Atlas of Dimension Stones of the Espírito Santo State

Project Geology and Mineral Resources
of the Espírito Santo State

Authors
Ruben Sardou Filho
Gerson Manoel M. Matos
Vanildo Almeida Mendes
Edgar R. H. de Figueiredo Iza

2015

CPRM
Geological Survey of Brazil

ATLAS OF DIMENSION STONES OF THE ESPÍRITO SANTO STATE

Project Geology and Mineral Resources of the Espírito Santo State

BRASÍLIA
2015

CPRM
Geological Survey of Brazil

Ministry of Mines and Energy

Secretary of Geology, Mining and Mineral Transformation

Geological Survey of Brazil – CPRM

Directory of Geology and Mineral Resources

Department of Mineral Resources

Division of Industrial Minerals and Rocks

Geology of Brazil Program

PROJECT GEOLOGY AND MINERAL RESOURCES OF THE ESPÍRITO SANTO STATE

ATLAS OF DIMENSION STONES OF THE ESPÍRITO SANTO STATE

Authors
RUBEN SARDOU FILHO
GERSON MANOEL MUNIZ DE MATOS
VANILDO ALMEIDA MENDES
EDGAR ROMEO HERRERA DE FIGUEIREDO IZA

BRASÍLIA
2015

CPRM
Geological Survey of Brazil

PROJECT GEOLOGY AND MINERAL RESOURCES OF THE ESPÍRITO SANTO STATE

INSTITUTIONAL COORDINATION – DEPARTMENT OF MINERAL RESOURCES AND DEPARTMENT OF GEOLOGY
Francisco Valdir Silveira
Reginaldo Alves dos Santos

TECHNICAL COORDINATION – DIVISION OF INDUSTRIAL MINERALS AND ROCKS AND DIVISION OF MINERAL ECONOMY AND EXPLORATION GEOLOGY
Ruben Sardou Filho
Gerson Manoel Muniz de Matos

OPERATIONAL LOGISTICS COORDINATION
Ruben Sardou Filho
Gerson Manoel Muniz de Matos

DEVELOPING TEAM

Geoprocessing and Modeling of Special Data
Edgar Romeo Herrera de Figueiredo Iza

Sampling
Ruben Sardou Filho
Gerson Manoel Muniz de Matos
Vanildo Almeida Mendes
Edgar Romeo Herrera de Figueiredo Iza
Isao Shintaku

Cooperation
Elvis Martins Oliveira
Ricardo Gallart
Valter Salino Vieira

Operational Assistants
Bruno Lauritzen Silva de Oliveira
Lupe da Motta Carvalho da Silveira

COVER
Edgar Romeo Herrera de Figueiredo Iza
Washington José Ferreira Santos

FINAL REVIEW
Ruben Sardou Filho
Gerson Manoel Muniz de Matos
Vanildo Almeida Mendes
Edgar Romeo Herrera de Figueiredo Iza
Isao Shintaku
Elvis Martins Oliveira
Marcos Luiz de Espírito Santo Quadros

ENGLISH EDITION SUPPORT

SINDIROCHAS Espírito Santo
SICOOB Credirochas

PUBLISHER
José Márcio Henriques Soares

EDITION OF PRODUCT

Department of Institutional Relations and Marketing
Ernesto von Sperling

Division of Marketing and Disclosure
José Márcio Henriques Soares

Division of Geoprocessing
João Henrique Gonçalves – SIG/GEOBANK

Division of Documentation
Roberta Pereira da Silva de Paula

Organization, Preparation and Final Edition Control
Alan Düssel Schiros

Edition for Publication
UNIKA Editora

English Text Translation
SINDIROCHAS
Isabel Echeverría

English Text Review
Gerson Manoel Muniz de Matos

Sardou Filho, Ruben
Atlas of dimension stones of the Espírito Santo state/Ruben Sardou Filho ...[et al.] ... – Scale 1:400,000 – Brasília : CPRM, 2015.1 atlas (353 p.)

ISBN 978-85-7499-242-6

1.Economical Geology – Atlas – Brazil – Espírito Santo. 2.Dimension Stons – Atlas – Brazil – Espírito Santo. I.Título

CDD 553.6098152

INDEX FOR SYSTEMATIC CATALOG
1.Dimension Stones: Atlas
CIRCULATION
300 samples

PRESENTATION

The Geological Service of Brazil – CPRM has the great pleasure to release the Atlas of Dimension Stones of the Espírito Santo State to the population of the state, to the technical-scientific community and to the entrepreneurs of the mineral sector; another product of the PAC – Program of Growth Acceleration of the Federal Government, and as part of the Project Geology and Mineral Resources of the Espírito Santo State, inserted in the Program of Geological Surveys of Brazil.

This work concentrates geological information that will allow the definition of favorable environments for dimension stones occurrences, basically along the geological entity recognized as Mantiqueira Province, which embraces a geodiversity widely favorable for the existence of deposits of high value rocks in the demanding international market. The final product is presented as an explicative text in both digital and printed format, together with a geological data base and a catalogue of the producing lithotypes.

During the development of this Project, it was carried out geological surveys and analysis of mineral occurrence data, included in the GEOBANK (data base of the CPRM geological data in the internet), that together with the results obtained during the registration of the enterprises provided technical and technological details of these studies.

This document brings to the Espírito Santo State an additional tool to attract new investments in the exploration of dimension stones, very important piece in the state economy, facilitating and orientating the planning of those new investments, adding importance to the present work.

This release provides the CPRM – Geological Service of Brazil, the conditions to continue the governmental policy, that has been developing in all the geographical areas of the country, whose objective is to increase the geological knowledge, either through geological, hydrogeological or basic geophysical surveys, or through thematic works such as this one, thus contributing with the regional development and subsiding the formulation of public policies, as well as giving support to make investment decisions.

It is important to highlight the relevant support of the Sindicato das Indústrias de Rochas Ornamentais, Cal e Calcário do Estado do Espírito Santo – SINDIROCHAS (Union of Industries of Dimension Stones, Lime and Limestone of the Espírito Santo State), which undertook efforts to develop the English version of the technical text, keeping its posture in terms of increasing the international recognition of the high value-added samples within the Espírito Santo State, in the perspective of boosting this promising market.

Finally, it is important to enhance the commitment of all the performers to achieve of this work and the importance of the partnership of the Federal Government with the states, enterprises and entities of the dimension stone sector, not only for the creation of geoscientific products, but also as an important tool for the building of an effective national geology policy, coordinated and articulated by the Secretary of Geology, Mining and Mineral Transformation of the Ministry of Mines and Energy, and carried out by the Geological Service of Brazil – CPRM.

MANOEL BARRETTO DA ROCHA NETO
Director-President
Geological Survey of Brazil – CPRM

ROBERTO VENTURA SANTOS
Director of Geology and Mineral Resources
Geological Survey of Brazil – CPRM

SAMUEL MENDONÇA
President of SINDIROCHAS

PREFACE

The dimension stones sector of Brazil is among the most important markets of the world contributing with the production and exportation of stones with recognized aesthetical and technological characteristics.

The state of Espírito Santo is the main producer and exporter pole of dimension stones in Brazil, holding hundreds of processing units with very high production.

This noticeable position is the consequence of a variety of factors, such as, harbor and railway infrastructure, localization nearby large consuming centers, tax incentive, supply of skilled workforce, spontaneous accumulation of companies of the sector, etc. These variables vastly contributed to consolidate the position of the state as a world reference in the production and commercialization of dimension stones.

Despite its remarkable position in the national and international scenario, the state of Espírito Santo did not count with a product that summarized the importance of the wide variety of products produced by the state nowadays.

In order to change this, The Geological Survey of Brazil - CPRM prepared this Atlas, which gathers and updates information about the main materials produced, providing information about technological parameters, appearance, quarries, producing counties, as well as data about production, exportation, infrastructure, etc.

The race for new market space has encouraged the search for new products with authentic characteristics. The objective of the results presented here is to create a technical reference and a market reference for domestic and international consumers and producers, as well as to contribute for a greater development and amplification of businesses, not only based on visual criteria but also on technological parameters.

ACKNOWLEDGMENTS

The Geological Survey of Brazil - CPRM gives sincere thanks to the professionals that kindly fulfilled the request of the coordination of the Atlas of Dimension Stones of the Espírito Santo State, providing information collected during field works, making the data available and, in some cases, providing material from their own files, that contributed greatly to the consolidation of this product.

Special remarks should be regarded to:

- Sindicato das Indústrias de Rochas Ornamentais, Cal e Calcário do Estado do Espírito Santo – SINDIROCHAS – ES. (Union of the Industries of Dimension Stones, Lime and Limestone of the Espírito Santo State)
- Centro tecnológico do Mármore e Granito – CETEMAG (Marble and Granite Technological Center)
- Centro Brasileiro dos Exportadores de Rochas Ornamentais – CENTROROCHAS (Brazilian Center of Dimension Stones Exporters)
- Centro de Tecnologia Mineral – CETEM (Mineral Technology Center)
- Entrepreneurs of the Mineral Sector of Dimension Stones of ES (Espírito Santo)
- Specialized consultancies of the Espírito Santo State
- Associação Brasileira da Indústria de Rochas Ornamentais – ABIROCHAS (Brazilian Association of the Dimension Stones Industry)
- Instituto de Pesquisas Tecnológicas – IPT (Institute of Technological Research)

RESUMO

Este atlas apresenta informações sobre as variedades de rochas ornamentais produzidas no estado do Espírito Santo e resulta do levantamento sistemático realizado junto às empresas mineradoras e beneficiadoras de rochas ornamentais instaladas no território capixaba no período de 2011-2013. Para tanto foram considerados materiais de minas ativas e inativas, tendo sido desenvolvido sob a égide do Projeto Geologia e Recursos Minerais do Estado do Espírito Santo.

Trata-se de um estudo temático realizado com foco principal na identificação e catalogação das variedades de produtos pétreos ornamentais existentes no estado, sendo levantadas paralelamente suas características geológicas e tecnológicas, formas de ocorrências dos depósitos minerados, aspectos fisiográficos, procedimentos operacionais de lavra como metodologias utilizadas para o seu desenvolvimento, tecnologias de corte e beneficiamento de rochas, características dos produtos comercializados e dados econômicos.

O atlas é composto por sete capítulos: o primeiro apresenta informações sobre clima, relevo, hidrografia e vegetação, além de dados socioeconômicos do estado; o segundo faz uma abordagem elucidativa sobre os conceitos emitidos sobre rochas ornamentais e de revestimento, de sua nomenclatura usual no mercado e significado geológico; o terceiro capítulo faz uma associação entre os tipos de rochas controladas por fatores geológicos, tectônicos ou outros fatores atuantes e os distintos materiais ornamentais deles derivados; o quarto capítulo apresenta breve considerações sobre o contexto geológico e tectônico-estrutural da área abrangida pelo estado; o capítulo cinco discorre sobre as características geológicas dos sítios produtores e potenciais dos materiais compilados no atlas; o sexto capítulo apresenta a metodologia de lavra e beneficiamento de materiais pétreos ornamentais; o capítulo sete discute o cenário técnico-econômico brasileiro e mundial do setor de rochas ornamentais. Por fim é apresentado o catálogo de rochas ornamentais consolidado do estado do Espírito Santo, integrado por pranchas dos materiais cadastrados, contendo localização, elementos básicos de geologia, foto da ocorrência ou frente de lavra, imagem da superfície polida da rocha, e os resultados dos ensaios de caracterização tecnológica.

ABSTRACT

This atlas presents informations about the variety of dimension stones produced in the Espírito Santo State, and it is the result of the systematic survey conducted among the producing and processing dimension stones companies within the territory of the State during the period 2011-2013, considering materials from active and inactive mines, and developed under the aegis of the Geology and Mineral Resource of the State of Espírito Santo project (Brazil).

It is a thematic study performed with the primary focus on the identification and cataloguing of the variety of dimension stones products existing in the State, being raised alongside its geological and technological characteristics, forms of occurrence of mined deposits, physiographic features, operational procedures of mining as methodology used for the development, and technology for cutting stones, characteristic of the commercialized products and economic data.

The atlas consists of seven chapters: the first chapter provides information about climate, topography, hydrography, and vegetation, besides socioeconomic data of the state; the second one makes an elucidative approach about the concepts issued on dimension and coating stones and its usual nomenclature in the market along with its geological meaning; the third chapter is an association between the type of rocks controlled by geological, tectonic, or other influencing factors, and the different materials derived from them; the fourth one presents small considerations about the geological and tectonic-structural context of the area covered by the state; chapter five discusses the geological characteristics of the production locations and the potential of the materials compiled in the atlas; the sixth chapter presents the guidelines of the mining and processing methodology of dimension stones; chapter number seven discusses the technical-economic scenario of the dimension stone sector of Brazil and the world. Finally, it is presented the consolidated catalog of dimension stones of the Espírito Santo State, containing the localization, basic geological elements, photo of the occurrences or the mining front, images of the polished surface of the stone, and the result of the technological characterization tests.

CONTENTS

INTRODUCTION

The dimension stones and coating stones, also named natural rocks, lapidus rocks or stonework materials, comprise the lithological types that can be extracted in blocks or slabs, cut in different ways and processed through squaring, polishing, etc. The main uses include isolated pieces, like sculptures, table tops and legs, countertops or general funerary art, as well as in buildings, standing out, in this case, the use as internal and external wall coating, floors, pillars, columns, edges, etc. The dimension stones sector is remarkable in the Espírito Santo economy, representing about 10% of the GDP (Gross Domestic Product) of the state and generating approximately 130,000 jobs (20,000 directly and 110,000 indirectly).

According to the Brazilian Center of Dimension Stones Exporters – CENTROROCHAS, the dimension stone sector in the Espírito Santo State ended the year 2012 with US$ 797.8mi in exportations, a growth of 14.6% if compared to the previous period. The state's present-day production accounts for more than 70% of the Brazilian stones exportations, contributing highly to the economic and social growth of the state.

More than 90% of the investments in this sector of the Brazilian industrial park are performed in the Espírito Santo State, which represents a world reference in marbles and granites, and thus being an absolute leader in the national production of stones, holding a great geological potential, seen and developed through investments in researches as well as extraction and processing technologies.

The data presented here are the result of a survey performed in the Espírito Santo State, where more than a hundred quarries were visited, among active and inactive, from where information regarding the geological and morphological characteristics of the outcrops and the different commercialized products was obtained, besides the collection/confirmation of the geographic coordinates, petrographic characterization and the technological tests of the exploited lithotypes. It was also confirmed the different methodologies used for extraction and processing, as well as the cycle of production of the quarries. This cycle involves stages, which go from the procedures of extraction of the primary volumes of rocks on the outcrops (massive rocks and large boulders), the cutting of vertical panels (slabs) when extracted from massive rock, to the production of commercial blocks (squaring) and its movement and loading for transport.

WORK METHODOLOGY

The procedure employed to elaborate this Atlas of Dimension Stones of the Espírito Santo State follows the methodology previously traced by the DIMINI/DIEMGE and approved by the DEREM, which consists initially in the compilation and gathering of geological information available, occurrences of known dimension stones that are in the CPRM Database – GEOBANK, ABIROCHAS database, IPT database and data obtained during field works through information collected at dimension stones companies and specialized technical consultancies.

In a global context, the development of this work was executed in three interrelated phases:

The first phase consisted in the research of geological and aerogeophysical data available in the Espírito Santo State, as well as in the databases available (CPRM, ABIROCHAS and IPT), and the consultation to dimension stones producing and processing companies located in the Espírito Santo State. In this stage it was also collected petrographic, geological and technological data of the exploited stones, and prepared the cartographic and geological basis on the scale 1:400.000, followed by a preliminary database, which aided with the planning of following actions.

Field work was carried out during the second phase in order to catalog the known occurrences, to provide detailed information of the main types produced, followed by visits to the producing units, together with the collection of samples to perform petrographic studies. In addition, visits to SINDIROCHAS-ES, CETEMAG, CETEM-ES and CENTROROCHAS assisted to adequately update the producing data of the sector.

During this phase, it was recognized about 1.024 different materials (folders and catalogs from companies, existent publications and verbal information). After a thorough analysis, it was observed that actually a variety of materials came from other states, mainly Minas Gerais and Bahia. Another fact detected was the repetition of the same material commercialized with different names, making this number reduce to 170, from which 120 were considered for the catalog shown in this work.

The third phase comprised the incorporation, reevaluation, interpretation and consolidation of the technical data and other parameters regarding the geological data collected on the previous

stages. The final structure of the atlas comprises 120 materials (records), distributed in 120 sheets (front and back), comprising the different types of materials catalogued. The samples were scanned in order to get high resolution images used in the atlas. A definite version of the database of the project was elaborated, which should be made available in GIS format.

The mentioned atlas is a highly illustrative and descriptive document, aiming to promote nationally and internationally the potential of the dimension stones market found in the Espírito Santo State, attracting new investments to this sector.

COMPLEMENTARY CONSIDERATIONS

The results achieved in this study are quite significant and emphasize the positive expectation that guided the formatting of this study and its importance in promoting the dimension stones sector of the Espírito Santo State.

It should be noted that this state has an extremely favorable geodiversity for the existence of deposits of dimension stones, from common types, to greatly rated materials and with a very high value in the demanding international stone market. This document intended to include all the stones produced, giving a view of the real potential of the dimension stones of the state.

This work could be complemented in the future with the development of new studies that can assist, from updated geological knowledge, the creation of a map of potential dimension stones of the Espírito Santo State. The purpose will be to provide the productive sector reliable geological information about the deposits of dimension stones, the types likely to be found in the territory and, especially, guide the direction of investments in the search and mining of new deposits.

PHYSIOGRAPHIC AND SOCIO ECONOMIC FEATURES

Chapter 1

Chapter 1

PHYSIOGRAPHIC AND SOCIOECONOMIC FEATURES

The Espírito Santo State is one of the 27 states of Brazil. It is located in the Southeast Region and is bounded on the east by the Atlantic Ocean, on the north by Bahia state, on the west and northwest by Minas Gerais state, and on the south by Rio de Janeiro state, occupying an area of 46,077.519 km². It is the fourth-smallest state of the country, after the states of Sergipe, Alagoas and Rio de Janeiro.

Its capital is the city of Vitória, and its largest city is Serra, making it, alongside the state of Santa Catarina, one of the few Brazilian states where the capital is not the most populous city. Other important towns are Aracruz, Cariacica, Cachoeiro de Itapemirim, Colatina, Guarapari, Linhares, São Mateus, Viana and Vila Velha. The gentilic of the state is "capixaba" or "espírito-santense".

On figure 1.1 it can be seen the division of this state, in 10 regions including the county boundaries.

On table 1.1 there is a list of the 20 most important cities of the Espírito Santo State including the number of inhabitants.

Figure 1.1 - Administrative microregions of the Espírito Santo state (modified from the State Secretary of Economy and Planning).

Place	City	Population
1º	Vila Velha	419,853
2º	Serra	416,028
3º	Cariacica	354,615
4º	Vitória	353,626
5º	Cachoeiro de Itapemirim	209,878
6º	Linhares	141,254
7º	Colatina	112,431
8º	São Mateus	110,453
9º	Guarapari	106,582
10º	Aracruz	83,152
11º	Viana	65,887
12º	Nova Venécia	46,262
13º	Barra de São Francisco	40,883
14º	Castelo	34,900
15º	Marataízes	34,591
16º	Santa Maria do Jetibá	34,178
17º	São Gabriel da Palha	32,264
18º	Domingos Martins	31,946
19º	Itapemirim	31,208
20ª	Afonso Cláudio	31,003

Table 1.1 - Most populous cities in Espírito Santo from the Census in 2011 (IBGE – Instituto Brasileiro de Geografia e Estatística, Brazilian Institute of Geography and Statistics).

1.1 RELIEF

Most of the Espírito Santo State is considered a plateau, part of the Atlantic Massif. The average altitude varies from six hundred to seven hundred meters, with very steep topography, consisting of Proterozoic terrains, where isolated peaks with a steep slope are common, mimicking the shape of fingers or sugarloaves. In the border with Minas Gerais, it becomes a mountainous area with elevations above 1,000 meters in the area where the Serra do Caparaó or Chibata rises. There, it is located one of the highest points of Brazil, Pico da Bandeira, with 2,890 m (photo 1.1).

In a simple way, a morphologic frame of the terrain can be composed in five units: the low coastline, formed by large sand covers, beaches and restingas; the coastal tablelands, zone of flat land about fifty meters high, which rises along the lowland with an abrupt slope, facing east; hills and isolated massive rocks, merging into the coast and in some places, rocky shores take place, whose indentations make natural ports, such as Vitória Bay; floodplains (lowlands), along rivers, which sometimes end in delta formations, e.g. the mouth

Photo 1.1 - Coastline of Ubu, Anchieta – ES.

of the Rio Doce; and the mountain range, eastern edge of the Brazilian Highlands, with an average height of seven hundred meters, composed by mountain ranges, among which stands out the Serra do Caparaó.

Contrary to what occurs in the states of Rio de Janeiro and São Paulo where there is a cliff almost continuous, in the Espírito Santo State the edge of the plateau appears as a mountain zone heavily permeated by rivers, where deep valleys were carved. From the center of the state to the north, such lands lose height and the transition between the coastal lowlands and the highlands of the interior becomes softer, until the top of the plateau in the state of Minas Gerais is reached. This way, north of the Rio Doce, the range is replaced by a zone of steep terrain, but with reduced height, where aligned peaks arise, inaccurately called mountain ranges.

1.2 CLIMATE

There are two main types of climates in the Espírito Santo State, tropical rainy and humid mesothermal. The first one predominates in the lowlands and is characterized by high temperatures throughout the year and an average temperature above 22°C. The other one is the humid mesothermal climate, without a dry season, which occurs in the mountainous region in the southern portion of the state. It is characterized by low temperatures in the winter (average of the coldest month is below 18°C).

1.3 VEGETATION AND HYDROGRAPHY

Regarding the vegetation, the rainforest, known as “Mata Atlântica”, once covered the entire state territory. With the successive deforestations, it is almost completely extinguished in the southern part of the state, the oldest inhabited area. There, the search for virgin soils by farmers and the extraction of firewood and high quality wood (hardwood) determined the proliferation of field crops, artificial pastures and extensive areas of low vegetation and bushes. Only in the northern portion of the state, where the process of human occupation is still ongoing, some forest reserves can be found. The Serra do Caparaó, formerly covered by the local rainforest, is now totally devastated, and it only presents country vegetation above one thousand meters of altitude.

The main rivers of the state are, from north to south, the Itaúnas, the São Mateus, the Doce and the Itapemirim, which lay from west to east, that is, from the mountain range to the coastline. The most important among them is the Rio Doce, which rises in Minas Gerais and divides the territory of Espírito Santo in two almost equal parts. In its delta, there are many lagoons, being Juparanã the most important.

1.4 COASTLINE

The south and central coastline of the state are predominantly rocky with sandstone cliffs in the south and large hills and granitic outcrops in its central portion. The south-central coastline has a lot of inlets and bays protected by rocks of the coastline (photo 1.2). It is sandy on the north, with beaches covered by weedy vegetation and extensive dunes, especially in Itaúnas and Conceição da Barra. In the Atlantic Ocean, 1140 km offshore, lies the Trindade Island (12.5 km^2) and Martim Vaz Islands, located 30 km from Trindade. These islands are under the administration of the Espírito Santo State.

The state has a more irregular coastline on the center-south, and open sea on the north, which

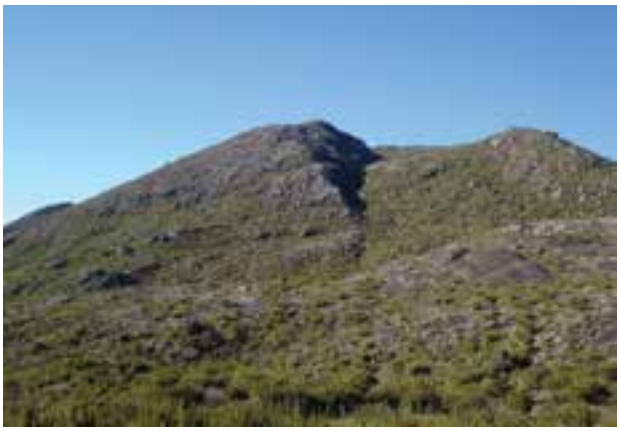


Photo 1.2 - General aspect of the Pico da Bandeira, highest point of the Espírito Santo State and third highest of Brazil.

makes most of the islands to concentrate on the central part of the state. Altogether, there are 73 islands located on the state's coast, being 50 of them in the capital Vitória.

1.5 DEMOGRAPHY

According to the demographic census conducted by IBGE in 2010, the Espírito Santo State held 3,512,672 inhabitants, being the fourteenth most populated state in Brazil, representing 1.8% of the Brazilian population. According to the same census, 1,729,670 are men and 1,783,002 inhabitants are women; 2,928,993 inhabitants lived in cities and 583,679 in rural areas. In ten years the state have recorded a population growth rate of 13.59%.

In recent years, the urban population growth increased abruptly, surpassing the total rural population. According to the 2000 estimate, 67.78% of the inhabitants lived in cities. There are two counties of the state where Pomeranian is held as official second language (besides Portuguese), Vila Pavão and Santa Maria de Jetibá.

The population density of the state, which is on seventh place in Brazil, is 76.23 inhabitants/km^2, similar to the density of Malaysia. The state distribution of the population is unequal, being higher in the inland mountainous region. In this area, the population density reaches 50 inhabitants/km^2 average and it surpasses this number in the southwest. The low coastline almost always shows densities below the state average. Only on the surroundings of Vitória, there is a small area with more than 50 inhabitants/km^2. The north side of the low coastline is the least populated area of the state. Six counties (Vila Velha, Serra, Cariacica, Vitória, Cachoeiro de Itapemirim and Linhares) make up about 45% of the population of Espírito Santo.

The Human Development Index (HDI-M) of the state, considered average by the United Nations Development Program (UNDP), is 0.802 being the seventh highest in Brazil and the third highest in the Southeast Region. The county with the highest HDI is Vitória, capital of the state, with a value of 0.856, while Água Doce do Norte, located in the Mesoregion of the Nortwest of the state, has the lowest value (0.659).

1.6 SOCIOECONOMIC FEATURES OF THE ESPÍRITO SANTO STATE

In the economy of the Espírito Santo State, the agriculture, livestock and mining are notorious. In the agriculture production, sugar cane, orange, Bahia coconut and coffee are highlighted. Regarding the livestock activity, the herd surpasses 1.8 million heads of cattle and regarding aviculture there are approximately 9.2 million birds. In the mining sector, there are important reserves of granites for the dimension stone market, besides the extraction of natural gas and oil. The industrial park of the Espírito Santo State embraces chemical, metallurgical, food, paper and cellulose industries.

The subsoil of the state is rich in minerals, including oil. There are considerable reserves of limestone, marble, manganese, ilmenite, bauxite, zircon, monazite and rare earth elements, although not all in operation. In mineral extraction, it is important to mention the reserves of marble, limestone and dolomite in Cachoeiro de Itapemirim.

The road system is organized from the BR-101, which crosses the state from north to south, bordering the coastline. The state has 30,100 km of roads.

Silviculture and fruit harvesting have been developed more recently, used for fruit conserves and the production of cellulose, being remarkable in this latter some reforestation projects that may make up, in part, for the deforestation seen in the state.

1.7 INDUSTRIAL ACTIVITY

All the main units of industry of the state are concentrated practically in the urban centers of the capital and Cachoeiro de Itapemirim. In the city of Vitória and surroundings (Greater Vitória) there are steel industries: Companhia Ferro e Aço de Vitória (Company Iron and Steel of Vitória), plant of pelletizing of iron ore of the Vale; logging, textile, ceramics, slaughterhouse, soluble coffee, and chocolate industry. On the valley of the Rio Itapemirim river, there are industries of cement, sugar and alcohol, and fruit conserves.

It should be noted that the south region of the state, more precisely the Cachoeiro do Itapemirim and Castelo, is the largest park for the industrial processing of dimension stones of the country, making the state responsible for a great part of the Brazilian exportation of processed stone products.

1.8 TRANSPORT

The Eurico de Aguiar Sales Airport located in the capital city Vitória is the only airport run by Infraero. There are other airports: Baixo Guandu/Aimorés, Cachoeiro de Itapemirim, Guarapari, Linhares and Tancredo de Almeida Neves (São Mateus), which are under the responsibility of their own county administration.

The Railway Vitória-Minas transports iron ore from Itabira (MG) to the port of Tubarão, and comes back with coal for the steel industry. It also transports passengers and general cargo along the Rio Doce

valley. The Centro-Atlântica railway operates in the south of the state and connects Vitória to Rio de Janeiro state. The main roads are the BR-101, which goes through the state from north to south alongside the coastline, and the BR-262 that connects Vitória to Belo Horizonte (MG) and to the west of the country. Other major roads are the BR-482 that goes through Alegre and Jerônimo Monteiro and merges with BR-101 on the district of Safra; the BR-342 that connects Ecoporanga to Nova Venécia on the north of the state; and the BR-381 that connects the county of São Mateus to the county São Paulo, through Nova Venécia and Barra de São Francisco.

The state has two harbors, both in the capital: the commercial pier of Vitória and the port for iron ore exportation of Tubarão.

1.9 POWER

Nowadays, the power condition of the Espírito Santo State is reliable, due to its connection with the Interlinked System South/Southeast/Center-west through a transmission network. The state produces 33% of its needs, thus importing 67% of the required power from FURNAS Centrais Elétricas S.A. The electric power distribution dealers operating in the state are the Espírito Santo Centrais Elétricas S/A (Escelsa – Electric Central Espírito Santo) and Empresa Luz e Força Santa Maria (ELFSM).

The Espírito Santo State has been using wind power as an alternative power source in order to cover the need of electric power due to the forthright development, expansion and growing demand that can afford consistently this process.

1.10 - OIL AND NATURAL GAS

In the last few years, the Espírito Santo State has been outshining in the production of oil and natural gas. With several discoveries made mainly by Petrobras, the state went from the fifth position in the national reserves ranking in 2002, to the second greatest oil province in the country, with total reserves of 2.5 billion barrels. About 140,000 barrels per day are extracted. The oil fields are located both on land and offshore, in shallow, deep and ultra-deep waters, containing light and heavy oil and non-associated gas.

The Golfinho field is among the remarks of the production, located on the north side of the state, with a reserve of 450 million barrels of light oil, which has a higher value. The first module of local production is already active; the second one should start operating by the end of the year. The Jubarte, Cachalote, Baleia Franca, Baleia Azul, Baleia Anã, Caxaréu, Mangangá and Pirambu fields make up the Parque das Baleias, a complex of fields in the south, which adds up a reserve of 1.5 million barrels. Nowadays, the Espírito Santo State is responsible for 40% of the new discoveries of oil and natural gas of Brazil, according to the survey conducted by the Agência Nacional de Petróleo, Gás Natural e Biocombustível (National Agency of Oil, Natural Gas and Biofuel – ANP) since its foundation in January 1998.

The oil industry in the Espírito Santo State makes possible the payment of royalties related to oil and natural gas exploration to the counties in which the producing fields and oil companies are located.

CONCEPTS AND DEFINITIONS

Chapter 2

Chapter 2

CONCEPTS AND DEFINITIONS

According to the specifications of the ABNT – Associação Brasileira de Normas Técnicas (Brazilian Association of Technical Standards), dimension stones are natural materials, extracted from quarries in the form of blocks and/or slabs, cut in different forms and processed through squaring, polishing, bush hammering or flaming (Frascá, 2001). They are normally used in architecture, especially in home decoration, as isolated pieces, tables, countertops, sinks and funerary art. Another application, which seems very promising, is in the civil construction industry as part of interior and exterior coating, lateral facades, floors, edges, columns and pillars.

According to the origin, rocks can be classified as igneous, sedimentary and metamorphic. Igneous or magmatic rocks come from the crystallization of the magma at different depths of the crust, when these rocks consolidate on the surface they are called volcanic or extrusive. The so called sedimentary rocks are formed by the chemical precipitation or by the dendritic deposition of products from weathering, erosion and transport of existing rocks accumulated in basins. Metamorphic rocks are lithologies transformed by the action of deformation agents, regional and contact metamorphism, on existing rocks (igneous and sedimentary), located at different levels of the crust.

In commercial terms, dimension stones are classified in granites and marbles. Granites are usually defined as silicate rocks, such as: granite, granodiorite, syenite, gneiss, metaconglomerates, migmatites, monzonites, schists, etc. On the other hand, marbles include sensu lato carbonate rocks, both sedimentary and metamorphic. There are also other lithologies included in the dimension stones sector, such as: quartzite, metasandstone, serpentinite and slates, very important subsector.

From a commercial point of view, dimension stones can be grouped in homogeneous and heterogeneous. The homogeneous or isotropic lithologies are materials that do not show any preferential orientation of its mineral content and are commonly used as coating material in buildings. The heterogeneous are anisotropic rocks, with foliation and, in the majority, show a multicolor appearance with curious designs caused by tectonic deformation that generated the foliation, thus being mostly used as pieces in isolated rooms or as ornamental details.

The color or chromatic pattern is the main characteristic for the commercial quantification of a rock, followed by its textural appearance and design of structures. According to these features, stone materials are classified as common, classic and exceptional. Common materials are those with broad application as coating material in buildings. In this type fall the gray to gray-whitish, beige and pinkish. The classic type includes rocks that are not influenced by fad and include white, red, yellow and black marbles, and white, brown, black, green, and red granites. Regarding the exceptional material, they are used in isolated pieces, and as coating of small areas, and it gathers blue, purple and green marbles, blue, and multicolor yellow granites, multicolor metaconglomerates and pegmatites multicolor as well. On figure 2.1, the variety of color of some type of rocks extracted in the Espírito Santo State is shown.

In production terms, the blocks extracted from quarries have a volume that varies from 5 to 8 $m^{3,}$ existing rarely blocks with 12 m^3. It is noted, however, that materials considered exceptional, with very high commercial value like the blue granites, allow using blocks with even of 1 m^3 of volume.

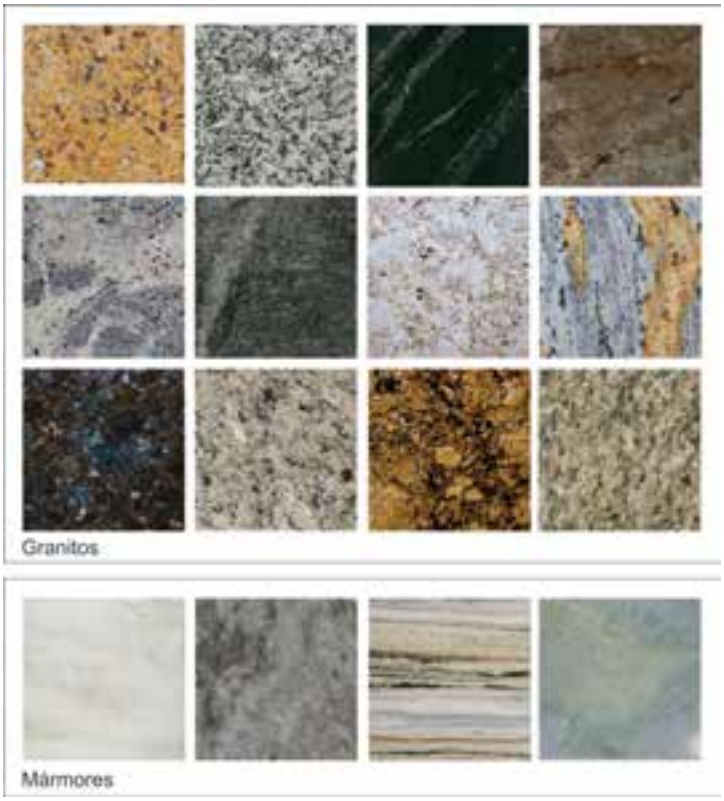


Figure 2.1 – Chromatic variety of some type of granites and marbles of the Espírito Santo State.

There is another classification of dimension stones used in the commercial area and it divides materials in special finishing and natural surface. Based on this, materials extracted from blocks, cut in slabs and processed through polishing, bush hammering or flaming are considered materials with special finishing, while products commercialized with natural surfaces, obtained from the cutting and squaring of slabs are considered products with simple finishing.

There are also dimension stones considered natural composed by foliated or slabbed materials, such as quartzite, gneiss, slate, phyllite and limestone (Pedra Cariri), which are extracted in the form of slabs with about 5 to 10 cm in thickness and dimensions that vary depending on the geological conditions of the deposit and on the market demands. After extracting this material, it is cut following standardized procedures with a diamond disc tool, being used usually on floors.

2.1 TECHNOLOGICAL CHARACTERIZATION OF DIMENSION STONES

Currently, dimension stones are one of the main materials used interiorly and exteriorly as vertical coating (walls and facades) and horizontal coating (floors) on buildings. Dimension stones are responsible for the protection of the structures and bases against weathering and degenerative agents, either domestic or industrial, besides providing unique aesthetic functions.

The flexibility of the use and application associated to the growth of the domestic and international market seen over the last few decades, combined mostly with the lack of knowledge of the physical-mechanical properties of rocks by suppliers, have leaded in some situations, to the misuse or inadequate application of such materials, leading to a significant shortening of the lifespan of the material or even render it useless to the point of inevitably having to replace the product immediately.

Technological tests on rocks used for coating in buildings currently involve different laboratory procedures in order to obtain chemical, physical, mechanical and petrographic parameters that guide the choice and appropriate application and use of these materials.

It is important to note that most of the problems identified in construction sites associated to dimension stones, could be avoided only evaluating the technological parameters of the rocks, and the specifications regarding mortars, adequate fixation, grouting and sealing techniques.

Therefore, such tests aim to determine more precisely the fields of application of these materials, according to standards required by large buyers and thus should be considered throughout the way, from the extraction, processing up to, and especially, the commercialization (buying/selling) and the whole period of use of the product. These procedures increase greatly the lifespan of the stone, eliminating or reducing significantly problems like smudges, cracks, rust, chemical alteration, polishing, etc.

The main sets of rules, not always equivalent in their specifications, are defined by the following associations: Brazilian Association of Technical Standards (ABNT), American Society for Testing and Materials (ASTM), German Institute for Standardization (Deutsch Institute für Normung – DIN), French Association of Standardization (Association Française de Normalizatio – AFNOR), Spanish Association of Standarization (Asociación Española de Normalización – AENOR), British Standard (BS), Italian Organization for Standardization (Ente Nazionale Italiano di Unificazione – UNI), European Norm (EN), etc. (Frascá, 2001).

Nowadays, there are many technological tests, however, some are taken as the most important and help define a standard of quality of the material, which are: petrographic analysis, physical properties (density, apparent porosity and water absorption), Amsler wear test, uniaxial compression breaking load at the natural, modulus of rupture on three and four points, and coefficient of linear thermal expansion. Other tests complement the analysis and are useful as well, such as compression breaking load after freezing/thawing and impact resistance.

The main technological tests presented in this work for each type of rock are described as follows:

2.1.1 MICROSCOPIC PETROGRAPHY

Microscopic analysis of the rock provides information about the mineral composition, petrographic classification and its origin. The results given by this test can help identify minerals, micro structural features or other lithological aspects that can influence the mechanical and chemical resistance, and consequently, affect the durability and appearance of the rock. The analysis procedures are conducted with a petrographic optical microscopy, with transmitted light, in which thin sections of rock samples are used.

2.1.2 PHYSICAL PROPERTIES

Physical properties evaluate the characteristics related to density (kg/m3), apparent porosity (%) and water absorption (%). The results indirectly allow the evaluation of cohesion and alteration of rocks. For instance, the porosity shows a direct relationship with the physical-mechanical resistance

of the rock, i.e., the greater the porosity, the lower the physical-mechanical resistance of the rock. On the other hand, water absorption indicates the capability of the rock to infiltrate liquids. The physical-mechanical resistance of the rock can be predicted using density values. The physical-mechanical resistance test allows calculating, with more precision, the individual weight of the slabs specified in the building project.

2.1.3 AMSLER WEAR TEST

The Amsler wear test shows a reduction in thickness (mm) that a sample (cut in slab) shows after going through an abrasive route, e.g. 1,000 m. The abrasive agent is usually quartz sand and it tries to simulate, in laboratory, the abrasion caused by traffic, either people or vehicles, and it is closely related to loss of luster of the polished surfaces. Thus, this test is extremely important for the selection of materials to be used on floors.

2.1.4 UNIAXIAL COMPRESSION BREAKING LOAD TEST

This test measures the compressive stress required to cause a rupture on the rock, when subjected to this kind of strength. The main objective is to evaluate the resistance of the rock when it is used as structural element and therefore infer the physical integrity and strength of the rock. This test is indispensable for all possible applications of a coating stone (vertical surfaces, floors, steps, tops, etc.).

2.1.5 UNIAXIAL COMPRESSION BREAKING LOAD AFTER FREEZING/THAWING

It involves exposing the sample to 25 cycles of freezing and thawing, and analyzing possible falls on the resistance. This is done executing tests of uniaxial compressive strength to natural rock and after the freezing-thawing cycles. This test is recommended for dimensions stones planned to be exported to countries with temperate climate, in which prior knowledge about the susceptibility of the rock to this process is significant. It is important to note that the result of this test has an inverse connection with the porosity index of the rock, because the higher this index the lower the value of the mechanical resistance of the rock will be after the freezing-thawing cycle.

2.1.6 MODULUS OF RUPTURE

The modulus of rupture, or yet, the flexural strength, or even the resistance to bending strength test, determines the strength (MPa) that causes the rupture of the rock when subjected to bending strengths. This test makes it possible to assess its suitability for coating, or as structural element, and it also provides a parameter that indicates the resistance to tension. Like the compressive index, the resistance to bending strength also gives suggestions about the sanity and strength of the rock. The values indicate the maximum bending strength that the rock supports, and it influences on the calculation of thickness and sizes of external slabs. On the technological tests collected at companies, it could be found that this type of test (bending strength resistance on three points) is effectively the most used in the state, even though there is another test, the modulus of rupture on four points, which is particularly important for the dimensioning of the slabs to be used on facade coating with the use of metal anchorage systems to install the slabs.

2.1.7 COEFFICIENT OF LINEAR THERMAL EXPANSION

This parameter is obtained when the samples are exposed to variation of temperatures ranging from 0ºC to 50ºC. The test aims to simulate situations of extreme thermal amplitudes in which a specific material could be exposed, especially when used on external coating. It is remarkably important for space calculation of the joints between slabs on coatings. Therefore, the coefficient of thermal expansion will help to define the minimum space between slabs to avoid contact, lateral compression and consequently cracking of slabs. Evidently, those materials with a greater coefficient of thermal expansion will demand greater spacing between slabs, specification of flexible mortars and adequate fixation.

2.1.8 IMPACT RESISTANCE

The impact resistance technological test is done through the determination of the height from which a solid body is dropped and causes fracture on the sample material exposed as a slab. It indicates the tenacity of the rock. It is suggested for interior coating, floors, steps, table tops and countertops. It is important to note that the lower the value on this test the less resistant to impact the material will be.

TYPOLOGY OF DIMENSION STONES

Chapter 3

Chapter 3

TYPOLOGY OF DIMENSION STONES

The deposits of dimensions are controlled by geological, tectonic and, sometimes, by physiographic factors that are present in the region. Therefore, for the perfect knowledge and study of a deposit, several aspects should be taken into account such as the lithostratigraphic and tectono-structural context of the area to be exploited, as well as its geological setting. These factors influence directly the formation and form of occurrence of the rocks, typology of the rock, chromatic appearance, rock structure, shape and dimensions of the massive rock, as well as the mining method to be adopted (Mendes, 2002).

For the dimension stones sector, the name "granite" covers, in a generic form, lithologies that are rich in silicates, including the granite itself, as well as the granodiorite, gabbro, syenite, monzonite, diorite, charnockite, gneiss, migmatites, schists, metaconglomerate, quartzite, -calc-silicate and mylonite.

In a petrographic sense, when crystalline igneous rocks, whether plutonic or volcanic, have more than 65% of silica (SiO2) they are considered acid (leucocratic) and show light colors. Granites and granodiorites fall into this category. When the level of SiO2 lies between 50 and 60%, rocks are classified as intermediate (mesocratic) and show grayish color, such as syenites. Rocks with a silica content between 40 and 50% are considered basic or mafic (melanocratic), and, commonly, show dark colors. Black granites fall in this category, such as gabbros and diorites. Finally, when the silica level is below 40%, rocks are considered ultramafic, such as eclogites, peridotites and serpentinites, which can generate deposits of dimension stones with dark colors, especially black and dark green.

Regarding the crystalline metamorphic rocks, such as metaconglomerate, quartzite, gneiss and migmatite, the form of occurrence can vary from pockets and lenses to large units of regional scale, caused by the action of metamorphic processes acting on a specific region.

For large outcropping geological units, like gneissic-migmatic terrains, the setting for the formation of deposits is influenced essentially by the mineralogy that determines the color of the lithotype and by the action of the tectonic events that gives the structural pattern of the rock. This characteristic controls the formation of deposits of heterogeneous materials (explained previously), likely to be found on Paleoproterozoic and Neoproterozoic terrains in the Espírito Santo State.

When these materials are subjected to the action of strong chemical weathering, the alteration of the biotite and sometimes garnet, and the discoloration of the feldspar, grants a yellowish color, which results in the formation of deposits of the called yellow granites. Regarding the homogeneous yellow granite without foliation, it is originated by the action of chemical weathering on Neoproterozoic biotite granites non-deformed, related to the Brasiliano cycle.

The carbonate rocks include limestone, travertine, and dolomite; being marble its metamorphic equivalent. The vast majority of the calcareous rocks have a biological or biodetrital origin, being formed in marine environments by the deposition of shells and skeletons of other organisms. When the depositional processes of direct precipitation of carbonates take place in continental environments, the formation of non-fossiliferous rocks, such as travertines and marlstones, occurs. Limestones are mainly composed by calcite and dolomite and include impurities like clay minerals, quartz, mica, amphibole, organic matter and sulfide. Due to impurities, they show a wide range of colors and as a result of the local geological settings, they show different textures and designs.

Regarding crystalline limestone recognized in the Espírito Santo State, the deposits are associated mostly to the lenticular type; however, there are cases of deposits related to the stratiform type, for instance, the Branco Esmeralda and Azul Acqua Marina marbles, located in Cachoeiro do Itapemirim county in ES.

3.1 TYPES OF DEPOSITS AND MODE OF OCCURRENCE

The extraction of dimension stones blocks in the Espírito Santo State is done in open pit quarries, associated to massive rocks (stocks, batholiths, etc.) or to large areas with boulders (photo 3.1). Commonly, the extraction begins on boulders arranged on the ground, which later becomes the pit floor, then develops and the extraction is done from the massive rock through benches, where the quarry itself is formed, whose height, bench arrangement and depth vary according to the geological setting of each deposit.

Boulders are the result of the action of chemical and physical weathering processes that occur on fractured massive rock where the pit floor is formed with little material removal. Regarding massive rock deposits, the main element of the deposit is the local lithological settings associated to geomorphological factors responsible for the formation of the relief of the area, together with physical-chemical characteristic of the rock and geotectonic parameters influencing the origin (photo 3.2).

Photo 3.1 – Extraction from boulders.

It is important to highlight that massive rock may appear deprived of overburden showing large outcrops. Sometimes, depending on the chemical, physical and mechanic characteristics, the massive rock show small outcropping dimensions, with the rest covered by eluvial soil overburden, occasionally dark clay soil when it is caused by the chemical weathering on rocks with a mafic and ultramafic nature.

Referring to mafic materials, commercially named black granites, depending on the nominal value of the lithotype, the massive rock of this type can be extracted without the need of topographic elevations, with mining methods applied below the topographic datum of the area. In this situation, the exploration activities can be developed only after the removal of the overburden, initiating mining operations below the soil level that formerly covered the area.

Photo 3.2 – Extraction from massive rock, using benches. At the front, it can be seen foliation and small amount of fractures on the rock.

GEOLOGICAL SETTING

Chapter 4

Chapter 4

GEOLOGICAL SETTING

Over the last thirty years, the southeast region of Brazil, counting the state of Espírito Santo (figure 4.1), hosted a series of regular geological mappings conducted by many survey institutions, particularly by the Geological Survey of Brazil – CPRM, that has been promoting the updating of the Geological Map of the state of Espírito Santo in the scale 1:400,000 (Vieira et. al., 2013, on press).

Figure 4.1 – Location map of the state of Espírito Santo.

In a tectono-structural view, the state of Espírito Santo is inside the Orogenic System of Mantiqueira (Almeida, 1977), Araçuaí Orogeny (Pedrosa – Soares et. al., 2001) which is a Neoproterozoic geotectonic unit with a NNE-SSW orientation, bordering the east side of the São Francisco Craton (figure 4.2). This unit consists of a belt of metamorphic rocks, folded and partly migmatized, including granitoid suites with several ages and compositional nature, confirming different magmatic events throughout its orogenetic evolution.

The crystalline basement of Espírito Santo encloses a geological history that is present from the Paleoproterozoic to Recent, having Neoproterozoic events associated to the Brasiliana Orogenesis and later altered during the Phanerozoic, when the Cenozoic sedimentary covers were formed. In relation to tectonics, the hinterland of the state is subdivided as follows: fragments of lower crust, rocks from the Araçuaí Orogeny and intrusive suites related to the Rio Doce arc, coated partly by the Phanerozoic covers

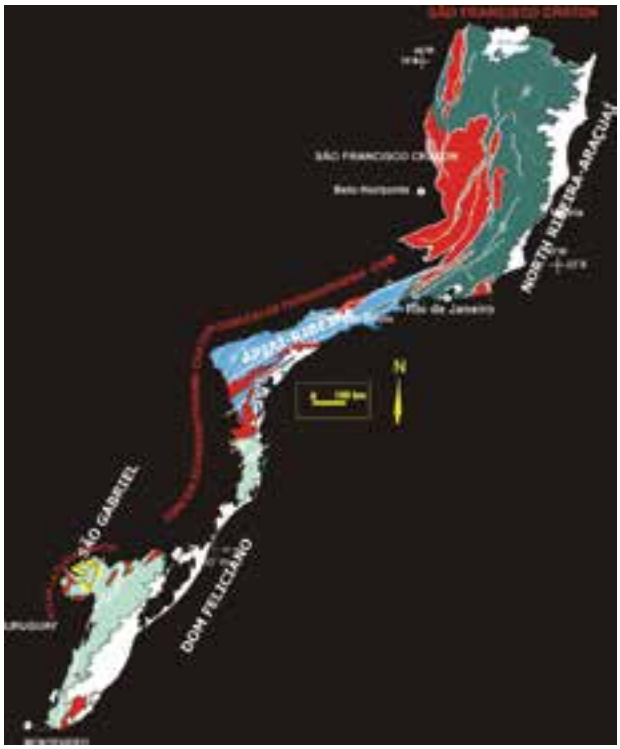


Figure 4.2 – Orogenic System of Mantiqueira 500 million years ago (extracted from Silva et. al., 2005).

arranged in the eastern part of the State.

Associated to Neoproterozoic events there are paragneiss (photo 4.1) and heterogeneous gneiss with golden yellow color considered the oldest rocks, which constitute the Nova Venécia Complex (figure 4.3), consisting of banded sillimanite-garnet-cordierite gneisses with well-developed foliation, having intercalations of calc-sillicates, quartzites and amphibolites. They are formed by dark levels containing biotite, cordierite and garnet with intercalations of layers rich in felsic minerals with a quartz-feldspathic composition. On the migmatized zones there is the transposition of stromatic structures to more homogeneous diatexitic cores.

Photo 4.1 – Appearance of the "Blue Brasil Granite" quarry, extracted from paragneisses rich in cordierite of the Nova Venécia Complex (Rio Bananal county. Source: Baltazar et. al., 2010).

In the state of Espírito Santo, the genesis of granites associated to the Araçuaí Orogeny is represented by the following orogenic phases: pre-orogenic, pre- to sin- orogenic, sin- to late- orogenic, late- orogenic and post- orogenic. Regarding the granitic rocks related to the pre- to sin- orogenic phase of the Brasiliano cycle, the instrusive units present on the basement are represented by rocks of the Carlos Chagas, Ataléia, and Montanha Suites, formed by granites that result from partial fusion. The first three suites are related to a type S magmatism, sincollisional in a compressional regimen, while the Aimorés Suite is associated to a type I plutonism, post-orogenic, connected to a extensional tectonic.

The Carlos Chagas Suite (photo 4.2, 4.3, 4.4 and 4.5) is formed by leucogranitoids with incipient foliation, peraluminous to calc-alkaline with high K, including types of porphyritic to equigranilar texture, and bodies from the Montanha Suite, taken as being granite bodies rich in mafic minerals, specifically biotite, and biotite-garnet granites without deformation. This suite consists of rocks of mainly granitic to syenogranitic, and more rarely monzogranitic composition, frequently with the presence of enclaves enriched with biotite which vary from few centimeters to decimeters in size. It comprises rocks with white to gray color – whitish, medium to coarse grained, presenting mylonitic foliation in several outcrops, highlighted by the alignment of biotite, which appears forming thin discontinuous levels. The mineralogical composition comprises quartz, alkali feldspar and plagioclase, containing biotite and garnet as main accessory minerals.

According to its composition, the Carlos Chagas Suite consists, regionally of a very extensive and relatively homogeneous unit (figure 4.4). In undisturbed areas, a prominent magmatic foliation is underscored by the alignments of large subhedral crystals of feldspar. On outcrop it can be seen the presence of restites of large proportions of fine biotite gneiss, whose parts with

Photo 4.2 – Features of the mylonitic foliation on the garnet-biotite granite of the Carlos Chagas Suite.

Photo 4.3 – Alignment of the feldspar phenocrystals by magmatic flow on the garnet-biotite granite of the Carlos Chagas Suite.

Photo 4.4 – Enclaves of garnet-biotite gneiss wrapped by leucogranites of the Carlos Chagas Suite.

Photo 4.5 – View of a different angle of the same outcrop of photo 4.4 showing more homogeneous regions between the two rocks that make the main target of the mine, Barra de São Francisco.

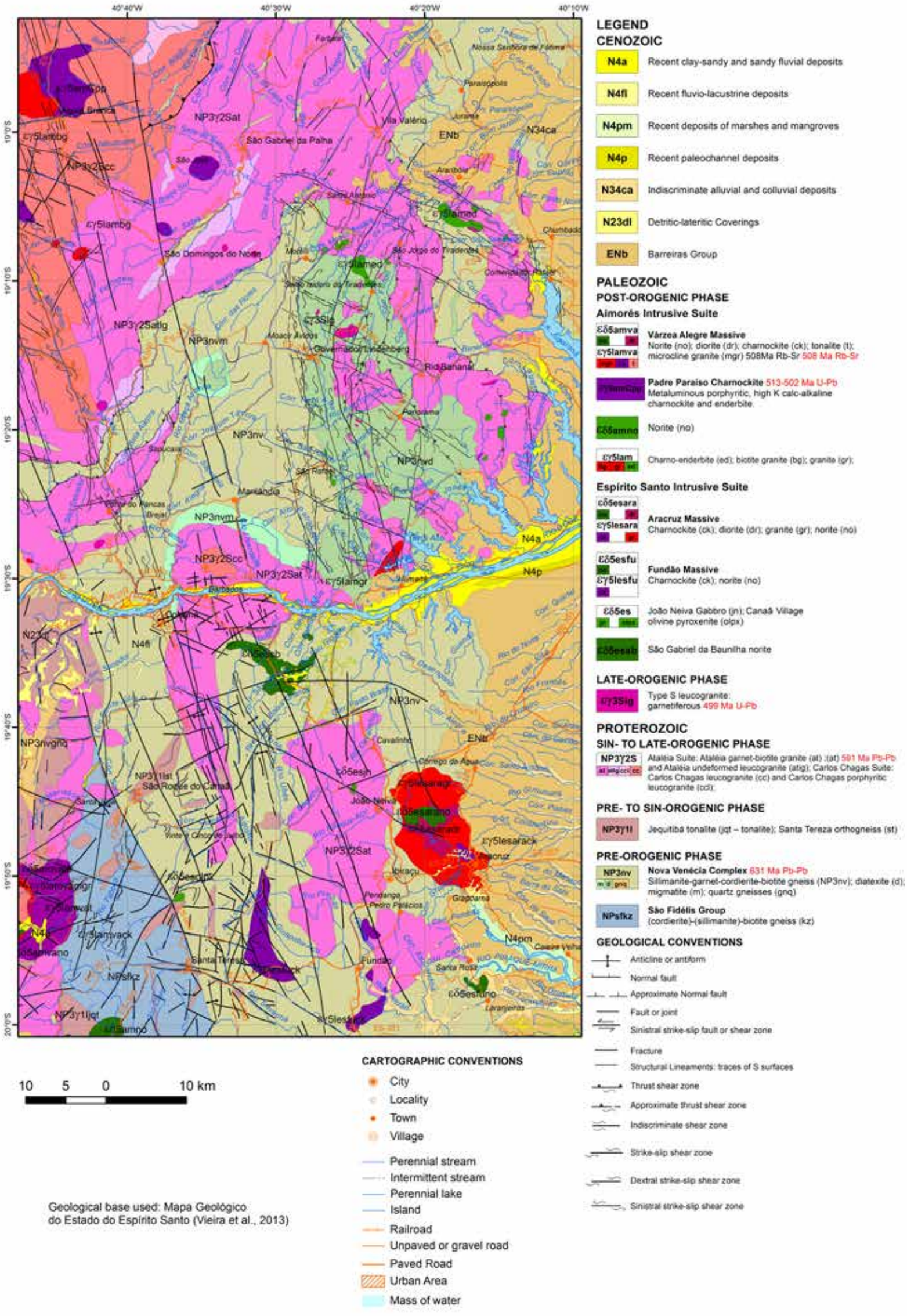


Figure 4.3 – Geological map of the central region of the state of Espírito Santo, scale 1:400 000 (Vieira et al., 2013).

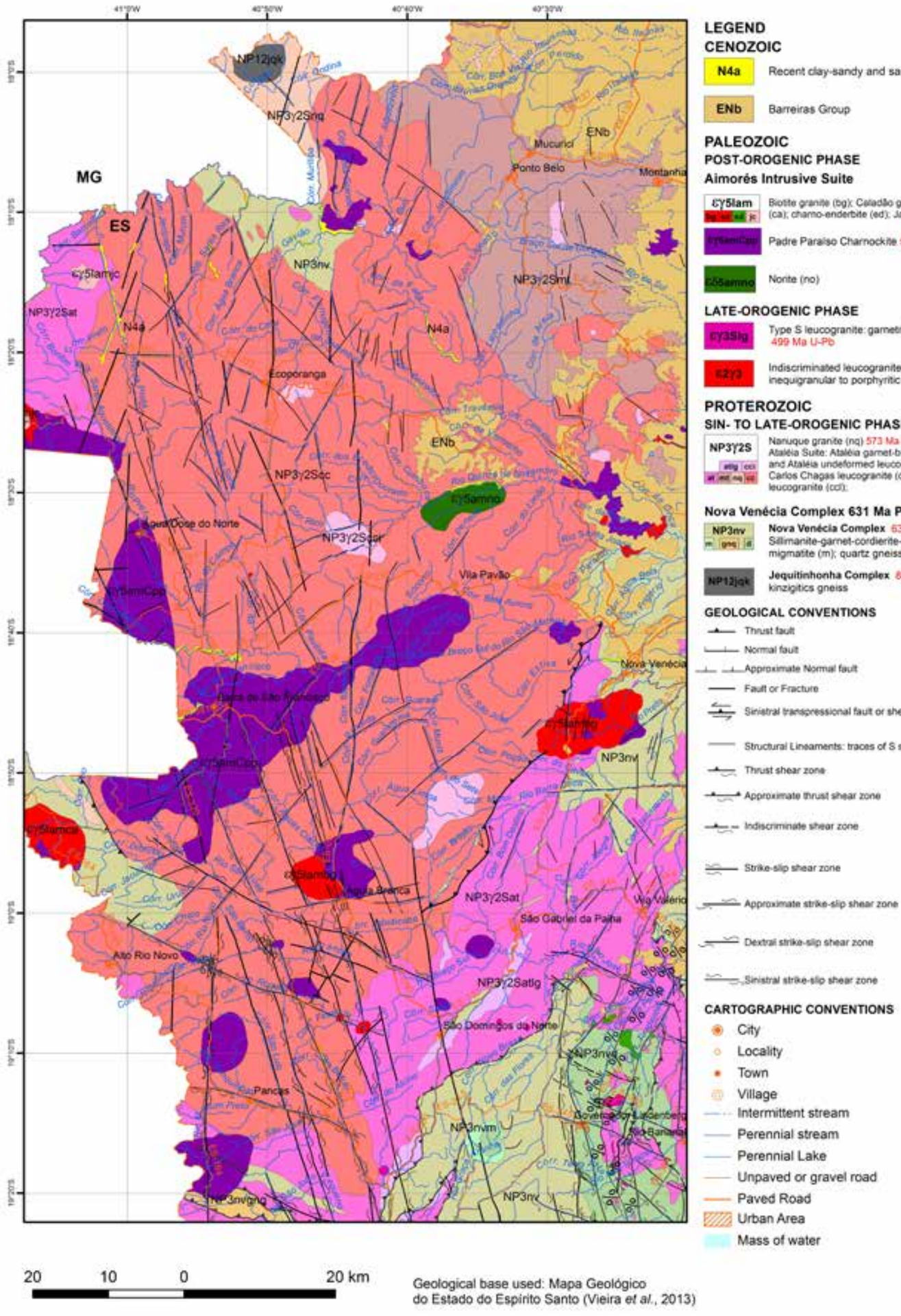


Figure 4.4 – Geological map of the northwest region of the state of Espírito Santo, scale 1:400 000 (Vieira et al., 2013).

a more homogeneous mixing with the intrusive leucogranites, are exploited as moved or exotic granites.

The plutonites of the Ataléia Suite comprise mesocratic rocks, formed by tonalites and granodiorites. In a lithochemical view, they present a peraluminous character, being interpreted as anatectic products originated from partial fusions at deep crustal levels. In common, they show gray to light gray colors, with fine to coarse granulation, and porphyritic subordinate types. They present mylonitic foliation on the deformed areas and homogeneous and massive aspect on the rest outcropped areas of the unit.

The rocks of the Aimorés Intrusive Suite are essentially represented by greenish charnockites of the Charnockito Padre Paraíso unit, gabbros, enderbites and black to dark gray norites from the Aracruz, Ibituba and Itapina massives, which show affinity with calc-alkaline porphyritic granites showing gray to pink colors. Among the largest exposures of rocks of the Aimorés Suite, the large intrusions of Barra de São Francisco and Alto Mutum stand out. In Barra de São Francisco the plutonic bodies of charnockites occur associated to porphyritic syenogranites and monzogranites, which maintain gradational contacts. Associated to these intrusions, the green charnockite is exploited, whose differential in relation to the plutonites of the region of Alto Mutum is the presence of garnet.

In general, they occur as intrusive bodies of variable sizes, but with an approximate circular shape and, more rarely, elongated. The rocks with a charnockitic composition present olive green to gray-greenish color, with an inequigranular to porphyritic texture and coarse granulation. These charnockitic massives stand out due to the frequency, homogeneity and dimensions, characterized by the exposure of rocks on large extensions on hillside walls and at the top the elevations.

Some lithotypes of this unit have magmatic textures partially recrystallized making granoblastic mosaics that create an excellent visual aspect. These structural features are, to some extent, the result of the intrusion mechanisms and may also result from a late transtensive tectonic of ancient structural discontinuities, which were probably responsible for the emplacement of the plutonites of this unit. It mainly consists of perthitic microcline, plagioclase and quartz, having biotite, hornblende and garnet as accessory minerals. In some places, there are transitional contacts with the porphyritic granites with a light gray to beige color, also inserted in this suite. The charnockites are intergranular, coarse to very coarse grained, usually with porphyritic texture. On photo 4.6 there is a quarry of charnockite of this geological unit.

Also associated to this suite, there are intrusions of porphyritic granites, with no foliation, medium to coarse grained, light gray, beige to slightly pink

Photo 4.6 – Green Charnockite extraction from massive outcrop of large proportion in San Francisco County- ES

color. Transition zones by irregular and relatively abrupt contacts between this granitoids and the charnockites were observed on a mine visited in Barra de São Francisco (photos 4.7 and 4.8).

Also within the Aimorés Suite, bodies of plutonite with a noritic to dioritic composition, more precisely gabbros to hypersthene, are exposed. Frequently, they form black rocks, with no foliation and equigranular texture and medium granulation (photos 4.9 and 4.10).

Related to late- to post-orogenic plutonism, there are leucogranitoids outcropping with garnets as intrusive stocks in gneisses of the Nova Venécia Complex and in granitoids of the Carlos Chagas and Ataléia Suites. They consist of large dimension massive outcrops, in which rocks vary almost from totally white to gray-whitish with equigranular to porphyritic texture and fine to medium or even coarse granulation where millimetric garnets crystals stand out.

These leucogranites have syenogranite to monzogranite composition, presenting mostly hypidiomorphic textures, locally granoblastic, being usually isotropic and homogeneous. It is important to note that the deformed zones may show mylonitic foliation, especially where associated to strike-slip shear zones.

The occurrences of marble in the south region of Espírito Santo are included in the dominium of the Italva Group – São Joaquim Unit, which corresponds to a metacarbonatic sequence, varying from 500 to 1000 meters thick, consisting of calcitic to dolomitic marble rich in graphite, with intercalations of amphibole, metaultramafic rocks, calc-sillicate and quartz metachert (Duarte, 2012).

Photo 4.9 – Extraction of blocks from boulders of norites of the Aimorés Suite in the São Rafael District, Linhares county.

Photo 4.7 – Detail of the porphyritic granite of the Aimorés Suite, commercialized with the name "Granito Giallo Latina" (Cotaxé District, Ecoporanga county).

Photo 4.10 – Extraction from massive rock block on norites of the Aimorés Suite in São Rafael District, Linhares county.

Photo 4.8 – Intrusion of porphyritic granite of the same unit in a mylonitized leucogranite of the Carlos Chagas Suite, locally in the form of a dike. On the contacts, there are concentrations of garnets.

These crystalline calcareous occur as big lenses along the Itaoca – Campo de São Fidelis and Campo Verde – Bom Jardim – São Cristovão zones, covering Castelo and Cachoeiro do Itapemirim counties. Marbles from this region have different commercial names according to the variation of colors, structural appearance of the lithotype and consequently mineral composition.

4.1 CHARACTERISTICS OF DEPOSITS

The production of deposits of dimension stones in Espírito Santo is done in open pit mines, and the vast majority is located on flanks of massive rocks, presenting different slopes and thus creating a great visual impact on the regional landscape. Such impact is greater on areas where leucogranites from the plutonites of the Carlos Chagas Suite is exploited, due to the large volume of production on the quarries located on this geological unit, with large fronts of extraction and consequently high amount of waste material generated, which currently represents a serious environmental problem.

This waste material is created during the stage of opening of the quarry, when benches are developed, due to the disposal of blocks considered outside the market specifications. The uniformity of the aesthetic appeal is changed by variations on the color of the rock due to changes on the mineral composition of the rock and on the texture, besides the existence of veins, enclaves and small igneous intrusions as dikes that may reduce the quality of the material.

The waste generated also comprises blocks with flaws, such as fractures and cracks, either of tectonic origin or as a result of the critical phases of mining operations, such as handling explosives, block tipping and handling, and mainly caused by the relief of internal stress of the rock. This is due to lack of major investments in geological research, where the immediate necessity leads to the opening of quarries on an empirical basis, without taking into account the study and the directions of the stress field acting on the massive of rock to be exploited.

It is important to highlight that in several quarries, after the selection of the blocks considered first quality, those considered lower quality are commercialized in local marble shops with lower prices, to produce bricks, tiles, thresholds, thick slabs and in some cases to cut slabs.

It should be noted that on the massive rocks of the Carlos Chagas Suite, due to the action of chemical weathering, there are altered portions, resulting in commercial granites of the yellow group, which are frequently exposed as altered mantle that commonly show some symmetry to the surface. The thickness of this weathering mantle is variable and it may reach up to 20 meters, which makes it feasible for its commercial exploitation. It turns out that the lack of homogeneity on the altered portion, many times compromises the aesthetic appeal of the rock and thus its use as a decorative material, increasing the quantity of disposal material as a consequence.

The formation of these granites of the yellow group is caused mainly from the network of microfractures that affect rocks in the region and are the main migration channel and control of the weathering solutions rich in Fe^{+2}. Probably the process is caused by the capillarity, with the subsequent precipitation of Fe^{+3} as a result of the oxygenation of the environment and the evaporation of interstitial water rich in iron. It is important to highlight that the foliation plane plays an important role on the control of these meteoric waters (photo 4.11 and 4.12).

It should be emphasized that this incipient weathering, besides expanding the market value of the rock, provokes a reduction on the mechanical resistance, without compromising its use as coating material; however, it makes it easier to cut, thus reducing operation time. Such fact minimizes the costs of sawing and polishing, especially in relation to the use of energy, steel shot and abrasives.

The extraction of dimension stones on the charnockites, norites, gabbros and intrusive biotite granites of the Aimorés Suite present the following singularities:

A- In these deposits, it is common the existence of spheroidal foliation, which causes large residual blocks, measuring up to 8 meters on the longest axis, but contiguous and separated by narrow alteration bands. Such situation leads to the generation of reasonable amount of waste at the time of the extraction of material.

Photo 4.11 – Lower boundary of the weathering mantle following the slope of the massive rock.

Photo 4.12 – Detail of the abrupt passage from the preserved to altered parts of the rock (Ecoporanga county).

B- It can be seen that due to the gradual depletion and subsequent deepening of the quarry for the withdrawal of stone material, there is a tendency to evolve into massive suboutcropping rock in the lower portions of exposure.

C- It is noted that the dimension of the blocks extracted from these deposits, due to the natural limitation of the deposit, frequently show sizes below those specified by the market to be considered commercially good (1.80 x 1.60 x 3.0 m). This fact makes these blocks to be developed in pairs in conventional looms in order to obtain slabs.

Regarding other lithological sequences outcropping in the state, the work of block exploitation follows the normal procedure, taking into account the geological singularities of each deposit and the dimensions according to the market specifications.

POTENTIALITIES

Chapter 5

Chapter 5

POTENTIALITIES

5.1 GRANITES

The state of Espírito Santo has an exceptional geological variety of the crystalline basement. This indicates a large competitive advantage in relation to dimension stones deposits, comprising common materials and those with high value in the demanding international market of stone materials (figure 5.1). The generation of these rocks is the direct result of several tectono-thermal events acting on the geological formation and evolution of its crystalline shield. Therefore the dimension stones currently exploited in the state were originated in geological events that took place during the Neoproterozoic, especially the intrusive plutonites in metamorphic rocks folded and partly migmitized, characterized by granitic suites of different ages and nature confirming diverse tectonic events.

This setting is represented by a bedrock composed by gneisses, migmatites and granitoids with different compositions, creating lands with great topographical differences and with a large quantity of massive rock exposed. This provides a huge geological potential for the exploration and prospection of dimension stones with a variety of colors and aesthetic appeal.

Regarding the variety of yellow ornamental granites, commercially attractive, and its unaltered equivalents of the white group, the Carlos Chagas Suite stands out as the most important geological unit, both in terms of volume production and potentiality. The sin- to late-orogenic granites that make up this unit form an extensive batholite located on the northwest of the state, spreading from Colatina county to the south, up to Ecoporanga on the north side (figure 5.1). This unit consists of leucocratic rocks with light gray to white color, mainly with a syenogranitic composition, more rarely monzogranitic, with medium to coarse granulation and commonly with porphyritic/porphyroclastic texture, showing mylonitic foliations in almost all the occurrences.

This is a very large unit with a remarkable compositional homogeneity. The diversification of aesthetic appeal and chromatic range is obtained by cutting blocks in different angles according to the foliation or other anisotropies, and by the slightly weathered parts of the granitoids as well (Gallart, 2012). In the group of homogeneous yellow granites without foliation, the color is the consequence of chemical weathering on the granitoids of this suite, which are not deformed and related to the sin- to late-orogenic phase.

Most of the dimension stones of the yellow and white group produced in the state of Espírito Santo originates in this geological unit. These samples are related to the exploitation of the deformed garnet-biotite leucogranites and biotite-garnet leucogranites of the northeast region of the state, embracing the producing counties of Barra de São Francisco, Ecoporanga and Vila Pavão. The yellow granites include several materials, such as Amarelo Ornamental, Santa Cecília, Ouro Brasil, Giallo Vitória, Giallo Napoleone, Giallo Latina; while the white granites include São Francisco Real, Branco Dallas, Icaraí Light, Branco Marfim, and Samoa.

The production of white granites is also well developed in leucogranitoids from the sin- to late-orogenic phase, related also to a type S magmatism, that formed intrusive stocks on the granitoids of the Carlos Chagas and Ataléia Suites and on the paragneisses of the Nova Venécia Complex. On this geological unit, there are outcrops that show significant massive rocks, liable to commercial exploitation of dimension stones. Those stocks are arranged on the terrain as large scale massive rocks, which are totally white, commonly homogeneous and massive, and they stand out for the millimetric spots of garnet. It shows a texture that varies from equigranular to porphyritic, fine to medium or even coarse grained. The composition is syenogranitic varying to monzogranitic or quartz-monzonitic, and, in the deformed zones, there is a mylonitic foliation.

As potentially important for the prospection of leucogranitoids of the late-orogenic phase, the area between Governador Lindemberg and São Rafael points out, in Linhares county, where there are several indiscriminated granitic stocks, currently producing white granites known as Acqualux, Branco Siena, Branco Saara and Desirée. Normally, the dimensions of the occurrences are not very noticeable, but, commonly stand out locally on the landscape as a prominent rock mass.

Regarding the potential for granitoids, the production of ornamental varieties of the gray line, gray dimension stones, outcropping in the state occur in granitic rocks type I, typical of post-orogenic environments, and consist of massive intrusions roughly circular, located in the mountainous region of the southwest portion of the state. Rocks with gray color are associated to magmas whose composition is monzonitic, while rocks with beige or cream colors are related to granitoids, with granodioritic to tonalitic composition.

Currently, the main poles of extraction of gray granites of different shades (gray, beige up to

brown), are developed mostly on the massive rocks of Castelo, Venda Nova and Alegre, included in the Santa Angélica Intrusive Suite, which is part of the post-orogenic phase of the Araçuai Orogen.

From the exploited granites of these massive are produced, the varieties known commercially as Cinza Corumbá, Corumbazinho, Cinza Andorinha, Cinza Nobre, Cinza Castelo, Cinza Ocre and Cinza Prata. The first five types come from the Castelo Massive (figure 5.2), which consists of a granitoid with biotite granite to mozogranite composition, containing allanite and titanite. Usually, they comply gray to light gray bodies, consisting of quartz, plagioclase and microcline, with biotite showing porphyritic texture and biotite and titanite fine to medium grained and equigranular texture as accessory minerals. The porphyritic textures are related to the granite deposits known as Cinza Corumbá and Corumbazinho, while the Cinza Andorinha, Cinza Nobre and Cinza Castelo granites are related to fine to medium granulation. The Cinza Andorinha granite is extracted from several smaller massive rocks found in Cachoeiro do Itapemirim and Mimoso do Sul, where varieties of similar features granites are commercially known as Cinza Bressan, Cinza Santa Rosa, Cinza Montanha and Cinza Imperial.

The material known as Granito Cinza Ocre or Ocre Itabira, with gray brownish color, is extracted from the Venda Nova Massive, located on the west side of Venda Nova do Imigrante county, which is a large body, with few fractures with outstanding exploitation conditions. The granite composition is mainly quartz-monzonitic, with porphyritic texture, consisting of microcline, plagioclase, quartz and biotite. On the other hand, the material known as Granito Cinza Prata is extracted on the northeast part of the Santa Angélica Massive. On the bordering facies there is a light gray granite, medium grained, slightly foliated, having biotite as main mafic mineral and titanite as main accessory mineral.

It should also be noted the occurrence of homogeneous granite, with a light gray color, granulation average and monzogranitic composition, producing ornamental varieties known as Cinza Nobre and Prata Imperial. It is related to the differentiated part of the intrusive body with grabbroid composition of the Iconha Massive, in the homonymous county, producer of the dimension stones of the black group.

In general, all the materials varieties of ornamental grayish previously mentioned, related to the post-orogenic stage, present monzogranitic composition, dominant gray color, with biotite as main mafic. These features make the granite outcropping massive in the southern part of the state, comprising the municipalities of Atílio Vivácqua, Muqui and Mimoso do Sul, potential targets for prospecting of the gray line of granites.

Concerning dimension stones, the rocks of the Ataléia Suite are also potential sources for the production of materials of the gray and beige groups, but currently they are almost completely ignored by mining companies, supposedly due to its lower commercial demand if compared to other similar materials commonly produced in the state.

In relation to black granites, its large potential in the state of Espírito Santo is in the granitoids type I intrusions, without deformation related to the post-orogenic phase, with a gabbroid to gabbro-dioritic composition, located on the Ecoporanga and Linhares counties, associated mostly to the Aimorés Intrusive Suite. The outcrops are commonly represented by suboutcropping fractured massive rocks, usually associated to boulders. The gabbros are massive, dark gray to black, average coarse grained. Differentiated parts of the intrusion in the Cotaxé district, Ecoporanga county, originated a black diopside-biotite norite, granoblastic to subophitic relict texture, with biotite, diopside, orthopyroxene, quartz and opaques, commercially named Preto Cotaxé or Granito Preto São Benedito. The intrusion in Linhares, embedded in gneisses of the Nova Venécia Complex, forms a body aligned NNW, on the south of the São Rafael Village, where excellent exposures of gabbro and norites occur, resulting in deposits of the variety known as Granito Preto São Rafael. It is noted that the relief associated to the grabbros, norites and enderbites is usually more devasted and hilly, capped by clay soils frankly clayed with dark reddish color.

Other important intrusive bodies led to massive Santa Angelica, in the county of Alegre, and Iconha, in the county bearing the same name. In the Santa Angélica Massive, gabbros are massive, medium grained, dark gray to black, forming large masses associated to diorites, occupying the central part of the intrusion. They are commercially named Granito Preto Santa Angélica, being produced from massive rocks and boulders. In the Iconha Massive, gabbros are black to dark gray color, with medium to coarse granulation or even porphyroid, being mainly extracted from boulders and commercialized as Granito Preto Absoluto.

Also related to the Aimorés Suite, bodies of plutonite outcrop with noritic to dioritic composition, more specifically by hypersthene grabbros. Mostly, they are black rocks, with equigranular texture, medium grained and devoid of foliation. Inserted into these plutonites, there are deposits of Preto Águia Branca material. The diorite of Águia Branca, located in the homonymous county, is a peripheral deposit in which the mining is developing on residual boulders.

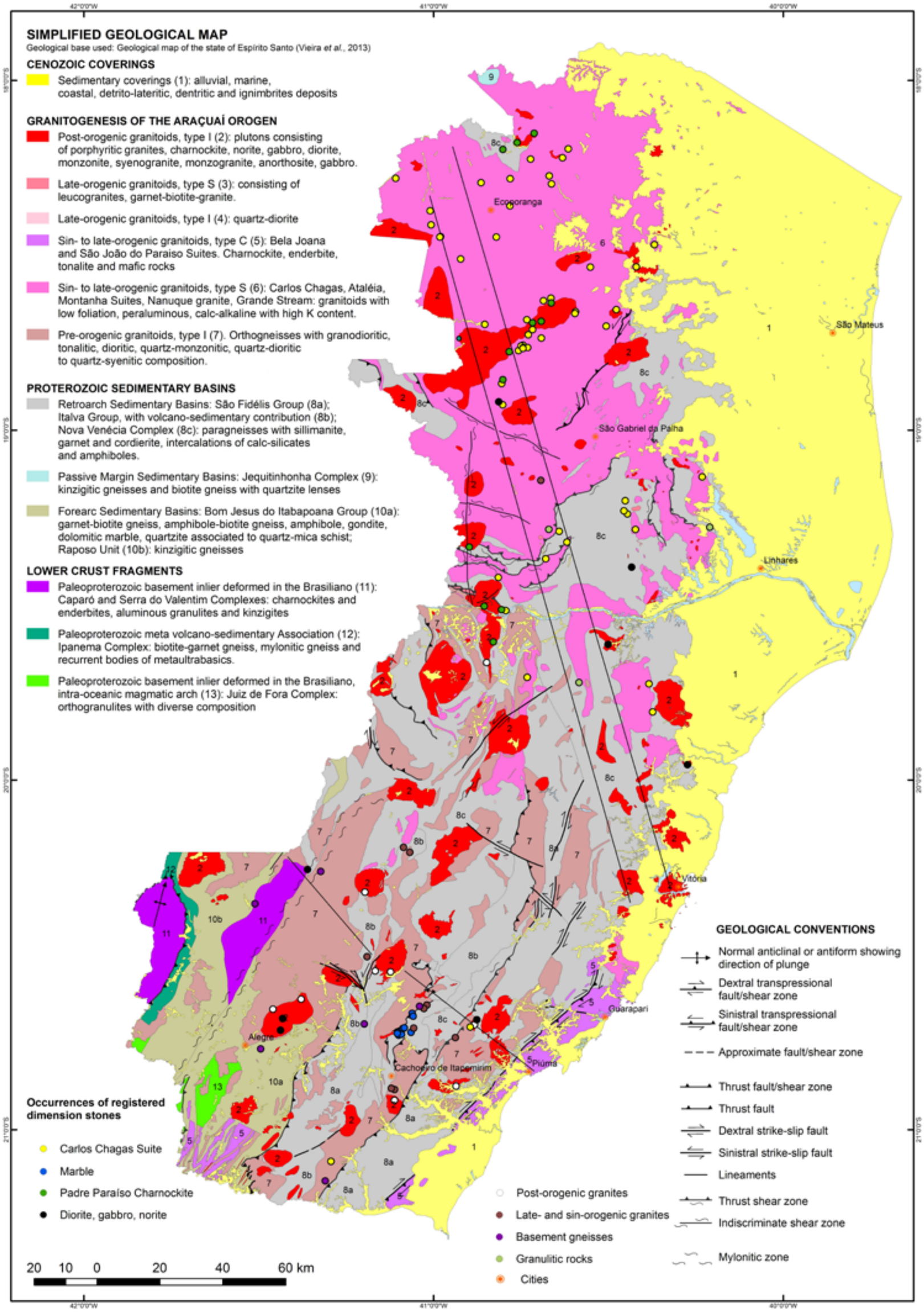
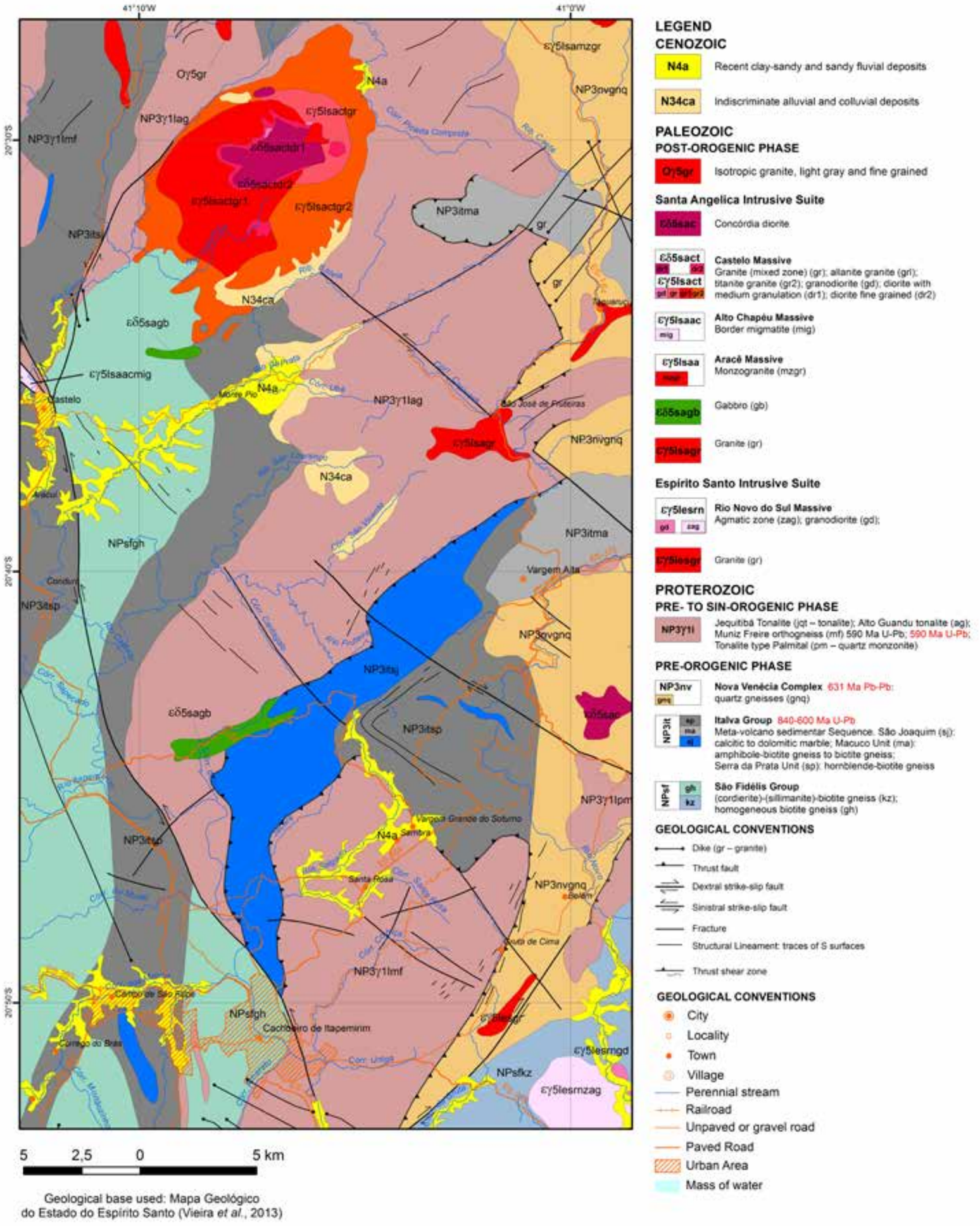


Figure 5.1 – Simplified geological map of the state of Espírito Santo and the registered occurrence of dimension stones.



Geological base used: Mapa Geológico do Estado do Espírito Santo (Vieira *et al.*, 2013)

LEGEND

CENOZOIC

- **N4a** – Recent clay-sandy and sandy fluvial deposits
- **N34ca** – Indiscriminate alluvial and colluvial deposits

PALEOZOIC

POST-OROGENIC PHASE

- **Oγ5gr** – Isotropic granite, light gray and fine grained

Santa Angelica Intrusive Suite

- **εδ5sac** – Concórdia diorite
- **εδ5sact / εγ5lsact** – **Castelo Massive** Granite (mixed zone) (gr); allanite granite (gr1); titanite granite (gr2); granodiorite (gd); diorite with medium granulation (dr1); diorite fine grained (dr2)
- **εγ5lsaac** – **Alto Chapéu Massive** Border migmatite (mig)
- **εγ5lsaa** – **Aracê Massive** Monzogranite (mzgr)
- **εδ5sagb** – Gabbro (gb)
- **εγ5lsagr** – Granite (gr)

Espírito Santo Intrusive Suite

- **εγ5lesrn** – **Rio Novo do Sul Massive** Agmatic zone (zag); granodiorite (gd);
- **εγ5lesgr** – Granite (gr)

PROTEROZOIC

PRE- TO SIN-OROGENIC PHASE

- **NP3γ1l** – Jequitibá Tonalite (jqt – tonalite); Alto Guandu tonalite (ag); Muniz Freire orthogneiss (mf) 590 Ma U-Pb; 590 Ma U-Pb; Tonalite type Palmital (pm – quartz monzonite)

PRE-OROGENIC PHASE

- **NP3nv** – **Nova Venécia Complex** 631 Ma Pb-Pb: quartz gneisses (gnq)
- **NP3it** – **Italva Group** 840-600 Ma U-Pb Meta-volcano sedimentar Sequence. São Joaquim (sj): calcitic to dolomitic marble; Macuco Unit (ma): amphibole-biotite gneiss to biotite gneiss; Serra da Prata Unit (sp): hornblende-biotite gneiss
- **NPsf** – **São Fidélis Group** (cordierite)-(sillimanite)-biotite gneiss (kz); homogeneous biotite gneiss (gh)

GEOLOGICAL CONVENTIONS

- Dike (gr – granite)
- Thrust fault
- Dextral strike-slip fault
- Sinistral strike-slip fault
- Fracture
- Structural Lineament: traces of S surfaces
- Thrust shear zone

GEOLOGICAL CONVENTIONS

- City
- Locality
- Town
- Village
- Perennial stream
- Railroad
- Unpaved or gravel road
- Paved Road
- Urban Area
- Mass of water

Figure 5.2 – Geological map of the south region of the state of Espírito Santo, escala 1:400 000 (Vieira et al. 2013).

The rocks of the Espírito Santo Intrusive Suite are potential sources for the production of black granites extracted from outcrops of the noritic body of São Gabriel da Baunilha, commercialized as Preto São Gabriel, on Colatina county. This norite is intrusive in the gneisses of the Nova Venécia Complex where the extraction is performed from suboutcropping massive rocks. The norites comprising lithotypes derived from the Aracruz and Fundão Massives, located on the homonymous counties, form rugged relief, characterized by elevations, constituting large flagstones exposed slopes. They are commercialized as Granito Preto de Aracruz and Granito Preto Brasil, respectively.

The granites of the green line produced in the state of Espírito Santo are associated to undeformed porphyritic coarsed grained charnockites, related to the post-orogenic stage, and also associated to granites type I included in the Aimorés Intrusive Suite. Rocks from this suite are metaluminous and calc-alkaline, mostly composed by meso to melanocratic charnockites, including enderbites, gabbros and norites, besides porphyritic gray pinkish biotite granites. Some of these rocks have magmatic textures partly recrystallized, creating granoblastic mosaics and foliation of magmatic flow.

Although the Aimorés Suite has a smaller exposure area than the Carlos Chagas Suite, it provides a wider range of products. The dimension stones from this geological unit are green, black, beige and brownish granites, that outcrop on the northwest of the state in Barra de São Francisco, Ecoporanga and Vila Pavão counties, where the extraction is performed on charnockites and, in a smaller scale, in norites and undeformed porphyroid granites.

Among the major exhibitions of charnockites rocks of the Aimorés Intrusive Suite, it should be highlighted the great intrusions of Barra de São Francisco and Alto Mutum Preto, in Pancas county. The differential between the intrusions of Barra de São Francisco, which produce the ornamental varieties of the green line called Verde Pavão, Verde Butterfly and Verde Jade; and the plutonites of Alto Mutum is the presence of garnet (Gallart, 2012). The plutonites are partly constituted by Charnockites and partly by porphyritic granites of syeno monzogranitic composition, with gradational contact with each other. Close to Itaperuna district, in Barra de São Francisco county, charnockites and "granites" are extracted from the same quarry and the materials are commercialized as Verde Pavão and Bege Pavão.

The massive charnockites of Alto Mutum Preto and Ibituba, located in the counties of Itaguaçu and Baixo Guandú, stand out in the landscape by high rocky bodies with frequent exhibitions of rocks on large extensions on large walls in the slopes and the top of the elevations. Such physiography makes these occurrence areas natural for exploration of dimension stones. The extracted charnockites in Alto Mutum, are called Verde Labrador or Ubatuba and Verde Bahia. Table 5.1 shows the color diversity of the granite producing and their counties.

5.2 EXOTIC OR MOVED

Regarding the so called metamorphic crystalline rocks, such as gneiss, migmatite, metaconglomerate and quartzite, as well as the large geological units outcropping, like gneissic-migmatitic terrains, the conditioning for formation of dimension materials is determined essentially by the mineralogy which defines the color of the lithotype and by the action resulting from tectonic events which print the structural pattern of the rock.

This controls the formation of this type of materials likely to be found in Neoproterozoic and Paleoproterozoic terrains in the state of Espírito Santo. The order of occurrence of these materials may vary from pockets to lenses, even up to large regional units, resulting from the action of the tectono-metamorphic processes that acted on the region, generating varieties of "granites" so called exotic or moved with varied colors.

The rocks of the Nova Venécia Complex are related to Neoproterozoic terrains and are potential sources for the moved or exotic "granites" with a wide range of colors, especially the diatexitic migmatites. Rocks generated by the mixture of leucogranites of the Carlos Chagas Suite and paragneisses of the Nova Venecia Complex, rich in biotite and garnet, occur as lenticular restites in granitoids. In such materials submitted to strong chemical weathering, the alteration on the biotite and sometimes on the garnet, and the discoloration of the feldspar prints a yellowish tinge, resulting in the generation of deposits of the called yellow exotic "granites".

From restites of a large portion of thin biotite gneisses, more homogeneous portions of the mixture with intrusive leucogranites, are exploited in the Paulista district, municipality of Barra de São Francisco producing varieties of moved "granites" known as Yellow River.

Gneissic facies containing cordierites of the Nova Venécia Complex are potential sources for the ornamental variety called Granito Blue Brasil. The so-called "blue granites" outcropping in the territory of Espírito Santo find themselves linked to the sillimanite-cordierite-biotite gneiss, associated to gneissic terrains of regional amplitude, more precisely in places where the rocks show a degree of metamorphism on the granulite facies. The

County / Color	Yellow	Blue	Beige	White	Gray	Brown	Black	Pink	Green
Afonso Claúdio						■			■
Água Doce do Norte	■		■	■	■				
Águia Branca				■			■	■	■
Alegre	■				■	■	■		
Aracruz							■		
Baixo Guandu	■								■
Barra de São Francisco	■		■	■					■
Boa Esperança	■								
Cachoeiro do Itapemirim	■				■				
Castelo	■				■	■			
Colatina	■	■		■			■		■
Ecoporanga	■			■		■	■		
Governador Lindemberg				■					
Ibiraçu	■								
Iconha					■		■		
Itaguaçu	■								
Iuna							■		
João Neiva				■					
Linhares				■					
Mimoso do Sul					■	■			
Muniz Freire			■				■		
Nova Venécia	■			■					■
Pancas				■					
Ponto Belo	■								
Rio Novo do Sul				■	■				
São Roque do Canaã	■				■				
Sooretama			■						
Vargem Alta	■			■			■		■
Venda Nova do Imigrante						■			
Vila Pavão	■			■					■

Table 5.1 – Chromatic varieties of granites produced in the Espírito Santo state and respective counties where they occur.

most known occurrence is located on the east side of Rio Bananal county, where it is presented free of mobilized quartz-feldspathic related to migmatization. This is a suboutcropping massive rock, with a thick mantle of soil, associated to a hilly relief gneiss typical of this geological unit.

Another possibility of detecting bluish shading rocks in the territory of the state, is the local intrusions related to the post-orogenic stage, associated to rhyolite or rhyodacite dikes, where quartz is crystallized at high temperatures provides a bluish tinge to the lithotype, as it occurs in neighboring states like Bahia.

Also related to rocks of the Complex Nova Venezia, deposits of dark gray to black moved ornamental material occur. It consists of mesocratic migmatitic gneisses, medium to coarse grained, constituted by alternating bands with biotite and granet and quartz-feldspathic layers rich in biotite. The uniformity of the phyllosillicatic and quartz-feldspathic layers, combined with a moderate thickness, outlines the aesthetic appeal of the diversity of dimension stones outcropping on the north side of the counties Duas Barras and Iconha, where the material produced is known as Preto Indiano.

Gneisses of the Italva Group – Macuco Unit are potential sources for the moved or exotic materials. The typical rock of this unit is a hornblende-biotite gneiss with a light gray color, predominant fine granulation, locally fine to medium and composition varying from granitic to granodioritic. It is usually anisotropic, and fine banding given by millimetric to centrimetic quartz-feldspathic layers and sheets rich in biotite and garnet (Duarte et.al., 2012).

North of the town of Vargem Alta, the gneisses of the Macuco Unit present a banded structure and occur as sinuous and isoclinally folded levels, giving rise to mutty ways highlighted by the felsic bands, being exploited and marketed under the name of Astrus.

Although not present at the time, occurrences of dimension stones in its outcropping areas, the Paleoproterozoic terrains of the state of Espírito Santo may, in the near future, be sources for the production of moved or exotic materials, both in shades of gray to dark gray and green to black colors.

The unit known as metagabbro outcropping in the municipality of Coneição do Castelo presents medium granulation and incipient foliation. It outcrops near the city and can become deposits of

rocks with black shades, slightly foliated, and may constitute an unprecedented kind of dimension stone in terms of market.

The rocks of Juiz de Fora and Serra do Valentim Complexes consist of orthogranulites of varied composition, and charnockites, norites, enderbites and charnoenderbites, which may include deposits of moved black and green lithotypes similar to the Verde Candeias type.

The lithologies of Ipanema Complex, characterized largely by biotite gneisses, mylonitic gneisses and biotite garnet gneisses, besides quartizites and metamafic and metaultramafic lenses, may include deposits of moved gray to dark gray materials and may also eventually become occurrences of exotic dimension stones with excellent decorative appearance.

The exotic materials are also extracted from leucogranites with enclaves of biotite gneisses bodies fine to medium grained of the Macuco Unit – Italva Group, partly assimilated, forming a banded irregular structure with pegmatoid levels. The granite, in this case, is extremely heterogeneous, inequigranular, with medium to very coarse granulation, even pegmatitic, with biotites and garnets dispersed in the rock. In the region of Pontões, in Afonso Claudio county, these granites occur with a reddish color due to the alteration of the biotite by weathering effect characterizing a material fairly valued, marketed as granite Crema Bordeaux. Another situation with potential for the formation of exotic materials is the interaction between granites.

Intrusion of leucogranites pegmatoids in biotite granites, with partial assimilation of the host rock, generated a mixed material that, southwest of the city of Mimoso do Sul, defines a standard commercial aesthetic known as Marrom Sucuri. These varieties are explored from portions slightly weathered and banded arrangements resulting from the interaction between granites and granites pegmatoid.

5.3 MARBLES

A carbonatic megalense (figure 5.2), deformed and consisting of marbles belonging to the Italva Group – São Joaquim Unit, is the major source of dimension marbles of the state. This lithological unit stretches over 40 km long and greatest width of about 4 km. It has a NE-SW orientation from the outskirts of Cachoeiro do Itapemirim up to the city of Vargem Alta. Other potential lenses for the production of marble are located in Castelo and Cachoeiro do Itapemirim counties, which are 3 and 4.5 km and oriented NE-SE and NNW respectively.

The marbles are white colored, calcitic and dolomitic, fine to coarse grained, granoblastic texture, with centimetric to decimetric banded structures due to alternation of levels with mineral impurities, as evidenced by weathering. Granulation, which varies from place to place, also contribute to highlight the banded appearance of the rock. The bands, usually irregular, are brownish, blueish, greenish, reddish and grayish, having impurities coming from material with calc-sillicatic, metapelitic, ferruginous and/or graphitic composition. Based in the structural appearance of the lithotype, mineralogical composition, and as a result, color diversity, marbles from this area have different commercial names such as Chocolate, Pinta Verde, Champagne, Branco, Calcita and Cintilante, among others.

The Chocolate marble consists of a muscovite-flogopite marble, with a light banding formed by micaceous bands, locally folded and light brown. It is moderately fractured, with no prominent topography and commonly exhibits good exploitability conditions.

The marble known as Pinta Verde is a tremolite marble, fine grained, granular texture, where the amphiboles, chaotically dispersed, give the rock a greenish appearance.

The Mármore Branco consists mainly of dolomita and calcite, but its primary characteristic is the calcite crystals with an average length of 2 mm, giving some homogeneity to the rock. It presents chromatic varieties ranging from red to pink, from gray to brown, due to the alteration of the ferromagnesian minerals.

The marble commercialized as Mármore Champagne is, in a petrographical sense, a muscovite-dolmite marble, light gray to whitish particularly given by the presence of micaceous minerals. It is folded, moderately fractured and has excellent conditions for explotability.

The Mármore Calcita or Calcita Mármore consists of marble rich in lenses of calcite ranging in size from 0.3 to 1 cm. Due to the impurities inserted in its crystalline lattice, it shows green to blue and gray to yellow colors. The Mármore Cintilante is a crystalline limestone practically pure, rich in white calcite, which lends the rock an excellent aesthetic and decorative effect, apart from giving it a good market perspective.

Like in other types of foliated rocks, the aesthetic appeal of ornamental slabs in banded marbles is defined according to the cuts performed taking into account its oriented structure. In this instance, cuts performed parallel to the natural bedding plane (cross-cut) aim to provide slabs with a dominant color pattern or monochromatic, such as the

materials Champagne (brown), Pinta Verde (white with greenish stains or spots), Acqua Marina and Azul Capixaba (blueish). The transversal cuts or perpendicular to the natural bedding plane (vein-cut) aim to privilege the design given by the banding structure, such as the Mármore Acinzentado, striped along dark colors. Table 5.2 shows a list of the marble producing counties and its respective color diversity.

5.4 OTHER VARIETIES

It is important to highlight that many other types of materials were informally informed by commercial and mining companies, as well as by technicians of the sector, these materials are not included in this atlas, due to the difficulties found identifying technical-technological characteristics and is geological setting. These different types of rocks can come from other states and can even be materials with the same name as those already registered during the field works. In some situations these exotic materials are produced in short periods of time and discontinued in the market. These varieties of materials are listed below aiming to enrich the universe of diverse types of material, produced and marketed in the state of Espírito Santo:

Amarelo Colonial, Amarelo Dallas, Amarelo Santo Agostinho, Amarelo São Francisco, Amêndoa Capixaba, Amêndoa Colonial, Azul Sigma, Branco Gaivota, Cashemere Marfim, Giallo Brasil, Giallo Sofia, Granito Dark, Juparaná Laranjeira, Juparaná Rosado Novo, Kashimir Rosé, Marrom Fantasia, Netuno Bordeaux, Rosa Imperial, Santa Inês, Tarso, Verde Ecologia, Verde Monterrey, Verde Vitória, Vertigo Blue, Branco Martinica, Onix Brasil, Ouro Fino, Prata BSF, Preto Bahia, Preto Rio Preto, Preto Santa Clara, and Preto São Domingos.

County / Color	Blue	White	Gray	Brown	Green
Cachoeiro do Itapemirim					
Vargem Alta					

Table 5.2 – Chromatic diversity of marbles produced in the Espírito Santo state and counties of origin.

QUARRYING AND PROCESSING

Chapter 6

Chapter 6

QUARRYING AND PROCESSING

6.1 – QUARRYING

The deposits of dimension stones in almost every mine are operated in open-pit mines and, according to the geological settings, the material can be extracted from massive rocks and boulders, using methods and techniques that provide satisfactory results in terms of cost/benefit relation.

The quarrying methods consist of a special set of works that include planning, dimensioning and execution of tasks. During the survey and planning phase, it is important to evaluate if the massive rock or boulders are ideal for extraction, being extremely necessary the study of lithological variations, fractures, cracks, alterations, presence of enclaves, veins, local topographic variations and available infrastructure. It is to be chosen the method that provides best results in terms of cost/benefit. Another important aspect in the planning refers to the need of defining the potential future uses of the mined area the once activity is completed.

A good mine planning will provide the design of equipment and facilities, cost calculations, sequence of activities, economic and social repercussions of the environmental impact, besides the analysis of the hydrological settings, and it must always be based on the results obtained during the geological survey.

The concern with the quality and volume of the produced rock carries the necessity of investments, initially, in the geological survey, and later in production technology to reduce costs and increase the productivity rate. Quarrying from massive rocks is the method that supplies greater operational advantages, because it provides a rational extraction, with a positive repercussion in the cost/benefit relation, due to the generation less waste material and a larger rate of recovery. Sometimes, depending on the geological settings of the deposit and the market value of the product, the quarrying method may be performed underground.

The execution of a good geological survey includes the lithostructural analysis of the body to be used as producer of dimension stone, followed by a study of the stress field acting on the area of extraction making the project of quarrying practical and concrete.

According to the geological settings of the deposit of dimension stones, quarrying is performed using one of the following methods: high benches, low benches, block toppling and boulders.

6.1.1 – QUARRYING METHODS

6.1.1.1 – HIGH BENCH QUARRYING

It is used on massive rocks with high heterogeneity in terms of quality and structure, which requires the assembling of an approach structure in order to extract and select blocks. It is done isolating primary volumes of rock and then splitting them in vertical blocks, where the height of the benches is equal to a number multiple of one of the dimensions of the commercial blocks (6 to 12 m) and thickness equal to one dimension (photo 6.1).

6.1.1.2 – LOW BENCH QUARRYING

It is a flexible method, appropriate for homogeneous massive rocks, with low occurrence of commercial flaws. It is also used in quarries where there are close subhorizontal fractures, having from 2 to 4m difference in distance between planes of fracture, which defines the height of the benches (photo 6.2).

Photo 6.1 – Yellow granite quarry with high benches.

6.1.1.3 – BLOCK TOPPLING QUARRYING

It is a methodology that can be used on quarries located on areas with steep topography, and it follows the uneven morphology of the area. On the points of relief difference (at the bottom of the hillside), the material is toppled in secondary volumes, which will be later split in commercial blocks. Usually the topography is steep, which makes it necessary to use explosives such as black powder for this method of quarrying by toppling blocks (photo 6.3).

Photo 6.2 – Quarry with low benches.

6.1.1.4 - BOULDER QUARRYING

This type of extraction is characterized by the operational simplicity, with very low costs of production and small investment of initial capital. It includes tasks like cleaning and removing soil to uncover the boulders that are partially buried. After exposing them, they are split using powder blasting techniques, which consist of making grooves using a pneumatic hammer and later placing black powder and a detonating cord. In some situations expansive mortars may be used. Then the squaring of the blocks is performed using manual or pneumatic hammers and wedges (photo 6.4).

Photo 6.3 – Quarrying of São Francisco Real granite – Barra de São Francisco.

6.1.2 - QUARRYING TECHNOLOGIES IN THE STATE OF ESPÍRITO SANTO

Mostly, the quarrying methodology used for the deposits of massive rocks in the state is the bench system. The number of steps or benches and heights are calculated according to the morphology, dimensions of the deposit and spacing between horizontal fractures of stress release, parallel to

Photo 6.4 – Boulder quarrying on the Kashimire White granite deposit

the topographic relief of the deposit, as well as the production demands. It is frequent that the quarrying tasks are performed using unique or multiple benches, generally with heights varying from 6 to 12 m (photos 6.5 and 6.6).

The techniques applied for cutting mono-blocks on massive rocks comprises continuous cutting technology, specifically diamond wire, together with cycling technologies, such as the discontinuous drilling, combined with expansive mortar or explosives and detonating cord (photos 6.7, 6.8 and 6.9).

According to the textural and structural aspect of the rock, especially those with coarse and porphyroid granulations as well as foliated and very fractured ones, the use of jet flame and explosives is discarded, especially those of high speed, which have a propellant and shearing power and can compromise the physical-mechanical integrity of the material. The use of these materials can cause irretrievable damages to the quarry derailing production.

Photo 6.5 – Quarrying with unique bench in Nova Venécia.

Photo 6.6 – Quarrying with multiple benches (Todos os Anjos District, Vila Pavão). On the center-left side of the photo, there is a toppled block for squaring.

Photo 6.7 – Two types of cut: on the right performed with diamond wire, and on the left, performed with discontinuous drilling combined with expansive mortar (white residue on the rails of the holes).

Photo 6.8 – Vertical cut using diamond wire.

Photo 6.9 – Detail of the regular line of cut of the horizontal plane (lifting plane) with diamond wire. On the foreground, manual pneumatic hammer used for drilling.

It is important to highlight that the method of discontinuous drilling together with the use of mortar or explosives, when used for slab isolation, is usually performed to cut the opposite face of the falling side.

Another technique for this last cut is the continuous drilling, which consists of collinear holes, with spacing equal to the size of the hole diameter, and it is complemented with holes drilled in between the first ones, but with a diameter exceeding the spacing. Expansive mortar is used to release the cut bench. Eventually, black powder may be used to release the final part of the block.

The disseminated use of the diamond wire is seen almost everywhere in the state and being employed regularly in all operations.

Due to its lower cost and easier application, the usual method for squaring pieces and obtaining commercial blocks is done using discontinuous drilling together with mechanical wedges (photos 6.10 and 6.11). In most of the quarries, the holes are done using manual pneumatic hammer, which is also the main tool used for drilling blocks on massive rocks.

Several quarries also use hydraulic drill rigs on trails (slot drill), for vertical holes and squaring slabs (photo 6.12). Besides its great efficiency, this equipment has the advantage of controlling better the regularity of the line holes, if compared to hand-held drills, leading to a better finishing of the future blocks to be extracted minimizing time and financial cost.

Photo 6.10 – Squaring of a slab using manual pneumatic hammers, Vila Pavão county.

The technique for cutting large boulders is the same used for slab squaring. The normal procedure for cutting large primary volumes of rock on outcrops starts performing vertical cuts, followed by horizontal cuts on the inferior side of the blocks (lifting plane). In the instance of cutting slabs or vertical panels, the opposite face of the falling side normally is the last one to be cut.

For toppling slabs, the usual techniques use hydraulic jack or heavy-duty machinery, such as wheel loader or backhoe loaders, with steel wires (tackle or pulley), or even only the hydraulic "arms" of these machinery directly on the slabs (photos 6.13 and 6.14); To preserve the rocks from any physical damage resulting from these tasks, they are toppled on masses of debris composed by soil and fragments of rocks for cushioning.

Photo 6.11 – Finalization of cutting through a block using mechanical wedges. Note the irregularity of the vertical cut, county Ecoporanga.

Photo 6.13 – Techniques used for toppling blocks with a backhoe loader in Baixo Guandu county. Note a mass of debris to absorb impact.

Photo 6.12 – Hydraulic drilling on trails for vertical holes to square slabs, Baixo Guandu county.

Photo 6.14 – Techniques used for toppling blocks using hydraulic jack, Ecoporanga county.

After splitting, squaring and dressing the blocks, they are dragged or rolled to the crane, usually with wheel loaders or a hoisting system like a winch, where they are fastened with steel wires and lifted using these cranes to place them in trucks (photos 6.15 and 6.16). Some quarries work without cranes and use only a heavy-duty wheel loaders to lift and load blocks directly onto trucks.

Photo 6.15 – Loading procedures of blocks. Block dragging to the crane using a wheel loader.

Photo 6.16 – Block lifting using steel wires to load onto truck.

Finally, regardless of their location, a correct determination of the mining method at a dimension stone quarry is essential for the proper conduction of the work, planning and execution of the mining activity itself. In the definition phase of the method, an error may result in costs of production excessively high magnifying the generation of tailings and therefore the reduction of the useful lifetime of the quarry.

A legally qualified technician, especially in the stages of exploration and explotation, will contribute significantly with the rational explotation of the deposits and consequent increase in productvility of the project, avoiding higher generation of sterile and raising the recovery rate of the quarry, with cost reduction and resulting in an increase in profitability.

On the other hand, it is important to note, the environmental impacts resulting from mining activities make the law more restrictive to this kind of activity; therefore it must be the object of a detailed analysis by the miner in order to avoid the preclusion of new enterprises.

The interest for the environmental issues is relatively recent. It is important to have a set of principles present and specific rules in order to favor a harmonious and balanced relationship between man and nature.

Actions that minimize environmental impacts resulting from the productive activity in question should be provided on the planning stage of the research and future mining operations, predicting future reclamation in order to recover the landscapes, and reuse these lands for other purposes.

6.2 – PROCESSING TECHNOLOGY USED IN THE STATE OF ESPÍRITO SANTO

The processing of ornamental stones relates to the deployment of raw materials extracted in quarries in the form of blocks, normally with variable sizes from 5 to 10 m^3. They are benefited, mainly through sawing (cutting process) in plates, on looms and bridge saws for subsequent polishing, finishing, squaring to its final size, for application both in architecture projects, or as coating material in the construction industry.

Depending on the beneficiation process to be used, the following products can be obtained from ornamental rocks: plates, thresholds and strips from primary processing, as well as panels for external cladding tiles for flooring, steps and rails, cubs, moldings and baseboards, tables and benches for decoration, columns and special products resulting from the final processing.

The looms are the most common equipment for cutting larger blocks, in order to produce slabs 2 to 3 cm thick. Regarding the bridge saw, they are more appropriate for smaller blocks, completely anti-economic in loom, to produce plates, stripes and tiles about 1 cm thick and pieces more than 3 cm thick.

6.2.1 – SAWING USING LOOMS

The cutting occurs by the action of an abrasive element driven by a set of bustling strip along the loom, which is formed by a structure with four columns that supports the weight of the cutter frame (photo 6.17). The sawing process in looms is aided by the use of Moorhen pulp, lime and steel shot, continuously poured over the loaded blocks for cutting optimization and cooling the blade of steel. They shall be aligned perfectly for the cutting process and stretched, in order to improve straightness, flatness and quality of the sheets obtained after sawing the set of blocks placed on the loom.

Photo 6.17 – Process of sawing blocks in a multi-blade Loom.

The load can consist of a unique block or paired blocks (photo 6.18), where there is a block with smaller width coupled to a larger block and used as load complement in some sawing processes. The blocks can have heights of up to 2 m, which is the maximum width of slabs that polishing equipments accept, and lengths of up to 4m. On the same load, blocks of different heights or with different composition should not be sawn, because this leads to a different wearing rate of the blades, vibration of the equipment, poor flatness of the slabs, fragmentation of the material, in addition to the waste of inputs (water, power, lime and steel shot), increasing noticeably the production cost, which consequently brings a reduction of profits of the company and its return time.

The preliminary processing or block squaring starts splitting blocks, using equipment with single blades or wires, which optimizes the posterior sawing, enabling a standardization of the block dimensions, a better coupling or grouting (lead welding) of the loaded blocks, having thus a greater productivity per m^2 and less production of waste material resulting from the sawing process.

Photo 6.18 – Preparation of a multi-blade loom, highlighting the correct positioning of the blocks.

The most modern looms have equipment that automatically control the supply and mixture of the abrasive pulp, which simplifies the sawing process because this supply must be constant, and the viscosity of the pulp cannot be excessive. The correct density and the constant addition of new steel shot, lime and water to the system is the base of a good quality sawing. This abrasive slurry runs through a closed circuit being continuously pumped bathing the block being cut.

The sawing process can also be performed using diamond multi-wire saws. The multi-wire saws (photo 6.19) represents a technological evolution evolution. The idea emerged from the use of diamond wire when quarrying marbles and granites for dimension stones. This equipment consists of a metallic structure, with diamond wires arranged equidistantly and tensioned, motioning in circles. This set of wires is supported on two or four columns (according to the model) that motion vertically down, with the wires contacting the blocks of rocks and thus splitting slabs with thickness between 1 and 3 cm according to the market demands. It is important to note that when the diamond wire technology is used on the primary processing of the blocks the productive process of the company is optimized remarkably, especially due to the speed of operation of the machine completely superior to traditional multi-blade gang-saws.

In this type of equipment, the main element is the diamond wire, which is a steel wire with diamonds fixed and spaced by a special plastic or rubber injected at high pressure. The diamond piece used starts with a diameter of 6.7 mm, and it can be used as long as it wears out to reach 5.2mm. It is to be noted, that the use of this technology has improved expressively the process of production of the companies that use it, especially by the increase of productivity and enhancement in the quality of the sawn material, besides a reasonable decrease of waste material generated hence reducing the production costs.

Photo 6.19 – Sawing blocks using a diamond multi-wire loom.

6.2.2 - SAWING USING BRIDGE SAWS

Bridge saws are sawing equipment with diamond discs qualified for cutting great depths mainly used for standard products (slabs). The use of the bridge saw is fundamental to cut smaller blocks, with inappropriate sizes for looms. Another advantage of the bridge saw is that the equipment admits movements in different angles and therefore allowing different forms of splitting material. On photo 6.20 there is a bridge saw equipment used to cut blocks vertically, whereas in photo 6.21 there is another type of bridge saw used to cut blocks horizontally.

In the manufacture of flooring material it is frequent to use tile manufacturing equipment, which includes the bridge saw of vertical and horizontal cut, coupled to a calibrating machine, multi-disc strip cutter to cut the slab longitudinally, multi-disc cutter for transversal cut, a strip polishing machine, a beveling machine and a drying equipment to process the final finishing of the tiles (photo 6.22). Equipment such as the one described above can manufacture approximately 6,000 m^2 of tiles per month, varying in size and thickness according to the market demands.

6.2.3 - SURFACE FINISHING

After sawing, the next step in the processing is the finishing of slabs and other pieces, through levigation, polishing and luster, or hammering and flaming. Levigation or grinding is a process that reduces the thickness of the slab, creating flat and parallel surfaces. Following the sequence, polishing causes a finer thinning of the slab and seals the mineral grains, creating a smooth, flat, opaque and more impermeable surface. The luster is applied in order to give a glossy appearance to the surface of the slab, which is produced by the mirroring of the faces of the crystals on the rock.

Photo 6.20 – Bridge saw used for vertical cutting and production of standardized tiles.

Photo 6.21 – Bridge saw equipment used for horizontal cutting of strips of the processed block.

Photo 6.22 – Complete production line of tiles, where it can be seen the calibrating machine on the foreground, the strip polisher on the left, followed by the rest of the equipment.

Levigation, polishing and luster are performed with abrasive grinding wheels, made of silicon carbide and diamond, with different grain sizes, coarser for levigation and finer for final luster.

The result of polishing and luster is defined by the gloss, seal and mirroring of the slabs, and the brightness can be assessed by visual acuity or using special equipment (glossmeter). The minimal index of gloss demanded by consumers is equal or greater than 70 points measured on the scale of the equipment. The greater the heterogeneity of the visual aspects of a rock, the greater the number of measures needed to get a representative average.

It should be stressed that concentrations of mafic minerals (especially biotite with coarse granulation) and sulphides generate problems when polishing slabs and a greater alterability when applying products. Nodules (enclaves, autolites, or other irregularities), small dikes and veins, especially in homogeneus rocks, cause problems of aesthetic appeal and losses during slab squaring.

Photo 6.23 – Automatic multi-head polisher used for slab polishing.

The most common equipments used for polishing rocks in the state of Espírito Santo are the manual polisher (1 head), bridge polisher (1 to 2 heads) and multi-head polishers (5 to 20 heads). The manual polishers are outdated, due to its low efficiency and large variation in the quality of the final products. On bridge polishers (multi-head) the motion of the heads is less random, allowing a greater productivity and quality of finishing. Lines of more modern and efficient polishers are multi-head (photo 6.23), completely automatic, which enables the processing of slabs up to 10-15 cm thick and 2 m long, and they discard the previous (levigation) and posterior operations (luster), as it happens in other equipment. The productivity of a multi-head polisher minimizes in a great proportion the production cost, because with only one equipment of this size it is possible to process the load taken by 4 traditional multi-blade loom.

Specific automatic/semi-automatic equipment is usually used for hammering, flaming, sandblasting, milling, squaring, rounding, beveling, curve cutting and drilling. This type of equipment produce isolated pieces, not necessarily standardized, usually requested to marble shops.

In some materials, as mentioned previously, hammering and flaming techniques give a visual effect more interesting than that given by polishing. Flaming is not recommendable on slabs less than 3 cm thick, unless water is casted on the opposite face of the acetylene flame application. The mineral crackling during flaming and the impact of the metallic edges during hammering induce microfractures that enable the infiltration of pollutants and accelerate the physical-chemical action on the slab surface. It is frequent the use of hammered and flamed rocks as anti-slippery material, used as coating of stairs and exterior surfaces with high rate of traffic, such as playgrounds and external areas of public and private buildings.

The general trend of technological evolution for the processing and finishing of dimension stones, is given by the automation of all types of equipments (loom, brigde saws, slab cutter, polishers, etc.) and by the best specification of the consumption materials (blades, steel shots, abrasives, etc.), with the purpose of reducing time and cost of operations, as well as the improvement of the quality of the products processed.

MARKET SCENARIO

Chapter 7

Chapter 7

MARKET SCENARIO

The major fields of application of dimension stones include the construction, as interior and exterior coating of walls, floors, pillars, columns, thresholds, architecture projects, decoration of rooms and as isolated pieces; and the manufacture of sculptures, table tops, countertops and funerary art.

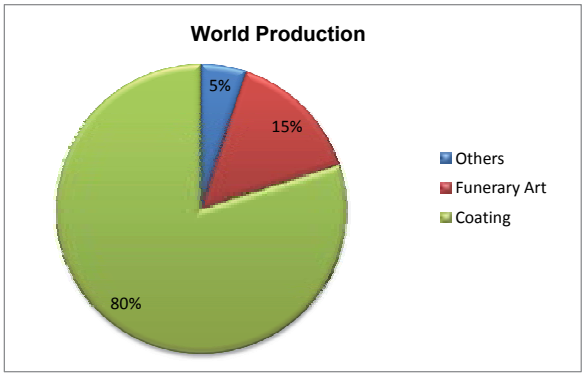
According to ABIROCHAS, it is estimated that the domestic market of the producing countries moves US$ 18 billion/year and the international market US$ 12 billion/year with the commercialization of raw and processed materials. Businesses of machinery, equipment, supplies, consumables and services move about US$ 10 billion/year.

The world production of dimension stone has an outstanding evolution, shifting from 1.5 million tons/year in the 1920s, to the current level 110 million tons/year.

This growth was determined by new uses of dimension stones in the urban landscapes, mainly as coating material in buildings, as well as the new technologies of block extraction, handling, transport and processing developed. The technological progress allowed the use and dissemination of several materials previously not commercialized, while new uses give aesthetical and functional solutions that are both interesting and liable in the civil construction.

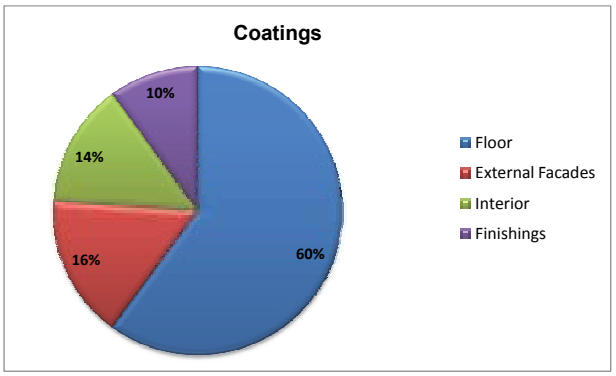
According to ABIROCHAS, approximately 80% of the world production is transformed in slabs and tiles for coating, 15% split for funerary art pieces and 5% for other applications (graph 7.1). About 60% of coating material is applied on floors, 16% on exterior facades, 14% on interior coating and 10% on special finishing works (graph 7.2).

OTHERS	FUNERARY ART	COATING
5%	15%	80%



Graph 7.1 – Percentage of world production for coatings and other applications.

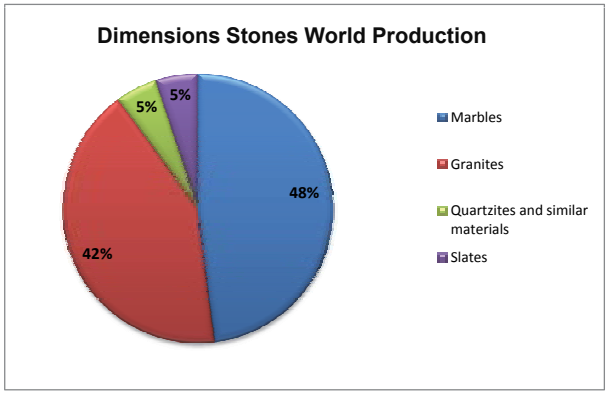
FLOOR	EXTERNAL FACADES	INTERIOR	FINISHINGS
60%	16%	14%	10%



Graph 7.2 – Percentage of production of coating material in various application sectors.

In the 1950s granites represented 15% of the dimension stone production. Currently, approximately 48% of the world production is marble, 42% is granite, 5% is quartzite and similar, and 5% is slate (graph 7.3).

MARBLES	GRANITES	QUARTZITES AND SIMILAR MATERIALS	SLATES
48%	42%	5%	5%



Graph 7.3 –Dimension stone world production.

According to SINDIROCHAS, it is estimated that the dimension stones world production reached approximately 111.5 million tons in 2010, from which 29.6% was produced in China, followed by Italy, India, Spain, Turkey and Brazil. During the previously mentioned year, among raw and processed rocks, the world exportations reached 45 million tons.

In 2012, the Brazilian dimension stones sector presented a growth in its industrial production (at least 5%); an increase in both physical volume and in exportation revenues; an increase in the diversity of processed rocks among the exported materials; and an expansion of the industrial investments.

One of the major positive indicators of these good perspectives, is that Brazil surpassed China in the American market, becoming again the largest provider of rocks in this country in 2011 and 2012, not only in revenues but also in physical volume. This is particularly significant when it is considered that the United States remains the largest importer of special processed dimension stones of the world, with total purchases of US$ 2.23 billion in 2011.

The dimension stones sector is remarkable in the economy of the state of Espírito Santo, representing, according to SINDIROCHAS, about 10% of the GDP of the state, with an annual revenue of approximately R$ 8 billion and generating about 130,000 jobs (20,000 direct and 110,000 indirect). Currently, the state of Espírito Santo is a reference, nationally and internationally, regarding stone materials of ornamental use.

According to the Federação das Indústrias do Espírito Santo (FINDES – Federation of Industries of Espírito Santo) the dimension stones segment of Espírito Santo constitutes more than 70% of Brazilian exportations of dimension stones.

The dimension stone industry has cooperated to generate jobs and incomes, reinforcing the regional development and demonstrating that mining can evolve in a sustainable way. The dimension stones fairs in the state of Espírito Santo, conducted both in Vitória and Cachoeiro do Itapemirim, add value to the Brazilian dimension stones industry.

7.1 - BRAZILIAN EXPORTS AND IMPORTS

According to ABIROCHAS, the exportation of polished slabs grew from 14.1 million m^2 equivalent in 2011 to 16.5 million m^2 in 2012.

The rocks processed comprised 76.8% of the billing and 47.8% of the physical volume of export sales, while crude material represented 23.2% and 52.2% respectively.

During 2011, there was a positive variation of 6.08% in revenues and 2.27% in physical volume of exports. The positive variation of revenues was due to the increase in the average price of the main exported products, and the increased participation of processed rocks, with higher value-added exports.

As in previous years, exports continued very polarized in polished granite slabs to the US and granite blocks to China. Thus, at least in 2012, the economic crisis of the euro zone had little impact on Brazilian dimension stones exportations. The same situation is expected in 2013, even due to the probable growth of exportations to the United States and China.

Brazilian imports of natural rock materials had a positive growth, both in value and in physical volume in 2012. These importations reached US$ 60.91 million and 98,983.70 tons, while artificial stone materials reached US$ 47.48 million and 60,358.68 tons, with positive variation of 57.48% and 96.24% respectively. The total of imports exceeded those of 2011.

Considering the increase in the physical volume of rock exports as well as some indirect indicators based on GDP growth in the performance of construction and information from miners and processors, it is estimated that the Brazilian production of rocks has been in a level of 9.3 million tons in 2012 (table 7.1), with a variation of 3.3% compared to 2011.

Type of Rock	Production (Milion t)
Granite and similar materials	4.6
Marble and Travertine	1.7
Slate	0.6
Foliated quartzite	0.6
Massive quartzite	0.6
Pedra Miracema	0.2
Others (Basalt, Pedra Cariri, Pedra-Sabão, Pedra Morisca, etc.)	1.0
Total Estimated	9.3

Table 7.1 – Profile of the Brazilian production by the type of rock (ABIROCHAS/2012).

By observing the production of rocks in Brazil, imports and exports, it is estimated that domestic consumption totaled 71.9 million m^2 equivalent, in 2 cm thick slabs in 2012.

According to data from ABIROCHAS in the year 2012 Brazilian exports of dimension stones and coating materials totaled US$ 1.06 billion, corresponding to a physical volume traded of 2,237,150.44 tons, whereby 18 Brazilian states with sales to the foreign market were registered.

State	Value (US$ 1.000)	Participation BR (%)	Weight (t)	BR Participation (%)
Espírito Santo	797,786.76	75.23	1,512,687.78	67.62
Minas Gerais	194,083.36	18.30	569,757.36	25.47
São Paulo	12,598.41	1.19	14,006.18	0.63
Ceará	12,484.26	1.18	17,806.70	0.80
Bahia	9,259.76	0.87	31,898.61	1.43
Santa Catarina	7,101.56	0.67	11,163.27	0.50
Rio Grande do Norte	6,533.06	0.62	28,815.64	1.29
Rio de Janeiro	5,388.57	0.51	6,660.78	0.30
Paraíba	4,091.36	0.39	10,638.05	0.48
Pernambuco	3,724.81	0.35	17,865.58	0.80
Rio Grande do Sul	3,363.61	0.32	9,777.58	0.44
Paraná	2,126.31	0.20	1,979.36	0.09
Piauí	1,322.65	0.12	3,349.60	0.15
Rondônia	381.61	0.04	297.02	0.01
Mato Grosso do Sul	71.80	0.01	199.35	0.01
Mato Grosso	35.90	0.00	102.40	0.00
Goiás	9.18	0.00	27.00	0.00
Acre	1.35	0.00	0.12	0.00
Consumption on Board	51.55	0.00	118.07	0.01
Total	1,060,415.86	100.00	2,237,150.44	100.00

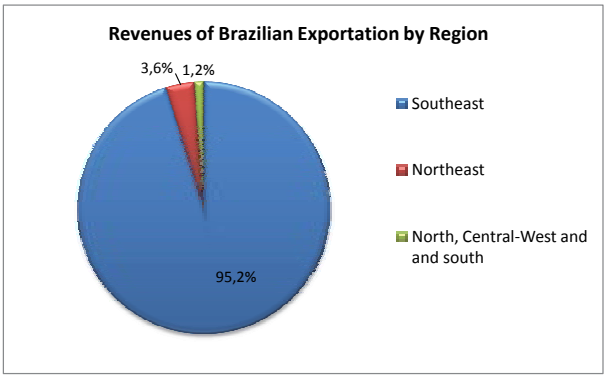
Table 7.2 – Exported values in US dollar and its weight in tons per state, as well as participation in percentage in relation to Brazil (source: ABIROCHAS, 2012).

Table 7.2 shows the values exported in US dollar and the weight in tons by state and participation in percentage compared to Brazil.

It is seen that the exportations of the state of Espírito Santo, in 2012, reached US$ 797.79 million equivalent to 1,512,687.78 tons, corresponding respectively to 75.2% and 67.6% of Brazilian exports.

Graph 7.4 shows the percentage of exportation revenues per Brazilian region in 2012, in which the Southeast (Espírito Santo, Minas Gerais, São Paulo and Rio de Janeiro) made up 95.2% of the total revenue; followed by the Northeast (Ceará, Bahia, Rio Grande do Norte, Paraíba, Pernambuco and Piauí) with 3.6% of the revenues. The North, Midwest and South together accounted for only 1.2% of the export revenues.

Southeast	Northeast	North, Central-West and and south
95.2%	3.6%	1.2%



Graph 7.4 – Revenue of Brazilian exports of rocks in 2012 per region.

7.2 - DIMENSION STONES SECTOR IN THE STATE OF ESPÍRITO SANTO

More than 90% of the investments in the Brazilian dimension stones industrial park are performed in the state of Espírito Santo. The state became absolute leader in the national production of rocks, with great geological potential, developed through investments in research, extraction and processing technologies.

Thanks to these investments, the state sector of dimension stones generates employment and income for about 130,000 people in the state. Currently, the state has about 900 looms (INFOROCHAS, 2011) with capacity to produce about 52 million m^2 of slabs, representing around 57% of the installed looms in Brazil, becoming the main industrial park of this sector in Latin America.

Per year, more than 900,000 cubic meters of dimension stones are extracted in the state of Espírito Santo. The sector consists of two main

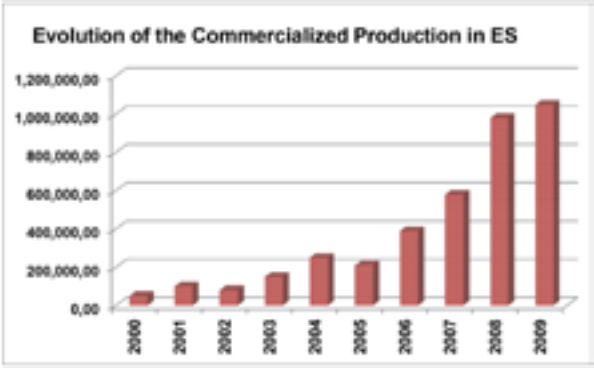
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Production	50,000	100,000	80,000	150,000	250,000	210,000	390,000	580,000	980,000	1,050,000

centers, where most of the quarrying and processing companies of marbles and granites are located. The first one is located around the industrial pole of Cachoeiro do Itapemirim, in the south territory of the state, and the second one is in the northwest, around Nova Venécia, Ecoporanga and Barra de São Francisco counties.

In addition to dimension stones, the mineral sector of the state is awarded with oil and gas exploration, clay for red bricks, aggregates for civil construction, industrial minerals, salts, coralline algae, mineral water and calcitic lime. Graph 7.5 shows the main mineral substances produced in the state of Espírito Santo, where it can be seen that 63% of the mineral production of this federal unit corresponds to dimension stones, thus showing the potential of the state in this segment.

7.3 - DIMENSION STONES PRODUCTION IN BRAZIL AND STATE OF ESPÍRITO SANTO

According to ABIROCHAS, in the year 2012, the Brazilian production was of 9.3 million tons, having a growth of 3.3% over the previous year. Such fact was the result of the combination of an elevation of the exports in about 34% caused by the recovery of the American market and the maintenance of the internal market growth in about 10%. Graph 7.6 shows the evolution of the marketed production in the state of Espírito Santo in the period 2000-2009.



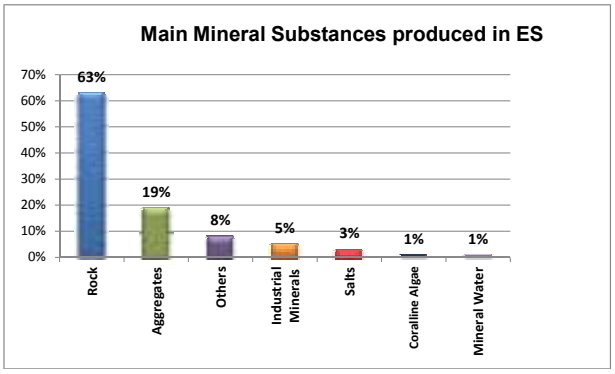
Graph 7.6 – Evolution of the marketed production in the state of Espírito Santo (Source: Brazilian Mineral Yearbook – AMB/DNPM, 2010).

Of the total produced in 2012, the contribution of granites and similar corresponded almost to 50% of the national production, followed by marbles and travertines (18.2%), slates (6.5%) and foliated quartzites (6.5%). Other types of rocks (massive quartzite, pedra miracema, cariri, morisca, basalt and soapstone) contributed with about 17.3% (table 7.3).

Graph 7.7 shows the Brazilian production discriminated by region. The southeast region held 65.2% of the national production, while the northeast region held 24.7%. The South, Midwest and North reached together 10.1%, with logistics and regional market impacts.

Type of Rock	Participation %
Granites and similar materials	49.5
Marble and Travertine	18.2
Slate	6.5
Foliated quartzite	6.5
Massive quartzito	6.5
Pedra Miracema	2.1
Others (Basalt, Pedra Cariri, Pedra-Sabão, Pedra Morisca, etc.)	10.7
Total Estimated	100.0

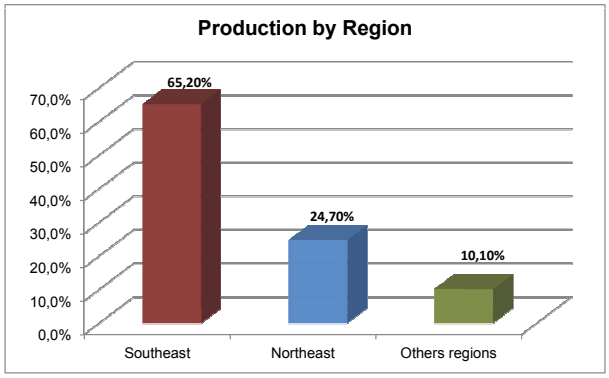
Table 7.3 – Percentage share of various different types of rocks in the Espírito Santo State.



ROCK	AGGREGATES	OTHERS	INDUSTRIAL MINERALS	SALTS	CORALLINE ALGAE	MINERAL WATER
63%	19%	8%	5%	3%	1%	1%

Graph 7.5 – Main mineral substances produced in the state of Espírito Santo (source: DNPM/ES).

REGION	SOUTHEAST	NORTHEAST	OTHERS REGIONS
PRODUÇÃO	65.20%	24.70%	10.10%



Graph 7.7 – Brazilian production of dimension stones by region (source: Anuário Mineral Brasileiro – AMB/DNPM, 2010 – Brazilian Mineral Yearbook).

About 90% of the national production comes from the states of Espírito Santo, Minas Gerais, Bahia, Ceará, Paraná, Rio de Janeiro, Goiás and Paraíba. Although Minas Gerais produces a lower percentage of granites, it stands out for its production of slates, foliated quartzites and soapstone (steatite). According to CETEM, there are 18 Local Productive Arrangements (LPAs) linked to dimension stones in 10 states in Brazil. According to ABIROCHAS, (2012) it is estimated that the rock production chain in Brazil has about 7,000 marble shops; 2,200 processing companies; 1,600 looms; 1,000 quarrying companies with about 1,800 active and legalized quarries in approximately 400 counties generating around 135,000 direct jobs.

The gross production of dimension stones in the state had a considerable rise in the late 2000s, caused by the raise of the quantity of exports, mainly to China, which stands as the new "locomotive" of the world economic growth.

7.4 - DIMENSION STONES EXPORTS IN THE STATE OF ESPÍRITO SANTO

The sector of dimension stones in the state of Espírito Santo ended the year 2011 with R$ 1.3 billion in exports, an increase of 3.7% if compared to the previous year. According to CENTROROCHAS, this result can be considered great if it is taken into account the stocks at Chinese ports, facing the difficulties in the European market and the gradual resumption of the US recommence, which is the main buyer of processed dimension stone in Brazil.

For the year 2013, CENTROROCHAS believes that the number will remain at the same level as 2012, but with a slight positive variation due to the inconstancy of the markets.

During 2011, Brazil exported US$ 999.6 million, registering a growth of 4.22% over the previous year. This value was the highest in the last four years, according to data published by Centro Brasileiro dos Exportadores de Rochas Ornamentais (CENTROROCHAS). Table 7.4 shows the variation of the value and the percentage of the growth of exports of Brazil and the state of Espírito Santo in the period 2010-2011.

	Year	US$ Exported	Growth %
Espírito Santo	2010	683.1 Milhões	3.71
	2011	708.5 Milhões	
Brazil	2010	959.1 Milhões	4.22
	2011	999.6 Milhões	

Table 7.4 – Change in percentage growth exports of the state of Espírito Santo and Brazil between 2010 and 2011.

7.5 - CURRENT PERSPECTIVES OF THE BRAZILIAN STONE MATERIALS SECTOR

Concerned about the European Union decline due to the economic and financial crisis on the continent and the slow recovery of the U.S. economy, the Brazilian government is seeking new markets and setting tax incentives and credits to this segment, in order to increase the competitiveness of the Brazilian industry of dimension stones, aiming to maintain the growth of exports in 2013 and following years. To achieve this, the government has been strengthening its trade promotion activities in the Middle East, especially in Arabic countries, Asia, Latin America and Africa (Angola, South Africa, and Mozambique), which are targeted for this market of Brazilian exports.

To achieve this goal, the foreign ministry Itamaraty intends to strengthen the trade promotion structure of the Brazilian embassies and consulates abroad in at least 23 countries. This measure is intended to increase by 40% the net importers.

Three variables were taken into account in order to define the priority locals for these new business centers: the main destination of Brazilian exports, where there is yet no commercial sector in the embassies; countries with better GDP growth retrospective since 2005, the ones with better perspectives by 2015; and countries with strong potential demands of products belonging to the basket of Brazilian exports. Of the preliminary 50 priorities established, 12 would be in the Americas, 12 in Europe, 12 in Africa, 13 in Asia and one in Oceania.

Based on estimates of ABIROCHAS, the apparent consumption of dimension stones in Brazil in 2010 reached 66.1 million m^2, leveraged by the maintenance of the civil construction growth.

It is important to mention that new areas within the country also began to produce and benefit rocks, giving better conditions to access this kind of material at lower freight cost, and thus boosting the growth of the internal market, especially in the Northeast, Midwest and Northwest of Brazil. At the time, beyond the state of Espírito Santo, there is the resumption of new projects in new producing areas throughout the interior of Brazil.

In turn, the Federal Government, especially the Ministry of Energy and Mines, through the CPRM – Geological Survey of Brazil, launched the book "Dimension Stones of Amazonia" and is starting the development of similar products in the states of Bahia, Ceará, Piauí, Maranhão and Rondônia.

The DNPM is supporting the legalization of several producing areas of dimension stones, ensuring production of mineral goods and subsequent generation of employment and income throughout the national territory.

Other projects should be highlighted as they are expected to be implemented and/or ongoing by various government institutions, such as study of tailings utilization of looms by CETEM in the state of Espírito Santo, utilization of sterile from quarries, quartzite slabs of artificial sand (Pirenópolis-GO) and generation of mosaic pieces, with value added (Várzea-Pb).

7.6 – ESPÍRITO SANTO, AN EXCELLENT PLACE TO PRODUCE DIMENSION STONES

Featured in the national economy as one of the states that most develops in the country, the state of Espírito Santo is an excellent place to work and invest. Its strategic localization, in the Brazilian southeast coast of Brazil, close to the major centers of production and consumption of Brazil, favors new investments of trading with the international and domestic market.

It has a diversified economic base that moves businesses of production chains, such as oil and gas, steel industry and mining, cellulose and dimension stones, besides agribusiness and productive arrangements in other areas such as metal-mechanic, furniture, textile, civil construction, food, among others.

Besides these features, the state of Espírito Santo has great advantages to enlarge growth. The state counts with one of the finest port structures in the country, which is one of the largest ports in the world -Porto de Tubarão-, a large cellulose production complex and the largest production of dimension stones in the Country.

The largest marble and granite reserves of Brazil are in the state of Espírito Santo, presenting a huge variety of colors. The state has an industrial park with about 1,000 companies, responsible for more than half of the looms installed in the country, representing 75% of the Brazilian exports and the sector accounts for 130,000 direct and indirect jobs in the state.

The state has achieved international credibility because it has a competitive environment with clear and stable rules for those who intend to invest.

In 2012, Serra was the county that had the highest volume of export of dimension stones. The total was US$ 237,175,598.00 (two hundred thirty-seven million one hundred seventy-five thousand five hundred ninety-eight dollars), an increase of 12.87% over the previous year (table 7.5).

7.7 – ROUTE OF MARBLE AND GRANITE – A GOOD BUSINESS ROUTE

The International Fair of Marble and Granite is the event that shows the potential that dimension stones of the state possess attracting large domestic and international businesses. Specially due to this, the Touristic Route of Marble and Granite was created, which is driven by stone buyers and professionals of the segment. It is the first touristic route specifically geared to business tourism in Brazil.

The counties Cachoeiro do Itapemirim, Nova Venécia and Vitória stand out in the route, which also includes the counties Barra de São Francisco, Ecoporanga, Água Doce do Norte, Pancas, Baixo Guandu, Vila Pavão, Muqui, Rio Bananal, São

County	Total 2011 (US$)	Total 2012 (US$)	Participation (%)	Growth (%)
SERRA	210,140,453	237,175,598	28.71	12.87
CACHOEIRO DE ITAPEMIRIM	203,804,536	220,432,098	26.68	8.16
BARRA DE SÃO FRANCISCO	64,726,756	91,608,476	11.09	41.53
SÃO DOMINGOS DO NORTE	42,159,691	43,304,955	5.24	2.72
VITÓRIA	29,765,377	32,134,019	3.89	7.96

Table 7.5 – Variation of the exported volume of dimension stones in the state of Espírito Santo 2011-2012. Source: CENTRO-ROCHAS – Centro Brasileiro dos Exportadores de Rochas Ornamentais (Brazilian Center of Dimension Stones Exporters).

Domingos do Norte, Águia Branca, Alegre, Atílio Vivácqua, Castelo, Conceição do Castelo, Linhares, Mimoso do Sul, Serra and Viana.

The state of Espírito Santo is the main producer, and the largest processor and exporter of dimension stones of Brazil. It accounts for almost half of the production and exportation of the Country and has more than half of the Brazilian industrial park.

Vitória, with its port complex, is the main route of export of blocks and slabs of dimension stones of Brazil, hosting one of the two annual editions of the International Fair of Marble and Granite, the Vitória Stone Fair Brazil. The event carries a key role in the organizational and technological development of the sector, as it is here that companies present their news. The other edition of the fair takes place in Cachoeiro do Itapemirim, the largest processor pole in Brazil, nationally known for its industrial park of dimension stones processing.

The size of the deposits and the importance of the business leveraged by this segment justify the inclusion of 21 counties in the Route of Marble and Granite. The marble deposits are concentrated in the southern part of the state, where Cachoeiro do Itapemirim stands as main extracting center.

To the north of the state, the quarrying and processing of marble and granite encouraged the creating of thousands of jobs. The region is known as the extraction core of Nova Venécia and has this county as a reference.

The main industrial processing park of dimension stones is on the southern part of the state. In parallel, the Metropolitan Region records an increase in the number of marble and granite processing companies, responsible for the offering of higher value added products.

7.8 – FINAL CONSIDERATIONS

As a result of the works conducted by the GEOLOGICAL SURVEY OF BRAZIL – CPRM, it was evidenced a prominent relevance of the dimension stones produced in the state of Espírito Santo in the world scenario.

It is necessary, however, the realization of greater investments in relation to the best use of reserves, focusing on the geological survey in order to guide the systematic adopted mining, contributing greatly to the increase of the productivity rate of the quarries and consequently minimizing sterile generation.

Another aspect to be highlighted is the need of intensification of studies to minimize the environmental impacts, notably generated in the mining and beneficiation of blocks.

It is for the sector greater disclosure and guidance, by qualified professionals, as regard the use and proper application of the various types of material, such as coating materials for the construction industry, avoiding future appearance of pathologies, that in a way compromise the use these rocks.

CATALOG OF DIMENSION STONES OF THE ESPÍRITO SANTO STATE

Chapter 8

Granites

Yellow

Amarelo Atacama

Mineralogic Composition (microscopy)
K-feldspar (24%); plagioclase (17%); quartz (12%); garnet (5%) and biotite (2%).

Macroscopic Description
Leucocratic rock with phaneritic texture and white slightly grayish color.

Petrographic Classification
Leucobiotite garnet granite

Technological Characteristics		
Density	2666	kg/m^3
Water Absorption	0.13	%
Compression Breaking Load at the Natural	65.8	MPa
Amsler Wear Test (1000m)	NA	cm^3/cm^2
Linear Thermal Expansion	0.000215482	mm/(mm x °C)
Apparent Porosity	0.35	%
Modulus of Rupture	11.6	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	52	cm

Recommended Use
Interior and exterior coating.

NA = not available

Amarelo Atacama

County
Água Doce do Norte

Localization
Bom Destino Stream - Vila Nelita District.

Coordinates
Geographic: 18°26'51"S / 40°58'55"W
UTM: 290686 E / 7959139 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Amarelo Cachoeiro

Mineralogic Composition (microscopy)
Microperthitic microcline (40%); quartz (20-25%); plagioclase - oligoclase/andesine (20-25%); biotite (10-15%); muscovite, opaques, zircon, chlorite, sericite, hydroxides and/or iron oxides (<5%);

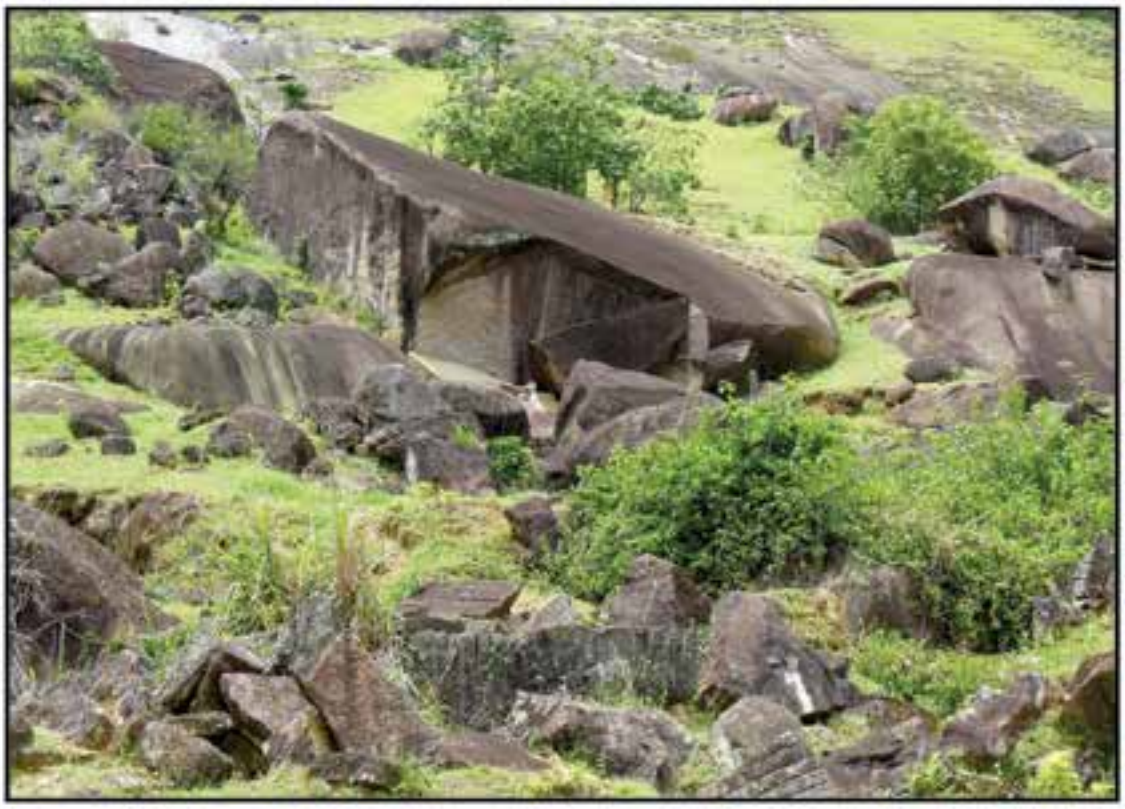
Macroscopic Description
Leucocratic porphyritic rock coarse grained with phenocrystals of k-feldspar spread over a coarse matrix rich in quartz, feldspar and biotite.

Petrographic Classification
Granitic biotite gneiss

Technological Characteristics		
Density	2621	kg/m^3
Water Absorption	0.27	%
Compression Breaking Load at the Natural	150.8	MPa
Amsler Wear Test (1000m)	0.94	mm
Linear Thermal Expansion	11.2	mm/m °C
Apparent Porosity	0.7	%
Modulus of Rupture	20.21	MPa
Compression Breaking Load After Freezing/Thawing	157.3	MPa
Impact Resistance	60	cm

Recommended Use
Floor, interior, and exterior coating.

Amarelo Cachoeiro



County
Alegre

Localization
Laranjeiras, Santa Angélica District

Coordinates
Geographic: 20°39'18"S / 41°27'34"W
UTM: 243731 E / 7714065 N Zone:24S

Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Boulder

Other Names

Type and Predominant Color
Yellow granite

Amarelo Dakar

Mineralogic Composition (microscopy)
Orthoclase (40%); quartz (30%); plagioclase (18%), biotite (10%), opaques (1%) and sericite + carbonates (1%).

Macroscopic Description
Compact, massive rock with a light yellow color, with weak anisotropy, and fine to medium granulation.

Petrographic Classification
Syenogranitic biotite garnet gneiss

Technological Characteristics		
Density	NA	kg/m^3
Water Absorption	NA	%
Compression Breaking Load at the Natural	NA	MPa
Amsler Wear Test (1000m)	NA	cm^3/cm^2
Linear Thermal Expansion	NA	mm/m °C
Apparent Porosity	NA	%
Modulus of Rupture	NA	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Amarelo Dakar

County
Ecoporanga

Localization
Imburana

Coordinates
Geographic: 18°16'23"S / 40°40'10"W
UTM: 323522 E / 7978797 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Amarelo Icaraí

Mineralogic Composition (microscopy)
Microperthitic microcline (45%); quartz (27%); biotite (10%); plagioclase (8%); garnet (7%); accessories (3%);

Macroscopic Description
Granitic rock medium grained with a yellowish white color.

Petrographic Classification
Syenogranitic garnet biotite gneiss with sillimanite.

Technological Characteristics		
Density	2633	kg/m^3
Water Absorption	0.37	%
Compression Breaking Load at the Natural	127.2	MPa
Amsler Wear Test (1000m)	1	mm
Linear Thermal Expansion	4.7	mm/m °C
Apparent Porosity	0.98	%
Modulus of Rupture	6.72	MPa
Compression Breaking Load After Freezing/Thawing	110.8	MPa
Impact Resistance	60	cm

Recommended Use
Floor, interior, and exterior coating.

Amarelo Icaraí

County
Barra de São Francisco

Localization
Paulista Stream.

Coordinates
Geographic: 18°46'21"S / 40°45'26"W
UTM: 314779 E / 7923430 N Zone:24S

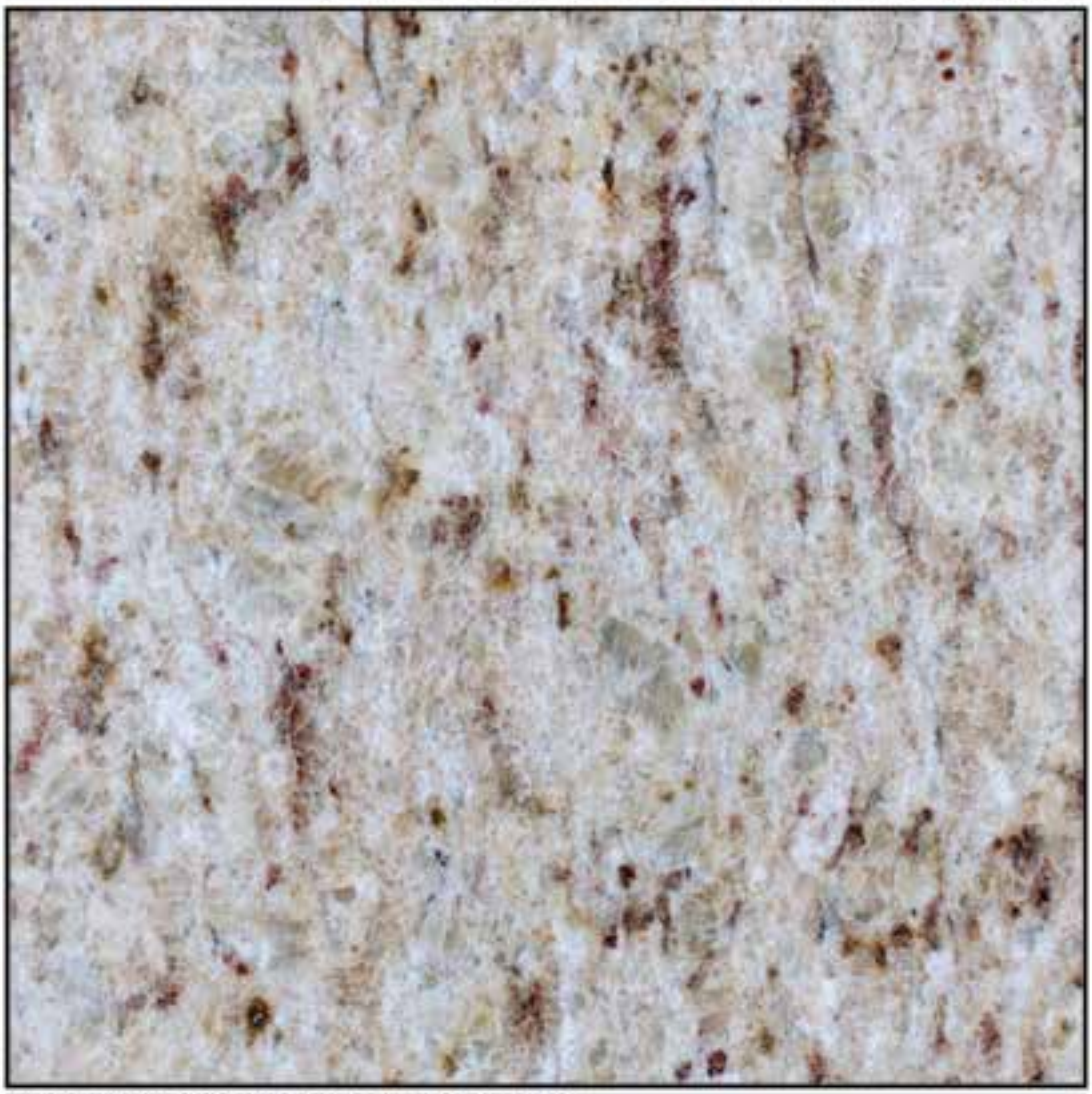
Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Yellow Icaraí; Amarelo Palha; New Icaraí; Amarelo Real; São Francisco Real;

Type and Predominant Color
Yellow granite

Amarelo Ornamental



Mineralogic Composition (microscopy)
Crypt- to microperthitic microcline (55%); quartz (25%), plagioclase - oligoclase (10%); garnet (5-10%); biotite <5%; opaques, apatite, spinel, sillimanite, zircon (accessories); iron hydroxide, sericite, muscovite (secundaries).

Macroscopic Description
Granoblastic inequigranular interlobated to porphyroclastic rock, fine to coarse grained, mainly medium, varying between 0.4 mm and 5.5 mm.

Petrographic Classification
Syenogranitic gneiss with garnet

Technological Characteristics		
Density	2631	kg/m³
Water Absorption	0.32	%
Uniaxial Compression Breaking Load at the Natural	137 (⊥) and 151 (//)	MPa
Amsler Wear Test (1000m)	0.87	mm
Linear Thermal Expansion	4.2	mm/m °C
Apparent Porosity	0.83	%
Modulus of Rupture	14.56	MPa
Compression Breaking Load After Freezing/Thawing	132 (⊥) and 148 (//)	MPa
Impact Resistance	55	cm

Recommended Use
Floor, interior and exterior coating.

⊥ Compression/flexion axis perpendicular to rock foliation
// Compression/flexion axis parallel to rock foliation

Amarelo Ornamental

County
Barra de São Francisco

Localization
Fortaleza Stream.

Coordinates
Geographic: 18°42'45"S / 40°43'01"W
UTM: 318935 E / 7930098 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Amarelo BMG; Amarelo Ornamental GD; Amarelo Ornamental VL; Giallo Ornamental;
Amarelo Ornamental Sigma; Ornamental; Giallo Ornamental;

Type and Predominant Color
Yellow granite

Amarelo Veneziano

Mineralogic Composition (microscopy)
Microperthitic microcline (45%); quartz (30%); plagioclase - oligoclase (16%); biotite (5%); accessories (4%);

Macroscopic Description
Grayish yellow rock with gneissic structure, medium to coarse grained.

Petrographic Classification
Syenogranitic gneiss with biotite and garnet

Technological Characteristics		
Density	2629	kg/m^3
Water Absorption	0.32	%
Compression Breaking Load at the Natural	117.1	MPa
Amsler Wear Test (1000m)	0.95	mm
Linear Thermal Expansion	7.1	mm/m °C
Apparent Porosity	0.84	%
Modulus of Rupture	17.79	MPa
Compression Breaking Load After Freezing/Thawing	116.5	MPa
Impact Resistance	NA	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Amarelo Veneziano

County
Nova Venécia

Localization
Água Preta Stream - Pipinuque Zone.

Coordinates
Geographic: 18°42'09"S / 40°30'23"W
UTM: 341133 E / 7931401 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Giallo Veneziano;

Type and Predominant Color
Yellow granite

Amêndoa Clássico

Mineralogic Composition (microscopy)
Microperthitic microcline (33%); plagioclase (27%); quartz (25%); biotite (15%);

Macroscopic Description
Rock with massive structure sltightly oriented with a yellowish pink color and medium granulation.

Petrographic Classification
Biotite monzogranite

Technological Characteristics		
Density	2632	kg/m³
Water Absorption	0.41	%
Compression Breaking Load at the Natural	132.1	MPa
Amsler Wear Test (1000m)	0.7	mm
Linear Thermal Expansion	5.4	mm/m °C
Apparent Porosity	1.08	%
Modulus of Rupture	8.76	MPa
Compression Breaking Load After Freezing/Thawing	111.3	MPa
Impact Resistance	NA	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Amêndoa Clássico

County
Barra de São Francisco

Localization
ES-080 Road, Km 26.

Coordinates
Geographic: 18°44'16"S / 40°55'38"W
UTM: 296789 E / 7927077 N Zone:24S

Geological Unit
Aimorés Intrusive Suite

Occurrence
Massive rock

Other Names
Amêndoa Jaciguá;

Type and Predominant Color
Yellow granite

Boreal Light

Mineralogic Composition (microscopy)
Antiperthitic plagioclase (30%), quartz (25); cryptoperthitic k-feldspar (15-20%); garnet (15%); brown biotite (10%); opaques, green biotite (<5%); sericite, carbonate, colorless phyllosilicates (secundaries).

Macroscopic Description
Heterogeneous rock with porphyritic granulation consisting of grayish quartz crystals, yellowish feldspar, cream color, with red garnet associations.

Petrographic Classification
Garnet biotite granite

Technological Characteristics		
Density	2664	kg/m^3
Water Absorption	0.203	%
Compression Breaking Load at the Natural	95.0	MPa
Amsler Wear Test (1000m)	0.16	cm^3/cm^2
Linear Thermal Expansion	0.000182	mm/(mm x ºC)
Apparent Porosity	0.54	%
Modulus of Rupture	11.2	MPa
Compression Breaking Load After Freezing/Thawing	79	MPa
Impact Resistance	50	cm

Recommended Use
Floor, interior, and exterior coating.

Boreal Light

County
Boa Esperança

Localization
Engano Stream - São Pedro Farm.

Coordinates
Geographic: 18°28'10"S / 40°22'06"W
UTM: 355500 E / 7957330 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Caramelo Ornamental

Mineralogic Composition (microscopy)
Quartz (48%); microcline (37%); oligoclase (10%); hornblende (5%); magnetite and zircon (traces).

Macroscopic Description
Cohesive grayish slightly brownish rock with heterogeneous appearance, phaneritic granulation, consisting of millimetric and centimetric quartz crystals with color associated to facies of quartz-feldspathic composition. Hornblende crystals spread.

Petrographic Classification
Hornblende granite

Technological Characteristics		
Density	2613	kg/m^3
Water Absorption	0.182	%
Uniaxial Compression Breaking Load at the Natural	108.4	MPa
Amsler Wear Test (1000m)	0.007	cm^3/cm^2
Linear Thermal Expansion	0.003883	mm/(mm x °C)
Apparent Porosity	0.48	%
Modulus of Rupture	14.6	MPa
Compression Breaking Load After Freezing/Thawing	73.3	MPa
Impact Resistance	35	cm

Recommended Use
Floor, interior and exterior coating.

Caramelo Ornamental

County
Baixo Guandu

Localization
Itapina

Coordinates
Geographic: 19°30'12"S / 40°51'19"W
UTM: 305290 E / 7842426 N Zone:24S

Geological Unit
Aimorés Intrusive Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Gegrége

Mineralogic Composition (microscopy)
Perthitic orthoclase/microcline (45%); quartz (30%); plagioclase (16%); biotite (5%); garnet (4%);

Macroscopic Description
Rock with homogeneous gneissic structure, with a light pinkish yellow color and medium to coarse granulation.

Petrographic Classification
Syenogranitic garnet gneiss

Technological Characteristics		
Density	2647	kg/m³
Water Absorption	0.24	%
Compression Breaking Load at the Natural	171.84	MPa
Amsler Wear Test (1000m)	0.66	mm
Linear Thermal Expansion	5.6	mm/m °C
Apparent Porosity	0.63	%
Modulus of Rupture	9.46	MPa
Compression Breaking Load After Freezing/Thawing	168.4	MPa
Impact Resistance	56	cm

Recommended Use
Floor, interior, and exterior coating.

Gegrége

County
Ecoporanga

Localization
Ponto Belo x Ecoporanga Road - Alegria
Farm, Jabuti Stream -
Santa Luzia do Norte.

Coordinates
Geographic: 18°13'16"S / 40°37'53"W
UTM: 327484 E / 7984576 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Amarelo Vitória; Santa Cecília;

Type and Predominant Color
Yellow granite

Giallo Fiesta

Mineralogic Composition (microscopy)
Microcline (33%); oligoclase (27%); quartz (23%); garnet (7%); biotite (6%);
sillimanite (4%), zircon and opaques (traces);

Macroscopic Description
Dense, cohesive, massive, leucocratic rock, coarse grained, consisting of feldspars
and quartz, together with agglomerates of fine biotite and garnet crystals that grant
the rock a heterogeneous appearance

Petrographic Classification
Foliated garnet-biotite granite

Technological Characteristics		
Density	2630	kg/m^3
Water Absorption	0.35	%
Uniaxial Compression Breaking Load at the Natural	82.2	MPa
Amsler Wear Test (1000m)	0.01	mm
Linear Thermal Expansion	0.001933	mm/(mm x °C)
Apparent Porosity	0.93	%
Modulus of Rupture	10.43	MPa
Compression Breaking Load After Freezing/Thawing	70.2	MPa
Impact Resistance	48	cm

Recommended Use
Floor, interior and exterior coating.

Giallo Fiesta

County
Ecoporanga

Localization
Paraiso Stream - Rural Zone.

Coordinates
Geographic: 18°26'50"S / 40°49'15"W
UTM: 307691 E / 7959344 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Fiesta Gold;

Type and Predominant Color
Yellow granite

Giallo Latina

Mineralogic Composition (microscopy)
Feldspars; quartz; biotite + amphibole (+-10%); garnet (< 1%); Present carbonatic minerals
Deletrious minerals: not observed. Accessory: zircon.

Macroscopic Description
Non-oriented rock, porphyritic texture, with inequigranular matrix coarse grained and a
pinkish yellow color.

Petrographic Classification
Amphibole biotite porphyroid granite

Technological Characteristics		
Density	2654	kg/m^3
Water Absorption	0.29	%
Compression Breaking Load at the Natural	80.5	MPa
Amsler Wear Test (1000m)	0.75	mm
Linear Thermal Expansion	6.1	mm/m °C
Apparent Porosity	0.76	%
Modulus of Rupture	6.5	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	133	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Giallo Latina

County
Ecoporanga

Localization
Primavera Farm, Cotaxé Village.

Coordinates
Geographic: 18°09'05"S / 40°42'45"W
UTM: 318844 E / 7992222 N Zone:24S

Geological Unit
Aimorés Intrusive Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Giallo Napoleone Golden

Mineralogic Composition (microscopy)
Potassium Feldspar (45%); quartz (40%); biotite (10%); opaques (5%);

Macroscopic Description
Rock of medium to coarse granulation, with a predominant feldspar, quartz and biotite composition, without preferred foliation of minerals.

Petrographic Classification
Biotite feldspar alkali granite

Technological Characteristics		
Density	2636	kg/m^3
Water Absorption	0.23	%
Uniaxial Compression Breaking Load at the Natural	142.2	MPa
Amsler Wear Test (1000m)	0.63	mm
Linear Thermal Expansion	6.1	mm/m °C
Apparent Porosity	0.60	%
Modulus of Rupture	13.2	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Floor, interior and exterior coating.

NA = not available

Giallo Napoleone Golden

County
Vila Pavão

Localization
Rapadura Steam, at about 9 km
from the Head Office of Vila Pavão.

Coordinates
Geographic: 18°39'41"S / 40°35'38"W
UTM: 331877 E / 7935881 N Zone:24S

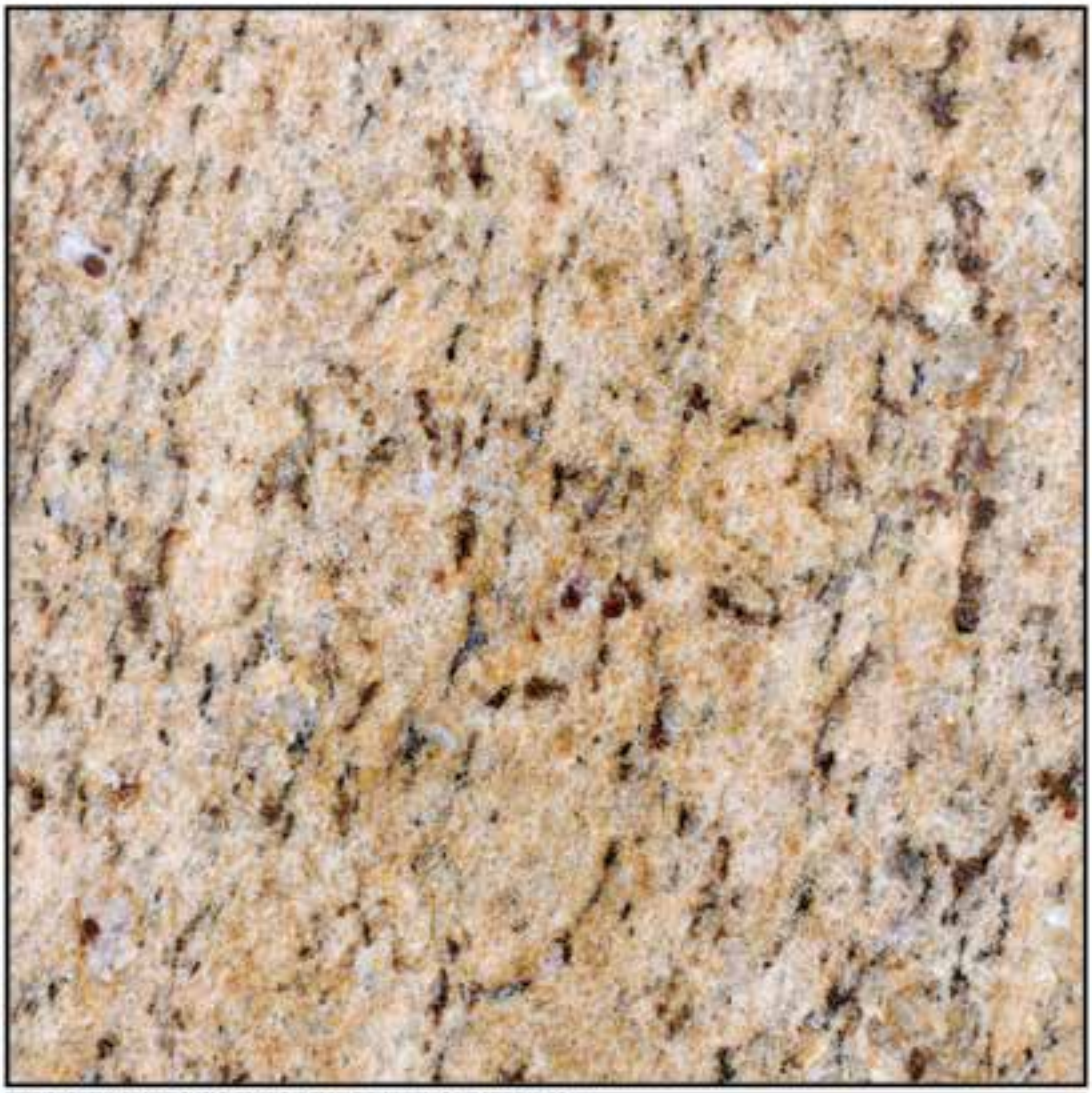
Geological Unit
Carlos Chagas Suite

Occurrence
Massive Rock

Other Names
Giallo Napoleone; Napoleone Gold;

Type and Predominant Color
Yellow granite

Giallo Topázio



Mineralogic Composition (microscopy)
Crypt- to microperthitic microcline (55%); quartz (30%); oligoclase (10%); biotite (<5); garnet (<5); sillimanite, opaques, spinel (trace); iron hydroxide and sericite (secundaries).

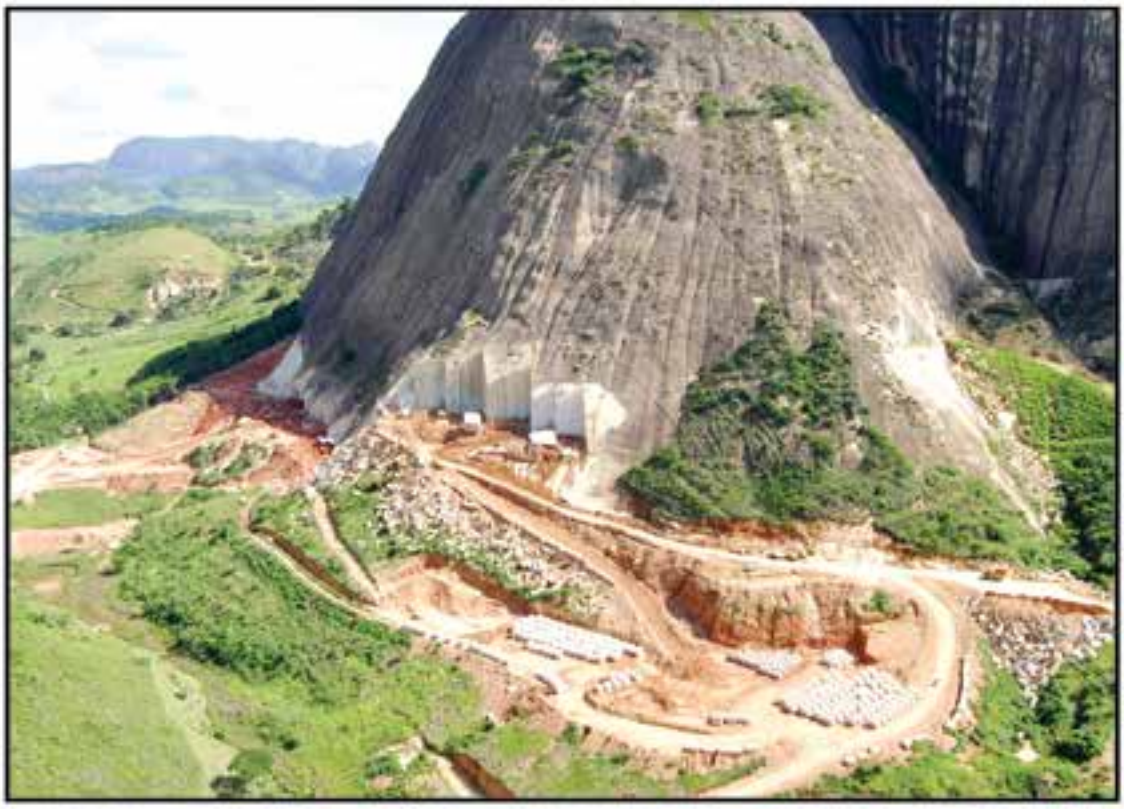
Macroscopic Description
Fine to coarse rock, mainly medium, varying between 0.3 and 5.5 mm. It presents weak weathering alteration evidenced by the turbidity of feldspars, caused by dots of iron hydroxide and sericite.

Petrographic Classification
Syenogranitic gneiss

Technological Characteristics		
Density	2623	kg/m³
Water Absorption	0.41	%
Uniaxial Compression Breaking Load at the Natural	132.3	MPa
Amsler Wear Test (1000m)	0.96	mm
Linear Thermal Expansion	5.8	mm/m °C
Apparent Porosity	1.08	%
Modulus of Rupture	13.71	MPa
Compression Breaking Load After Freezing/Thawing	154	MPa
Impact Resistance	62	cm

Recommended Use
Floor, interior and exterior coating.

Giallo Topázio



County
Nova Venécia

Localization
Itaperuna

Coordinates
Geographic: 18°46'48"S / 40°44'55"W
UTM: 315671 E / 7922594 N Zone:24S

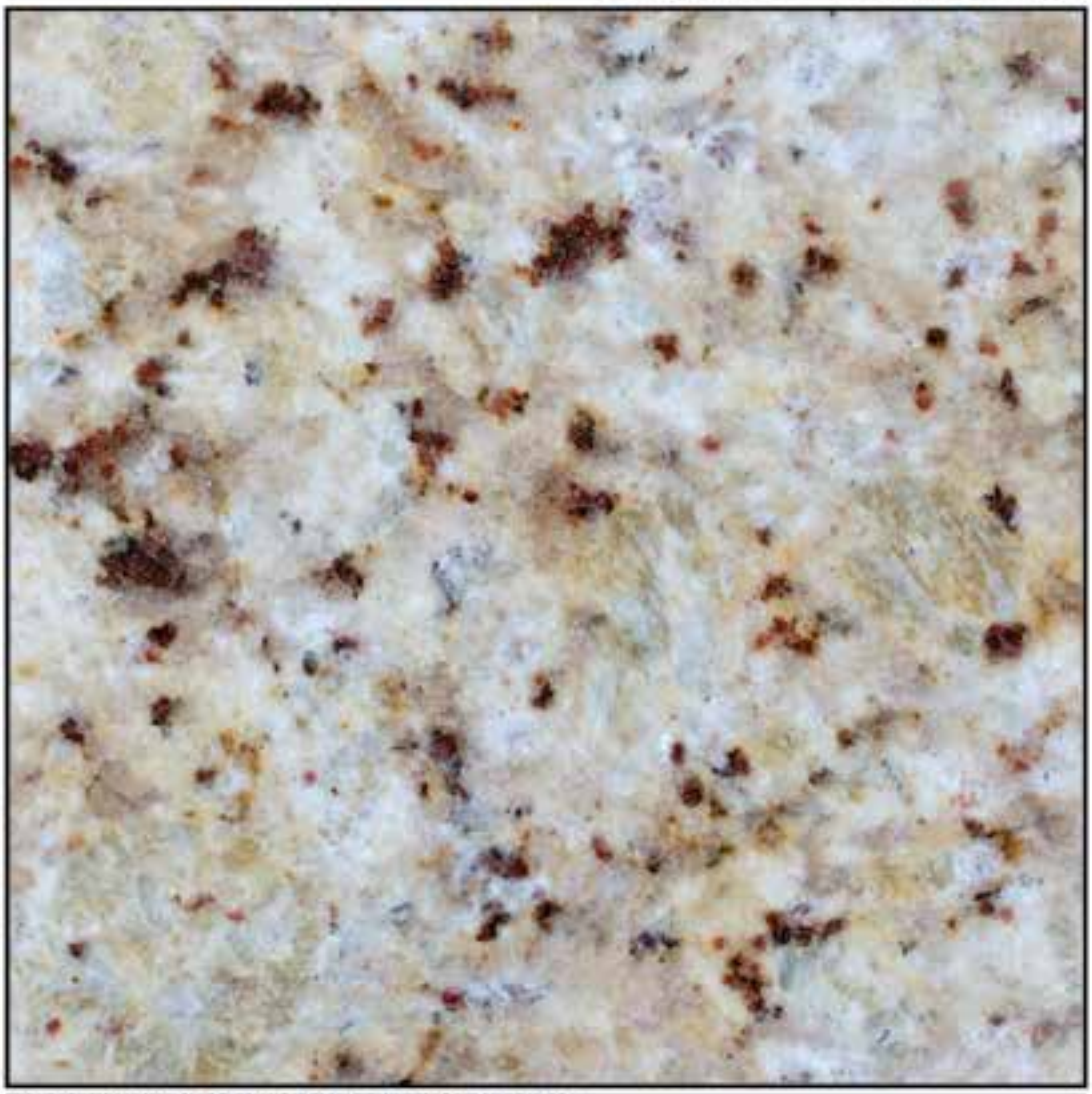
Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Giallo Verona



Mineralogic Composition (microscopy)
Perthitic microcline (45%); quartz (35%); andesine (10-15%); garnet (5%); biotite, opaques, apatite, zircon, spinel, sillimanite (accessories); sericite-muscovite, cabonate, colorless clay minerals, iron hydroxide.

Macroscopic Description
Fine to coarse (0.5 mm to 20 mm), mainly medium to coarse (2 mm to 15 mm). At natural it presents a light beige color with black dots. When polished, it is light beige with black to red dots.

Petrographic Classification
Syenogranitic gneiss with garnet and sillimanite

Technological Characteristics		
Density	2638	kg/m^3
Water Absorption	0.30	%
Uniaxial Compression Breaking Load at the Natural	140	MPa
Amsler Wear Test (1000m)	1.02	mm
Linear Thermal Expansion	4.9 (⊥) and 5.3 (//)	mm/m °C
Apparent Porosity	0.78	%
Modulus of Rupture	12.31	MPa
Compression Breaking Load After Freezing/Thawing	141	MPa
Impact Resistance	53	cm

Recommended Use
Floor, interior and exterior coating.

⊥ Thermal expansion axis perpendicular to rock foliation
// Thermal expansion axis parallel to rock foliation

Giallo Verona

County
Barra de São Francisco

Localization
Fortaleza Farm.

Coordinates
Geographic: 18°43'04"S / 40°41'43"W
UTM: 321244 E / 7929551 N Zone:24S

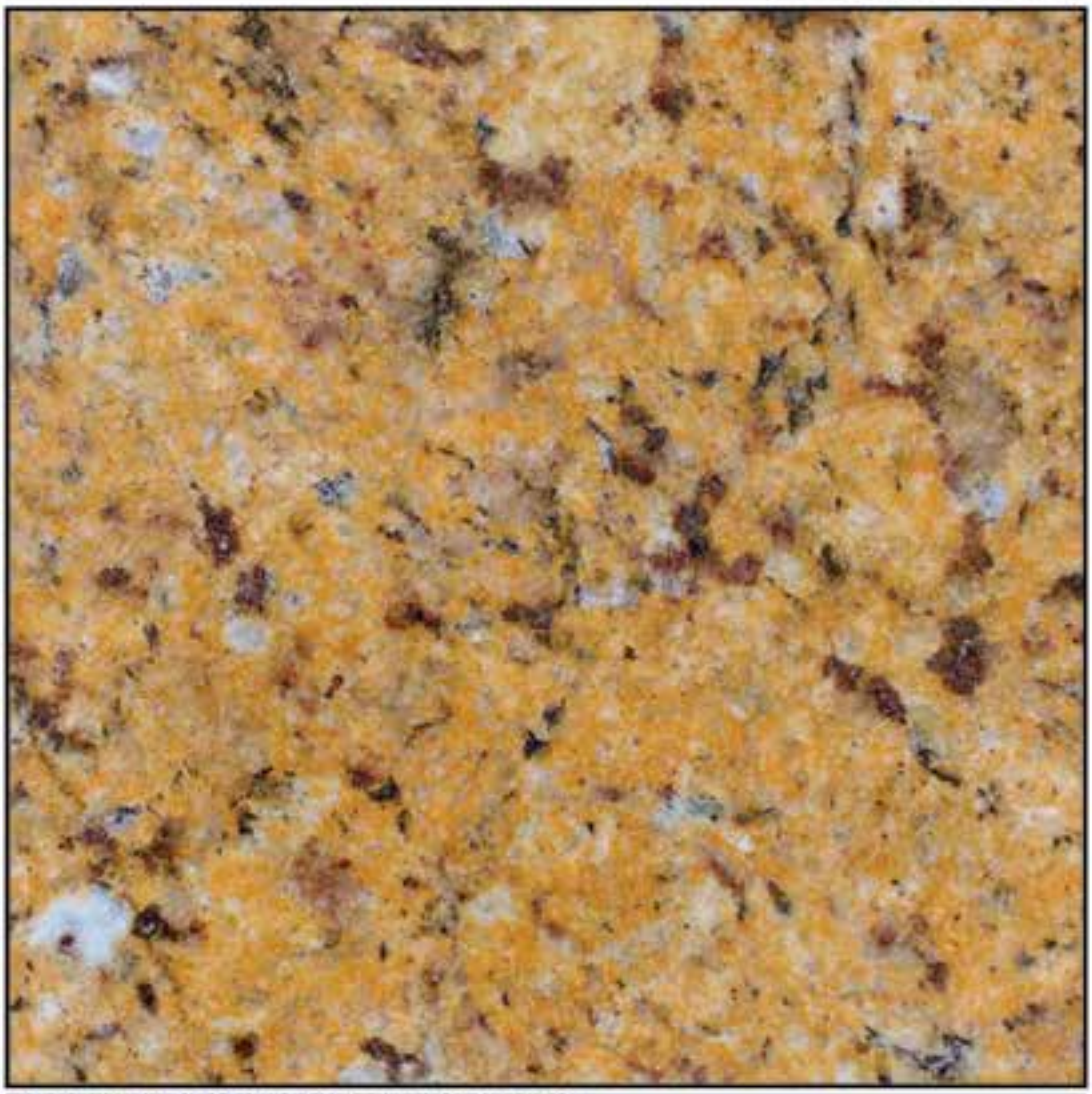
Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
New Venetian; Bege Pavão;

Type and Predominant Color
Yellow granite

Gold 500



Mineralogic Composition (microscopy)
Crypt- to microperthitic microcline (50-55%); quartz (30-35%); oligoclase (10%); biotite(<5%); garnet (<5%); opaques, zircon, espinel, sillimanite (tr); iron hydroxides, sericite (secundaries).

Macroscopic Description
Gneissic grayish yellow rock, fine to coarse grained, mainly medium.

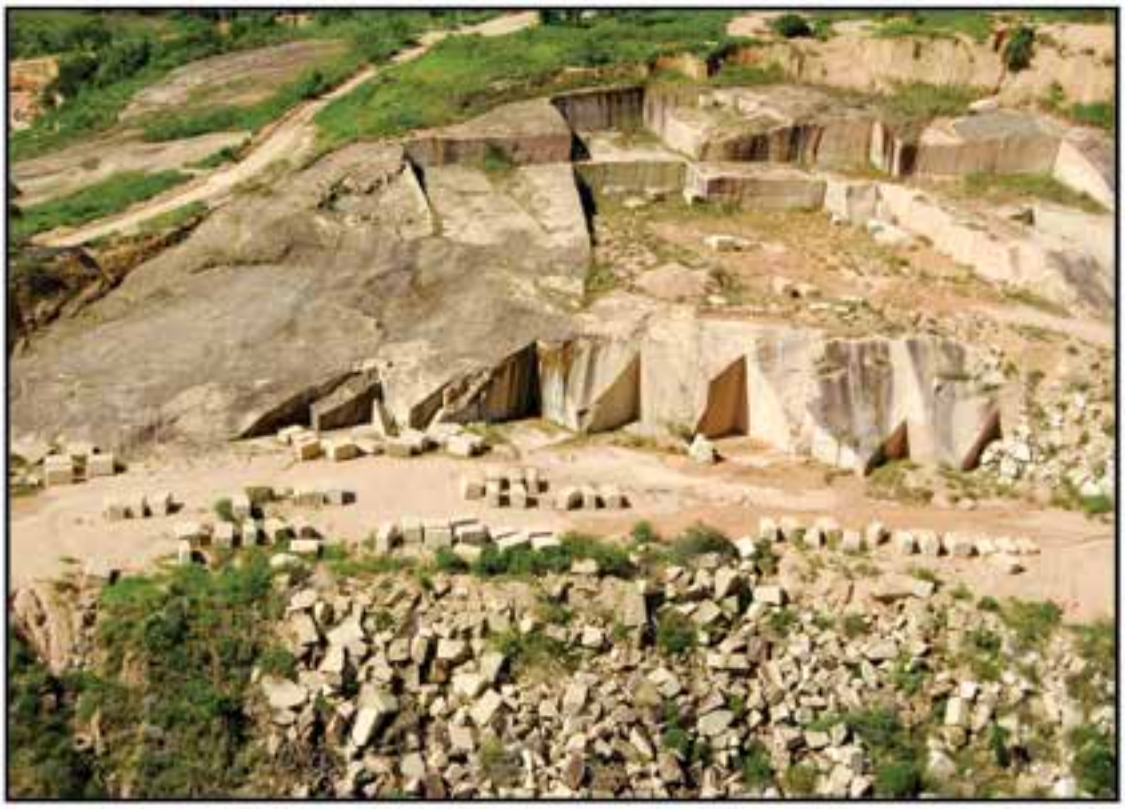
Petrographic Classification
Syenogranitic gneiss

Technological Characteristics		
Density	2631	kg/m³
Water Absorption	0.36	%
Uniaxial Compression Breaking Load at the Natural	138 (⊥) and 147 (//)	MPa
Amsler Wear Test (1000m)	0.73	mm
Linear Thermal Expansion	5.9	mm/m °C
Apparent Porosity	0.94	%
Modulus of Rupture	15.6 (⊥) and 8.92 (//)	MPa
Compression Breaking Load After Freezing/Thawing	127 (⊥) and 153 (//)	MPa
Impact Resistance	61	cm

Recommended Use
Floor, interior and exterior coating.

⊥ Compression/flexion axis perpendicular to rock foliation
// Compression/flexion axis parallel to rock foliation

Gold 500



County
Barra de São Francisco

Localization
Boa Esperança Stream.

Coordinates
Geographic: 18°45'58"S / 40°44'40"W
UTM: 316120 E / 7924151 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Golden King

Mineralogic Composition (microscopy)
Microperthitic potassium feldspar (45%); quartz (25%); biotite (10%); plagioclase (10%); garnet (7%); acessories (3%).

Macroscopic Description
Gneissic pale reddish yellow rock, fine to coarse grained, predominantly medium.

Petrographic Classification
Syenogranitic biotite gneiss with garnet and sillimanite.

Technological Characteristics		
Density	2636	kg/m^3
Water Absorption	0.41	%
Compression Breaking Load at the Natural	116.4	MPa
Amsler Wear Test (1000m)	0.8	mm
Linear Thermal Expansion	7	mm/m °C
Apparent Porosity	1.08	%
Modulus of Rupture	11.11	MPa
Compression Breaking Load After Freezing/Thawing	106.6	MPa
Impact Resistance	50	cm

Recommended Use
Floor, interior, and exterior coating.

Golden King

County
Ecoporanga

Localization
Limão Stream, Imburana.

Coordinates
Geographic: 18°13'30"S / 40°43'21"W
UTM: 317836 E / 7984064 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Golden King (Cross Cut);

Type and Predominant Color
Yellow granite

Golden Sun

Mineralogic Composition (microscopy)
Quartz (33%); plagioclase - oligoclase (30%); microperthitic microcline (27%); hornblende (7%); accessories (3%).

Macroscopic Description
Gneissic pale reddish yellow rock with banded structure, medium granulation and pegmatoid parts very coarse grained.

Petrographic Classification
Monzogranitic gneiss

Technological Characteristics		
Density	2591	kg/m^3
Water Absorption	0.426	%
Compression Breaking Load at the Natural	93.6	MPa
Amsler Wear Test (1000m)	0.0166	cm^3/cm^2
Linear Thermal Expansion	0.002026	mm/(mm x ºC)
Apparent Porosity	1.1	%
Modulus of Rupture	6.4	MPa
Compression Breaking Load After Freezing/Thawing	79.5	MPa
Impact Resistance	50	cm

Recommended Use
Floor, interior, and exterior coating.

Golden Sun

County
Cachoeiro do Itapemirim

Localization
Areinha Farm.

Coordinates
Geographic: 20°41'52"S / 41°11'54"W
UTM: 271030 E / 7709748 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Boulder

Other Names

Type and Predominant Color
Yellow granite

Juparaná Casablanca

Mineralogic Composition (microscopy)
Mesoperthitic microcline (50%); plagioclase - oligoclase (20%); quartz (20%); biotite (5%); garnet (3%); sillimanite - fibrolite (2%).

Macroscopic Description
Gneissic yellowish orange rock, medium grained with black dots (biotite).

Petrographic Classification
Syenogranitic gneiss with biotite and garnet

Technological Characteristics		
Density	2594	kg/m^3
Water Absorption	0.50	%
Compression Breaking Load at the Natural	133.6	MPa
Amsler Wear Test (1000m)	0.8	cm^3/cm^2
Linear Thermal Expansion	6.4	mm/(mm x °C)
Apparent Porosity	1.29	%
Modulus of Rupture	6.06	MPa
Compression Breaking Load After Freezing/Thawing	90.9	MPa
Impact Resistance	70	cm

Recommended Use
Interior and exterior coating.

Juparaná Casablanca

County
Ecoporanga

Localization
Peixe Branco/Novo Horizonte.

Coordinates
Geographic: 18°16'47"S / 41°06'30"W
UTM: 277067 E / 7977596 N Zone:24S

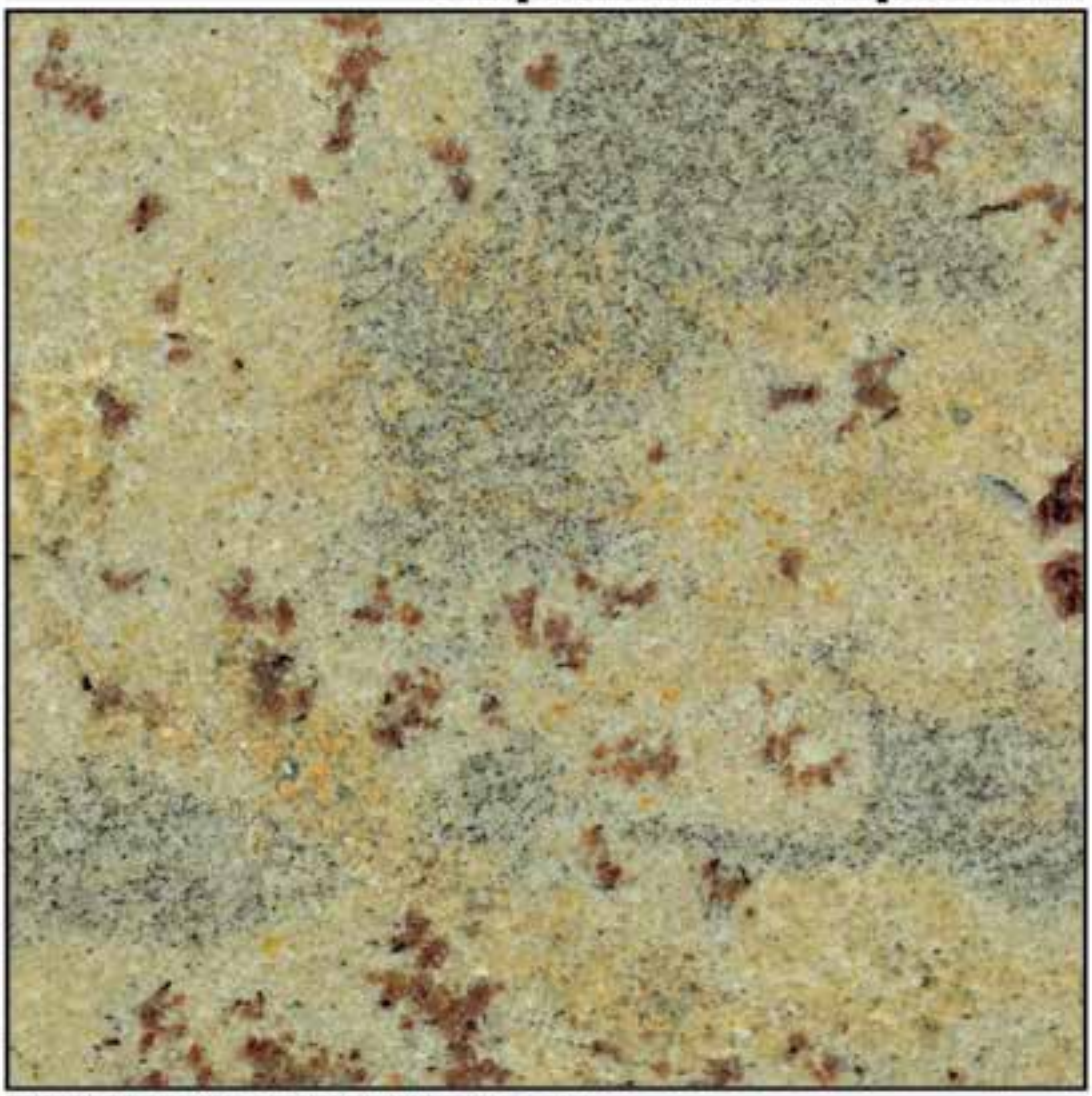
Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Juparaná Imperial



Mineralogic Composition (microscopy)
Microperthitic microcline (35-40%); quartz (20-25%); oligoclase (20-25%); garnet (10%); biotite (5-10%); zircon, apatite and opaques (accessories); sericite, muscovite, carbonate, colorless and brown clay minerals (secundaries);

Macroscopic Description
Pinkish to yellowish white rock fine to coarse grained

Petrographic Classification
Biotite garnet gneiss

Technological Characteristics		
Density	2627	kg/m^3
Water Absorption	0.42	%
Uniaxial Compression Breaking Load at the Natural	109.8	MPa
Amsler Wear Test (1000m)	1.26	mm
Linear Thermal Expansion	5.6	mm/m °C
Apparent Porosity	1.11	%
Modulus of Rupture	6.91	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	57	cm

Recommended Use
Interior and exterior coating.

NA = not available

Juparaná Imperial

County
Ibiraçu

Localization
Taquaruçu Stream.

Coordinates
Geographic: 19°48'20"S / 40°22'25"W
UTM: 356126 E / 7809437 N Zone:24S

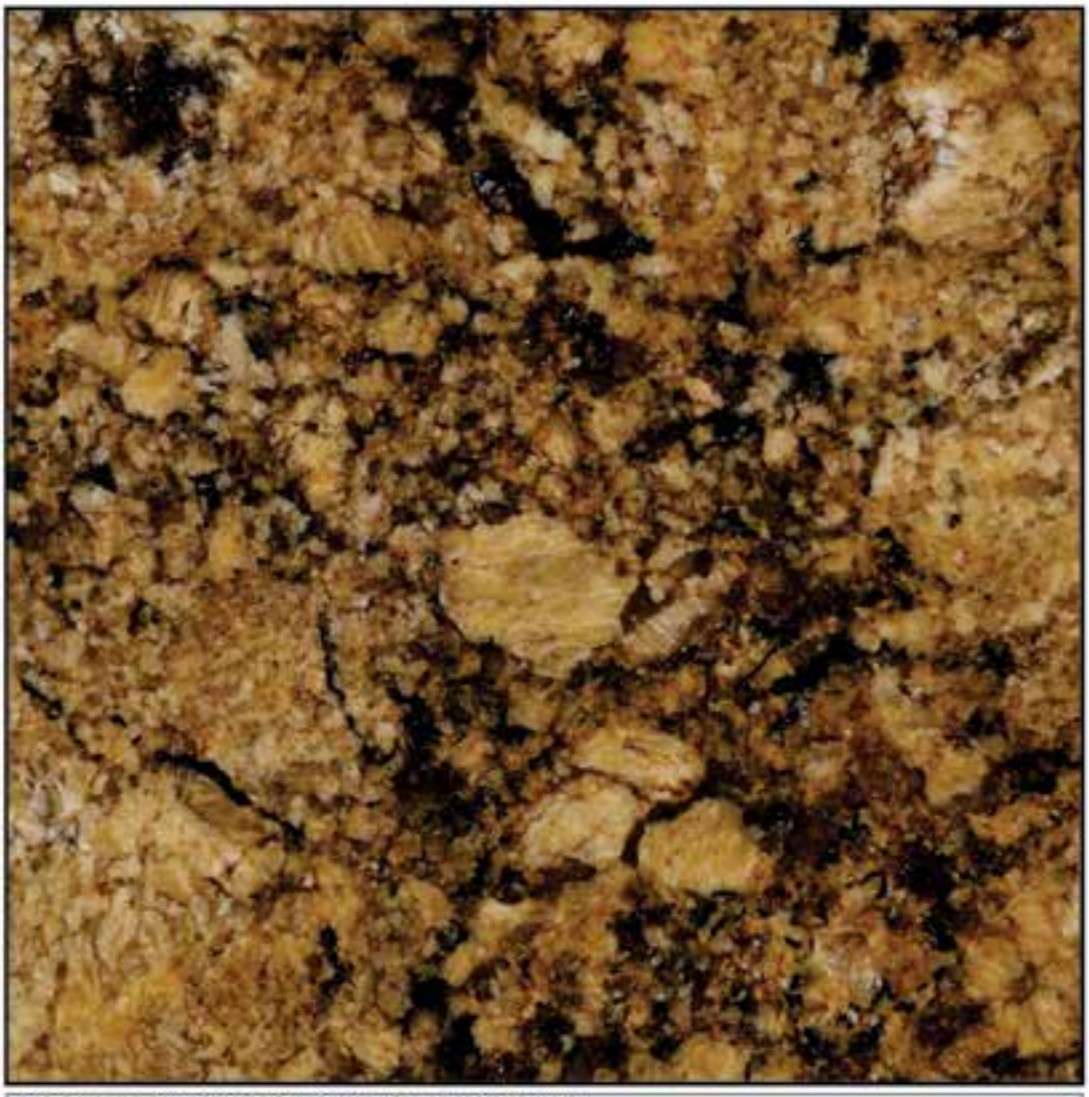
Geological Unit
Carlos Chagas Suite

Occurrence
Massive Rock

Other Names

Type and Predominant Color
Yellow granite

Juparaná Persa



Mineralogic Composition (microscopy)
Plagioclase - andesine (33%); perthitic microcline (32%); quartz (22%); biotite (5%); garnet (5%); acessories (3%).

Macroscopic Description
Gneissic brownish yellow rock, medium to coarse grained with small yellowish brown dots and spots (feldspar and mafic minerals oxidation).

Petrographic Classification
Alkali granite

Technological Characteristics		
Density	2605	kg/m^3
Water Absorption	0.40	%
Compression Breaking Load at the Natural	112.3	MPa
Amsler Wear Test (1000m)	0.92	mm
Linear Thermal Expansion	7.2	mm/m °C
Apparent Porosity	1.04	%
Modulus of Rupture	12.35	MPa
Compression Breaking Load After Freezing/Thawing	121.5	MPa
Impact Resistance	55	cm

Recommended Use
Floor, interior, and exterior coating.

Juparaná Persa

County
Vargem Alta

Localization
Bela Vista Farm

Coordinates
Geographic: 20°38'36"S / 41°01'10"W
UTM: 289596 E / 7716009 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock

Other Names
Persa; Amarelo Persa;

Type and Predominant Color
Yellow granite

Juparaná Sunny

Mineralogic Composition (microscopy)
Microperthitic alkali feldspar (38%); quartz (27%); plagioclase (18%); sillimanite (7%); biotite (5%); garnet (5%).

Macroscopic Description
Gneissic slightly yellowish white rock coarse grained with reddish dots (garnet).

Petrographic Classification
Syenogranitic gneiss with sillmanite and garnet

Technological Characteristics		
Density	2628	kg/m³
Water Absorption	0.42	%
Compression Breaking Load at the Natural	82	MPa
Amsler Wear Test (1000m)	0.8	mm
Linear Thermal Expansion	5.7	mm/m °C
Apparent Porosity	1.1	%
Modulus of Rupture	6.62	MPa
Compression Breaking Load After Freezing/Thawing	81.51	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Juparaná Sunny

County
Barra de São Francisco

Localization
Itaperuna Stream.

Coordinates
Geographic: 18°43'37"S / 40°43'45"W
UTM: 317678 E / 7928476 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Juparaná Talpic

Mineralogic Composition (microscopy)
Plagioclase-oligoclase (35%); quartz (32%); microcline (23%); garnet (10%);

Macroscopic Description
Banded gneissic rock, fine to medium grained, showing white bands intercalated with pink bands.

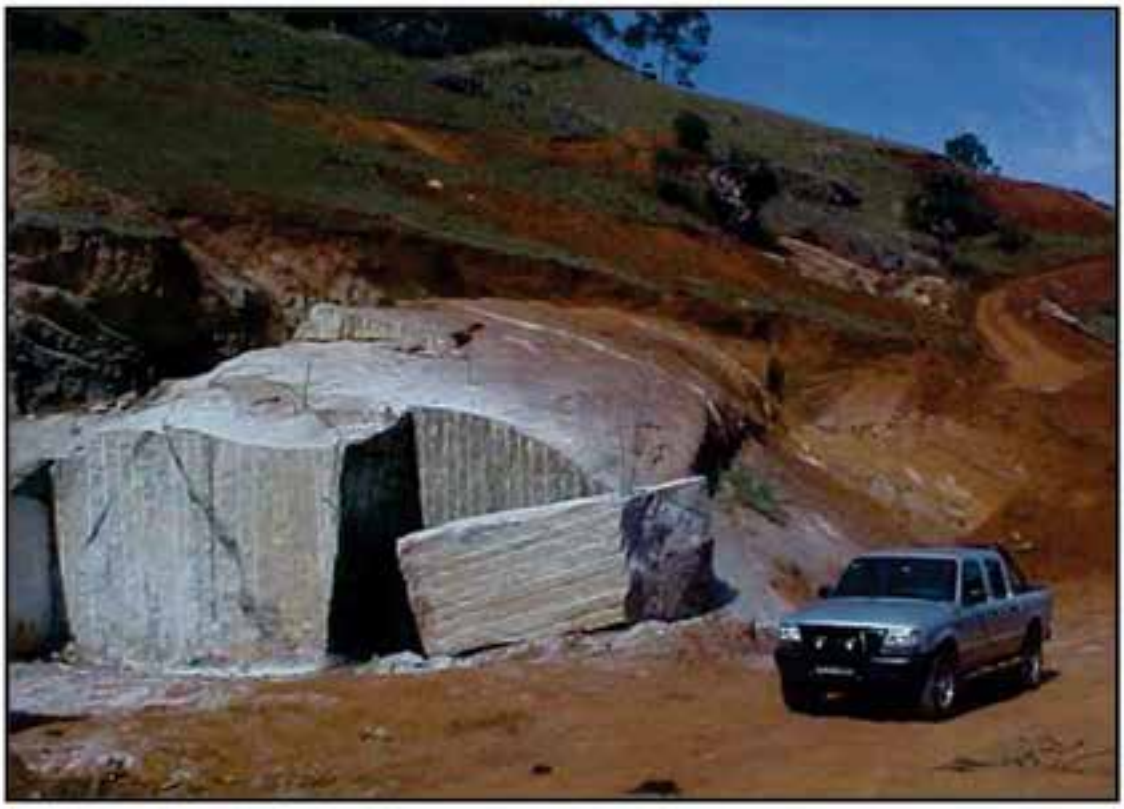
Petrographic Classification
Garnet monzogranitic gneiss

Technological Characteristics		
Density	2616	kg/m^3
Water Absorption	0.42	%
Compression Breaking Load at the Natural	NA	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	6.3	mm/m °C
Apparent Porosity	1.1	%
Modulus of Rupture	6.78	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Juparaná Talpic



County
Castelo

Localization
Nogueira

Coordinates
Geographic: 20°30'19"S / 41°11'25"W
UTM: 271581 E / 7731063 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock and boulders

Other Names

Type and Predominant Color
Yellow granite

Key West Gold

Mineralogic Composition (microscopy)
Antiperthitic plagioclase (30%), quartz (25%); cryptoperthitic k-feldspar (15-20%); garnet (15%); brown biotite (10%); opaques, green biotite (<5%); sericite, carbonate, colorless phyllosilicates (secundaries).

Macroscopic Description
Heterogeneous grayish rock with porphyritic granulation, brownish yellow feldspar, and red garnet associations.

Petrographic Classification
Porphyritic granite with biotite and garnet

Technological Characteristics		
Density	2666	kg/m^3
Water Absorption	0.203	%
Compression Breaking Load at the Natural	86.7	MPa
Amsler Wear Test (1000m)	0.16	cm^3/cm^2
Linear Thermal Expansion	0.000182	mm/(mm x °C)
Apparent Porosity	0.541	%
Modulus of Rupture	12.4	MPa
Compression Breaking Load After Freezing/Thawing	79	MPa
Impact Resistance	50	cm

Recommended Use
Interior and exterior coating.

Key West Gold

County
Boa Esperança

Localization
Engano Stream - São Pedro Farm.

Coordinates
Geographic: 18°28'10"S / 40°22'06"W
UTM: 355500 E / 7957330 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Madeira Gold

Mineralogic Composition (microscopy)
Perthitic microcline (35-40%); quartz (25%), plagioclase - oligoclase/andesine (30-35%); garnet (5%). Accessories: biotite, zircon, opaques. Secundaries: sericite, muscovite, chlorite and iron hydroxides.

Macroscopic Description
Gneissic pale to dark yellow rock with pink and black dots.

Petrographic Classification
Syenogranitic gneiss with garnet

Technological Characteristics		
Density	2627	kg/m^3
Water Absorption	0.46	%
Uniaxial Compression Breaking Load at the Natural	88	MPa
Amsler Wear Test (1000m)	1.68	mm
Linear Thermal Expansion	4.7 (⊥) and 4.2 (//)	mm/m °C
Apparent Porosity	1.2	%
Modulus of Rupture	7.06	MPa
Compression Breaking Load After Freezing/Thawing	125	MPa
Impact Resistance	53	cm

Recommended Use
Interior and exterior coating.

⊥ Thermal expansion axis perpendicular to rock foliation
// Thermal expansion axis parallel to rock foliation

Madeira Gold

County
Colatina

Localization
Bela Aurora Stream, Angelo Frechiani.

Coordinates
Geographic: 19°22'04"S / 40°40'45"W
UTM: 323613 E / 7857608 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Napoleone Gold

Mineralogic Composition (microscopy)
Microperthitic microcline (30%-35%); plagioclase - oligoclase (25-30%), quartz (25%); biotite (15%); zircon, apatite, opaques, sericite, carbonates, phyllosilicates, clay minerals and iron hydroxide (accessories).

Macroscopic Description
Rock with granitic composition coarse grained. It is gneissified with elongated crystals and inequigranular texture.

Petrographic Classification
Biotite monzogranite

Technological Characteristics		
Density	2638	kg/m^3
Water Absorption	0.41	%
Uniaxial Compression Breaking Load at the Natural	89.3	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	NA	mm/m °C
Apparent Porosity	1.08	%
Modulus of Rupture	8.76	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Napoleone Gold

County
Vila Pavão

Localization
Rapadura Stream.

Coordinates
Geographic: 18°39'58"S / 40°35'45"W
UTM: 331680 E / 7935348 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Giallo Napoleone;

Type and Predominant Color
Yellow granite

New Icaraí

Mineralogic Composition (microscopy)
Microcline, quartz, plagioclase and biotite.

Macroscopic Description
Rock with gneissic structure, medium to very coarse grained with a light reddish yellow color.

Petrographic Classification
Porphyroid foliated protomylonitic garnet-biotite granite

Technological Characteristics		
Density	2650	kg/m^3
Water Absorption	0.23	%
Compression Breaking Load at the Natural	146.13	MPa
Amsler Wear Test (1000m)	1.55	mm
Linear Thermal Expansion	NA	mm/m °C
Apparent Porosity	0.62	%
Modulus of Rupture	13.17	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

New Icaraí

County
Ecoporanga

Localization
Pitengo Stream.

Coordinates
Geographic: 18°17'44"S / 40°39'45"W
UTM: 324269 E / 7976298 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Santa Helena;

Type and Predominant Color
Yellow granite

Oriental Yellow

Mineralogic Composition (microscopy)
NA

Macroscopic Description
Foliated pale yellow rock with coarse to very coarse granulation, lepidoblastic texture, consisting of k-feldspar, biotite, quartz, sillimanite and sometimes garnet.

Petrographic Classification
Syenogranitic biotite gneiss with garnet and sillimanite

Technological Characteristics		
Density	2641	kg/m³
Water Absorption	0.24	%
Compression Breaking Load at the Natural	136.1	MPa
Amsler Wear Test (1000m)	1.24	mm
Linear Thermal Expansion	6.0	mm/m °C
Apparent Porosity	0.64	%
Modulus of Rupture	10.28	MPa
Compression Breaking Load After Freezing/Thawing	134.8	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Oriental Yellow

County
Ecoporanga

Localization
Ferrugem Stream.

Coordinates
Geographic: 18°16'52"S / 40°46'52"W
UTM: 311723 E / 7977795 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Giallo Oriental;

Type and Predominant Color
Yellow granite

Ouro Brasil

Mineralogic Composition (microscopy)
Microperthitic alkali feldspar (45%); quartz (25%); plagioclase - oligoclase (20%); biotite (5%); garnet (5%).

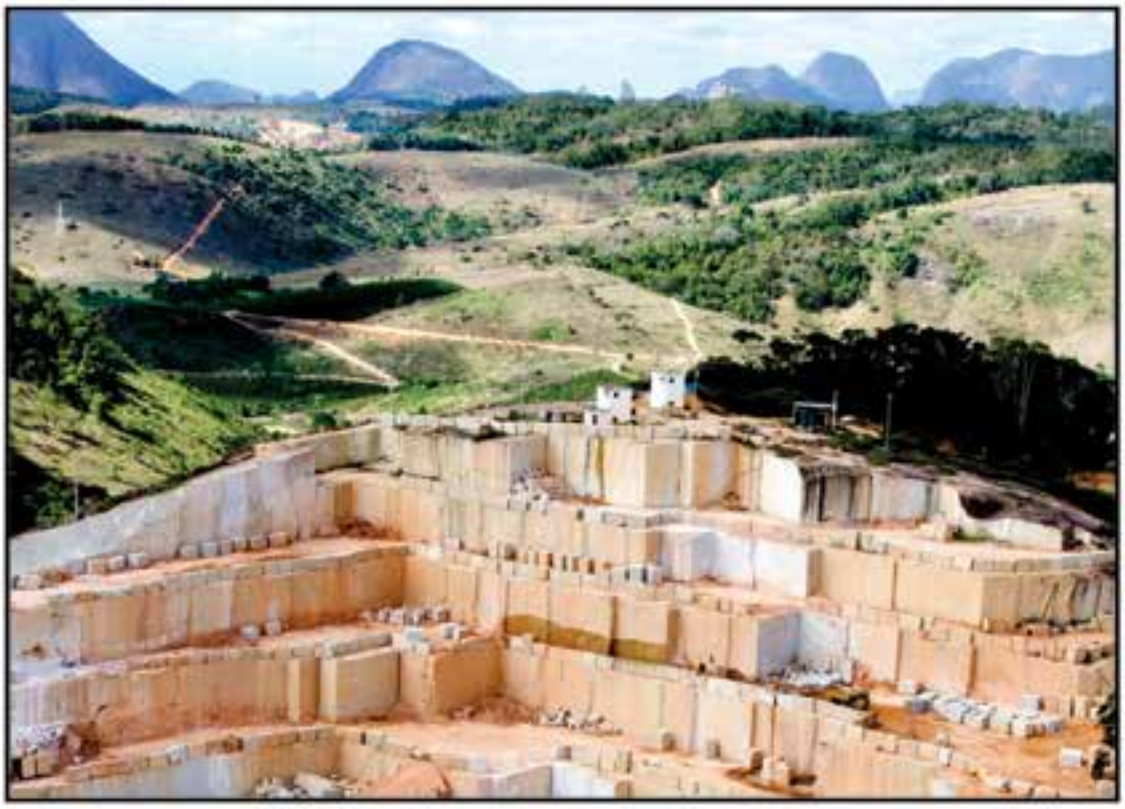
Macroscopic Description
Rock presenting orientation and banded irregularly with a medium to very coarse granulation.

Petrographic Classification
Syenogranitic garnet gneiss

Technological Characteristics		
Density	2670	kg/m^3
Water Absorption	0.32	%
Uniaxial Compression Breaking Load at the Natural	152	MPa
Amsler Wear Test (1000m)	1.76	mm
Linear Thermal Expansion	0.48	mm/m °C
Apparent Porosity	0.85	%
Modulus of Rupture	9.23	MPa
Compression Breaking Load After Freezing/Thawing	146.3	MPa
Impact Resistance	58	cm

Recommended Use
Interior and exterior coating.

Ouro Brasil



County
Vila Pavão

Localization
Todos os Anjos Stream.

Coordinates
Geographic: 18°37'49"S / 40°41'09"W
UTM: 322136 E / 7939249 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
New Venecian Gold; Gold Star;

Type and Predominant Color
Yellow granite

Ouro do Deserto

Mineralogic Composition (microscopy)
Mesoperthitic microcline (43%); quartz (32%); plagioclase (10%); sillimanite (5%); biotite (5%); garnet (5%); other (5%).

Macroscopic Description
Gneissic rock coarsed grained with a slightly brownish orange color with black aggregates (biotite) and red dots (garnet).

Petrographic Classification
Syenogranitic gneiss with sillimanite and garnet

Technological Characteristics		
Density	25.60	kg/m^3
Water Absorption	0.40	%
Compression Breaking Load at the Natural	131	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	5.6	mm/m °C
Apparent Porosity	0.82	%
Modulus of Rupture	8.27	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Ouro do Deserto

County
Ecoporanga

Localization
Quarry MHB.
Located on Montes Verdes Farm.
Ponto Belo x Santa Luzia Road Km 12.

Coordinates
Geographic: 18°11'45"S / 40°36'53"W
UTM: 329220 E / 7987388 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Persa Caravelas

Mineralogic Composition (microscopy)
Plagioclase - andesine (33%); perthitic microcline (32%); quartz (22%); biotite (5%); garnet (5%); accessories (3%).

Macroscopic Description
Gneissic brownish yellow rock medium to coarse grained with small yellowish brown dots and spots (feldspar and mafic minerals oxidation).

Petrographic Classification
Alkali granite

Technological Characteristics		
Density	2605	kg/m^3
Water Absorption	0.4	%
Compression Breaking Load at the Natural	112.3	MPa
Amsler Wear Test (1000m)	0.92	cm^3/cm^2
Linear Thermal Expansion	7.2	mm/(mm x ºC)
Apparent Porosity	1.04	%
Modulus of Rupture	12.35	MPa
Compression Breaking Load After Freezing/Thawing	121.5	MPa
Impact Resistance	55	cm

Recommended Use
Floor, interior, and exterior coating.

Persa Caravelas

County
Vargem Alta

Localization
Bela Vista Farm.

Coordinates
Geographic: 20°39'11"S / 41°01'40"W
UTM: 288727 E / 7714900 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Purple Dunes

Mineralogic Composition (microscopy)
Microcline (40%); quartz (28%); plagioclase (22%); biotite (10%); garnet (1%); zircon (traces).

Macroscopic Description
Rock with low grade foliation, heterogeneous, phaneritic.

Petrographic Classification
Biotite granitic gneiss

Technological Characteristics		
Density	2631	kg/m^3
Water Absorption	0.34	%
Uniaxial Compression Breaking Load at the Natural	83.1	MPa
Amsler Wear Test (1000m)	0.008	cm^3/cm^2
Linear Thermal Expansion	0.002853	mm/(mm x °C)
Apparent Porosity	0.9	%
Modulus of Rupture	11.7	MPa
Compression Breaking Load After Freezing/Thawing	71.1	MPa
Impact Resistance	51	cm

Recommended Use
Floor, interior and exterior coating.

Purple Dunes

County
São Roque do Canaã

Localization
Mutum Stream, Jacinto small Farm.

Coordinates
Geographic: 19°43'17"S / 40°35'03"W
UTM: 333978 E / 7818563 N Zone: 24S

Geological Unit
Nova Venécia Complex

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Santa Cecília

Mineralogic Composition (microscopy)
Microperthitic potassium feldspar (34%); quartz (25%); plagioclase (20%); biotite (10%); garnet (7%) and accessories 4%.

Macroscopic Description
Gneissic pale reddish yellow rock, medium to very coarse grained.

Petrographic Classification
Monzogranitic biotite gneiss with garnet and sillimanite

Technological Characteristics		
Density	2647	kg/m^3
Water Absorption	0.32	%
Compression Breaking Load at the Natural	103.6	MPa
Amsler Wear Test (1000m)	0.60	mm
Linear Thermal Expansion	7.2	mm/m °C
Apparent Porosity	0.86	%
Modulus of Rupture	7.21	MPa
Compression Breaking Load After Freezing/Thawing	114	MPa
Impact Resistance	55	cm

Recommended Use
Interior and exterior coating.

Santa Cecília

County
Ecoporanga

Localization
Água Stream.

Coordinates
Geographic: 18°46'51"S / 40°39'13"W
UTM: 325680 E / 7922605 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Santa Cecília Napoli (Cross Cut); Giallo Vitória; Santa Cecília Classic; Santa Rita Yellow;
Clássico; Gegrége;

Type and Predominant Color
Yellow granite

Santa Cecília Gold

Mineralogic Composition (microscopy)
Consisting of quartz, feldspar, biotite, amphibole, garnet and sillimanite.

Macroscopic Description
Leuco- to mesocratic granitic rock with a yellowish light gray color, fine to medium granulation, and equigranular to hypidiomorphic texture.

Petrographic Classification
Biotite leucogranite

Technological Characteristics		
Density	2634	kg/m^3
Water Absorption	0.24	%
Compression Breaking Load at the Natural	60.1	MPa
Amsler Wear Test (1000m)	0.0116	mm
Linear Thermal Expansion	0.000247569	mm/(mm x °C)
Apparent Porosity	0.63	%
Modulus of Rupture	NA	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Santa Cecília Gold

County
Água Doce do Norte

Localization
Nelita Village, Bom Destino Stream.

Coordinates
Geographic: 18°26'48"S / 40°58'48"W
UTM: 290880 E / 7959230 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

São Francisco Cristal

Mineralogic Composition (microscopy)
K-feldspar (24%); plagioclase (17%); quartz (12%); garnet (5%) and biotite (2%).

Macroscopic Description
Leucocratic rock with phaneritic texture and a slightly grayish white color.

Petrographic Classification
Leucobiotite garnet granite

Technological Characteristics		
Density	2667	kg/m^3
Water Absorption	0.13	%
Compression Breaking Load at the Natural	63.8	MPa
Amsler Wear Test (1000m)	NA	cm^3/cm^2
Linear Thermal Expansion	0.000221482	mm/(mm x °C)
Apparent Porosity	0.38	%
Modulus of Rupture	10.9	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	51	cm

Recommended Use
Interior and exterior coating.

NA = not available

São Francisco Cristal

County
Água Doce do Norte

Localization
Bom Destino Stream - Vila Nelita District.

Coordinates
Geographic: 18°26'51"S / 40°58'55"W
UTM: 290686 E / 7959139 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Soft Yellow

Mineralogic Composition (microscopy)
Perthitic microcline (40%); quartz (25%); andesine (20-25%); biotite (5%); garnet (5%); sillimanite (<5); titanite, opaques, zircon, espinel (traces); sericite-muscovite, carbonate, clay minerals, iron hydroxide (secundaries);

Macroscopic Description
Pale beige rock slightly oriented to gneissic, with granulation predominantly medium to coarse with black and red dots.

Petrographic Classification
Syenogranitic gneiss with garnet and sillimanite

Technological Characteristics		
Density	2636	kg/m³
Water Absorption	0.29	%
Uniaxial Compression Breaking Load at the Natural	142	MPa
Amsler Wear Test (1000m)	0.93	mm
Linear Thermal Expansion	4.5 (⊥) and 3.7 (//)	mm/m °C
Apparent Porosity	0.76	%
Modulus of Rupture	5.95	MPa
Compression Breaking Load After Freezing/Thawing	147	MPa
Impact Resistance	51	cm

Recommended Use
Floor, interior and exterior coating.

⊥ Thermal expansion axis perpendicular to rock foliation
// Thermal expansion axis parallel to rock foliation

Soft Yellow

County
Barra de São Francisco

Localization
Comprido Stream - 2.2 Km NNE of
Itaperuna Village.

Coordinates
Geographic: 18°41'04"S / 40°44'00"W
UTM: 317203 E / 7933202 E Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Toffee

Mineralogic Composition (microscopy)
Microcline (55%), quartz (24%), oligoclase (12%), biotite (7%), opaque mineral (2%), zircon, apatite (traces).

Macroscopic Description
Heterogeneous rock with a fine to medium matrix.

Petrographic Classification
Porphyritic biotite granite

Technological Characteristics		
Density	2618	kg/m^3
Water Absorption	0.45	%
Compression Breaking Load at the Natural	71.3	MPa
Amsler Wear Test (1000m)	0.0108	cm^3/cm^2
Linear Thermal Expansion	0.002734	mm/(mm x ºC)
Apparent Porosity	1.25	%
Modulus of Rupture	8.5	MPa
Compression Breaking Load After Freezing/Thawing	56.7	MPa
Impact Resistance	59	cm

Recommended Use
Interior and exterior coating.

Toffee

County
Itaguaçu

Localization
Itaimbé.

Coordinates
Geographic: 19°39'51"S / 40°50'54"W
UTM: 306200 E / 7824630 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Yellow Fenix

Mineralogic Composition (microscopy)
Quartz, microcline, plagioclase, biotite and amphibolite.

Macroscopic Description
Consists of beige potassium feldspar, color that dominates the rock due to the size of the crystals, followed by quartz, also well developed crystals, complemented by plagioclase, which contributes with the light color of the rock, and by mafics with fine granulation.

Petrographic Classification
Syenogranitic gneiss with biotite and garnet

Technological Characteristics		
Density	2629	kg/m^3
Water Absorption	0.32	%
Compression Breaking Load at the Natural	117.1	MPa
Amsler Wear Test (1000m)	0.98	mm
Linear Thermal Expansion	7.1	mm/m °C
Apparent Porosity	0.84	%
Modulus of Rupture	17.79	MPa
Compression Breaking Load After Freezing/Thawing	116.5	MPa
Impact Resistance	NA	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Yellow Fenix

County
Boa Esperança

Localization
Cachoeira da Lapa Farm.

Coordinates
Geographic: 18°31'59"S / 46°25'13"W
UTM: 350070 E / 7950233 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Yellow River

Mineralogic Composition (microscopy)
NA

Macroscopic Description
Leucocratic rock with coarse granulation, pegmatitic texture, isotropic structure consisting of quartz, plagioclase, microcline, biotite, garnet and muscovite dots. It shows a yellowish gray to white color with very oxidated dots that grant the rock an excellent appearance.

Petrographic Classification
Inequigranular garnet-biotite gneiss and migmatitic quartzodioritic hornblende-biotite gneiss.

Technological Characteristics		
Density	2786	kg/m^3
Water Absorption	0.27	%
Uniaxial Compression Breaking Load at the Natural	138.7	MPa
Amsler Wear Test (1000m)	0.010	cm^3/cm^2
Linear Thermal Expansion	NA	mm/m °C
Apparent Porosity	0.74	%
Modulus of Rupture	6.00	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	62	cm

Recommended Use
Floor, interior and exterior coating.

NA = not available

Yellow River

County
Barra de São Francisco

Localization
Ouro Stream - Paulista District.

Coordinates
Geographic: 18°41'55"S / 40°51'30"W
UTM: 304530 E / 7931615 N Zone:24S

Geological Unit
Carlos Chagas Suite

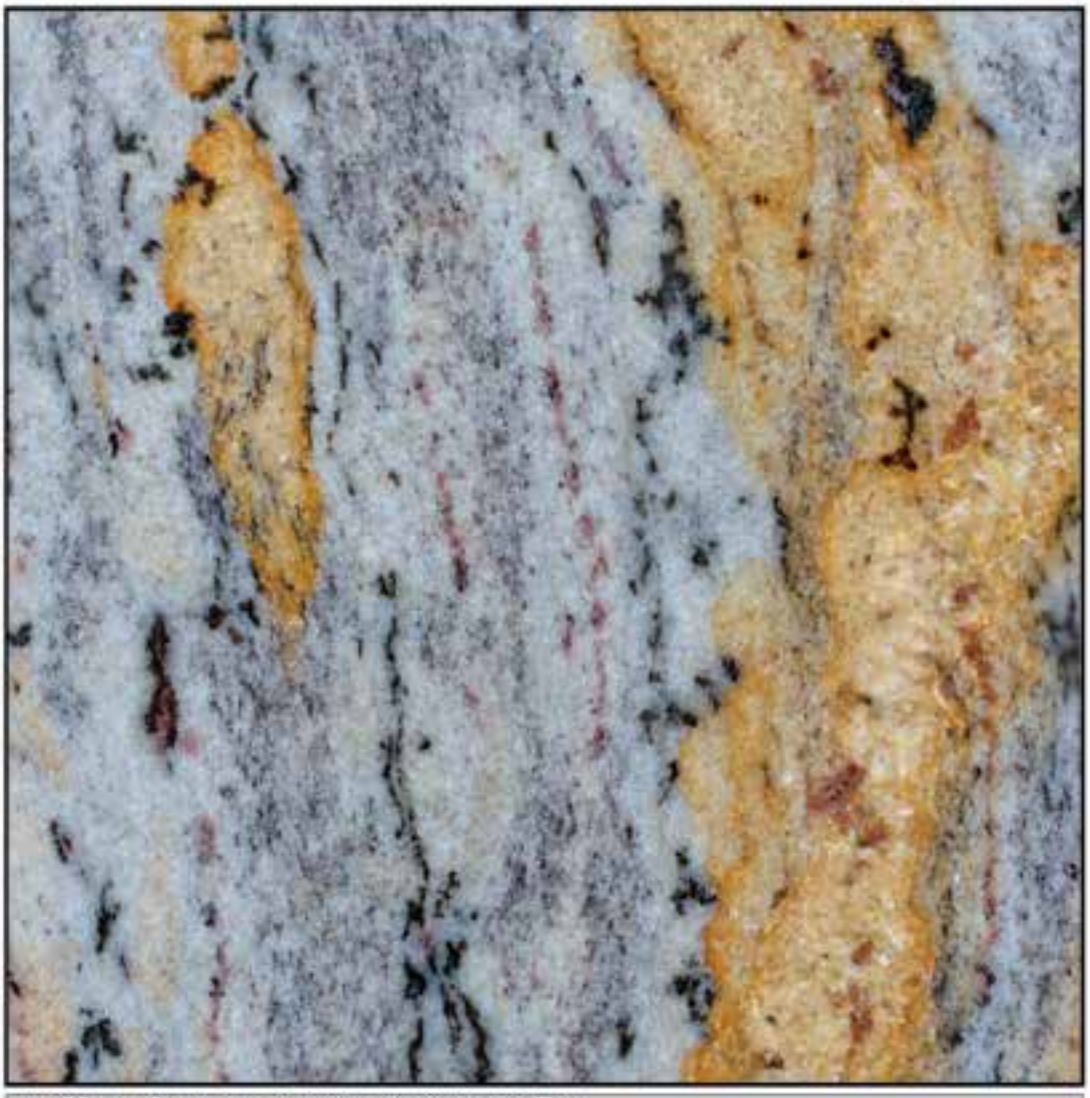
Occurrence
Massive rock

Other Names

Type and Predominant Color
Yellow granite

Blue

Blue Jaguar



Mineralogic Composition (microscopy)
Perthitic microcline (40-45%); quartz (25%), plagioclase -oligoclase/andesine (10-15%); biotite (5-10%); sillimanite (5-10%); garnet (5%). Accessories: zircon, opaques and cianite. Secundaries: sericite, muscovite and chlorite.

Macroscopic Description
Rock with gneissic structure, light to dark gray, slightly blueish, with black bands and pink dots.

Petrographic Classification
Syenogranitic gneiss with garnet and sillimanite

Technological Characteristics		
Density	2628	kg/m^3
Water Absorption	0.31	%
Compression Breaking Load at the Natural	141	MPa
Amsler Wear Test (1000m)	1.05	mm
Linear Thermal Expansion	4.5 (⊥) and 5.9 (//)	mm/m °C
Apparent Porosity	0.81	%
Modulus of Rupture	16.0	MPa
Compression Breaking Load After Freezing/Thawing	134.0	MPa
Impact Resistance	44	cm

Recommended Use
Interior and exterior coating.

⊥ Thermal expansion axis perpendicular to rock foliation
// Thermal expansion axis parallel to rock foliation

Blue Jaguar

County
Colatina

Localization
North Ângelo Frechiani Village -
ES-080 Road. Queiroz Farm.

Coordinates
Geographic: 19°17'01"S / 40°40'14"W
UTM: 324455 E / 7866946 N Zone:24S

Geological Unit
Nova Venécia Complex

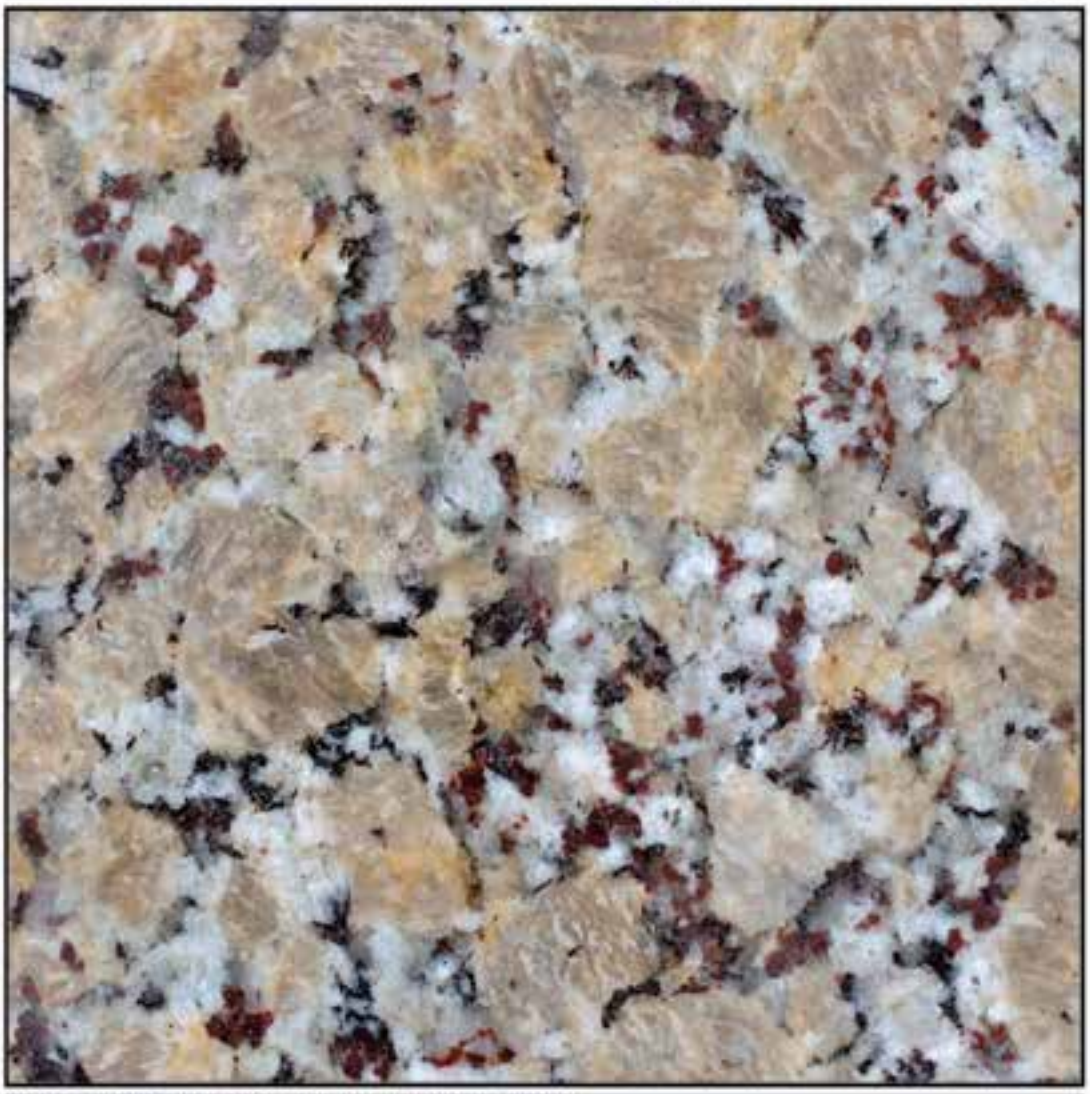
Occurrence
Massive rock

Other Names

Type and Predominant Color
Blueish gray granite

Beige

Bege Butterfly



Mineralogic Composition (microscopy)
Microperthitic microcline (40-45%); plagioclase - oligoclase (30%); quartz (20%); garnet (5%); orthopyroxene (hypersthene) trace; opaques (oxydes and sulfides), zircon, apatite, biotite (accessories <5%); iron hydroxides, uralite, carbonate, clay minerals, chlorite, green mica (secundaries);

Macroscopic Description
Rock with hypidiomrophic to granoblastic inequigranular texture, medium to very coarse granulation, with the majority of the grains measuring between 1 and 3 mm. Microcline megacrystals measure up to 3 cm.

Petrographic Classification
Charnockite with garnet

Technological Characteristics		
Density	2702	kg/m³
Water Absorption	0.25	%
Compression Breaking Load at the Natural	125.03	MPa
Amsler Wear Test (1000m)	1	mm
Linear Thermal Expansion	5	mm/m °C
Apparent Porosity	0.69	%
Modulus of Rupture	8.31	MPa
Compression Breaking Load After Freezing/Thawing	125.8	MPa
Impact Resistance	42	cm

Recommended Use
Floor, interior, and exterior coating.

Bege Butterfly

County
Barra de São Francisco

Localization
Comprido Stream - 2.5 Km NE Itaperuna Village.

Coordinates
Geographic: 18°41'34"S / 40°43'01"W
UTM: 318940 E / 7932270 N Zone: 24S

Geological Unit
Aimorés Intrusive Suite

Occurrence
Massive rock

Other Names
Bege Pavão;

Type and Predominant Color
Beige granite

Bege Ipanema

Mineralogic Composition (microscopy)
Microcline (35%); plagioclase - oligoclase (30%); quartz (30%); biotite (5%).

Macroscopic Description
Pale gray oriented banded rock, fine to medium coarse grained with gneissic structure.

Petrographic Classification
Monzogranitic gneiss

Technological Characteristics		
Density	2637	kg/m³
Water Absorption	0.21	%
Compression Breaking Load at the Natural	106.1	MPa
Amsler Wear Test (1000m)	0.73	mm
Linear Thermal Expansion	5.2	mm/m °C
Apparent Porosity	0.55	%
Modulus of Rupture	10.37	MPa
Compression Breaking Load After Freezing/Thawing	105.9	MPa
Impact Resistance	44	cm

Recommended Use
Floor, interior, and exterior coating.

Bege Ipanema

County
Muniz Freire

Localization
Madeira Farm, Rural Zone Piaçu District.

Coordinates
Geographic: 20°15'42"S / 41°19'21"W
UTM: 257386 E / 7757852 N Zone:24S

Geological Unit
Muniz Freire orthogneiss

Occurrence
Massive rock

Other Names

Type and Predominant Color
Beige granite

Juparaná Linhares

Mineralogic Composition (microscopy)
Antiperthitic plagioclase (30%); quartz (25%); cryptoperthitic k-feldspar (15-20%); garnet (15%); brown biotite (10%); opaques, zircon and green biotite (<5%); sericite, carbonate, colorless phyllosilicate (secundaries).

Macroscopic Description
Heterogeneous rock with porphyritic granulation, formed by grayish quartz crystals, yellowish feldspar, cream, with reddish garnet associations.

Petrographic Classification
Monzogranitic garnet gneiss

Technological Characteristics		
Density	2652	kg/m^3
Water Absorption	0.26	%
Compression Breaking Load at the Natural	95	MPa
Amsler Wear Test (1000m)	0.16	mm
Linear Thermal Expansion	7.5	mm/m ºC
Apparent Porosity	0.70	%
Modulus of Rupture	15.20	MPa
Compression Breaking Load After Freezing/Thawing	79	MPa
Impact Resistance	50	cm

Recommended Use
Floor, interior, and exterior coating.

Juparaná Linhares

County
Sooretama

Localization
Júlia Road - Santa Júlia.

Coordinates
Geographic: 19°08'00"S / 40°13'54" W
UTM: 370449 E / 7883948 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Beige granite

Luna Perla

Mineralogic Composition (microscopy)
Phenocrystals (59%): orthoclase (35%); quartz (16%); oligoclase (8%); opaques (accessories) <1%; Matrix (41%), orthoclase (13%); cordierite (10%); oligoclase (8%); quartz (6%); garnet (3%), biotite (1%); sillimanite (<1);

Macroscopic Description
Inequigranular porphyritic rock, with phaneritic matrix in which k-feldspar is associated to plagioclase, quartz, garnet and biotite crystals.

Petrographic Classification
Porphyritic cordierite granite with garnet, biotite and sillimanite.

Technological Characteristics		
Density	2624	kg/m^3
Water Absorption	0.23	%
Compression Breaking Load at the Natural	74.4	MPa
Amsler Wear Test (1000m)	0.0130	cm^3/cm^2
Linear Thermal Expansion	0.00031127	mm/(mm x ºC)
Apparent Porosity	0.60	%
Modulus of Rupture	11.15	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	46	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Luna Perla

County
Água Doce do Norte

Localization
Santo Agostinho District,
Cedro Stream.

Coordinates
Geographic: 18°33'43"S / 40°59'09"W
UTM: 287969 E / 7962917 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Beige granite

White

Arabesco

Mineralogic Composition (microscopy)
Microperthitic microcline (33%); quartz (27%); plagioclase - oligoclase (20%);
garnet (10%); biotite (7%); accessories (3%);

Macroscopic Description
Gneissic slightly yellowish white rock, coarse grained with red (garnets) and black (biotite) dots.

Petrographic Classification
Monzogranitic garnet gneiss with sillimanite

Technological Characteristics		
Density	2636	kg/m^3
Water Absorption	0.39	%
Compression Breaking Load at the Natural	107.8	MPa
Amsler Wear Test (1000m)	0.70	mm
Linear Thermal Expansion	6.5	mm/m °C
Apparent Porosity	1.02	%
Modulus of Rupture	7.89	MPa
Compression Breaking Load After Freezing/Thawing	103.6	MPa
Impact Resistance	NA	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Arabesco

County
Águia Branca

Localization
Barra do Sertão.

Coordinates
Geographic: 18°55'38"S / 40°48'07"W
UTM: 310216 E / 7906232 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Samoa; Branco Primata; MG 6; White Rose; Samoa Light;

Type and Predominant Color
White granite

Branco Alaska

Mineralogic Composition (microscopy)
K-feldspar (30%); quartz (25%); plagioclase (10%); biotite (11%); garnet (4%); sillimanite (<1%); opaque mineral and zircon (accessories); phenocrystals (k-feldspar -10%, quartz 8%, plagioclase 2%).

Macroscopic Description
Dense, cohesive, leucocratic slightly grayish white rock with phaneritic granulometry, consisting mainly of feldspars and quartz, with red garnet and fine biotite concentrations constituting short levels, granting foliation to the rock

Petrographic Classification
Biotite granite with garnet

Technological Characteristics		
Density	2631	kg/m^3
Water Absorption	0.19	%
Compression Breaking Load at the Natural	69.8	MPa
Amsler Wear Test (1000m)	0.0119	cm^3/cm^2
Linear Thermal Expansion	0.000168923	mm/(mm x °C)
Apparent Porosity	0.5	%
Modulus of Rupture	10.2	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	75	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Branco Alaska

County
Governador Lindemberg

Localization
Bolívia Stream - Rural Zone.

Coordinates
Geographic: 19°13'50"S / 40°27'20"W
UTM: 346979 E / 7872994 N Zone:24S

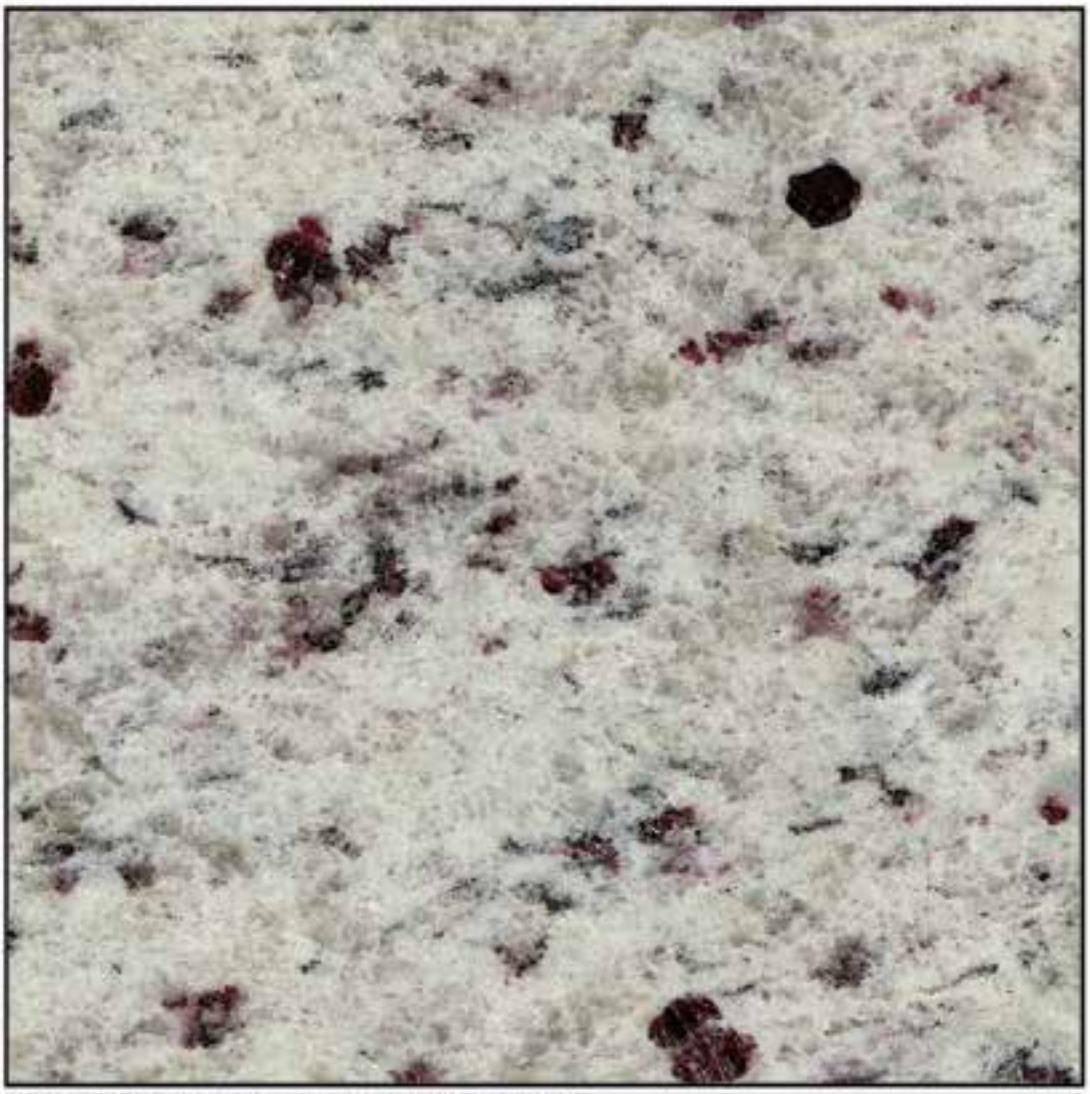
Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock

Other Names

Type and Predominant Color
White granite

Branco Dallas



Mineralogic Composition (microscopy)
Alkali feldspar (67%); quartz (24%); garnet (5%) and plagioclase (4%).

Macroscopic Description
Whitish cream compact rock, inequigranular, isotropic, medium to very coarse grained.

Petrographic Classification
Leuco alkali granite with garnet

Technological Characteristics		
Density	2630	kg/m^3
Water Absorption	0.24	%
Compression Breaking Load at the Natural	140.81	MPa
Amsler Wear Test (1000m)	0.0035	cm^3/cm^2
Linear Thermal Expansion	0.000312849	mm/(mm x °C)
Apparent Porosity	0.64	%
Modulus of Rupture	7.92	MPa
Compression Breaking Load After Freezing/Thawing	130.22	MPa
Impact Resistance	76	cm

Recommended Use
Floor and interior coating.

Branco Dallas

County
Barra de São Francisco

Localization
Pancieri Quarry. Locate on Santa Rosa Stream.

Coordinates
Geographic: 18°45'33"S / 40°44'59"W
UTM: 315540 E / 7924890 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock

Other Names
Branco Leblon; São Francisco Real Light;

Type and Predominant Color
White granite

Branco Desirée

Mineralogic Composition (microscopy)
Perthitic to mesoperthitic microcline (42%); quartz (30%); plagioclase - oligoclase (25%); garnet (3%).

Macroscopic Description
Rock with banded structure and slightly oriented, medium to coarse and medium to fine grained.

Petrographic Classification
Monzogranitic Leucogneisse

Technological Characteristics		
Density	2630	kg/m^3
Water Absorption	0.26	%
Compression Breaking Load at the Natural	107.1	MPa
Amsler Wear Test (1000m)	1.11	mm
Linear Thermal Expansion	4.9	mm/m °C
Apparent Porosity	0.67	%
Modulus of Rupture	9.81	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	53	cm

Recommended Use
Interior and exterior coating.

NA = not available

Branco Desirée

County
Pancas

Localization
Santa Helena Stream, Rural Zone.

Coordinates
Geographic: 19°08'36"S / 40°41'36"W
UTM: 321897 E / 7882433 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock

Other Names

Type and Predominant Color
White granite

Branco Everest

Mineralogic Composition (microscopy)
K-feldspar (28%); plagioclase (12%); biotite and muscovite (8%); quartz (7%); garnet (5%).
Phenocrystals: quartz (25%); k-feldspar (13%); plagioclase (2%).

Macroscopic Description
Dense, cohesive rock, with heterogeneous appearance consisting of milky white feldspars and slightly grayish quartz, which occurs, mainly, forming concentrations associated to red garnet porphyroblasts.

Petrographic Classification
Porphyroclastic granite

Technological Characteristics		
Density	2615	kg/m^3
Water Absorption	0.444	%
Compression Breaking Load at the Natural	90.98	MPa
Amsler Wear Test (1000m)	0.0079	cm^3/cm^2
Linear Thermal Expansion	0.0003060	mm/(mm x °C)
Apparent Porosity	1.16	%
Modulus of Rupture	8.84	MPa
Compression Breaking Load After Freezing/Thawing	73.1	MPa
Impact Resistance	62	cm

Recommended Use
Floor, interior, and exterior coating.

Branco Everest

County
Barra de São Francisco

Localization
São João Stream.

Coordinates
Geographic: 18°46'31"S / 40°47'01"W
UTM: 311985 E / 7923073 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
White granite

Branco Ipanema

Mineralogic Composition (microscopy)
Quartz (35%); mesoperthite (35%); plagioclase - oligoclase (20%); biotite (5%); garnet (5%); opaques, zircon and apatite (traces); muscovite and carbonate (secundaries).

Macroscopic Description
Gneissic pale gray rock, with granoblastic inequigranular to porphyroblastic texture, fine to coarse granulation varying between 0.2 and 0.5 mm for the quartz-feldspathic matrix and 1 and 7 mm for the mesoperthite and porphyroblastic quartz.

Petrographic Classification
Syenogranitic garnet gneiss

Technological Characteristics		
Density	2634	kg/m^3
Water Absorption	0.36	%
Compression Breaking Load at the Natural	141.3	MPa
Amsler Wear Test (1000m)	1.54	mm
Linear Thermal Expansion	3.8	mm/m °C
Apparent Porosity	0.95	%
Modulus of Rupture	14.89	MPa
Compression Breaking Load After Freezing/Thawing	140.7	MPa
Impact Resistance	78	cm

Recommended Use
Interior and exterior coating.

Branco Ipanema

County
Colatina

Localization
São Pedro Frio.

Coordinates
Geographic: 19°25'16"S / 40°48'53"W
UTM: 309461 E / 7851572 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Branco Polar;

Type and Predominant Color
White granite

Branco Marfim

Mineralogic Composition (microscopy)
Microperthitic alkali feldspar (38%); quartz (27%); plagioclase (18%); sillimanite (7%); biotite (5%); garnet (5%).

Macroscopic Description
Gneissic yellowish white rock coarse grained, with reddish dots (garnet).

Petrographic Classification
Syenogranitic gneiss with sillimanite and garnet

Technological Characteristics		
Density	2628	kg/m^3
Water Absorption	0.42	%
Compression Breaking Load at the Natural	82	MPa
Amsler Wear Test (1000m)	0.8	mm
Linear Thermal Expansion	5.7	mm/m °C
Apparent Porosity	1.1	%
Modulus of Rupture	6.62	MPa
Compression Breaking Load After Freezing/Thawing	81.51	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Branco Marfim

County
Barra de São Francisco

Localization
Itaperuna Stream.

Coordinates
Geographic: 18°43'37"S / 40°43'45"W
UTM: 317678 E / 7928476 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
White granite

Branco Palha

Mineralogic Composition (microscopy)
NA

Macroscopic Description
Gneissic pale reddish yellow rock, medium to very coarse grained.

Petrographic Classification
Monzogranitic biotite gneiss with garnet and sillimanite

Technological Characteristics		
Density	NA	kg/m³
Water Absorption	NA	%
Compression Breaking Load at the Natural	NA	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	NA	mm/m °C
Apparent Porosity	NA	%
Modulus of Rupture	NA	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Branco Palha

County
Nova Venécia

Localization
Fortaleza Stream, Guararema Village.

Coordinates
Geographic: 18°44'12"S / 40°41'30"W
UTM: 321631 E / 7927451 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Branco Veneza; Icaraí Light;

Type and Predominant Color
White granite

Branco Polar

Mineralogic Composition (microscopy)
Microperthitic microcline (40-45%); quartz (30-35%); plagioclase - oligoclase (20%); garnet (5%); opaques, zircon, muscovite, biotite, sericite (tr).

Macroscopic Description
Leucocratic foliated white rock, with biotite garnet dots.

Petrographic Classification
Granitic garnet gneiss

Technological Characteristics		
Density	2625	kg/m^3
Water Absorption	0.34	%
Compression Breaking Load at the Natural	168.1	MPa
Amsler Wear Test (1000m)	1.08	mm
Linear Thermal Expansion	6.9	mm/m °C
Apparent Porosity	0.89	%
Modulus of Rupture	15.1	MPa
Compression Breaking Load After Freezing/Thawing	166.2	MPa
Impact Resistance	81	cm

Recommended Use
Floor, interior, and exterior coating.

Branco Polar

County
Colatina

Localization
São Pedro Frio.

Coordinates
Geographic: 19°25'16"S / 40°48'53"W
UTM: 309461 E / 7851572 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Cotton White;

Type and Predominant Color
White granite

Branco Romano

Mineralogic Composition (microscopy)
Mesoperthitic microcline (48%); quartz (30%); plagioclase - antiperthitic oligoclase (10%); sillimanite + fibrolite (5%); garnet (5%).

Macroscopic Description
Gneissic slightly yellowish white rock coarse grained, with big red sparsed dots (garnet).

Petrographic Classification
Syenogranitic garnet sillimanite gneiss

Technological Characteristics		
Density	2633	kg/m^3
Water Absorption	0.36	%
Compression Breaking Load at the Natural	146.9	MPa
Amsler Wear Test (1000m)	1.4	mm
Linear Thermal Expansion	5.2	mm/m ºC
Apparent Porosity	0.95	%
Modulus of Rupture	7.16	MPa
Compression Breaking Load After Freezing/Thawing	136.1	MPa
Impact Resistance	NA	cm

Recommended Use
Interior coating.

NA = not available

Branco Romano

County
João Neiva

Localization
BR 259 Road, Km 02.

Coordinates
Geographic: 19°43'30"S / 40°23'03"W
UTM: 354946 E / 7818345 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock

Other Names

Type and Predominant Color
White granite

Branco Saara

Mineralogic Composition (microscopy)
Microperthitic alkali feldspar (30%); plagioclase - albite (30%); quartz (30%); garnet (10%);

Macroscopic Description
Oriented pale pink rock, fine to medium grained with small pink dots (garnet).

Petrographic Classification
Monzogranitic garnet gneiss

Technological Characteristics		
Density	2631	kg/m³
Water Absorption	0.25	%
Compression Breaking Load at the Natural	153.3	MPa
Amsler Wear Test (1000m)	1	mm
Linear Thermal Expansion	5	mm/m ºC
Apparent Porosity	0.66	%
Modulus of Rupture	11.23	MPa
Compression Breaking Load After Freezing/Thawing	119.9	MPa
Impact Resistance	NA	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Branco Saara

County
Linhares

Localization
Sapucaia Stream.

Coordinates
Geographic: 19°17'01"S / 40°25'21"W
UTM: 350502 E / 7867161 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Boulder

Other Names

Type and Predominant Color
White granite

Branco Serenata

Mineralogic Composition (microscopy)
K-feldspar (36%); plagioclase (27%); quartz (26%); garnet (6%); other (5%);

Macroscopic Description
Granoblastic to porphyroblastic rock, fine to medium grained.

Petrographic Classification
Monzogranitic garnet biotite gneiss.

Technological Characteristics		
Density	2620	kg/m^3
Water Absorption	0.36	%
Compression Breaking Load at the Natural	122.34	MPa
Amsler Wear Test (1000m)	0.014	cm^3/cm^2
Linear Thermal Expansion	0.003083	mm/(mm x °C)
Apparent Porosity	0.94	%
Modulus of Rupture	7.77	MPa
Compression Breaking Load After Freezing/Thawing	108.18	MPa
Impact Resistance	0.6	cm

Recommended Use
Floor and interior coating.

Branco Serenata

County
Vila Pavão

Localization
Sossego Stream - Rural Zone.

Coordinates
Geographic: 18°37'22"S / 40°39'51"W
UTM: 324409 E / 7940096 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
White granite

Branco Siena

Mineralogic Composition (microscopy)
Microperthitic microcline (30-35%); oligoclase (20-25%); quartz (20-25%); garnet (10%); rutile, spinel, red biotite, zircon (5%); leucoxene, carbonate, biotite (trace).

Macroscopic Description
Gneissic pinkish white rock medium to coarse grained with small reddish dots (garnet).

Petrographic Classification
Monzogranitic garnet gneiss

Technological Characteristics		
Density	2644	kg/m^3
Water Absorption	0.24	%
Compression Breaking Load at the Natural	128.9	MPa
Amsler Wear Test (1000m)	0.8	mm
Linear Thermal Expansion	5	mm/m ºC
Apparent Porosity	0.64	%
Modulus of Rupture	6.38	MPa
Compression Breaking Load After Freezing/Thawing	118.4	MPa
Impact Resistance	50	cm

Recommended Use
Floor and interior coating.

Branco Siena

County
Governador Lindemberg

Localization
Bolívia Stream.

Coordinates
Geographic: 19°14'21"S / 40°26'45"W
UTM: 348029 E / 7872055 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock

Other Names
Aqualux; Moonlight; Branco Santa Inês;

Type and Predominant Color
White granite

Galaxy White

Mineralogic Composition (microscopy)
Microcline (48%); quartz (32%); plagioclase (15%); biotite (3%); garnet (2%), muscovite and opaques (traces).

Macroscopic Description
Whitish cream rock with slight orientation, inequigranular, fine to medium grained.

Petrographic Classification
Syenogranitic gneiss with biotite and garnet

Technological Characteristics		
Density	2680	kg/m^3
Water Absorption	0.43	%
Compression Breaking Load at the Natural	132.2	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	NA	mm/m °C
Apparent Porosity	1.11	%
Modulus of Rupture	8.65	MPa
Compression Breaking Load After Freezing/Thawing	127.94	MPa
Impact Resistance	70	cm

Recommended Use
Interior and exterior coating.

NA = not available

Galaxy White

County
Colatina

Localization
2 Km west from Graça Aranha Village.

Coordinates
Geographic: 19°19'12"S / 40°37'08"W
UTM: 329923 E / 7862970 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock

Other Names

Type and Predominant Color
White granite

Giallita

Mineralogic Composition (microscopy)
Microcline(48%); albite (30%); quartz (20%); garnet, biotite and muscovite (2%).

Macroscopic Description
Coarse pegmatitic grained white rock consisting mainly of milky feldspars with variable granulation, millimetric and centimetric, reaching up to diameters of 40 cm, and slightly grayish quartz.

Petrographic Classification
Porphyritic pegmatitic granite with garnet and biotite

Technological Characteristics		
Density	2580	kg/m^3
Water Absorption	0.45	%
Compression Breaking Load at the Natural	70	MPa
Amsler Wear Test (1000m)	0.0011	cm^3/cm^2
Linear Thermal Expansion	NA	mm/m °C
Apparent Porosity	1.17	%
Modulus of Rupture	6	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	49	cm

Recommended Use
Floor and interior coating.

NA = not available

Giallita

County
Vargem Alta

Localization
Santana.

Coordinates
Geographic: 20°42'34"S / 41°03'25"W
UTM: 285777 E / 7708640 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock

Other Names

Type and Predominant Color
White granite

Icaraí Light

Mineralogic Composition (microscopy)
Microperthitic microcline (45%); quartz (35%); plagioclase - oligoclase (7%); biotite (5%); garnet (5%); sillimanite (3%).

Macroscopic Description
Gneissic yellowish gray rock with fine to coarse granulation.

Petrographic Classification
Syenogranitic gneiss with garnet and sillimanite

Technological Characteristics		
Density	2637	kg/m³
Water Absorption	0.32	%
Compression Breaking Load at the Natural	102.7	MPa
Amsler Wear Test (1000m)	0.80	mm
Linear Thermal Expansion	3.9	mm/m °C
Apparent Porosity	0.83	%
Modulus of Rupture	8.65	MPa
Compression Breaking Load After Freezing/Thawing	114.9	MPa
Impact Resistance	57	cm

Recommended Use
Floor, interior, and exterior coating.

Icaraí Light

County
Barra de São Francisco

Localization
Boa Esperança, Itaperuna Village.

Coordinates
Geographic: 18°45'50"S / 40°43'51"W
UTM: 317538 E / 7924397 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Branco Dallas; São Francisco Real Light;

Type and Predominant Color
White granite

Kashimire White

Mineralogic Composition (microscopy)
Micro- to mesoperthitic alkali feldspar + microcline (65%); quartz (25%); plagioclase (5%); garnet (5%); zircon, opaque (accessories); colorless phyllosilicates, muscovite, carbonate (secundaries);

Macroscopic Description
Rock with granoblastic inequigranular interlobated to amoeboid texture, fine to medium granulation, mainly medium (1.5-2.0 mm).

Petrographic Classification
Granitic alkali-feldspar gneiss with garnet

Technological Characteristics		
Density	2615	kg/m^3
Water Absorption	0.42	%
Compression Breaking Load at the Natural	176.4	MPa
Amsler Wear Test (1000m)	0.83	mm
Linear Thermal Expansion	4.6	mm/m °C
Apparent Porosity	1.10	%
Modulus of Rupture	13.62	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	74	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Kashimire White

County
Colatina

Localization
Piabas Stream - Itapina.

Coordinates
Geographic: 19°30'57"S / 40°47'37"W
UTM: 311774 E / 7841111 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Boulder

Other Names

Type and Predominant Color
White granite

Ouro Branco

Mineralogic Composition (microscopy)
K-feldspar (38%); plagioclase (25%); quartz (13%), biotite (17%); garnet (7%), carbonates (trace).

Macroscopic Description
Rock with isotropic texture and medium to coarse granulation. Biotite and garnet form mafic agglomerates spread over the quartz feldespathic whitish matrix. It shows a white color when dry and whitish cream when humid.

Petrographic Classification
Garnaet biotite leucogranite

Technological Characteristics		
Density	2640	kg/m^3
Water Absorption	0.36	%
Compression Breaking Load at the Natural	83.68	MPa
Amsler Wear Test (1000m)	0.0151	cm^3/cm^2
Linear Thermal Expansion	0.000265309	mm/(mm x °C)
Apparent Porosity	0.95	%
Modulus of Rupture	6.86	MPa
Compression Breaking Load After Freezing/Thawing	79.5	MPa
Impact Resistance	60	cm

Recommended Use
Floor and interior coating.

Ouro Branco

County
Água Doce do Norte

Localization
Pipoca Stream.

Coordinates
Geographic: 18°30'38"S / 40°55'21"W
UTM: 297026 E / 7952219 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Amarelo Ouro;

Type and Predominant Color
White granite

Santa Cecília Light

Mineralogic Composition (microscopy)
Potassium fedspar (30-35%), quartz (5%), plagioclase (20%), biotite (10%), garnet (5-10%), sillimanite (5%), zircon, opaques, altered mafics, apatite, sericite/muscovite, iron hydroxides.

Macroscopic Description
Gneissic pinkish pale gray rock with granoblastic inequigranular interlobated and porphyroclastic texture, fine to coarse grained.

Petrographic Classification
Syenogranitic gneiss with garnet

Technological Characteristics		
Density	2631	kg/m^3
Water Absorption	0.32	%
Compression Breaking Load at the Natural	151.9	MPa
Amsler Wear Test (1000m)	0.87	mm
Linear Thermal Expansion	4.2	mm/m ºC
Apparent Porosity	0.83	%
Modulus of Rupture	7.39	MPa
Compression Breaking Load After Freezing/Thawing	114	MPa
Impact Resistance	55	cm

Recommended Use
Floor, interior, and exterior coating.

Santa Cecília Light

County
Ecoporanga

Localization
Água Branca Stream (rural zone).

Coordinates
Geographic: 18°17'33"S / 40°51'52"W
UTM: 302917 E / 7976440 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Santa Cecília Soft;

Type and Predominant Color
White granite

São Francisco Real

Mineralogic Composition (microscopy)
Crypt- to microperthitic microcline (55-60%); quartz (20%); antiperthitic plagioclase (oligoclase-10%); garnet (5-10%); biotite (<5%); carbonate, chlorite, epidote, iron hydroxide (secundaries).

Macroscopic Description
Gneissic pinkish gray rock, fine to very coarse grained, mainly medium.

Petrographic Classification
Syenogranitic gneiss with garnet

Technological Characteristics		
Density	2674	kg/m^3
Water Absorption	0.26	%
Compression Breaking Load at the Natural	141.9	MPa
Amsler Wear Test (1000m)	0.82	mm
Linear Thermal Expansion	5.1	mm/m °C
Apparent Porosity	0.69	%
Modulus of Rupture	11.01	MPa
Compression Breaking Load After Freezing/Thawing	125.8	MPa
Impact Resistance	45	cm

Recommended Use
Floor, interior, and exterior coating.

São Francisco Real

County
Barra de São Francisco

Localization
6.5 Km ESE from Santo Antônio Village

Coordinates
Geographic: 18°45'52"S / 40°44'40"W
UTM: 316118 E / 7924305 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
White granite

Vênus

Mineralogic Composition (microscopy)
K-feldspar (33-35%), quartz (30-33%), plagioclase (20-24%) and biotite (7%). Altered minerals: muscovite, chlorite and sericite (<1%). Main mineral accessories: opques.

Macroscopic Description
Heterogeneous rock with massive structure, leucocratic with colors from withish, pink to whitish grayish, medium to coarse grained.

Petrographic Classification
Biotite alkali monzogranite

Technological Characteristics		
Density	2613	kg/m^3
Water Absorption	0.2	%
Compression Breaking Load at the Natural	120.16	MPa
Amsler Wear Test (1000m)	0.79	mm
Linear Thermal Expansion	3.69	mm/m °C
Apparent Porosity	0.51	%
Modulus of Rupture	10.49	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	40	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Vênus

County
Rio Novo do Sul

Localization
Pau D´alho.

Coordinates
Geographic: 20°52'32"S / 40°56'09"W
UTM: 298601 E / 7690404 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock

Other Names
Arany;

Type and Predominant Color
White granite

Gray

Cinza Andorinha

Mineralogic Composition (microscopy)
Microperthitic microcline (30%); plagioclase (30%); biotite (16%); quartz (20%); titanite (4%);

Macroscopic Description
Pale gray granitic coarse grained rock.

Petrographic Classification
Biotite monzogranite

Technological Characteristics		
Density	2703	kg/m^3
Water Absorption	0.31	%
Compression Breaking Load at the Natural	151.5	MPa
Amsler Wear Test (1000m)	1	mm
Linear Thermal Expansion	7.1	mm/m ºC
Apparent Porosity	0.83	%
Modulus of Rupture	12.63	MPa
Compression Breaking Load After Freezing/Thawing	150.6	MPa
Impact Resistance	78	cm

Recommended Use
Floor, interior, and exterior coating.

Cinza Andorinha

County
Castelo

Localization
Alto Corumbá - Centro Farm.

Coordinates
Geographic: 20°32'45"S / 41°10'01"W
UTM: 274060 E / 7726599 N Zone:24S

Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Massive rock and boulder

Other Names

Type and Predominant Color
Gray granite

Cinza Bressan

Mineralogic Composition (microscopy)
Plagioclases - oligoclase/andesine (33%); microcline (30%); quartz (27%); biotite (8%); accessories (2%).

Macroscopic Description
Pale gray rock, mainly medium grained, with the presence of small black dots (biotite), homogeneously distributed.

Petrographic Classification
Biotite monzogranite

Technological Characteristics		
Density	2725	kg/m³
Water Absorption	0.25	%
Compression Breaking Load at the Natural	212.37	MPa
Amsler Wear Test (1000m)	0.84	mm
Linear Thermal Expansion	6.3	mm/m °C
Apparent Porosity	0.67	%
Modulus of Rupture	14.26	MPa
Compression Breaking Load After Freezing/Thawing	160.87	MPa
Impact Resistance	NA	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Cinza Bressan

County
Cachoeiro do Itapemirim

Localization
Tijuca Farm.

Coordinates
Geographic: 20°54'57"S / 41°06'42"W
UTM: 280374 E / 7685715 N Zone:24S

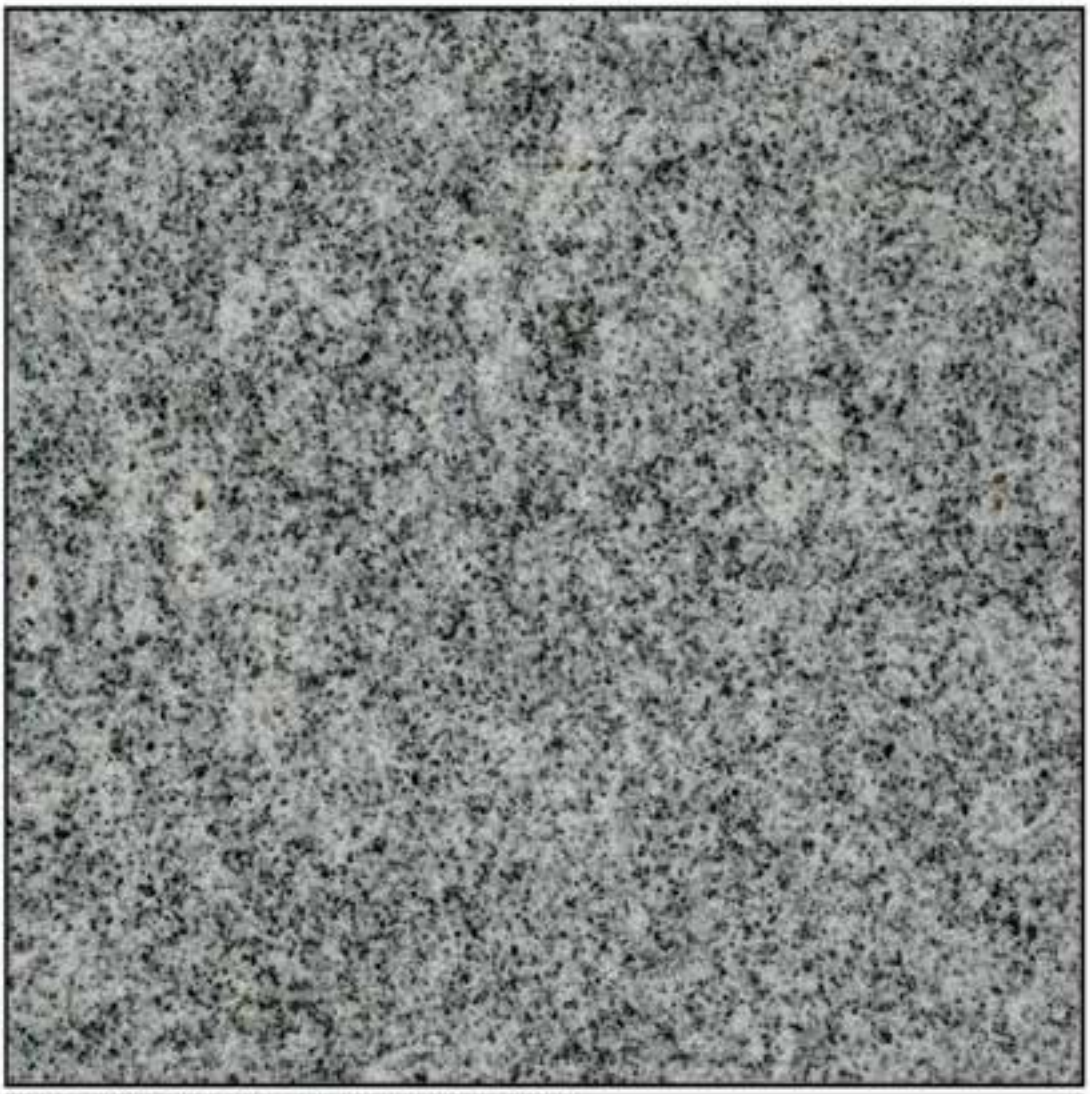
Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Massive rock and boulder

Other Names

Type and Predominant Color
Gray granite

Cinza Castelo



Mineralogic Composition (microscopy)
Microperthitic microcline (30%); plagioclase-oligoclase (27%); quartz (23%); biotite (17%); titanite (3%);

Macroscopic Description
Massive pale gray rock fine grained with abundant black dots.

Petrographic Classification
Biotite monzogranite

Technological Characteristics		
Density	2657	kg/m^3
Water Absorption	0.31	%
Compression Breaking Load at the Natural	169.6	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	4.6	mm/m °C
Apparent Porosity	0.83	%
Modulus of Rupture	17.37	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior, and exterior coating.

NA = not available

Cinza Castelo

County
Castelo

Localization
Descoberta.

Coordinates
Geographic: 20°36'32"S / 41°13'38"W
UTM: 267884 N / 7719540 N Zone:24S

Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Massive rock and boulder

Other Names
Super Gray;

Type and Predominant Color
Gray granite

Cinza Corumbá

Mineralogic Composition (microscopy)
Microperthitic microcline (33%); plagioclase (30%); quartz (20%); biotite (12%); accessories (5%);

Macroscopic Description
Pale gray rock with oriented structure, mainly coarse grained.

Petrographic Classification
Biotite monzogranite

Technological Characteristics		
Density	2673	kg/m³
Water Absorption	0.35	%
Compression Breaking Load at the Natural	130.2	MPa
Amsler Wear Test (1000m)	1	mm
Linear Thermal Expansion	5.2	mm/m °C
Apparent Porosity	0.93	%
Modulus of Rupture	10.18	MPa
Compression Breaking Load After Freezing/Thawing	131.4	MPa
Impact Resistance	73	cm

Recommended Use
Floor, interior, and exterior coating.

Cinza Corumbá

County
Castelo

Localization
Alto Corumbá, Serra do Forno Grande.

Coordinates
Geographic: 20°32'55"S / 41°07'24"W
UTM: 278620 E / 7726353 N Zone:24S

Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Massive rock and boulder

Other Names

Type and Predominant Color
Gray granite

Cinza Montanha

Mineralogic Composition (microscopy)
Microcline (50%); quartz (25%); plagioclase (11%); biotite (5%); opaque minerals (2-3%);
muscovite (secundary (3%); epidote + allanite (2%); apatite and carbonates (alteration) << 1%.

Macroscopic Description
Mesocratic gray rock, medium grained, isotropic with porphyritic texture.

Petrographic Classification
Biotite granite

Technological Characteristics		
Density	NA	kg/m^3
Water Absorption	NA	%
Compression Breaking Load at the Natural	NA	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	NA	mm/m ºC
Apparent Porosity	NA	%
Modulus of Rupture	NA	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior coating.

NA = not available

Cinza Montanha

County
Cachoeiro de Itapemirim

Localization
Alto São Geraldo.

Coordinates
Geographic: 20°52'54"S / 41°07'15"W
UTM: 279373 E / 7689493 N Zone:24S

Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Massive rock and boulder

Other Names
Cinza Café;

Type and Predominant Color
Gray granite

Cinza Prata

Mineralogic Composition (microscopy)

Microcline (34%); quartz (29%); plagioclase - oligoclase (22.5%); biotite (8%), accessories (opaques 0.6%; titanite 0.7%, allanite (0.3%), apatite (0.2%) and zircon and fluorite); secundaries (sericite 2.5%; muscovite 1%; chlorite 0.5% and epidote, carbonate and clay minerals (<4.5%)).

Macroscopic Description

Massive pale gray rock with equigranular texture, medium tending to fine granulation, and a homogeneous general appearance. The grains size vary from submillimetric to 5 mm, mainly between 1 and 2.5 mm.

Petrographic Classification

Monzogranite

Technological Characteristics

Density	2658	kg/m^3
Water Absorption	0.29	%
Compression Breaking Load at the Natural	149.3	MPa
Amsler Wear Test (1000m)	0.83	mm
Linear Thermal Expansion	5.5	mm/m °C
Apparent Porosity	0.77	%
Modulus of Rupture	12.82	MPa
Compression Breaking Load After Freezing/Thawing	136.8	MPa
Impact Resistance	50	cm

Recommended Use

Floor, interior, and exterior coating.

Cinza Prata

County
Alegre

Localization
Lambari Frio.

Coordinates
Geographic: 20°37'36"S / 41°22'44"W
UTM: 252101 E / 7717355 N Zone:24S

Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Gray granite

Cinza Santa Rosa

Mineralogic Composition (microscopy)
Quartz (20%); k-feldspar (45%), plagioclase (20%); biotite (10%); opaque minerals (3%); titanite (2%); accessories - traces (zircon, epidote, sericite/ muscovite and carbonate secundaries).

Macroscopic Description
Holocrystalline pale gray rock, leuco to mesocratic, with equigranular texture, fine grained and homogeneous appearance, without foliation.

Petrographic Classification
Isotrope inequigranular garnet biotite granite

Technological Characteristics		
Density	NA	kg/m^3
Water Absorption	NA	%
Compression Breaking Load at the Natural	NA	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	NA	mm/m °C
Apparent Porosity	NA	%
Modulus of Rupture	NA	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Cinza Santa Rosa

County
Mimoso do Sul

Localization
Córrego do Vinagre Farm.

Coordinates
Geographic: 21°05'26"S / 41°17'37"W
UTM: 261723 E / 7666097 N Zone:24S

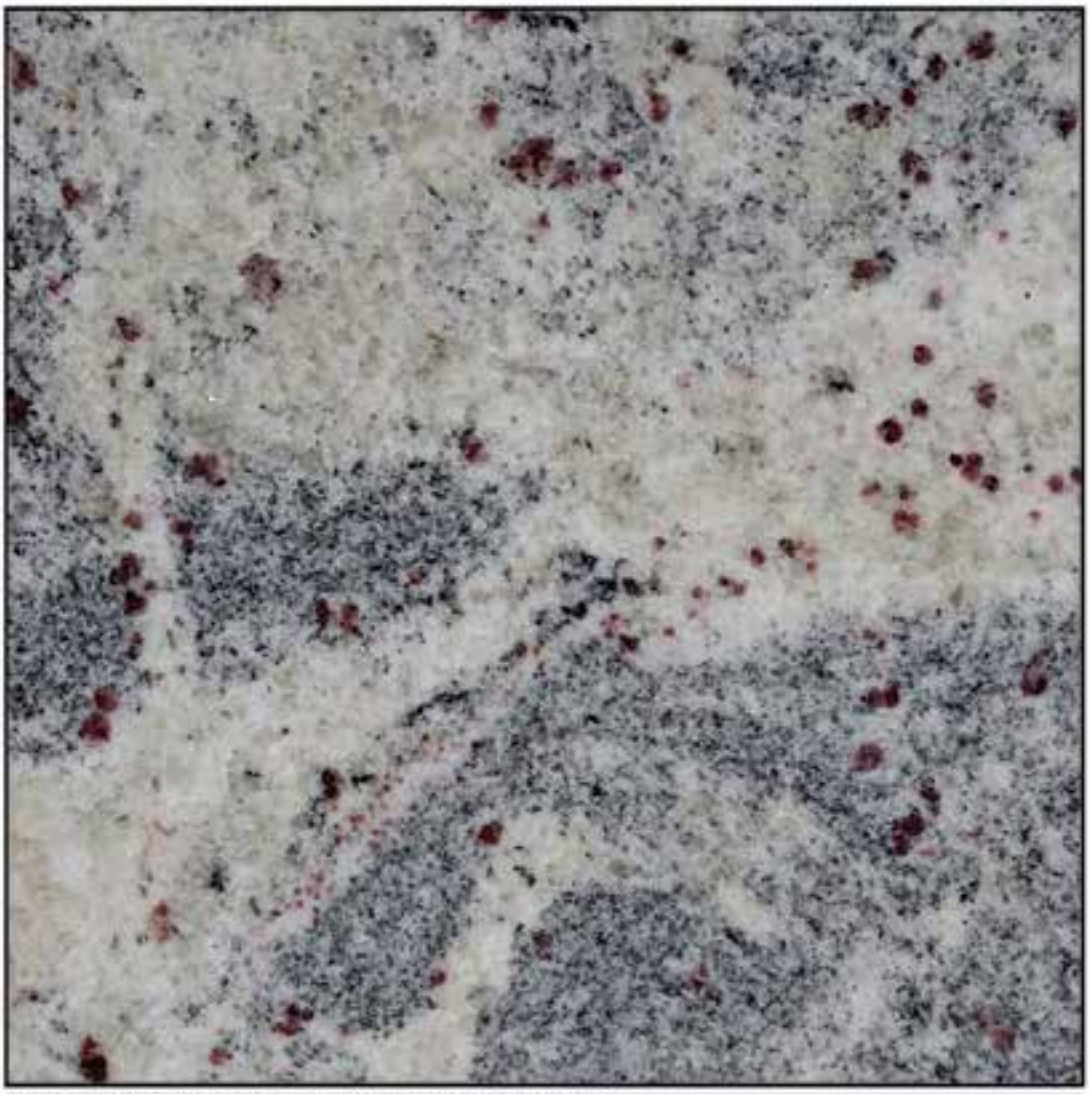
Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Boulder

Other Names

Type and Predominant Color
Gray granite

Índigo



Mineralogic Composition (microscopy)
Plagioclase - oligoclase (28%); perthitic microcline (28%); quartz (24%); garnet (15 %); biotite (5%);

Macroscopic Description
Rock with gneissic heterogeneous structure medium to coarse grained, with intercalations of millimetric to centimetric gray to dark gray bands and light yellowish green. Crystals or maroon aggregates (garnet) are common.

Petrographic Classification
Monzogranitic garnet gneiss

Technological Characteristics		
Density	2678	kg/m³
Water Absorption	0.29	%
Compression Breaking Load at the Natural	164.27	MPa
Amsler Wear Test (1000m)	0.85	mm
Linear Thermal Expansion	7.5	mm/m °C
Apparent Porosity	0.77	%
Modulus of Rupture	12.76	MPa
Compression Breaking Load After Freezing/Thawing	154.7	MPa
Impact Resistance	NA	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Índigo

County
São Roque do Canaã

Localization
Júlia Road - Santa Júlia.

Coordinates
Geographic: 19°42'23"S / 40°43'55"W
UTM: 318447 E / 7820059 N Zone:24S

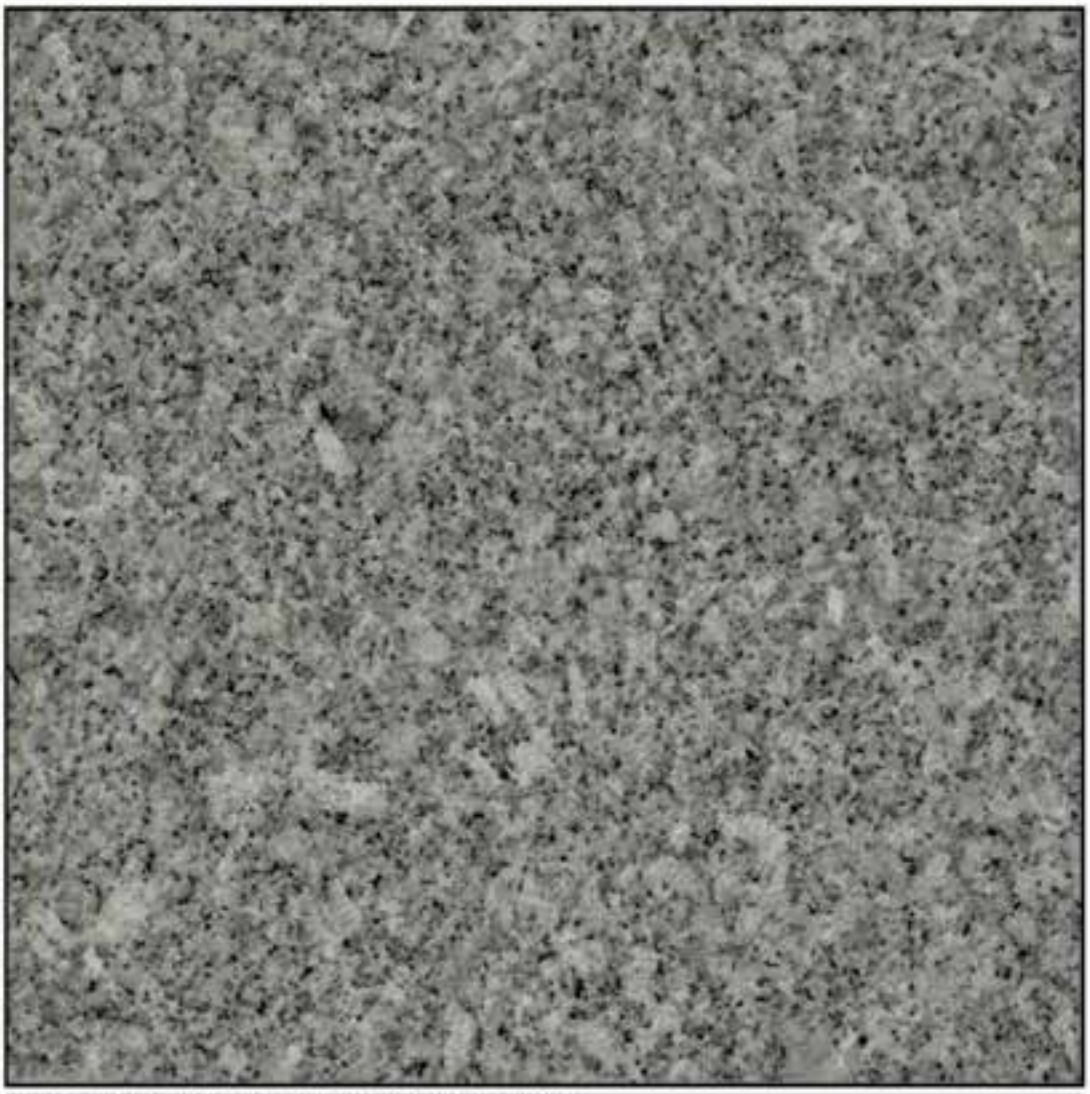
Geological Unit
Orthogneiss Santa Tereza

Occurrence
Massive rock and boulder

Other Names

Type and Predominant Color
Gray granite

Prata Clássico



Mineralogic Composition (microscopy)
Perthitic microcline (30 – 35%), plagiolase - oligoglase (25 – 30%), quartz (25%), biotite (15%), accessory minerals, zircon, apatite, opaques, muscovite and titanite. Secundaries, sericite, carbonates, clay minerals and iron hydroxide.

Macroscopic Description
Leucocratic gray to yellowish pink massive rock, slightly oriented, with an inequigranular and hypidiomorphic texture.

Petrographic Classification
Biotite monzogranite

Technological Characteristics		
Density	2632	kg/m^3
Water Absorption	0.41	%
Compression Breaking Load at the Natural	89.3	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	5.4	mm/m °C
Apparent Porosity	1.08	%
Modulus of Rupture	8.76	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior, and exterior coating.

NA = not available

Prata Clássico

County
Água Doce do Norte

Localization
Santa Luzia do Córrego Azul.

Coordinates
Geographic: 18°33'43"S / 40°59'09"W
UTM: 290414 E / 7946462 N Zone:24S

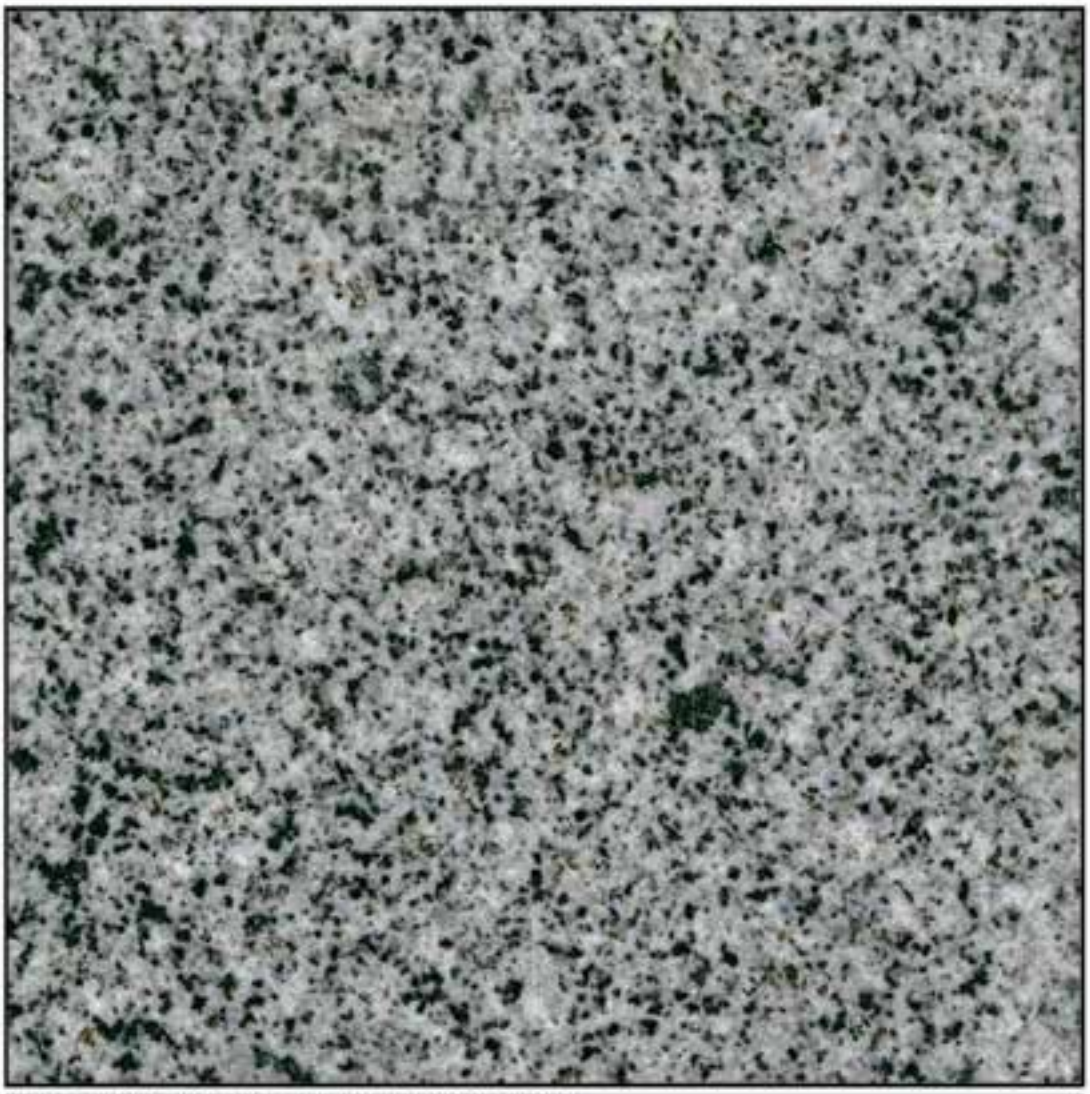
Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Massive rock

Other Names
Silver Jaciguá; Prata Jaciguá;

Type and Predominant Color
Gray granite

Prata Imperial



Mineralogic Composition (microscopy)
Plagioclase - oligoclase (40%); microcline (24%); quartz (17%); biotite (12%); opaques (5%); titanite (2%).

Macroscopic Description
Pale gray rock slightly oriented, fine to medium grained with black dots (biotite).

Petrographic Classification
Biotite monzogranite

Technological Characteristics		
Density	2727	kg/m^3
Water Absorption	0.38	%
Compression Breaking Load at the Natural	127.7	MPa
Amsler Wear Test (1000m)	1.3	mm
Linear Thermal Expansion	6.1	mm/m °C
Apparent Porosity	1.03	%
Modulus of Rupture	9.53	MPa
Compression Breaking Load After Freezing/Thawing	155.5	MPa
Impact Resistance	73	cm

Recommended Use
Floor, interior, and exterior coating.

Prata Imperial

County
Iconha

Localization
Santo Antônio do Rio Mineiro.

Coordinates
Geographic: 20°41'59"S / 40°53'01"W
UTM: 303825 E / 7709917 N Zone:24S

Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Gray granite

Topázio

Mineralogic Composition (microscopy)
Plagioclase (35%); quartz (17%); biotite (16%); microcline (12%); titanite (6%); opaques (5%); apatite (4%); hornblende (3%); allanite (1%); carbonate (secundary) ~1%; muscovite (secundary) <1%.

Macroscopic Description
Mescocratic homogeneous gray rock, fine to medium grained with equigranular texture and isotropic structure.

Petrographic Classification
Biotite granite

Technological Characteristics		
Density	2682	kg/m³
Water Absorption	0.25	%
Compression Breaking Load at the Natural	135.1	MPa
Amsler Wear Test (1000m)	0.94	mm
Linear Thermal Expansion	9.5	mm/m °C
Apparent Porosity	0.68	%
Modulus of Rupture	20.7	MPa
Compression Breaking Load After Freezing/Thawing	132.7	MPa
Impact Resistance	50	cm

Recommended Use
Floor, interior, and exterior coating.

Topázio

County
Rio Novo do Sul

Localization
Monte Alegre Village, Rural Zone.

Coordinates
Geographic: 20°44'10"S / 40°56'16"W
UTM: 298219 E / 7705819 N Zone:24S

Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Massive rock and boulder

Other Names
Boreal;

Type and Predominant Color
Gray granite

Brown

Café Brasil

Mineralogic Composition (microscopy)
Microcline (57%); quartz (25%); plagioclase (11%); biotite (7%).

Macroscopic Description
Brown to pink equigranular rock, fine to medium grained involving quartz, biotite and feldspar.

Petrographic Classification
Biotite syenogranite

Technological Characteristics		
Density	2650	kg/m^3
Water Absorption	0.25	%
Compression Breaking Load at the Natural	173.22	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	NA	mm/m ºC
Apparent Porosity	0.66	%
Modulus of Rupture	10.6	MPa
Compression Breaking Load After Freezing/Thawing	173.22	MPa
Impact Resistance	57	cm

Recommended Use
Interior and exterior coating.

NA = not available

Café Brasil

County
Ecoporanga

Localization
Palmeiras Farm.

Coordinates
Geographic: 18°11'50"S / 40°48'07"W
UTM: 309429 E / 7987058 E Zone:24S

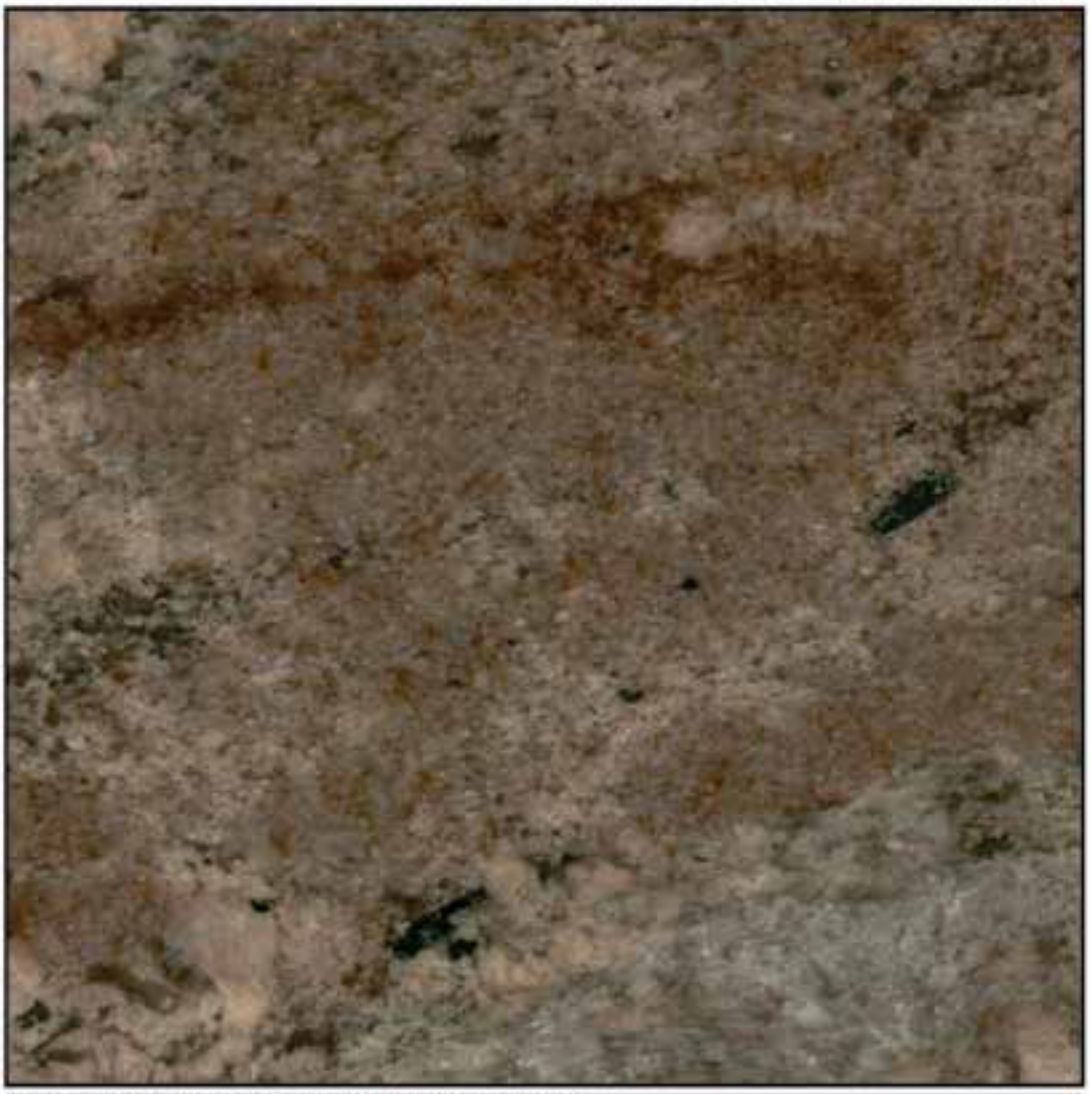
Geological Unit
Aimorés Intrusive Suite

Occurrence
Boulder

Other Names

Type and Predominant Color
Brown granite

Crema Bordeaux



Mineralogic Composition (microscopy)
Plagioclase - oligoclase (40%), quartz (30%), microcline (25 a 30%) and accessories (<5%).

Macroscopic Description
Granoblastic banded gneiss, inequigranular interlobated to porphyroblastic.

Petrographic Classification
Monzogranitic banded gneiss

Technological Characteristics		
Density	2616	kg/m³
Water Absorption	0.3	%
Compression Breaking Load at the Natural	138.7	MPa
Amsler Wear Test (1000m)	1.41	mm
Linear Thermal Expansion	6.6	mm/m °C
Apparent Porosity	0.79	%
Modulus of Rupture	7.61	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	44	cm

Recommended Use
Interior and exterior coating.

NA = not available

Crema Bordeaux

County
Afonso Claúdio

Localization
Cedro Stream - Pontões.

Coordinates
Geographic: 20°12'25"S / 41°04'05"W
UTM: 283904 E / 7764270 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock

Other Names
Iberê Crema Bordeaux; Crema Bordeaux Gold;

Type and Predominant Color
Brown granite

Golden Bordeaux

Mineralogic Composition (microscopy)
Consisting of quartz, plagioclase and small quantity of biotite and garnet

Macroscopic Description
Beige to light brown rock with inequigranular texture and coarse granulation.

Petrographic Classification
Monzogranitic garnet gneiss

Technological Characteristics		
Density	2601	kg/m^3
Water Absorption	0.31	%
Compression Breaking Load at the Natural	83.8	MPa
Amsler Wear Test (1000m)	0.009	cm^3/cm^2
Linear Thermal Expansion	NA	mm/m ºC
Apparent Porosity	NA	%
Modulus of Rupture	11.7	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	65	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Golden Bordeaux

County
Castelo

Localization
Santa Fé.

Coordinates
Geographic: 20°30'19"S / 41°11'25"W
UTM: 271581 E / 7731063 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Brown granite

Golden Fantasy

Mineralogic Composition (microscopy)
Microcline (42%); quartz (25%); plagioclase (18%); biotite (15%).

Macroscopic Description
Gneiss medium to coarse up to porphyroblastic with mobilized coarse to pegmatoid feldspathic, quartz locally structured in irregular bands.

Petrographic Classification
Biotite gneiss

Technological Characteristics		
Density	2592	kg/m^3
Water Absorption	1.33	%
Compression Breaking Load at the Natural	93	MPa
Amsler Wear Test (1000m)	0.009	cm^3/cm^2
Linear Thermal Expansion	NA	mm/m °C
Apparent Porosity	0.51	%
Modulus of Rupture	9	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	68	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Golden Fantasy

County
Alegre

Localization
Granada Farm, Rive Village.

Coordinates
Geographic: 20°46'08"S / 41°29'40"W
UTM: 240276 E / 7701416 N Zone:24S

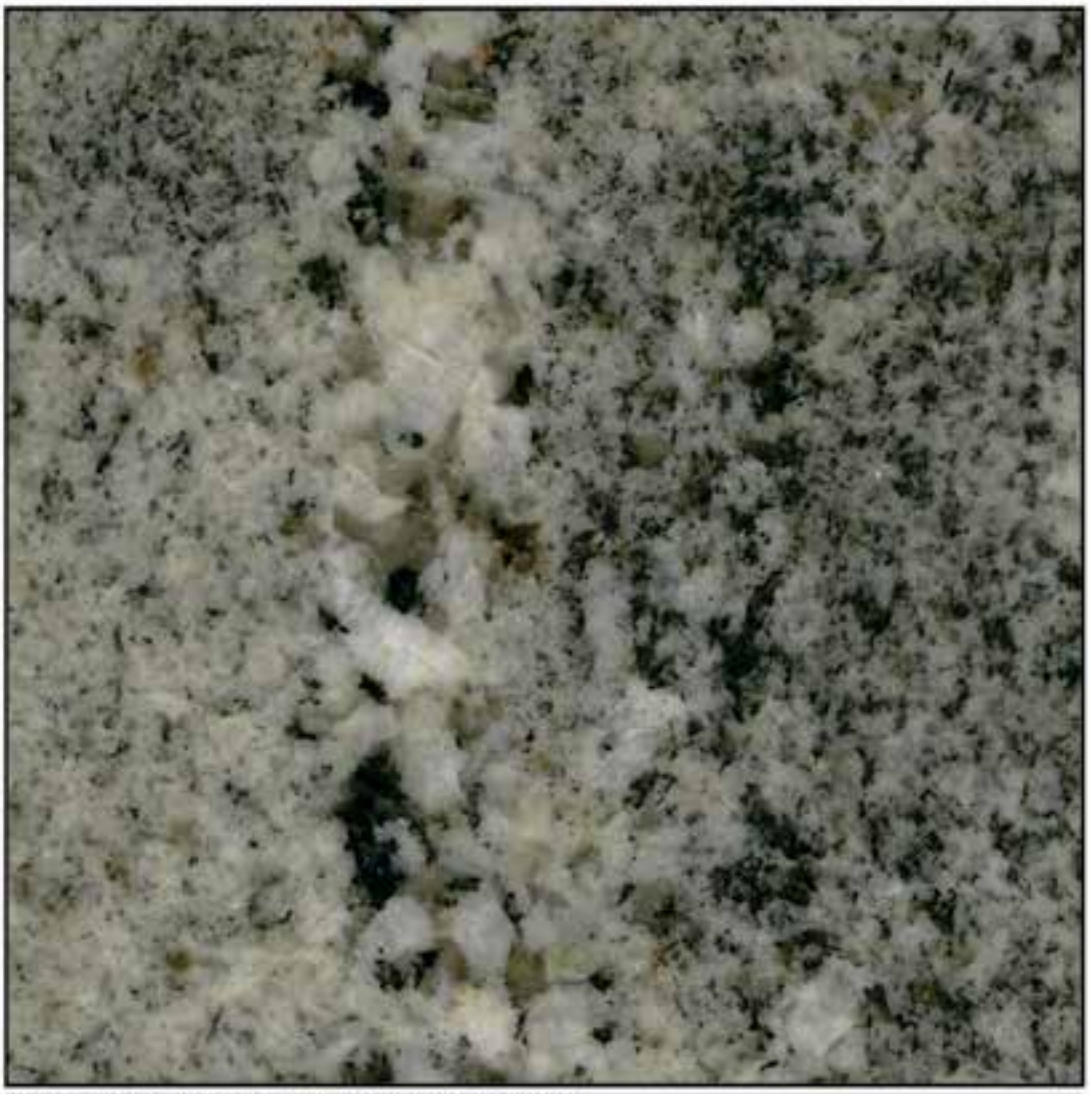
Geological Unit
Bom Jesus Itabapuana Group

Occurrence
Massive rock

Other Names

Type and Predominant Color
Brown granite

Marrom Sucuri



Mineralogic Composition (microscopy)
Microcline, quartz, plagioclase and biotite.

Macroscopic Description
Granite with mobilized feldspathic quartz and mafic schlieren.

Petrographic Classification
Biotite garnet gneiss

Technological Characteristics		
Density	2611	kg/m^3
Water Absorption	0.76	%
Compression Breaking Load at the Natural	119.3	MPa
Amsler Wear Test (1000m)	0.0063	mm
Linear Thermal Expansion	0.002027	mm/m ºC
Apparent Porosity	2.23	%
Modulus of Rupture	11.17	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	60	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Marrom Sucuri

County
Mimoso do Sul

Localization
Penha Farm.

Coordinates
Geographic: 21°08'46"S / 41°18'36"W
UTM: 260110 E / 7659937 N Zone:24S

Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Brown granite

Ocre Itabira

Mineralogic Composition (microscopy)
Microperthitic microcline (45%); plagioclase - oligoclase/andesine (20%); hornblende (14%); biotite (7%); opaques (5%); quartz (5%); titanite (4%).

Macroscopic Description
Brown to light medium gray rock with coarse granulation.

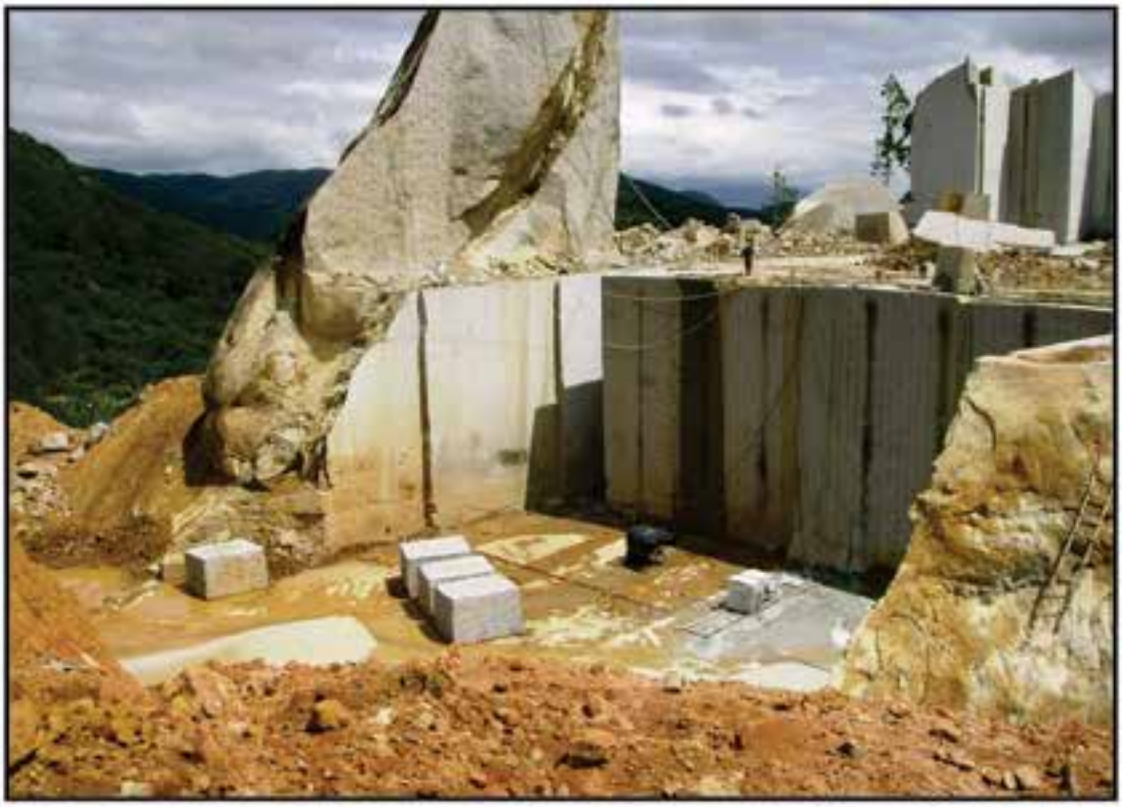
Petrographic Classification
Hornblende quartz syenite

Technological Characteristics		
Density	2710	kg/m^3
Water Absorption	0.22	%
Compression Breaking Load at the Natural	121	MPa
Amsler Wear Test (1000m)	0.91	mm
Linear Thermal Expansion	2	mm/m °C
Apparent Porosity	0.61	%
Modulus of Rupture	10.13	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Ocre Itabira



County
Venda Nova do Imigrante

Localization
Rural Zone - Mata Fria.

Coordinates
Geographic: 20°19'14"S / 41°11'47"W
UTM: 270670 E / 7751491 N Zone:24S

Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Massive rock and boulder

Other Names
Marrom Graphite; Cinza Santa Clara; New Caledônia;

Type and Predominant Color
Grayish brown granite

Black

Astrus

Mineralogic Composition (microscopy)
Oligoclase (37%); biotite (28%); quartz (25%); hornblende (10%); titanite and zircon (traces).

Macroscopic Description
Oriented rock, with phaneritic granulometry and heterogeneous appearance, formed by bands of mainly biotite intercalated with bands of quartz feldspathic composition.

Petrographic Classification
Tonalitic gneiss with hornblende and biotite

Technological Characteristics		
Density	2735	kg/m^3
Water Absorption	0.34	%
Compression Breaking Load at the Natural	104	MPa
Amsler Wear Test (1000m)	0.0213	cm^3/cm^2
Linear Thermal Expansion	0.002327	mm/(mm x °C)
Apparent Porosity	0.97	%
Modulus of Rupture	9.63	MPa
Compression Breaking Load After Freezing/Thawing	86.4	MPa
Impact Resistance	45	cm

Recommended Use
Floor, interior, and exterior coating.

Astrus

County
Vargem Alta

Localization
Alto Stream.

Coordinates
Geographic 20°38'36"S / 41°01'10"W
UTM: 289589 E / 7716009 N Zone:24S

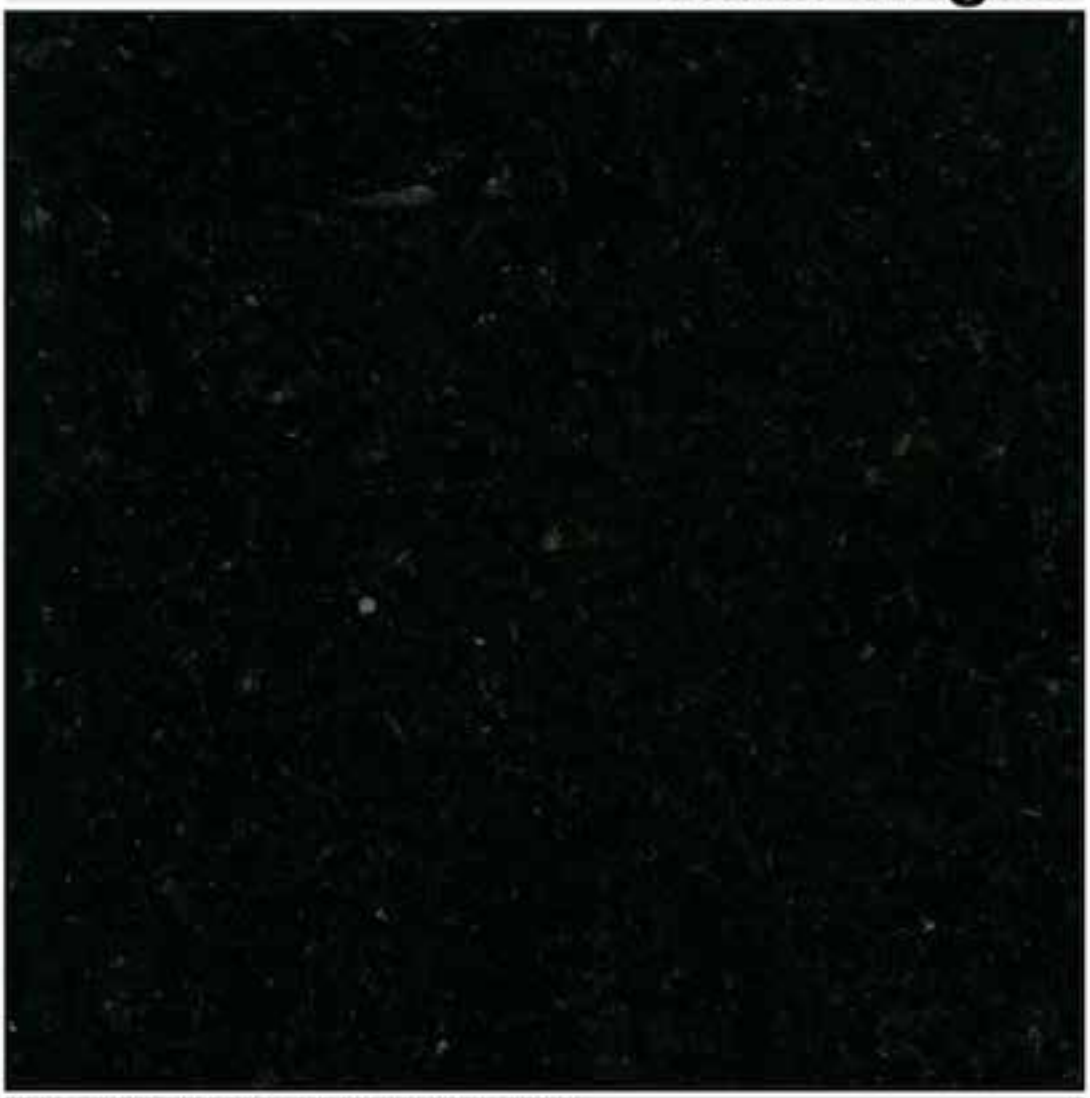
Geological Unit
Italva Group/Serra da Prata Unit

Occurrence
Massive rock

Other Names

Type and Predominant Color
Black granite

Ouro Negro



Mineralogic Composition (microscopy)
Plagioclase - andesine/labradorite (70%); orthopyroxene - clinopyroxenes (15%); magnetite (5%); hornblende (5%); biotite (5%).

Macroscopic Description
Massive black to greenish gray rock medium to coarse grained.

Petrographic Classification
Gabbronorite

Technological Characteristics		
Density	2859	kg/m^3
Water Absorption	0.2	%
Compression Breaking Load at the Natural	111.3	MPa
Amsler Wear Test (1000m)	1.4	mm
Linear Thermal Expansion	5.8	mm/m °C
Apparent Porosity	0.56	%
Modulus of Rupture	18.7	MPa
Compression Breaking Load After Freezing/Thawing	88.9	MPa
Impact Resistance	68	cm

Recommended Use
Interior and exterior coating.

Ouro Negro

County
Iconha

Localization
Santo Antônio do Rio Mineiro.

Coordinates
Geographic: 20°41'07"S / 40°52'35"W
UTM: 304551 E / 7711527 N Zone:24S

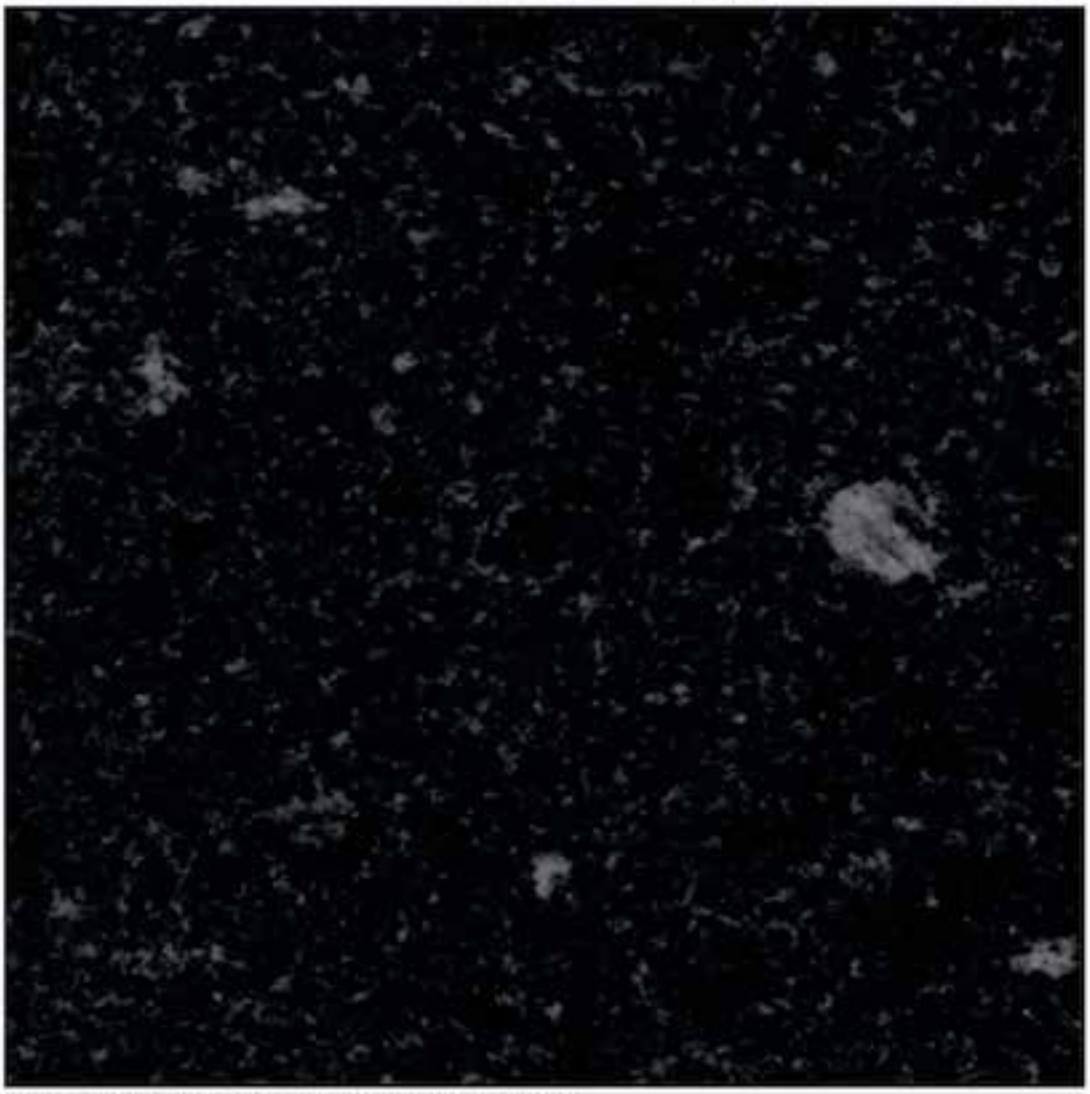
Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Boulder

Other Names

Type and Predominant Color
Black granite

Preto Águia Branca



Mineralogic Composition (microscopy)
Plagioclase - andesine-labradorite (42%); biotite (25%); hornblende (20%); opaques (10%); apatite (3%).

Macroscopic Description
Massive dark gray rock medium to coarse grained.

Petrographic Classification
Hornblende biotite diorite

Technological Characteristics		
Density	2987	kg/m³
Water Absorption	0.15	%
Compression Breaking Load at the Natural	89.6	MPa
Amsler Wear Test (1000m)	1.8	mm
Linear Thermal Expansion	7	mm/m ºC
Apparent Porosity	0.44	%
Modulus of Rupture	16.08	MPa
Compression Breaking Load After Freezing/Thawing	112.7	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Preto Águia Branca

County
Águia Branca

Localization
Águas Claras Farm.

Coordinates
Geographic: 18°55'07"S / 40°48'50"W
UTM: 308966 E / 7907171 N Zone:24S

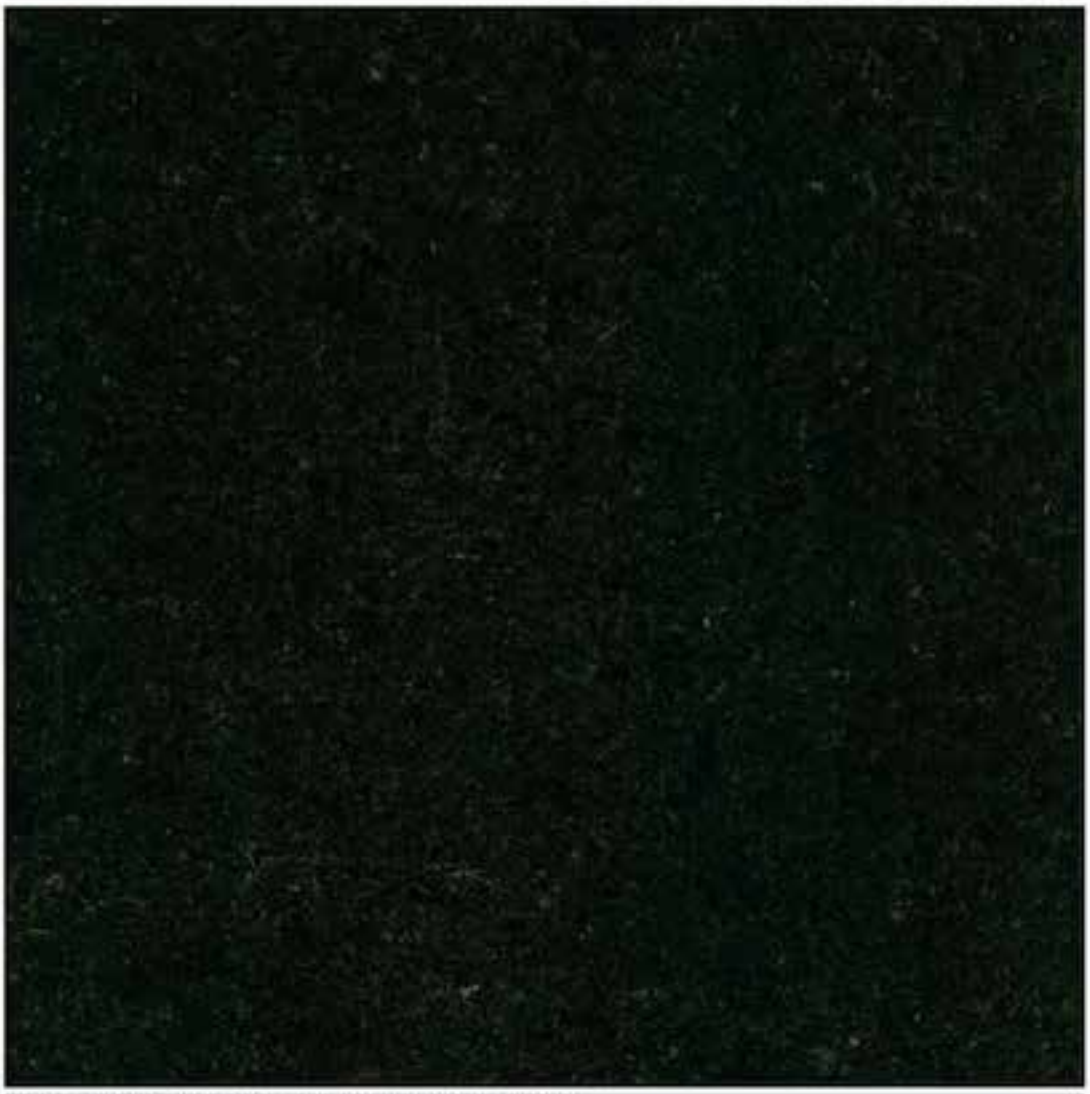
Geological Unit
Aimorés Intrusive Suite

Occurrence
Boulder

Other Names

Type and Predominant Color
Black granite

Preto Absoluto



Mineralogic Composition (microscopy)
Plagioclase - andesine/labradorite (55-60%); diopside (15-20%); biotite (15%); hyperstene(5%); opaques (<5%); apatite (<5%); quartz, chlorite, carbonate, sericite, iron hydroxides and/or oxides (tr).

Macroscopic Description
Black rock with equigranular melanocratic texture, medium grained with dots of mica.

Petrographic Classification
Biotite gabbronorite

Technological Characteristics		
Density	2931	kg/m³
Water Absorption	0.07	%
Compression Breaking Load at the Natural	113.3	MPa
Amsler Wear Test (1000m)	2.02	mm
Linear Thermal Expansion	9.7	mm/m °C
Apparent Porosity	0.20	%
Modulus of Rupture	22.43	MPa
Compression Breaking Load After Freezing/Thawing	115.7	MPa
Impact Resistance	88	cm

Recommended Use
Interior and exterior coating.

Preto Absoluto

County
Alegre

Localization
Santa Angélica District, Bom Ares.

Coordinates
Geographic: 20°42'56"S / 41°26'15"W
UTM: 246112 E / 7707409 N Zone:24S

Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Boulder

Other Names
Preto Total; Preto São Francisco; Preto Ferrugem;

Type and Predominant Color
Black granite

Preto Aracruz

Mineralogic Composition (microscopy)
Plagioclase - oligoclase (55%); microperthitic microcline (18%); biotite (17%); accessories (5%); quartz (5%).

Macroscopic Description
Black rock with massive structure, medium grained.

Petrographic Classification
Biotite norite

Technological Characteristics		
Density	2969	kg/m³
Water Absorption	0.07	%
Compression Breaking Load at the Natural	113.95	MPa
Amsler Wear Test (1000m)	0.86	mm
Linear Thermal Expansion	10.2	mm/m °C
Apparent Porosity	0.19	%
Modulus of Rupture	19.1	MPa
Compression Breaking Load After Freezing/Thawing	111.2	MPa
Impact Resistance	67	cm

Recommended Use
Floor, interior, and exterior coating.

Preto Aracruz

County
Aracruz

Localization
Estrada Taquaral.

Coordinates
Geographic: 19°57'22"S / 40°16'26"W
UTM: 366681 E / 7792852 N Zone:24S

Geological Unit
Espírito Santo Intrusive Suite

Occurrence
Massive rock and boulder

Other Names
Aracruz Black; Preto Cajugran;

Type and Predominant Color
Black granite

Preto Florido

Mineralogic Composition (microscopy)
Plagioclase (24%); hornblende (18%); microcline (17%); biotite (15%); quartz (10%); opaques (7%); apatite (4%); epidote (4%); muscovite (<1%); carbonate (<1%); titanite (<<1%);

Macroscopic Description
Melanocratic deformed rock with slight foliation but noticeable by the mafic and felsic mineral alignment. Fine to medium grained with equigranular texture, containing biotite, amphibole, microcline and little quartz. Centimetric quartz levels are common.

Petrographic Classification
Hornblende biotite diorite

Technological Characteristics		
Density	NA	kg/m^3
Water Absorption	NA	%
Compression Breaking Load at the Natural	NA	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	NA	mm/m ºC
Apparent Porosity	NA	%
Modulus of Rupture	NA	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Preto Florido

County
Iuna

Localization
Santo Antônio Stream.

Coordinates
Geographic: 20°21'13"S / 41°30'39"W
UTM: 237872 E / 7747367 N Zone:24S

Geological Unit
Juiz de Fora Complex

Occurrence
Massive rock

Other Names
Black Stype;

Type and Predominant Color
Black granite

Preto Indiano

Mineralogic Composition (microscopy)
Biotite (40%); quartz (40%); sillimanite (10%); K-feldspar - microcline (6%); plagioclase (3%); accessories - opaques and zircon (1%);

Macroscopic Description
Gneissic and locally schistous rock with migmatized portions and leucogranite intercalations; banded structure. It is seen biotitic and sillimanitic, lepidoblastic bands, leucogranitic granoblastic portions, inequigranular with grains between 1mm and 3mm.

Petrographic Classification
Biotite gneiss with sillimanite

Technological Characteristics		
Density	NA	kg/m^3
Water Absorption	NA	%
Compression Breaking Load at the Natural	NA	MPa
Amsler Wear Test (1000m)	NA	cm^3/cm^2
Linear Thermal Expansion	NA	mm/(mm x °C)
Apparent Porosity	NA	%
Modulus of Rupture	NA	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Preto Indiano

County
Iconha

Localization
Palmeiras.

Coordinates
Geographic: 20°42'23"S / 40°53'42"W
UTM: 302623 E / 7709171 N Zone:24S

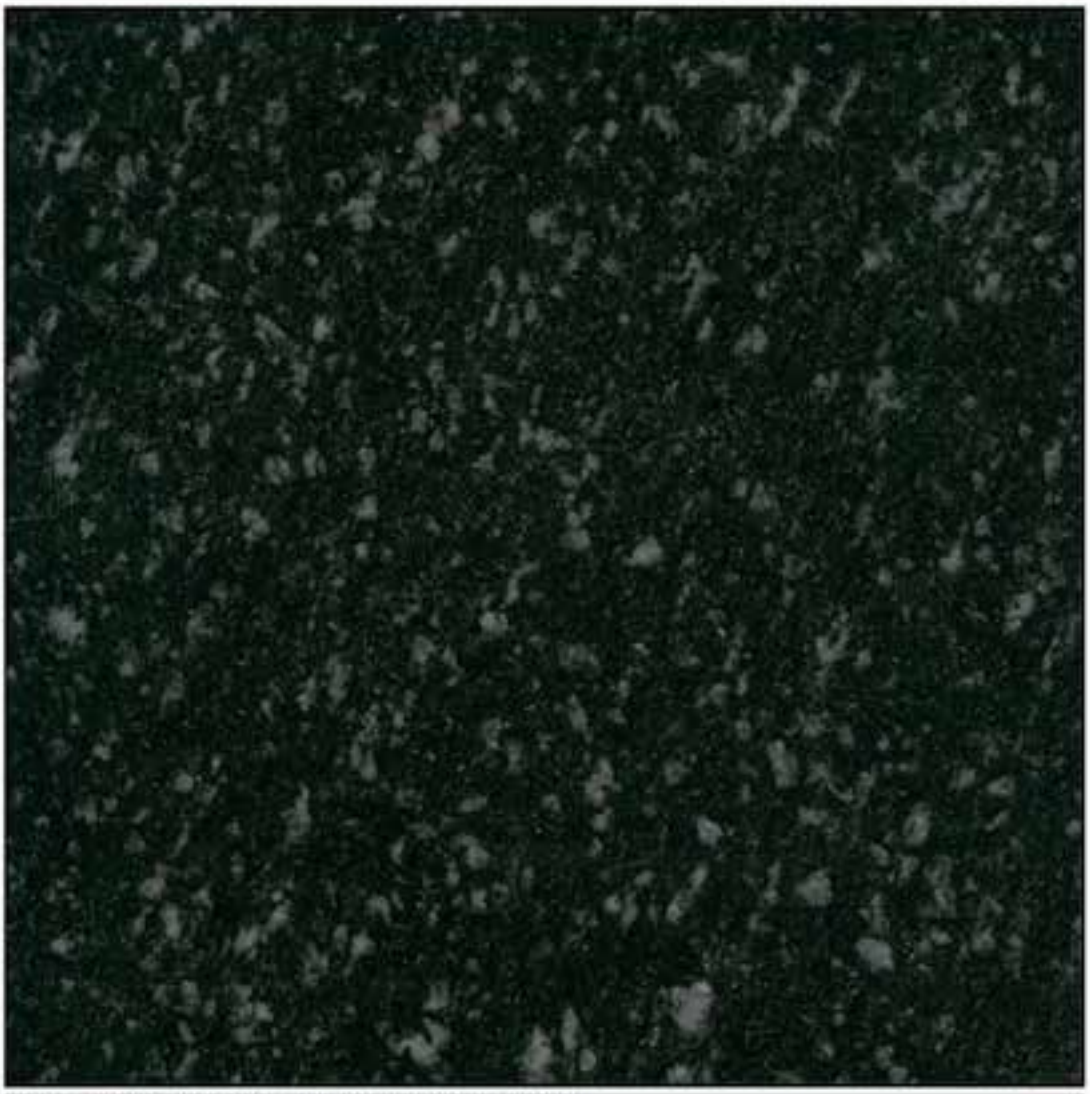
Geological Unit
São Fidelis Group

Occurrence
Massive rock

Other Names

Type and Predominant Color
Black granite

Preto Nevada



Mineralogic Composition (microscopy)
Feldspar, biotite, amphibole, garnet, little quartz, and opaques. It shows a low level of microfissuring and deletrious minerals.

Macroscopic Description
Melanocratic black rock, fine grained with equigranular texture, facies with dark gray color can be seen locally.

Petrographic Classification
Diorite

Technological Characteristics		
Density	2786	kg/m³
Water Absorption	0.28	%
Compression Breaking Load at the Natural	162	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	NA	mm/m ºC
Apparent Porosity	0.79	%
Modulus of Rupture	13.7	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	65	cm

Recommended Use
Interior and exterior coating.

NA = not available

Preto Nevada

County
Muniz Freire

Localization
Alto Assunção, Piaçu.

Coordinates
Geographic: 20°15'20"S / 41°21'37"W
UTM: 253430 E / 7758453 N Zone:24S

Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Black granite

Preto Santa Angélica

Mineralogic Composition (microscopy)
NA

Macroscopic Description
Melanocratic black rock, with equigranular texture, medium grained without deformation.

Petrographic Classification
Hyperstene gabbro diorite

Technological Characteristics		
Density	2870	kg/m³
Water Absorption	0.10	%
Compression Breaking Load at the Natural	112.83	MPa
Amsler Wear Test (1000m)	1.93	mm
Linear Thermal Expansion	9.93	mm/m °C
Apparent Porosity	0.29	%
Modulus of Rupture	21.68	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Preto Santa Angélica

County
Alegre

Localization
Distrito de Santa Angélica, Bela Aurora.

Coordinates
Geographic: 20°40'54"S / 41°25'54"W
UTM: 246680 E / 7711159 N Zone:24S

Geological Unit
Santa Angélica Intrusive Suite

Occurrence
Massive rock and boulder

Other Names

Type and Predominant Color
Black granite

Preto São Benedito

Mineralogic Composition (microscopy)
Plagioclase (49%); biotite (15%); diopside (13%); orthopyroxene (12%); quartz (7%); opaques (3%); apatite (1%); calcite, clay minerals, allanite.

Macroscopic Description
Black rock, with fine to medium granulation and a slightly oriented structure.

Petrographic Classification
Diopside biotite norite

Technological Characteristics		
Density	NA	kg/m^3
Water Absorption	NA	%
Compression Breaking Load at the Natural	NA	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	NA	mm/m ºC
Apparent Porosity	NA	%
Modulus of Rupture	NA	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Preto São Benedito

County
Ecoporanga

Localization
Eldorado Farm, Cotaxé Village.

Coordinates
Geographic: 18°10'40"S / 40°45'41"W
UTM: 313699 E / 7989252 N Zone:24S

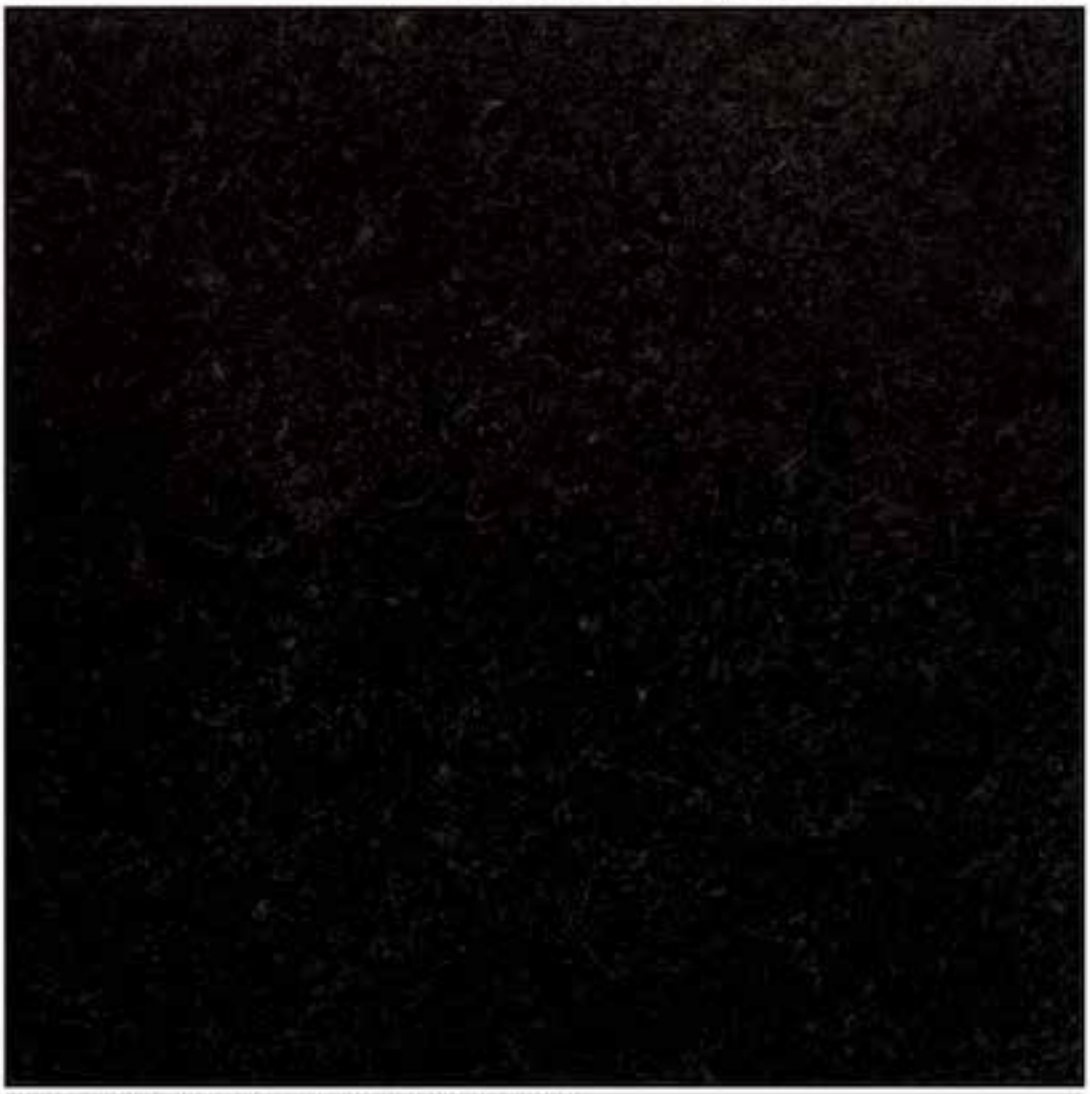
Geological Unit
Aimorés Intrusive Suite

Occurrence
Massive rock and boulder

Other Names
Preto Cotaxé;

Type and Predominant Color
Black granite

Preto São Gabriel



Mineralogic Composition (microscopy)
Plagioclase - andesine/labradorite (60%); hyperstene (15%); biotite (15%); hornblende (5%); quartz (5%).

Macroscopic Description
Medium grained dark gray rock with compact structure.

Petrographic Classification
Noritic diorite

Technological Characteristics		
Density	2960	kg/m^3
Water Absorption	0.33	%
Compression Breaking Load at the Natural	75.25	MPa
Amsler Wear Test (1000m)	1.76	mm
Linear Thermal Expansion	7.8	mm/m °C
Apparent Porosity	0.96	%
Modulus of Rupture	14.1	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	56	cm

Recommended Use
Interior and exterior coating.

NA = not available

Preto São Gabriel

County
Colatina

Localization
Rural Zone, KM 28 BR-259 Road.

Coordinates
Geographic: 19°36'45"S / 40°30'03"W
UTM: 342592 E / 7830708 N Zone:24S

Geological Unit
Espírito Santo Intrusive Suite

Occurrence
Massive rock

Other Names
Preto Santa Clara; Preto Baunilha;

Type and Predominant Color
Black granite

Pink

Juparaná Premium

Mineralogic Composition (microscopy)
Quartz (35%); microperthitic microcline (28%); plagioclase - oligoclase (17%); biotite (15%); garnet (5%);

Macroscopic Description
Gneissic orangish pink rock, coarse grained, with black (biotite) and red (garnet) aggregates.

Petrographic Classification
Syenogranitic gneiss with sillimanite and garnet

Technological Characteristics		
Density	2629	kg/m^3
Water Absorption	0.44	%
Compression Breaking Load at the Natural	93.3	MPa
Amsler Wear Test (1000m)	0.80	mm
Linear Thermal Expansion	6.2	mm/m °C
Apparent Porosity	1.17	%
Modulus of Rupture	6.31	MPa
Compression Breaking Load After Freezing/Thawing	70.5	MPa
Impact Resistance	NA	cm

Recommended Use
Floor, Interior and exterior coating.

NA = not available

Juparaná Premium

County
Águia Branca

Localization
Barra do Sertão.

Coordinates
Geographic: 18°52'00"S / 40°48'19"W
UTM: 309790 E / 7912950 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names
Juparaná Clássico;

Type and Predominant Color
Pink granite

Green

Jade Green

Mineralogic Composition (microscopy)
Plagioclase (50%); quartz (16%); k-feldspar (15%); biotite (9%); orthopyroxene (6%); hornblende (3%); opaques (1%);

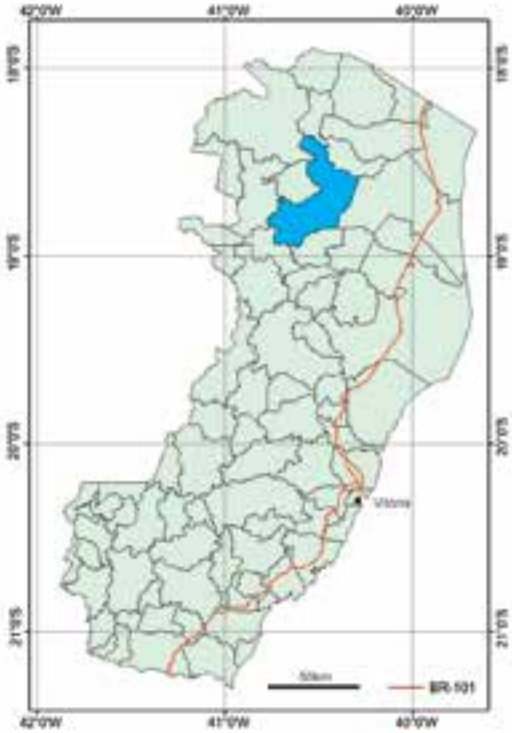
Macroscopic Description
Coarsed olive green rock, with hypidiomorphic feldspar crystals measuring up to 4 cm, having the intergranular spaces filled with millimetric quartz and mafic minerals. Intergranular fractures on feldspars are present.

Petrographic Classification
Optadalite

Technological Characteristics		
Density	2750	kg/m^3
Water Absorption	0.20	%
Compression Breaking Load at the Natural	106.97	MPa
Amsler Wear Test (1000m)	0.013	cm^3/cm^2
Linear Thermal Expansion	0.00243	mm/(mm x °C)
Apparent Porosity	0.54	%
Modulus of Rupture	11.12	MPa
Compression Breaking Load After Freezing/Thawing	103.04	MPa
Impact Resistance	65	cm

Recommended Use
Floor, interior, and exterior coating.

Jade Green



County
Nova Venécia

Localization
Itaperuna Village, Lapa Stream.

Coordinates
Geographic: 18°41'20"S / 40°41'31"W
UTM: 321545 E / 7932751 N Zone:24S

Geological Unit
Aimorés Intrusive Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Green granite

Mombasa

Mineralogic Composition (microscopy)
Quartz, microcline, plagioclase, biotite, amphibole and opaques.

Macroscopic Description
Granitic leucocratic light gray rock with greenish tones, inequigranular texture, coarse to very coarsed grained.

Petrographic Classification
Granitic biotite gneiss

Technological Characteristics		
Density	2596	kg/m³
Water Absorption	0.352	%
Compression Breaking Load at the Natural	139.9	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	NA	mm/m °C
Apparent Porosity	0.92	%
Modulus of Rupture	10.9	MPa
Compression Breaking Load After Freezing/Thawing	140.1	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Mombasa

County
Afonso Claúdio

Localization
Cedro Stream - Pontões.

Coordinates
Geographic: 20°11'33"S / 41°05'09"W
UTM: 282028 E / 7765824 N Zone:24S

Geological Unit
Late-orogenic leucogranite

Occurrence
Massive rock

Other Names
Iberê Mombasa;

Type and Predominant Color
Green granite

Typhon Green

Mineralogic Composition (microscopy)
Microcline (57%); quartz (24%); plagioclase (15%); opaque minerals (3%); muscovite (1%).

Macroscopic Description
Pale gray to yellow leucocratic rock with greenish tones, granolepidoblastic texture
It presents a gneissic structure, and coarse granulation and it consists of quartz, plagioclase, microcline, garnet and epidote.

Petrographic Classification
Garnetiferous biotite leucosyenogranite

Technological Characteristics		
Density	NA	kg/m^3
Water Absorption	NA	%
Compression Breaking Load at the Natural	NA	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	NA	mm/m ºC
Apparent Porosity	NA	%
Modulus of Rupture	NA	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Typhon Green

County
Vargem Alta

Localization
Alegre Stream, Prosperidade District.

Coordinates
Geographic: 20°38'49"S / 41°02'25"W
UTM: 287419 E / 7715578 N Zone:24S

Geological Unit
Late- orogenic leucogranite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Green granite

Verde Amazonas

Mineralogic Composition (microscopy)
Quartz (27%), K-feldspar (40%), plagioclase - oligoclase (19,5%), hyperstene (3,5%), hornblende (2.7%), biotite (2.5%), diopside (2.5%), accessories (2%).

Macroscopic Description
Megaporphyirtic grayish dark green serial charnockite coarsely gneissified. The gneissification is homogeneous, protomylonitic, given by intercalations of bands irregularly spaced with different intensities of mineral stretching.

Petrographic Classification
Megaporphyritic gneissified charnockite

Technological Characteristics		
Density	2684	kg/m^3
Water Absorption	0.19	%
Compression Breaking Load at the Natural	106.6	MPa
Amsler Wear Test (1000m)	0.76	mm
Linear Thermal Expansion	6.60	mm/m °C
Apparent Porosity	0.6	%
Modulus of Rupture	7.9	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	50	cm

Recommended Use
Interior and exterior coating.

NA = not available

Verde Amazonas

County
Colatina

Localization
Casa Branca Road Km 33, rural zone - Itapina District.

Coordinates
Geographic: 19°36'18"S / 40°49'46"W
UTM: 308106 E / 7831187 N Zone:24S

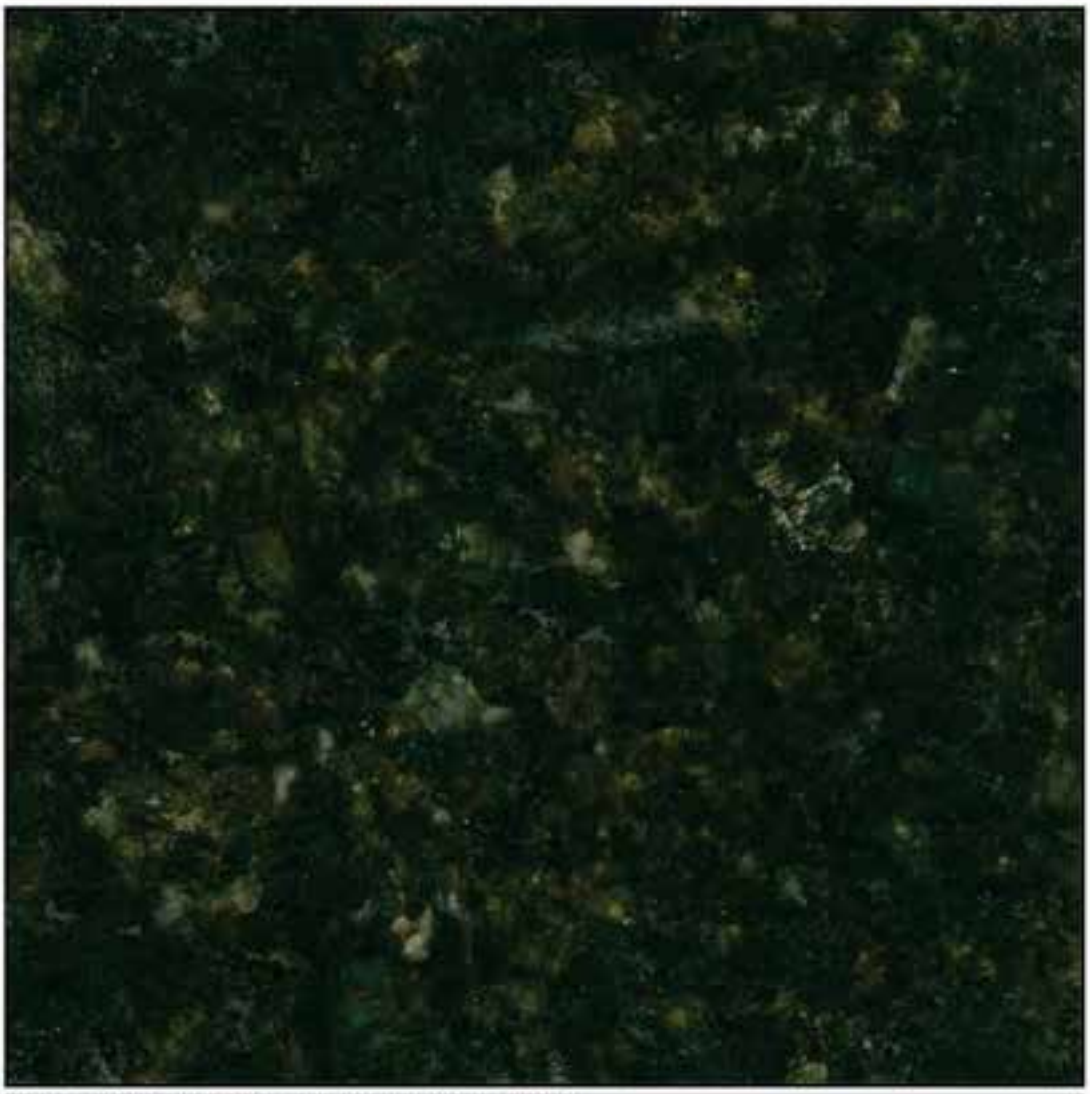
Geological Unit
Aimorés Intrusive Suite

Occurrence
Massive rock and boulder

Other Names

Type and Predominant Color
Green granite

Verde Bahia



Mineralogic Composition (microscopy)
Plagioclase - Andesine (35%); microperthitic alkali feldspar (27%); quartz (15%); hyperstene (10%); accessories (5%); hornblende (3%); biotite (3%); opaques (2%);

Macroscopic Description
Massive dark green rock, coarse grained.

Petrographic Classification
Mangerite

Technological Characteristics		
Density	2671	kg/m^3
Water Absorption	0.14	%
Compression Breaking Load at the Natural	135.1	MPa
Amsler Wear Test (1000m)	0.81	mm
Linear Thermal Expansion	9.6	mm/m °C
Apparent Porosity	0.37	%
Modulus of Rupture	18.16	MPa
Compression Breaking Load After Freezing/Thawing	146.6	MPa
Impact Resistance	48	cm

Recommended Use
Floor, interior, and exterior coating.

Verde Bahia

County
Baixo Guandu

Localization
Santa Maria Farm, Mangue Stream.

Coordinates
Geographic: 19°17'52"S / 40°52'17"W
UTM: 303388 E / 7865145 N Zone:24S

Geological Unit
Aimorés Intrusive Suite

Occurrence
Massive rock

Other Names
Labrador; Ubatuda; Verde Panorama; Verde Pérola;

Type and Predominant Color
Green granite

Verde Butterfly

Mineralogic Composition (microscopy)
Perthitic orthoclase (50%); plagioclase - oligoclase (30%); quartz (12%); orthopyroxene (8%);

Macroscopic Description
Coarse grained green rock.

Petrographic Classification
Hyperstene quartz monzoniteo with garnet

Technological Characteristics		
Density	2674	kg/m³
Water Absorption	0.15	%
Compression Breaking Load at the Natural	138.3	MPa
Amsler Wear Test (1000m)	0.8	mm
Linear Thermal Expansion	5.4	mm/m ºC
Apparent Porosity	0.41	%
Modulus of Rupture	9.13	MPa
Compression Breaking Load After Freezing/Thawing	138.8	MPa
Impact Resistance	NA	cm

Recommended Use
Floor, interior, and exterior coating.

NA = not available

Verde Butterfly

County
Vila Pavão

Localization
Jaó Stream.

Coordinates
Geographic: 18°38'11"S / 40°39'49"W
UTM: 324496 E / 7938589 N Zone:24S

Geological Unit
Aimorés Intrusive Suite

Occurrence
Massive rock and boulder

Other Names
Verde Pavão;

Type and Predominant Color
Green granite

Verde Eucalipto

Mineralogic Composition (microscopy)
Perthitic microcline (45%); quartz (25%); plagioclase-oligoclase (20%); garnet (4%); sillimanite (3%); cordierite (3%).

Macroscopic Description
Gneissic greenish light gray rock, fine to medium grained.

Petrographic Classification
Syenogranitic leucogneiss with garnet, sillimanite and cordierite

Technological Characteristics		
Density	2628	kg/m^3
Water Absorption	0.18	%
Compression Breaking Load at the Natural	167.98	MPa
Amsler Wear Test (1000m)	1.2	mm
Linear Thermal Expansion	6.7	mm/m ºC
Apparent Porosity	0.48	%
Modulus of Rupture	19.33	MPa
Compression Breaking Load After Freezing/Thawing	182.16	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Verde Eucalipto

County
Nova Venécia

Localization
Volta Stream, rural zone.

Coordinates
Geographic: 18°39'19"S / 40°28'39"W
UTM: 344137 E / 7936645 N Zone:24S

Geological Unit
Carlos Chagas Suite

Occurrence
Massive rock

Other Names

Type and Predominant Color
Green granite

Verde Labrador

Mineralogic Composition (microscopy)
Plagioclase - andesine (30%); microperthitic microcline (30%); quartz (15%); biotite (13%); hornblende (7%); orthopyroxene (5%);

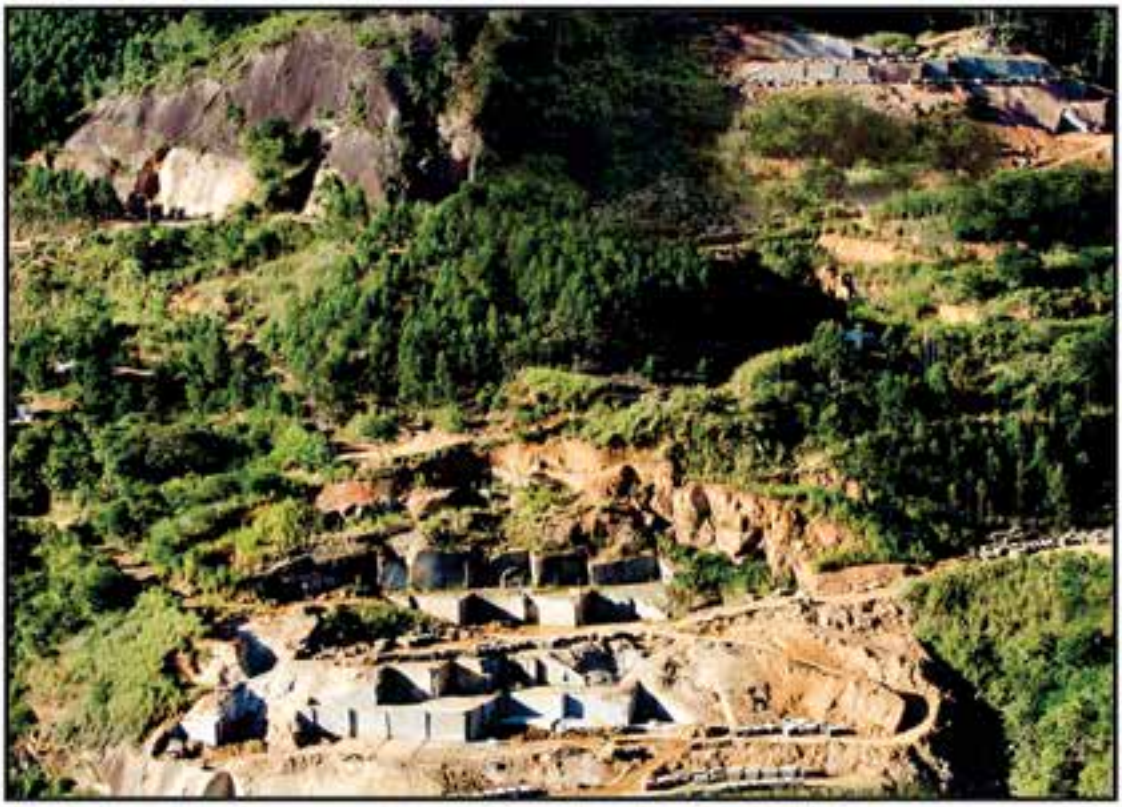
Macroscopic Description
Massive greenish gray rock, slightly oriented and coarse grained.

Petrographic Classification
Hyperstene hornblende biotite quartz monzonite

Technological Characteristics		
Density	2690	kg/m^3
Water Absorption	0.26	%
Compression Breaking Load at the Natural	146	MPa
Amsler Wear Test (1000m)	0.35	mm
Linear Thermal Expansion	6.4	mm/m °C
Apparent Porosity	0.71	%
Modulus of Rupture	9.9	MPa
Compression Breaking Load After Freezing/Thawing	131.52	MPa
Impact Resistance	54	cm

Recommended Use
Floor, interior, and exterior coating.

Verde Labrador



County
Baixo Guandu

Localization
Mutum Preto Road - Alto Mutum
Km 20 Rural Zone.

Coordinates
Geographic: 19°20'08"S / 40°53'52"W
UTM: 300636 E / 7860939 N Zone:24S

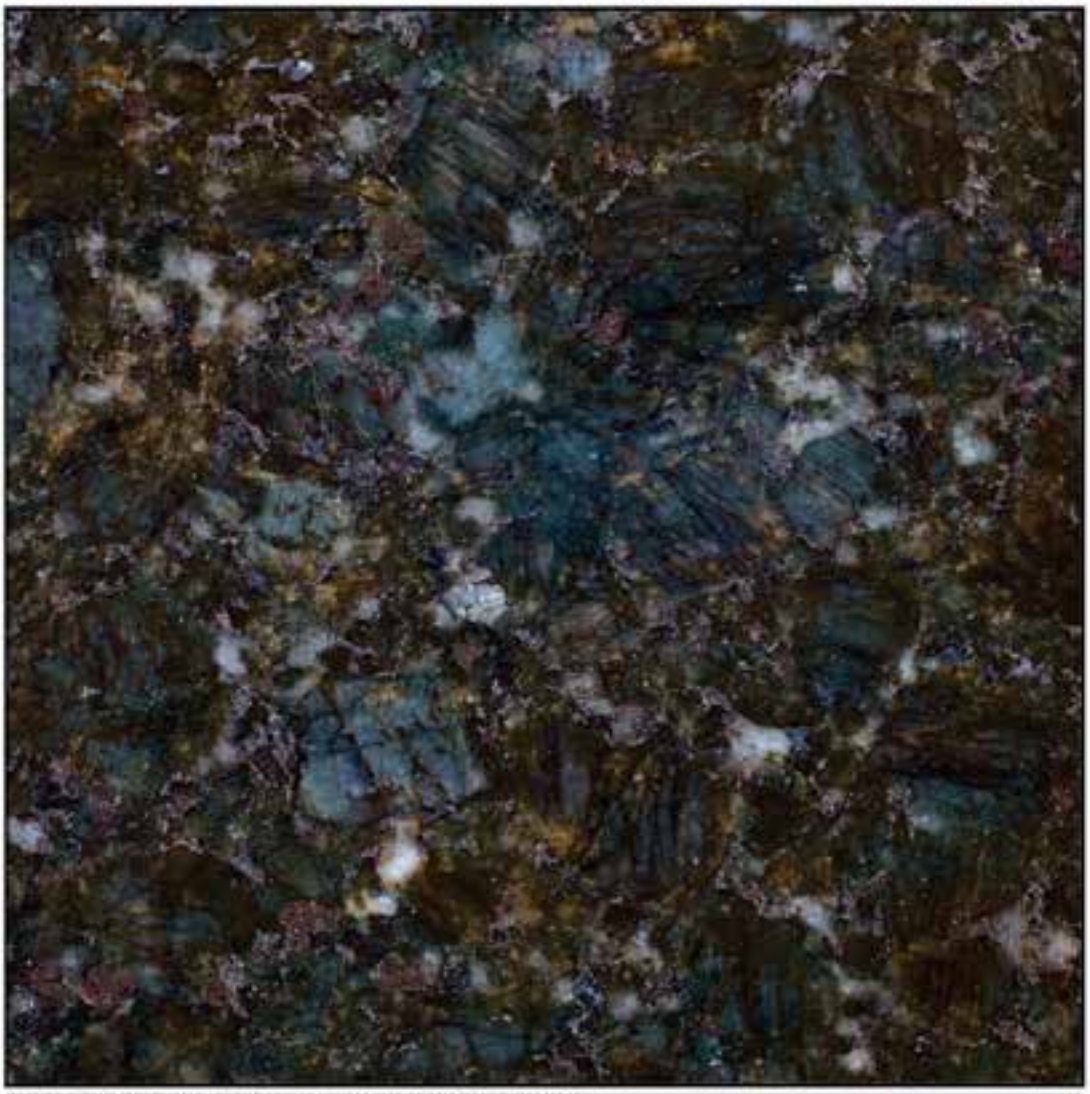
Geological Unit
Aimorés Intrusive Suite

Occurrence
Massive rock

Other Names
Ubatuba; Verde Gold;

Type and Predominant Color
Green granite

Verde Pavão



Mineralogic Composition (microscopy)
Microperthitic microcline (40-45%); plagioclase - oligoclase (30%); quartz (20%); garnet (5%); orthopyroxene (hypersthene) trace; opaques (oxides and sulfides), zircon, apatite, biotite (accessories <5%); iron hydroxides, uralite, carbonate, clay minerals, chlorite, green mica (secundaries);

Macroscopic Description
Hypidiomorphic to granoblastic inequigranular rock, medium to very coarse grained with predominance of grains between 1mm and 3mm. Microcline megacrystals can measure up to 3 cm.

Petrographic Classification
Charnockite with garnet

Technological Characteristics		
Density	2702	kg/m³
Water Absorption	0.25	%
Compression Breaking Load at the Natural	125.03	MPa
Amsler Wear Test (1000m)	1	mm
Linear Thermal Expansion	5	mm/m ºC
Apparent Porosity	0.69	%
Modulus of Rupture	8.31	MPa
Compression Breaking Load After Freezing/Thawing	125.8	MPa
Impact Resistance	42	cm

Recommended Use
Floor, interior, and exterior coating.

Verde Pavão

County
Barra de São Francisco

Localization
Comprido Stream - 2,5 Km NE from
Itaperuna Village

Coordinates
Geographic: 18°41'34"S / 40°43'01"W
UTM: 318940 E / 7932270 N Zone:24S

Geological Unit
Aimorés Intrusive Suite

Occurrence
Massive rock

Other Names
Verde Butterfly;

Type and Predominant Color
Green granite

Verde Volcano

Mineralogic Composition (microscopy)
Plagioclase - oligoclase/andesine (40%); quartz (20%); biotite (12%); hornblende (10%); microperthitic alkali feldspar (5%); opaques (5%); hyperstene (5%); accessories (3%).

Macroscopic Description
Gneissic dark green rock medium grained.

Petrographic Classification
Opdalitic hornblende biotite gneiss

Technological Characteristics		
Density	2774	kg/m^3
Water Absorption	0.16	%
Compression Breaking Load at the Natural	133.6	MPa
Amsler Wear Test (1000m)	1.2	mm
Linear Thermal Expansion	7	mm/m °C
Apparent Porosity	0.45	%
Modulus of Rupture	11.42	MPa
Compression Breaking Load After Freezing/Thawing	90.9	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Verde Volcano

County
Águia Branca

Localization
Águas Claras Farm.

Coordinates
Geographic: 18°51'20"S / 40°48'06"W
UTM: 310170 E / 7914189 N Zone:24S

Geological Unit
Aimorés Intrusive Suite

Occurrence
Massive rock and boulder

Other Names
Verde Imperial;

Type and Predominant Color
Green granite

Marbles

Blue

Azul Acqua Marina

Mineralogic Composition (microscopy)

Calcite (40-45%); dolomite (30-35%); diopside (10-15%); forsterite (5-10%); phlogopite, plagioclase, tremolite, chlorite, serpentine (5%).

Macroscopic Description

Blueish gray rock, with fine grained matrix.

Petrographic Classification

Forsterite-diopside-dolomite-calcite marble

Technological Characteristics

Density	2901	kg/m^3
Water Absorption	0.01	%
Compression Breaking Load at the Natural	113	MPa
Amsler Wear Test (1000m)	3.11	mm
Linear Thermal Expansion	8.9	mm/m ºC
Apparent Porosity	0.04	%
Modulus of Rupture	18.11	MPa
Compression Breaking Load After Freezing/Thawing	108.3	MPa
Impact Resistance	52	cm

Recommended Use

Interior and exterior coating.

Azul Acqua Marina

County
Cachoeiro do Itapemirim

Localization
Gironda District, Alto Gironda.

Coordinates
Geographic: 20°43'02"S / 41°05'45"W
UTM: 281733 E / 7707714 N Zone:24S

Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rock

Other Names

Type and Predominant Color
Blue marble

Azul Capixaba

Mineralogic Composition (microscopy)
Calcite + Dolomite (98%); diopside (1%); wollastonite (1%).

Macroscopic Description
Isotropic white rock with slight blueish gray tones, granular texture, fine to medium grained, with content of white calcite, dolomite and rare micaceous minerals.

Petrographic Classification
Calcite dolomite marble

Technological Characteristics		
Density	2855	kg/m^3
Water Absorption	0.06	%
Compression Breaking Load at the Natural	86.4	MPa
Amsler Wear Test (1000m)	6.92	mm
Linear Thermal Expansion	8.9	mm/m ºC
Apparent Porosity	0.17	%
Modulus of Rupture	13.04	MPa
Compression Breaking Load After Freezing/Thawing	86.7	MPa
Impact Resistance	35	cm

Recommended Use
Interior and exterior coating.

Azul Capixaba

County
Cachoeiro do Itapemirim

Localization
Gironda District, Alto Gironda.

Coordinates
Geographic: 20°42'38"S / 41°05'16"W
UTM: 282559 E / 7708484 N Zone:24S

Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rock

Other Names
Mármore Tropical;

Type and Predominant Color
Blue marble

Calcita Azul

Mineralogic Composition (microscopy)
Calcite (65%); muscovite (11%); diopside (24%);

Macroscopic Description
Mineral aggregates consisting of romboedric centimetric translucid slightly blueish white calcite crystals.

Petrographic Classification
Calcite marble

Technological Characteristics		
Density	NA	kg/m^3
Water Absorption	NA	%
Compression Breaking Load at the Natural	NA	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	NA	mm/m ºC
Apparent Porosity	NA	%
Modulus of Rupture	NA	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior coating.

NA = not available

Calcita Azul

County
Cachoeiro do Itapemirim

Localization
Serra da Gironda.

Coordinates
Geographic: 20°43'16"S / 41°05'59"W
UTM: 281310 E / 7707287 N Zone:24S

Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rock

Other Names
Cristalita;

Type and Predominant Color
Blueish white marble

White

Branco Azulado

Mineralogic Composition (microscopy)
Dolomite (90%); calcite (5%) and apatite, opaques and iron oxide (5%).

Macroscopic Description
Blueish gray rock with fine grained matrix

Petrographic Classification
Calcite dolomite marble

Technological Characteristics		
Density	2855	kg/m³
Water Absorption	0.06	%
Compression Breaking Load at the Natural	86.4	MPa
Amsler Wear Test (1000m)	6.92	mm
Linear Thermal Expansion	8.9	mm/m °C
Apparent Porosity	0.17	%
Modulus of Rupture	13.04	MPa
Compression Breaking Load After Freezing/Thawing	86.7	MPa
Impact Resistance	35	cm

Recommended Use
Interior and exterior coating.

Branco Azulado

County
Vargem Alta

Localization
Gironda District, Alto Gironda.

Coordinates
Geographic: 20°42'31"S / 41°05'00"W
UTM: 283000 E / 7708700 N Zone:24S

Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rock

Other Names
Acinzentado;

Type and Predominant Color
White marble

Branco Cintilante

Mineralogic Composition (microscopy)
Dolomite (calcitic band 5%), (dolomitic band 70%); calcite (calcitic band 95%),
(dolomitic band 25%); tremolite on calcitic band (trace) and on dolomitic band (5%).
Secundary phyllosilicates (traces).

Macroscopic Description
Medium grained slightly greenish white rock.

Petrographic Classification
White marble

Technological Characteristics		
Density	2813	kg/m^3
Water Absorption	0.09	%
Compression Breaking Load at the Natural	82.1	MPa
Amsler Wear Test (1000m)	5.28	mm
Linear Thermal Expansion	3.1	mm/m ºC
Apparent Porosity	0.25	%
Modulus of Rupture	4.41	MPa
Compression Breaking Load After Freezing/Thawing	79.3	MPa
Impact Resistance	NA	cm

Recommended Use
Interior coating.

NA = not available

Branco Cintilante

County
Cachoeiro do Itapemirim

Localization
Serra da Gironda/Cava 7.

Coordinates
Geographic: 20°43'28"S / 41°06'14"W
UTM: 280895 E / 7706900 N Zone:24S

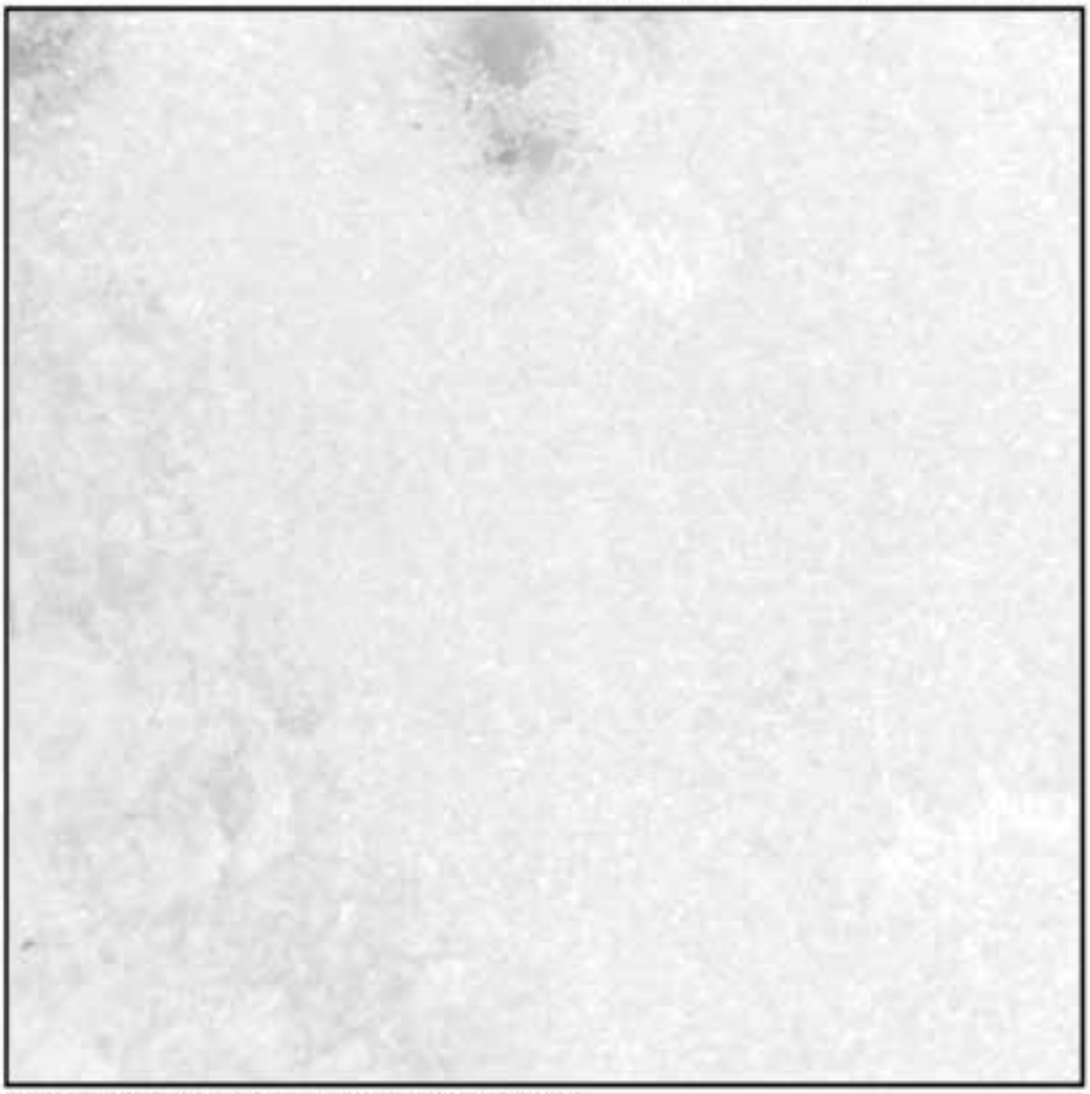
Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rock

Other Names

Type and Predominant Color
White marble

Branco Clássico



Mineralogic Composition (microscopy)
100% Calcite + dolomite

Macroscopic Description
Medium grained white rock

Petrographic Classification
Calcite dolomite marble

Technological Characteristics		
Density	2849	kg/m³
Water Absorption	0.09	%
Compression Breaking Load at the Natural	120.8	MPa
Amsler Wear Test (1000m)	3.89	mm
Linear Thermal Expansion	6.3	mm/m ºC
Apparent Porosity	0.25	%
Modulus of Rupture	6.83	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	44	cm

Recommended Use
Interior and exterior coating.

NA = not available

Branco Clássico

County
Cachoeiro do Itapemirim

Localization
Serra de Itaóca, Alto Moledo.

Coordinates
Geographic: 20°43'49"S / 41°06'16"W
UTM: 280854 E / 7706258 N Zone:24S

Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rock

Other Names
Branco Cachoeiro; Cachoeiro White;

Type and Predominant Color
White marble

Branco Comum

Mineralogic Composition (microscopy)
Dolomite (90%); calcite (5%) and apatite, opaques and iron oxide (5%).

Macroscopic Description
Massive medium to coarse grained white rock.

Petrographic Classification
Calcite dolomite marble

Technological Characteristics		
Density	2855	kg/m³
Water Absorption	0.06	%
Compression Breaking Load at the Natural	86.4	MPa
Amsler Wear Test (1000m)	6.92	mm
Linear Thermal Expansion	8.9	mm/m °C
Apparent Porosity	0.17	%
Modulus of Rupture	13.04	MPa
Compression Breaking Load After Freezing/Thawing	86.7	MPa
Impact Resistance	35	cm

Recommended Use
Interior and exterior coating.

Branco Comum

County
Vargem Alta

Localization
Gironda District, Alto Gironda.

Coordinates
Geographic: 20°42'31"S / 41°05'00"W
UTM: 283000 E / 7708700 N Zone:24S

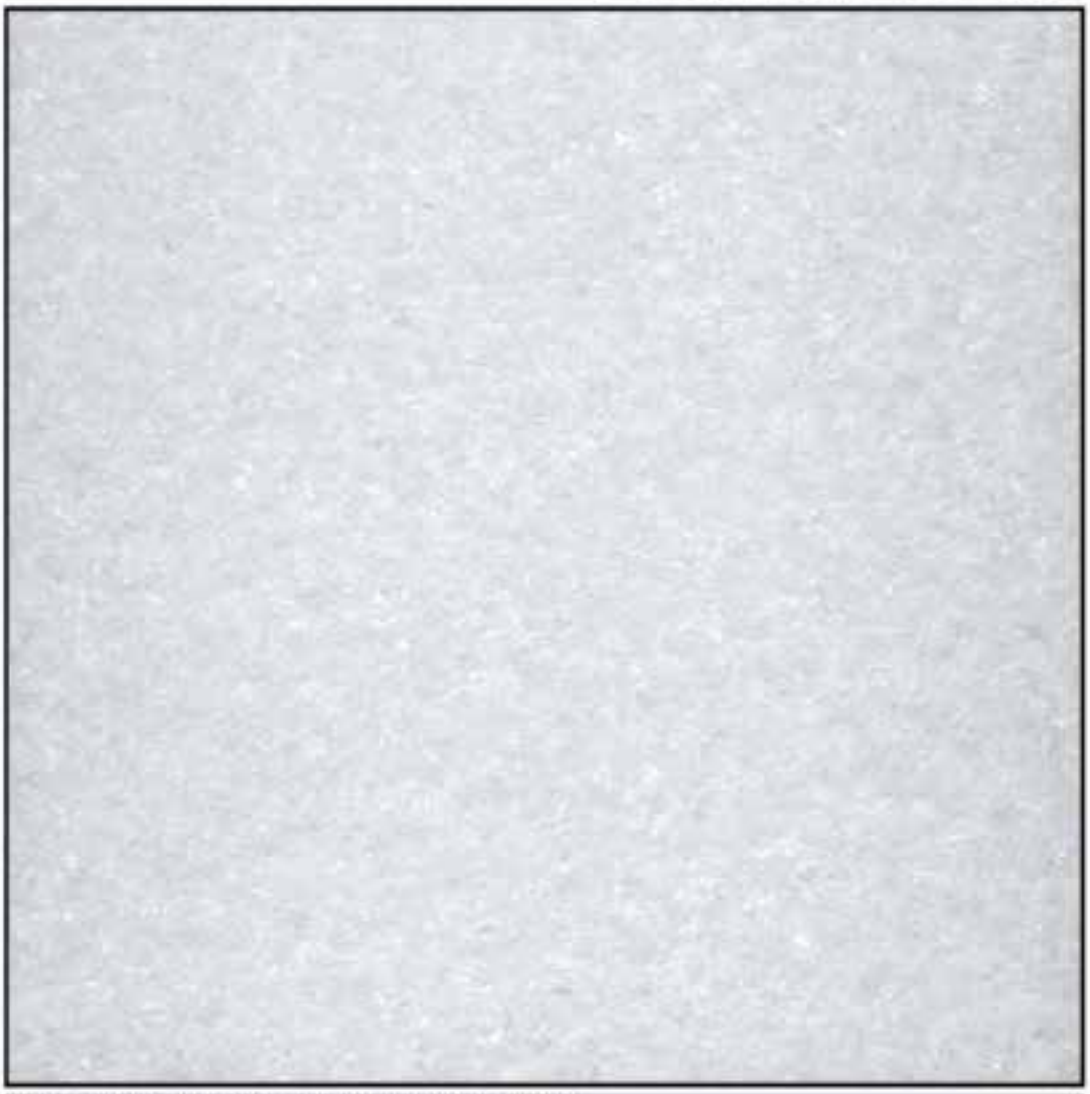
Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rock

Other Names
Mármore Branco; Mármore Cachoeiro;

Type and Predominant Color
White marble

Branco Neve



Mineralogic Composition (microscopy)
Dolomite (85%); calcite (10-15%); phlogopite, apatite, tremolite, phyllosilicates secundaries (<5%).

Macroscopic Description
Massive sacaroid white rock.

Petrographic Classification
Calcite dolomite marble

Technological Characteristics		
Density	2853	kg/m³
Water Absorption	0.08	%
Compression Breaking Load at the Natural	84.8	MPa
Amsler Wear Test (1000m)	8.08	mm
Linear Thermal Expansion	9.6	mm/m °C
Apparent Porosity	0.23	%
Modulus of Rupture	13.29	MPa
Compression Breaking Load After Freezing/Thawing	69.9	MPa
Impact Resistance	44	cm

Recommended Use
Interior and exterior coating.

Branco Neve

County
Cachoeiro do Itapemirim

Localization
Gironda District, Alto Gironda.

Coordinates
Geographic: 20°43'47"S / 41°06'00"W
UTM: 281320 E / 7706340 N Zone:24S

Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rock

Other Names
Branco extra;

Type and Predominant Color
White marble

Branco Rajado

Mineralogic Composition (microscopy)
Dolomite (85%); calcite (10-15%); phlogopite, apatite, tremolite, phyllosilicates secundaries (<5%).

Macroscopic Description
Massive sacaroid white rock.

Petrographic Classification
Calcite dolomite marble

Technological Characteristics		
Density	2853	kg/m³
Water Absorption	0.08	%
Compression Breaking Load at the Natural	84.8	MPa
Amsler Wear Test (1000m)	8.08	mm
Linear Thermal Expansion	9.6	mm/m °C
Apparent Porosity	0.23	%
Modulus of Rupture	13.29	MPa
Compression Breaking Load After Freezing/Thawing	69.9	MPa
Impact Resistance	44	cm

Recommended Use
Interior and exterior coating.

Branco Rajado

County
Cachoeiro do Itapemirim

Localization
Gironda District, Alto Gironda.

Coordinates
Geographic: 20°43'47"S / 41°06'00"W
UTM: 281320 E / 7706340 N Zone:24S

Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rock

Other Names

Type and Predominant Color
White marble

Branco Santo Antônio

Mineralogic Composition (microscopy)
Dolomite (70%); olivine (15%); calcite (15%);

Macroscopic Description
Massive medium grained rock with bands rich in fine forsterite.

Petrographic Classification
Forsterite calcite dolomite marble

Technological Characteristics		
Density	2846	kg/m^3
Water Absorption	0.087	%
Compression Breaking Load at the Natural	80.,3	MPa
Amsler Wear Test (1000m)	0.015	cm^3/cm^2
Linear Thermal Expansion	0.001219	mm/(mm x °C)
Apparent Porosity	0.248	%
Modulus of Rupture	12.5	MPa
Compression Breaking Load After Freezing/Thawing	66.7	MPa
Impact Resistance	50	cm

Recommended Use
Floor, interior, and exterior coating.

Branco Santo Antônio

County
Vargem Alta

Localization
Prosperidade Village.

Coordinates
Geographic: 20°40'01"S / 41°03'40"W
UTM: 285260 E / 7713330 N Zone:24S

Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rock

Other Names
Candelária White;

Type and Predominant Color
White marble

Medusa

Mineralogic Composition (microscopy)
100% Calcite + dolomite

Macroscopic Description
Medium grained white rock

Petrographic Classification
Calcite dolomite marble

Technological Characteristics		
Density	2849	kg/m³
Water Absorption	0.09	%
Compression Breaking Load at the Natural	120.8	MPa
Amsler Wear Test (1000m)	3.89	mm
Linear Thermal Expansion	6.3	mm/m ºC
Apparent Porosity	0.25	%
Modulus of Rupture	6.83	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	44	cm

Recommended Use
Interior and exterior coating.

NA = not available

Medusa

County
Cachoeiro do Itapemirim

Localization
Serra de Itaóca, Alto Moledo.

Coordinates
Geographic: 20°43'49"S / 41°06'16"W
UTM: 280854 E / 7706258 N Zone:24S

Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rock

Other Names
Branco Clássico Veiado;

Type and Predominant Color
White marble

Gray

Acinzentado

Mineralogic Composition (microscopy)
Dolomite (90%); calcite (5%) and apatite, opaques and iron oxide (5%);

Macroscopic Description
Grayish white rock with a fine grained matrix.

Petrographic Classification
Calcite dolomite marble

Technological Characteristics		
Density	2855	kg/m³
Water Absorption	0.06	%
Compression Breaking Load at the Natural	86.4	MPa
Amsler Wear Test (1000m)	6.92	mm
Linear Thermal Expansion	8.9	mm/m ºC
Apparent Porosity	0.17	%
Modulus of Rupture	13.04	MPa
Compression Breaking Load After Freezing/Thawing	86.7	MPa
Impact Resistance	35	cm

Recommended Use
Interior and exterior coating.

Acinzentado

County
Vargem Alta

Localization
Gironda District, Alto Gironda.

Coordinates
Geographic: 20°42'31"S / 41°05'00"W
UTM: 283000 E / 7708700 N Zone:24S

Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rock

Other Names

Type and Predominant Color
Gray marble

Brown

Champagne

Mineralogic Composition (microscopy)
Dolomite (85%); calcite (10-15%); phlogopite, apatite, tremolite, secundary phyllosilicates (<5%).

Macroscopic Description
Massive and sacaroid white rock.

Petrographic Classification
Calcite dolomite marble

Technological Characteristics		
Density	2853	kg/m^3
Water Absorption	0.08	%
Compression Breaking Load at the Natural	84.8	MPa
Amsler Wear Test (1000m)	8.08	mm
Linear Thermal Expansion	9.6	mm/m ºC
Apparent Porosity	0.23	%
Modulus of Rupture	13.29	MPa
Compression Breaking Load After Freezing/Thawing	69.9	MPa
Impact Resistance	44	cm

Recommended Use
Interior and exterior coating.

Champagne

County
Cachoeiro do Itapemirim

Localization
Gironda District, Alto Gironda.

Coordinates
Geographic: 20°43'47"S / 41°06'00"W
UTM: 281325 E / 7706345 N Zone:24S

Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rocck

Other Names

Type and Predominant Color
Light brown marble

Chocolate

Mineralogic Composition (microscopy)

Calcite (85-90%); quartz (5-10%); feldspars (<5%); phlogopite, scapolite, opaques, zircon, apatite (<5%).

Macroscopic Description

Light brown rock, slightly banded, fine to medium grained with granular texture where micaceous bands slightly folded can be seen.

Petrographic Classification

Tremolite phlogopite calcite marble

Technological Characteristics

Density	2733	kg/m^3
Water Absorption	0.01	%
Compression Breaking Load at the Natural	69	MPa
Amsler Wear Test (1000m)	4.02	mm
Linear Thermal Expansion	3.2	mm/m ºC
Apparent Porosity	0.02	%
Modulus of Rupture	17.54	MPa
Compression Breaking Load After Freezing/Thawing	59.7	MPa
Impact Resistance	69	cm

Recommended Use

Interior and exterior coating.

Chocolate

County
Cachoeiro do Itapemirim

Localization
Gironda District, Alto Gironda.

Coordinates
Geographic: 20°43'38"S / 41°05'31"W
UTM: 282141 E / 7706604 N Zone:24S

Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rocck

Other Names

Type and Predominant Color
Brown marble

Green

Lumen

Mineralogic Composition (microscopy)
Calcite, dolomite, sericite, apatite and opaques.

Macroscopic Description
Leucocratic isotropic white rock with blueish tones, fine granulation, granular texture.

Petrographic Classification
Calcitic Lime

Technological Characteristics		
Density	NA	kg/m^3
Water Absorption	NA	%
Compression Breaking Load at the Natural	NA	MPa
Amsler Wear Test (1000m)	NA	mm
Linear Thermal Expansion	NA	mm/m ºC
Apparent Porosity	NA	%
Modulus of Rupture	NA	MPa
Compression Breaking Load After Freezing/Thawing	NA	MPa
Impact Resistance	NA	cm

Recommended Use
Interior and exterior coating.

NA = not available

Lumen

County
Vargem Alta

Localization
Prosperidade.

Coordinates
Geographic: 20°40'32"S / 41°03'30"W
UTM: 285566 E / 7712389 N Zone:24S

Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rock

Other Names

Type and Predominant Color
Green marble

Pinta Verde

Mineralogic Composition (microscopy)
Dolomite (90%); calcite (5%) and apatite, opaques and iron oxide (5%).

Macroscopic Description
Grayish to greenish white rock with a fine grained matrix.

Petrographic Classification
Calcite dolomite marble

Technological Characteristics		
Density	2855	kg/m³
Water Absorption	0.06	%
Compression Breaking Load at the Natural	86.4	MPa
Amsler Wear Test (1000m)	6.92	mm
Linear Thermal Expansion	8.9	mm/m ºC
Apparent Porosity	0.17	%
Modulus of Rupture	13.04	MPa
Compression Breaking Load After Freezing/Thawing	86.7	MPa
Impact Resistance	35	cm

Recommended Use
Interior and exterior coating.

Pinta Verde

County
Vargem Alta

Localization
Gironda District, Alto Gironda.

Coordinates
Geographic: 20°42'31"S / 41°05'00"W
UTM: 283000 E / 7708700 N Zone:24S

Geological Unit
Italva Group/São Joaquim Unit

Occurrence
Massive rock

Other Names
Pinta Verde Extra; Pinta Verde Classic;

Type and Predominant Color
Green marble

ACRONYMS

Abbreviation	Acronyms
ABIROCHAS	Brazilian Association of the Dimension Stones Industry
ABNT	Brazilian Association of Technical Standards
AENOR	Spanish Association of Standarization
AFNOR	French Association of Standardization
ANP	National Agency of Oil, Natural Gas and Biofuel
ASTM	American Society for Testing and Materials
BS	Standard
CENTROROCHAS	Brazilian Center of Dimension Stones Exporters
CETEM	Mineral Technology Center
CETEMAG	Marble and Granite Technological Center
CIP	Cataloging in Publication
CPRM	Company of Mineral Resources Exploration
DEGEO	Department of Geology
DEREM	Department of Mineral Resources
DERID	Department of Institutional Relations and Marketing
DGM	Director of Geology and Mineral Resources
DIEMGE	Division of Mineral Economy
DIHEXP	Division of Hydrogeology and Exploration
DIMINI	Division of Industrial Mineral and Rocks
DIN	German Institute for Standardization
ELFSM	Santa Maria Electric Power
EN	European Norm
ESCELSA	Electric Central Espírito Santo
FURNAS	Central Electric
GEOBANK	CPRM - data base internet
IBGE	Brazilian Institute of Geography and Statistics
IDH-M	Human Development Index (local)
IPT	Institute of Technological Research
MME	Ministry Of Mines and Energy
MPa	Mega Pascal (Pressure and Stress Unit)
PAC	Program of Growth Acceleration
PDF	Adoble Portable Document Format
PNUD	United Nations Development Programme
REPO	CPRM Local Office in Porto Velho
SEP	State Secretary of Economy and Planning of the Espírito Santo
SGB/CPRM	The Geological Survey of Brazil / Company of Mineral Resources Exploration
SGM	Secretar y of Geolog y, Mining and Mineral Transformation
SIG	GIS - Geographic Information System
SINDIROCHAS-ES	Union of the Industries of Dimension Stones, Lime and Limestone of the Espírito Santo State
SUREG-RE	CPRM Local Office in Recife
UNI	Italian Organization for Standardization

BIBLIOGRAPHY

ALMEIDA, Fernando Flávio Marques de et al. Províncias estruturais brasileiras. In: SIMPÓSIO DE GEOLOGIA DO NORDESTE, 8., 1977, Campina Grande. Atas... Campina Grande: SBG Núcleo Nordeste, 1977. p. 363-391.

ANUÁRIO MINERAL BRASILEIRO. Brasília: DNPM, 2010. Disponível em: <http://www.dnpm.gov.br>. Acesso em: 19 abr. 2013.

ASSOCIAÇÃO BRASILEIRA DA INDÚSTRIA DE ROCHAS ORNAMENTAIS. Balanço das exportações e importações brasileiras de rochas ornamentais e de revestimento em 2012: informe 01/2013. Disponível em: <http://www.abirochas.com.br>. Acesso em: 18 abr. 2013.

CENTRO BRASILEIRO DOS EXPORTADORES DE ROCHAS ORNAMENTAIS. Exportações. Disponível em: <http://www.centrorochas.org.br>. Acesso em: 18 abr. 2013.

CENTRO DE TECNOLOGIA MINERAL. Disponível em: <http://www.cetem.gov.br>. Acesso em: 18 abr. 2013.

DUARTE, Beatriz Paschoal et al. Geologia e recursos minerais da folha Itaperuna SF.24-V-C-I, estado do Rio de Janeiro, escala 1:100.000: Sistema de Informação Geográfica-SIG. Belo Horizonte: CPRM, 2012. 1 CD-ROM.

FRASCA, Maria Heloisa Barros de Oliveira. Caracterização tecnológica de rochas ornamentais e de revestimento: estudo por meio de ensaios e análises e das patologias associadas ao uso. Disponível em: <http://www.fiec.org.br>. Acesso em 19 abr. 2013.

MELLO, Ivan Sérgio de Cavalcante; CHIODI FILHO, Cid.; CHIODI, Denize Kistemann. Atlas de rochas ornamentais da Amazônia Brasileira. São Paulo: CPRM, 2011. 301 p. il. color. Projeto Consolidação para Revestimento na Construção Civil da Região Amazônica.

MENDES, Vanildo Almeida. Os jazimentos de rochas ornamentais e a sua relação com os eventos tectônicos atuantes no território brasileiro. In: SIMPÓSIO DE ROCHAS ORNAMENTAIS DO NORDESTE, 3., 2002, Recife. Anais... Recife: CETEM;UFPE, 2002. 1 CD-ROM.

MENEZES, Ricardo Gallart de; SAMPAIO, Paulo Roberto Almeida. Rochas ornamentais do noroeste do estado do Espírito Santo. Rio de Janeiro: CPRM, 2012. 52p. (Informa de Recursos Minerais. Série Rochas e Minerais Industriais, 08).

REVISTA INFOROCHAS. Disponível em: <http://www.inforochas.com.br>. Acesso em: 07 dez. 2012.

REVISTA ROCHAS DE QUALIDADE. Disponível em: <http://www.revistarochas.com.br>. Acesso em: 19 abr. 2013.

SILVA, Luiz Carlos da et al. The Neoproterozoic Mantiqueira Province and its African connections: a zircon-based U-Pb geochronologic subdivision for the Brasiliano/Pan-African systems of orogens. Precambrian Research, Amsterdam, v. 136, n. 3-4, p. 203-240, Feb. 2005.

SINDICATO DA INDÚSTRIA DE ROCHAS ORNAMENTAIS, CAL E CALCÁRIOS DO ESPÍRITO SANTO. História setor de rochas. Disponível em: <http://www.sindirochas.com. br>. Acesso em: 18 abr. 2013.

SOARES, Antonio Carlos Pedrosa et al. The Araçuaí-West-Congo Orogen in Brazil: an overview of a confined orogen formed during Gondwanaland assembly. Precambrian Research, Amsterdam, v. 110, n. 1-4, p. 307-323, 2001.

SUMÁRIO MINERAL BRASILEIRO. Brasília: DNPM, 2012. Disponível em: <http://www.dnpm.gov.br>. Acesso em: 30 abr. 2013.

VIEIRA, V. S. et al. Mapa geológico do estado do Espírito Santo, escala 1:400.000.[S.l.]: CPRM, 2013. 1 mapa. Escala 1:400.000.

WIKIPEDIA. Disponível em: <http://www.wikipedia.org.br>. Acesso em: 16 abr. 2013.

Atlas of Dimension Stones of the Espírito Santo State

Agência Brasileira do ISBN
ISBN 978-85-7499-242-6

The Geological Survey of Brazil – CPRM is very pleased to provide the technical community, entrepreneurs and the local community the Atlas of Dimension Stones of the State of Espírito Santo, another distinguished product of the Programa de Aceleração do Crescimento – PAC of the Brazilian Federal Government. It is part of the Project Geology and Mineral Resources of the Espírito Santo State according to the methodology of the Program Geology of Brazil.

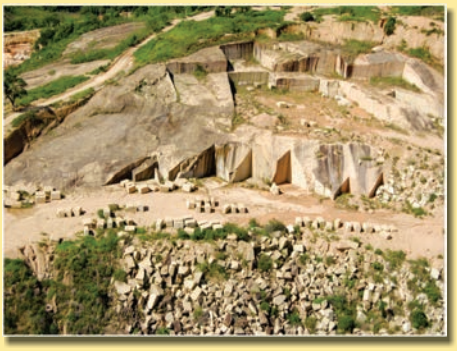
The data and information presented in the Atlas are the results of the research performed in the whole state where about one hundred active and inactive quarries were visited to collect information about morphological and geological features of the outcrops and the different commercialized products. Furthermore, geographical coordinates of the deposits and petrographic characterization were collected, as well as the conduction of some technological tests of the exploited lithotypes.

It was also studied different methodologies used during quarrying and processing as well as the productive cycle of the quarries.

With this work the State of Espírito Santo has another tool to attract new investments in mineral exploration, especially for the dimension stones sector, which is very important to the state economy.

It is important to highlight the relevant support of the Union of Industries of Dimension Stones, Lime and Limestone of the Espírito Santo State – SINDIROCHAS, which undertook efforts to develop the English version of the technical text, keeping its posture in terms of increasing the international recognition of the high value-added samples within the Espírito Santo State, in the perspective of boosting this promising market.

It should be highlighted the importance of the fellowship between the Federal Government and the states, not only to provides new geoscientific products but also as an inductive tool for effective national policy of geology and mineral resources, coordinated by the Secretary of Geology, Mining and Mineral Processing of the Ministry of Mines and Energy through the effort of the Geological Survey of Brazil – CPRM.



Support

SINDIROCHAS Espírito Santo
SICOOB Credirochas
PAC Programa de Aceleração do Crescimento

CPRM Geological Survey of Brazil
Secretariat of Geology, Mining and Mineral Transformation
Ministry of Mines and Energy
BRAZILIAN GOVERNMENT BRASIL