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ANCIENT UNDERGROUND CHANNELS NEAR ORVIETO

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Abstract
This paper deals about two artificial cavities located near Porano, in between the town of Orvieto and the lake of Bolsena. These tunnels very likely belong to the etruscan age, a few centuries before Christ and the purpose for which they were made is not so clear, altough we think they were built by the ancients very likely for some hydraulic function, perhaps a sort of floodway channel, since both the cavities are open at the end, suggesting water flow. Each of these underground systems is marked by peculiar features that make it unique: one of them looks like as if it was opened on a former mining gallery later turned to hydraulic function, while the other one shows on the walls many pieces of carbonized wood, clearly recognizable as trees of an ancient forest shattered by pyroclastic flow, the deposition of which forms the stratification containing the gallery, belonging to the Volsinian volcanic system.
Keywords: Volsinian volcanism, Leucite, alteration minerals, etruscan underground, ancient mines.

Riassunto
In questa ricerca vengono descritte due cavità artificiali situate nei dintorni di Porano, tra la città di Orvieto ed il lago di Bolsena. Si tratta con ogni probabilità di cavità risalenti all'epoca etrusca il cui uso non è ancora chiaro, anche se l'ipotesi più plausibile resta la funzione idraulica, scolmatore o deflusso di acque superficiali, in considerazione del fatto che si tratta in entrambi i casi di gallerie con uno sbocco, dunque di passaggio di acque. Ognuno di questi sistemi sotterranei presenta particolarità che lo contraddistinguono: in uno di essi vi sono caratteristiche tali che porterebbero ad ipotizzare anche un uso minerario prima di essere convertito ad opera idraulica, l'altro presenta al suo interno numerosi frammenti chiaramente riconoscibili come tronchi e fronde carbonizzate dalle nubi piroclastiche i cui depositi costituiscono la sequenza stratigrafica in cui è alloggiata la galleria, pertinenti all'apparato Volsinio.
Parole chiave: *Apparato vulcanico volsinio, leucite, minerali di alterazione, sotterranei etruschi, miniere antiche.*

Introduction

In the north of our region, Latium, is relatively easy to come across tunnels and underground works of etruscan origin.
Some have small dimensions, well known are funerary cavities and the so called "colombari", cavities whose walls have many small squared holes as if they were housing for pigeons, some others are cavities that may have decent size and could serve as transit routes.
Two of such cavities located in the Orvieto area, have been explored and investigated by us over the past two years.
Both are located a few kilometres west of Orvieto, where the volcanic plateau of Volsini degrades eastwards to stop abruptly on the alluvial plain of the ancient Pliocene Tyrrhenian Sea.
The first of these galleries that we have explored and found, has been named by us MontacchioneTunnel, after the name of a small water course near Porano, and another Buonrespiro Tunnel, after the name of the locality.
We give a brief description of these underground works, whereas the study undertaken by us is just begun, and it might offer unexpected developments.

The Fosso Montacchione tunnel

The first tunnel we present is located by the archeological site of Porano, a few kilometres west of Orvieto, by the Montacchione valley brook. This Gallery opens on the left side of the ditch, in a clearing at the foot of a mass of volcanic rock, which generates a small waterfall.
This area is not very easy to reach particularly during the growing season, which has helped to make this gallery almost unknown.
It opens on the left side of the Montacchione brook through a hillside leading to a vertical wall, from which you cannot lean without putting yourself in danger, from which one can see the tops of trees, a few dozen metres below.The overall length is approximately 135 m and the Gallery has remarkable width, especially towards the exit.
It is a very old cavity, about which there are no doubts it is artificial and not natural; could be raised doubts about the percentage of artificiality: the question we asked ourselves is whether this was a totally artificial gallery or an enlargement of a pre-existing cavity of natural origin.
Exploring it we realized there are several inconsistencies: as we said before, it has an entrance and an exit. The entrance can be reached from a small plain caused by the widening of the Montacchione brook just at the feet of a small water jump. The entrance has a mining type plant with horizontal floor and a semicircular wide vault. Here the material consists of a cluster of dark type phonolitic lava with evident signs of alteration, heavily decayed.
These lavas are filled with really many crystals of

Fig. 1: the stately exit of Montacchione tunnel.
Fig. 1: la maestosa uscita del tunnel del Montacchione.

leucite strongly altered, in some places almost undone, with crystalline aggregates some of which are very large, centimetre-sized. It was a dark tephra very rich in leucite, that now grounds in dusty breccias.
In the beginning this is the dominant material, and for the first few tens of meters excavation is not regular, but presents indentations and enlargements as if they were made to follow up the ore deposit. At one point there is a short stony wall as if it was built to retain the crumbly material of a widening.
Here the floor consists of stone boulders that look as if they were polished, with an apparently irregular disposition. The Gallery continues straight up to a very perturbed front, where the shape becomes very uneven due to the presence of collapsed material, and from this point the gallery changes direction abruptly.
Here the material changes and the tephra gives way to a barely coherent material, breccia type, sometimes dark until black, fading to brown, with many small clear pieces of rock included.
After irradiation with ultraviolet Wood's lamp you can clearly notice blue fluorescent spots and others with greenish fluorescence, totally confused in the rocky matrix without the use of the Wood's lamp.
I noticed one of these greenish fluorescence with wavy horizontal position, as deposed by an aqueous layer.
On a big stone on the floor there are traces of sulfur.
Here the walls are irregular, with high ceilings and the floor is full of cobbles. The nature of human artifact is particularly evident here, where the rock is excavated with a rectangular shape, and the floor here seems lower than the excavation level, covered with a cobbled paving at times tortuous, with marked erosion of the walls in some places.
The impression you get is that the tunnel has been ran through by a stream with a very turbulent motion in some period of its history. Today it is completely dry, but there are many traces showing clearly that the floor has been shaped by running water, in a word, the floor was a riverbed.
Approaching the exit the material changes again and return the levels of breccias in variously coloured layers, mostly dark, without leucitic inclusions.
Towards the end there are some limited parts of the floor covered of very fine dark volcanic sand, rich in iron, with magnetic properties.
A sample of material taken in the collapsed central area was analyzed by x-ray diffraction at the Earth Sciences Laboratory at the University of Padua on interest of prof. Mietto, and was confirmed to be dickite, a phyllosilicate polymorph of kaolinite, with formula $Al_2Si_2O_5(OH)_4$, of hydrothermal genesis.
The presence of this material, typical alteration mineral, together with vitriolic earths, gives evidence of a mineralizing provision through some gaseous or hydrothermal exhalation, both nowadays extinct.
These events would undoubtedly be attributable to post-Volsinian volcanism.
Approximately 500 metres northwards, between the Vocabolo Gabelletta and the Strada dell'Arcone, at the southern side of Orvieto, in the 1st century. BC and 1st century. d. C, was built a spa situated approximately along a line connecting the exit of the tunnel and the cliff of the city (Della Fina, Pellegrini, 2013).
For an aqueduct, reaching these ancient baths would be very easy, since the distance would be covered flowing downhill by gravity.
This spa remained in use until the 4th century of our age, and was later turned into a rural residence and that remained for at least a century, until the 5th century, during which ceased to exist the Roman Empire as a State entity.
We don't know if these spas were powered by water originated from our tunnel and led there through a channel.
If there had been such channel, today there is no trace of it, but one must consider that the exit of the tunnel, which opens on a vertical wall, is almost dismantled and has been prone to slides that altered the morphology.
Other objections that can be raised, is that if there had been some thermal outcrop there would be layers of travertine, which is entirely absent in the gallery.
We have traces of strong chemical alteration, caused by thermal or endogenous gas reaching the surface, we have evidence of a turbulent water flow in some period of the past, but nothing certain can be said about the real nature and use of this underground.
In conclusion, it can be said that the Montacchione gallery is a problem for a correct typology attribution: hydraulic or mining work? Partly natural, partly artificial, or perhaps naturalized, but the question it poses to us is why men in ancient times, Roman or Etruscan doesn't mater, felt the need to dig a similar artifact?
In front of these questions, this underground amazes us with its impressive dimension and the intensity of

Fig. 2: charred tree on the wall of Buonrespiro tunnel.
Fig. 2: albero carbonizzato sulla parete del tunnel di Buonrespiro.

the forces that acted into it, witnessed on the walls and the floor molded into a riverbed.

The Vocabolo Buonrespiro Tunnel

Few kilometres west, near the highway Umbro-Casentinese, in the locality called Buonrespiro, opens a second tunnel, completely different from the first described in this work.

It is a very large gallery, whose features are somewhat impressive, which opens at the foot of a hilly relief and crosses through it from side to side.

The area is a volcanic plateau, with gentle slopes and shallow ditches, and the Gallery shows a wide opening on a ditch collecting percolation and draining waters, dry most of the year.

The opposite entrance gives onto a land on which doesn't seem there is today the presence of streams.

The slope at the right side of the tunnel has many debris of bricks and tiles of Roman manufacture brought to the surface by agricultural works, which leads to assume the presence of a Roman villa or a residential centre of unknown age but previous to the Middle Age anyway.

This gallery opens on a ditch which constitutes the continuation of the draining board, arranged in North-South direction.

It has a very large and stately entrance, with the ceiling resembling an ogival arch, carved in low consistency tuff.

The ceiling for at least half the length, has a height of nearly six meters with ogival vault.

The walls are vertical and dug at the interface between two layers, a lower level of fine yellowish ash and one of lithic tuff material including products by pyroclastic fall-out.

The thickness of the layers is in the order of metres, brought in place in presumably only two eruptive events which lasted quite a long time, accumulating several metres thickness.

The plant is not straight, but bends with wide-ranging curves.

The width of the Gallery is such as to allow the passage walking always in an upright position, and the North opening might also be covered by a man on horseback.

The purpose of this gallery is unknown at the actual state of knowledge, as also the assignment to a given historical context.

It likely may constitute a crossing through the hill, but there is no such obstacle that would justify a so challenging work.

The main feature of this tunnel, what makes it worth a visit, apart from the magnificence that stands out right in the eyes of the visitor, is that on the walls it is possible to distinguish clearly a certain number of charred wood fragments, that without any stretch of the imagination are recognizable as downed trees and charred by the fury of a pyroclastic cloud.

The arrangement of these wooden fragments, in some of which we can see the trunk and in others we recognize part of the crown, is random, as some lie across the axis of the Gallery, others are longitudinal, some others were intercepted by excavation at the height of the trunk, others in the crown.

It is obvious that it is a forest, evidence that between two consecutive eruptive events that have accumulated layers of ashes must be spent at least a few dozen years, enough the time it takes to colonize and grow a young forest.

Index of soil fertility due to the high potassium content, and climate warm enough to encourage processes of diagenesis of the soil with a good degree of humidity, certainly higher than today.

Such climatic conditions are found in the interglacial Mindel-Riss, from 470,000 to 350,000 years ago, the period to which the layers can be ascribed.

This period corresponds to the second stage of the volcanic volsinian phase, called Bolsena-Orvieto.

In this period the Bolsena Lake formation was underway, the calderic depression was not entirely collapsed yet since the process took several steps, documented by a series of concentric faults in the steep slopes of the East side, faults, precisely, generated after a gradual collapse (cfr. Varekamp, 1980; Nappi, 1995; Peccerillo, 2005).

The discovery of charred plant material is not at all a quite uncommon event, but in the Buonrespiro Gallery

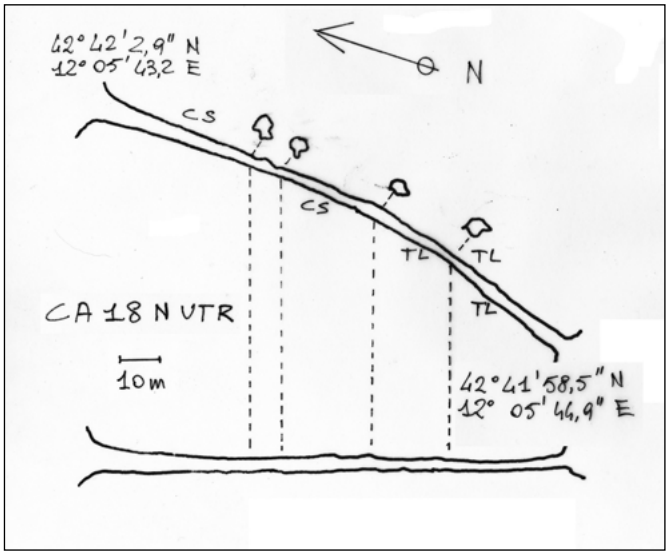

Fig. 3: sketch of the Montacchione gallery (TL Leucitic Tephra; CS ash beds).
Fig. 3: schizzo della galleria di Montacchione.

you can see a glimpse of geologic history f the volsinian volcanoes, concentrated in a few tens of meters of excavation.
The trees culled and charred by the pyroclastic flow are many, and it seems as though they are lying messy one above the other.
There had to be a forest with trees of small and medium size, judging from the diameter of the logs, a few tens of years old, a young forest grown on a ground of fine ash.
The Gallery is currently under study, and our efforts are aimed to the survey of all the underground works in the volcanic plateau of Alfina, the territory bounded on the East by the plain of Orvieto, and West from Bolsena Lake.

Aknowledgements
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At the moment, there is no known work or research about these tunnels, besides this work of ours. Useful information about the area are obtainable in:
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