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Outstanding Geomorphic Feature of a Complete Traverse of the Espinhaço Range

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The Talhado Canyon is located in the Espinhaço Range, eastern of the Porteirinha town, in the northernmost part of the Minas Gerais State. This important geomorphic feature represents a unique natural traverse that totally cuts the Espinhaço Range in this State. The canyon was carved by the Mosquito River, along an east-west trending normal fault. The canyon exposes a record of slightly folded and metamorphosed sediments and volcanics of the Espinhaço Supergroup, which is composed in that region by five informal mapping units, from base to top: Mato Verde, Talhado, Gerais de Santana, Resplandecente, and Serra Nova units. This sequence was deposited in a rift type basin and was deformed during the Brasiliano Cycle (Neoproterozoic). Besides its geological and morphological aspects, the Talhado canyon has also an historical and social importance, once it has served during centuries as a passage to travelers, muleteers and donkeys of burden between the west (Porteirinha and Serranópolis de Minas counties) and the east (Rio Pardo de Minas county). Nowadays the canyon is inserted in an environmental protection area and so the ecotourism should be stimulated to turn public this outstanding geomorphological feature and the stratigraphic section of the Espinhaço there exposed.

Keywords: Talhado Canyon; Espinhaço Range; Porteirinha town; Minas Gerais.

INTRODUCTION

The Espinhaço (back-bone) range, a noun given in the beginning of the nineteenth century by the German mining engineer Baron Wilhelm von Eschwege, is a linear, relatively narrow and more than one thousand km long north-south striking belt. The range begins near the city of Belo Horizonte (central part of the Minas Gerais State), and follows northwards crossing the whole Bahia State, until the borders of the Piauí State. In Minas Gerais the width of the ridge is extremely variable between 60-80 km in the parallel of Diamantina, until about than 3 km width north of the Grão Mogol town. To the east of Porteirinha, in the northern extreme of Minas Gerais, there is an 8 km width natural passage, the only one in this State that crosses the Espinhaço Range side by side. This notable geomorphological and structural feature known as “Talhado” (meaning carved or cut out) (Fig. 1 and 1A) is assigned as the Talhado Canyon. It represents an important feature not only by its geologic and morphologic characteristics and the beauty of its landscape, but also by its historical and social interest, since it has joined during centuries people of both sides of the range. Thus, all these

aspects recommend the Talhado Canyon as a site of the Brazilian natural heritage to be preserved.

LOCALIZATION

Porteirinha town is placed in the north extreme of the Minas Gerais State, distant about 600 km from the capital Belo Horizonte (Fig. 2). This distance can be covered totally by asphalted roads; initially by road BR-040 and after by road BR-135 in direction to Curvelo, and Montes Claros towns, arriving finally to the-Porteirinha town. The Talhado Canyon is located in the small municipality of Serranópolis de Minas, located 21 km from Porteirinha by a precarious land road. The “entrance” of the canyon occurs 5 km east from Serranópolis de Minas (42°48'W and 15°49'S).

SHORT HISTORY

The first habitants of Porteirinha region were adventurers searching gold deposits at the beginning of the XVIII century. Although such diggings obtained no success, extreme areas were explored and a village named São Joaquim de Porteirinha was established in the edges of the Mosquito River.



Figure 1: View from west to east of the Talhado Canyon entrance, detaching the wall of the Espinhaço Supergroup quartzites in the western part of the range. **Figure 1A:** Detailed view of the initial stretch of the canyon, also showing the exuberant vegetation still preserved in the interior of this structural feature.

Porteirinha town was created only in 1937, by the dismemberment of the lands of Grão Mogol county. Of recent creation the formerly named Serranópolis district was emancipated of Porteirinha in 1997, with the new name of Serranópolis de Minas. Like all this region is very poor, the Talhados's Canyon has been an way of passage to travelers and troop of donkeys with provisions between Porteirinha and Serranópolis de Minas towns with the other (east) side of the Espinhaço Range, in direction to small villages as Nova Aurora, Rio Peixe Bravo, Curralinho, etc., in the Rio Pardo de Minas county.

DESCRIPTION OF THE SITE

The Espinhaço Range in the northern extreme of Minas Gerais State is still bad known concerning to geological aspects. First studies in this region are due to Schobbenhaus (1971, 1972) that mapped a long interval of the range between Porteirinha and Monte Azul towns, the last one near the frontier of the Bahia State. At the end of the 1970's decade a DNPM/CPRM agreement carried out the Porteirinha–Monte Azul Project aiming the search of

mineral deposits at the western side of Espinhaço Range (Drummond et al., 1980). In the 1990's decade, the Espinhaço Project (COMIG/UFMG agreement) was centrated on the geological cartography and data integration at scale 1:100,000 of the whole range in the Minas Gerais State, and the focused area is a part of the Rio Pardo de Minas map sheet of this project (Roque et al., 1996). The stratigraphy of the Espinhaço Supergroup is actually object of detail studies (preliminary results in Chaves et al., 2005).

Geomorphological Context

The region of Porteirinha–Serranópolis de Minas, to the west of the Espinhaço Range, is inserted in the “Edges of the Espinhaço Plateau” which is enclosed in the “Domain of Crystalline Plateaus”, according to Mauro et al. (1982). These plateaus constitute transition belts separating units situated in different topographical levels, and thus forming a topographical platform between the range and the lowest areas. The climate is tropical half-dry to dry and the vegetal covering integrates different types, where species of savannah and stational forest predominates. In

general, the relief reveals considerably dissected, with the development of an intense net of draining, mainly the west of the range in the domain of the Crystalline Basement. In the range zone, the “Espinhaço Plateau” present steps sculptured in quartzitic rocks, with altitudes that vary between 700 and 900 m, occurring a peak that is raised up to 1,465 m.

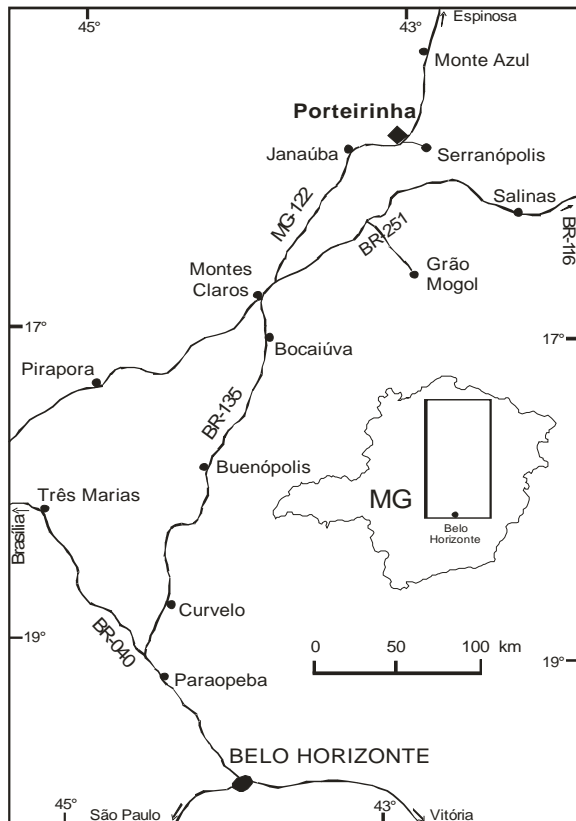


Figure 2: Location map and access to Porteirinha – Serranópolis de Minas region (State of Minas Gerais).

According to King (1956), such steps belong to different planning surfaces. The west of the mountain range, the surface leveled between 600-700 m integrates the “Velhas Surface”, while the range platforms between 850-950 m and 1,200-1,300 m compose distinct surfaces developed in the range zone represented, respectively, by the “South American” and “Post-Gondwana” surfaces of this author. The high ridges are conditioned by the structure of the Espinhaço, with pattern marked for by tiltings and faults, responsible for the morphology of the relief characterized by canyon-shaped valleys and sharp scarps. In the same context, the Espinhaço Supergroup includes at its base acid and intermediate lava flows and intrusions (Mato Verde Unit), with variations in the lithologic composition and resistance to erosion, having as result several peaks that put in evidence synclinal and anticlinal structures and others of circular aspect. The biggest valleys of north-south direction had been sculptured in more susceptible rocks to the erosion as phyllites, soft quartzites and

metaconglomerates (Gerais de Santana Unit), while the ridges are supported by quartzites.

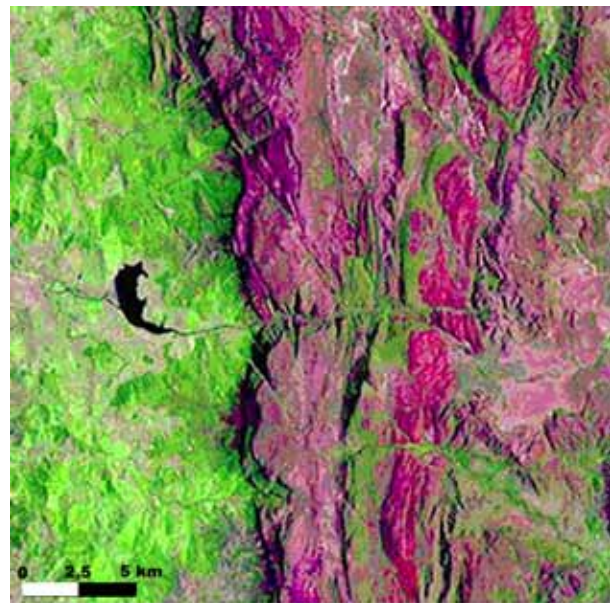


Figure 3: Landsat 7/TM+ satellite image showing in its central part the east-west oriented canyon in the Espinhaço Range formed by the Mosquito River (Source: www.embrapa.gov.br, 2004, Brazil Seen from the Space).

The metamorphic basement was uplifted by the cretaceous epeirogeny and the resulting faults represent a reactivation of older Precambrian inherited fault lines. It is admitted that the planning surfaces formed during this uplift are the result of the action of morphogenetic processes truncating different lithologies and/or superimposed structures. Thus, the feature known as “Talhado” represents a canyon formed by the Mosquito River throughout a normal fault that cuts the units of the Espinhaço Supergroup (Fig. 3). The scarps of the canyon show superimposed structures, like folds and small faults. Altitude variations that define different steps are well shown along the valley of the Mosquito River. In the more elevated plans, a ruin-shaped landscape is observed, as well as the presence of great isolated boulders.

The development of the Talhado Canyon throughout geologic time is associated to different periods of staging of the above mentioned geomorphological evolution. The Mosquito River belongs to the basin of the São Francisco River and has its springs in 1,300 m of altitude, in the area of “Gerais de Santana”, flowing firstly about 10 km in north-south direction between quartzite ridges. After this river forms a curve of 90° to take the east-west direction, resulting in the development of the canyon. One suggests that the processes of epeirogenic uplift that had led to the formation of the range, were more intense or were submitted to posterior reactivations to

the east side of the range, in the contact zone of the Espinhaço Supergroup with the Macaúbas Group. The north-south striking part of the river probably ran initially to the east, in direction to the basin of the Pardo River (only about 700 m separates the two basins). The mentioned uplift caused the capture of the east-west arm of the Mosquito River, so allowing the increasing of the erosion along the fault and originating the canyon.

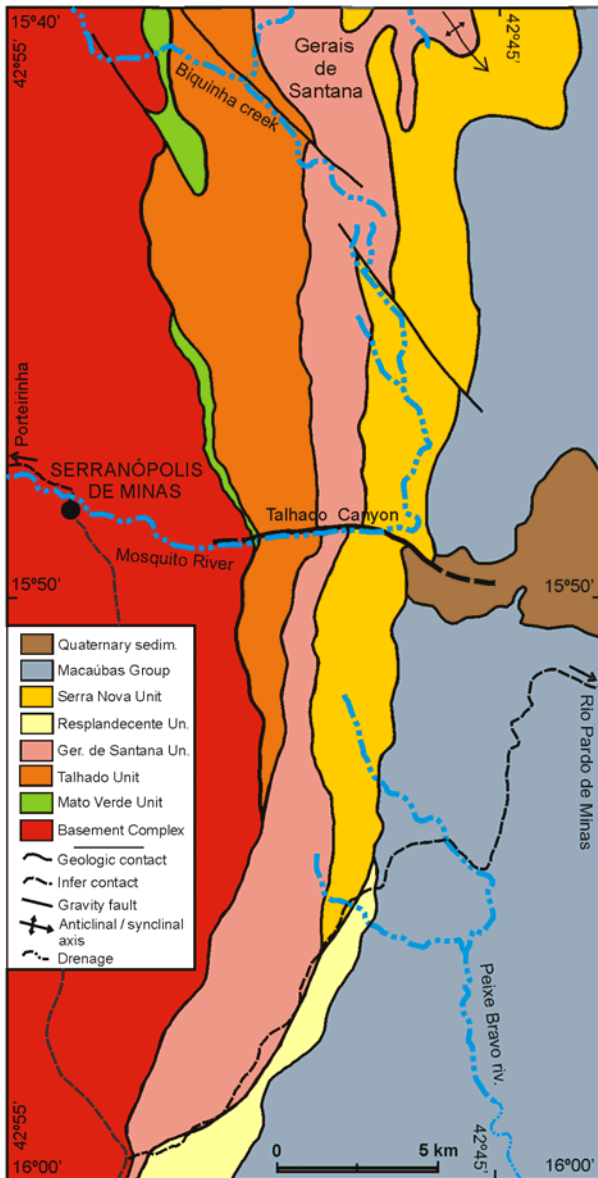


Figure 4: Geology of the Serra do Espinhaço in Serranópolis de Minas region, eastern of Porteirinha town (State of Minas Gerais).

Geology

At the western side of the range, the Espinhaço Supergroup is covering on angular and erosive discordances granitic and gneissic rocks of the Basement Complex, while at the eastern side the

Espinhaço rocks covered in conformity by the Macaúbas Group. The width of the Espinhaço Range in the region is about 8-10 km while in the diamondiferous district of Grão Mogol, to south, its width is lesser than 7 km. In the same way, the (volcano) sedimentary sequence is very thicker in the focused area with 1,000 m against 300 m in the Grão Mogol region.

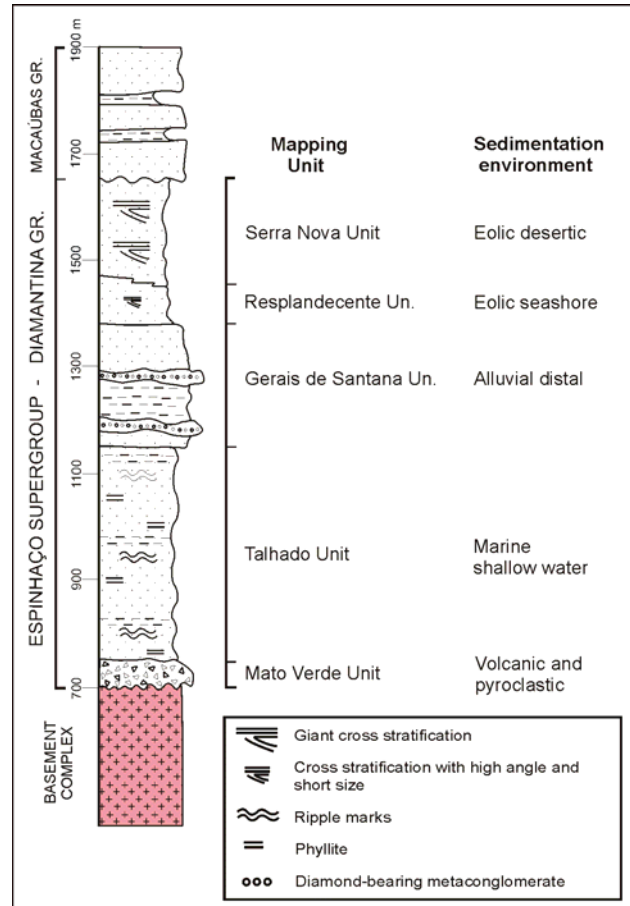


Figure 5: Proposed stratigraphic section of the Espinhaço Supergroup along the Talhado Canyon.

According to Chaves et al. (2005) five units are recognized in the Espinhaço Supergroup, informally named from base to top Mato Verde, Talhado, Gerais de Santana, Resplandecente and Serra Nova units, with N-S strike trends (Fig. 4 and 5). Additional studies also have been conducted aiming the formalization of the mentioned units and the correlation with other lithostratigraphic units of the Espinhaço Supergroup that occur both to the south (Grão Mogol-Itacambira areas) and to the north (Southern Bahia State).

MATO VERDE UNIT

This unit occurs in the western border of the range, enclosing metavolcanic rocks associated with

metaconglomerates that mainly occur at east of the Mato Verde town (north of Porteirinha). Some scattered outcrops of the unit also occur to the south, disappearing completely after crossing the Mosquito River, when the upper stratigraphic units (Talhado and Gerais de Santana) form the basal portion of the supergroup. Thus, in the Talhado Canyon, the Mato Verde unit is only a few meters thick, while to the north it can reach about 50 m, allowing its division in two levels. The basal level is composed by polymictic metaconglomerate with (rare) associated arcossian schist. Clasts of gneiss, migmatite, metabasic rock and vein quartz can reach 25 cm in diameter, generally with angular to subrounded forms, and a phyllitic or schistose gray, iron oxide-rich matrix. The upper level encloses acid and intermediate volcanic rocks with interbedded pyroclastic rocks. In the first class occur rhyolite, dacite, and rhyodacite, while in the other class are found andesitic lavas with associated tuffaceous rocks.



Figure 6: Oscillation ripple marks that separate in the top distinct levels of the Talhado Unit, outcropping in the initial western part of the Talhado Canyon, in the Mosquito River margins.

TALHADO UNIT

Placed over the Mato Verde metavolcanics, this unit is characterized by fine and pure quartzites, rarely micaceous, and thin intercalations of ferruginous quartzites. Locally this unit occurs directly over the Basement Complex, like for example at southeastern of the Serranópolis de Minas town. The Talhado designation was proposed in reference to the Talhado

Canyon presenting magnificent outcrops. This unit has a special geomorphology showing quartzite with long parallel crests divided by flat valleys in concordance with the structural N-S trend. Primary sedimentary structures are metric plan-parallel levels separated by ripple mark horizons (Fig. 6), and assynthetic cross stratifications of small size. The ripple marks are more frequent to the top of the unit, pointing out the thinning of the beds in this direction. The complete estimated thickness is between 350 to 400 m. Rocks and sedimentary structures indicate to a coastal to shallow marine environment.

GERAIS DE SANTANA UNIT

A sudden reducing in the relief can be observed to east of the Talhado Unit based on aerophotos and satellite images (Fig. 3). Field works showed that such change is determined by the presence of more soft rocks like coarse quartzites, phyllites and metaconglomerates (Fig. 7). The designation Gerais de Santana was based on the name given to a planned area at southwestern of Serra Nova, a small village pertaining to the Rio Pardo de Minas County. In this area, a series of narrow folds caused enlarging of the unit to 4-6 km against 1 km verified in the Talhado Canyon section. The total thickness of the unit is between 150 and 200 m. Lithologies and primary sedimentary features, as channel cross stratifications, point out to an original alluvial environment.



Figure 7: Metaconglomeratic level (Gerais de Santana Unit) with rounded clasts preferentially of quartz vein. These conglomerates constitute the source rock of diamonds in the region (outcrop in the confluence of the Agua Fria stream with the Mosquito River).

RESPLANDECENTE UNIT

The Resplandecente term was firstly used by Karfunkel and Karfunkel (1976) as a formation that is characterized by fine and micaceous, white to red quartzites occurring as fine beds in the Itacambira region (Resplandecente mountain). Such rock type

was also recognized in the Grão Mogol region by Chaves et al. (1999), when the unit had been considered as a stratigraphic index-level for the whole northern belt of the Espinhaço Range in Minas Gerais. Similar rocks were mapped in the southern part of the study area on the Gerais de Santana Unit. However, such rocks are restricted to the Talhado area. Beyond the granulometry and texture of the quartzites, another characteristic of these rocks is the presence of small, medium, and large tabular cross stratifications along the whole 200 m thick section of the unit, that can be interpreted as of eolic origin, probably in a seashore context.

SERRA NOVA UNIT

This unit occurs continuously at the eastern side of the range, forming a quartzitic horst that is limited to east by eroded Macaúbas Group rocks. The Serra Nova designation has been taken from the name of the small village where excellent outcrops of the unit occur. At this village begins a long track through the highlands crossing the range from east-west (Fig. 4). The Serra Nova Unit is composed by fine, white quartzites with plane-parallel stratifications and giant cross stratifications (Fig. 8). At west the contact with the Resplandecente Unit is gradational, while at east an erosive contact with the Macaúbas Group is being object of specific investigation. The estimated thickness of this sedimentary unit is of 200 m, deposited in eolic environment, possibly under desert conditions.



Figure 8: Cross stratification of great dimension in quartzites of the Serra Nova Unit in the top of the profile located in Talhado Canyon.

Tectonic evolution and the canyon formation

Actually most authors consider that the sedimentation and associated volcanism of the Espinhaço basin has been developed in a north-south striking rift valley from late Paleoproterozoic ($\pm 1,75$ Ga) until the Mesoproterozoic (1,4 Ga). However, the

orogeny that folded the volcano-sedimentary sequence of this basin only occurred in the neoproterozoic during the Brasiliano Cycle (eg., Dussin and Dussin, 1995). A main regional phase of folding was responsible for the formation of synclinal and anticlinal folds with north-south axis and west vergence in direction to the São Francisco Craton. The result structures of this phase are shear zones (ductile domain) and thrust faults (ductile-ruptile domain) with west direction. In the Porteirinha area the Espinhaço Supergroup presents a homocline structure showing low to medium dip values to east. In north direction, at west of Monte Azul and Espinosa towns (MG) and Guanambi town (BA), the Central and Palmas do Monte Alto mountains show dips to west, indicating that in Porteirinha region the other flank of this megastructure has been eroded. Gravity faults (ruptile domain) are associated to a late, not much intense folding phase that refolded the north-south axis generating brachyanticline and brachysyncline structures. The Talhado Canyon is related to this last fault type (Fig. 9), that also enclosed rocks of the Basement Complex at the western side of the range.



Figure 9: Detail of the western initial part of the canyon crossing the quartzite sequence (Talhado Unit), showing the approach W-E direction of the normal fault that generated the structure.

PRESERVATION MEASURES

The Espinhaço Range presents a landscape of rare beauty in which isolated hills and mounts, waterfalls, steep valleys and typical vegetation with extremely specialized floristics varieties can be observed and appreciated. In consequence, the majority of the towns related to the Espinhaço have looked for to establish norms of environmental control or protection in areas located over the range and at its borders. One of the first units of conservation with integral protection in this mountain range was the National Park of the Serra do Cipó, created at 1984 year. Since then, several other units of

conservation had been created along the mountain range with objective to preserve the biodiversity of the region. Recently, in 2005, the UNESCO recognized the Espinhaço as a reserve of the biosphere for sheltering innumerable species of the threatened fauna and the flora of extinguishing. This recognition opens new perspectives for conservation through the partnership of biodiversity, geodiversity and economic development.

Moreover, the social importance of the Talhado Canyon must be enhanced as it constitutes a natural landscape that has served as communication route through the two edges of the mountain range (Fig.10).



Figure 10: Aspect of the passage of the Talhado Canyon showing handle-of-steel affixed at a thick wall of quartzite (Talhado Unit), so that the people can hold themselves during sudden torrents.



Figure 11: Image of the Espinhaço Range showing in its central part the Talhado Canyon, at a cold morning of July, in which clouds are totally concentrated over the mountain range.

The region still shelters part of the State Park of Serra Nova (located in the Rio Pardo de Minas county) and the Serrado Environment Protection Area (located in the Porteirinha county), both at north of the canyon. New studies are being carried out aiming to create the National Park of the Serrado that

will enclose areas of the counties of Porteirinha, Mato Verde, Monte Azul and Rio Pardo de Minas. Preliminary studies indicate the presence of four species that integrate the "Red Book" of the threatened species extinguishing flora of Minas Gerais (Mendonça and Lins, 2000) beyond several other endemic and/or restricted species. Although having in mind its extremely privileged landscape shown by the forms the relief (Fig. 11), the crystalline water springs, the vegetation, and a relatively mild climate, the region needs sustainable development strategies focusing the tourism, the commerce of handicrafts, recreation clubs, hotel net, etc. Such aspects will contribute to ecotouristic activities easily developed in the regional economy and are the way to stimulate the environment preservation.

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