ISSN: 2447-3359

REVISTA DE GEOCIÊNCIAS DO NORDESTE

Northeast Geosciences Journal

v. 8, n° 1 (2022)

https://doi.org/10.21680/2447-3359.2022v8n1ID20645

The relationship between familiar agriculture and mineral-based activities: a study on Rio Grande do Norte and the microregion of the Eastern Seridó

A relação entre agricultura familiar e atividades de base mineral: um estudo sobre o Rio Grande do Norte e sua microrregião Seridó Oriental

Ana Alice Lima dos Santos[1]; Raquel Franco de Souza[2]; Robson Rafael de Oliveira[3]

[1] IFRN/Diretoria de Administração, IFRN, Nova Cruz//RN, Brasil. Email: aalicelima@gmail.com.
ORCID: https://orcid.org/0000-0003-4993-0041

[2] UFRN/Departamento de Geologia, Natal/RN, Brasil. Email: raquel@gelogia.ufrn.br.
ORCID: https://orcid.org/0000-0001-8818-0605

[3] IFRN/Diretoria Acadêmica, Parelhas/RN, Brasil. Email: robson.oliveira@ifrn.edu.br.
ORCID: https://orcid.org/0000-0003-1310-3132

Abstract: Mining is an alternative occupation for farmers in geologically favorable areas. This study investigates the relationship between mining and family farming in Rio Grande do Norte (RN) State and its Eastern Seridó microregion using geological data and the 2006 Agricultural Census. As methodological procedures, bibliographic documental research, as well as production of maps from the IBGE (revenues from mineral exploration - 2006 Agricultural Census) and CPRM (mineral resources of Rio Grande do Norte) databases, were used to determine the relationship between the two activities. From the study, we can infer that there is an intrinsic relationship between mining and family farming in Rio Grande do Norte State. This is particularly observed in Eastern Seridó, where the extent of mining, primarily artisanal mining, is substantial, indicating the need to investigate these two activities, not only in the Eastern Seridó, but also in other regions with concentrated mineral resources and mineral exploration revenues.

Keywords: Agriculture; Agricultural census; Mineral exploration.

Resumo: Em áreas geologicamente favoráveis, a mineração é uma ocupação alternativa para os agricultores. Dessa forma, buscou-se nesse trabalho analisar a relação existente entre a mineração e a agricultura familiar no Rio Grande do Norte (RN) e em sua microrregião do Seridó Oriental, através dos dados geológicos e do Censo Agropecuário 2006. Como procedimentos metodológicos foram utilizados a pesquisa bibliográfica, documental e a produção de mapas a partir do banco de dados do IBGE (receitas provenientes da exploração mineral – Censo Agropecuário 2006) e da CPRM (recursos minerais do Rio Grande do Norte) para assim ser possível estabelecer uma relação entre as duas atividades. Concluiu-se que existe uma relação intrínseca entre a mineração e a agricultura familiar no Rio Grande do Norte e, principalmente no Seridó Oriental, onde a quantidade de lavra, principalmente garimpeira, é muito grande, revelando a necessidade de investigação dos indivíduos que exercem essas duas atividades, não só no Seridó Oriental, mas também em outras regiões em que se concentram recursos minerais e receitas advindas de exploração mineral.

Palavras chave: Agricultura; Censo agropecuário; Exploração mineral.

Recebido: 03/05/2020; Aceito: 29/03/2022; Publicado: 30/05/2022.

1. Introduction

The search for different sources of income has always been present in the lives of people from the semi-arid region of Brazil. The low rainfall and high evapotranspiration rate of this region (BRASIL, 2007) prevent the populations living in this geographical area from surviving with only agricultural activity.

In the Northeast of Brazil, the search for income sources arises as a survival strategy for rural families, particularly those with restricted water access. This factor hinders enhanced economic dynamism.

In geologically favorable areas, mining activities such as artisanal and small-scale mining (artisanal mining and small mining companies), are an alternative occupation for farmers (MMSD, 2002).

This mining category is characterized by the intense use of physical labor, the absence or a reduced level of mechanization, little investment in geological research, easy access to ore, nonexistent or minimal safety standards, low levels of productivity and recovery, and a reduced or non-existent concern for the environment (MMSD, 2002).

Family farming was initially studied by the Brazilian Institute of Geography and Statistics (IBGE) for the 2006 Agricultural Census. This survey aimed to identify the Brazilian farms and the activities conducted therein.

> IBGE considers family farmers and rural family entrepreneurs as individuals that practice rural activities and satisfy the requirements provided in Law No. 11,3260/2006. Namely:
> I - does not hold, by any means, an area greater than 4 (four) tax modules;
> II - uses predominantly family labor in the economic activities of the farm or business;
> III - Has family income predominantly originating from economic activities linked to the farm or business, as defined by the Executive Branch;
> IV - Runs the farm or business with the family (BRASIL, 2006).

The census unit adopted by IBGE is “farming establishment” and defined as:

> [...] any production unit devoted in whole or in part to agricultural, forestry, and aquaculture activities, subject to a single administration: that of the producer or the administrator. Regardless of its size, legal form, or location in an urban or rural area, having its objective the production for subsistence and/or for sale, thus constituting a census unit (IBGE, 2006).

Brazil has 4,551,855 farming establishments with family farming, wherein 2,274,114 (50%) are located in the Northeast region (IBGE, 2006).

Mineral exploitation appears in the Agricultural Census as "other revenue," i.e., income not from agricultural activities (agriculture, livestock, forest production, and aquaculture).

Studies such as Nóbrega and Menezes (2012), Lima and Lima (2009), and Santos (2015), discussed the relationship between mining and agriculture in the northeastern Seridó.

This study aims to investigate the relationship between mining and family farming in the microregion of the Eastern Seridó of Rio Grande do Norte by using geological data and the 2006 Agricultural Census data. The initial contextualization will be developed from the information on the State of Rio Grande do Norte (RN), with subsequent focus on the microregion of the Eastern Seridó.

2. Methodology

2.1 Study area characterization

The State of Rio Grande do Norte is in the Northeast region of Brazil. It has 3,168,027 inhabitants with 77.8% living in urban areas and 22.2% in rural areas (IBGE, 2010).

The climate ranges from humid (coastal) to semi-arid (backland), with diversified vegetation: Atlantic Forest, Caatinga, Mangroves, Mountain and Riparian Forests of Carnaúba, and beach and dune vegetation (FELIPE *et al.* 2006).

The State's geomorphology comprises fluvial and coastal plains, Sertaneja and sub-coastal depressions, coastal tablelands, Chapadas do Apodi and Serra Verde, and the Borborema Plateau (ROSS, 2003).

Rio Grande do Norte covers an area of 52,811.110 km² and is divided into 4 mesoregions, 19 microregions, and 167 municipalities (IBGE, 2010).

The 3,777,267 km² (see Figure 01) microregion of Eastern Seridó is a microregion of the State of Rio Grande do Norte. It is in the Potiguar Central Region. The inhabitant population is 118,828 with 83.5% resident in the urban area and 16.5%

in the rural area (IBGE, 2010), distributed in 10 municipalities (Acari, Carnaúba dos Dantas, Cruzeta, Currais Novos, Equador, Jardim do Seridó, Ouro Branco, Parelhas, Santana do Seridó, and São José do Seridó).

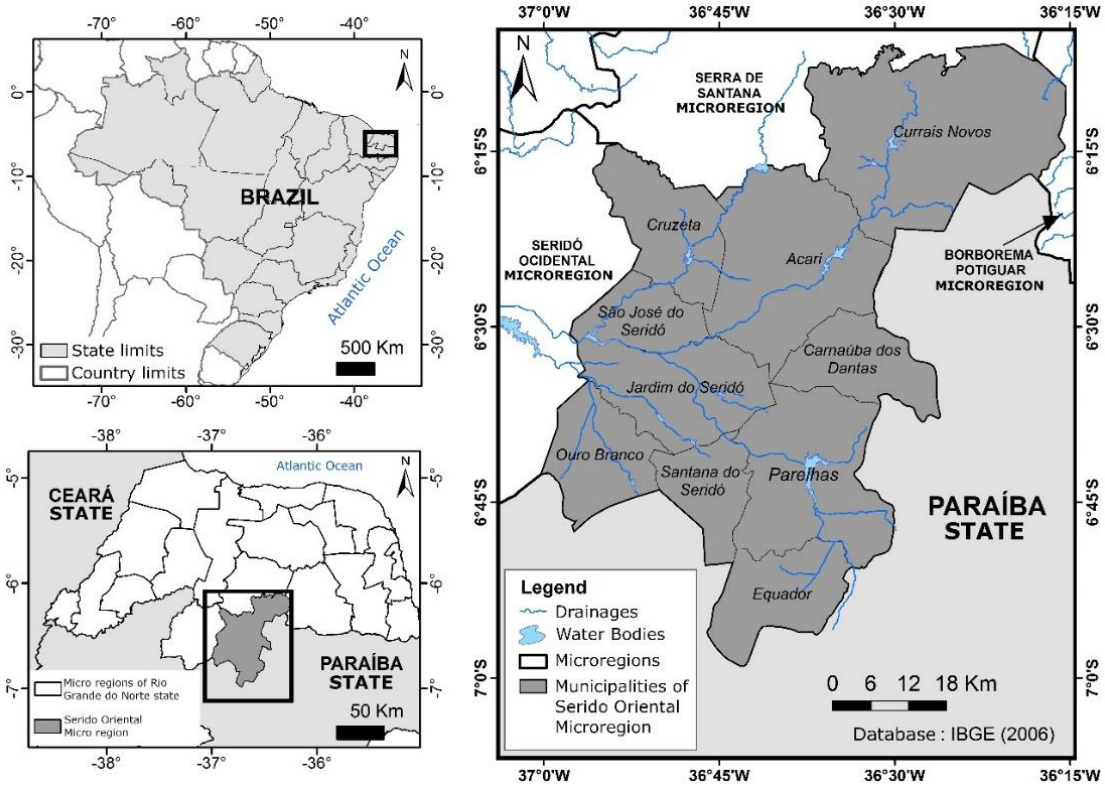

Figure 01 – Location of Rio Grande do Norte State and the microregion of the Eastern Seridó. Source: The authors (2017).

The climate of the Eastern Seridó is semi-arid, with an average annual rainfall of 500 to 800 mm (BRAZIL, 2007), inserted in the Caatinga biome and the Piranhas-Açu river basin.

The microregion's relief comprises the Sertaneja Depression and the Borborema Plateau (ROSS, 2003). The types of soils found are Chromic Luvisols, Litolic Neossols, Natric Planossols, and the Red-Yellow Latosol (EMBRAPA, 1999).

2.2 Methodological procedures

The study was performed in two stages. First, bibliographic research was carried out that facilitated development of a theoretical basis on family farming, artisanal and small-scale mining; and the documentary research, based on the current legislation and official entities, predominantly the Brazilian Institute of Geography and Statistics (IBGE), where data related to family farming and mineral exploration revenues from the national level to the microregional (smallest territorial section of data availability) of the 2006 Agricultural Census were obtained using the IBGE System of Automatic Recovery (SIDRA).

The second stage was cartographic production. The georeferenced databases for developing the maps were obtained using IBGE and CPRM (Brazilian Mineral Resources Research Company) and tabular data (.xls) from the 2006 IBGE Agricultural Census. The data were managed in the ArcMAP application of ESRI's ArcGIS 10.1 platform, using Datum SIRGAS2000 (Geocentric Reference System for the Americas 2000).

The geological data (lithology and mineral resources) were obtained from the digital base of the Geological Map of the State of Rio Grande do Norte that was performed in 2006 by CPRM on the 1:500.000 scale (Angelim *et al*., 2006). The

lithological data were simplified to produce the simplified geological map of RN and the Eastern Seridó Microregion. This simplification was also used to create the map of mineral occurrences in RN State and the map of mineral occurrences in Eastern Seridó. The GEOBANK/CPRM (Angelim *et al*., 2006) was used, with 1993 occurrences.

Data from the 2006 Brazilian Census of Agriculture were used to create the map "Number of farming establishments with revenues in mineral exploration in 2006 by RN microregions". From the number of farming establishments with revenues in mineral exploration, a choroplethic map was developed. Each microregion was represented by a graduated color to indicate the proportionality of the variable "Number of establishments".

Thus, the data from the 2006 Brazilian Census of Agriculture could be spatialized and compared with the local geology, making it possible to establish a relationship between family farming and mineral-based activities.

3. Results and discussion

3.1 Rio Grande do Norte

Rio Grande do Norte State has the lowest number (approximately 74,456 units) of farming establishments with family farming in the Northeast Region of Brazil (Table 01). However, the state stands out for the total of farming establishments with revenues from mineral exploration.

Proportionally, the total farming establishments with revenue from mineral exploration (279 units), considering the total of farming establishments with family farming in the RN State, records the highest value in the last column of Table 01 (0.37%), which stands out from those of the other states in the Northeast region.

Table 01 – Total number of farming establishments with family farming and number of farms with revenue from mineral exploration by state of the Northeast in Brazil.

Unit of the federation	Total of farming establishments with family farming (units)	Number of farming establishments with revenue in the year from mineral exploration (units)	%
Maranhão	270,263	354	0.13
Piauí	230,226	294	0.13
Ceará	35,.487	300	0.08
Rio G. do Norte	74,456	279	0.37
Paraíba	154,303	237	0.15
Pernambuco	285,249	185	0.06
Alagoas	115,722	44	0.04
Sergipe	93,212	43	0.05
Bahia	693,196	834	0.12

Source: IBGE (2006).

The significant proportion of farming establishments with revenues from mineral exploration in Rio Grande do Norte State (0.37%), compared to other northeastern states, may be related to the geological diversity of the state, shown in Figure 02, which displays the lithological units in a simplified approach in this study: Pre-Cambrian metamorphic terrains, formed by ortho-metamorphic rocks and for derivates of the Paleoproterozoic Archean of the Jaguaribeano, São José do Campestre and Rio Piranhas-Seridó domains; Neoproterozoic metamorphic terrains, represented by the Seridó Group (Seridó, Jucurutu, Equador, and Serra dos Quintos Formations); Ediacaran and Cambrian plutonic activity, represented by the São João do Sabugi intrusive suite, Dona Inês intrusive suite, Catingueira intrusive suite, Umarizal intrusive suite and pegmatite dykes; Mesozoic sedimentary basins, represented by Potiguar basin, Gangorra basin, Coronel João Pessoa basin and Rafael Fernandes Basin; Mesozoic volcanism, represented by the Rio Ceará-Mirim Basalt, Serra do Cuó Basalt and Macau Basalt; and Cenozoic sedimentary coverings, constituted by the paleogene siliceous sediments belonging to the

Barreiras Group and the Tibau, Serra do Martins and Potengi Formations, and by the unconsolidated Neogenous sediments (modified from ANGELIM *et al.*, 2006).

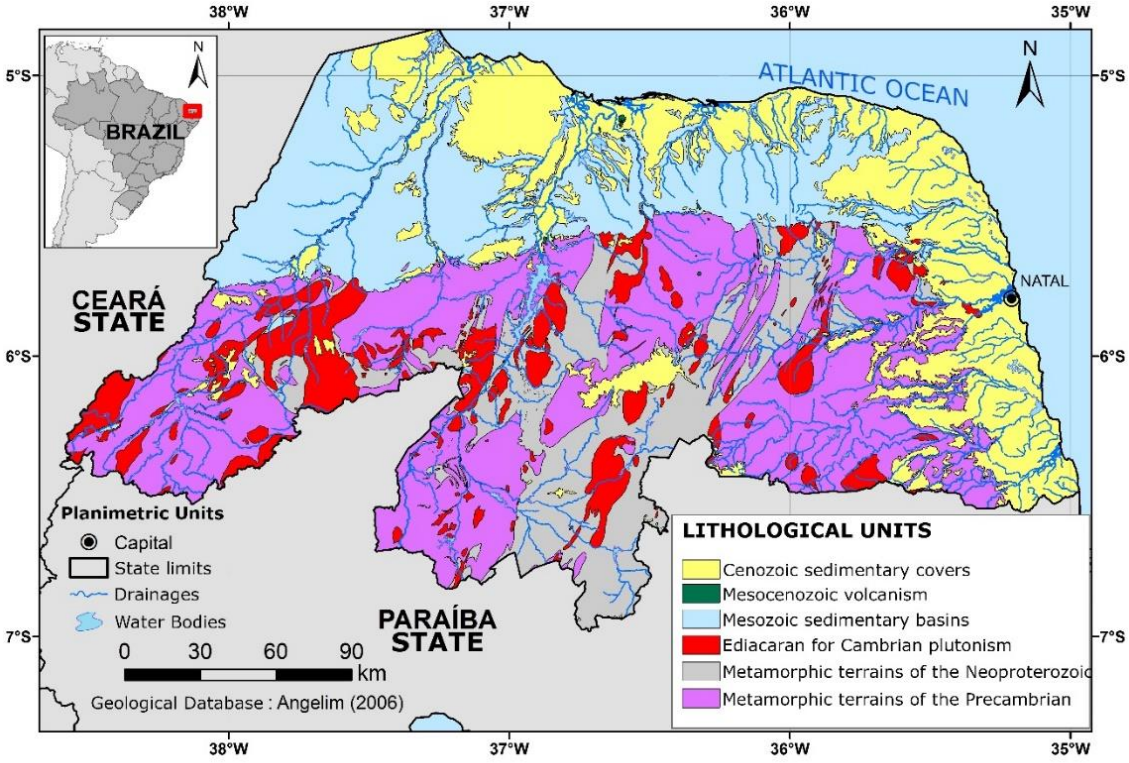

Figure 02 – Simplified geological map of Rio Grande do Norte State.
Source: Angelim et al. (2006), adapted by the authors (2017).

The geological characteristics shown in Figure 02 indicate that Rio Grande do Norte has a significant mining potential, with occurrences of gems; noble metals; ferrous metals; non-ferrous metals, and semimetals; material for use in civil construction; energetic mineral resources; and rocks and industrial minerals, explored by small companies and artisanal miners (see Figure 03).

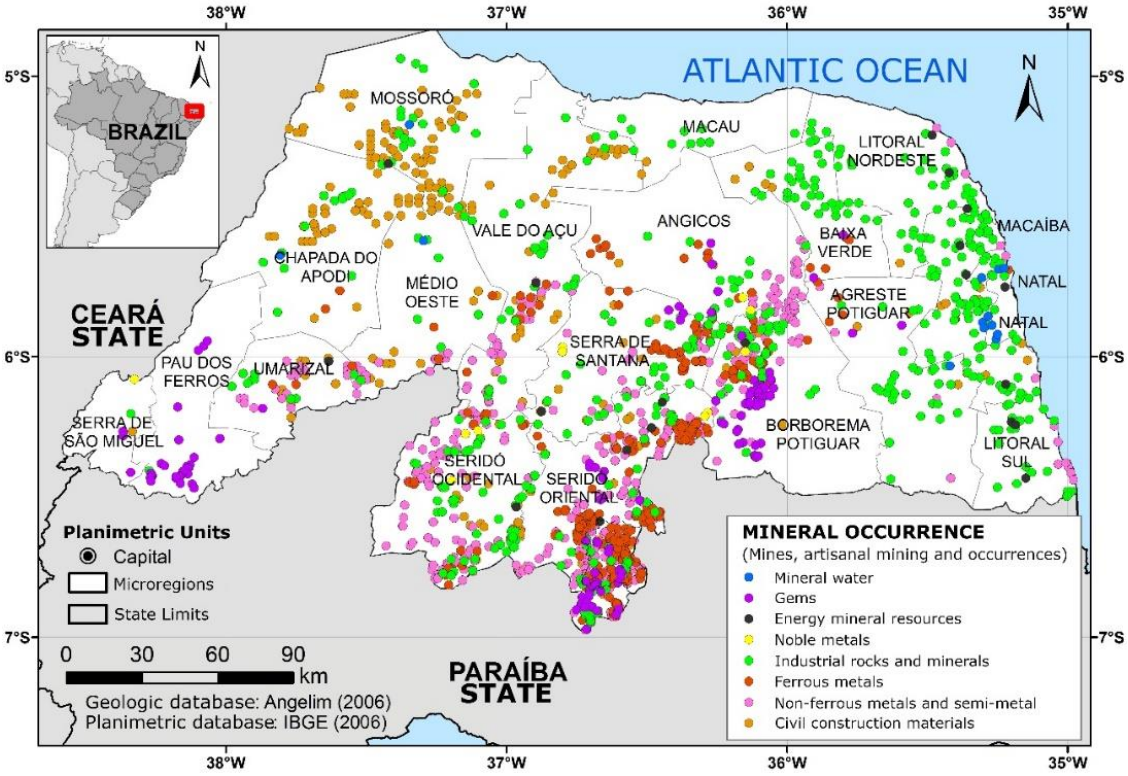

Figure 03 – Map of mineral occurrences, mines and artisanal mining sites in Rio Grande do Norte State with microregions.
Source: Angelim et al. (2006), adapted by the authors (2017).

The categories of mineral resources in Figure 03 (mines, artisanal mining sites, and mineral occurrences) were grouped by Angelim *et al.* (2006, p.63) according to Table 02:

Table 02 – Categories of mineral resources.

Mineral categories	Detailing
Mineral water	-
Gems	Aquamarine, amethyst, corundum (ruby and sapphire varieties), cordierite (iolite variety), emerald, euclase, garnet (Spessartine variety), lazulite, pink quartz, stained tourmaline (elbaites), and beryl for collection.
Noble metals	Gold
Ferrous metals	Iron ore, molybdenum ore (molybdenite) and tungsten ore (scheelite).
Non-ferrous metals and semi-metals	Beryl, tantalite-columbite, lithium ore (amblygonite and spodumene), copper ore, and titanium and zirconium ore (ilmenite, rutile, and zircon).
Civil construction materials	Sand, common clays and plastic clays (ball-clay), mudstone, gravel, crushed stone, ornamental rock, and stonework.
Energy mineral resources	Thorium ore (monazite), uranium ore, oil, natural gas, and peat.
Industrial rocks and minerals	Asbestos, barite, kaolin, diatomite, native sulfur, feldspar, fluorite, gypsum, celestine, dolomitic marl, mica, quartz, carbonate rocks (limestone, dolomite, and marble), sea salt, talc, and vermiculite.

Source: Angelim et al. (2006).

Oil, natural gas, and sea salt are not listed among the 1993 mineral occurrences contained in the GEOBANK/CPRM, used to design Figure 3, which is why these mineral resources are not included in this figure.

The mineral waters are primarily distributed in the microregions of Natal, Macaíba, and Agreste Potiguar, and, to a lesser extent, in the western microregions of Médio Oeste, Chapada do Apodi, and Mossoró.

Gems predominantly occur in the central portion of the state, spanning the microregions Eastern Seridó, Borborema Potiguar, Serra de Santana, Angicos, Baixa Verde, and Agreste Potiguar. Furthermore, smaller representations in the microregions Pau dos Ferros, Serra de São Miguel and Umarizal are observed.

Mineral energy resources are distributed along the coastal regions of the state, including the Litoral Sul, Natal, Macaíba, and Northeast Coast microregions, and stretch along the Eastern and Western Seridó, Borborema Potiguar, Serra de Santana, Umarizal, Mossoró, and Vale do Açu microregions.

Noble metals occur in the central region of the state, encompassing the Seridó Oriental e Ocidental (Western and Eastern Seridó), Serra de Santana, Borborema Potiguar, Angicos microregions, besides an occurrence to the west, in the Serra de São Miguel microregion.

Industrial minerals are found in all microregions of Rio Grande do Norte, with the highest densities in the coastal and central-south portions.

Ferrous metals are distributed mainly in the Seridó Oriental (Eastern Seridó), Borborema Potiguar and Serra de Santana microregions, besides occurrences located in the Seridó Ocidental (Western Seridó), Vale do Açu, Médio Oeste, Chapada do Apodi, Umarizal, Angicos, Baixa Verde, Agreste Potiguar, Macaíba and Natal microregions.

The main occurrences of non-ferrous metals and semi-metals are observed in the central-south part of the state, including the microregions of Seridó Oriental and Ocidental (eastern and western Seridó), Borborema Potiguar, Angicos, and Vale do Açu and the microregions of Médio Oeste, Umarizal, Agreste Potiguar, Litoral Nordeste and Sul, Macaíba, and Natal.

Civil construction materials are mainly distributed in the western region of the state, including the microregions of Mossoró, Chapada do Apodi, Médio Oeste, Vale do Açu, Umarizal, and Serra de São Miguel. They also occur in the microregions of Seridó Oriental and Ocidental (eastern and western Seridó), Serra de Santana, Angicos, Borborema Potiguar, Baixa Verde, Agreste Potiguar, Litoral Nordeste, and Macaíba.

In Figure 04, the farming establishments with family farming and revenues from mineral exploration were partitioned quantitatively (by units) into five sections to show its distribution in the state. The light shade represents the microregions with the lowest proportional number of establishments with mineral exploration revenues in the RN according to the 2006 Agricultural Census, grading to darker shades as the number increases.

The dark brown color indicates that the microregions Mossoró, Vale do Açu and Chapada do Apodi have between 32 and 60 agricultural establishments of family farming and with revenue from mineral exploration, followed by the microregions of Angicos and Western Seridó (between 13 and 31), Agreste Potiguar, Pau dos Ferros and Serra de Santana (between 7 and 12).

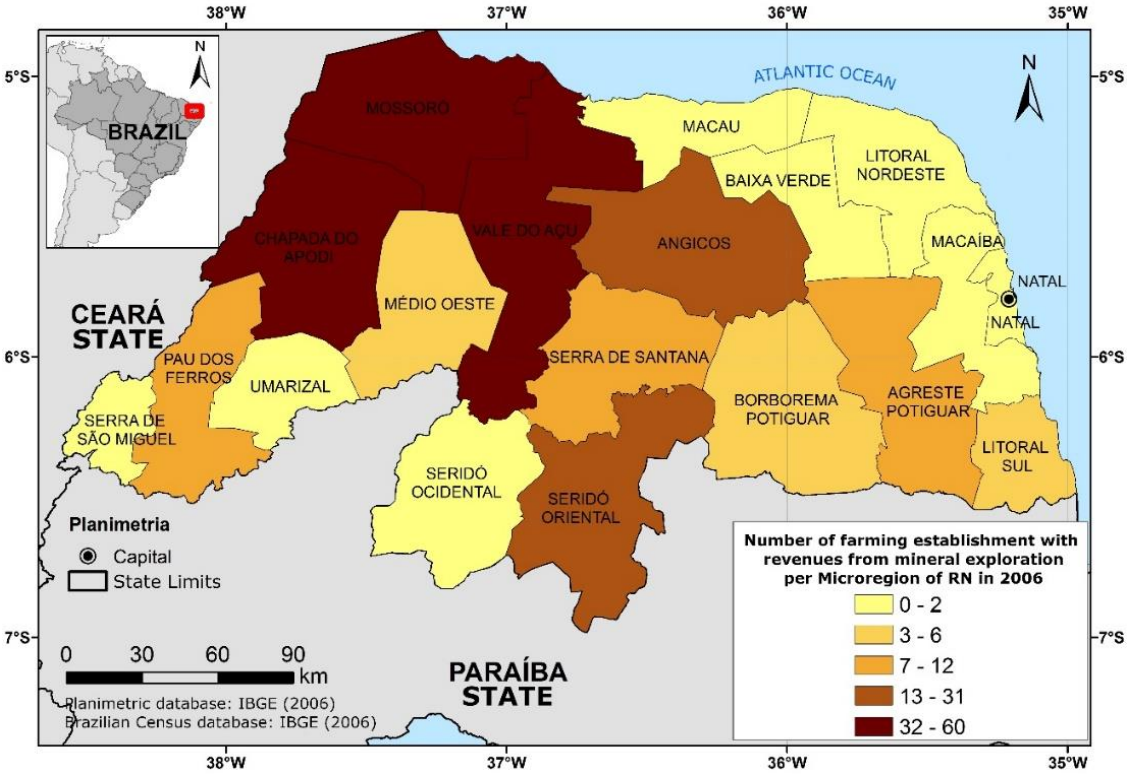

Figure 04 – Number of farming establishments with revenues from mineral exploration per microregion of Rio Grande do Norte.

Source: IBGE (2006), adapted by the authors (2017).

Alternatively, the data that were used to develop Figure 04 are presented in Table 03 (third column). The fourth and last column of this table present the proportion of farming establishments with revenue from mineral exploration considering the total farming establishments with family farming in the state's microregions, organized in descending order of values. Presented in this way, the Eastern Seridó is third (0.98%), surpassed only by Mossoró and the Vale do Açu.

Table 03 – Total number of farming establishments with family farming and number of farms with revenue from mineral exploration per microregion of Rio Grande do Norte.

Microregions – RN	**Total of farming establishments with family farming (units)**	**Number of farming establishments with revenue in the year from mineral exploration (units)**	**%**
Vale do Açu	3559	60	1.69
Mossoró	3641	60	1.65
Seridó Oriental (Eastern Seridó)	3174	31	0.98
Angicos	2620	24	0.92
Chapada do Apodi	5902	48	0.81
Litoral Sul	1856	6	0.32
Pau dos Ferros	4933	12	0.24
Médio Oeste (Midwest)	1901	4	0.21

Serra de Santana	6486	10	0.15
Seridó Oriental (Western Seridó)	1658	2	0.12
Agreste Potiguar	12398	12	0.10
Litoral Nordeste	3767	2	0.05
Borborema Potiguar	8214	4	0.05
Baixa Verde	2078	1	0.05
Macaíba	2632	1	0.04
Umarizal	3332	1	0.03
Serra de São Miguel	5296	1	0.02
Macau	760	-	0.00
Natal	249	-	0.00

Source: IBGE (2006).

In the farming establishments with family farming and revenues from mineral exploration, in the microregions of Mossoró, Vale do Açu, and Chapada do Apodi (Figure 04), materials for use in civil construction, rocks and industrial minerals are probably explored. In the Angicos and Eastern Seridó microregions occur materials used in civil construction, energy mineral resources, gems, noble metals, ferrous metals, non-ferrous metals and semimetals.

3.2 Eastern Seridó Microregion

The microregion of the Eastern Seridó has one of the largest mining potentials of Rio Grande do Norte State; its geology comprises of metamorphic terrains of the Pre-Cambrian and Neoproterozoic, plutonic rocks of the Ediacaran and Cambrian, underlayed by Cenozoic sedimentary coverings (Figure 05).

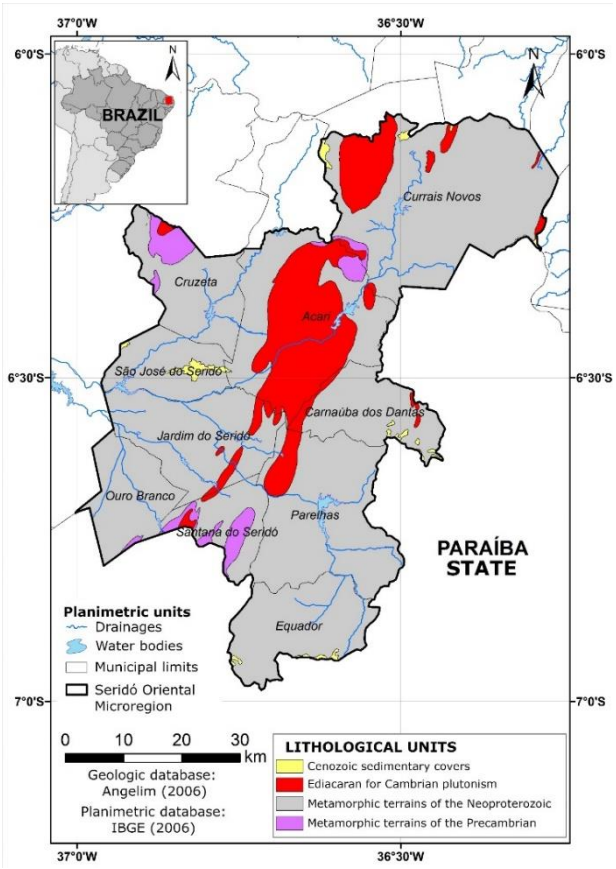

Figure 05 – Simplified geological map of the Eastern Seridó microregion.
Source: Angelim et al. (2006), adapted by the authors (2017).

Its geology is favorable for several minerals of economic value that can be exploited (Figure 06). In this microregion, there are occurrences of gems, energy mineral resources, noble metals, rocks and industrial minerals, ferrous metals, non-ferrous and semi-metallic metals, and construction materials, that is, all types of occurrences in the state, except mineral waters, which in turn is more characteristic of the sedimentary environments of the eastern coastal region. In 2006, there were 38 mines and 594 artisanal mining sites in the microregion of the Eastern Seridó. The highest concentration was in the Parelhas municipality, with 183 artisanal mining areas (ANGELIM *et al*., 2006).

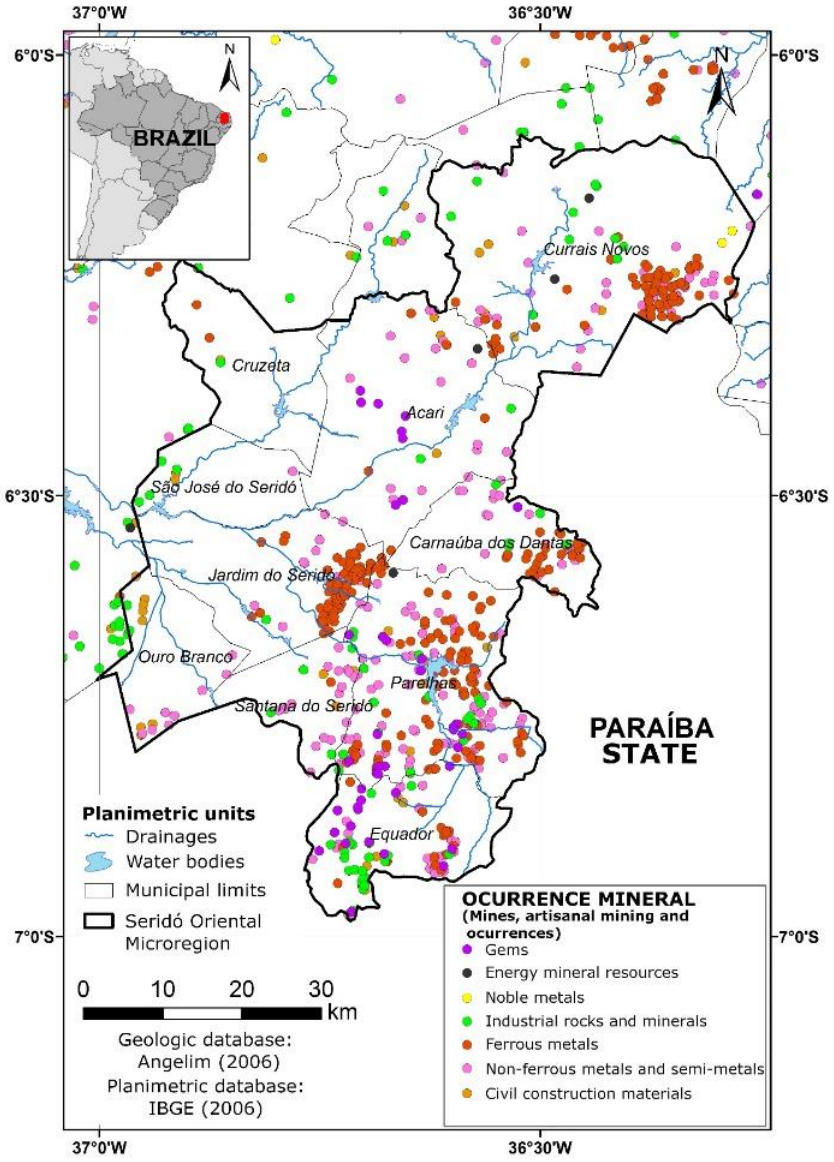

Figure 06 – Mineral occurrences in the microregion of the Eastern Seridó of Rio Grande do Norte State. Source: Angelim et al. (2006), adapted by the authors (2017).

Considering the data from the 2006 Agricultural Census, the Eastern Seridó has 31 farming establishments with mineral exploration revenues (Table 03); however, when compared to the total number of farming establishments in the microregions of Rio Grande do Norte, it is seen that the microregion of Eastern Seridó is only behind the Vale do Açu and Mossoró microregions, which in turn have the highest concentration of cement/ceramic production in the state, according to Angelim *et al.* (2006).

The strong connection of family farming with mining in this microregion is due both to geological diversity and to easy access to ore and commercialization, especially among small scale miners and small companies. This relationship is evidenced by the total mineral occurrences, artisanal mining sites, and small companies in the region, if confronted with data from the 2006 Agricultural Census. Artisanal and small-scale mining represents extra incomes for farmers, particularly in drought; it represents also convenience for several companies that save money with extraction, buying products ready for the beneficiation stage.

4. Final considerations

From the official data from CPRM, related to the geology and mineral resources of Rio Grande do Norte, and by IBGE, using the results on mineral exploration revenues in family farming establishments, it was possible to notice that there is an intrinsic relationship between mining and family farming in Rio Grande do Norte State, particularly in the Eastern Seridó microregion, where the extent of mining, primarily artisanal mining, is extensive.

This situation points to the need to investigate individuals who are family farmers and artisanal /small scale miners, in order to know the working and health conditions they live in, not only in the Eastern Seridó, but in other microregions of the state, once the maps produced in this research showed concentrations of mineral resources and mineral exploration revenues in other areas of Rio Grande do Norte State.

References

ANGELIM, L. A. A. et al. *Geologia e recursos minerais do Estado do Rio Grande do Norte* - Escala 1:500.000. Recife: CPRM - Serviço Geológico do Brasil, 2006. 119 p.

BRASIL. Lei nº 11.326, de 24 de julho de 2006. *Diário Oficial da União*, Brasília, DF, 25 jul. 2006. Disponível em: http://www.planalto.gov.br/ccivil_03/…/L11326.htm. Acesso em: 18 abr.2016.

_____. Ministério do Meio Ambiente. *Atlas das áreas susceptíveis à desertificação do Brasil***.** Brasília: MMA, 2007.

EMBRAPA; *Sistema Brasileiro de Classificação de Solos*. Recife: EMBRAPA, 1999. Disponível em < http://www.cnps.embrapa.br/sibcs/ > Acessado em 12 ago. 2016.

FELIPE, J. L. A.; CARVALHO, E. A.; ROCHA, A. P. B. *Atlas Rio Grande do Norte:* espaço geo-histórico e cultural. João Pessoa: Grafset, 2006.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. *Censo agropecuário 2006*. Rio de Janeiro: IBGE, 2006.

_____. *Censo Demográfico 2010*. Rio de Janeiro: IBGE, 2010

LIMA, R. F. S.; LIMA, E. M. Atividades de Base Mineral no Seridó Norte-Riograndense: aspectos de saúde e meio ambiente. In: *Recursos Naturais das Caatingas: uma visão multidisciplinar***.** Natal: EDUFRN, 2009. p. 151-172.

MINING MINERALS AND SUSTENTAINABLE DEVELOPMENT, MMSD. *Breaking new ground:* the report of the Mining, Minerals and Sustentainable Development – The Report of the MMSD Project. London, Earthscan Publications Ltd. 2002. 441p.

NÓBREGA, J.A.S; MENEZES, M.A. "É do caulim pro roçado": o trabalho agrícola e a extração mineral no Seridó Paraibano. *ABET*. V. XI n. 2, 2012.

ROSS, J. L. S. *Geografia do Brasil*. São Paulo: Edusp, 2003.

SANTOS, H. C. *O agrominerador familiar "Por detrás da Serra" de Parelhas, Seridó do Rio Grande do Norte*. 2015. 115f. Dissertação (Mestrado em Estudos Urbanos e Regionais) – Programa de Pós-graduação em Estudos Urbanos e Regionais, Universidade Federal do Rio Grande do Norte, Natal, 2015.