

“Dueça Speleological Cave System”

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Abstract: This presentation describes the work carried out by speleology groups (CIES, GPS, NEC e SAGA) who have been associated with Dueça Cave System for the past 7 years (1998-2005), in particular in relation to the exploration, the diving, the surveying, the photography and interpretation of the various caves of the system.

1 -Introduction

1.1 - General geomorphologic background

The Karst Ridge of *Condeixa-Sicó-Alvaiázere* comprise a group of marly limestone and dolomitic limestone relieves, which, are situated at the meso-cenozoic western Portuguese border between the parallels of *Condeixa* and *Alvaiázere*. Even though, as a whole, they are not considered a limestone massif as such, their distinct tectonics and the erosion places this orographic group, with no more than 400 km², above the surrounding areas, to the East and West, and even though in a more subtle way, to the North and the South. There are also different geomorphologic units linked to these levelling lithologies, the main one being (for its extent, altimetry development and importance in the karstic functioning) the group nominated “*Serras e Planaltos Calcários*” (CUNHA, 1990) which is associated with the levelling of the “purest” limestone favourable to the karst of the Middle Jurassic.

In relation to this unit, the outline of the fault system, especially, the structural combination during Jurassic and post Jurassic periods, allows us to see in the current regional landscape two sub-units which, in a way, correspond to two small massifs functioning independently. Thus, there is the Massif of *Condeixa-Sicó* (to the NW) and the narrow Massif of Castelo do Sobral - *Alvaiázere* (to the SE), separated by a complex area of faults and folds, related with the great tardi-hercynian accident of *Lousã-Pombal-Nazaré*.

It is precisely in this last, most northern massif that the **Dueça Cave System** arises. It is, generically, not a very high sector in comparison to the base level which commands the drainage in the area, which is the bottom of the *Dueça* Valley at approximately 200 m ASL. As it is, the highest point of the area is at 347 meters in the Geodesical National Reference of *Castelo do Sobral*.

1.2 - Location and surroundings

Dueça Cave System is situated at the extreme East of the *Sicó-Alvaiázere* Karst, in the county of Penela, district of Coimbra, in a sector of great morphological and structural complexity, with diversely oriented faults which impede the levelling of dolomitic limestone (Lower Lias), marls and marly limestone (Middle and Upper Lias) and limestone (Dogger).

The karst levelling where the system occurs, which is the top of a residual anticlinal structure consisting in marly limestone from the Upper Lias and Dogger, is now nearly totally isolated from the rest of the massif in relation to the karst underground flow, except in the SW, where an isthmus of limestone makes a link with the East. To the East, the limestone is in contact with the schist of the Iberian Massif along a area of several faults directed to the N-S. To the North, NNW, S and SSE, the normal and karst erosion provoked the total dismantlement of the top part of the anticlinal structure, showing therefore marls from the Lias, not too favourable to karstification and permeable. The evolution of the base level on the edge of the levelling presents a complex history, which we will only be able to study after a future synthesis of speleological work currently in progress. However, we can say that it has a significant role in the determination of the genesis and the evolution of the system's galleries, which is constituted by an intricate crossing of sinkholes, at various stages of the hydraulic activity.

In this underground system, we highlight *Sumidouro da Várzea* (*Várzea* Sinkhole), *Gruta do Algarinho* (*Algarinho* Cave), *Soprador do Carvalho* (Oak tree Blowhole), and *Olho do Dueça* (*Dueça* Spring) – the main spring.

2 – Oak Tree Blowhole / Oak Tree Woods Pit

2.1 - Summary of the history of the exploration

Oak Tree Blowhole, also known as *Gruta Talismã* (Lucky charm Cave), was discovered in 1992 by the Archeology and Speleology Group of Pombal (GAEP) following the indications given by Mr. António Dias – an inhabitant of the village Taliscas. A strong air blow flew through a small crack in the limestone, which indicated a link to a big cave. A few days of clearing generated a 4 meters deep pit, which led into an underground river with unique characteristics. It is

probably the largest underground water course in Portugal that may be followed without diving techniques. The cave's exploration was carried out by GAEP, who thought it to be of about 4000m long. However, the cave survey was never presented. To proceed with the exploration and the study of the cave, GAEP asked for the collaboration of CIES and SAGA, but did not allow these groups to do a topographic survey, which was essential for the exploration progress. This impediment enabled the possibility of collaboration, and the group's incapability to proceed with the work on their own, ended up compromising the exploration of the cave in the following years. The feelings was that the group was not up to what was expected and therefore, in 1999, the speleologists of CIES, GPS, NEC and SAGA groups decided to put all their efforts together and engage in the exploration and survey of Oak Tree Blowhole. They breakthrough new galleries and surveyed more than 2000 metres of cave passages.

In the meantime, the local council of Penela was attracted by the idea of potentially increasing their tourism with the exploration of this cave, and, in 1999, acquired the land where the entrance of the cave is situated and started organising touristy visits of the cave. Even worse, they impeded the speleological community to have access to it, compromising therefore the continuation of the study. We still do not know the real extent of the Oak Tree Blowhole, for which mainly the group that ironically discovered it and the Local Council of Penela may be held responsible.

2.2 - Hydrogeology and Morphology

Situated at the Eastern border of the system, Oak Tree Blowhole arises from South to North, along faults with the same direction, parallel to the edge of the limestone levelling, following the valley where *Sabugueira* Stream flows. This is the stream along which we may find, on the way down, the main spring of the system. At this point it changes its name to *Dueça* River, which collects mainly the waters coming from the Iberian Massif composed of schist and quartzite.

The fact that the stream got in contact with the sedimentary land of the limestone massif resulted in the emergence of springs, as the underground flow followed the already existing faults, which essentially originated the galleries of Oak Tree Blowhole. The changes of the water level and the deviations of the streambed along the years, due to the erosion, and successive periods of obstruction and clearing of the sinkhole provoked the areas of sink to change location either up or down river, and therefore forming new galleries and sometimes even changing the course of the flow within these galleries. Thus, on the left side of the valley we can see various infiltration areas, both fossilised and active, which are successively sinkholes and springs. Nowadays, the main sinkhole area of *Sabugueira* Stream only exists partially. It is situated near the main road IC3 which crosses it. This sinkhole is responsible for the great flow of the underground stream of Oak Tree Blowhole in winter. However, these are not the only waters it collects. In the summer, even after a very dry period and when *Sabugueira* Stream is dry, even though there is less flow, it remains in the siphon and right up to the point where the cave has been explored. This fact has not yet been explained (Could it be deep phreatic waters?). The sinkhole area, or the joining of external waters, has not yet been totally explored. Most probably it still carries on for more than a kilometre upwards beyond the point we reached. It comprises both paragenetic galleries – sometimes several metres high – and siphons in smaller channels, intersected by a few chambers due to subsidence and fault with rejection, allowing the contact with different lithologies. This is the most intricate area of the cave.

Oak tree Woods Pit is situated in this area. There is an old entrance – found with the help of the SLOTER system (CARVALHO and VEIGA,1989) – which may have been functioning has a sinkhole or as an spring. This entrance is well-hidden and blocked by large blocks cemented in with calcite. It was opened in 2001 by the CIES, SAGA, NEG and GPS groups, who worked very hard for several months to breakthrough it. Chronologically, it was the second entrance of this cave to be opened so that it would allow the access to the last part of the cave at any time during the year. This is also due to the fact that, approximately in the middle of the cave, there is a 200 meters narrow gallery, which becomes a siphon due to the rising level of the river in autumn/winter impeding therefore the access to the rest of the cave.

On the way down, the cave continues as one gallery of 3 to 4 meters in section, allowing for free flow in the dry period, along 1000 meters in a straight line. At this point the underground stream leaves the large gallery and part of it diverts to a smaller gallery. 150 meters of this small gallery has already been explored, which revealed that it is intersected by small siphons in direction to the *Dueça* Spring. The continuation of its exploration is now compromised by the arrival of domestic effluents of the village of *Taliscas*. The larger gallery continues downwards and is still active in periods of greater water flow. Its exploration is still undergoing. The fact that this gallery is not as important for water flow has resulted in its blockage with sediments, which has made its exploration more difficult. It is further down from the disjunction of these galleries that we find the first entrance – Oak Tree Blowhole – which was opened in 1992 by GAEP.

Due to its great hydraulic activity, the cave has relatively low amounts of calcite. It has a few areas exhibiting a great number of fossils, of great beauty and speleological interest. Some of these areas may be compromised by the expansion of the “tourist activities”. Some of these areas have already been vandalised and some speleothemes have been broken and taken away. It is therefore urgent to find a way to prevent this type of behaviour.

At the present time 2800 metres have been surveyed and 4500 metres have been estimated. This cave is not only thought to be the largest in the *Sicó* Massif but also one of the largest in Portugal.

There is still a lot to study and discover, not only in terms of exploration of the cavity but also in terms of geological interest due to the complexity of the structure of the area where it is set in, in terms of biospeleology and archaeology.

3 – Algarinho Cave

3.1 - Summary of the history of the exploration

The *Algarinho* Cave is referred to in 1993 by the group GAEP. At that time it was obstructed but water poured out of the blockage during the rainy season.

In April 1998, the speleology groups SAGA, CIES, GPS, and STEA, cleared the entrance of the cavity by using a mechanical digger. After 4 hours removing stone and blocks, they found a small entrance from which we could feel a air flow which suggested that it was a large cave.

The progression in the cave was relatively easy and the speleologists went approximately 1200 meters inside. During this first exploration, two manmade constructions were identified near the entrance. A first analysis revealed that they dated from the pre-roman period.

The next weekend, a new member joined us – NEC, who could not proceed further than the Sand Sump (*Sifão das Areias*), 200 meters from the entrance of the *Algarinho* Cave, due to the rain fall of that week. During the next few month and after the lowering of the water level in that sump we did several exploration and surveying studies, going further than the 1200 meters already known right up to a new sump. The water levels of this sump was successively checked until, at the end of the second month, some NEC members managed to go further still, exploring the cave up to another new sump named *Algarinho End Sump* (*Sifão Terminal do Algarinho*). Two dives attempts in this sump were made – one by Ricardo Rodrigo (STEA) and another by Jesus Manteca (G.E. GORFOLI – Spain), both were unfruitful as the exploration of this sump turned out to be difficult and dangerous due to its sandy bottom.

In September 1999, an archaeological team carried out a study of the manmade constructions found in the cave, but it was not possible to determinate the origin of such constructions (VILAÇA and CARVALHO, 1999).

In May 2001, the speleologist Hugo Mendes – member of GPS – discovered one bronze spear, approximately 2900 years old, in an area of the cave about 50 meters from the entrance. This discovery was of utmost importance as it brought about the possibility of the cave being connected to the old Castle of *Sobral*, situated in the surrounding area. The presence of the spear and the manmade constructions suggest that this cave may have been used as the tomb of one of the tribe chiefs of the old castle. If this theory is confirmed, we have then a tomb cave, sealed after the chief's burial, which makes it unique in Portugal. (PESSOA, 2003).

It is only in 2002 that a new fossil gallery was found near the end of the cave, which seemed to be an obstructed entrance from which ran a great air drought.

Until now the water level in the *Algarinho End Sump* has dropped several metres, but not enough to allow the breakthrough beyond this sump.

We must also highlight the discovery of tar deposits in the water and on the walls of the cave along 600 meters. An aerial photograph shows that the cave is located near a quarry at the bottom of *Vez Hill*, which is probably the source of this pollution.

At the moment, 2296 meters of galleries of the *Algarinho* Cave are surveyed, and we estimate them to be 2500 meters long. It goes from East to West, its entrance is situated at approximately 250 meters from Oak tree Blowhole, and it ends approximately 650 meters of *Várzea* Sinkhole.

3.2 - Hydrogeology and Morphology

The *Algarinho* Cave is a key element to understand the flow within the system. The dimensions of its galleries are not in accordance with its current hydraulic activity as a spring. The flow remains reduced even after heavy rainy periods. This highlights the importance that this cave had in past years, having probably been the main spring of the cave system. Due to the drop of the base level of *Dueça* Spring, the main gallery formed several springs along 500 meters in an area furthest from the entrance. These springs deviated further and further way towards *Dueça* Spring, which became more and more important as the valley gradually deepened due to the erosion. Up from this area, there was, at a certain point, a sinkhole, which collected nearly all the water, and which still collects the greatest part of the flow. The estimated depth and the characteristics of the terminal sump suggest that there is a passage connecting to *Várzea* Sinkhole or *Dueça* Spring.

The galleries of *Algarinho* follow perfectly the fault scheme of the local area. They have rectilinear branches and winding areas. The galleries slope frequently follows the slight slope of the deposits. There is hardly any solidification even though there are a great number of galleries with free or sub-aerial flow.

4 - Várzea Sinkhole

4.1 - Summary of the history of the exploration

Situated in the south-eastern border of *Várzea da Póvoa* depression, between the county of *Ansião* and *Penela*, *Várzea* Sinkhole is considered to be the most important sinkhole of the *Sicó-Alvaiázere* Massif, and it is also the most studied. In recent years, there have been various attempts to pump up the waters of this sinkhole, which even caused an accident with the group GAEP due to the accumulation of carbon monoxide from the water pump installed inside the cave.

Fortunately, this accident did not develop into what could have been a tragedy. It was quite a dramatic scenario involving a forward emergency system never seen in Portugal.

In summer 1998, after the exploration of the *Algarinho* Cave, the groups CIES, GPS, NEC and SAGA dived into this sinkhole, to see if there was an accessible gallery beyond the sump situated near the entrance. This dive was performed by Christian Thomas and João Neves of SAGA and resulted in the discovery of a 150 meters long gallery with considerable dimensions across three sumps. After this underwater exploration, the groups decided to set up a pumping system to dry the sumps and to find out if there was a connection between the Algarinho Cave and Várzea Sinkhole, taking into account that the connection to *Duença* Spring had already been verified by tracing methods (CRISPIM, 1986).

In October 1998, with the support of SPE - *Sociedade Portuguesa de Espeleologia* (Portuguese Speleological Society), the pumping of Várzea sumps were carried out, which revealed a 520 meters long gallery right across to a new active sump. This sump was later on explored by João Neves (SAGA) and Ricardo Rodrigo (STEa), who confirmed the existence of successive active branches of galleries with high levels of CO₂. These were intersected with sumps that were difficult to explore because of their small size and dirty waters, therefore, they only managed to go in 150 meters. The rising water levels closed the passage, which meant having to dive or pump the water out again to be able to have access to the majority of the cave.

Várzea Sinkhole is now surveyed in 428 meters long, and towards the NE. It ends at less than 650 meters from the end of Algarinho Cave.

4.2 - Hydrogeology and Morphology

Várzea Sinkhole is another example of the importance of the waters of this system in the past, which drained all the Karst area situated in the W, and which has now been eroded to the impermeable centre. Thus, once again, the large sizes of its galleries are not in proportion with the current water flow.

The first part of the cave follows a fault which is mainly directed to the SE. The cave presents a succession of steps – already obvious at the entrance of the gallery – conditioned by transversal faults, which are replicas of the large fault along the Várzea Depression, crossed by horizontal branches. At the base of each step, we frequently found a sump. After 100 meters, the entrance area joins another gallery directed to the NE where there is a permanent water flow. Upwards, there is a sump that is so restrictive that it has not yet been explored. However, we hope that it will lead to the straight of Dogger which makes the link to the rest of the Massif. This water course, together with the permanent waters of the Oak tree Blowhole, constitutes the greater part of the flow of *Dueça* Spring occurring during the dry season. Further down the gallery, there is once more a succession of rectilinear branches intersected by steps, which change direction by taking advantage of the directions taken by the fault system. However, the cave morphology changes and becomes narrow passages – sometimes only a few centimetres high – and some rooms with subsidence, in a context with a thinner stratification than at the entrance gallery, which suggest a change of lithology (top of Aalenian). The typical steps are sub-aerial passages, whereas the horizontal branches are, in their great majority, sumps. All the aerial passages have high levels of CO₂, which makes it very difficult to explore.

5 – Dueça Spring

5.1 - Summary of the history of the exploration

The first exploration goes back to the sixties, subsequent to the breakthrough of the entrance carried out by Mondego Water Services with the intention of studying and stabilising the flow. For years, we had no idea of this fact. We could see that some work had been done to the spring, such as making impermeable the adjacent area, constructing a well in concrete, and rising a dam and canals, which we thought to be due to the needs of irrigating water to the fields nearby. In the eighties, João Neves (SAGA) dived in the well and saw that there was a gallery at approximately 3 meters deep, opened and held with cement blocks and already rotting wood, but the subsidence impeded the exploration to proceed. The water level had low visibility and the bottom of the well was full of cement blocks and vegetation down to 6 meters deep. The spring was then considered inaccessible and the hope of being able to get breakthrough the system given up. Further attempts to find a way in were also unsuccessful. By striking a conversation with a local inhabitant who participated in the breakthrough works, he told us that approximately 600 metres of this system – although this distance can not be confirmed – had already been explored in the past. We were also told that, at the end of the 1990s, the bottom of the well had been cleaned which exposed the artificial gallery giving access to the cave. Immediately we started the exploration again. As soon as the water flow and the visibility allowed it, a series of dives were done by João Neves (SAGA) and Manuel Soares (CIES), who allowed the exploration and the topography of approximately 300 metres of galleries.

In 2004, several new dives on *Dueça* Spring lead to new discoveries, resulting in 600 meters of partial flooded galleries, ending on a large breakdown, near Oak tree Blowhole.

5.2 - Hydrogeology and Morphology

Dueça Spring is the main spring of the system and constitutes the base level, which controls all its “recent” evolution. The origin and morphology of the galleries depend greatly on large faults bearing generically towards E-W, where the section may reach several metres in section and faults towards N-S, where a section is highly reduced.

The cave starts at the vertical well (7 meters deep) which allows access to the 20 meter artificial gallery. At the end of it, it goes into the natural gallery which takes approximately a SW direction. 50 meters further, starting at the bottom of the well, and upwards, we find the first room whose dimensions are 3 by 4 meters. From then on, the cave is very close to the surface, with areas where the water flow is done alternatively in sumps and in rooms; there is evidence in these galleries of varied quantities of sand deposits, and a breakdown at various states of erosion. It is common to find a layer of light-coloured and very thin silty clay especially in the galleries where there are blocks. Some of the galleries that have been seen are no more than the areas surrounding fissures from which the river has taken the filling materials.

Nevertheless, the continuation of exploration has been compromised by the emergence of domestic and industrial effluents from the nearby village of Taliscas and the industries implanted upstream.

6 - Conclusion

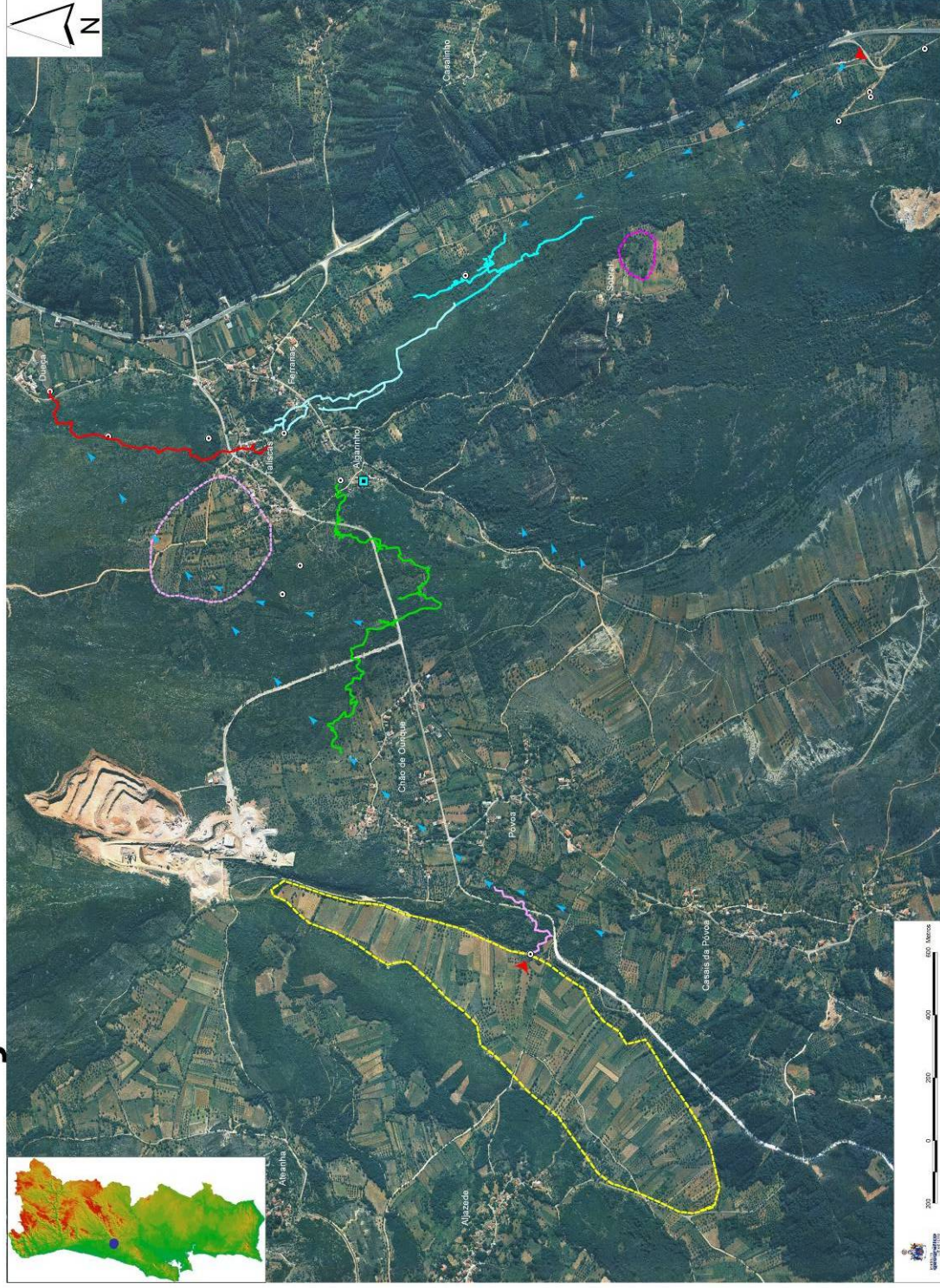
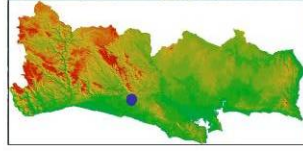
All the works carried out until now are a small part of what we consider important for the study and the protection of this amazing underground network. Nowadays, the connection between Oak tree Blowhole and Dueça Spring, the exploration of the sinkholes situated south of Oak tree Woods Pit, the connection between Várzea Sinkhole and Algarinho Cave, the confirmation of the water flow between Várzea Sinkhole and Dueça Spring, are some of the great challenges for the explorers. Other studies like climatology, bioespeleology and archaeology are some of the areas that is urgent to plan and develop.

We believe that Dueça Cave System is of utmost importance, both regionally and nationally and we feel it is our obligation to carry on with the exploration and the research. We know that this is a somewhat modest presentation but it is a start. Therefore, we are prepared to make all the necessary efforts to prevent the work from stopping, so that, with the collaboration of all interested parties, we may show to the speleological community one of the most interesting cave system in Portugal.

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DUEÇA CAVE SYSTEM (PENELA - PORTUGAL)



- LEGEND:
- System cavities
 - Dueça Spring
 - Oak-Tree Blowhole
 - Oak-Tree Woods Pit
 - Algarinho Cave
 - Várzea Sinkhole
 - Talscas Doline
 - Sobral Doline
 - Várzea Depression
 - Caving shelter
 - Possible Hydrological Flow
 - Active sinkhole



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