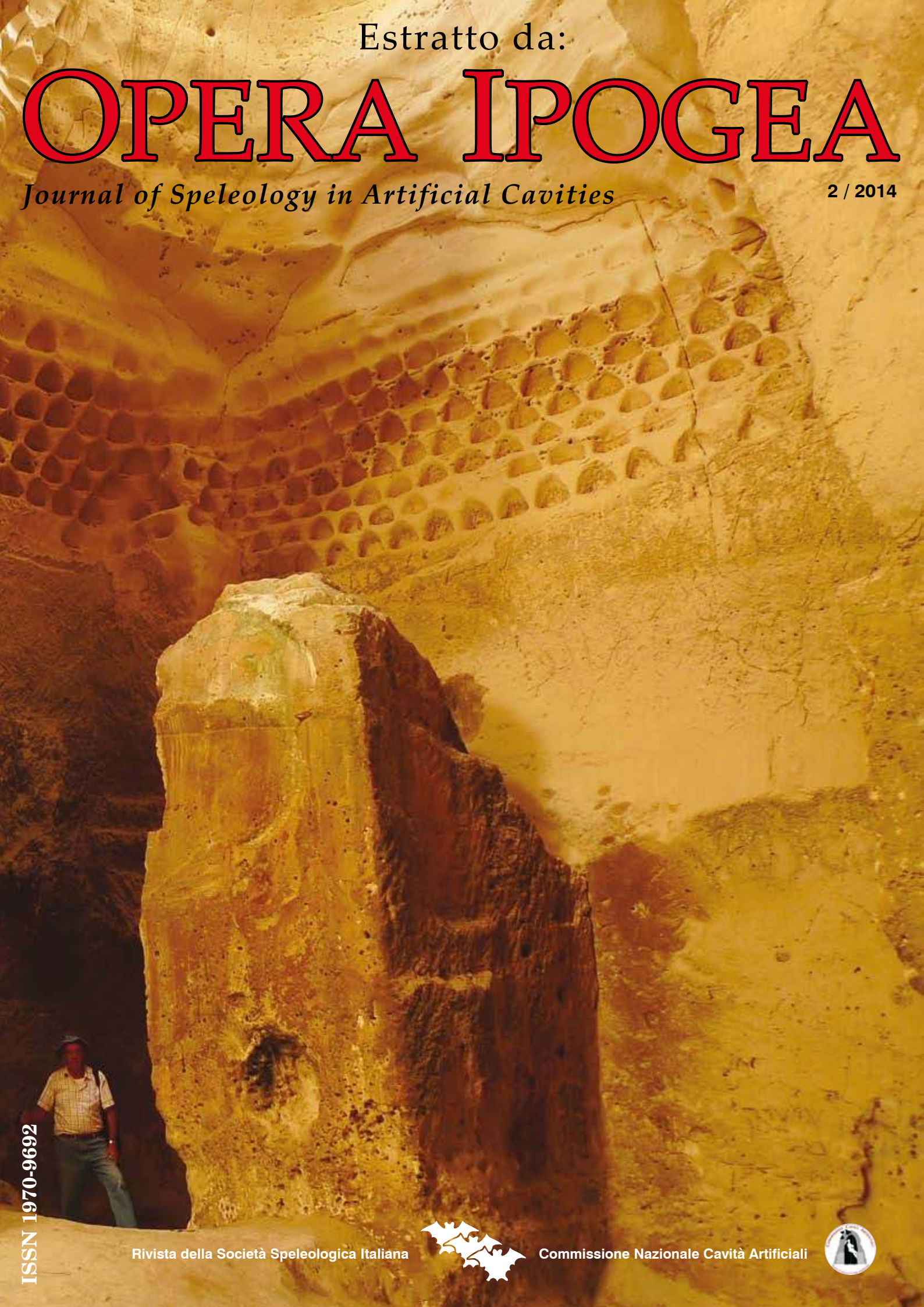
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Halys deviation tunnel and cliff dwellings of Sarıhıdır (Cappadocia - Turkey)

Eric Gilli[1], Ali Yamac[2], Ezgi Tok[2,3]

Abstract

The region known as Cappadocia and located today in the borders of four provinces, has witnessed continuous settlement from prehistoric times up to now. Tuffaceous rocks spewing out of the active volcanos in the late Pliocene and Pleistocene period in the region were used for many different purposes such as houses, barns, churches, etc. There are even underground cities for shelter and defence. Yet, one of the most interesting underground artificial caves of the region is, without any doubt, the tunnel, which is supposed to be used to divert Kızılırmak River (antique name Halys), located in Sarıhıdır Village near Avanos. The aim of digging the tunnel should have been to build a ford or a shallow point in order to cross the main stream of Halys. The age of the tunnel is unknown but a text from Herodotus reports the use of a deviation of Halys by Croesus' army in 550 BC to attack the city of Pteria, in the Persian kingdom of Cyrus. The conception is attributed to Thales. Its location helps to precise the geography of the road network in the Antiquity.
During the exploration of the whole area, 16 different dwellings located above the deviation tunnel were also explored and surveyed. Three of these dwellings were natural caves which were partly fitted out and inhabited. Among the remaining 13 artificial dwellings, a large caravanserai (or a guarding post), several cisterns and graves are important items to mention.

Keys words: Cappadocia, troglodyte, deviation tunnel, cave dwelling, Croesus.

Riassunto

Il tunnel per la deviazione del fiume Halys e le abitazioni rupestri della falesia di Sarihidir (Cappadocia - Turchia)

La regione conosciuta come Cappadocia e situata oggi nei confini di quattro province, è stata la scena di continui insediamenti dalla preistoria fino ad oggi. Le rocce tufacee eiettate dai vulcani attivi all'epoca del tardo Pliocene e Pleistocene nella regione sono state scavate e utilizzate dalla locale popolazione per molti scopi diversi, come costruire case, fienili, magazzini, chiese, moschee, ecc. Vi sono anche città sotterranee per nascondiglio e per difesa. Tuttavia, una delle più interessanti cavità sotterranee della regione è, senza dubbio, il tunnel, che doveva essere usato per deviare il fiume Kızılırmak (nell'antichità chiamato Halys), situato nel villaggio Sarıhıdır, vicino Avanos. La ragione per cui fu scavato il tunnel potrebbe essere riconducibile alla esigenza di creare un guado, o comunque un punto di attraversamento, del ramo principale del fiume Halys. La datazione del tunnel non si conosce esattamente, ma un testo di Erodoto riporta la notizia della deviasione del corso del fiume Halys da parte dell'esercito di Creso nel 550 a.C. per attaccare la città di Pteria, nel regno persiano di Ciro. L'ideazione dell'opera è attribuita a Thales. La sua posizione è di supporto alla individuazione della geografia della rete stradale nell'antichità. Durante l'indagine di tutta l'area, sono state esplorate e studiate 16 diverse abitazioni rupestri situate lungo la scarpata fluviale posizionata sopra il tunnel di deviazione. Tre di queste cavità sono grotte naturali, parzialmente attrezzate ed un tempo abitate. Delle restanti 13 cavità artificiali sono degne di nota il grande caravanserraglio (o posto di guardia) e diverse cisterne e tombe.

Parole chiave: Cappadocia, insediamenti rupestri, tunnel di deviazione, Creso.

[1] Paris 8 University. Department of Geography. 2, Rue de la Liberté, 93526, Saint Denis, Paris, France, e-mail: e.gilli@wanadoo.fr.
[2] OBRUK Cave Research Group, Açikhava Apt. 16/7, Nisantasi, Istanbul, Turkey, e-mail: ayamac@gmail.com.
[3] ITU, Istanbul Technical University, EURASIA Earth Sciences Institute.

Introduction

In the Cappadocia region of Turkey (fig.1), the difficulty of disposing of construction materials like building stone, wood and binder, combined with the existence of friable volcanic tuff has fostered the development of a troglodyte civilization (Bixio & Castellani, 1995, 2002). Ultimately, all of the structural problems such as sheltering, inhabitancy, barns and religious buildings were resolved by underground structures. In 1984, during a speleological expedition (Gilli, 1984; 2013), discovery of an enigmatic tunnel revealed another surprising underground solution that had solved the problem of crossing a major river, which was a natural border between Persian and Greek worlds during antiquity. Five kilometres upstream of Avanos, at the Sarıhıdır Village, the river Halys (Kızılırmak) makes a tight loop that encloses on the east bank a cliff of light yellow ignimbrites whose vertical walls are pierced by cave dwellings (figs. 2, 3 and 4).

The total number of artificial caves located in the eastern wall, 400 m long and 80 m high, are 16. Among these, some are simple settlements with cisterns, caravanserai or a military guard post and even Roman graves.

At the bottom of the cliff, only few meters above the river, a deviation tunnel exists which is longer than 200 meters. Both entrances of the tunnel are at the same level and there is no different tributary or a gallery inside. In such a case, no aim for this tunnel, which is 200 m long, could be thought other than deviating Halys and forming a way to cross the main stream of river.

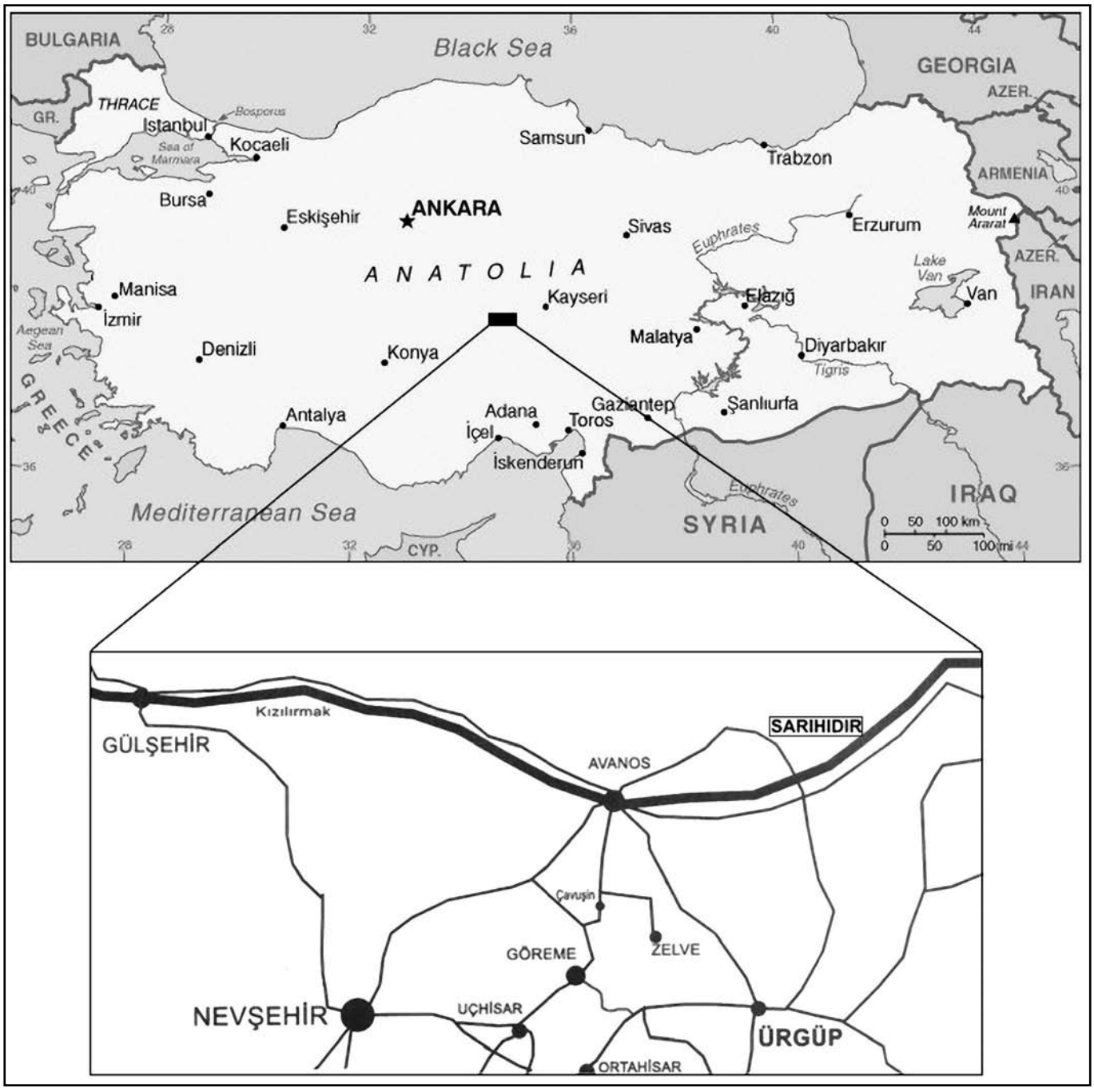


Fig. 1 - Location map of Cappadocia and Sarıhıdır Village (drawing: A. Yamac).
Fig. 1 - Carta di ubicazione della Cappadocia e del villaggio di Sarıhıdır (grafica: A. Yamac).



Fig. 2 - Google Earth view of the area of study. Location of Sarıhıdır Wall shown with a rectangle.
Fig. 2 - Vista di Google Earth della zona di studio. Il rettangolo indica l'ubicazione della Falesia di Sarıhıdır.



Fig. 3 - Sarıhıdır Wall, north is on the right side of photo (doc. Google Earth).
Fig. 3 - Panoramica della Falesia di Sarıhıdır; il nord è a destra della foto (doc. Google Earth).

Halys (Kizilirmak) River Deviation Tunnel

Description

The tunnel is a man-made structure, 8 to 10 meters wide, entirely dug into volcanic tuff (figs. 5 and 6). The southern entrance quickly gives access to a wider portion where the progression is easy, mostly standing. The floor is covered with river sand. Traces of picks and oil lamps housings are visible on the walls. The height is about two meters above the sedimentary fill. It is understood from the researches that the sedimentary fill has a thickness of at least 2 m. The tunnel is interrupted by two collapsed zones, filled with fallen blocks and after a course of about 200 m, it exits at the foot of the wall, close to the river. It has long functioned as its floor is covered with river sand and the walls are eroded. Two collapsed zones, which partially blocked the flow, and provoked river sediment deposit, are probably responsible for the interruption of this deviation, forcing the Halys (Kızılırmak) to regain its original bed. Outlying facilities were then ruined by the Kızılırmak floods and the natural erosion of the hillsides.

Geotechnics of the Tunnel

The shape of the tunnel is simple, with a plane vault and vertical walls. Near the entrances, the tunnel is eroded at its basis, but in its central part, it offers a well-preserved section.
The height of the tunnel is more than 3 m, probably 4 m, which, for a section of 32 m^2 and a length of about 200 m, would approximately be 6.400 m^3 of excavated material. With a density close to 2 ton/m^3, this represents about 12.800 tons of cuttings to be evacuated. In the places that were preserved from erosion, traces of picks

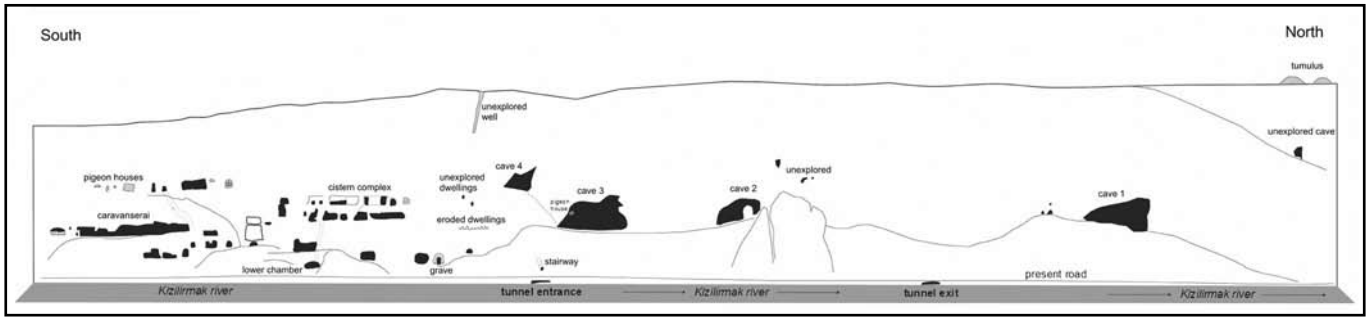


Fig. 4 - Sketch of Sarıhıdır Wall, showing all dwellings and natural caves. Entrance and exit of Deviation Tunnel can be seen at the bottom of the cliff near to Halys River (drawing: E. Gilli).
Fig. 4 - Schizzo della Falesia di Sarıhıdır, con l'indicazione delle grotte e delle destinazioni d'uso delle diverse cavità artificiali. Ingresso e uscita del tunnel sono visibili alla base della falesia prospicente il fiume Halys (grafica: E. Gilli).

and oil-lamp housings can be seen. In both places where the tunnel collapsed, the tuff is weakened by the presence of faults. Moreover, the horizontal shape of the vault shows that tuffs have a good mechanical behaviour when they are homogeneous. However, they are sensitive to erosion and the lower parts of the tunnel sidewalls are over excavated by water. Given the presence of river sand it is impossible to know the shape and the state of conservation of the lower sections of the tunnel.



Fig. 5 - Deviation Tunnel. The ground is filled with sediment thicker than 2 meters (photo: E. Gilli).
Fig. 5 - Galleria di deviazione. Il pavimento è pieno di sedimento, per uno spessore superiore ai 2 metri (foto: E. Gilli).

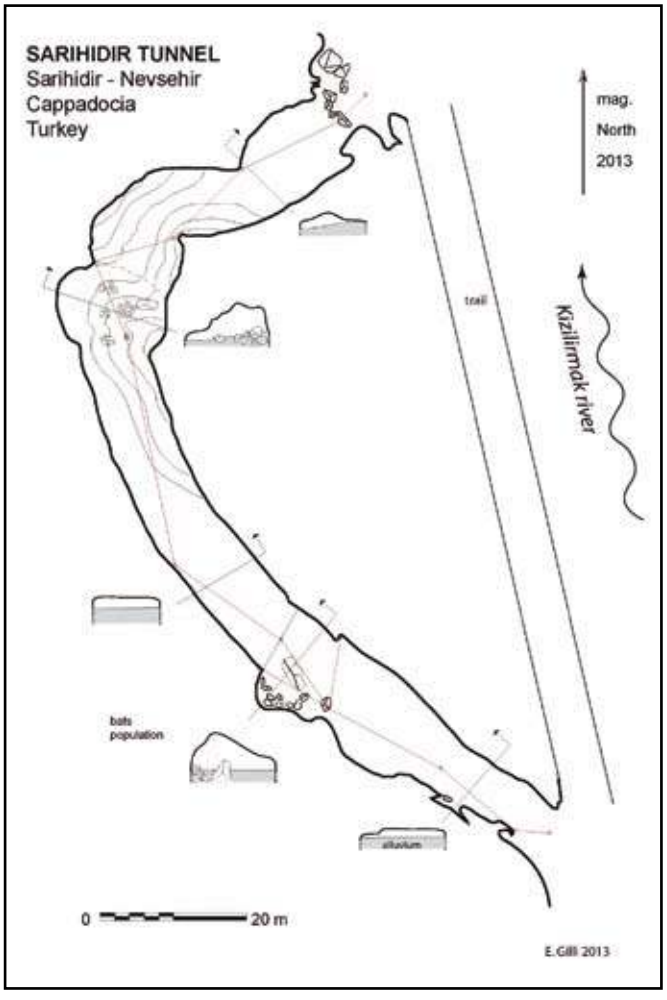


Fig. 6 - Plan of Deviation Tunnel (drawing: E. Gilli).
Fig. 6 - Pianta della Galleria di deviazione (grafica: E. Gilli).

Purpose, Possible Age and Duration of Sarıhıdır Tunnel

The most attractive explanation for the presence of this tunnel is an hydraulic by-pass to deviate the Kızılırmak river and to drain a portion of its bed. This made it possible to create a ford and to allow its crossing by caravans.

Kızılırmak river is approximately 60 meters wide, but the observed altitude of sedimentary deposits on the river banks proves that the water level can significantly rise up during floods and cause damage. For instance, a modern bridge, 2.5 km downstream of the site, was washed away during the 1983 winter floods. In the second millennium BC, during the Hittite period, important works were realized in Central Anatolia to solve water problems (Castellani, 2002; Ozis et al., 2010). For a civilization that dominated water works and cave dwellings techniques, it had to be easier digging a tunnel than building a bridge. The cuttings were probably used to make a dike or cofferdams, to create the ford. Troglodyte stairs are placed vertically to the tunnel, thus it is possible that this by-pass was equipped with a system of locks to activate the ford.

When Croesus went from Lycia to war against Cyrus II, in 547 BC, he had to cross the Halys river to reach Pteria, an important city that was completely destroyed during that war. Pteria was localized in the center of the loop of the Halys, at Kerkenes Dağ (Summers, 1997).

A first hypothesis is that Croesus used a north route, by Gordion. The following course can be proposed: from Sardis, this road goes east to Gordion, crosses the Halys, then reaches Pteria. Its course to the east and the southeast is unknown. Herodotus indicates that the route then passes through Cappadocia and Cilicia to reach and cross the Euphrates, but the distances he gives are not correct (Briant, 1996).

One can imagine a second scenario in which Croesus could choose to take a more southerly route and enter to the kingdom of Cyrus at Sarıhıdır (fig. 7). This is supported by a legend from Herodotus (Book 1-75), where Thales of Miletus is involved (Macaulay, 1890). The latter, a Croesus' military advisor, would have allowed the passage of troops through a derivation of the Halys.

"… And when Croesus came to the river Halys, then, according to my account, he passed his army across by the bridges which there were; but, according to the account which prevails among the Hellenes, Thales the Miletian enabled him to pass his army across. For, say they, when Croesus was at a loss how his army should pass over the river (since, they add, there were not yet at that time the bridges which now there are), Thales being present in the army caused the river, which flowed then on the left hand of the army, to flow partly also on the right; and he did it thus: beginning above the camp he proceeded to dig a deep channel, directing it in the form of a crescent moon, so that the river might take the camp there pitched in the rear, being turned aside from its ancient course by this way along the channel, and afterwards passing by the camp might fall again into its ancient course; so that as soon as the river was thus parted in two it became fordable by both branches: and some say



Fig. 7 - Map of Croesus' possible routes towards the Kingdom of Cyrus II (drawing: E. Gilli).
Fig. 7 - Mappa dei possibili percorsi di Creso verso il Regno Persiano di Ciro II (grafica: E. Gilli).

even that the ancient course of the river was altogether dried up. But this tale I do not admit as true, for how then did they pass over the river as they went back?"
The presence of pathways and cave dwelling facilities proves that the bypass ran for a long time. This is not a temporary structure, quickly dug by the army of Croesus. It seems more likely that Thales has suggested using a pre-existing work, and then the oral transmission has wrongly assigned to him the paternity of the work. Especially, since Thales would have been 75 years old in 550 BC, which seems too old to participate in such a military campaign.
Sarıhıdır Tunnel which is located on an important commercial axis from Mersin to Sinop (fig. 7) was probably the best place to cross the Halys River for an unknown period. However it was not in function during the fourth century. The study of the correspondence of St. Basil of Caesarea, by Louis Sébastien Lenain Tillemont (1732) reveals a request made in 355 AD to Theodosius (Vicar of the Pont) to repair a bridge over the Halys.
"If a letter to Theodosius of our named Saint is truly from him (he may have written it in that time, at the end of winter, because the subject of this letter is that the Halys river, swollen by melted snow, and flooded the country with a bridge that broke) Cappadocia received various conveniences from Galatia, Paphlagonia and Helenopont, the author requests Theodosius [who could be Vicar of Pontica] to repair it, to relieve all that has been afflicted by storms and hail and prevent starvation the region was threatened by".
Later, the Bishop of Caesarea, in a letter intended for the Emperor Theodosius I (reigned 379-395 AD) similarly complains about the need for traders to make a wide detour to the south, to cross the Halys river. They had to use the Royal Road, till the Kesik bridge, to transport to the north their goods and he asked for the construction of a bridge on the Halys (Hild, 1977). Subsequently, a bridge was built at Tekgoz during the 13th century (Culpan, 2002).

Sarihidir Cliff Structures

Cave Dwellings

Thirteen out of the 16 structures, located in the mentioned wall and all of which have been surveyed, are artificial dwellings. Most of these structures are rather small and were used as graves, barns or living spaces. The two structures, most important in terms of size and architecture, are:
Caravanserai or Guarding Post (figs. 8 and 9): the first floor of this structure, 11 m-high from the basement and on the southern edge of the wall, has a impressive length of 52 m. In this floor, the dimensions of 14 cells suggest they are horse stalls.
These facilities are partly degraded and some of them have been converted into pigeon houses. In the upper levels water was collected to fill cisterns. In some places tiny water infiltrations seem to have been channelled to feed the stalls. In the second storey, reached through an inside stairs, there is a large saloon of unknown use.
Cistern Complex (figs. 10 and 11): another structure in 70 m north of the abovementioned structure and in the same level is a three decker. The cistern of this structure, wholly carved into the rock is surprisingly at the top floor. A narrow water canal reaches the cistern here and the rest of the canal which carries water is still active today.
During our survey it was totally flooded and could not be investigated. The water collected in the cistern

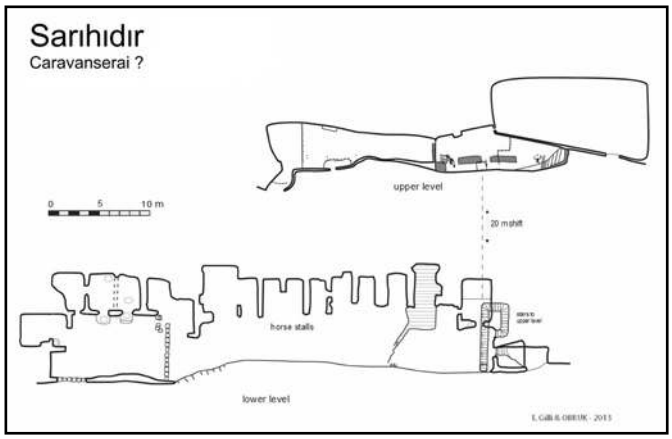


Fig. 8 - Plan of Caravanserai's first and second floors (drawing: E. Gilli).
Fig. 8 - Pianta del primo e secondo livello del Caravanserraglio (grafica: E. Gilli).



Fig. 9 - First floor of Caravanserai, remainings of horse stalls can be seen on the left side of photo (photo: E. Gilli).
Fig. 9 - Primo livello del Caravanserraglio: resti dei box per cavalli sono visibili sul lato sinistro della foto (foto: E. Gilli).

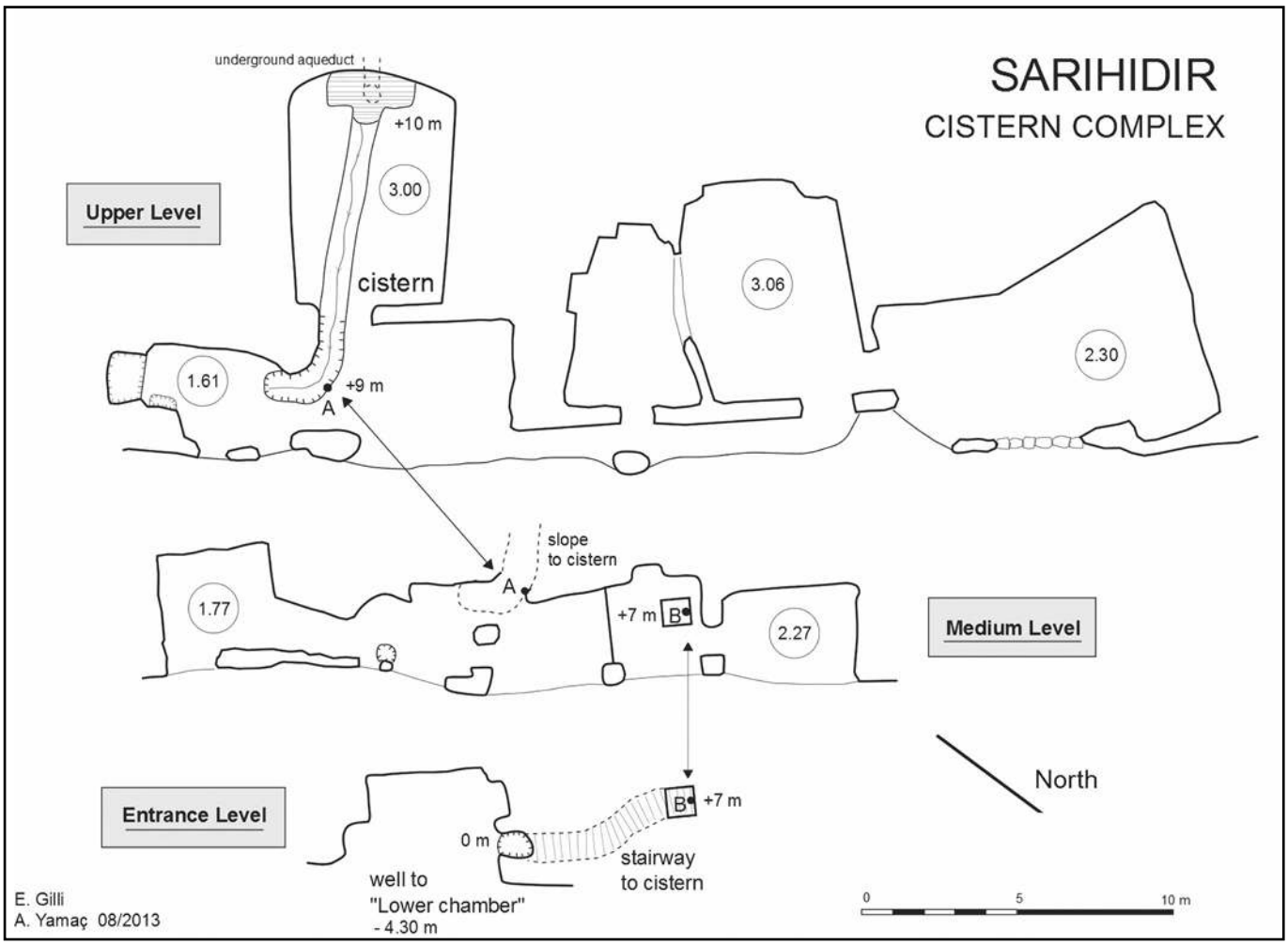


Fig. 10 - Plan of Cistern Complex (drawing: E. Gilli, A. Yamac).
Fig. 10 - Pianta del complesso della Cisterna (grafica: E. Gilli, A. Yamac).

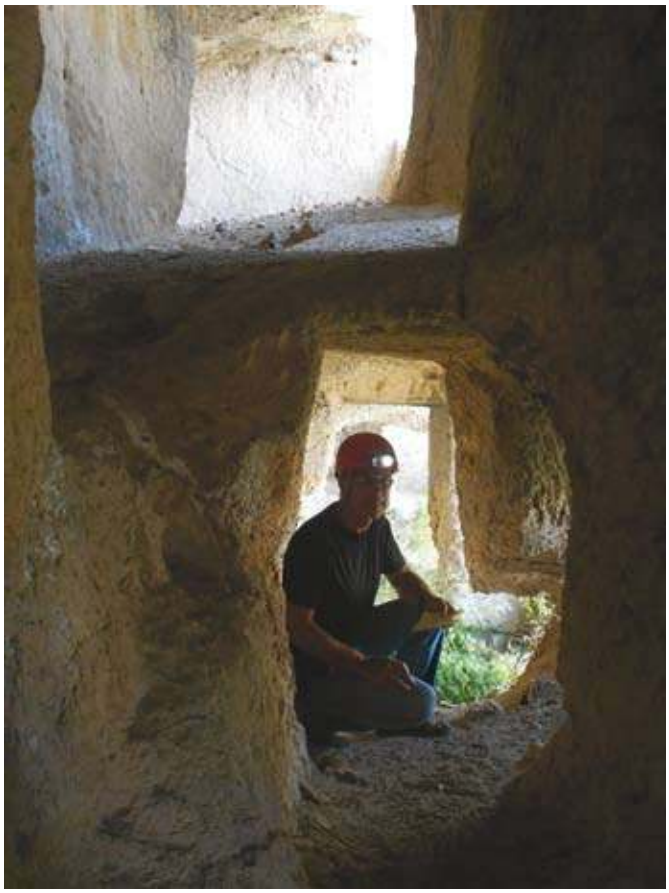


Fig. 11 - Middle level of Cistern Complex (photo: A. Yamac).
Fig. 11 - Livello intermedio del Complesso della Cisterna (foto: A. Yamac).

flows to the down storeys today; however it is clear that it was used by transferring to the canal in the past. There are small living spaces in all three storeys of this structure.

Natural Caves

In addition to the cave dwellings, the site also presents several natural caves which were partly fitted out and inhabited (figs. 12 and 13). Rings, basins and platforms carved into the rock and stone walls, are visible in all these caves. They all are in volcanic ignimbrites and are located in correspondence of local stratigraphic or structural discontinuities (faults, folds, cracks, clay lens), enlarged by the water.

Trail

The presence of an old track at the foot of the mountain and the existence of several levels of cave dwellings reinforce the hypothesis of a major road. On the west bank, south of the site, an old trail, with steps carved into the rock, can be followed to the top of the rock wall, where it disappears in a ploughed field.

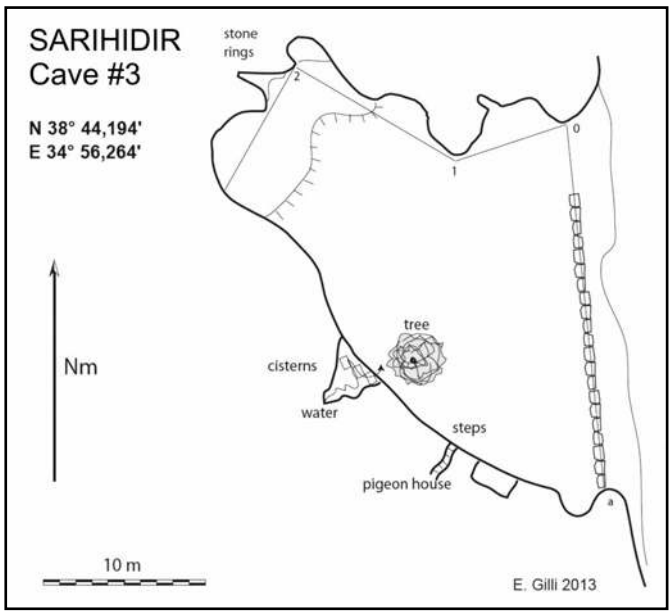


Fig. 12 - Plan of natural cave no.3 (drawing: E. Gilli).
Fig. 12 - Pianta della grotta n. 3 (grafica: E. Gilli).



Fig. 13 - Photo of the southern part of the Sarıhıdır Wall. From left; Caravanserai and Cistern Complex. Two natural caves, namely Cave 3 and Cave 2 are towards the right of the photo (A. Yamac).
Fig. 13 - Foto della porzione sud della Falesia di Sarıhıdır. Da sinistra: Caravanserraglio e Complesso della cisterna. Nella parte destra della foto sono visibili le due grotte, Grotta 3 e Grotta 2 (A. Yamac).

Geology of the Area

The Cappadocia zone is covered by horizontally layered, several hundred metres thick, volcanic tuffs, lavas and ignimbrites from Erciyes, Melendiz and Hasandağ volcanoes. These volcanic formations extend as a belt in the NE–SW direction, with a long axis of about 300 km (Aydan & Ulusay, 2012). They deposited on a bedrock formed by Mesozoic aged metamorphic, upper Cretaceous aged ultrabasic rocks and Palaeogene intrusions. The main volcanic phases took place from the Upper Miocene to the Quaternary (Ercan et al., 1991). In Sarıhıdır area the bedrock is formed, at north, by the Upper Cretaceous Ortaköy Granitoid mostly composed of granite and granodiorite dykes that intrude metamorphic terranes where marble is present. It is bordered to the south by a short strip of travertine left by thermal underground waters in the fault zones (Atabey, 1989). Marble and travertine are extracted in the İlktaş Madencilik Enerji Jeotermal quarry, immediately north to Sarıhıdır Village. Hot springs are still present on the left bank of Kızılırmak River, north to the Halys tunnel site.
Further to the south, extends the Upper Miocene – Pliocene Tuzköy Formation, which consists of laminated sandstone and claystone. The tunnel and the cave dwellings are dug in ignimbrites that belong to the Kavak volcanic formation (ignimbrites, tufs and lavas) which is present into and above the Tuzköy Formation. The ignimbrites locally contain Kızılırmak conglomerate (Atabey, 1989; fig.14). In some places they overlay claystone, lacustrine deposits or alluvium that are more sensitive to erosion. This made it possible the presence of the large natural caves that are present on the site (figs. 12 and 13).

Conclusions

The Sarıhıdır Tunnel is an interesting example of a troglodytic solution to a major hydrological problem in the Antiquity: the adaptation of a road network to an impetuous stream. We have no knowledge of a similar work elsewhere in the world. An underground drilling program to determine the thickness of the alluvium is necessary to define the accurate features of the tunnel. A search for remnants of equipment (locks, cofferdams, dikes) could also be carried out, but it has little chance of success because the violent floods of Halys have probably washed away any vestige.
Apart from its technical interest, the site could also have a great historical interest if its role, as the southern door of Cappadocia, used by Croesus in 550 BC, was confirmed. This can only be done through a campaign of dating. Although attractive, the theory of a design by Thales is implausible because the presence of troglodyte facilities proves a sustainable use of the site. However, this theory cannot be ruled out because the text of Herodotus remains, as a matter of fact, the only historical relation of a bypass on the Halys river.

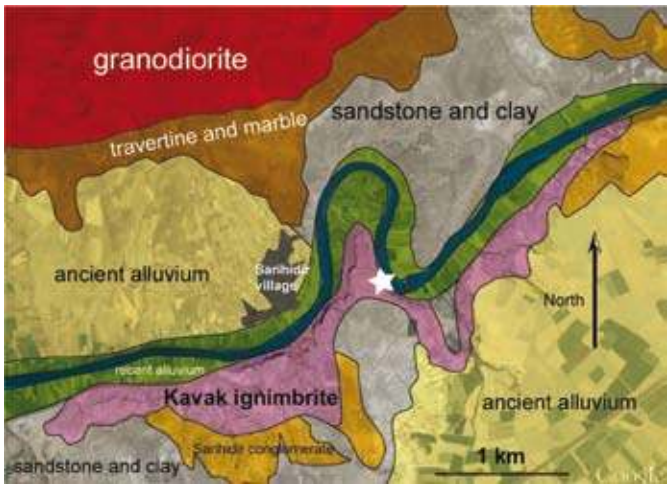


Fig. 14 - Geology of Sarıhıdır and surrounding areas (E. Gilli after Atabey, 1989)
Fig. 14 - Geologia di Sarıhıdır e delle zone circostanti (E. Gilli da Atabey, 1989)

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