# Geological and sociological factors influencing the construction and occupation of historic stone mining shelters, Bahia State, Brazil, 1844 – present

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**Abstract**

The geological and sociological factors that influenced the construction and habitation of the “toca” rockshelters built and occupied by diamond miners starting in 1844 are discussed. Extensive field excursions were made into the Chapada Diamantina Mountains, in what is now the Chapada Diamantina National Park, over a period of more than 40 years to document the archaeological vestiges of the diamond rush there. A total of 650 archaeological features were identified, geo-referenced, photo-documented, and classified; 286 of those features were “toca” rockshelters and 53 were stone houses. The local geology, water resources, regional climate, and human factors dictated the construction and occupation of those shelters, including the availability of appropriate overhanging rock ledges, the proximity of potable water, site humidity, and the proximity of diamond-bearing formations. The “toca” shelters themselves share a number of common features, including fire pits, a lack of windows, construction without the use of mortar, and the avoidance of East-facing sites.

**Keywords:** Chapada Diamantina, Tocas, Diamond Mining, Rockshelters.

**Resumo**

São discutidos os fatores geológicos e sociológicos que influenciaram a construção e habitação dos abrigos de toca construídos e ocupados por garimpeiros a partir de 1844. Extensas excursões de campo foram feitas na Serra da Chapada Diamantina, no atual Parque Nacional da Chapada Diamantina, por um período de mais de 40 anos para documentar os vestígios arqueológicos da corrida do diamante ali. Um total de 650 feições arqueológicas foram identificadas, georreferenciadas, fotodocumentadas e classificadas; 286 dessas feições eram abrigos de toca e 53 eram casas de pedra. A geologia local, os recursos hídricos, o clima regional e os fatores humanos ditaram a construção e ocupação desses abrigos, incluindo a disponibilidade de bordas rochosas salientes adequadas, a proximidade de água potável, a umidade do local e a proximidade de formações diamantíferas. Os próprios abrigos de toca compartilham uma série de características comuns, incluindo fogueiras, falta de janelas, construção sem uso de argamassa e evitar locais voltados para o leste.

**Palavras-chave:** Chapada Diamantina, Tocas, Mineração de Diamantes, Abrigos de Pedra.

**Resumen**

Se discuten los factores geológicos y sociológicos que influyeron en la construcción y habitación de los abrigos rocosos de “toca” construidos y ocupados por los mineros de diamantes a partir de 1844. Se realizaron extensas excursiones de campo a las montañas Chapada Diamantina, en lo que ahora es el Parque Nacional Chapada Diamantina, durante un período de más de 40 años para documentar los vestigios arqueológicos de la fiebre del diamante allí. Se identificaron, georreferenciaron, fotodocumentaron y clasificaron un total de 650 elementos arqueológicos; 286 de esos elementos eran abrigos rocosos de “toca” y 53 eran casas de piedra. La geología local, los recursos hídricos, el clima regional y los factores humanos dictaron la construcción y ocupación de esos refugios, incluida la disponibilidad de salientes rocosos colgantes apropiados, la proximidad de agua potable, la humedad del sitio y la proximidad de formaciones diamantíferas. Los refugios de "toca" comparten una serie de características comunes, que incluyen fogatas, falta de ventanas, construcción sin el uso de mortero y la evitación

de sitios orientados al este.

**Palabras clave:** Chapada Diamantina, Tocas, Minería de Diamantes, Abrigos rochosos.

## 1. Introduction

Shelter, together with food, water, clothing, tools and weapons, is one of the basic necessities of all humans. The very word "shelter" implies protection from the elements (climatic extremes), from other life forms (animals, insects) and, too often, from other humans. We have evolved together with our structures, from treetops to open bivouacs to caves, and from igloos and thatch-covered huts to modern buildings that create and maintain their own ecosystems. While modern buildings are often constructed using materials brought from every corner of the world (e.g., the stones of many churches in the New World came as ready-to-assemble ballast in ocean going ships) as well as materials that never existed in nature, such as carbon fibers, artificial resins, and fabrics, humans have historically used materials at hand to build shelters of natural materials such as stone, mud, ice, mastodon bones, trees and animal skins.

Mining is at least as old as the search for cryptocrystalline materials such as chert used to make stone tools, and has extended to the harvest of useful metals and minerals such as copper, tin, lead, iron, rare-earths and, of course, precious minerals such as silver, gold, and diamonds – and miners who tunnel into the earth have always required some sort of shelter.

There is a considerable volume of literature describing mining operations on many continents dating from thousands of years in the past to modern times (e.g., Bromehead, 1940; Gregory, 2001), however, much less is known about how the miners sheltered themselves.

Depending on their surroundings, miners could live in caves or similar natural shelters (or perhaps in the mines themselves). Lacking appropriate natural features, however, they would have needed to construct suitable protective structures.

The ephemeral nature of shelters made from organic materials (wood, thatch, skins) leave few remains over time. For example, hard midden remains (shell, bone) and artifacts left at late precolonial campsites at Western Cape Province, South Africa, mark 500 to 1000 years old and long-disappeared windbreak campsites (Parkington et al., 2009). Mining sites, on the other hand, tend to be occupied for long periods of time, sometimes hundreds of years. While human shelters were likely first erected around mines using organic materials, stone shelters are often found associated with those sites (Chiavazza and Olavarría, 2012; Hardesty, 2010) as they employ durable, easily available materials. More modern, but abandoned, mining sites are marked by wooden shelters (Saleeby, 2000) or just their foundations (Hardesty, 2010).

Diamonds, long associated with adornment and power, were only known from India until their discovery, hundreds of years later, in Brazil in the early 1700s (Pearson, 1909). Alluvial diamonds were discovered in the Serra do Sincorá Range within the Chapada Diamantina Mountains, Brazil, in 1844, initiating a "diamond rush" and the subsequent occupation of an area previously sparsely, if at all, inhabited.

Tens of thousands of miners rushed to the area in the first two decades after the discovery of precious stones, including experienced miners from southern Brazil, regional subsistence farmers and cattlemen, and slave owners from the eastern seaboard and Minas Gerais State (Svisero, 2017).

While towns and villages grew and prospered, thousands of miners, and often their families, lived scattered throughout the mountains close to their diggings, as the diamond bearing rivers and mountain slopes covered approximately 416 km2 (largely within what is now the Chapada Diamantina National Park) (Figure 1).

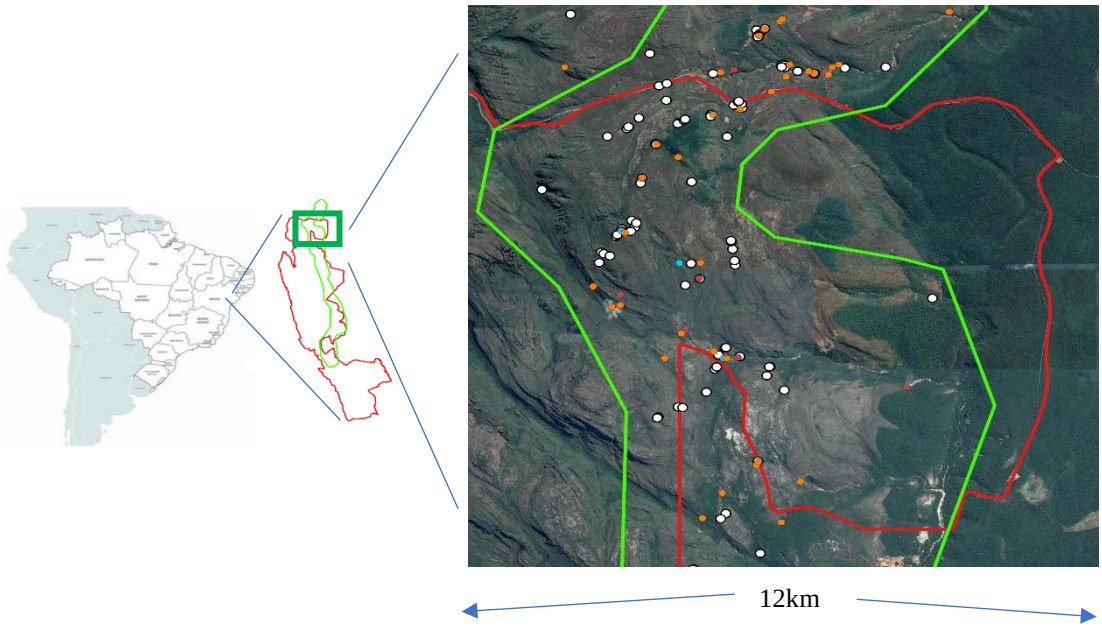


**Figure 1.** Map showing the location of the Chapada Diamantina National Park in Bahia State, Brazil (red outline) and the diamond-mining zone (green outline). White dots indicate constructed rock shelters ("*tocas*"); orange dots indicate simple hunting or resting shelters; red dots indicate stone houses.

It is reasonable to assume that the early miners followed the principal rivers where the diamonds were first discovered and were most abundant. As more miners arrived, their searches led them upstream along numerous smaller tributaries, then to the cracks and crevices in the uplands slopes and lands covered by dense forests growing on deep soils – requiring the removal of huge deposits of soil, sand, and rocks through placer mining.

The occupation of the wide extent of the diamond-bearing mountain slopes, and the necessity of living in those hills, brought the need for shelter from the frequent rains, hot sun, and the insects/animals that co-inhabited the region.

Again, it is probable that the miners first improvised shelters using tarps, animal skins, or thatched roofs, and other locally available materials. However, the geology of the area presented a unique and convenient solution to the problem of shelter: the hard layers of sandstone of the Sincorá Range frequently jutted out various meters from the rock walls to form natural "shelves" (freestanding ledges) that could be faced off beneath with stones (without mortar) and thus provide excellent rockshelters – called "*tocas*". Those rockshelters were generally small, but could often house various miners or even small families (Figure 2 a-h).


**Figure 2.** Typical rockshelters ("*tocas*")

Diamond mining in the region provided abundant riches for many years, although, like every other mining cycle, the inevitable exhaustion of the mines was evident in the late 1860's to 70's (and was accelerated by the discovery of rich diamond fields in South Africa, which caused global prices to fall by 1870 and mining populations to migrate) (Machado & Figueirôa, 2001).

Those that could, moved on during subsequent years, but large numbers stayed, including many enslaved peoples that were freed after the abolition of slavery in Brazil in 1888. Thus, the search for diamonds continued until the present, although with ever-diminishing returns.

Miners are now very few, but their *tocas* (among many other permanent mining features) remain. Those stone legacies can be used, together with oral records, to interpret the miners' way of life.

Many decades spent exploring and studying the archaeological remains of manual diamond mining efforts in the Sincorá Range (now largely included within the Chapada Diamantina National Park) allowed the development of a working hypothesis that the construction of rockshelters in the mountains was determined by inherent geological and meteorological factors and refined by human necessities and sociological influences – generating identifiable and consistent patterns of shelter construction and occupation.

## 2. Materials and Methods

A database of mining features was constructed based on extensive excursions into the Serra do Sincorá Range, concentrating principally on the area contained within the Chapada Diamantina National Park, Bahia State, Brazil (12.45°- 13.32°S x 41.13°-41.55°W; Fig 1)

Initial excursions into the mountains were made in the company of artisanal diamond miners in the late 1970s, and included visits to their mining sites and staying with them in their *toca* rockshelters. With experience gained from the miners themselves (as well as the use of historical references, information from local residents, satellite images, and a growing knowledge of geographical features and constraints on site locations), innumerable additional excursions were made into the mountains to document the archaeological features left after almost 2 centuries of manual diamond mining.

Features constructed during the mining era that can still be encountered in the mountains include rock shelters ("*tocas*"), stone houses, aqueducts, holding ponds, stone fences, bridges, etc. (and occasionally much older petrographs drawn by Amerindians). The diamond mines and diggings themselves were not documented individually, as they cover virtually every square meter of the mountainous landscape. The man-made constructions were geo-referenced, measured, photographed, and described (Figure 3), creating a database of the archaeology of the diamond mining in the region between 1844 and the present.

| Nome | | MAN-0600 |
|---|---|---|
| Name | | |
| Coord. | 235131 8617150 | |
| Localização/Location | Campo Alegre, Lençóis | |
| Descrição | Toca boa! Parede de pedra alta >2m; 3 camas; interior triangular – 8m de frente, 5 cada lado; encontramos calumbé, pineira, garrafas; | |
| Description | Very good rock shelter! Tall rock walls >2m; 3 beds; triangular interior, 8m front, 5 each inner side; found wooden bowl, sieve, bottles; | |
| Comentários | desenhos rupestres desbotadas perto | |
| Comments | faded petrographs nearby | |
| Data/Date Foto | 09-08-2019 | |
| | Dentro dos limites do Parque Nacional | |
| | Within the boundaries of the National Park | Ref # 1071 |

**Figure 3.** A rockshelter ("*Toca*") registration file.

Among the 650 features currently documented (03/2021) 286 are "*tocas"* and 53 are stone houses.

No excavations were made, nor were any artifacts removed.

*Site Classification*

Using the example of the CRMIM project (Cultural Resources Mining Inventory and Monitoring Program) of mining sites in nine National Parks in Alaska, drainage basins were used to classify placer mining sites (Saleeby, 2000). As the diamonds found within the region are alluvial, a preliminary classification of toca sites was developed that likewise considered the drainage basins within the Chapada Diamantina Mountains. The results

presented here primarily cover the drainage basins most intensively searched: the Mucugezinho, Mandassaia, Lapão, Lençóis, Ribeirão, Capivara, and Roncador rivers near the town of Lençóis, Bahia State, Brazil.

This database is not complete, as there are certainly many more sites yet to be discovered and recorded. Nevertheless, the number of tocas catalogued represents a large enough sample to allow general inferences concerning those unique shelters.

**3. Results and Discussion**

Tocas are found throughout the diamond-bearing zone of the Serra do Sincorá Range and have a number of characteristics in common:

1) *Tocas* are almost invariably found within a few tens of meters of a water source (river, stream, or aqueduct). Some *tocas* even have small underground springs immediately below them.
2) *Tocas* are often (17%) associated with non-native mango trees, so that an old fruit tree in the hills is a sure sign of previous habitation. The trees are apparently unable to reproduce in the mountains on their own, and seedlings are never found near them. That situation may be related to predation from herbivores (presumably inhibited by human presence) or abiotic requirements (such as dependence on human wastes to supplement the otherwise unfertile sandy soils, and discarded water) (Figure 4a).
3) Windows are rare in *tocas* (1%).
4) More than half of all *tocas* have visible remains of fire/cooking pits (54%), which can be found on the floor within the shelter or, commonly, on a constructed rock shelf against one of the inner walls (Figure 4b). Fire pits likely were originally present in 100% of the *tocas*, as they would be needed for cooking, warmth, light, security, and warding off insects. However those remains are frequently not still visible in *tocas* that have been abandoned for long periods of time; camp fires near simple hunters' shelters may have been set without even a rock ring to define them (Figure 4c).
5) Many *tocas* (18%) still being used (occasionally used, or abandoned in more recent times) have (the remains of) beds made from thin poles elevated above the shelter floor (Figure 4d,e).
6) The walls and ceilings are always blackened from fires maintained for cooking, heating, and generating smoke to combat insects.
7) *Tocas* sometimes have laid flagstone floors (12%) (Figure 4f).
8) Mortar holes for pounding grains are occasionally found in front of the shelters (4%) (Figure 4g).
9) Internal divisions are fairly frequent (17%).
10) Internal plastering is rare, as opposed to unfinished stone (1%).
11) External stone walls held together by mortar are extremely rare, although some of the most comfortable and larger serially-occupied shelters can have mortared walls.
12) *Tocas* are generally solitary/isolated.
13) *Tocas* can be constructed under very narrow rock overhangs that would not otherwise cover sufficient livable areas; in these cases, an outer wall was constructed some distance from the rock face of the overhang and a thatch roof was added to complete the usable space. (Fig 4h)
14) *Tocas* outnumber stone house by 4.5 to 1 (262 to 58). Stone houses are significantly more laborious to build, require greater building skills, are much more difficult to maintain (acquisition and maintenance of the wooden roof supports and thatching), and tend to be more fragile (especially the two taller end walls that support the roof). (Figure 5a,b,c)
15) *Tocas* are probably slightly older than stone houses, as the thousands of miners that rushed to the diamond fields likely first took advantage of available natural rock overhangs for shelter. Stone houses, being more difficult and time consuming to construct and maintain, would presumably only appear in richer sites worked for longer periods of time, to justify the effort required to erect and maintain them.
16) The most comfortable and well-placed *tocas* (with more headroom, at dryer and more illuminated sites, with easily available water sources) have been serially occupied since the beginning of the mining era, while others are occasionally used by itinerant miners searching for new mining sites or hunters. (Figure 5d)

17) Some *tocas*, higher in the mountains, may have been constructed at slightly later dates, because as the prime mining areas on the lower slopes became exhausted, later miners migrated to marginal and less productive sites at higher elevations.

18) Artifacts are rarely encountered in tocas. Bottles and extremely worn iron implements (Figure 5e) are occasionally found in abandoned sites. Usable tools, cooking utensils and other day-to-day items, however, are invariably moved from site to site rather than abandoned. Additionally, to avoid pilfering, when the miners were to spend longer periods of time between visits, they would carefully hide their tools some distance from the shelter. The author visited one toca that had been abandoned for many years. The miner had intended to return shortly, but had fallen ill in town. The toca was reminiscent of an Egyptian tomb: the table set with dishes and utensils, and pots and pans and personal items were still in their places (Figure 5f). Discarded plastic items (sandals, water pipes), tin cans, bottles, and clothing are commonly found in recently occupied shelters. (Figure 5g)

Writing on rock walls at or near *tocas* (sometimes names, mostly dates) is quite rare (10 known sites). When present, they are usually written in charcoal, with paint in second place. One site had writing carved into soft rock (Figure 5h). While Amerindian rock drawing are relatively common, we have encountered no pictorial designs left by the miners themselves.

4A

4B

4C

4D

4E

4F

4G

4H

**Figure 4.** A – Remains of stone houses, with mango trees; B – Elevated fire pit and smoke stains on wall; C – A hunters bivouac bed; D & E – Beds in tocas; F – Paved floor in a toca; G – Mortar stone outside of a toca; H – "Half" toca requiring thatching to complete the roof cover.

5A

5B

5C

5D

5E

5F

5G

5H

**Figure 5.** A-C stone houses; D – Toca in current use; E – Abandon objects found in a stone house; F – Toca suddenly abandoned; G – Inside of a toca currently being used; H – Etched writing in soft sandstone.

*Geological/environmental factors*:

1) *Tocas* are very rarely face east – due to consistent wind and rain from that direction.

*Tocas* are rarely found in conglomerate rock formations (polymitic conglomerates) of the Mesoproterozoic Tombador Formation (Magalhaes et al., 2015) that are the immediate source of the diamonds. Those rocks form extremely hard and very thick layers (up to 50 m), with a predominance of rounded and smooth weathering and without overhanging ledges that could serve as roofs for shelters;

2) Appropriate rock shelf overhangs (projection distance, height above ground level, suitable level and usable floor areas, geological security, accessibility, distance to available water, dryness, not east-facing) that can be used to construct *tocas* are not common in the mountains and generally are scattered irregularly through meta-sandstone areas of the Mesoproterozoic Tombador Formation. (Figure 6a,b)

*Toca* overhang sizes vary greatly, but are generally only suitable for comfortable habitation by from 2 to 4 miners. (Figure 6c,d)

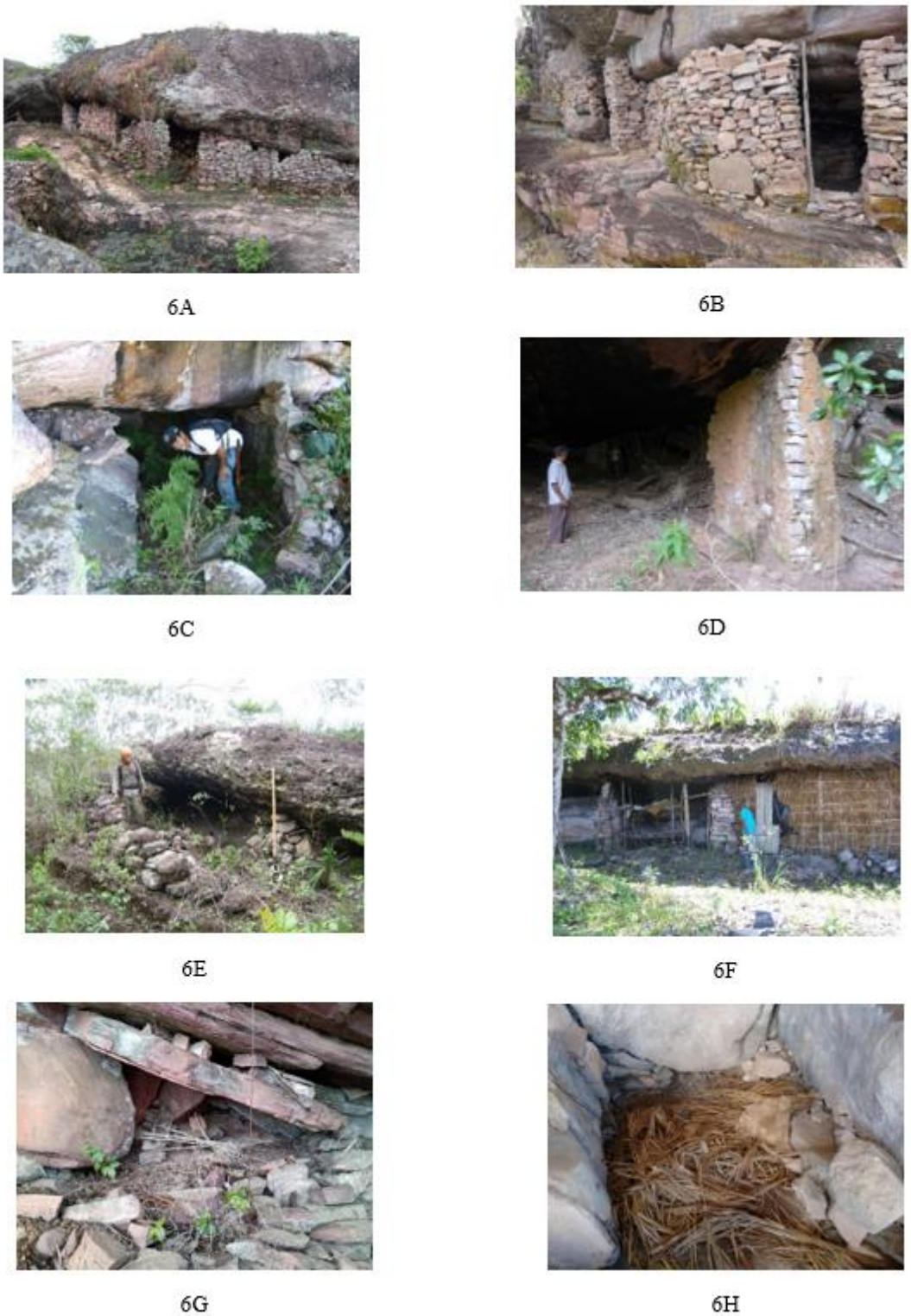


**Figure 6.** A-B – Multiple rock shelters; C – Small toca rock shelter; D – Unusually large rock shelter; E – Low toca rock shelter that required a thatched roof covering; F – Multiple toca rock shelter still being used by various miners; G – Bivouac shelter; H – Bivouac sleeping area.

*Human (and geological) factors*

*Tocas*, because of their dependence on the local geology and the chance weathering of stone, are rarely found in groups. Some of the more comfortable *tocas*, can be found with the nearby remains of smaller and less comfortable "satellite" shelters of more rustic natures – reflecting the tendency of humans to aggregate socially. The more comfortable shelters are often largely intact (or serially used), while satellite shelters are in greater disrepair (as they were most almost surely abandoned first as the numbers of miners decreased with the depletion of the diamond fields).

The remains of *tocas* constructed under short rock overhangs (that required thatching to complete a livable area) are relatively common, but very rarely serially occupied, as they are "high maintenance", in that the thatch roofing would need to be regularly renewed and the shelters would not be immediately ready for use if abandoned for any significant period of time (Schlanger, 1992). (Fig 6e)

When visiting the miners in the late 1970s and early 1980s (when traditional manual mining operations in the mountains were still reasonably prevalent) many of them lived in small groups in the largest and most comfortable *tocas* available (in terms of ceiling height, over-all size, dryness, and proximity to plentiful potable water) – even though their individual mining sites were often more distant (Fig 6f). Large, or sometimes grouped, *tocas* allowed for more social interactions in regions otherwise almost devoid of human occupation, and different miners could have distinct and separate mining sites at different distances even while living in the same *toca*.

The most comfortable tocas have almost certainly been continuously occupied since their construction in the mid-1800s. "Rights" to the use of a toca can be sold or bartered (often associated with mining rights in the area) or simply granted to a friend or relative.

Tocas are almost exclusively associate with diamond mining areas. Only very few such shelters were encountered in non-diamond mining areas. Locals identify them as shelters used while pasturing animals (cattle or horses) on high plateaus where edible plants and water are available during the dry season.

In addition to *tocas*, smaller, much more rustic shelters (54 in this initial survey) dot the hills. Those shelters are not classified as *tocas* because they: i) are not faced with a stone wall, but are open to the outside environment, with just very low walls or piles of stone (<0.5 m tall) defining their horizontal limits; ii) are found under rock ledges that are too narrow and/or too low to serve as comfortable, long-term living spaces. These rude shelters were presumably used for work breaks or short-term bivouacs. Many have been used by hunters over the years, as the remains of bedding materials (e.g., grass, leaves) are often observed. (Fig 6g,h)

More than 286 tocas have now been identified and documented within the diamond zone of the Serra do Sincorá, mostly within the Chapada Diamantina National Park. While it is difficult to determine their precise number, perhaps 80% of those shelters have been encountered in intensively surveyed areas.

Caves and rock overhangs have been occupied and modified to suit human needs throughout history in every corner of the world (e.g., Ossendorf 2019, Delannoy 2015, Štuhec 2019), although structures similar to tocas are less common (e.g., in the Walnut Creek National Monument where Ancestral Puebloans, the Hisatsinom, lived in over 80 very similar rock-overhang shelters) (US National Park Service, 2021). No references to rockshelters similar to *tocas* (and related to mining activities) in other countries have been encountered, and while they undoubtedly exist, their numbers would probably not equal those found in the Sincorá Range.

## 4. Conclusions

The diamond zone of the "Serra do Sincorá" Mountains presents unique geological/social conditions that have acted as filters for the locations and construction of toca rockshelters.

Over time, with the exhaustion of the mines and urban migration thinning the ranks (from the 1950s onward) of the remaining miners, actively used tocas were concentrated in locations that allowed greater comfort and more social interactions, even when individual miners worked different claims.

Currently only approximately 18% of the extant tocas are used regularly or occasionally, and that number will certainly decrease as older miners retire from the hills and the Park Department continues to suppress hunting. Nevertheless, the growing importance of tourism to the regional economy should increase the use of some tocas as shelters by trekkers and perhaps stimulate their conversion into rustic hostels.

## 5. Acknowledgments

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