-  Pre-Littoral Low Plateaux

Fig. 2 - Geomorphological map of the study area
RADAMBRASIL (1981)

