Rock-cut cisterns and funnels in Cappadocia (Turkey) Considerations on findings in Göreme, Uçhisar, Şahinefendi and Sarıhıdır sites

Andrea Bixio[1], Roberto Bixio[1, 2], Andrea De Pascale[1, 3], Eric Gilli[4]

Abstract

The strategies for water collection, storing and distribution are fundamental for any human settlement. In Cappadocia, a region located on the Central Anatolian Plateau (Turkey), characterized by wide areas of volcanic tuffs, the ancient water works, as well as the dwellings, the churches, the refuges and whole villages, are mostly carved in the rock. Since the 1990s several researchers, with expertise in caving, started specific surveys on Cappadocian underground water works, finding out the draining function of longitudinal tunnels, dug to reclaim the deep valleys around Göreme for farming purposes and, most recently, the real structure and construction techniques of "tunnel-cisterns" consisting of tunnels fed by loose stone trenches, instead of "chamber-cisterns". In this article we describe and compare some rock devices for water supply, alternative to wells and aqueducts, located and documented during recent expeditions in the four sites of Göreme, Uçhisar, Şahinefendi and Sarıhıdır, in the provinces of Nevşehir and Ürgüp. Those devices basically consist of "chamber cisterns", excavated in the cliffs, fed by rock-cut "funnels", that is a combined device of an opencast collecting basin, on the top of the cliff, and a vertical duct (downpipe) coming down to the ceiling of the cistern. Instead of water tables or sources, this system is directly fed by rainfall and snow melting, mainly during the spring, stored inside underground spaces, also pensile, adequate for domestic and farming needs and to provide drink for animals during the dry seasons. Actually, due to presence of flooded parts or to the erosional activity, always in progress, which caused destruction of large parts of the rock mass, it was not possible to entirely document every structure. However, the comparative analysis of the four sites provides some insights which allow us to present what we believe is a plausible scheme based upon similarity of the structures.

Key words: Cappadocia, Turkey, artificial cavities, rock-cut cisterns, draining tunnels, funnels, underground water works.

Riassunto

Cisterne e colatoi rupestri in Cappadocia. Considerazioni sui ritrovamenti nei siti di Göreme, Uçhisar, Şahinefendi e Sarihidir

Le strategie di raccolta, conservazione e distribuzione dell'acqua sono basilari per qualsiasi insediamento umano. In Cappadocia, regione collocata sull'Altipiano Centrale Anatolico, caratterizzata da enormi estensioni di tufo vulcanico, gli antichi impianti idrici, così come le abitazioni, le chiese, i rifugi e interi villaggi, sono stati in gran parte realizzati scavando all'interno delle masse rocciose. Dagli anni Novanta del Novecento diversi ricercatori, con esperienza speleologica, hanno dato inizio a indagini specifiche sulle opere idriche sotterranee della Cappadocia, scoprendo la funzione drenante dei cunicoli longitudinali, creati per la bonifica a scopi coltivi delle profonde valli attorno a Göreme e, più recentemente, la reale conformazione e tecnica costruttiva dei "cunicoli-cisterna" costituiti da tunnel alimentati da trincee-vespaio, anziché da camere. In questo articolo vengono descritti e comparati alcuni dispositivi rupestri destinati all'approvvigionamento idrico, alternativi a pozzi e acquedotti, individuati e documentati nel corso di recenti spedizioni

[1] Centro Studi Sotterranei. Genova (Italy)
[2] Hon. Inspector for Artificial Cavities - MiBACT, Rome (Italy), roberto.bixio@gmail.com
[3] Archaeological Museum of Finale - Istituto Internazionale di Studi Liguri, sez. Finalese (Italy)
[4] Paris 8 University, Department of Geography (France), e.gilli@wanadoo.fr

nei quattro siti di Göreme, Uçhisar, Şahinefendi e Sarıhıdır, nelle province di Nevşehir e Ürgüp. Tali dispositivi sono essenzialmente costituiti da "cisterne a camera", scavate nelle pareti delle falesie, alimentate da "colatoi" rupestri composti da un bacino di raccolta a cielo aperto, posto sulla sommità del gradone di roccia, e da un condotto verticale (pluviale) che scende sino al soffitto della cisterna. Tale sistema, anzichè da falde o sorgenti, è alimentato da precipitazioni meteoriche ed acqua di fusione nivale concentrate in primavera e accumulate in volumi sotterranei, anche pensili, sufficienti alle necessità domestiche, agricole e per l'abbeveraggio degli animali durante i periodi siccitosi stagionali. In realtà, a causa di parti allagate o dell'erosione, sempre in divenire, a seguito della quale grandi porzioni di roccia sono scomparse, non è stato possibile esplorare e documentare integralmente ciascuna struttura. Tuttavia, l'esame comparato dei quattro siti, fornisce riscontri reciproci che, per similitudine, hanno consentito la ricostruzione di uno schema, nei termini sopra esposti, che riteniamo attendibile.

Parole chiave: Cappadocia, Turchia, cavità artificiali, cisterne rupestri, cunicoli di drenaggio, colatoi, opere idriche sotterranee.

Introduction

There is no doubt that a fundamental element for any settlement, not only rock-cut, is the water availability. If the water is not present at the surface, strategies for collection, storage and distribution have been carried out, everywhere and at any time, depending on local geological and morphological characteristics, by realizing wells, *qanat* (see e.g.: Castellani, 2001; Hu et al., 2012; Kuros & Khaneiki, 2007; Lightfoot, 2009; Mays, 2010), aqueducts (see e.g.: Gilli & Yamaç, 2015; AA.VV., 2007) and assorted reservoirs.

In Cappadocia (Central Anatolian Plateau - Turkey) the different solutions have been greatly influenced by a territory with a wide and thick deposit of soft volcanic tuffs (fig. 1) in which, due to the scarcity of building stones and timber, the settlements have been mainly developed by carving the rocks: here dwellings, stores, stables, pigeon-houses, apiaries, churches, refuges and whole villages have been excavated in the cliffs and the subsoil (Bixio, 2012).

In the same way, most of the ancient water works have been dug inside the rock mass.

Since only a couple of decades some researchers, not surprisingly all expert cavers, are realising specific investigations on the ancient excavated water works, especially inside the deep valleys, strongly carved, which characterize a portion of the territory in the district of Nevşehir (fig. 2).

Vittorio Castellani was, in the 1990s, precursor in such research (Bicchi et al., 1995; Castellani, 2002): he first documented the longitudinal collectors, named "drai-

Fig. 1 - Location of the study area. The dotted area corresponds to volcanic tuffs of Cappadocia (drawing R. Bixio).
Fig. 1 - Ubicazione dell'area di studio. La zona punteggiata corrisponde ai tufi vulcanici della Cappadocia (grafica R. Bixio).

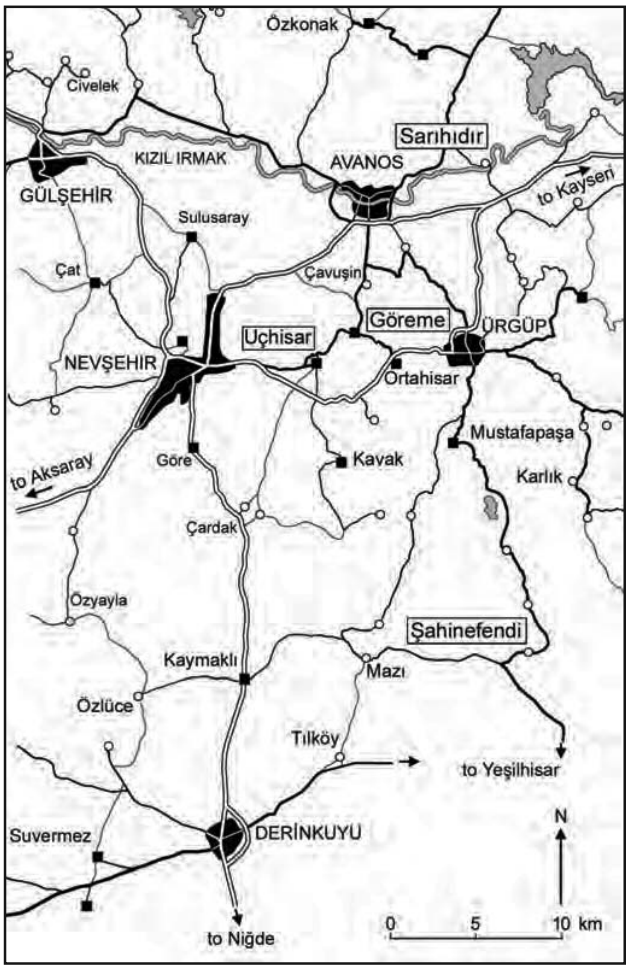

Fig. 2 - Nevşehir district: location of Göreme, Uçhisar, Şahinefendi and Sarıhıdır sites (drawing R. Bixio).
Fig. 2 - Distretto di Nevşehir: collocazione dei siti di Göreme, Uçhisar, Şahinefendi e Sarıhıdır (grafica R. Bixio).

ning tunnels" (fig. 3), dug along the axis of the valleys carving the plateau around Göreme.
He was able to define their real function that was to contain the torrential flows, by eliminating from the beds the water in surplus that provoked intense erosion, in order to make it available for farming sheltered areas that were supplied, in the meantime, with water reservoirs for irrigation (fig. 4).
Recently, some intake points have been subject to detailed investigations which led to discover their real structure and realization technique.
In detail, they consist of special systems for water gathering, storage and distribution by means of "linear cisterns", i.e. structures consisting of long tunnels working like reservoirs.
This ducts are dug with the "opposite front" technique and are fed, rather then by water tables, by means of simple and effective devices consisting of "intake rooms" (fig. 5) and "loose stone trenches", where the rainfalls and the snowmelt are channelled.
Those devices, named "tunnel-cisterns" (fig. 6), will be subject in the next future of a specific work.
In the meantime, with this article, we point out four characteristic rock-cut water systems, which prove the variety of solutions devised to obtain the indispensable water. These are located in four different places in the provinces of Nevşehir and Ürgüp, near the villages of Göreme, Uçhisar, Şahinefendi and Sarıhıdır (fig. 2).
At least two of them presume the presence of "chamber cisterns", dug in the rock of the cliffs, fed by "funnels" consisting of external collecting basins connected by means of vertical ducts (downpipes).

Fig. 3 - Göreme. Draining tunnel in the Kılıçlar Vadisi (photo A. De Pascale).
Fig. 3 - Göreme. Cunicolo di drenaggio nella Kılıçlar Vadisi (foto A. De Pascale).

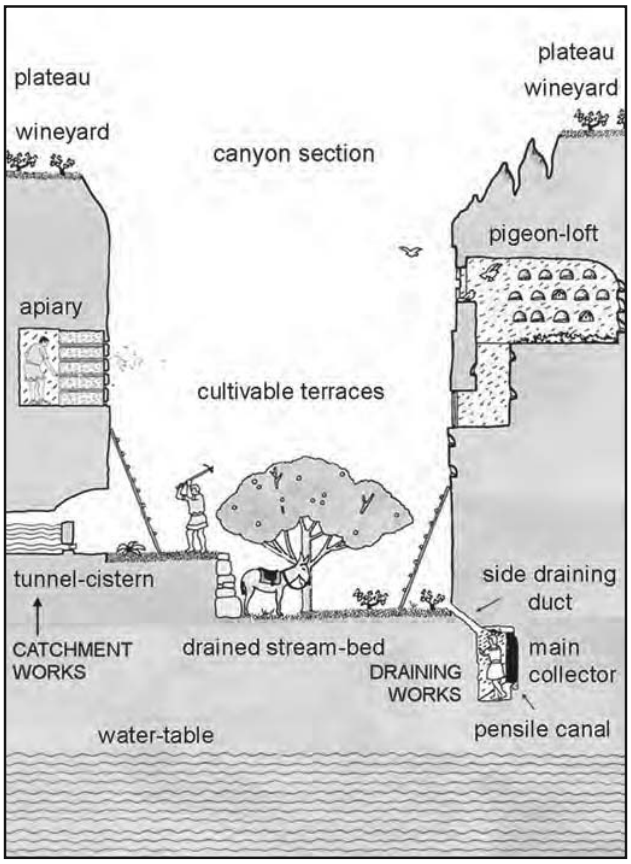

Fig. 4 - Scheme of underground hydric systems in the valleys of Göreme area (drawing R. Bixio).
Fig. 4 - Schema dei sistemi idrici ipogei realizzati nelle valli dell'area di Göreme (grafica R. Bixio).

Fig. 5 - Kılıçlar Vadisi (Göreme). Intake room of a tunnel-cistern (photo A. Bixio).
Fig. 5 - Kılıçlar Vadisi (Göreme). Camera di prelievo di un cunicolo-cisterna (foto A. Bixio).

The cistern of the Funnel in Zemi Vadisi

This site (GPS 54) is located in the Zemi Vadisi (figs. 7, 8). This is a long valley, outlined by two narrow ridges (*sırt*), remains of a large plateau, which divide it, we-

Fig. 6 - Göreme. Flooded tunnel-cistern in the Kılıçlar Vadisi (photo A. Bixio).
Fig. 6 - Göreme. Cunicolo-cisterna allagato nella Kılıçlar Vadisi (foto A. Bixio).

stward, from the Pigeon Valley (Güvercinlik Vadisi) on whose outlet is located the village (*köy*) of Göreme (old name Avcılar, corresponding to the ancient Matiane), and eastward from the basin where the Byzantine rock churches complex of Korama is located, from which the name of the whole area is derived.
The Cistern of the Funnel is part of a group of cavities dug in the cliff which defines the present stream-bed (*dere*), completely dry, on the right bank, at an altitude of 1.250 m a.s.l., 500 m south of the well-known church (*kilise*) of El Nazar, and almost in front of the Flamboyant Church. The rock crag is topped by a natural terrace corresponding to the paleo stream-bed, and bordered by a second surrounding cliff, backwards.
The complex consists of some half collapsed pigeon-houses and, probably, an apiary pointed out by a small door flanked by two parallel slits.
The various rooms open on some terraces, once cultivated, supported by dry stone walls. There are also rings of rock with old grapevines remaining still hanged up.
In addition to the rural complex, a cistern with a special feeding system has been carved inside the rock, 15 m sideways from the first two structures.

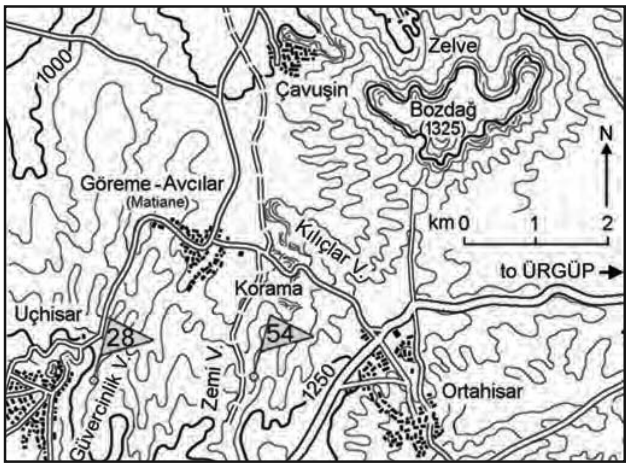

Fig. 8 - Göreme. Zemi (flag 54) and Güvercinlik (flag 28) valleys area (drawing R. Bixio).
Fig. 8 - Göreme. L'area delle valli di Zemi (punto 54) e di Güvercinlik (punto 28; grafica R. Bixio).

The elevated entrance, dug in the rock face about 4 m above the ground level, is reachable (today with difficulty), by means of a worn foothold (figs. 9, 10).

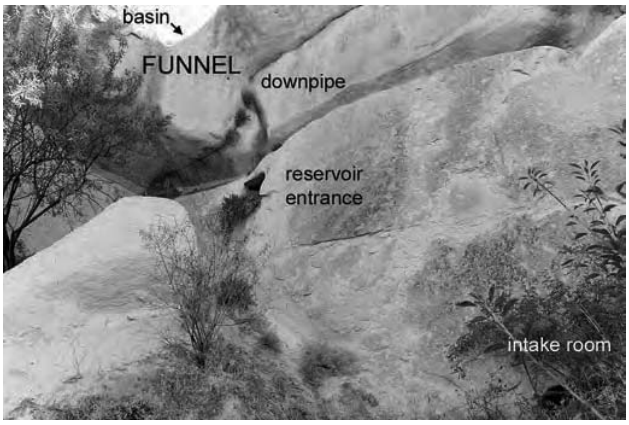

Fig. 9 - Zemi valley. The cliff where the Cistern of the Funnel was excavated (photo A. Bixio).
Fig. 9 - Valle di Zemi. La falesia in cui è stata scavata la Cisterna del Colatoio (foto A. Bixio).

Fig. 7 - Zemi Valley, between the Göreme village (köy) and the ancient area of Korama churches (photo A. Bixio).
Fig. 7 - La valle di Zemi, tra il villaggio (köy) di Göreme e l'antica area delle chiese di Korama (foto A. Bixio).

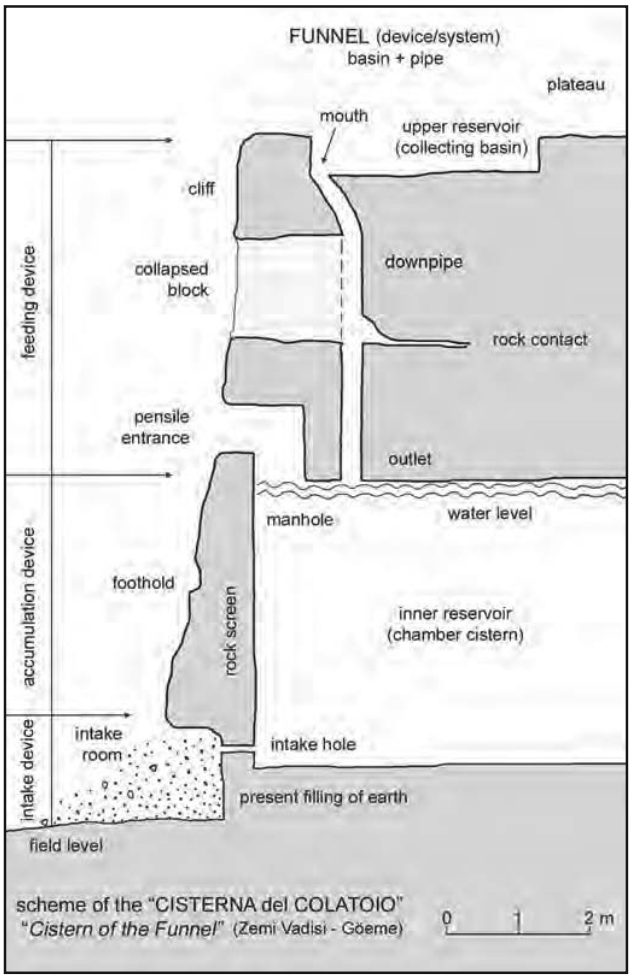

Fig. 10 - Göreme, Zemi valley. Scheme of the Cistern of the Funnel (drawing R. Bixio).
Fig. 10 - Göreme, valle di Zemi. Schema della Cisterna del Colatoio (grafica R. Bixio).

The opening is rectangular, about 70 cm high, with a short parapet leading in a manhole, which opens on the ceiling of the underground chamber, with a step about 25 cm lower than the entrance threshold (fig. 10).
Shape and dimensions of the cistern, separated from the outside by a thin rock screen, cannot be evaluated since the room is fully flooded, up to the ceiling.
For this reason, we could not check whether in this case, as for others nearby founded, there is or not a horizontal feeding tunnel which penetrates into the rock. However, we believe that the device realized above the entrance could be sufficient for the water storage.
It consists of a vertical winding duct, about 20 cm in diameter, which, by coming down through the rock thickness, allows the rainfall water to percolate from the top of the cliff to the ceiling of the cistern.
The pretty long perforation (about 4 m), was probably facilitated by a natural recess, corresponding to the contact between two horizontal tuff layers, where the duct develop with an open section.
Since, during the survey, we could not reach the top of the cliff, we can only hypothesize that the feeding system should probably include an open basin, carved on the rock surface, to collect the rainfall and snowmelt, and to channel it in the cistern through the downpipe described above. We extend the name "funnel" to the whole feeding system.
This hypothesis is corroborated by the finding of several enigmatic basins in the site of Yarlağan Tepe, documented in the next section, cut by the recession of the cliff, which would be explained precisely with the configuration of the system found in the Zemi Vadisi.
We finally point out that, at the base of the rock wall, under the entrance of the cistern, a few metres aside, there is the entrance of a buried cavity (fig. 8), which probably, in analogy to similar devices in the area (fig. 5), should be the intake room of the reservoir (fig. 10). In this case, it is clear that the water system is not used since long time. Anyway we point out that the period of drought, at the time of the exploration, in summer 2014, produced the full drying up or a considerable decrease of reservoirs in all the investigated structures nearby. On the contrary this cistern was totally flooded: so we believe it should have an excellent rate of water-proofing.

The Funnels of Yarlağan Tepe

The site of Yarlağan Tepe is located near the rural village of Şahinefendi, 20 km south of Göreme (fig. 2). The present settlement is inside a natural amphitheatre, at an altitude of 1.350 m a.s.l., surrounded by high trachyte cliffs which border the top of the plateau, at altitudes between 1.500 and 1.600 m a.s.l. (fig. 11).

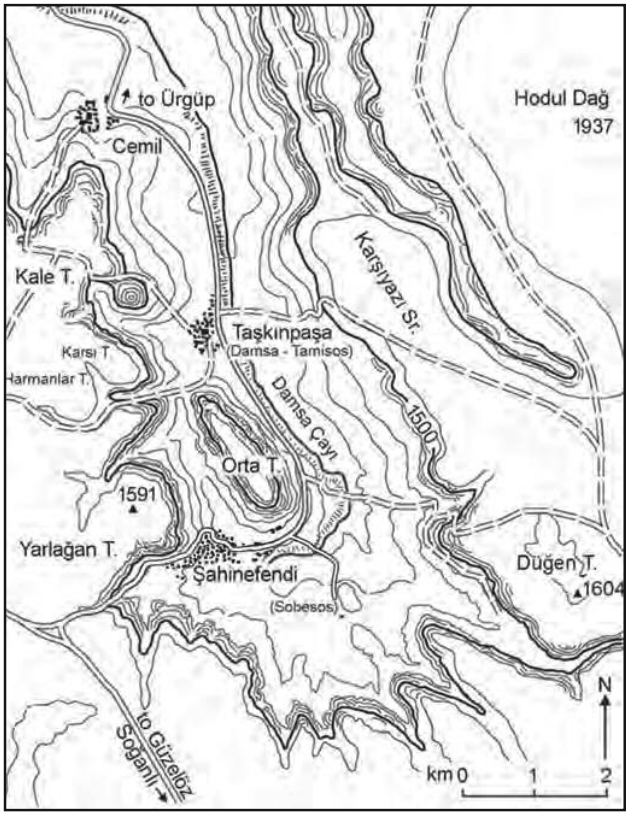

Fig. 11 - The catchment basin amphiteather of Şahinefendi (drawing R. Bixio).
Fig. 11 - L'anfiteatro fluviale di Şahinefendi (grafica R. Bixio).

The archaeological excavation of the Roman settlement known as Sobesos (Yenipinar et al., 2007) is located in its central part, while a large necropolis dating from the Phrygian period, or maybe from the oldest cultural horizon known as "Cappadocian painted ware" or "Alişar III" (Düring, 2011, pp. 287-299), dating back to the Early Bronze Age (EBA III – 2300-2000 a.C.), extends over the top of the Orta Tepe butte.

Several ancient rock-cut settlements have been found in the amphitheatre, the most known of which are the Byzantine complex around the Church of Forty Martyrs, wholly excavated inside a tuff pinnacle, and the Monastery, located in a slightly higher rock crag. However, during recent explorations other rock structures have been found, such as the "vertical refuge" of Orta Tepe and two "cliff wall villages", dug at heights, on the cliffs around the river basin (Andaloro et al., 2015).

The rock settlement of Yarlağan is located on the cliff above the urban centre of Şahinefendi (fig. 12).

It consists of several rooms excavated on superimposed levels along the vertical face of the cliff, approximately on a 300 m front (fig. 13).

At both ends there are two rock-cut roads (flags 113 and 122 in figs. 12, 13), now deteriorated, realized to reach the upper plateau, today connected by other ways, still used for agricultural and pastoral activities.

We note that the cliff morphology, in the course of time, has been considerably altered by collapsing of large parts of rock which produces the destruction of several underground rooms and their related infrastructures.

The impact of the slow but incessant cliff recession can be observed both on the boulders fallen at the base on which, sometimes, evidences of human intervention (niches, remains of tunnels or windows) could be noted, and on the vertical face where, together with dozens of

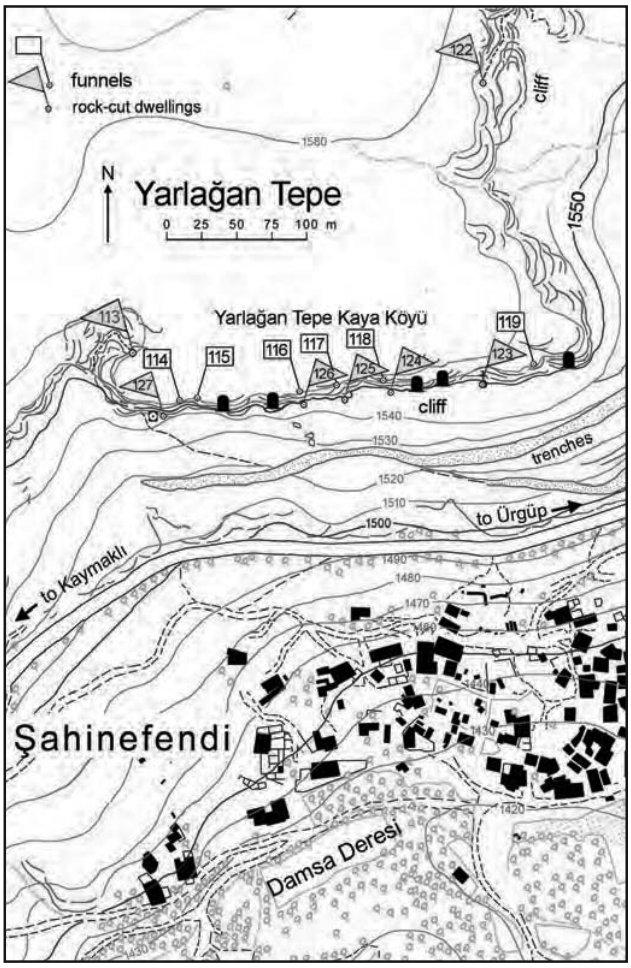

Fig. 12 - Şahinefendi. The cliff where the rock-cut village of Yarlağan Tepe is located (drawing R. Bixio).
Fig. 12 - Şahinefendi. La falesia che ospita il villaggio rupestre di Yarlağan Tepe (grafica R. Bixio).

Fig. 13 - Şahinefendi. Yarlağan Tepe cliff village (photo A. Bixio).
Fig. 13 - Şahinefendi. Villaggio a parete di Yarlağan Tepe (foto A. Bixio).

small windows revealing the presence of rooms still intact inside the rock, one can see many collapsed rooms, with their whole longitudinal section, parallel to the cliff, open to the outside and difficult to be reached.
For this reason, we could carry out so far only short inspections, in a very small part of the settlement, without surveying.
However, we found particular rock-cut structures (see triangular flags in figs. 12, 13), including a church, a "mushroom-like" oven, a vertical refuge with housing for a millstone-door, rooms interconnected by vertical shaft with the function of "traps" (figs. 14, 15).

Fig. 14 - Şahinefendi. Yarlağan Tepe: connecting shaft with footholds (photo A. Bixio).
Fig. 14 - Şahinefendi. Yarlağan Tepe: pozzo di collegamento con pedarole (foto A. Bixio).

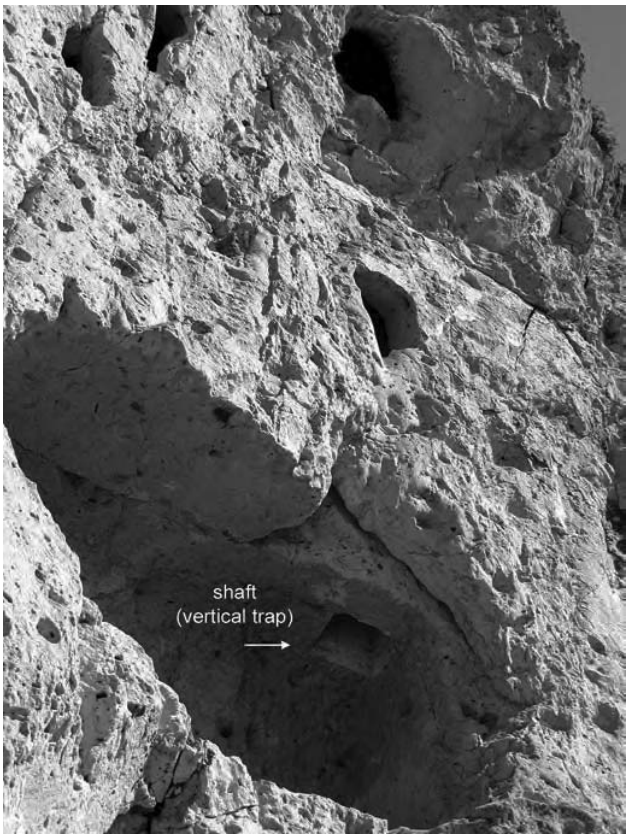

Fig. 15 - Yarlağan Tepe cliff village: superimposed storeys linked by an ascending shaft (photo A. De Pascale).
Fig. 15 - Villaggio a parete di Yarlağan Tepe: piani sovrapposti collegati da un pozzo ascendente (foto A. De Pascale).

The structures are all located above the break-slope line, at altitudes between 1.542 and 1.570 m a.s.l., with a relief of at least 100 m (the valley bottom is at about 1.450 m a.s.l.).
The question is, as for the others settlements at heights on the opposite sides of the basin, whether in the past springs, also temporary, could have been along the contact line corresponding to the entrances of the rock-cut dwellings, as the traces of water flowing in some cavities at the bottom of the rock bastion seem to suggest.
Moreover, we should not underestimate the well-known phenomenon of "peak springs" fed by the condensation that could be generated inside natural debris deposits or cracked rocks next to the ridges (Maifredi, 1995, p. 104).
However, during the exploration at the base of the cliff we did not notice any catchment work, or active springs. Instead, on the top of the cliff, we found traces of excavations that, we believe, correspond to a gathering system for rainfall and snowmelt, consisting of remains of several small basins carved at the surface, near the border of the plateau (see square flags in figs. 12, 13).
The basins identifiable, more or less worn, are at least eleven, spread along the whole front of the settlement. These basins still partially intact have an opening towards the valley or a short duct which could drop the water on the overhanging cliff (figs. 16, 17, 18, 19).
We note that, in the present state, this water gathering system would be useless, if not even detrimental for the integrity of the rock below in which the water would penetrate by producing erosion and cryoclastic phenomena. Indeed, we should not forget that, as we said before, the cliff recession was caused, over the centuries, exactly by the slope instabilities, in the forms of collapses of rock masses.
Therefore, we believe very likely that a portion of the distribution device for the water gathered in the basins is missing. Similarly to the Cistern of the Funnel described in the previous chapter, these devices probably consisted of vertical ducts, carved inside the face below, then cut by the rock collapse.
In some cases pairs of joints have been observed carved on both sides of the basins, near the border overlooking the valley (figs. 18, 19).
They could be housing for a sort of tripod or shutter, maybe for the water flow regulation. These vertical ducts should have channelled the water in specific cisterns that might be located on the higher levels of the settlement, then distributed in the lower residential levels.
As already said, we could not have access to the higher levels of the cliff wall village so we cannot confirm our hypothesis so far. However, the probable existence of pensile cisterns is indirectly supported, as well as by logical deduction, by the finding of this type of water system in the site of Sarıhıdır, described in the next section.

Figs. 16-17-18-19 - Remains of a few funnels (small basins with drains) on the cliff edge of YarlağanTepe (photo A. Bixio).
Figg. 16-17-18-19 - Resti di alcuni colatoi (vaschette con spandenti) sul bordo della falesia di YarlağanTepe (foto A. Bixio)

The elevated cisterns of Sarihidir

Close to Sarıhıdır Village (fig. 20), near Avanos, the Halys tunnel site is one of the most interesting underground artificial water work of the region (fig. 24).
A 200 m long tunnel was excavated in the ignimbrites (fig. 22) to divert the Kızılırmak River (antique name Halys), downstream the present dam (*baraj*). This work was done to create a ford or a shallow point in order to cross the river[1].
Above the tunnel (figs. 21, 24), a complex of cave dwellings was probably a caravanserai or a post guard (Gilli, 2013; Gilli et al., 2014). It includes numerous rooms in several stories. Their shape shows they were for both men and animals.
The lower part is a disorganised series of artificial rooms and natural caves partly modified by men.
The medium part is a more sophisticated system that contains different rooms and fourteen cells that were probably horse stalls (figs. 23, 25).

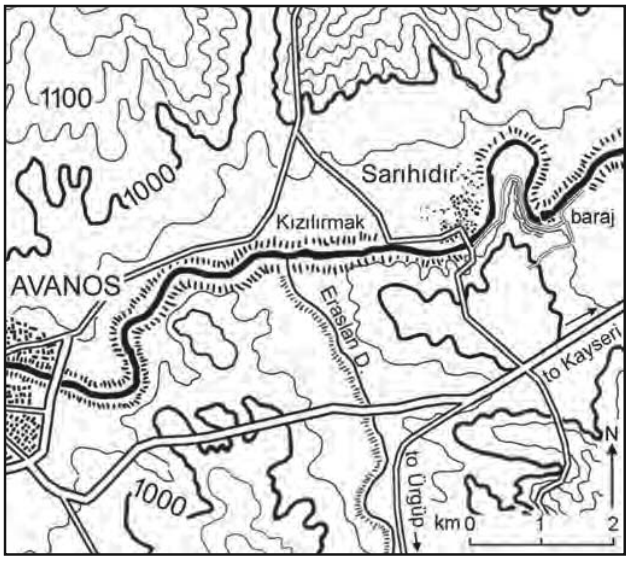

Fig. 20 - Loop of the Kızılırmak river near Sarıhıdır (drawing R. Bixio).
Fig. 20 - L'ansa del fiume Kızılırmak presso Sarıhıdır (grafica R. Bixio).

[1] The excavation of semi-circular trenches during a battle, in order to deviate a river, was cited by Herodotus who explains that Cresus used that solution to cross the Halys river to destroy Pteria (Gilli, 2013). This type of procedure was then mentioned in a Byzantine war strategy treaty (chapter "Crossing rivers") written by an anonymous war engineer in the middle of the sixth century A.D. (Dennis, 1985, p. 67).

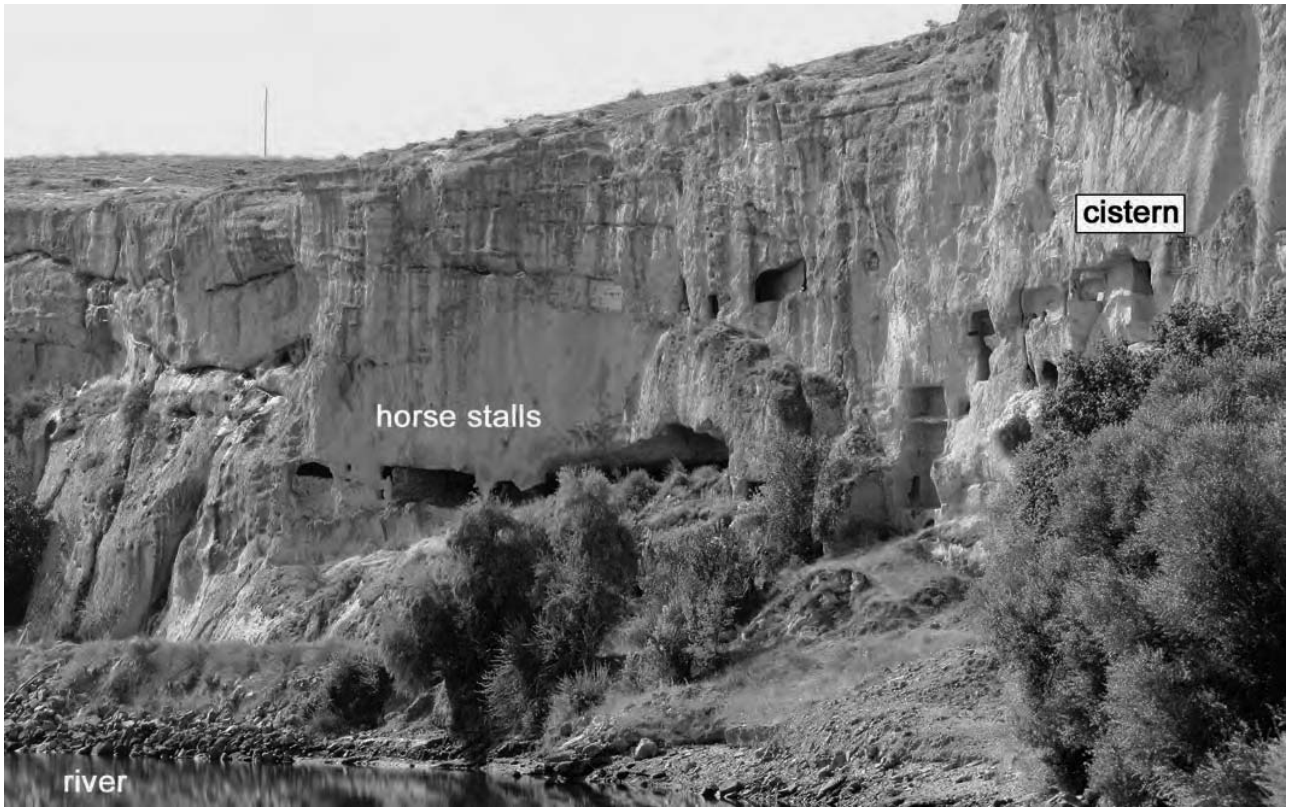

Fig. 21 - The rock wall above the loop of the Kızılırmak near Sarıhıdır (photo A. De Pascale).
Fig. 21 - La parete di roccia sopra l'ansa del Kızılırmak presso Sarıhıdır (foto A. De Pascale).

Fig. 22 - Ancient tunnel excavated to divert the Kızılırmak River (photo A. Bixio).
Fig. 22 - Antica galleria scavata per deviare il fiume Kızılırmak (foto A. Bixio).

Fig. 23 - Rock-cut partitions likely used as horse stalls (photo M. Traverso).
Fig. 23 - Tramezzi scavati nella roccia usati forse come stalli per cavalli (foto M. Traverso).

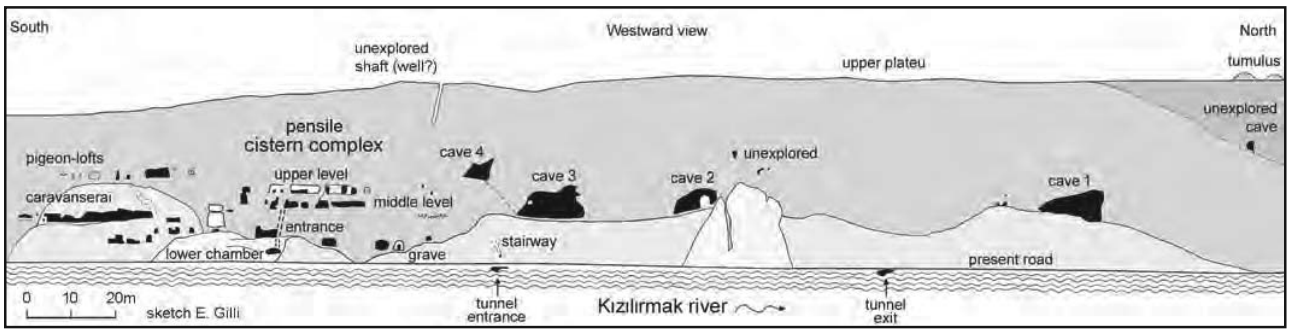

Fig. 24 - Sketch of Sarıhıdır rock face showing all artificial and natural caves (drawing E. Gilli).
Fig. 24 - Schizzo della parete di Sarıhıdır con vista di tutte le cavità artificiali e naturali (grafica E. Gilli).

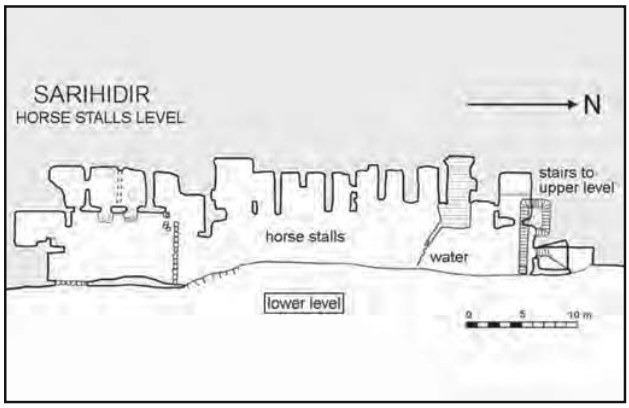

Fig. 25 - Sarıhıdır. Level of horse stalls (drawing E. Gilli, A. Yamaç).
Fig. 25 - Sarıhıdır. Il livello delle poste per cavalli (grafica E. Gilli, A. Yamaç).

In some places water seepage from the ignimbrites seem to have been channelled to feed the stalls.
One of the stall is full of water but more work has to be done to say this is a cistern or only a low part where local seepages is now accumulating.
At present, this water is flowing on a small channel cutting the floor of the horse stalls levels before pouring outside.

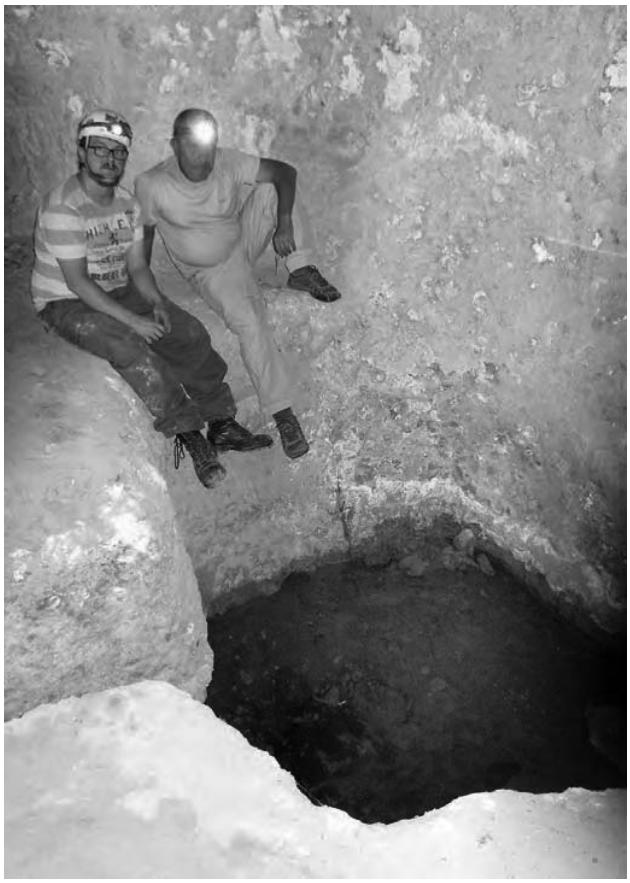

Fig. 26 - Sarıhıdır. South-western part of the cistern room. The aqueduct tunnel is in the centre of the pond, below the water level (photo E. Gilli).
Fig. 26 - Sarıhıdır. Lato SW della camera della cisterna. Il cunicolo dell'acquedotto si trova nel centro del bacino, sotto il livello dell'acqua (foto E. Gilli).

Most of the water comes from the uppermost level, the Cistern Complex (figs. 27, 28), that contains a cistern totally carved in the ignimbrites, about 20 m above the ground level. A narrow underground aqueduct feeds it, still active at present time.
The cistern is totally flooded and cannot be investigated (fig. 26). Local people reported to have emptied it, but no description was given about what they discovered, and the origin of water remains unknown.
Further inspection should be done to check if the water from this cistern, that is located at the uppermost part of the cave dwellings, was distributed to the horse stalls by men or by a system of terracotta, wood or leather pipes.
The presence of a channel that was probably covered by a wooden double deck supports the latter theory, as it could have contained the pipes.
If this is confirmed, the site could be one of the first examples of a running water system inside a block of rooms.

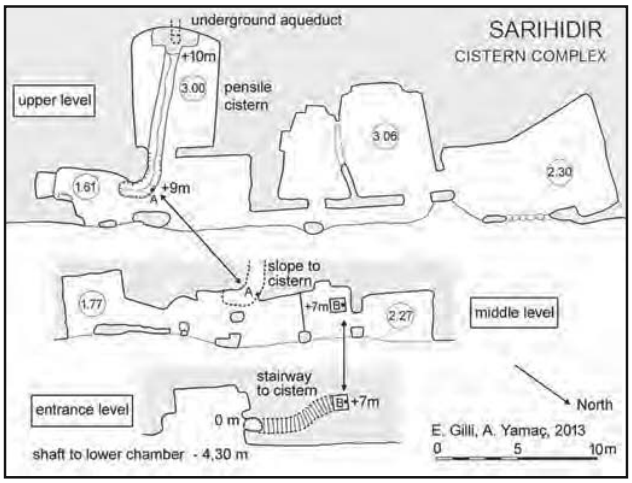

Fig. 27 - Sarıhıdır. Plan of pensile Cistern Complex (drawing E. Gilli, A. Yamaç).
Fig. 27 - Sarıhıdır. Pianta del Complesso della Cisterna pensile (grafica E. Gilli, A. Yamaç).

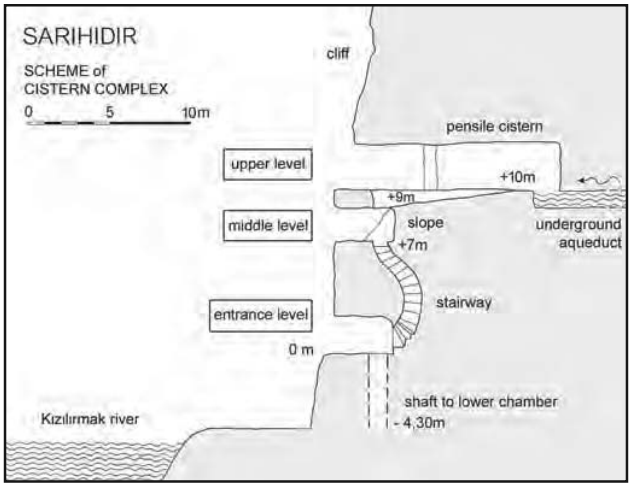

Fig. 28 - Schematic section of pensile Cistern Complex (drawing E. Gilli, A. Yamaç).
Fig. 28 - Sezione schematica del Complesso della Cisterna pensile (grafica E. Gilli, A. Yamaç).

The underground cisterns of Uçhisar

In order to compare a different water feeding system we shortly report the description of some underground cisterns recently documented in the Güvercinlik valley (Gilli & Yamaç, 2015), 2 km westward of the Zemi valley above described.
Close to Uçhisar (fig. 2), the Güvercinlik aqueduct is a 4 km long underground tunnel that brings water from the hills, south (upstream) of the village. The tunnel was dug on the left bank of the Güvercinlik valley (flag 28 in figs. 7, 8).
The water is collected either on a gutter, directly dug in the ignimbrites, or in a couple of terracotta pipes. For the time being, the origin of the water is unknown.
The aqueduct probably collects seeping water from cracks, as observed in some side tunnels.
The upstream part remains unexplored and the total development is certainly longer than 4 km. Downstream, it reaches the semi-troglodytes settlements of Uçhisar. In that area a group of cisterns was discovered beneath the houses of the south-eastern part of the village.
The cisterns are located lower than the level of the aqueduct which makes it possible to fill in them, up to the horizontal ceiling. Marks of water levels are still visible on the walls (fig. 29).
The system includes twin cisterns, dry at present, both provided with central pillars (figs. 29, 30), and a side cistern that still collects waters, and is used by locals (fig. 30).
From the cisterns the water flows in a tunnel parallel to the main aqueduct. It is divided in two branches: one drives the water towards the south-east, to feed an outside fountain. Further downstream, the other part of the water was probably driven towards another cistern

Fig. 29 - Uçhisar. GüvercinlikVadisi. Main twin cisterns. (photo E. Gilli, A. Yamaç).
Fig. 29 - Uçhisar. Valle di Güvercinlik. Le principali cisterne gemelle (foto E. Gilli, A Yamaç).

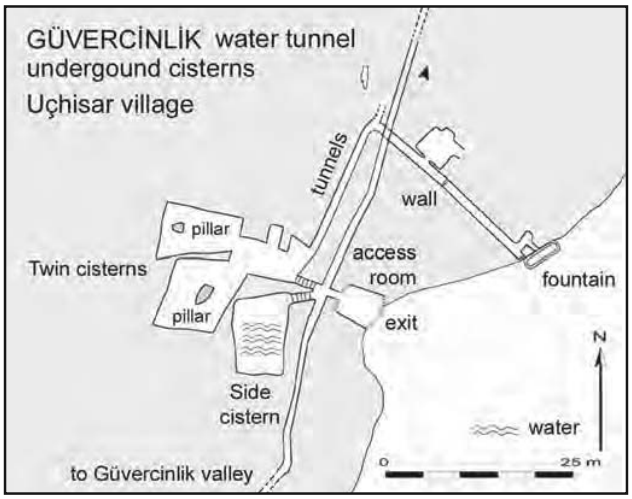

Fig. 30 - Uçhisar. Group of underground cisterns in the Güvercinlik valley (drawing E. Gilli).
Fig. 30 - Uçhisar. Gruppo di cisterne sotterranee nella valle di Güvercinlik (grafica E. Gilli).

to also feed a fountain, but this part cannot be explored due to collapses.
These cisterns are not the only parts of the aqueduct that collect waters. In some places walls were built across the tunnel to create small reserves and along the Güvercinlik valley some small aqueducts feed semi-troglodytes or masonry outside cisterns, as observed in other valleys like at Meskendir (Castellani, 2002): in these cases the ducts present similarity with the tunnel-cisterns cited in the first part of this article.

Conclusions

The conclusion can thus be drawn that, in Cappadocia, the funnels are a water supply system alternative to wells and aqueducts, not necessarily connected with tunnel-cisterns.
Actually, owing to the natural erosion of the slopes and/or of flooded parts that prevent the complete exploration of the structures, not all their elements are known. However, the compared analysis of the four sites, supplies mutual confirmations which, by analogy, allow to create a reliable scheme, shown in fig. 10.
In short, it is a sort of a combined device consisting of a collecting basin located on the top of a cliff, near the edge, connected with a duct, more or less vertical, channelling the catched water inside a reservoir below, both carved inside the cliff.
The basins at the top are dug opencast on the rock surface of the plateau, arranged so to gather (as for the loose stone trenches) the snowmelt water, concentrated in springtime and, occasionally, the rainfall.

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