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PROCEEDINGS VOLUME IV

Session 09 : Exploration, Speleological Techniques, and Materials
09:1 : Cave Diving
09:2 : Exploration
09:3 : Topography, Mapping, 3D Scanning, and Documentation
Session 10 : Cave Rescue: Karst Geomorphology

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Contributions to national speleological databases: caves of the middle Rio das Velhas watershed

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Abstract

The two primary Brazilian speleological databases (CNC and CANIE) are vital for the preservation and scientific understanding of Brazil's caves and their speleological heritage. To enhance and improve georeferenced cave data, as well as to produce maps and scientific content demonstrating the importance of these records, the Brazilian Speleological Society (SBE) launched the "Ampliando Rotas" call for proposals. This initiative aimed to encourage speleological groups across Brazil to explore, identify and map caves. In Minas Gerais, within the middle Rio das Velhas watershed, the Opilião - Speleological Study Group (OGrEE) identified and mapped ten caves, six of which were previously unregistered, totaling 2,871 meters of new passages in caves newly discovered or previously registered with inaccuracies. New caves in the Brazilian speleological databases are recorded and inaccurate information in their records is supplemented or corrected. The surveyed caves exhibited significant geological, biological, and cultural characteristics, including speleothems, endemic wildlife, and archaeological remains. Some caves displayed evidence of historical religious practices, while others contained active hydrological systems. The project underscored the importance of cave conservation and highlighted the potential of these sites for scientific research, education, and sustainable tourism.

Resumo

Os dois bancos de dados espeleológicos no Brasil (CNC e CANIE) são a chave para a preservação e conhecimento científico das cavidades nacionais e de seu patrimônio espeleológico. Visando o incremento e correção de dados georreferenciados das grutas, assim como produção de mapas e conteúdo científico que comprovem a relevância dos cadastros, o "Edital Ampliando Rotas" da Sociedade Brasileira de Espeleologia (SBE) teve como objetivo a exploração, identificação e mapeamento de cavernas em solo nacional por grupos de espeleologia brasileiros. Em Minas Gerais, na bacia do médio Rio das Velhas, o Opilião - Grupo de Estudos Espeleológicos (OGrEE) identificou e mapeou com sucesso dez cavernas, seis das quais eram desconhecidas anteriormente, totalizando 2.871 m de novos condutos de cavernas inéditas ou já cadastradas com imprecisões. Também efetuou registros, nos bancos de dados espeleológicos brasileiros, de novas cavernas e acrescentou ou corrigiu informações imprecisas nos seus registros. As cavernas exploradas exibiram características geológicas, biológicas e culturais significativas, incluindo espeleotemas, vida selvagem e vestígios arqueológicos. Algumas delas mostraram sinais de práticas religiosas passadas, enquanto outras apresentaram sistemas hidrológicos ativos. O projeto destacou a importância da conservação de cavernas e também enfatizou o potencial dessas cavernas para pesquisa científica, educação e turismo sustentável.

1. Introduction

The conservation of speleological heritage is essential for the advancement of scientific knowledge and the preservation of subterranean ecosystems and karst landscapes. Caves and karst systems are unique resources protected by the Brazilian Constitution (BRASIL, 1988). They harbor endemic biodiversity (ZAMPAULO; PROUS, 2022), paleoclimatic, historical, archaeological and cultural records (FERNANDES; FARIA, 2024), in addition to playing a critical role in aquifer recharge and hydrological regulation, due to the contact with groundwater (AUDRA; PALMER, 2015). However, the conservation of these systems faces significant challenges (FIGUEIREDO; RASTEIRO, 2010), underscoring the need for initiatives to promote their protection.

In this context, the *Sociedade Brasileira de Espeleologia* (SBE) launched the SBE 01/2023 call for proposals, titled "Ampliando Rotas" (SBE, 2023), which aims to foster speleological research and conservation. The

initiative encourages speleological groups to develop projects focused on mapping, identifying and protecting caves in areas with high speleological potential. Opilião - Speleological Study Group (OGrEE) submitted a proposal to this call, which was approved, and in 2024, implemented the actions outlined in the project.

This project aimed to identify, map and register caves in the karst region of the middle Rio das Velhas watershed, located in the central region of the state of Minas Gerais, Brazil, which covers key municipalities to expand knowledge and to promote the conservation of the local speleological heritage. Additionally, it sought to address inconsistencies in existing speleological databases and enhance the training of OGrEE members to conduct fieldwork in the speleology domain. This entire area is of great importance in terms of traces of the first American populations and the recent scientific history of Minas Gerais, as it was the

birthplace of Brazilian paleontology and archaeology, with the Danish naturalist Peter W. Lund (1801–1880) being one of the first scientists to reveal to the world the natural heritage stored in the caves of the region (FERNANDES; FARIA, 2024).

This article aims to present the results achieved during the project,

2. Material and Methods

To identify the speleological potential of the area under study, we collected information about caves previously recorded in Brazilian speleological databases (*Cadastro Nacional de Cavernas* - CNC managed by SBE and *Cadastro Nacional de Informações Espeleológicas* - CANIE managed by *Centro Nacional de Pesquisa e Conservação de Cavernas* - ICMBIO/CECAV of the Brazilian government), analyzed satellite imagery (Google Earth Pro and mobile applications such as Google Maps and AlpineQuest), and reviewed topographic and thematic maps, particularly from IBGE databases (IBGE, 2024), supplemented by the Avenza smartphone app.

During the fieldwork phase, we employed traditional speleological prospection and topographic survey methodologies (Figures 1 and 2).



Figure 1: Speleological prospection in Curvelo (Minas Gerais, Brazil) surveys. Source: from the authors, 2024.

In the study area, in addition to the electronic tools mentioned above, inquiries were made to residents to trace caves in the region. Speleological walks were conducted in areas with potential for the existence of caves. Once a cave was located, it was assigned a provisional code or name. When a newly discovered natural cavity was confirmed, an inventory was created following the CNC - SBE and CANIE - ICMBIO/CECAV registration protocols, using geographic coordinates of the cave entrance for verification.



Figure 2: Topographic surveys in Água Santa II cave. Source: from the authors, 2024.

including the identification of new caves, corrections to existing records, and contributions to the national speleological databases. Furthermore, it discusses the relevance of the actions undertaken in strengthening speleological conservation in Brazil.

The cave with the greatest speleological significance in a given region was then surveyed using rangefinders, clinometers and compasses. During this stage, we chose to use a paperless surveying technique facilitated by the TopoDroid application. Subsequently, the electronic sketches were digitized using software compatible with technical drawings.

The maps created complied with the same surveying standard defined by the BCRA and were classified in category 4C.

Finally, in the office phase, the newly discovered caves were registered in the CNC - SBE and CANIE - ICMBIO/CECAV databases, becoming part of the listed speleological records.

2.1. Study Area

The study area is located in the karst region of the Bambuí Geological Group (Figure 3) in the state of Minas Gerais, Brazil, covering the municipalities of Curvelo, Cordisburgo, Corinto, Monjolos, Presidente Juscelino, Santo Hipólito, Baldim, Jequitibá, Santana do Pirapama, and Jaboticatubas.

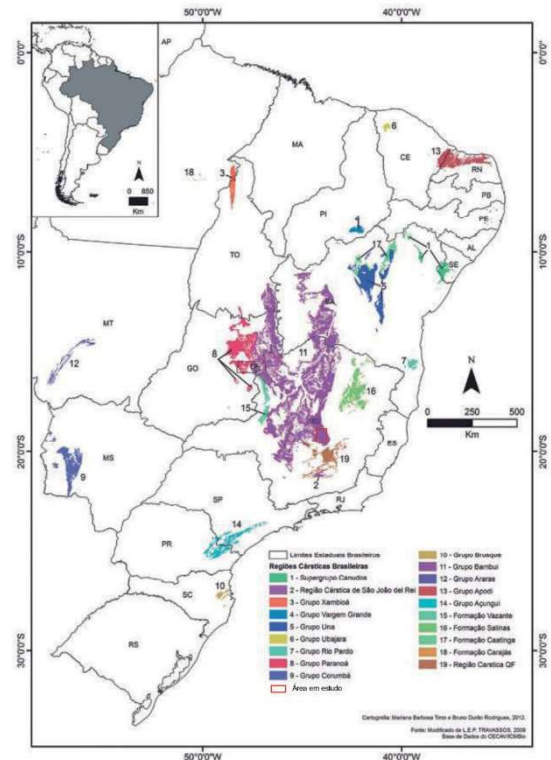


Figure 3: Brazilian Karst Regions. Source: TRAVASSOS, L. E. P., 2019.

According to Travassos (2010), the karst landscape encompassing Cordisburgo City and its surroundings is shaped by perennial and intermittent rivers, which are responsible for features such as lapieés, sinkholes, and valleys. Lima, Silva and Cassimiro (2024) point out that the region features outcrops of rocks belonging to the lower sequence of sedimentary rocks of the Bambuí Group, characterized from the base

to the top as follows:

- i. **Sete Lagoas Formation**, located north of Belo Horizonte, composed of pelitic rocks with the Lagoa Santa facies, consisting of limestones and dolomites of diverse compositions;
- i. **Serra de Santa Helena Formation**, composed of shales, silstones, marls and sparse lenses of black limestone;
- i. **Lagoa do Jacaré Formation**, with sequences of siltstones, marls, black limestones, fetid limestones and oolitic and pisolitic limestones;

- i. **Serra da Saudade Formation**, consisting of siltstones, green pelitic rocks, shales and claystones with sparse lenticular intercalations of limestone.

The area is part of the middle Rio das Velhas watershed, a tributary of the upper stretch São Francisco River, bordered to the right by the mountainous region of the Espinhaço Range. The vegetation covering the landscape consists predominantly of the phytophysionomies of the Cerrado biome (Brazilian Savanna).

3. Results

Between January and September 2024, regions in the municipalities of Curvelo, Cordisburgo, Corinto, Monjolos, Presidente Juscelino, Santo Hipólito, Baldim, Jequitibá, Santana do Pirapama and Jaboticatubas (all in the state of Minas Gerais, Brazil) were visited and prospected (Figure 4).

These municipalities have a significant number of caves, most of which have already been registered in Brazilian databases; however, inconsistencies are observed when they are compared (Figure 5).

During the fieldwork phase, ten caves were identified and mapped (*Gruta da Água Santa, Toca do Geraldo, Lapa Velha Nova, Lapa da Lagoa do Rótulo, Gruta da Fazenda da Lapa, Gruta da Água Santa II, Gruta no Teto I, Peixe no Teto II, Peixe no Teto III and Gruta da Estiva I*). Of these, the last six caves were not listed in the databases of the referenced institutions and four caves had their records corrected based on contributions by the OGrEE. In total, 2,871 meters of new cave passages were surveyed in less than one year.

Municipalities	CNC - SBE	CANIE - CECAV
Baldim	12	8
Cordisburgo	47	76
Corinto	9	15
Curvelo	25	38
Jaboticatubas	4	31
Jequitibá	9	21
Monjolos	30	77
P. Juscelino	4	29
S. Hipólito	9	11
S. Pirapama	12	23
Total	161	329

Figure 5: Number of caves in databases in Brazil.

¹ Updated in: Dec/2024.

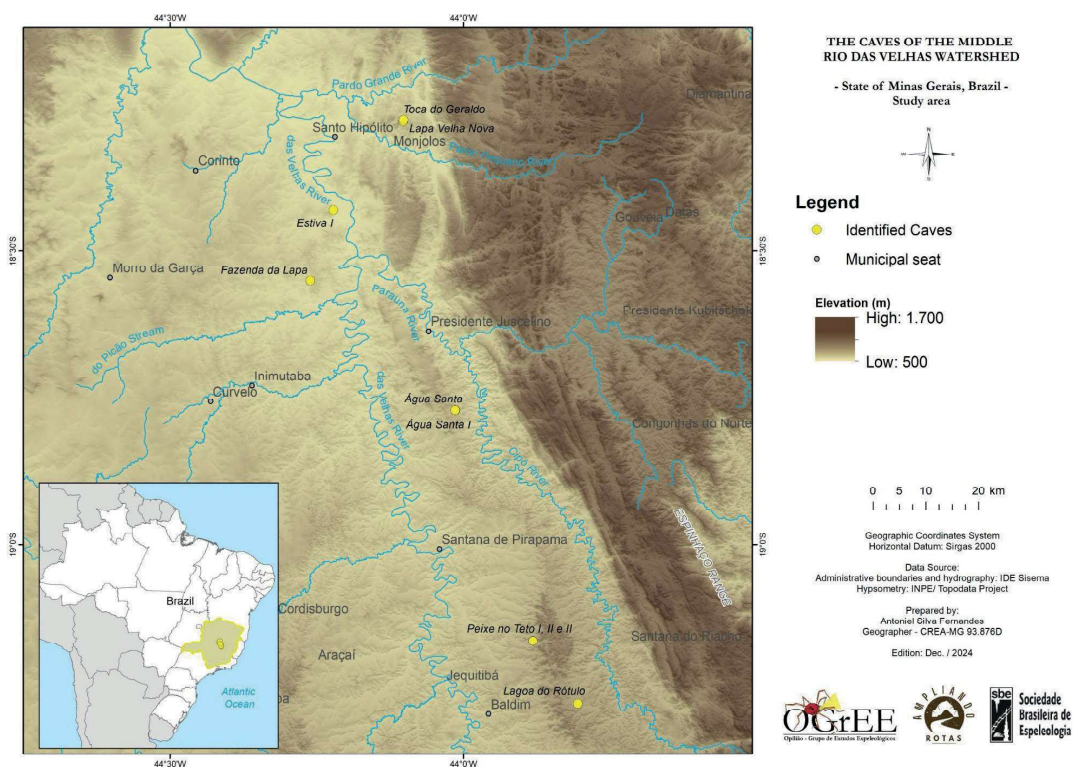


Figure 4: Identified Caves. Source: from the authors, 2024.

As an example of corrections to data inconsistencies, we note two caves located in Monjolos (red asterisks in Figure 6). The image also highlights the inconsistency between the two speleological databases (CNC and CANIE), showing duplicate records, coordinates with errors greater than 200 meters, incomplete names or even the absence of cavities of high speleological relevance. The region is part of the property known as “Fazenda Velha,” and different speleological teams/groups that visited it at various times registered names and coordinates in different ways. Only after consulting references from works conducted in this region (GUIMARÃES, 2012), it was possible to conclude that the cave to the north (upper red asterisk) is the one commonly referred to as “Gruta Velha Nova,” which was studied by *Sociedade Excursionista e Espeleológica - SEE* (the first speleological group in Brazil) on two occasions, and whose maps are part of its collection.

The point corresponding to this cave in the CANIE database is located 380 meters northwest of the original cave entrance, at the bottom of a sinkhole. In the CNC database, however, the name “Velha Nova” is not listed as a record for any cave in the municipality of Monjolos. The

inconsistencies were identified and outlined in a report submitted to the SBE, in which we suggested the correction of the database.



Figure 6: case of inconsistency, red asterisks caves discovered for this work, the river dashed in yellow has its sinkhole in the cave to the south, in the north, the direction, indicated by blue arrows, of the delineation of four well-defined sinkholes on the horizon.

4. Discussion

During the topographic surveys, cultural elements were identified in the form of traces of religious activity inside some caves. For example, remains of animals possibly associated with African-origin religious ceremonies were verified in the *Fazenda da Lapa* cave, in Curvelo (Figure 7), in addition to the local report of catholic pilgrimages in the cave. A very rich biological heritage was also found in some cavities, observing small and medium-sized animals such as wild canines and felines and bats, in addition to species with a troglomorphic appearance. The marked presence of hydrological activity also highlighted the importance of karst systems for the preservation of water resources and for local and regional water security (Figure 8). In the *Água Santa* cave (Presidente Juscelino), for example, there was a small stream of crystal-clear water that cut through its wider hall in a west-east direction. Important archaeological remains were also found, such as in the *Peixe no Teto* cave system (Jequitibá), with well-preserved geometric, zoomorphic and anthropomorphic cave paintings (Figure 9).



Figure 7: remains of animals possibly associated with African-origin religious ceremonies in the *Fazenda da Lapa* cave. Source: from the authors, 2024.

Cave survey update also proved quite important for improving map quality, as it provided better detailing of some areas and the identification of others not represented in previous surveys that, in some cases, date back to 50 years ago. However, in general, the comparison of the maps showed a good agreement in terms of morphology and occurrence of elements inside the caves, such as speleothems and flora records, which suggests good accuracy in the mapping work, in addition to a reasonable good state of preservation of the caves along the years. However, it is worth noting that some of them contained residues inside, either left by visitors or brought from the external environment. In the most striking case, bottles of agricultural pesticides were observed close to a water stream in a cave.

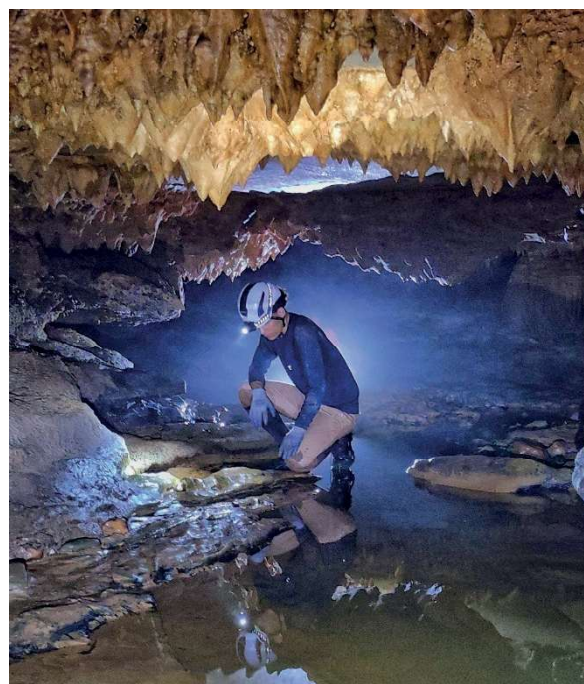


Figure 8: Hydrological activity inside the *Toca do Geraldo* cave. Source: from the authors, 2024.



Figure 9: new discoveries of geometric, zoomorphic and anthropomorphic cave paintings. Source: from the authors, 2024.

5. Conclusion

The project carried out by the Opilião Speleological Study Group (OGrEE) successfully contributed to the enhancement of speleological research and conservation in the karst region of the middle Rio das Velhas watershed. By identifying and mapping ten caves, six of which previously unregistered, and correcting inaccuracies in existing databases, the project addressed critical gaps in the documentation of speleological heritage.

The discoveries during this project underscore the diverse significance of the caves in this region, encompassing geological, hydrological, biological, cultural, and archaeological elements. These findings not only highlight the urgent need for conservation efforts but also emphasize the potential of these caves for advancing scientific research, education, and sustainable tourism.

Furthermore, the project demonstrated the importance of consistent and accurate documentation in national speleological databases,

In general, geolocation inconsistencies are due to data acquisition with no GPS equipment during older surveys. The discrepancy between the number of caves registered in the CNC - SBE and CANIE - ICMBIO/CECAV databases, in turn, is due to the unofficial nature of the first platform. Finally, the activities conducted through this project allowed group members to acquire expertise in speleological activities, thus providing a major contribution to the training of a new generation of cave scientists.

providing valuable contributions for their improvement.

This initiative exemplifies how targeted conservation actions — supported by collaborative efforts and robust methodological approaches — can strengthen the preservation of speleological heritage while fostering public awareness and scientific understanding.

As a secondary objective, the project was also important for the training and consolidation of speleologists who are members of OGrEE and participated in the execution of this project.

Finally, it is worth highlighting the importance of initiatives such as this one by institutions dedicated to the protection of speleological heritage. It is expected that new initiatives will be promoted in the near future, ensuring that the country's rich speleological heritage is safeguarded for future generations.

Acknowledgments

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