**UNIVERSIDADE FEDERAL DA BAHIA**
**INSTITUTO DE GEOCIÊNCIAS**
**PROGRAMA DE PESQUISA E PÓS-GRADUAÇÃO EM GEOLOGIA**
**ÁREA DE CONCENTRAÇÃO:**
**GEOLOGIA AMBIENTAL, HIDROGEOLOGIA E RECURSOS HÍDRICOS**

**DISSERTAÇÃO DE MESTRADO**

# PATRIMÔNIO GEOLÓGICO E GEODIVERSIDADE DAS MINAS HISTÓRICAS DA CHAPADA DIAMANTINA, NO CONTEXTO DA PROPOSTA DO GEOPARQUE MORRO DO CHAPÉU, BAHIA

**ACIEL ASHANTIS**

SALVADOR
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*Orientadora: Profa. Dra. Débora Correia Rios*

Dissertação de Mestrado apresentada ao Programa de Pós-Graduação em Geologia do Instituto de Geociências da Universidade Federal da Bahia como requisito parcial à obtenção do Título de Mestre em Geologia, Área de Concentração: Geologia Ambiental, Hidrogeologia e Recursos Hídricos.

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*À Dra. Débora Rios, mestre e mentora deste projeto e do seu potencial de realização.*

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Cheguei "tardiamente" à Universidade Federal da Bahia, em busca, portanto, não tanto de uma formação acadêmica, mas de uma imersão nas Ciências da Terra, o que me foi plenamente facultado pelo modelo curricular do Bacharelado Interdisciplinar em Ciência e Tecnologia, ao propiciar a liberdade de escolha e de concentração da minha grade nos Institutos de Geociências e de Física. Por essa inusitada e tão realizadora experiência, sou imensamente grato à instituição que agora orgulhosamente ostento como *Alma Mater*.

Quando apresentei meu projeto de pesquisa em Patrimônio Geológico e Geoconservação à comissão de seleção do Programa de Pós-graduação em Geologia, fui seriamente advertido de que o tema era completamente estranho à instituição, onde os trabalhos costumam lidar com "dados concretos" da geoquímica, da petrologia e dos depósitos minerais. Qual não foi minha surpresa ao ver dias depois o resultado, o projeto foi não apenas aprovado mas, ao longo de todo o período do mestrado, os próprios membros da comissão e outros professores do programa deram o seu irrestrito apoio e encorajamento, o que contribuiu positivamente para a empreitada bem sucedida do trabalho que hora se materializa, não obstante haver transcorrido nas condições sociais e econômicas adversas impostas pela crise sanitária da COVID-19.

Ao geólogo Antônio José Dourado Rocha (a quem por deferência conhecemos como Dr. Dourado), coautor da Proposta do Geoparque Morro do Chapéu, por ter me iniciado na geologia da região, por ter aberto as portas da sua casa em Salvador para as discussões, e as portas do Centro Integrado de Estudos Geológicos (CIEG) e da cidade de Morro do Chapéu (onde é cidadão bem-quisto e honorário) para o trabalho de pesquisa, durante as viagens de campo à Chapada Diamantina.

À comunidade remanescente da Vila do Ventura, zelosa guardiã do legado geológico e cultural deixado pelos seus antepassados, por ter aberto as portas de suas casas e de seus corações para me mostrar o valor e o sentido daquele lugar para si mesmos e para as novas gerações.

# RESUMO

Diferentemente do que se pode depreender de muitos artigos e vários outros trabalhos sobre o tema, publicados nos últimos dez anos, os geoparques não são Unidades de Conservação e não se constituem apenas das formações geológicas de uma dada região, por mais excepcionais que elas sejam. Trata-se, na realidade, de um empreendimento de valorização do patrimônio geológico e da "memória da Terra" como motores de políticas territoriais de desenvolvimento sustentável. Apenas para o Estado da Bahia, o Serviço Geológico do Brasil propôs a criação de cinco geoparques — São Desidério, Cânion do Rio São Francisco, Alto Rio de Contas, Serra do Sincorá e Morro do Chapéu, sendo os três últimos na Chapada Diamantina, região Central da Bahia. Localizada na zona norte oriental da Chapada, em altitudes que chegam a 1290 metros, Morro do Chapéu ostenta uma história e conformações geológicas que fazem da região uma das mais promissoras para a criação de um geoparque nos moldes do conceito da Rede Global de Geoparques da UNESCO. Sua geologia pode ser sintetizada na Formação Tombador, constituída por rochas sedimentares que outrora formavam as dunas de um deserto Mesoproterozoico sucessivas vezes invadido pelo mar; na Formação Caboclo, com seus carbonatos silicificados e estromatólitos; e nos registros em suas rochas de processos e eventos que remontam ao Pré-Cambriano. Por cerca de 30 anos, e até recentemente, a região serviu como área-escola de sistemas deposicionais para o treinamento de gerações de profissionais e estudantes das geociências, provenientes de todas as partes do país. Acresce a isto, a singularidade de suas paisagens, a presença de pinturas rupestres e sítios arqueológicos, de vilas históricas e arquitetura ligadas à história dos garimpos de diamantes e de carbonados, e seu entrecruzamento com a Segunda Revolução Industrial na Europa e nos Estados Unidos. Sendo a Geoconservação uma ciência aplicada, este trabalho teve o objetivo de abordar os conceitos de patrimônio geológico e de elementos da geodiversidade no contexto dos geossítios propostos pela CPRM para a composição do geoparque Morro do Chapéu, na forma de roteiros integrados. Ênfase especial é dada à caracterização e iniciativas de geoconservação das minas históricas abandonadas, consoante os princípios da *Carta de El Bierzo*. Assim, o Roteiro dos Diamantes recebeu a mais completa caracterização e tratamento na forma do artigo *Recovering the Ventura Village*. Se bem explorado, esse é o roteiro que pode servir de núcleo das atividades geoturísticas, e que depois de estruturado e bem consolidado, pode servir de ponto de partida para a implementação dos outros roteiros e da constituição do próprio geoparque. No contexto da pandemia da COVID-19, o papel do geoturismo em áreas distantes dos grandes centros torna-se ainda mais relevante economicamente, por representarem destinos com menor concentração de pessoas, e por oferecerem experiências e atividades ao ar-livre. A pandemia representa, portanto, a oportunidade de se repensar a proposta da CPRM para Morro do Chapéu e região e desse modo promover os objetivos da Agenda 2030 da ONU para o desenvolvimento sustentável.

**Palavras-chave:** Patrimônio Geológico, Geodiversidade, Geoparque Morro do Chapéu

# ABSTRACT

Unlike what can be inferred from a number of journal articles and other works about the topic published in the last ten years, geoparks are not protected areas, and they are not composed solely of the geological formations in a given area, however exceptional they are. They are rather projects for the appreciation of geoheritage and "the memories of the Earth" as drivers of territorial policy for sustainable development. Just for the State of Bahia, the Brazilian Geological Survey (CPRM) have proposed the creation of five geoparks — São Desidério, Cânion do Rio São Francisco, Alto Rio de Contas, Serra do Sincorá and Morro do Chapéu, the last three being in the central region known as the Chapada Diamantina. Located in the northeastern part of the Chapada Highlands, at altitudes reaching 1290 meters, Morro do Chapéu boasts a history and geological formations that make the region one of the most promising for the creation of a geopark along the lines of the UNESCO Global Geoparks Network concept. The Tombador Formation (consisting of sedimentary rocks that once formed the dunes of a Mesoproterozoic desert successively invaded by the sea), the Caboclo Formation (with its silicified limestones and stromatolites), and records on its rocks of geological processes and events dating back to pre-Cambrian. For nearly 30 years and until recently, the region served the CPRM as a depositional systems school area for training generations of geoscience professionals and students from all over the country. In addition, the uniqueness of its landscapes, the presence of cave paintings and other archaeological sites, historic villages and architecture linked to the history of diamond and carbonado mining, and their intersection with the Second Industrial Revolution in Europe and the United States. Since geoconservation is an applied science, this work aimed to address the concepts of geological heritage and geodiversity elements in the context of the geosites proposed by the CPRM for the composition of the Morro do Chapéu geopark, in the form of integrated tracks or itineraries. Special emphasis is given to the characterization and geoconservation of abandoned historic mines, following the principles of the Spanish *El Bierzo Charter*. Accordingly, the Diamond Track received a complete characterization and treatment in the form of the article *Recovering the Ventura Village*. If well explored, this is the track that can serve as the nucleus of the geotouristic activities in the area, and which, after being structured and well consolidated, can serve as a starting point for the implementation of the other tracks and its integration into a geopark. In the context of the COVID-19 pandemic, the role of geotourism in areas far from large centers becomes even more relevant for the economic recovery of these areas, as they represent destinations with a lower concentration of people, and because they offer outdoors experiences and activities. The pandemic represents, therefore, the opportunity to rethink the CPRM proposal for the implementation of the Morro do Chapéu Geopark, as it promotes the objectives of the United Nations 2030 Agenda for Sustainable Development.

**Keywords**: Morro do Chapéu Geopark, Geoheritage, Geodiversity

# SUMÁRIO

# CAPÍTULO 1
# INTRODUÇÃO GERAL

Findo o ciclo dos diamantes e carbonados, que perdurou de meados do século dezenove até à época que antecedeu à Segunda Grande Guerra, a Chapada Diamantina entrou em persistente e progressivo declínio social e econômico, revertido apenas nas últimas décadas com a expansão do turismo ecológico e o recente advento de indústrias de geração de energia eólica. No entanto, levantamento da Superintendência de Estudos Econômicos e Sociais do Estado da Bahia (SEI-Bahia 2019) demonstram que, não obstante a grande extensão da Chapada Diamantina e a enorme quantidade e diversidade de seus atrativos naturais e culturais, sua atividade turística está entre as economicamente menos representativas das regiões turísticas do Estado, com participação no Valor Adicionado Bruto (VAB) de apenas 1,23%. E mesmo assim, grande parte dessa pequena representatividade concentra-se numa área de cerca de 5.000 km² no entorno da Serra de Sincorá e do Parque Nacional da Chapada Diamantina.

Uma estratégia viável para a região seria a implementação de geoparques. Os geoparques são áreas singulares e unificadas onde sítios e paisagens de importância geológica internacional são geridos a partir de um conceito integrado de proteção, educação e desenvolvimento sustentável (UNGG 2016). Trata-se, portanto, de um empreendimento de valorização do patrimônio geológico e da "memória da Terra" como motores de políticas territoriais de desenvolvimento sustentável.

Entre os bens e serviços científicos e educacionais de um geoparque encontram-se a reconstituição de períodos e eras geológicas e dos processos de formação da geodiversidade do planeta, os registros de eventos de extinção, a reconstituição de paleoambientes e a formação dos relevos. Servem também de locais para a visitação e a realização de viagens de campo com objetivos educacionais e treinamento profissional. Oferecem ainda serviços terapêuticos e de saúde e bem-estar, esportes e lazer, a vista espetacular, a visitação a coleções de fósseis, a minas históricas, a sítios arqueológicos, a museus temáticos, a sítios sagrados e de importância espiritual, a participação em manifestações culturais, a inspiração artística e o senso de lugar, entre vários outros (Gray 2018; Dunlop et al. 2017).

A sociedade pode beneficiar-se desses bens e serviços dos elementos da geodiversidade sem ter de extraí-los e de forma renovável e sustentável (Brilha et al. 2018). Foi com base nesse reconhecimento que a Rede Global de Geoparques da UNESCO subscreveu a Agenda 2030 das Nações Unidas para o Desenvolvimento Sustentável. Dos 17 alvos da Agenda, seis são considerados particularmente relevantes para os projetos dessa natureza: 1) Erradicar a pobreza em todas as suas formas; 2) Promover a igualdade de gênero e a autonomia econômica e financeira das mulheres (incluindo as meninas); 8) Promover o crescimento econômico sustentado, sustentável, inclusivo, e o emprego pleno e produtivo, e trabalho decente para todos; 11) Tornar as cidades e povoamentos humanos inclusivos, seguros, resilientes e sustentáveis; 12) promover e assegurar padrões de consumo responsáveis e produção sustentável; 17)

Fortalecer os meios de implementação e revitalização de parcerias globais voltadas para o desenvolvimento sustentável (Rosado-González et al. 2020).

Em um mundo globalizado, o desenvolvimento regional assume importância crucial para a qualidade de vida econômica, social e ambiental das comunidades locais. A implementação de um geoparque em uma dada região, onde outrora existira apenas exploração dos recursos naturais e minerais, pode incentivar e impulsionar investimentos em infraestrutura, turismo e na disponibilização de bens e serviços de natureza cultural e científica. Se bem planejado, o empreendimento pode se traduzir em desenvolvimento regional na forma de geração de empregos diretos e indiretos e de renda para as comunidades envolvidas e impulsionar o comércio, a oferta de serviços, e toda uma gama de pequenos negócios e a agroindústria (Gray 2017). A Declaração de Arouca (*Arouca Declaration* 2011) define o geoturismo como o turismo que sustenta e incrementa a identidade de um território, considerando a sua geologia, ambiente, cultura, valores estéticos, o patrimônio e o bem-estar das comunidades locais.

Atualmente, 169 unidades fazem parte da Rede Global de Geoparques da UNESCO, espalhados por 44 países. Sua distribuição, no entanto, é bastante desigual. Quase metade desses empreendimentos encontram-se em território europeu, enquanto cerca de 40% deles estão em países asiáticos. Entre os países europeus, a Espanha se destaca com 15 geoparques e vários outros em processo de consolidação. Nenhum país do mundo, no entanto, tem uma política tão robusta na criação de geoparques quanto a China, que já conta com 41 unidades reconhecidas pela UNESCO e dezenas de outras preparando-se para receber a creditação (Sumanapala & Wolf 2020).

Enquanto isso, a América Latina está representada na Rede Global com apenas 8 unidades, uma das quais no Brasil —o Geoparque do Araripe, no Ceará (2013, Bétard et al. 2018, Carvalho et al. 2021). Desde o início deste século, o Serviço Geológico do Brasil (SGB/CPRM) já publicou dezenas de propostas para a criação de geoparques em todas as regiões do país, cinco das quais — Morro do Chapéu (Rocha e Pedreira 2012), Serra do Sincorá (Pereira et al. 2017), Alto Rio de Contas (Martins et al. 2017), Cânion do Rio São Francisco (Ferreira et al. 2018), e São Desidério (Pereira et al. 2018) — apenas no Estado da Bahia. Das 29 propostas  da CPRM (e outras tantas publicadas independentemente, os projetos mais avançados até agora são os dos Geoparques Seridó/RN (https://geoparqueserido.com.br/), Caminhos dos Cânions do Sul/SC-RS (https://canionsdosul.org/), Costões e Lagunas do Rio de Janeiro (https://www.geoparquecostoeselagunas.com/), Caçapava/RS (https://geoparquecacapava.com.br/) e Quarta Colônia/RS (https://www.geoparquequartacolonia.com.br/home ), já em processo de reconhecimento pela Rede Global de Geoparques da UNESCO..

O interesse por geoparques no Brasil começou em 2006, logo após o reconhecimento do Geoparque do Araripe pela UNESCO — primeiro geoparque das Américas reconhecido pela UNESCO. Desde então várias propostas e inscrições de potenciais geoparques foram levadas à Rede Global e rejeitadas (Tavares et al. 2020, Rosado-González et al. 2020). Apesar da relevância das áreas, os projetos só podem ser aceitos pela entidade internacional depois de estarem em pleno funcionamento por pelo menos 2 ou 3 anos dentro dos padrões estabelecidos pela UNESCO.

Na tentativa de esclarecer por que tem sido tão difícil desenvolver geoparques na América Latina e no Caribe, Rosado-González e colaboradores (2017) realizaram estudo de caso das dificuldades encontradas para a criação do Geoparque Mixteca Alta, no México. Uma das conclusões do estudo é que as diferentes realidades sociopolíticas e culturais dos dois blocos podem ser um obstáculo ao modelo europeu original, que não se encaixa muito bem na necessária adaptação à diversidade cultural e sociopolítica latino-americana, muito embora isso não explique por que os geoparques se proliferam tanto nos países asiáticos. Entre as principais dificuldades identificadas no estudo, encontram-se i) o fato de a economia local basear-se predominantemente no setor primário; ii) a falta de oportunidades educacionais; iii) o baixo índice de desenvolvimento social e econômico; iv) a falta de estruturas e estratégias de gestão territorial; v) a ausência de capacidade e de estrutura turística; e vi) a pouca divulgação e conscientização acerca do conceito Unesco de Geoparques e até mesmo o papel da UNESCO.

Entre as dificuldades e desafios encontrados por Nascimento, Mansur e Santos-Pinto (2018) para a implementação de geoparques no Brasil encontram-se a falta de compreensão do conceito geográfico de "território" por muitos dos geólogos que elaboraram as propostas de geoparques da CPRM; a de conhecimento ou de maior esclarecimento dos gestores públicos acerca do Programa Mundial de Geoparques UNESCO; a falta de planejamento estratégico e de instrumentos de gestão que atendam aos critérios da certificação UNESCO; e na falta de articulação territorial entre os atores públicos e privados no sentido de consolidar os projetos.

Acresce a essas dificuldades o fato de o conceito de geoparques ser muitas vezes confundido com o de Unidades de Conservação, como se vê em Bétard et al. 2011, Lima et al. 2016, de Paula Silva et al. 2021 e na quase totalidade das dezenas de propostas da própria CPRM ao caracterizar os geossítios como meras formações geológicas de valor preponderantemente científico e acadêmico, sem nenhum entrecruzamento social, econômico ou cultural. A propósito, as bases que direcionam a criação de um geoparque visam promover uma nova ordem de desenvolvimento econômico para uma dada região, como bem colocado por Salvetti (2020). E uma das vantagens dos geoparques em relação às unidades de conservação, demonstra o autor, está justamente na liberdade jurídica associada à sua criação e gestão.

Que estratégias de desenvolvimento territorial e de gestão poderiam ser adotadas no Brasil no sentido de implementar e consolidar algumas das propostas de geoparques da CPRM? Como integrar os conceitos de patrimônio geológico ao de patrimônio histórico e cultural de uma dada região? Estas foram as questões que nortearam este trabalho de pesquisa.

Localizada na zona norte oriental da Chapada Diamantina da Bahia (**Figura 1.1**), em altitudes que chegam a 1290 metros, Morro do Chapéu ostenta uma história e conformações geológicas que fazem da região uma das mais promissoras para a criação de um geoparque nos moldes do conceito da Rede Global de Geoparques da UNESCO. A Formação Tombador (constituída por rochas sedimentares que outrora formavam as dunas de um deserto Mesoproterozóico sucessivas vezes invadido pelo mar); a Formação Caboclo (com seus carbonatos silicificados e estromatólitos); e os registros em suas rochas de processos e eventos geológicos que remontam ao pré-cambriano são apenas alguns exemplos que fazem da região uma área-escola de sistemas deposicionais, com importância didática para o ensino das geociências. Acresce a isto, a singularidade de suas paisagens, a presença de pinturas rupestres

e sítios arqueológicos, de vilas históricas e arquitetura ligadas à história dos garimpos de diamantes e de carbonados, além de suas ricas tradições culturais.

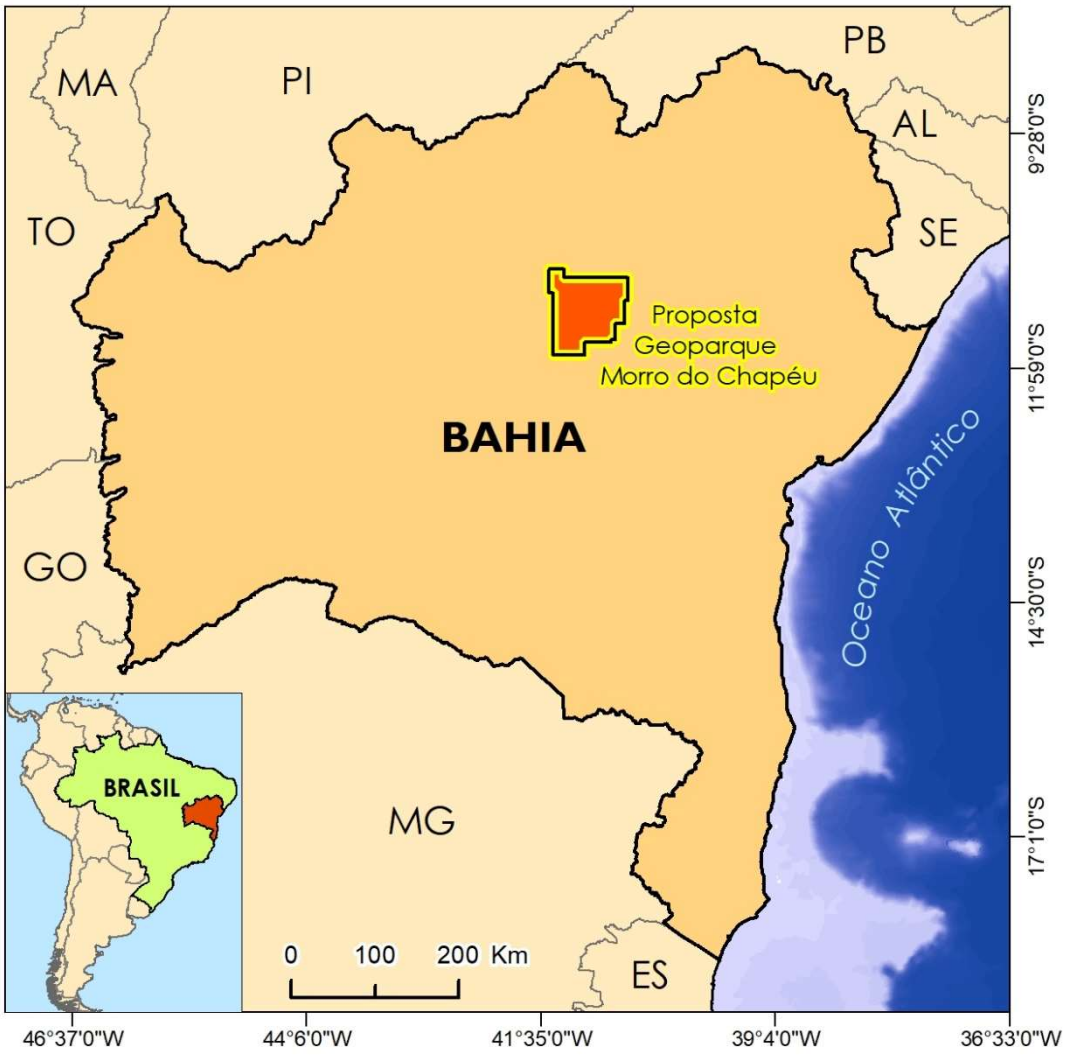


**Fig 1.1** Mapa de localização da área de estudo.

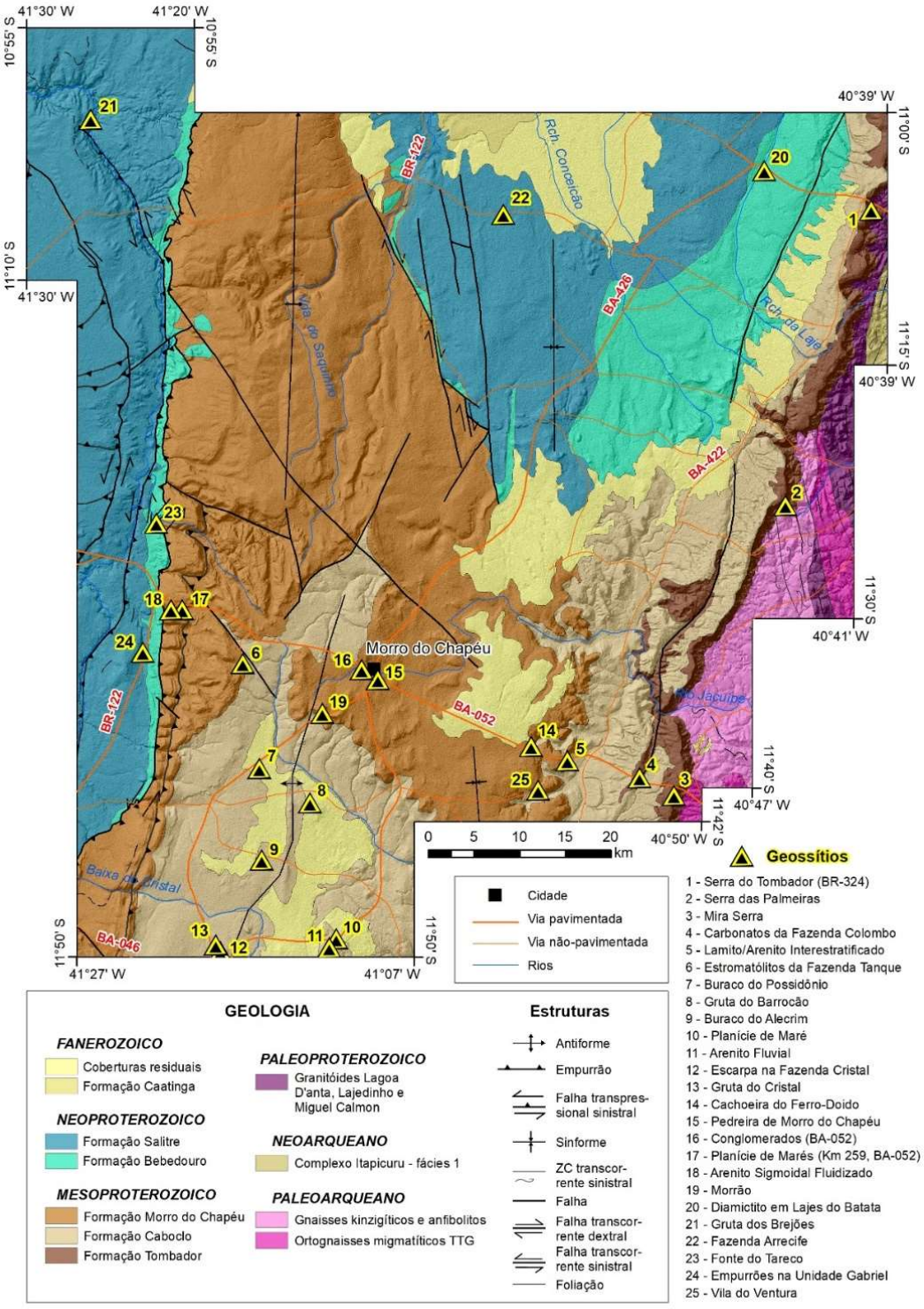


**Fig 1.2** Mapa Geológico generalizado apresentando a distribuição dos geossítios que compõem a Proposta da CPRM para o Geoparque Morro do Chapéu.

O presente trabalho tem como objetivo abordar os conceitos de patrimônio geológico e geodiversidade no contexto da proposta do Geoparque Morro do Chapéu, tomando como núcleo integrador a Vila do Ventura – uma comunidade criada em função da exploração de diamantes – e seu entorno. Os objetivos específicos incluem (i) fornecer subsídios para o desenvolvimento de um plano estratégico tendo em vista a implementação do Geoparque proposto, seguindo o modelo conceitual da UNESCO; e, (ii) qualificar e quantificar o patrimônio geológico na área da Vila do Ventura, de modo a posicioná-la como núcleo para a futura implementação do geoparque e sua integração com os outros geossítios identificados pela CPRM na região (**Figura 1.2**).

Para tanto, foram empreendidas viagens de campo à região, com a ajuda de guias locais e de antigos garimpeiros e residentes. Somam-se aos trabalhos de campo uma extensa pesquisa bibliográfica com foco nos registros históricos e artigos científicos publicados nos últimos dois séculos sobre a exploração e uso dos diamantes e carbonados da Chapada Diamantina, e seu papel como *commodity* ao longo da Segunda Revolução Industrial na Europa e nos Estados Unidos. Na ausência de um método específico para a avaliação do patrimônio geológico relacionado a minas históricas abandonadas ligadas à mineração aluvial de diamantes, optou-se pelo emprego do método quantitativo desenvolvido por Marescotti et al (2018), que mede tanto os pontos críticos quanto os valores positivos de ocorrências desse tipo.

Embora inicialmente criado com o propósito de avaliar comparativamente um conjunto de potenciais geossítios de uma dada região, aplicou-se ainda exclusivamente ao geossítio e ao seu entorno o método desenvolvido por Brilha (2016) para a avaliação quantitativa do valor científico, do potencial turístico e educacional, e dos riscos de degradação da área proposta neste trabalho como núcleo para a implantação do Geoparque Morro do Chapéu.

Apesar de essencialmente quantitativos, os resultados dos dois métodos de avaliação empregados servem também como ferramentas de avaliação qualitativa e para a gestão estratégica dos geossítios propostos para a composição do geoparque. Assim, integrou-se ao estudo a análise SWOT (Gürel & Tat 2017, Benzaghta et al. 2021), de modo que pudesse permitir a obtenção de linhas de ação norteadoras de futuras políticas de prevenção e conservação do conjunto geológico, histórico e cultural da área de estudo.

Este trabalho se justifica pela importância dos geoparques para o desenvolvimento social e econômico de regiões possuidoras de patrimônio geológico e geodiversidade singulares, como é o caso do Brasil e, mais particularmente, da Chapada Diamantina. Além disso, gestores públicos, empresas e investidores, instituições não-governamentais e demais partes implicadas poderão, a partir dos resultados, ter à mão ferramentas essenciais e indispensáveis para a tomada de decisões com relação à implantação e implementação de geoparques em diversas regiões do país.

E dada a importância política e econômica do Brasil na América Latina, a criação bem-sucedida aqui de um geoparque pode servir de modelo para outros países do bloco e do continente africano. Efeito semelhante ocorreu na Europa depois da criação, em 2004, da Rede Europeia de Geoparques em que os primeiros que se estabeleceram com sucesso serviram de modelo para outras regiões no mesmo bloco e posteriormente para vários países fora do bloco.

Por último, mas não menos importantes, é a abordagem interdisciplinar do projeto proposto – uma empreitada cada vez mais valorizada nos ambientes acadêmico e científico, e indispensável nos processos decisórios das organizações públicas e privadas.

De acordo com as normas do Programa de Pós-Graduação em Geologia da Universidade Federal da Bahia esta dissertação de mestrado contempla o formato artigo. Os trabalhos de pesquisa culminaram com a elaboração e apresentação deste volume que contém quatro (4) capítulos ilustrados com figuras, tabelas, e listagem das referências bibliográficas consultadas. Somam-se a eles apêndices e anexos.

O **capítulo 1** traz uma introdução geral que apresenta e discute aspectos conceituais sobre o trinômio Patrimônio Geológico, Geoconservação e desenvolvimento sustentável, além de uma breve descrição dos avanços nestes temas no Brasil e no mundo. O capítulo apresenta também os objetivos geral e específicos, motivações e justificativas. A área de estudo é localizada e apresenta-se a forma como o volume foi estruturado.

O **capítulo 2** apresenta e discute o patrimônio geológico e geodiversidade das minas históricas da Chapada Diamantina e dos minerais ali explorados ao longo de mais de cem anos, e será convertido em artigo para posterior publicação.

O **capítulo 3** traz o artigo científico com os principais resultados da pesquisa, submetido ao *Geoheritage Journal* (https://www.springer.com/journal/12371), uma revista internacional da Editora Springer, classificado com Qualis CAPES A2 na área de Geociências.

O **capítulo 4** contêm as considerações finais para o trabalho, nossas principais conclusões, e recomendações para estudos futuros.

O **Apêndice A** discorre sobre as contribuições de cada um dos co-autores do artigo. O **Apêndice B** contempla a divulgação dos resultados parciais, em formato resumo, publicados ao longo do desenvolver da pesquisa.

Por fim, o **Anexo 1** traz as regras de formatação do periódico selecionado para a publicação dos resultados e o **Anexo 2** apresenta o comprovante de submissão do artigo.

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# CAPÍTULO 2
# PATRIMÔNIO GEOLÓGICO E GEODIVERSIDADE DAS MINAS HISTÓRICAS DA CHAPADA DIAMANTINA

Conforme definido por Brilha (2016), o patrimônio geológico refere-se 1) a geossítios e ocorrências de elementos *in situ* da geodiversidade, com alto valor científico e 2) a elementos *ex situ* da geodiversidade (tais como minerais, fósseis e rochas) que, apesar de terem sido extraídos do local natural de ocorrência, mantém alto valor científico. Além do valor científico, tanto o patrimônio *in situ* quanto o *ex situ* podem ter valor educacional, estético e cultural que justifiquem também o seu uso pela sociedade em termos de ensino/aprendizagem/treinamento, turismo, lazer, entre outros. Considerando, conclui o autor, que o patrimônio geológico somente se justifica pelo valor científico, sua relevância é, portanto, internacional, ou pelo menos nacional, posto que, em última análise, não existe ciência apenas local.

O conceito de geoturismo considera não apenas o patrimônio geológico, mas também sua relação com todos os outros aspectos do patrimônio natural, cultural e intangível como ferramentas de desenvolvimento e fundamentos de sustentabilidade e bem-estar social e econômico (Beretić 2019). O turismo é um dos setores da economia que mais crescem no mundo e um dos mais resilientes do nosso tempo. A atividade responde por cerca de 7% da economia global e gera milhões de empregos diretor e indiretos. No entanto, um relatório da Organização Mundial do Turismo (WTO 2020), órgão das Nações Unidas mostra que em muitos lugares os benefícios do turismo, incluindo a otimização do emprego e das oportunidades de gênero, se concentram nas regiões urbanas e costeiras, o que contribui para uma distribuição territorial desigual da riqueza e das oportunidades econômicas. Promover o turismo em zonas rurais e cidades do interior permite uma distribuição mais ampla dos benefícios do setor, ao mesmo tempo em que mitiga os riscos ambientais — e agora até sanitários — associados com a concentração do turismo em lugares específicos.

Este capítulo aborda a recuperação e revitalização de minas históricas fundamentada na *Carta de El Bierzo* e nos conceitos mais recentes de patrimônio geológico e elementos da geodiversidade, contextualizando-os ao geossítio mineiro da Vila do Ventura e seu entorno. Em seguida, demonstra-se como o carbonado ou diamante negro satisfaz os critérios para o seu reconhecimento como Recurso Mineral Patrimônio Global (*Global Heritage Stone Resource*), e a Chapada Diamantina da Bahia como Província Mineral Patrimônio Global (*Global Heritage*

*Stone Province*). Por último, são propostos alguns roteiros geoturísticos que, à semelhança do Roteiro dos Diamantes apresentado no artigo *Recovering the Ventura Village*, podem ser objeto de futuros estudos para publicação em revistas científicas.

## 2.1 A RECUPERAÇÃO DE MINAS HISTÓRICAS

A *Carta de El Bierzo para la Conservación del Patrimonio Industrial Minero* foi um dos documentos fundamentais para o estabelecimento de critérios para o inventário, seleção, proteção legal, intervenções de salvaguarda da integridade, e o desenvolvimento de programas educacionais, culturais e turísticos voltados para a promoção dos sítios do patrimônio mineiro, bem como a sua preservação para as futuras gerações (IPCE 2009). Entre os critérios de seleção dos sítios estão:

i) sua autenticidade histórica,
ii) a representatividade do seu contexto histórico,
iii) o estado de conservação,
iv) a integridade de sua identidade cultural,
v) seu significado histórico,
vi) a relação do lugar com a comunidade onde está inserido, e
vii) a perspectiva de gestão do sítio mineiro pela comunidade local, de modo a poder prover condições mínimas de sustentabilidade.

O artigo que acompanha o presente volume buscou estabelecer justamente esses critérios para a Vila do Ventura, cuja autenticidade e representatividade do seu contexto histórico e geológico, seu estado de conservação, a integridade de sua identidade cultural e o seu significado histórico se encontram muito bem evidenciados e documentados. A comunidade composta hoje por pequeno, mas expressivo número de moradores, muitos deles descendentes dos antigos garimpeiros, tem tentado preservar o quanto podem do patrimônio arquitetônico e cultural do lugar, ao longo dos cerca de oitenta anos desde o fim da atividade mineira. Em reuniões recentemente realizadas na igrejinha do Ventura, esse propósito foi reiterado (Fig. 2.1). Busca-se principalmente chamar a atenção da administração pública local e dos órgãos estaduais ligados à preservação do patrimônio em suas variadas vertentes.

**Fig. 2.1** Reunida na igrejinha de N. Sra. da Conceição, em março deste ano, a comunidade de moradores da Vila do Ventura reitera o seu interesse e propósito de lutar pela preservação do valioso legado cultural e histórico deixado pelos seus antepassados na vila e em seus arredores.

A *Carta* e várias outras iniciativas nacionais e internacionais criadas nas últimas décadas com o objetivo de preservar e promover os sítios mineiros históricos mostram como a definição de patrimônio (*heritage*) evoluiu, passando de uma ideia restrita, relacionada a monumentos e elementos artísticos, para um conceito mais abrangente que inclui a paisagem, os sítios históricos, os espaços construídos, a biodiversidade, e as tradições culturais (Brilha 2016, Kaźmierczak et al. 2019). O patrimônio mineiro compõe-se, portanto, do remanescente da cultura industrial e dos valores histórico, tecnológico, social, arquitetônico e científico que lhe são inerentes.

Iniciativas semelhantes com o propósito de recuperar e revitalizar minas históricas podem ser vistas em várias partes do mundo. Uma delas é a do Projeto do Geoparque Cajón del Maipo, na região central dos alpes chilenos, próximo à fronteira com a Argentina. Dentre os 40 geossítios que compõem o geoparque, encontra-se o Distrito Mineiro de cobre El Volcán, localizado no vale do rio homônimo e considerado o mais icônico do projeto, por representar a melhor evidência da relação entre a comunidade local e a geologia em seu entorno. Assim como

ocorre com muitas minas históricas, El Volcán também é uma “vila fantasma”, abandonada em 1958 após um terremoto haver devastado a área (Vergara et al. 2020).

Localizada às margens do rio Zarqa, distante apenas 15 km de Aman, Russeifa chegou a ser considerada a capital jordaniana da mineração. Hoje é o cenário de minas e prédios abandonados. Os afloramentos de fosfato localizados entre as margens do rio e o que restou de uma ferrovia exibem a história de sua gênese. O fosfato do cinturão foi ali depositado em ambiente marinho raso do Mar de Tétis, no final do Cretáceo. São abundantes também os vestígios de paleo-ambientes contendo registros fósseis e outras características sedimentares. O ambiente do fundo marinho parece ter sido anóxico, com uma taxa de deposição muito baixo, embora muito extensa. A principal composição mineral é a francolita, uma hidroxi-fluorapatita.

Até o início do século 20 a economia local era dependente da agricultura desenvolvida às margens do rio Zarqa. Tudo isso mudaria nos anos 1930 à medida que a extração das camadas de fosfato, o processamento, secagem e transporte do minério requeriam mão de obra cada vez maior e mais intensa. Com a expansão dos negócios, em 1953 a empresa exploradora tornou-se pública e se registrou como a Companhia Jordaniana de Fosfato S.A.

Nos anos 1970, mais obras de expansão foram feitas no local, e novos silos de armazenagem, fornos e secadores foram construídos nas adjacências. Meio século depois de iniciada a exploração, no entanto, a mina de Russeifa foi considerada economicamente desinteressante, devido à descoberta de depósitos mais ricos do minério no sul do país, com a vantagem adicional de se localizarem mais próximos do Golfo e, portanto, do estratégico porto de Áqaba.

Entendendo a importância de se preservar o patrimônio geológico e industrial da região, teve início na última década esforços por parte de instituições públicas, da comunidade local e da Universidade Germano-Jordaniana com vistas à criação de um geoparque no sítio das minas abandonadas. Muitos perfis das mineralizações se encontram bem preservados, o que permite a realização de exposições didáticas, as camadas geológicas servem de base para explicar os processos de formação, e planeja-se a transformação das dependências do complexo industrial em museus e oficinas para a exposição do maquinário e dos fósseis abundantes na região. O geossítio também tem um valor histórico por ter sido a primeira mina moderna da história da Jordânia, entremeada com a arquitetura local. O projeto está sendo desenvolvido com o objetivo de dar ao visitante a experiência de uma jornada pela história geológica do sítio, de forma inovadora e interativa, com o auxílio inclusive de recursos de geovisualização (AlRayyan et al. 2017).

Embora com critérios e conceitos bastante diversos dos da geoconservação e do patrimônio geológico, algumas minas históricas são de valor cultural tão expressivo que foram reconhecidas como Patrimônio Mundial da UNESCO, como as da cidade de Ouro Preto, em Minas Gerais; as minas de mercúrio de Almadén, na Espanha; as da cidade de Guanajuato, no México; as minas de Cerro Rico (Potosí), na Bolívia; e as minas de Wieliczka, na Polónia (Mata-Perelló et al. 2018). Em sua maioria, o reconhecimento internacional veio nas décadas de 1970 e 1980, muito antes, portanto, das iniciativas de geoconservação e geopatrimônio, e do surgimento dos primeiros geoparques no mundo. O valor excepcional das minas Potosí está em seus 500 anos de história da exploração de prata, estanho e zinco, na preservação das instalações industriais, pela existência alí de uma Casa da Moeda do tempo da colonização espanhola, a presença de uma antiga catedral, a igreja de S. Lourenço, e pelo rico conjunto arquitetônico composto por mansões, monumentos e por antigos "barrios mitayos" onde viviam os trabalhadores. Mais de 60% de toda a prata produzida no mundo no século 16 provinha da mina andina, cuja história entrecruzou-se com a das minas de Almadén, na Espanha, de onde provinha o mercúrio para o amálgama do minério, que tinha o propósito de aumentar a concentração do metal precioso. O custo em vidas humanas (principalmente das comunidades nativas) e a agressão ao meio-ambiente só seriam avaliados séculos mais tarde (Nriagu 1994, Robins 2011). A exploração de minérios na região continua até o presente.

## 2.2 A TÉCNICA DE GARIMPAGEM DOS DIAMANTES E CARBONADOS

Os diamantes e carbonados da Chapada Diamantina eram recuperados diretamente do leito e das margens dos rios, ou de rochas sedimentares não-consolidadas encontradas nas próximidades de cursos d'água presentes ou pretéritos (paleocorrentes). Os cascalhos ou sedimentos - uma mistura de argila, areia, silte, cascalho e seixos - eram lavrados e lavados em peneiras e bateias, de modo que os diamantes e carbonados, por serem mais densos, se concentravam no fundo da peneira, que então podia ser virada ao solo para permitir que o garimpeiro pudesse recolher as pedras de seu interesse (Catharino 1986 p. 186, Svisero et al. 2017).


**Fig 2.2** Foto do início do século XX, tirada pelo naturalista britânico Sir Harry Johnston (1910) em Lençóis, Chapada Diamantina. A imagem hoje pertencente à Coleção Digital do Centro Schomburg de Pesquisa da Cultura Negra, integrante da Biblioteca Pública de Nova York, ilustra muito bem o ambiente das lavras diamantinas da região, e do grande número de trabalhadores e garimpeiros negros empregados na atividade mineira. Disponível em: https://digitalcollections.nypl.org/items/510d47df-8ced-a3d9-e040-e00a18064a99

Uma fotografia (hoje pertencente à coleção digital da Biblioteca de Nova York) tirada em Lençóis no início do século 20, pelo naturalista britânico Harry Johnston (2010), ilustra muito bem o ambiente de um garimpo da região à época (Fig 2.2). Por vezes, para se obter acesso ao leito e aos cascalhos dos rios, construiam-se barragens ou então os cursos d'água eram desviados pela abertura de grandes valas laterais, com o consequente impacto ambiental em todo o sistema hidrogeológico da região.

## 2.3 CARBONADO COMO PATRIMÔNIO GEOLÓGICO DA CHAPADA DIAMANTINA

O patrimônio geológico ou *geoheritage* se constitui dos elementos da geodiversidade do planeta que são considerados dignos de conservação (geoconservação) em razão da sua significativa importância e valor científico (Gray 2018). Desse modo, podem ser considerados patrimônio geológico tanto ocorrências *in situ* — como as rochas, relevos e paisagens — quanto as *ex situ* (como as amostras de rochas e minerais disponíveis para pesquisa em museus) de elementos da geodiversidade, e até processos geológicos, como as atividades glaciais e vulcânicas. Concomitantemente ao valor científico, os elementos da geodiversidade podem ademais ter valor educacional, cultural, estético e turístico.

Os bens e processos legados da mineração também podem ser considerados como elementos do patrimônio geológico e da geodiversidade (Brilha 2016, Newsome & Dowling 2018, p. 305). O termo inglês *geomining* se aplica a toda e qualquer exploração mineral ativa ou inativa e às rochas e minerais que foram (ou ainda são) extraídas, às instalações industriais, às obras de engenharia, aos sítios e documentos históricos, aos processos e técnicas de exploração "e até mesmo às histórias e tradições das comunidades de garimpeiros" (Brilha 2016, p. 121; Kazmierczak et al. 2019).

Os conceitos e designações de Patrimônio Mundial (*World Heritage*) e o reconhecimento de alguns recursos e províncias geológicas como Patrimônio Mineral Global (*Global Heritage Stone Resource* e *Global Heritage Stone Province*) têm sido amplamente divulgados nas últimas décadas pela Organização das Nações Unidas para a Educação, a Ciência e a Cultura (UNESCO), pela União Internacional de Geociências (IUGS) e pela Associação Internacional de Engenharia Geológica e Meio Ambiente (IAEG). O conceito fornece meios pelos quais geocientistas, planejadores e a indústria possam explicar a importância de alguns tipos de rochas na construção e manutenção de estruturas históricas (Pereira et al. 2015, Marker 2015, Cooper 2018).

Para ser assim reconhecida, a pedra, rocha ou recurso mineral precisa estar em conformidade com os seguintes critérios:

1) ter uso histórico por um período significativo de tempo (pelo menos meio século);
2) ter tido aplicação em uma ampla área geográfica;
3) ter sido utilizado em projetos públicos e industriais significativos;
4) ter sido extraído exclusivamente em uma dada área ou região;
5) ter amplo reconhecimento como ícone cultural dessa mesma área;
6) encontrar-se ainda disponível;

7) ter tradições e histórias locais ligadas à sua extração e exploração;
8) apresentar potenciais benefícios culturais, científicos, ambientais e/ou comerciais.

Nesse sentido, os carbonados ou diamantes negros explorados na região por cerca de um século representam um extraordinário patrimônio geológico, tanto in situ quanto ex situ, bem como um elemento de sua geodiversidade, pelo seu valor cientifico e cultural. Sua descoberta e amplo uso como *commodity* industrial com grande número de aplicações tecnológicas coincidiram com o advento, na Europa e nos Estados Unidos, da Segunda Revolução Industrial, marcada pelo uso da eletricidade, e pelo desenvolvimento das indústrias do aço, dos transportes de massa, e da exploração petrolífera.

A Chapada Diamantina da Bahia ainda tem razoavelmente preservados muitos sítios históricos da mineração de ouro e de diamantes que podem ser objetos de projetos de geoconservação envolvendo as universidades públicas, os entes governamentais, as comunidades locais e a iniciativa privada. Um desses sítios é a Vila do Ventura, que como outras localidades da Chapada, teve um papel emblemático, pouco conhecido, na história da Segunda Revolução Industrial e na construção de impérios econômicos na Europa Central e na América do Norte.

Embora os carbonados não sejam mais interessantes do ponto de vista econômico, ainda é um desafio estabelecer os processos que definem a sua gênese, paragênese, sua concentração no Cráton São Francisco-Congo e os meios de deposição, pois isto pode lançar luz sobre a formação e interação química de outros minerais e tornar mais robustos os modelos exploratórios e sistemas minerais que, por sua vez, servirão de ferramenta para a prospecção deste e de outros minerais. E uma vez que os sistemas minerais são correlatos, não é incomum nas geociências a elucidação de um fenômeno intrigante ajudar a esclarecer vários outros até então não relacionados entre si. Além do valor científico excepcional, tanto *in situ* quanto *ex situ*, o carbonado também representa um alto valor educacional e cultural, o que justifica sua adoção como patrimônio geológico da Chapada Diamantina e, em sentido mais amplo, do Estado da Bahia.

Dados, portanto, a) o seu amplo emprego por todo o período da Segunda Revolução Industrial, inclusive durante a Segunda Grande Guerra como commodity e como material estratégico, b) sua ampla aplicação tecnológica pelos impérios industriais da época da Europa e Estados Unidos; c) sua disseminada utilização em grandes obras de engenharia, mineração, infraestrutura, exploração de petróleo, e na indústria do aço; d) por ter sido extraído exclusivamente nas minas da Chapada Diamantina da Bahia; e) pelo seu reconhecimento entre comunidades locais como símbolo cultural; e principalmente f) pelo seu valor científico,

cultural e socioeconômico, o carbonado deve ser reconhecido como patrimônio geológico da Chapada Diamantina.

## 2.4 ROTEIROS GEOTURÍSTICOS PARA O GEOPARQUE MORRO DO CHAPÉU

Para a composição do Geoparque Morro do Chapéu foram selecionados os mesmos pontos e geossítios usados pela CPRM para o treinamento de equipes de geólogos, nos mais de 20 anos que antecederam à publicação da Proposta (Rocha & Pedreira 2012). Na perspectiva de um geoparque, no entanto, os locais mais apropriados às atividades educacionais e à visitação geoturística são aqueles que reúnem e integram o maior número possível de elementos da geodiversidade em seu entorno. Estes poderiam inclusive ser caracterizados como roteiros da geodiversidade.

Com esta visão, propomos aqui os seguintes roteiros geoturísticos a serem desenvolvidos como atividade preliminar na proposta do Geoparque Morro do Chapéu:

**(1) O Roteiro dos Diamantes**, muito bem caracterizado pela presença da vila de garimpeiros conhecida como a Vila do Ventura, situada ás margens do rio que lhe deu o nome e que corre sobre rochas da Formação Morro do Chapéu, de onde eram extraídos os diamantes e carbonados que alimentaram a Segunda Revolução Industrial na Europa e Estados Unidos. Este é o roteiro delineado no artigo *Recovering the Ventura Village and the History of Carbonado-Diamond Mining in the Chapada Highlands of Bahia, Brazil, in the Late Industrial Revolution*.

**(2) O Roteiro Geoarqueológico** representado pelas tocas e paredões rochosos de arenito que por milênios serviram de abrigo para grupos indígenas de cultura tupi, e que registram uma grande coleção de arte rupestre. Entre eles, a Toca do Pepino, a Toca da Figura e o Complexo Arqueológico Lagoa da Velha. A região ostenta a maior coleção de arte rupestre e de sítios arqueológicos do Estado da Bahia (Etchevarne et al. 2015).

**(3) O Roteiro Espeleológico** da APA Gruta Lapa dos Brejões, uma das mais extensas e volumosas do . Brasil e de rara beleza cênica (Berbert-Born & Karmann 2002, Barleto et al. 2007). Apesar do risco substancial de degradação, o geossítio é também de importância espitirual, pois em seu interior ocorre anualmente a Procissão à Nossa Senhora dos Milagres, além de local para atos de devoção de fiéis e visitantes;

**(4) O Roteiro Estratigráfico e Paleoambiental**, que inclui afloramentos diversos localizados desde o Complexo da Cachoeira do Ferro-Doido na extremidade sudeste da área proposta para o geoparque, até a Escarpa do Tombador, em seu limite a nordeste. O roteiro inclui ainda a visitação a associações de litofácies, a ambientes de deposição, e aos processos de formação dos relevos e de bacias sedimentares;

**(5) O Roteiro de Campo**, de grande interesse para a comunidade geocientífica nacional, compõe-se em grande parte dos sítios que serviram de base para as operações do Centro Integrado de Estudos Geológicos, o CIEG, do Serviço Geológico do Brasil, que funcionou por cerca de 30 anos na região, até 2018. Anualmente, o centro atraia centenas de estudantes, professores e grupos de profissionais para treinamento na interpretação de modelos deposicionais.

**(6) O Roteiro do Morrão,** próximo à área urbana, nos limites do Parque Estadual de Morro do Chapéu, que oferece ao visitante diversos atrativos como a vista espetacular do próprio Parque Estadual, do Parque Eólico e da cidade de Morro do Chapéu; e em razão das propriedades do solo e do clima da região —conhecidas como *o terroir* (Lugeri et al. 2011, Torres et al. 2013, Oliveira et al. 2019) — a presença em suas proximidades de vinícolas, e do cultivo de morangos e rosas-do-deserto.

Não existem ainda **museus temáticos** na área proposta para o geoparque, embora os temas potenciais sejam bastante evidentes, como o garimpo e a mineração de diamantes e carbonados, a ocupação ameríndia nos milênios que antecederam à colonização portuguesa, o poder político dos coronéis das pedras preciosas, a arquitetura e traçado urbano de Morro do Chapéu, entre tantos outros. É justamente esse o roteiro que integra e otimiza para os visitantes e para as comunidades locais o senso de lugar e de pertencimento (Dameria et al. 2020).

Outros roteiros podem ser criados que incluam a prática de esportes de aventura, como as geotrilhas, *mountain hiking* e *mountain biking*, o rapel, a cavalgada; e os serviços terapêuticos e de saúde e bem-estar, proporcionados pelas fontes termais do Tareco e pelo contato com o clima e com a natureza (White et al. 2019).

Já nas noites de céu claro, pode-se oferecer aos grupos de visitantes a experiência, vez mais inusitada, de observação dos céus e de fenômenos astronômicas que, dada à elevada altitude da região, à baixa umidade do ar e à localização distante dos grandes centros urbanos e sua ofuscante iluminação, podem ser vistos com e sem o auxílio de instrumentos. Dependendo da época do ano e da declinação dos astros, pode-se ver o Braço de Sagitário (um dos braços da Via-Láctea) dominando os céus com exuberante nitidez, oportunidade propícia também para

a prática de fotografia celeste e noturna. E embora não estejamos acostumados a pensar na observação celeste como patrimônio cultural da humanidade, Hoerger (2016) faz uma persuasiva argumentação e revisão da literatura sobre o tema na revista de ciência e tecnologia *The New Atlantis*. E embora visto de uma perspectiva bastante inusitada, mas em vários aspectos relacionada a esta, é a proposta apresentada por arquitetos, urbanistas e turismólogos do Distrito Federal, com vistas ao tombamento pelo IPHAN (e/ou talvez pela própria UNESCO) dos céus de Brasília (de Paula 2015).

Todos esses roteiros estão cercados pela maior concentração e diversidade de cactos do Estado da Bahia (Machado 1999) e por belíssimas orquídeas e bromélias-do-mato, alecrins-de-vaqueiro, quixabeiras e arrudas-de-égua (rutáceas), por tarântulas gigantes e cascavéis que se abrigam entre as rochas à menor aproximação dos visitantes, e por córregos, nascentes e cachoeiras integrantes de uma biogeodiversidade que têm inspirado gerações de viajantes e naturalistas. Seguindo a tradição técnica e artística inaugurada por Eschwege (ao descrever com esboços a paisagem e a geologia de Minas Gerais), e por Orville Derby, o fundador da geologia brasileira (ao descrever a Serra do Espinhaço), o geólogo americano John Branner descreveu pela primeira vez, com imagens que beiram à inspiração artística, a geomorfologia e a geologia da Serra do Tombador, desde a escarpa a sudoeste de Jacobina até Gameleira (antigo nome de Morro do Chapéu) nas proximidades do Ventura, sendo essa a primeira menção feita à cidade e à Vila de garimpeiros em um artigo científico internacional, publicado no *American Journal of Science* (Branner 1910).

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# CAPÍTULO 3

# ARTIGO: RECOVERING THE VENTURA VILLAGE AND THE HISTORY OF CARBONADO-DIAMOND MINING IN THE CHAPADA HIGHLANDS OF BAHIA, BRAZIL, IN THE LATE INDUSTRIAL REVOLUTION

**Recovering the Ventura Village and the History of Carbonado-Diamond Mining in the Chapada Highlands of Bahia, Brazil, in the Late Industrial Revolution**

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**Abstract –** In the last two decades, the Brazilian Geological Survey (CPRM) has published dozens of proposals for the creation of geoparks throughout Brazil, five of which just in the Northeastern State of Bahia. None of them however has so far been implemented by local governments or public initiative. One of these proposals is the Morro do Chapéu Geopark, published in 2010. As envisaged by the CPRM, the area would include 24 geosites representing sedimentological, stratigraphic, paleontological, hydrogeological, tectonic and speleological interests from the Tombador, Caboclo and Morro do Chapéu Formations of the Chapada Diamantina Group. Except for the Ferro-Doido Waterfalls in its surroundings, the historical diamond mining Village of Ventura and its archaeological sites were left out of the geosites list and were accorded only a small account in the proposal's last pages. This work is the first attempt to recover the importance of the Ventura Village for the history of diamond and carbonado mining in the Chapada Diamantina Highlands of Bahia, during the Late Industrial Revolution. The whole work is based on the premise that instead of being a marginal site, the Ventura Village and its surroundings represent the nucleus from which a future geopark could spread to the wider Morro do Chapéu region, including nearby municipalities. The proposition is supported by extended fieldwork in the area, an exhaustive historical and scientific literature review, two quantitative assessments and a qualitative evaluation.
**Keywords –** Geosites, Geoparks, Ventura Village, Chapada Diamantina Highlands

## INTRODUCTION

Located in the eastern part of the Chapada Diamantina Highlands of Bahia, northeastern Brazil, at altitudes that reach 1350 meters, Morro do Chapéu boasts a history and geological

conformations that make the region one of the most promising for the creation of a geopark along the lines of the UNESCO Global Geoparks Network concept. The hills and escarpments of the Tombador Formation, described since the 19th century by foreign geologists and naturalists traveling through the country and consisting of sedimentary rocks that once formed the dunes of a Proterozoic desert, successively invaded by the sea; stromatolites and silicated carbonates from the Caboclo Formation; and the records in its rocks of geological processes and events that date back to the Precambrian are just some examples that make Morro do Chapéu an exceptional Earth Sciences school-area. In addition, the uniqueness of its landscapes, the presence of rock paintings and archaeological sites, historic villages and architecture linked to the history of diamond and carbonado mines, besides its rich cultural traditions.

None of them, however, summarizes and represents so well the geodiversity and scientific and cultural value of the region as well as the village, still partially preserved, known as Vila do Ventura, mentioned in the international scientific literature since the beginning of the 20th century (Branner 1910; Torrend 1925).

Nestled in the deep valley of the river that gave it its name, Vila do Ventura came to have about 500 houses and 5,000 residents between the second half of the 19th century and the beginning of the 20th century. The period in which the region's economy flourished coincided with the advent in Europe and the United States of the Second Industrial Revolution, marked by the use of electricity and the development of the steel, oil and automobile industries, to which it contributed by supplying carbonados - also known as black-diamonds - employed at the time as industrial and technological commodities.

Directly affected by a set of adversities from the international scene in the 1930s, such as the Great Economic Depression and the Second World War, precisely among the most industrialized nations of the period, Vila do Ventura and the entire Morro do Chapéu region entered a steep economic decline. And affected at the same time by a prolonged and unrelenting drought, the exodus of the village population resulted in its nearly total abandonment, so much so that it came to be known in the area as "the ghost town".

As the concept of a geopark is in many cases neither readily apprehended nor quickly implemented, Brilha (2012) recommends establishing it, initially, in a limited area, and that, after being implemented, “to consider its possible expansion” to the adjacent areas. The main objectives of this article are: 1) to recover the long forgotten historical, cultural and scientific importance of the Ventura Village and its geoheritage; 2) to quantitatively assess and evaluate it and compare our findings with that of other similar geomining heritage initiatives around the world; and 3) to demonstrate that, if well planned, none of the geosites proposed by the

Brazilian Geological Survey for the Morro do Chapéu Geopark, proves to be as conducive to constituting a geotouristic nucleus with potential for eventual expansion as that of the Vila do Ventura and its surroundings. The fact that an important part of the geological history of the Earth, prehistory and the social, technological, and economic history of the Second Industrial Revolution intersect there, makes the place a geosite of extraordinary scientific, didactic and cultural value, along the lines of the UNESCO concept for a geopark.

**Geology and Geography**

The area (shown in the map of Fig. 1) is made up of rocks from the Chapada Diamantina Group, which in turn is part of the Espinhaço supergroup crossing the States of Bahia and Minas Gerais with metasedimentary sequences, with a predominance of quartzites and metasandstones. The folded topography is the product of a Neoproterozoic cycle of compression and extension events known as the Brasiliano and is full of incised valleys, steep escarpments, and ridges at high levels. Erosion is dominated by river processes that contributed to the development of geomorphological characteristics of great scenic beauty (Lima and Nolasco 2015), such as the Ferro-Doido and Ventura waterfalls. The village itself is located on rocks of the Morro do Chapéu formation, which presents at its base conglomerates deposited by fluvial systems from which diamonds and carbonados were mined (Rocha 1997).

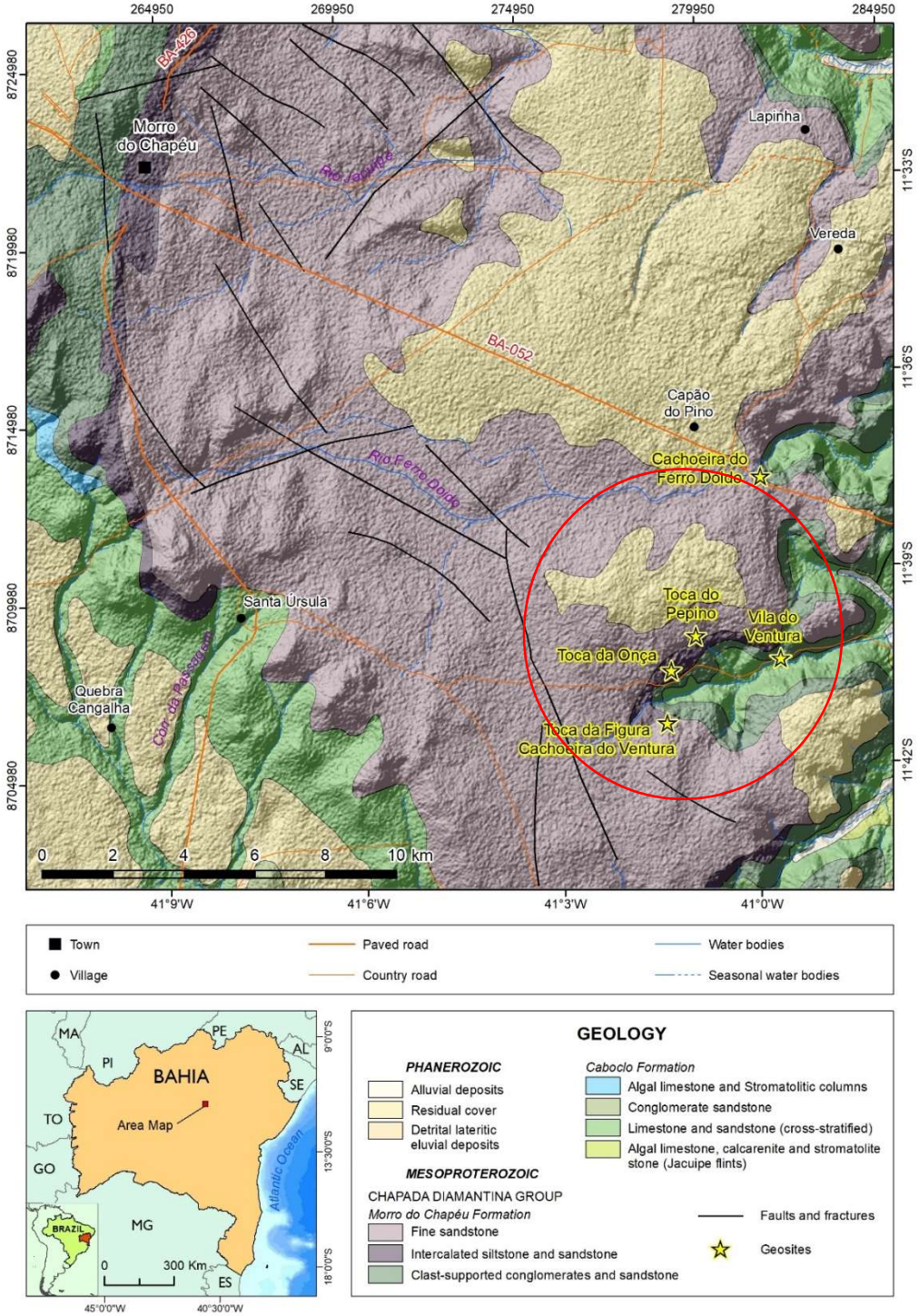


**Fig. 1** Location and Geological Map of the Ventura Village and its surroundings at Latitude 11°40'28.10"S and Longitude 40°59'42.18"W. Besides the historical mining village, the main nearby geoheritage and geodiversity elements with potential scientific, educacional and touristic values, include the Ferro-Doido (11°37'30"S 41°00'06"W) and the Ventura (11°41'06"S 41°01'42"W) Waterfalls, and the geoarchaeological complex (11°41'25.6"S 41°01'26.4"W), covering a total area of approximately 82 square kilometers.

A significant part of the stratigraphy of the area can be easily seen in the nearly 100 m height of the Ferro-Doido Waterfall (Fig. 2) with intercalated limestone and sandstone rocks

from the Caboclo formation at its base, huge conglomerates of the Morro do Chapéu formation at its lower section, and a very high outcrop of pink and gray sandstone integrating the upper part of the same formation.

**Fig. 2** Aerial view of the Ferro-Doido Waterfall, designated in 1988 a Natural Monument and Conservation Unit but, as can be seen from the presence of tourists at the edge of the cliff, there is no safety structure, access control or conservation measures. Photo by Ricardo Sampaio, used with permission

The village is located in a deep valey crossed by the Ventura and other smaller rivers, like the Ferro-Doido and the rio Preto, which make up the sub-basin of the Jacuípe river. And despite the distance that separates it from the larger Paraguaçú ("Great River", in the native language), it merges with it after crossing more than 500 km in semiarid territory. Thus, one can say that the diamonds and carbonados explored in Bahia in the period treated here originated exclusively in the Paraguaçú basin. The climate in the region is strongly influenced by altitude and has two well-defined seasons. In summer, temperatures can reach above 30 ºC, while in winter, especially at night, they can reach below 10 ºC, with averages ranging between 14 ºC and 26 ºC.

**Methods**

To gather all possible piece of information about the Ventura Village and its value as a mining geosite, several inspection fieldtrips were undertaken to the area and its surroundings with the help of local guides, and interviews with old miners and local residents were conducted. An exhaustive search was carried out for historical records, old pictures, and

scientific papers of the last two centuries dealing with the exploration and use of carbonado as an industrial commodity during the Late Industrial Revolution. In the absence of a specific method for evaluating derelict alluvial diamond mining geoheritage, we adopted Marescotti et al. (2018) quantitative method for the evaluation of the critical issues and positive values of abandoned mining areas. Although initially designed to assess and evaluate a set of geosites in any given area, Brilha (2016) evaluation method was further applied as a means to assess the Ventura nucleus scientific value, its educational and touristic potential, and its risk of degradation. Finally, as the above procedures allowed for a wide spectrum view of the geosite's importance and conditions, a SWOT analysis was integrated to the study, to not only inform further protection and conservation policy actions for the area but also to help promote it as the nucleus of the future Morro do Chapéu Geopark. The whole procedure is summarized in Table 1.

**Table 1**: Scheme of the methodology used in this study for the Qualitative and Quantitative Assessment of the Ventura Village Geosite and its surroundings. Adapted from Brilha (2016), Marescotti et al. (2018), Carrión Mero et al. (2018) and Datta (2020).

<table>
<tr><td colspan="3">Preliminary Search for information about the site and its surroundings</td></tr>
<tr><td rowspan="4">Fieldwork in the Geosite area</td><td colspan="2">Interview with old miners and local residents</td></tr>
<tr><td colspan="2">Search for local public archives and pictures</td></tr>
<tr><td colspan="2">Consulting with experts that have worked in the area</td></tr>
<tr><td colspan="2">Ground and aerial photographic documentation of the village and its surroundings</td></tr>
<tr><td>Literature Review</td><td colspan="2">History of the Village<br>The Second Industrial Revolution<br>Carbonado and Diamond Artisanal Mining<br>Geomining and geoheritage<br>Diamond mining and Environmental Geology<br>Geology of the Chapada Diamantina</td></tr>
<tr><td colspan="3">Definition of geological frameworks associated with the geosite</td></tr>
<tr><td rowspan="5">Quantitative Assessment</td><td>Geomining Site</td><td>Geosite & Geodiversity</td></tr>
<tr><td>Critical Issues</td><td>Scientific value</td></tr>
<tr><td>Positive Values</td><td>Degradation risk</td></tr>
<tr><td></td><td>Educational potential</td></tr>
<tr><td></td><td>Touristic potential</td></tr>
<tr><td>Qualitative Assessment</td><td colspan="2">SWOT Analysis</td></tr>
</table>

**The Context**

In the second half of the nineteenth century, while most of Europe and North America were entering the Second Industrial Revolution driven by great scientific discoveries and the emergence of new technological developments, Brazil — the largest country in South America — was just giving its first steps to overcome its strongly rural and pre-industrial social and economic structure.

The discovery in 1840s of diamonds in the Highlands of central Bahia changed that area – earlier scarcely peopled – into one of the most dynamic regions in the Province and established till then unimaginable connections between the Chapada Diamantina and the industrial powers of Central Europe and the United States. Diamond production in the area at that time coincided with the decrease of that gem production in Minas Gerais, which had till then (since the early 1700s) been the main source of the precious stone in the country (Svisero et al. 2017). Like most of the other commodities produced in Brazil – like coffee, sugar and gold – diamonds were mostly traded to French, British, German and North American companies or sold to their agents located in the Highland villages and then exported overseas.

Between 1855 and 1865 an average of 228,000 carats of diamonds were exported every year from the Chapada Highlands to Europe. A small amount, if compared to the mechanical production of our days but very expressive if we take into consideration the rudimentary mining techniques of those days. Herold (2013) tells how, in 1856, a record of 320,000 carat of the precious stone were exported to the Port of Liverpool and from there passed on to Jewish merchants located in Amsterdam for cutting and polishing. These numbers do not include the large amounts of the stone believed to have been unofficially smuggled out of the country or simply never declared. This demand for diamonds from the Chapada Highlands was surpassed in the 1870s with the discovery in South Africa of the first kimberlitic rock source for these gems (Svisero et al. 2017).

Besides its use as jewelry, diamonds were also employed for industrial purposes, as when they were attached to the tips of tools used to cut and bore other precious stones and hard metals, or as ground “powder” incrusted on the surface of bars and revolving rings to polish and design gems. Later, besides their use as cutting and abrasion tools, diamonds were also employed in drilling, milling and crushing machines. Rudimentary rock drilling machines had already been in use since the previous century, and in the second half of the 19th century diamonds were extensively used in drilling machines employed in the mining and engineering industries. A milestone development was the invention in the early 1860s of a diamond-headed drilling machine (Fig. 4a) invented by the French engineer Rodolphe Leschot (Warner 1872).

**Carbonado Gets to the Universal Exposition**

The technological innovation was presented to the world in 1867 in the famous Universal Exposition, organized in Paris by the French emperor Napoleon III, attended by authorities and businesspeople from 42 nations, including Brazil. The diamonds installed in the crown of the drill were replaced by the Brazilian carbonados, a polycrystalline stone also known as black diamonds (Fig. 3). As puzzling as it might seem, whereas the invention and its use of the black diamonds from Bahia called the attention of the North American Commission attending the Exposition - as detailed in their Report (D'aligny et al. 1870) - no one in the Brazilian Commission - including the Emperor - noticed that the new technology employed a commodity whose suppliers could only be found in the Highlands of Central Bahia.

Soon there appeared in the market other machines employing the same principles, in a variety of shapes and sizes, with purposes as diverse as the opening of tunnels through hills and mountains, drilling oil wells, constructing building foundations and in mining operations. And they could be driven by either steam or compressed air (Fig. 4b and 4c). Besides its hardness and outstanding cutting and abrasive properties, its capacity to quickly remove high quantities of heat from the tip of the cutting tool, its low friction coefficient, combined with its unmatched strength and resistance turned carbonado’s applications so efficient (Haggerty 2014, 2017).


**Fig. 3** Variety of carbonado stones, also known as "black diamonds", from the Chapada Diamantina Highlands of Bahia. Source: Haggerty 2014. Image used with permission

Foreign diamond buyers visiting the Chapada highlands used to take rock samples for analyses back in their countries. In an article published in 1848 in the *Annales de Mines*, the French Engineer L. E. Rivot describes a few samples of small rocks brought to the Mining School by a precious stones merchant who said they looked harder than diamonds. Rivot was then invited by the laboratory director so they could conduct an in-depth analysis of the intriguing material (Rivot 1848). In London, an article appearing in an 1868 issue of *The Engineering and Mining Journal* tells of a diamond-like black or dark gray stone brought in for analysis. The study concluded that the stone was of no use and no value. It was therefore no wonder that French engineers were the first ones to recognize the carbonado's use and value for industrial applications. And in 1882, the North American Dessau & Company, headquartered in New York, started using "the black diamonds" from Bahia in their famous drills.

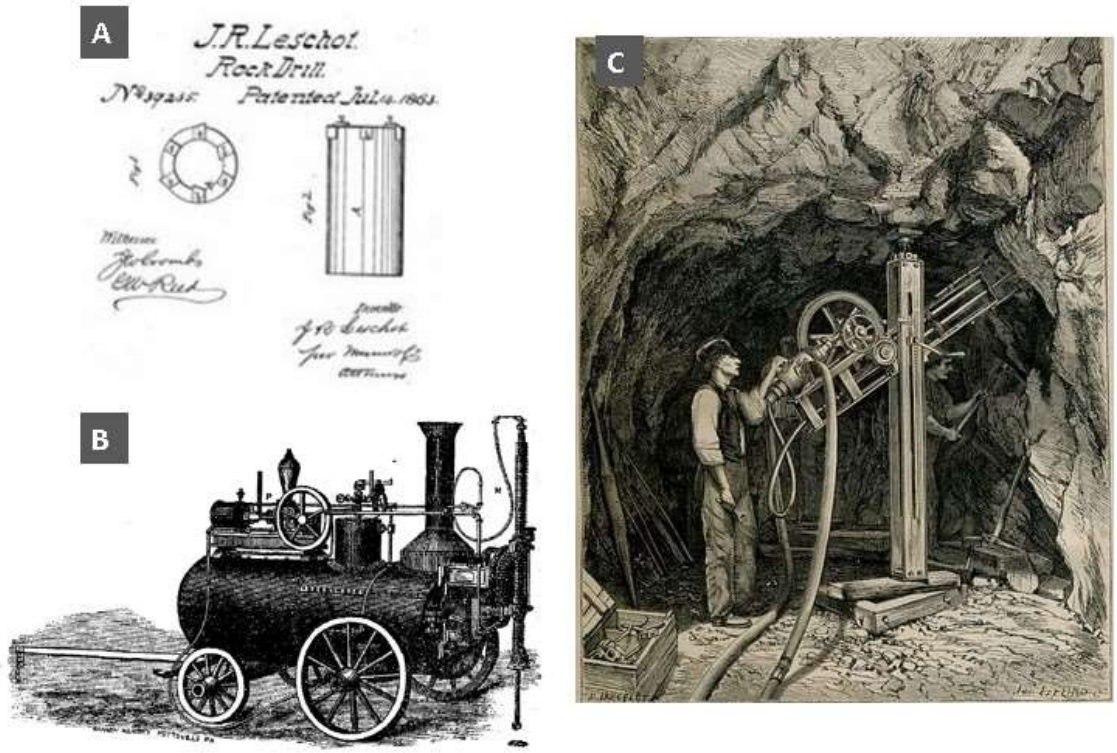


**Fig. 4** Technological evolution of the Leschot Drill, patented in the United States in 1863 and presented at the Universal Exhibition in Paris in 1867 (Herold 2013). A) See in the detail how the carbonados were arranged in the drill bit (Herold 2013). B) One of the first steam powered equipment, developed for drilling rocks in the opening of artesian wells and in prospecting for coal and other minerals (Raymond 1870, Warner 1972). C) Combination of the Leschot Drill with the Perret Engine, created to drive the drill by means of steam pressure and carry out infrastructure works (Charton 1866).

**Building Empires**

Carbonado's superior capacity to resist wearing down, known in materials science as "low abrasivity" as well as its combined properties of hardness and toughness were increasingly recognized and by the end of the nineteenth and early twentieth centuries the new technology was widely used in small and large scale construction works such as the opening of tunnels in the Swiss and Italian Alps region, in the opening of the Suez and the Panama Channels, in the construction of the trans-Andean railways — the Oroyan (in Peru) and the Chilean-Argentinian Railways in South America — and for the construction of the London network of subways, the drilling of oil fields in Pennsylvania and of the 82 feet (25 m) deep foundations of the then highest building in the world, the *Equitable*, in New York City (Herold and Rines 2011).

All this goes without mentioning the use of carbonados in milling machinery and in the metallurgy industry. We were in the height of the Second Industrial Revolution and the production of the Chapada Highlands of Central Bahia were the sole suppliers of the commodity.

Leschot drills operated with carbonado pieces attached to the surface of the tool`s crown and turned 250 to 300 revolutions per minute. In a construction Project in Rheinfeld, Switzerland, it took just 60 days to open a 475 m tunnel. Earlier, it would take between two and three years, depending on the hardness of the rock.

Early in the 1870s a carat of carbonado was sold for 2 shillings. Five years later it cost eight times more, and at the end of that century you could not buy it for less than 40 shillings a carat. In the beginning of the twentieth century, it was worth 100 shillings. Between 1895 and 1909 in the United States the price per carat ranged from 25 to 85 dollars, depending on demand and supply. By the time of the "Big Crash" of the New York Stock Exchange a "black diamonds" was worth over $100 USD a carat. Export documentation from 1915 from the American Consulate in Salvador revealed that at their source in the Chapada Highlands whereas a carat of diamond cost $18.00, the same weigh of carbonado was bought for $32,00 (Herold 2013).

**The Road to the Black Diamonds**

Probably no other innovation was so emblematic of the technological revolution of the nineteenth century as the emergence and rapid development of the railways transportation system, marked by an exponential increase in speed and in the quantity of people and goods being transported. In Brazil, the second half of that century was marked by the arrival of the first banks, the first industrialization projects, the advent of the first telegraph lines and the massive investment in the construction of railways.

To get from Salvador – where the major European and American buyers and their agents had offices – to the mines in the Chapada highlands, one had first to do part of the trip by train to Cachoeira and from there move on by boat in a two-day trip through the Paraguaçu River onto the Highlands where most of the major mining operations were located. From there, one could also ride on horseback to make it to Morro do Chapéu, where tens of diamond and carbonado mines thrived. Altogether, a trip of four or five days. Ventura Village was, in the words of Camillo Torrend — a French naturalist who visited the highlands mines in the early 20$^{th}$ century — "the most diamondiferous" place in Morro do Chapéu area (Torrend 1925; Catharino 1986).

In the second half of the 19th century Morro do Chapéu was also a strategic commercial outpost to which livestock from backland farms closer to the São Francisco river and the states

of Goiás and Piauí was brought to the eastern coast of Bahia, over 250 miles away. About 10,000 people lived in the town at the time.

Once in town, the travelling buyer could rest from the long journey and, early in the morning, follow on horse to the mines. A special kind of dealers known to the miners as "the *capangueiros*" (a reference to the leather bag they carried on) went from village to village searching for the precious stones on which they could make a profit reselling them to buyers located in strategic places like Lençóis or sent them by railroad directly to agents in the capital city of Salvador.

Adding up to its historical importance, the region and the village itself is crossed by a still preserved stretch of the "Royal Road", built earlier in the 18th century for the circulation of gold, precious stones, and several other commodities during the Portuguese and the Brazilian Empires. And not only goods and merchants were seen crossing it. American and European scientists like Frederick Hartt and John Casper Branner, from the Geological Commission described for the first time the nearby Tombador Escarpment formation. The first reference to the Ventura Village in a scientific publication appeared in 1910 in an article by Branner, who also mentions the earlier (1868) visit to the region of the Ornithologist J. A. Allen and, in 1870, of the Canadian Geologist Frederick Hartt (Branner 1910).



**Fig. 5 a)** Sunset view of the Ventura Village as it was in early 20th century. **b)** Today's view from the same perpective, with the difference that now trees and shrubs cover most of the village's streets and houses. **c)** The philharmonic orchestra whose members were many of themselves "garimpeiros" in the Ventura and in other mining villages around it. **d)** Francisco Dias Coelho (1864-1919) a Lieutenant who got wealthy with the trade of diamonds and carbonados and became the first black Coronel landlord and politician in the Chapada Highlands. Photos from the Archives of the Morro do Chapéu Public Library. **e)** Mr. Flamarion, one of the last surviving miners of the village inspecting one of the lamps of the old (later rebuilt) Chapel of Our Lady of Conception, currently in need of restauration.

At the height of the diamond and carbonado production at the turn of the century, the Ventura Village had about 500 houses, six streets and two squares (compare Figs. 5A and 5B). An estimated 3,000 people lived in the Ventura, while hundreds of other miners and their families lived in the surrounding farms and smaller villages. Besides a lively business district there were also in the village a theater, an orchestra (Fig. 5C), a Post and Telegraph Office and two elementary schools. And at the highest section of the town (known as the Star Heights) there is still a church — later rebuilt — The Chapel of Our Lady of Conception (Fig. 5E).

Later, part of the route could be made by train through the Central Railroad. Over time, French companies established farther south in Lençóis an agency (sometimes wrongly called "consular agency") where their dealers could more conveniently make the transactions and export the stones to the strategic markets in Europe and the U.S.

A few interesting facts and features of Carbonado makes the Ventura Village and the wider Chapada Highlands an outstanding geosite. For a long time, the "black diamond" was found only in the highlands of Bahia. Later, it was also found in the Central African Republic. The two regions now separated by the Atlantic Ocean were once contiguous and shared a common geologic formation we call the São Francisco and Congo Cratons, on a supercontinent known as Rodinia (Alkmim et al. 2006; De Waele et al. 2008; Evans et al. 2015) as illustrated in Fig. 8.

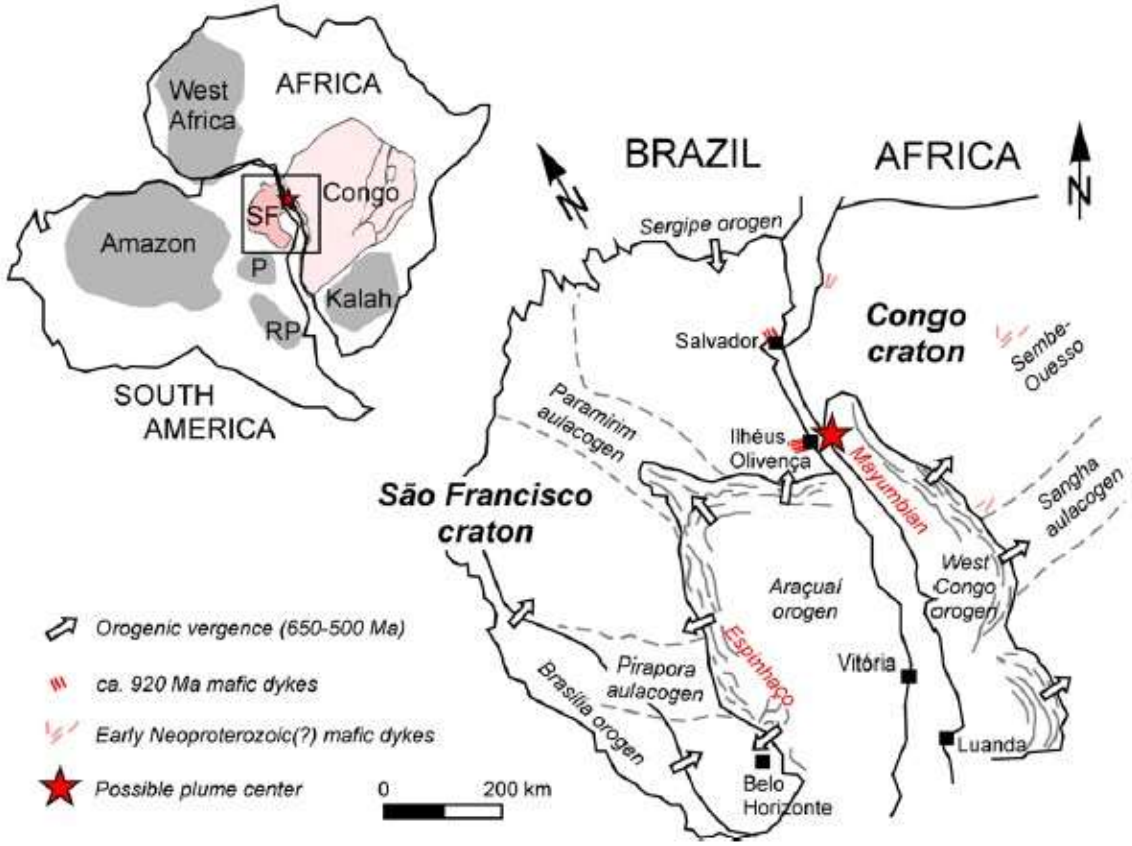


**Fig. 6** Illustrated paleogeography of the São Francisco-Congo Craton, before the Atlantic Ocean seafloor spread between South America and Africa begun, in the Cretaceous period (Evans et al. 2015, fig. 1)

**Geomine heritage**

The design of the village with its streets and buildings allows for identifying the urban structure as it was during the period of diamond exploration (Etchevarne et al. 2015, p. 17). There are very few furniture and utensils still preserved, but along the years there has been a growing and expressive collection of photos gathered on a website (http://www.fotosdemorrodochapeuba.com.br/morro/pagina/101) and at the Public Library. In addition, the first and only newspaper of the town, the *Correio do Sertão* (The Backlands Post), founded in 1917 is still active, what makes possible the reconstitution of the village's and the town's daily life and historical events. Such projects could be developed in partnership with universities and the State and local government for the creation of a mining museum in the Ventura. The village also represents an excellent archaeological site that could help understand

the social life of a miners' community between the second half of the 19th and the first half of the 20th centuries (Etchevarne et al. 2015, p. 26).

**Geoarchaeological sites**

Morro do Chapéu holds the largest collection of rock paintings in the State of Bahia, some of the most representative of them are located in the surroundings of the Ventura Village. They are typical of what archaeologists call "the northeastern tradition" brought from the Serra da Capivara hills by Amerindian groups that spread throughout the Chapada Highlands in the millennia preceding the arrival of European settlers (van Havre 2015). Most of these rock paintings are located in mushroom-like shelters and caves naturally sculpted in sandstone rocks, like the *Toca da Figura* (Fig. 7) and *Toca do Pepino* (Etchevarne et al. 2015, p. 16), with carbon dating to at least 2400 years (Etchevarne e Fernandes 2015, p. 33) (Etchevarne & Fernandes, 2011, p. 33). The similarities of these paintings to the ones found in the Serra da Capivara and other sites in northeastern Brazil have been the subject of a documentary called *Die Ersten Amerikaner* (The First Americans) for the German television network ZDF (2017; Etchevarne 2016).

**Fig. 7 -** Stone painting in the Toca da Figura (The Figure Shelter) attesting to the presence of Amerindians in and around the Ventura Village in the millennia preceding the Portuguese settlement. The pen enclosing several wild deers seen in the lower left of the image is a common feature in the rock paintings of the Chapada Highlands and is believed to be a kind of stockyard, representative of the transition of the native groups living in the area, from hunters to herdsmen (see Etchevarne 2020).

**The black stone landlords**

Among its famous residents were powerful landlords known as *coronéis*, such as Horácio de Matos, Antonio de Souza Benta and Francisco Dias Coelho. They were the feared "stone bosses" for whom many of the miners worked. The trade of carbonados was propitious for the emergence in the Chapada Highlands of a new prosperous class in an age and place where the structures did not allow for climbing the social and economic ladder. A few in the emerging class nurtured political aspirations and developed strategies to conquer local power and rule the region.

The most emblematic of them was Francisco Dias Coelho (Fig. 5D), a self-educated son of former slaves who became "the middleman" between the miners and foreign diamond and carbonado dealers and grew rich enough to buy military patents from the government and

become Coronel Dias Coelho, one of the wealthiest politicians in the highlands and in the whole State of Bahia (Sampaio 2009).

Another, Coronel Bieca, ordered built a reservoir like the Roman aqueducts, to supply the village with treated water. It is an impressive engineering work locals call the Bieca's Well (Fig. 8). Similar structures can be found in very few other places in Brazil (Souza 2017).

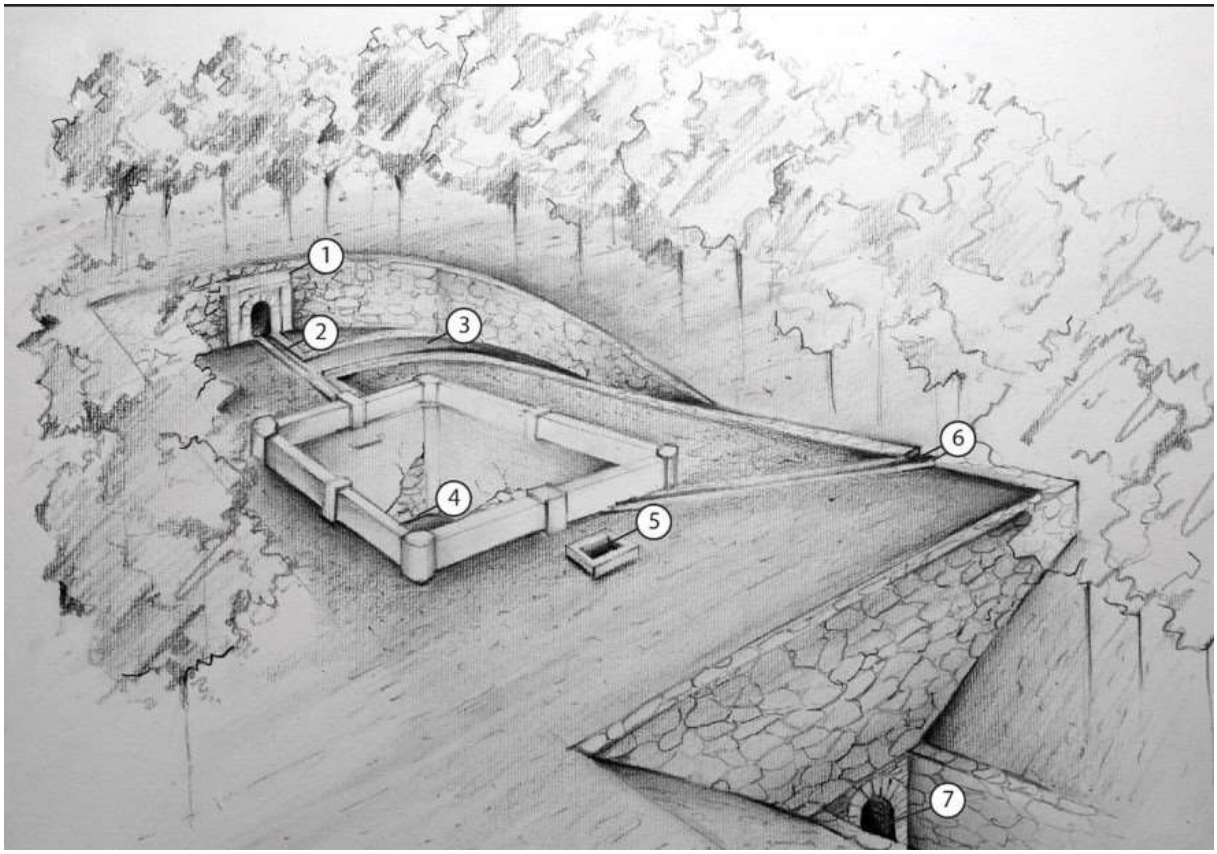


**Fig. 8** Sketch of the Ventura Village Reservoir, a hydraulic system similar to Roman aqueducts, built iín the early 20th century, to supply water to the village. It is better known as Coronel Bieca's Well. l) Superior arc; 2) Frontal gutter; 3) Lateral gutter; 4) Reservoir; 5) Sinkhole; 6) Overflow gutter; 7) Inferior arc. Modified from Souza (2017), used with permission.

**The Great Depression and the fate of the Village**

From the Universal Exposition in Paris up until the time of the Great Depression and the Second World War the history of the Ventura Village in particular and that of the highlands was marked by the feverish trade of diamonds and carbonados. For over half a century, the Ventura played a small but singular role in the construction of the industrial powers of the time. From there, flowed enormous quantities of the "black diamond" that would help build financial and economic empires like France, the Netherlands, Germany, and the United States.

Along with the Great Economic Depression of the 1930s, a relentless drought affecting the semi-arid regions of northeastern Brazil and the Second Great War involving the very

industrial powers that promoted the use of carbonado as a commodity, the village entered in a steady decline. And to complicate even further, there appeared in Europe and in the U.S. other technologies, like the production of synthetic diamonds, that could now replace the carbonados in a more cost-effective way. In the following decades, the village was gradually abandoned, businesses closed and the old generation of miners who resisted the exodus passed out. The place entered in such a ruined condition that today it is known by its casual visitors as a "ghost village" (Fig. 9). A process was started in 2004 by the local authorities and the Bahia State Artistic and Cultural Heritage Institute (IPAC) to designate the Ventura Village as a historic site worthy of preservation but it has never become fully effective. Encouraged by the prospect of the designation, a few old residents even tried to restore the houses preserving the old architecture (Fig. 10), what provides glimpses of the positive impact the continued initiative would hold on the desolate scenery.

**Fig. 9** A few old commercial buildings are still intact whereas others are in thorough ruin

**Fig. 10** A house recently renovated according to the old style quite common in mining towns and villages

**Assessing the geosite**

For Marescotti et al (2018), mining sites can be defined as geosites because, among other things, they afford a more comprehensive view of geologic features by unveiling the exposition of rocks, minerals, geological structures, and stratigraphic units. Among the critical environmental, ecological and landscape issues impacting abandoned mines, they highlight 1) the hydrogeological conditions adversely affected by significant variations in surface and underground water circulation through drainage disruption and gradient alteration; and 2) landscape visual impact caused by waste rock dumps and widespread deforestation of the area. Among the positive values abandoned mining sites incorporate the stories of local communities, their economic and social relationships, and represent a valuable potential for scientific,

touristic, recreational, and educational activities. The authors proposed a quantitative method for assessing the condition, potential and risks of such places. Applying the proposed method for the Ventura Village, the following evaluation can be found for the geosite.

***Critical issues (CI)***

As for ***soil (Sc)*** and ***water (Wc) contamination***, the Ventura Village area fares very well because in the 19th and early 20th century diamond and carbonado exploration did not involve the use of potentially toxic elements and there was no *in situ* beneficiation process or contaminant employed in the mining activity. As a result, there was no need to measure de ***acid drainage (Ad)*** of the rocks and sediments exposed along the mining sites.

Although in the artisanal method of diamond-washing mines the ***visual impact (Vi)*** is not as high as is the case in several other mineral exploration, the rock dumps and unconsolidated sediments left behind in the beds and banks of the rivers, preventing the water free course, and the deforestation of the surrounding area do add to the degraded landscape. A study has yet to be made to decide whether and to what extent the environmental impact of the mining activity in the highlands contributed to the drought that devastated the region in the 1930s, causing the exodus of the miners and their families and the nearly total abandonment of the mining villages.

Last but not least among the critical issues, the ***hydrogeomorphological impact (Hi)*** may not have provoked large modifications in the former topography of the area, but the intense and prolonged diamond mining activity may have been strong enough to affect the surface and underground water circulation and interfering with the river basin, besides adding to further degradation of the landscape.

***Positive Values (PV)***

The ***geologic value (Gv)*** of the Village and its surroundings is determined by the presence of a diverse number of elements like the diamonds and carbonados found in paleoplacers, the geological processes and climate changes recorded in the rocks of the Chapada Diamantina Group (the region is considered by the Brazilian Geological Survey (CPRM) a school-area for depositional systems of a diverse number of environmental conditions), the widespread faults and folds provoked by compression and extension events of the Neoproterozoic age.

The ***landscape value (Lv)*** is represented by the Ferro-Doido and the Ventura Waterfalls, both of which can be easily accessed either by car or by trail. The Ferro Doido Waterfall is already a tourist attraction all year long, but the spectacular view can be greatly enhanced during

the rainy season that goes from late October to early May. In addition, despite its critical conservation condition, the Ventura Village itself offers the visitor an impressive historical setting worth the trip. The area's fauna and flora remain to be studied and catalogued and may well configure one of the attractions of the place.

In the past, says the authors, much more than today, mining activity used to involve not only the *garimpeiros* directly working in the mining sites, but in an indirect way, their families, the villages where they lived, and sometimes even the whole district. No other place in the whole Morro do Chapéu region is so intricately connected with the social, political, and commercial life of the wider northeastern part of the Chapada Highlands. We have already mentioned the Stone Landlords, especially the Coronel Dias Coelho, who lived "in the City" — over 20 miles away — but whose wealth and life had strong connections with the Ventura. All these historical elements assign to the geosite a high ***historical value (Hv)***.

Unfortunately, in the recent history of the Ventura Village there has been no effort to rescue and protect its ***archaeological value (Av)***, not to be here confused with the geoarchaeology of the stone paintings. The authors refer to the presence of valuable items or artifacts that bear a testimony to the mining culture of the day, with historical, technological, social, architectural, or scientific value (Kaźmierczak et al. 2019). A search for possible private remains and excavations in and around the village could result in a few but valuable findings to help compound a museum of the Ventura.

Regrettably, despite all the area's intrinsic value and potential, there has been no initiative by local or State agencies to implement a structured tourist offer. There's no visitor's center, no cultural or recreational activities during the year, no travel agencies promoting the place, no nearby airport. To make things worse, the Brazilian Geological Survey training center, known as CIEG, that for 30 years attracted hosts of university students and other professional organizations doing fieldwork, closed its activities in 2018. All these factors discount from the ***touristic value (Tv)*** of this geosite under consideration.

**Results**

The Ventura Village geosite total score (TS), shown in Table 2, can be summarized as follows:

$$TS = (Gv + Lv + Hv + Av + Tv) + (Sc + Wc + Ad + Vi + Hi).$$

$$TS = 8$$

From the eight historical mining sites assessed by Marescotti and colleagues only one was scored 13 points. Seven had TS ≤6. So, with a TS=8, the Ventura Village geosite has fared

comparatively much better. Due to its mostly artisanal, non-mechanized and chemicals-free mineral exploration, its environmental critical problems are reasonably limited. Contrastingly, due to a lack of public and private initiative and investment, the village's archaeological value and touristic potential are severely compromised, though not entirely unrecoverable.

**Table 2.** Total and partial scores for the Ventura Village geosite based on the evaluation method proposed by Marescotti et al. 2018.

| | Mining Site | Class | Assessment | Ventura Village |
|---|---|---|---|---|
| Critical Issues | Soil Contamination (CI1—Sc) | Nil | No contamination of soils due to the absence of contaminants in the exploited ore and wall rocks | 0 |
| | Water contamination (CI2—Wc) | Nil | No contamination due to absence of contaminant release (inert ore, gangue minerals and wall rocks; effective natural or artificial neutralization processes) | 0 |
| | Acid Mine Drainage (CI3—Ad) | Nil | AMD impossible or possible but non-persisting over time | 0 |
| | Visual impact (CI4—Vi) | High | Diffuse degraded elements are restricted to the mining area | -3 |
| | Hydrogeomorphological impact (CI5—Hi) | High | Most of the critical issues described above are present but restricted to specific sites within the mining area | -3 |
| | **Partial score** | | | **-6** |
| Positive Values | Geological value (PV1—Gv) | Very high | Diffuse presence of accessible geologically valuable elements within the mine and surroundings | 4 |
| | Landscape and ecological values (PV2—Lv) | Very high | Diffuse presence in the mine site and surrounding areas of recognized ecological values. Landscape with high scenic quality and evocative elements | 4 |
| | Historical mining value (PV3—Hv) | Very high | Diffuse presence of readable and valuable elements related to the mining history within the mine site and surrounding areas | 4 |
| | Archaeological value (PV4—Av) | Low | Archeologically valuable elements are present but not accessible within the mining area | 1 |
| | Touristic value (PV5—Tv) | Low | Few tourist attractions are present in the neighborhoods and the mining sites are accessible with some difficulties | 1 |
| | **Partial Score** | | | **14** |
| | **Total Score** | | | **8** |

## The Scientific Value of the Ventura Village Geosite

As defined by Brilha (2016), the scientific value of a geosite is closely related to its significance as a place for unveiling and understanding the geological history and evolution of our planet, especially the interaction of the geosphere with the other systems like the biosphere, the hydrosphere, and the atmosphere.

**Representativeness** – with part of its buildings and street design still preserved, the Ventura Village is a unique and exceptional site illustrating the history of alluvial mining of diamonds and carbonados, an activity closely related to the technological developments of the Late Industrial Revolution in Europe and the United States.

**Key locality** – From 1987 until recently (2018) the Brazilian Geological Survey (CPRM) operated in Morro do Chapéu a center for training groups of geologists, as the region is considered a school-area in depositional systems, carbonate petrology, sedimentary rocks formation, structural geology, mapping techniques, and basin dynamics. Every year, hundreds of national and even international university students, professors and other professionals in the geosciences and mining industries from public and private organizations flooded the area in search of the exceptional fieldwork experience. Unfortunately, so far, no effort has been done for its recognition as a reference site by the international geoscientific community.

**Scientific knowledge** – regrettably, there is no paper in either international or national scientific journal about the Ventura Village or the other sites in its surroundings, though there is a reasonable number of thesis, dissertations, books, and other national institutional publications about its historical, archaeological, biodiversity and geoheritage (Ferreira 2014; Silva et al. 2015; Sampaio 2009; Souza 2017; Schobbenhaus and Silva 2012; van Havre 2015; Etchevarne et al. 2015). There is however an interesting article titled Pela Terra Diamantina (Journeys in the Diamond-washing Lands) by the French naturalist Camillo Torrend published in the journal Broteria in 1925. Though not a specialized geologist, Torrend, who was guided in the area by Joaquim Barreto de Araújo — one of Bahia's wealthiest precious stones traders — was the first to describe the geology of the Ventura Village — which he found to be "the most diamondiferous place" in the Morro do Chapéu area. He also visited the Ventura surroundings, including the Igrejinha geoarchaeological complex. Both Torrend and Mr. Araújo were hosted in the Ventura by the famous landlord Coronel Bieca, the same one who built the village's aqueduct (shown in Fig. 9).

**Integrity** – The geosite is not so well preserved but the main architectural elements of a miner's village is still there, though in need of restauration and conservation works. The old cemetery, the water fountain, and Bieca's Fountain are totally covered by the bush. The Ferro Doido Waterfalls and the geoarchaeological sites are also in great need of protection so it can be preserved for future generations.

**Geological diversity** – the history of diamond and carbonado mining during the Late Industrial Revolution, the alluvial and conglomerate source for the gem and the stone, the diverse depositional and sedimentary environments registered in its rocks, the stratigraphic

relationships openly seen in the rock profiles of the Ferro-Doido and Ventura Waterfalls, the geoarchaeological and cave paintings are all witnesses to this geosite's geological diversity.

**Rarity** – No other geosite in the whole area proposed for implementation of the Morro do Chapéu Geopark combine so many elements of the geological framework considered in this study.

**Use limitations** – though diamond and carbonados are no longer exploited neither in the village nor in its surroundings, there is no limitation or physical barrier to carry out fieldwork or sampling.

**Potential Educational and Touristic Use**

**Vulnerability** – Regrettably there has been no conservation or protection efforts the village's geoheritage and, if not appropriately done, touristic and educational activities may further deteriorate the condition of all the elements, including the area's rivers, the architecture, the superficial sedimentary rocks, and the rock paintings.

**Accessibility** – from the town of Morro do Chapéu to the Ventura, visitors should take the well paved BA-052 road and drive down the Angelim hills for about 27 km, till they come to a crossroad. At that point, a left sign indicates an exit to the Fedegoso village and (to the right) an exit to the Ventura. The remainder 8 km to the village must be done through an unpaved gravel road. If it is in the rainy season in the Highlands (usually from late October to early May) you might have to either manage to drive through the Ventura riverbed or leave the vehicle behind and follow on on foot for about 2 km. From the village, the access to the rock painting sites and to the Ventura Waterfall has to be done on trails that should never be done without the help of local guides and good hiking shoes.

**Use limitations** - the site has no limitations to be used by students and tourist, though it is in great need of protection measures like forbidding cars from entering the town and installing wood decks from where visitors can see the rock paintings and take pictures without having to either step on the site or touch the cave walls.

**Safety –** though there are a number of potential risks of accidents in an excursion to the Ventura geosite — especially falls and bites from snakes, spiders, bees and wasps — there is no safety facilities or emergency service nearby. And no mobile phone service covers the area.

**Logistics** – the nearest lodging and restaurants are located 35 km away, in Morro do Chapéu.

**Density of population** - less than 10 families still live in the village today, whereas a few people living in Morro do Chapéu own houses in the Ventura. Even in Morro do Chapéu, the population density is just 6 inhabitants per square kilometer.

**Association with other values** - the trails themselves, the waterfalls and their scenery and geology and the cave paintings and sightseeing represent exceptional values located in less than 7 km from downtown Ventura Village.

**Scenery** – though most of the attractions in the Ventura Geosite are not well known around the country, the Ferro-Doido Waterfalls attracts many people for its extraordinary sightseeing and for the practice of sports like rappel, trekking and hiking, as this geomorphosite is easily accessible from the BA-052 road. Unfortunately, local authorities do not take advantage from this to promote protection and geotouristic activities.

**Uniqueness** – as far as the historical geomining heritage and framework is concerned the village shows unique and uncommon features that can be found in no other place, either in Brazil or internationally.

**Observation conditions** – Despite the total lack of protection and conservation, all geological, geoarchaeological and historical elements can be observed in good or reasonable conditions.

**Didactic potential** - the site presents geological elements that can be taught in all teaching levels much better than if they could be seen from a textbook or a video presentation.

**Geological diversity** – the historical village, the mining geoheritage, the waterfalls geomorphology, the prehistorical cave paintings, the sedimentary rocks, the rock profiles, and marks of ancient paleoenvironments represent just a few examples of the geodiversity elements occurring in the Ventura and its surroundings.

**Interpretative potential –** the public obviously need to have some geological background to understand the geological elements of the site, what can be provided by local guides and the implementation of interpretive panels.

**Economic level** - after the diamond and carbonado economic cycle in the Highlands, most towns entered a decline in business activity, low private and public investment and household income is lower than the national average. Tourism has not been very expressive as no investment has been made to promote it. The arrival in the region in recent years of wind-power plants represents a promising perspective in this scenario, as the Highlands are considered a “Wind mine” for this kind of industry. 1

**Proximity of recreational areas** – Ferro-Doido waterfalls, located at about 10 km from the village by car (or about 6 km by trail) is the nearest recreational area or tourist attraction in this geosite. All the other ones, like the Morrão hill or the Agreste Waterfall are located much further north.

**Risk of degradation**

**Deterioration of geological elements** – there a serious possibility of deterioration of all geological elements if no protection and conservation initiative is taken by local authorities.

**Proximity to areas/activities with potential to cause degradation** – though protected by a natural conservation law, the Ferro-Doido Waterfalls is the most vulnerable of these sites, as it is located right by the BA-052, one of the main State roads of the region.

**Legal protection –** both the village, the archaeological sites and the waterfalls are under legal protection instruments, as mentioned before, but —as it is quite common with conservation units in our country —this does not translate into effective measures to secure and safeguard the sites. There is, therefore, no control of access.

In Brilha's assessment approach, scores of 0 to 4 are assigned to each one of the criteria grouped in Scientific Value, Potential Educational and Touristic Use, and Degradation Risk, as summarized in Table 3. The total score for each group is the weighted mean calculated for that set of criteria, as expressed in the equation 1, below

$$\overline{X}_w = \frac{\sum_{i=1}^{n}(xi \cdot wi)}{\sum_{i=1}^{n} wi} \qquad \text{Eq. 1}$$

In which ***x*** is the score obtained for each criteria and ***w*** is its corresponding weight. Or more explicitly (Eq. 2),

$$\overline{x}_w = \frac{w_1 x_1 + w_2 x_2 + w_3 x_3 \ldots}{w_1 + w_2 + w_3 \ldots} \qquad \text{Eq. 2}$$

So, in a scale of 1-10 the Ventura Village scores (2.95/4∗10=7,3) in Scientific Value. The main disadvantage here falls on a lack of scientific papers about the geosite published in international journals, which affects both its key locality and the geoscientific community awareness about it. Following the same procedure, the site's potential educational and touristic use were scored 7.5 and 6.0, respectively. The main flaws here come mostly from a total lack of state and local public investment in the area's potential to attract hosts of visitors all year long, a condition that tends to worse as a result of the CPRM closing its training center

operations in the area and the pandemics short and mid-term impact on the tourism industry, including restrictions on group fieldtrips.

As the risk of degradation represents a set of criteria directly affecting the geosite's management strategies, and to avoid the statistical normalization of the sets, we have put it on a scale from 0-1, in which the closer to 1 the highest the site's vulnerability and fragility. The risk of degradation scored 0.75, what is considered moderate, though it represents the threshold beyond which the threat becomes exceedingly high.

**Table 3.** Criteria used for quantitative evaluation of the Vila do Ventura geoheritage. SV – Scientific Value; PEU – Potential Educational Use; PTU – Potential Touristic Use; DR – Degradation Risk.

| Value | Criteria | Score | Weight used for | | | |
|---|---|---|---|---|---|---|
| | | | SV | PEU | PTU | DR |
| SCIENTIFIC | Representativeness | 4 | 30% | - | - | - |
| | Key locality | 1 | 20% | - | - | - |
| | Scientific knowledge | 1 | 5% | - | - | - |
| | Integrity | 2 | 15% | - | - | - |
| | Geological diversity | 4 | 5% | - | - | - |
| | Rarity/Uniqueness | 4 | 15% | - | - | - |
| | Use limitations | 4 | 10% | - | - | - |
| EDUCATIONAL USE | Vulnerability | 2 | - | 10% | 10% | - |
| | Accessibility | 2 | - | 10% | 10% | - |
| | Use limitations | 4 | - | 5% | 5% | - |
| | Safety | 2 | - | 10% | 10% | - |
| | Logistics | 3 | - | 5% | 5% | - |
| | Density of population | 1 | - | 5% | 5% | - |
| | Association w/ other values | 3 | - | 5% | 5% | - |
| | Scenery | 1 | - | 5% | - | - |
| | Uniqueness | 4 | - | 5% | - | - |
| | Observation conditions | 4 | - | 10% | - | - |
| | Didactic potential | 4 | - | 20% | - | - |
| | Geological diversity | 4 | - | 10% | - | - |
| TOURISTIC USE | Scenery | 1 | - | - | 15% | - |
| | Uniqueness | 4 | - | - | 10% | - |
| | Observation conditions | 4 | - | - | 5% | - |
| | Interpretative potential | 3 | - | - | 10% | - |
| | Economic level | 1 | - | - | 5% | - |
| | Proximity of recreational areas | 3 | - | - | 5% | - |
| DEGRADATION RISK | Deterioration of geological elements | 4 | - | - | - | 35% |
| | Proximity to areas/ activities with potential to cause degradation | 4 | - | - | - | 20% |
| | Legal protection | 2 | - | - | - | 20% |
| | Accessibility | 2 | - | - | - | 15% |
| | Density of population | 1 | - | - | - | 10% |

## Qualitative SWOT Analysis

Though no comprehensive review of geodiversity and geoconservation assessment methods (Brilha 2016; Brilha et al. 2018; Zwolinski 2018) refers to SWOT analysis, it has been increasingly used in geoheritage studies (Kubaliková 2017; Kubaliková et al. 2020; Carrión-

Mero 2018; Gayek et al. 2019; Cai et al. 2019; Datta 2020, to name just a few) as a complementary qualitative tool for developing action strategies. The main idea behind its use in geoconservation efforts is that it works almost symbiotically with most quantitative methods, as they usually provide a reliable basis for developing a strategic action plan. In other words, whereas quantitative methods like the ones employed for this article analyses the conditions of a given geoheritage or geodiversity element, the SWOT matrix tries to offer a kind of prospect for the strategic implementation of the enterprise.

**Table 4:** SWOT Analysis of the study area's internal (left) and external (shaded) features.

| | **Strengths** | | **Oportunities** |
|---|---|---|---|
| 1. | Reasonably high scientific value. | (a) | Boost to economic activity in the area. |
| 2. | High educational and touristic potential. | (b) | Expansion of tourism offer. |
| 3. | Low environmental degradation from mining activity. | (c) | New investment in service sector. |
| 4. | Promotion of the area's geoheritage is a long-standing desire of the local Community. | (d) | Promotion of research, development, innovation, and extension projects for universities. |
| 5. | High cultural value due to its direct association with the Late Industrial Revolution, the vestiges of prehistoric peoples living in the area, and the social and political history of the Highlands during that period. | (e) | Preservation of the area's geoheritage |
| 6. | The singularity of the geological framework. | (f) | Enhancement of identity and the sense of place and belonging in the local community |
| | **Weaknessess** | | **Threats** |
| 1. | Lack of joint initiatives with community, universities, private and public organizations to develop cultural, scientific and tourism plans | (a) | Lack of investment to preserve, restore and appreciate the area's geoheritage. |
| 2. | Very basic tourism infrastructure. | (b) | Impact of the new social and sanitary restrictions on travel and tourism after the 2019-2021 pandemics. |
| 3. | Closing, in 2018, of the Brazilian Geological Survey (CPRM) operations in the area. | (c) | Environmental and physical degradation of the area's assets due to increased presence of visitors. |
| 4. | Lack of exposure of the geosite's importance and attributes in local, national, and international scientific, institutional, and popular media. | (d) | Vulnerability of all the area's assets. |
| 5. | Lack of protection and geoconservation initiatives. | | |

Initially used as a synthesis of the **S**trengths and **W**eaknesses, **O**pportunities and **T**hreats involved in corporate and state strategic planning, a SWOT analyses is presented in a matrix with two vertical axis: one including the internal strengths and weaknesses of the activity

intended to be explored; and another with the external opportunities and threats that can impact the enterprise's success, as can be seen in Table 4.

**Discussion and Final Remarks**

Clearly, Marescotti and colleagues' method has shown that despite the high visual and hydrogeomorphological impact from over a century of mining activities in the area, the geosite experienced low soil and water contamination and fortunately no acid drainage threatening the environment. And despite the long decades in thorough abandonment, the village and its surroundings are still rich in valuable elements related to the history of diamond mining in the Highlands and its connections with the Late Industrial Revolution. In addition, diverse depositional systems and sedimentary paleo-environments registered in its rocks, stratigraphic relationships, and geoarchaeological and cave paintings are still preserved and can easily be seen in the area.

The geoheritage and geodiversity assessment method for its part has shown that the geosite's scientific value is reasonably high. A comparison with the scores found in other studies using the same evaluation criteria and procedures (Yaseen et al. 2019; Nguyen-Thuy et al. 2019; Vergara et al. 2019; Carrión-Mero et al. 2018) shows that geosites hardly ever get scores higher than 7, especially when dealing with the long-abandoned — if not long-forgotten — condition of many of them. Out of a total of 11 gold mining sites inventoried and assessed by Carrión-Mero et al. (2018) in the Zaruma-Portovelo district in Southern Ecuador, only one ranked 280 (equivalent to our 7) in Scientific Value. Most of the other sites had scores lower than six. Surprisingly, among the 40 geosites inventoried and evaluated for the Cajon del Maipo Geopark in Chile there is a copper mining village called El Volcán, that after centuries of copper exploitation was abandoned after an 8 $M_s$ earthquake hit the area in 1958 (Vergara et al. 2019). The scientific value for this geosite was 270, which is equivalent to our 6.75, a moderate score that helped include it in the proposed inventory of the aspiring UNESCO geopark. We conclude therefore that the Ventura Village and its surroundings compound an outstanding geosite worthy the efforts and initiatives to preserve its geoheritage for current and future generations.

To promote the Village's Geoheritage and consolidate the area's educational and touristic use potential (ranked 7.5 and 6.0 respectively) a series of strategic initiatives can be proposed, based both on the quantitative methods and the qualitative SWOT Analysis employed in this study:

1) Develop partnerships with local, State, and national public and private organizations like universities, businesses and mining and energy industries to implement protection and geoconservation projects both in the Ventura and its surroundings.
2) Design and build a website intended to promote the geosite's geoheritage and geodiversity.
3) Create in the village a diamond and carbonado mining museum and visitor center housing all possible information about the geosite.
4) Making available for visitors maps and other printed and digital geovisualization media with information on the geosite.
5) Strategically installing geointerpretive panels introducing visitors to the meaning and importance of each stop in the visitor's itinerary.
6) Involve the local Community in all planning and decision-making related to the development and promotion of the geosite.
7) Initiate talks with the Brazilian Geological Survey (CPRM) to reestablish the training center and activities in the area.
8) Plan and promote a yearly calendar of sports and other cultural events and activities integrated with geotourism, including St. John's Festivities, the Horse Trail and the Celebrations to Our Lady of Conception.
9) Promote in Morro do Chapéu and in the Ventura the startup and development of small businesses dedicated to attending the growing demand for geotouristic products and services.
10) Creation of a committee dedicated to the protection, promotion, and expansion of the area's geoheritage and its future integration into a geopark.

Though last in the order of assessment criteria, the risk of degradation of the Ventura Village is by no means less important for the effective management of the geosite. It should receive special attention and be among the priorities and urgent needs to be taken in consideration before promoting any educational or touristic activity in the proposed area. Special attention should be directed to the village's architecture, the Ventura riverbed, the cave paintings, the waterfall lakes, the stone walls lining off plot boundaries for diamond mining purposes, the rare fauna and flora, and the records on sedimentary rocks of paleo-environments in and around the Ferro-Doido Waterfalls, as there is otherwise a high probability of causing damage to an already fragile geoheritage.

A question that remains unresolved, especially after the closing of the local CPRM Training Center, is who should take the lead and try to build regional partnerships towards the implementation of a Geopark in Morro do Chapéu. There is no successful model in the scientific literature on how to get it started. In an increasing number of cases, however, higher education public institutions mobilize their students, professors and departments and take the initiative by proposing the project to local and regional authorities, community leaders and businesspeople, the media and other organizations. The Geosciences Institute of the Federal University of Bahia has the prestige and is very well positioned for this challenging but rewarding task.

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**Authors' contribution**

A Ashantis and DC Rios conceived the research project idea and decided on the most appropriate methods to be used in the study. A Ashantis conducted the literature review and the quantitative assessment, and elaborated the manuscript, with contributions from all the authors. AJD Rocha revised the whole work. All authors discussed the results and contributed to the final document.

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# CAPÍTULO 4
# CONCLUSÕES

Entre meados do século dezenove e a primeira metade do século 20, entrecruzaram-se na Chapada Diamantina a história geológica da Terra, a pré-história, e a história social, tecnológica e econômica da Segunda Revolução Industrial, protagonizadas pela mineração de diamantes e carbonados. Não obstante o declínio econômico e social após o ciclo dos diamantes e carbonados, parte significativa desse inusitado cruzamento está muito bem preservada nas formações geológicas siliciclásticas e carbonáticas do Grupo Chapada Diamantina Oriental, na arquitetura e no traçado urbano de Morro do Chapéu e das vilas e municípios em seu entorno, em documentos históricos e comerciais nacionais e estrangeiros. Se outrora a riqueza regional advinha da pecuária e das minas de diamantes, no século 21 se afiguram outras possibilidades de desenvolvimento territorial não menos pujantes. As "Jazidas de Ventos" estão em franca expansão no interior da Bahia, sendo a maior parte na Chapada Diamantina, com um fluxo de potência eólica que já produz cerca de 4 gigawatts de energia, com potencial para dobrar a capacidade até o fim desta década, graças à geomorfologia privilegiada da região.

Outro potencial — esse ainda não explorado — está na promoção da vocação da região para o geoturismo por meio da implementação de geoparques, seguindo o modelo da Rede Global de Geoparques da UNESCO. Um geoparque não se constitui apenas das formações geológicas de uma dada região, por mais excepcionais que elas sejam. Trata-se, na realidade, de um empreendimento de valorização do patrimônio geológico e da "memória da Terra" como motores de políticas territoriais de desenvolvimento sustentável. A Bahia reúne em Morro do Chapéu e região todas as condições favoráveis à implantação de um robusto projeto geoturístico, e a oportunidade ímpar de assumir o papel de protagonista de uma ideia inovadora de desenvolvimento sustentável, e de inestimável valor científico e educacional.

Por meio do artigo e da dissertação, esforço foi envidado no sentido de embasar e caracterizar o que aqui se denominou o Roteiro dos Diamantes. Futuros estudos poderão ser desenvolvidos para a caracterização de cada um dos roteiros aqui propostos, para o reconhecimento do carbonado como Recurso Mineral Patrimônio Global (*Global Heritage Stone Resource*), e a Chapada Diamantina como Província Mineral Patrimônio Global (*Global Heritage Stone Province*). É necessário também integrar o estudo da geodiversidade da área da proposta para o geoparque, com estudos da sua biodiversidade.

No contexto da pandemia da COVID-19, o papel do geoturismo em áreas distantes dos grandes centros é ainda mais relevante para a recuperação da economia dessas áreas, haja vista a previsão de que muitos turistas tenderão a buscar destinos com menor concentração de pessoas, e experiências e atividades ao ar-livre. A pandemia representa, portanto, a oportunidade de se repensar a proposta da CPRM para Morro do Chapéu e região, de modo a poder promover os objetivos da Agenda 2030 da ONU para o desenvolvimento sustentável.

# APÊNDICE A – JUSTIFICATIVA DA PARTICIPAÇÃO DOS CO-AUTORES

A Ashantis e DC Rios conceberam a ideia do projeto de pesquisa e verificaram os métodos a serem empregados no estudo. A Ashantis fez a revisão da literatura, a avaliação quantitativa e redigiu o manuscrito, com contribuições de todos os autores. AJD Rocha revisou todo o trabalho. Todos os autores discutiram os resultados e contribuíram para o manuscrito final.

# APÊNDICE B – PUBLICAÇÃO DOS RESULTADOS PARCIAIS EM EVENTOS

**Congresso UFBA 2019**

**Categoria:** Apresentação Oral

**Área:** Ciências Exatas e da Terra - Geociências

Ashantis A, Rios DC (2019) *Geoparque Morro do Chapéu: Potencial e Oportunidade para a criação na Chapada de um geoparque modelo, nos moldes do Conceito Unesco*. **Congresso UFBA Pesquisa Ensino e Extensão**, 29 a 31 de outubro de 2019, Salvador – Bahia, 1300-1301. https://proext.ufba.br/sites/proext.ufba.br/files/congresso-ufba-2019_caderno-resumos.pdf

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## Geoparque Morro do Chapéu: Potencial e Oportunidade para a criação na Chapada Diamantina de um geoparque modelo, nos moldes do Conceito Unesco

Localizada na zona oriental da Chapada Diamantina da Bahia, em altitudes que chegam a 1350 metros, Morro do Chapéu ostenta uma história e conformações geológicas que fazem da região uma das mais promissoras para a criação de um geoparque nos moldes do conceito da UNESCO Global Geoparks Network. As Escarpas da Formação Tombador, descritas desde o século dezenove por geólogos e naturalistas estrangeiros em viagem pelo Brasil e constituídas por rochas sedimentares que outrora formavam as dunas de um deserto proterozóico, sucessivas vezes invadido pelo mar; os estromatólitos e os carbonatos silicificados da Formação Caboclo; e os registros em suas rochas de processos e eventos geológicos que remontam ao pré-cambriano são apenas alguns exemplos que fazem de Morro do Chapéu uma área-escola com importância didática para o ensino das geociências. Acresce a isto, a singularidade de suas paisagens, a presença de pinturas rupestres e sítios arqueológicos, de vilas históricas e arquitetura ligadas à história dos garimpos de diamantes e de carbonados, além de suas ricas tradições culturais. Se bem-sucedido, o empreendimento pode servir de modelo para a implantação de outros projetos de desenvolvimento semelhantes no Brasil e em outros países do hemisfério sul. O conceito de geoparque não é de fácil apreensão, pois é muitas vezes confundido com o de unidades de conservação tais como as reservas naturais e os parques nacionais e estaduais. Enquanto as unidades de conservação são simplesmente demarcadas e

criadas por instrumentos político-legais, os geoparques são um empreendimento ao mesmo tempo público e privado de médio e longo prazo. Trata-se de uma estratégia de desenvolvimento territorial multidisciplinar que tem como um de seus principais desafios estabelecer um diálogo produtivo entre diversos atores como as comunidades locais, os empresários, instituições governamentais, científicas e educacionais, e os políticos regionais e estaduais. Os Geoparques são definidos como regiões singulares em que sítios e paisagens de importância geológica são geridos a partir de um conceito integrado de proteção, educação, turismo e desenvolvimento sustentável. Entre os bens e serviços científicos e educacionais encontram-se a reconstituição de períodos e eras geológicas e dos processos de formação da geodiversidade do planeta, os registros de eventos de extinção, a reconstituição de paleoambientes e a formação dos relevos. Servem de locais para a visitação e para a realização de viagens de campo com objetivos educacionais e treinamento profissional. Oferecem ainda serviços terapêuticos e de saúde e bem-estar, esportes e lazer, a vista espetacular, a visitação a coleções de fósseis, a minas históricas, a sítios arqueológicos, a museus temáticos, a sítios sagrados e de importância espiritual, a participação em manifestações culturais, a inspiração artística e o senso de lugar. Trata-se de uma oportunidade ímpar de a Bahia assumir o papel de protagonista de uma ideia inovadora de desenvolvimento sustentável, e de inestimável valor científico e educacional.

**Palavras-chaves**: Geoparques, Morro do Chapéu, Chapada Diamantina

# ANEXO A – REGRAS DE FORMATAÇÃO DA REVISTA GEOHERITAGE

**Submission guidelines**

https://www.springer.com/journal/12371/submission-guidelines

**Instructions for Authors**

**Manuscript Submission**

Submission of a manuscript implies: that the work described has not been published before; that it is not under consideration for publication anywhere else; that its publication has been approved by all co-authors, if any, as well as by the responsible authorities – tacitly or explicitly – at the institute where the work has been carried out. The publisher will not be held legally responsible should there be any claims for compensation.

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Please follow the hyperlink "Submit manuscript" on the right and upload all of your manuscript files following the instructions given on the screen.

Please ensure you provide all relevant editable source files. Failing to submit these source files might cause unnecessary delays in the review and production process.

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Please make sure your title page contains the following information.

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The title should be concise and informative.

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The name(s) of the author(s)

The affiliation(s) of the author(s), i.e. institution, (department), city,(state), country

A clear indication and an active e-mail address of the corresponding author

If available, the 16-digit ORCID of the author(s)

If address information is provided with the affiliation(s) it will also be published.

For authors that are (temporarily) unaffiliated we will only capture their city and country of residence, not their e-mail address unless specifically requested.

**Abstract**

Please provide an abstract of 150 to 250 words. The abstract should not contain any undefined abbreviations or unspecified references.

For life science journals only (when applicable)

Trial registration number and date of registration

Trial registration number, date of registration followed by “retrospectively registered”

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Please provide 4 to 6 keywords which can be used for indexing purposes.

**Declarations**

All manuscripts must contain the following sections under the heading 'Declarations'.

If any of the sections are not relevant to your manuscript, please include the heading and write 'Not applicable' for that section.

To be used for all articles, including articles with biological applications

**Funding** (information that explains whether and by whom the research was supported)

**Conflicts of interest/Competing interests** (include appropriate disclosures)

**Availability of data and material** (data transparency)

**Code availability** (software application or custom code)

**Authors' contributions** (optional: please review the submission guidelines from the journal whether statements are mandatory)

Additional declarations for articles in life science journals that report the results of studies involving humans and/or animals

**Ethics approval** (include appropriate approvals or waivers)

**Consent to participate** (include appropriate statements)

**Consent for publication** (include appropriate statements)

Please see the relevant sections in the submission guidelines for further information as well as various examples of wording. Please revise/customize the sample statements according to your own needs.

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Use a normal, plain font (e.g., 10-point Times Roman) for text.

Use italics for emphasis.

Use the automatic page numbering function to number the pages.

Do not use field functions.

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Save your file in docx format (Word 2007 or higher) or doc format(older Word versions).

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LaTeX macro package (Download zip, 190 kB) .....
.....

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Please use no more than three levels of displayed headings.

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Footnotes can be used to give additional information, which may include the citation of a reference included in the reference list. They should not consist solely of a reference citation, and they should never include the bibliographic details of a reference. They should also not contain any figures or tables.

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Always use footnotes instead of endnotes.

**Acknowledgments**

Acknowledgments of people, grants, funds, etc. should be placed in a separate section on the title page. The names of funding organizations should be written in full.

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Please always use internationally accepted signs and symbols for units (SI units).

Please use the standard mathematical notation for formulae, symbols etc.:

Italic for single letters that denote mathematical constants, variables, and unknown quantities

Roman/upright for numerals, operators, and punctuation, and commonly defined functions or abbreviations, e.g., cos, det, e or exp, lim, log, max, min, sin, tan, d(for derivative)

Bold for vectors, tensors, and matrices.

**References**

**Citation**

Cite references in the text by name and year in parentheses. Some examples:

> Negotiation research spans many disciplines (Thompson 1990).
>
> This result was later contradicted by Becker and Seligman (1996).
>
> This effect has been widely studied (Abbott 1991; Barakat et al. 1995a,b; Kelso and Smith 1998; Medvec et al. 1999, 2000).

**Reference list**

The list of references should only include works that are cited in the text and that have been published or accepted for publication. Personal communications and unpublished works should only be mentioned in the text.

Reference list entries should be alphabetized by the last names of the first author of each work. Please alphabetize according to the following rules: 1) For one author, by name of author, then

chronologically; 2) For two authors, by name of author, then name of coauthor, then chronologically; 3) For more than two authors, by name of first author, then chronologically.

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Gamelin FX, Baquet G, Berthoin S, Thevenet D, Nourry C, Nottin S, Bosquet L (2009) Effect of high intensity intermittent training on heartrate variability in prepubescent children. Eur J Appl Physiol 105:731-738. https://doi.org/10.1007/s00421-008-0955-8

Ideally, the names of all authors should be provided, but the usage of“et al” in long author lists will also be accepted:

Smith J, Jones M Jr, Houghton L et al (1999) Future of health insurance. N Engl J Med 965:325–329

**Article by DOI**

Slifka MK, Whitton JL (2000) Clinical implications of dysregulated cytokine production. J Mol Med.https://doi.org/10.1007/s001090000086

**Book**

South J, Blass B (2001) The future of modern genomics. Blackwell, London

**Book chapter**

Brown B, Aaron M (2001) The politics of nature. In: Smith J (ed) The rise of modern genomics, 3rd edn. Wiley, New York, pp 230-257

**Online document**

Cartwright J (2007) Big stars have weather too. IOP PublishingPhysicsWeb. http://physicsweb.org/articles/news/11/6/16/1. Accessed26 June 2007

**Dissertation**

Trent JW (1975) Experimental acute renal failure. Dissertation, University of California

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**Tables**

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Tables should always be cited in text in consecutive numerical order.

For each table, please supply a table caption (title) explaining the components of the table.

Identify any previously published material by giving the original source in the form of a reference at the end of the table caption.

Footnotes to tables should be indicated by superscript lower-case letters (or asterisks for significance values and other statistical data)and included beneath the table body.

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**Electronic Figure Submission**

Supply all figures electronically.

Indicate what graphics program was used to create the artwork.

For vector graphics, the preferred format is EPS; for halftones, please use TIFF format. MSOffice files are also acceptable.

Vector graphics containing fonts must have the fonts embedded in the files.

Name your figure files with "Fig" and the figure number, e.g.,Fig1.eps.

**Line Art**

Definition: Black and white graphic with no shading.

Do not use faint lines and/or lettering and check that all lines and lettering within the figures are legible at final size.

All lines should be at least 0.1 mm (0.3 pt) wide.

Scanned line drawings and line drawings in bitmap format should have a minimum resolution of 1200 dpi.

Vector graphics containing fonts must have the fonts embedded in the files.

**Halftone Art**

Definition: Photographs, drawings, or paintings with fine shading, etc.

If any magnification is used in the photographs, indicate this by using scale bars within the figures themselves.

Halftones should have a minimum resolution of 300 dpi.

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Definition: a combination of halftone and line art, e.g., half tones containing line drawing, extensive lettering, color diagrams, etc.

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Color art is free of charge for online publication.

If black and white will be shown in the print version, make sure that the main information will still be visible. Many colors are not distinguishable from one another when converted to black and white. A simple way to check this is to make a xerographic copy to see if the necessary distinctions between the different colors are still apparent.

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To add lettering, it is best to use Helvetica or Arial (sans serif fonts).

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All figures are to be numbered using Arabic numerals.

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Refer to the supplementary files as “Online Resource”, e.g., "... as shown in the animation (Online Resource 3)", “... additional data are given in Online Resource 4”.

Name the files consecutively, e.g. “ESM_3.mpg”, “ESM_4.pdf”.

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**Author Approve Changes or submits updated ms by author - [EMID:64192e0f5e249288]**
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Tue 6/22/2021 11:09 AM
To:

- Aciel Ashantis <acielj@ufba.br>

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Re: Recovering the Ventura Village and the History of Carbonado-Diamond Mining in the Chapada Highlands of Bahia, Brazil, in the Late Industrial Revolution

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