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A REPORT ON THE MEDIEVAL MINING AND ORE PROCESSING COMPLEX: ZILAN VALLEY, VAN, TURKEY

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ABSTRACT

Literature has records of the use of obsidian that shows the existence of a knowledge base on raw material resources around Lake Van extending to very ancient times. Against this background, very little information can be obtained from literature about accurate location of historical mining activities in the region today. An ancient mining and processing complex, located northwest of the city of Van (Turkey) has been discovered by chance in 2007. The purpose of this article is to describe this historical mining area. The site contains mining structures such as shafts and galleries, and heaves of stone chips indicating some ore enrichment activities taking place there. The XRD and chemical analyses show the samples taken from the ore vein are rich in Manganese (Mn) and Barium (Ba), and it is concluded that the Zilan Valley Mining and Processing Complex was for Pyrolusite (MnO2), Barium or both. The site is being described for the first time in the literature and offers an opportunity to fulfill the gap in literature regarding mining history. The discovery and the description of the site would also have implications in a wide multidisciplinary scientific community, including metallurgy, archeology, and world heritage.

KEYWORDS: Mediaeval, Mining, Archeology, Van, Survey, Turkey, Van

1. INTRODUCTION

Historically, the shores of Lake Van and the surrounding region have been a region of convergence for people from different geographical backgrounds and cultures, who established important civilizations of their times. The idea that the first human activities around Lake Van in eastern Turkey occurred in the Middle Paleolithic age has been in the archeological agenda because of the discovery of an obsidian workshop at the Meydan Mountain located northwest of the town of Erciş (Kökten, 1964). Obsidian sources in the region are regarded as the main reason for establishment of prehistoric settlements there (Burney, 1958), and obsidian to faraway regions has been transported (Chataigner et al 1998). This shows the existence of a knowledge base on raw material resources around Lake Van extending to very ancient times.

The region is also the centre of the Urartian (860-640 BC) land, who are known to be 'the biggest mining society of their times in both Anatolia and the old Eastern World' (Belli, 1991). It is reported that on one occasion, Urartians gave Assyrians, their rivals, tons of gold and silver, and items made of these, as war reparations (Akçil, 2006). Today, the Urartian metallic art objects are spread all over the world in the hands of collectors, traders and museums (Musceralla, 2006).

Mines in the region were of considerable importance to the Byzantine Empire (395-1453) as well. They continued to exploit the mining resources for coinage, manufacture of luxurious gold and silver items, weapons, and developing industries of the time. Not only the mines were important, but they also were near surface; thus easily accessible. The mines in the eastern borderland caused at least four wars between Persia and Byzantium in the V. - VI. Century AD (Speros, 1962).

Selcuks were dominant in the region between 11-14th century and continued to benefit from the richness by using the mines for their own needs and by exporting, as were the Ottomans (1299 - 1923). Ottoman imperial edicts, as recorded in the Divan-ı Hümayun, mentions on 30 November 1571 that K-nitrate (Na-, or Ca- at times), or "güherçile", being mined, gunpowder produced, transported to Trabzon from the region of Erciş (Altınay 1931 & 1989: 13- 14). Bayartan (2008) presents lists of Ottaman mines during XIX century, showing only lead mines nearby Hakkari province, but none recorded in the province of Van or the Zilan Valley. Same by V. Cuinet, who prepared a report at the end of the XIX. Century for the creditors about the potential to pay the foreign debts of the Ottoman Empire, has no mentions of mines in the Zilan Valey of Van, except from the hot water springs (Cuinet, 1894: 198 – 199, 202).

There is very little work done on establishment of exact location, and methods of mining and processing of the raw materials during the Urartians and in mediaeval times. Archeological work on ancient mining in the area had been going on since late 1970's, without a single discovery until a historical mining site of Balaban was located in 1990 (Kaptan, 1990). The site is situated at the southeast corner of Lake Van, near Tatvan-Van state highway running along the east side of the lake. This site and another location near Bahçesaray in the mountainous region of southern side of the lake, remain the only historical sites to date that appear in the local mining/geological literature. Even these sites do not contain mining structures such as well-developed galleries and/or shafts.

In this study, we describe remnants of an ancient mine operation in the Zilan Valley (Zilan Valley Historical Mine), located on north side of Lake Van, for the first time in literature. The discovery and the description of the site would have significant implications over a wide range of multidisciplinary scientific community;

including education about historical mining, geology, metallurgy, and archeology.

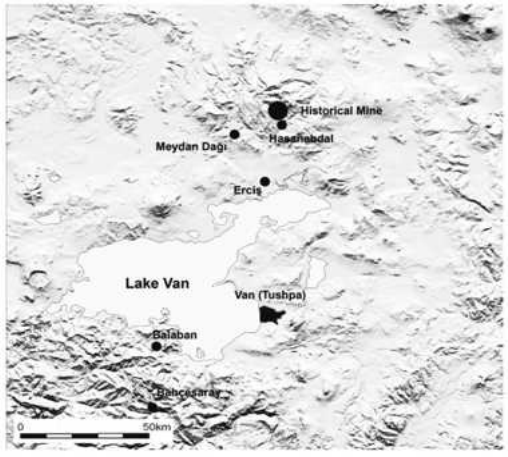

Figure 1. Location map

2. METHODS AND RESULTS: ZILAN VALLEY HISTORICAL MINE – DESCRIPTION, SURVEYS AND ORE ANALYSES

2.1 Location

The Zilan Valley Historical Mine, as its name implies, is located in the Zilan Valley, close to the Hasanabdal Village, North of the Lake Van (Figure 1). There is a paved highway connecting the village and the town of Erciş near northern shores of Lake Van. This valley is intruded into by several creeks forming the Zilan (Ilıca) River and it is one of the largest drainage channels in the basin of Lake Van. One of the oldest settlements known around Erciş, called "Zernişan Kale" by local people ("Zernaki Tepe" by Burney 1958) is situated at the entrance of Zilan Valley. The word "zern-" in its name means, in Persian, "golden" and "kale" means fortress. The establishment of the settlement was dated to the Urartian era by Burney (1958), but Sevin (1997) concluded that it should rather belong to the times of Shapur the Great (241-272 AD) of Sassanid dynasty.

In 2007 during a trip to the valley a former mining area has been discovered by chance. The mining complex is accessed by leaving the paved highway and turning west from the hot springs facilities near Hasanabdal Village to an unpaved seasonal road. This road runs through the north flank of a small valley with a creek running approximately in a west to east direction and joining the Zilan River. The remnants of the historical mining facilities are located on both sides of this small valley (Figure 2).

To understand the mineralogy and chemical composition, samples are taken from locations in the valley and the from a hill behind the valley. The significance of the hill (the 2096 m above the sea level and about 500 m west of the mining and processing complex) being that the villagers mentioned a company drilling there in 1997.

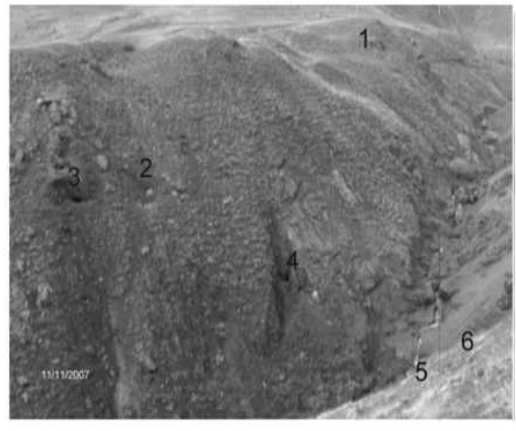

Figure 2. Specific locations of historic mining activities on both sides of the small valley.

2.2 Geology

The complex geology of the basin of Lake Van continues to be an active research topic (Demirtasli and Pisoni, 1965; Ketin, 1977; Degens et al., 1978, Degens et al., 1984; Acarlar et al., 1991). Accordingly, the oldest rocks in the basin are dated to Paleozoic, 560 million years before present. Since the upper Miocene, there has been lacustrine influence in the basin. In general, surface

geology is made up of metamorphic rock mass in the South known as Bitlis Massive (Paleozoic); volcanic, volcano-clastic (basaltic, dacitic, and andesitic) and sedimentary rocks are in the West and the North (Pliocene-Quaternary); finally, older sedimentary (Miocene) and ophiolite rock complex (ultarabasics, flysch deposits, limestone) are in the East (Degens et al., 1984).

A more detailed geology of the study area, the Zilan Valley and its vicinity, is discussed in an unpublished dissertation (Elmastaş 2002). The valley occupies about a 1210 km^2, with its highest peak at 3538m in northeast. Rock formations from Paleozoic age can be observed along the banks of the Zilan River. These formations have been described in a likewise unpublished report for General Directorate of Mineral Research and Exploration in Turkey (MTA) as containing biotite, chlorite, quartz, schist, feldspar, and sericite minerals (Karamanderesi et al., 1984). Volcanic activities continued in the area until the Quaternary time, and are evidenced by presence of a volcanic shield containing basalt, tuff, agglomera, and obsidians. Calcareous formations occupy the east and west of the Erciş delta. Miocene-aged andesitic and basaltic formations overlie the calcareous formations. There are also some coal outcrops near the bottom of the valley sandwiched between clays and marls. A further characteristic of the valley is the hot springs near Hasanabdal Village, which are being used for heating buildings, recreation and health purposes today. The hot springs and travertine outcrops occur along the valley depending on the path of the Şor Fault through the Zilan Valley.

Geological and geochemical studies (Arslan and B.E. Leake, 1995; Arslan, 1997; Arslan and Akçay, 1998) on rocks taken from the Zilan area support the possibility of manganese and titanium type of mineralization, although none of these studies indicate specific ore formations to the extent found during this study. Specifically, Arslan (1997) reported biotites in the rocks containing 5.5 to 6.7 wt% TiO2, and Arslan and Akçay (1998) reported manganese occurrences in the pumice tuffs.

2.3 Mining and processing evidence at the site

The specific mining and processing location are marked on Figure 2, and descriptions the facilities found at these locations are given below.

Location No. 1 (Figure 3): This is the farthest away upstream location examined. There is a rectangular well, a mining shaft, in this location with 1.4x2.5m cross-sectional dimensions that narrows down to a 1x1m square dimension at about 2m-depth. The well, sunk from a steep rock slope to follow a near vertical ore vein, gently spirals down with its bottom invisible. Its total depth could not be determined at this time but, from the sound of falling debris on water, is estimated to be at least 10 m.

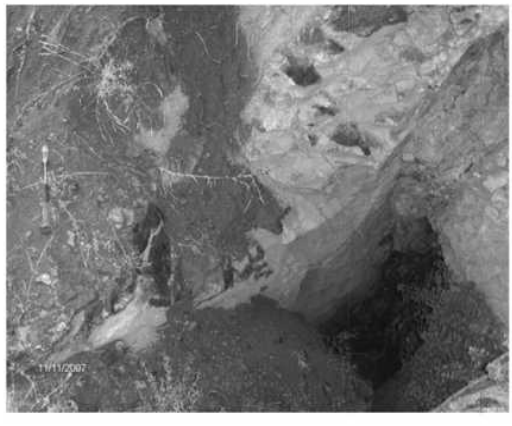

Figure 3: This shaft on location No.1 follows the hanging wall of the mineralized zone (note the geologists hammer on the mid-left of the picture for scale).

Location No. 2 is about 75m away in a down- and parallel direction to the creek

from the location 1. It is located on a more gently sloping ground. The site has an appearance of a stone-chip yard. The chips are hand-sized and cover an area of about 100m2. These are likely to be rejects from the larger ore-bearing pieces from which the valuable ore was recovered. In the center of the yard, there is a vertical shaft (2.4x2.4m) filled with similar stone chips. Moving away from the site at a vertical angle to the creek-line and to a higher elevation, there is another smaller chip-yard area with no shaft. This could be an area where the master craftsmen worked, or/and an area where a secondary ore recovery took place.

Location No. 3 (Figure 4) is about 10m away in a downstream- and parallel direction to the creek from the location 2. The scene gives an appearance of three entrances to three circular tunnels (0.7m diameter) starting from adjacent locations but spreading to three different directions. The eastern tunnel turns and continues more in length than others.

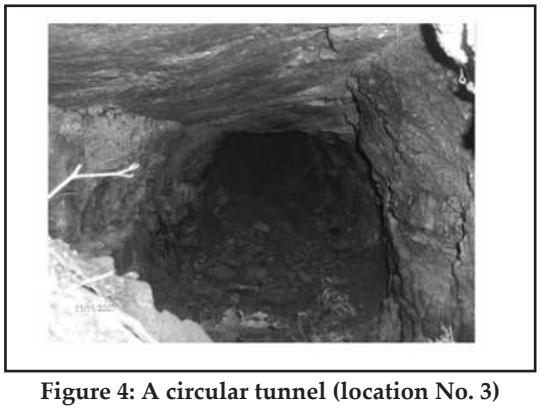

Figure 4: A circular tunnel (location No. 3) demonstrating the type of mining methods used.

Location No 4 (Figure 5) is the last location on the southern flank of the creek valley. It has a tunnel and an open vein which was worked upwards.

Locations 5 (Figure 6) and 6 are on the north flank of the creek valley. Location 5 has a spirally stepped-down shaft excavated in a massive andesitic hard rock

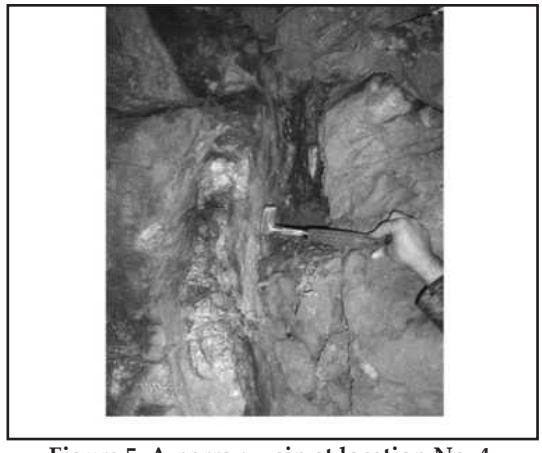

Figure 5: A narrow vein at location No. 4. The picture shows lower sections of the vein being filled by non-ore material as the mining progressed upwards along the vein.

formation. It was difficult to chip pieces from the shaft wall; yet the 0.7m diameter circular shaft has been excavated with smooth curvature to a depth which could be traced down several meters. Contrary to the sites on the south of the creek, there are no remnants of mineralization along the shaft walls at this site. The purpose of this shaft, therefore, could not be associated to direct ore-mining activities.

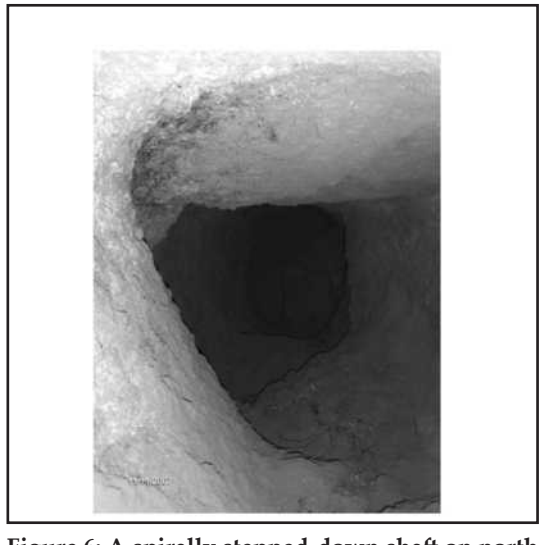

Figure 6: A spirally stepped-down shaft on north flank of the creek valley Location No. 5.

Location No: 6: This location is on the up-stream side of location No.5. It consists of a

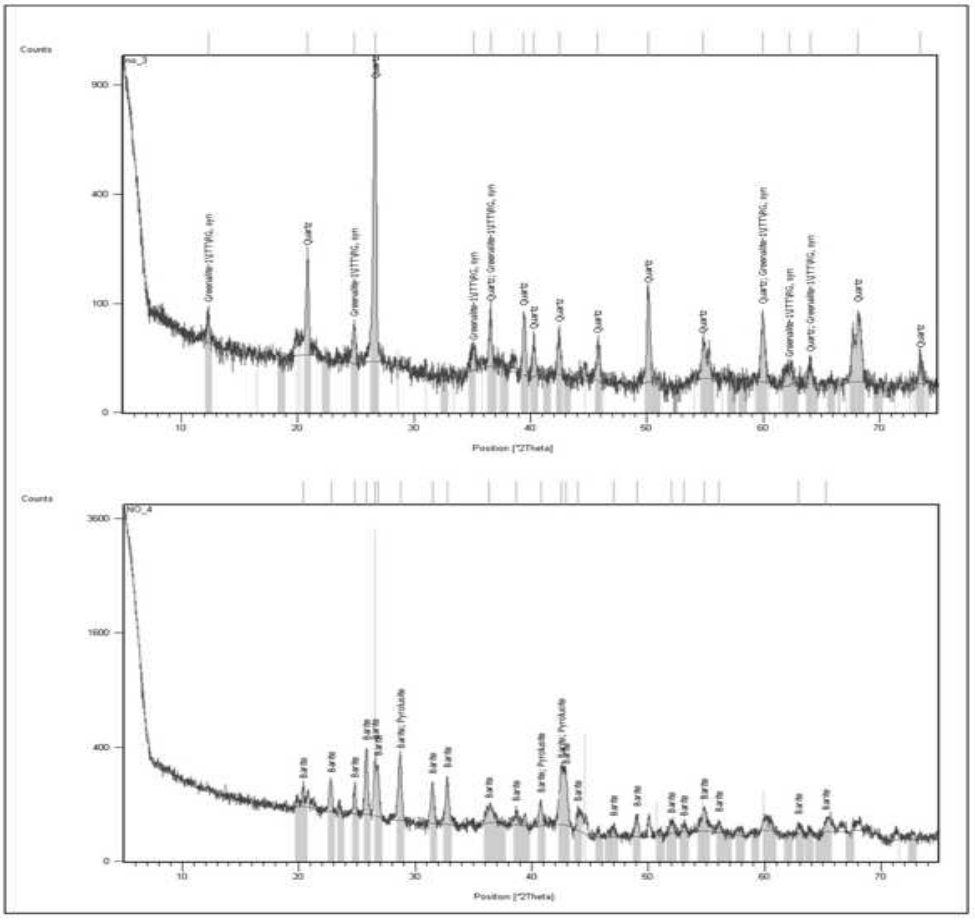

Figure 9: XRD mineralogical analyses of samples from Locations 3 and 4(a).

near circular (0.6x0.7m) tunnel.

3. ANALYSES OF SAMPLES TAKEN FROM SELECTED LOCATIONS (UPPER HILL, LOCATION NO.3 AND LOCATION NO. 4)

Four samples are analyzed for their mineralogy and chemical composition. Two of these samples are from an ore vein in location # 4 and the other two are from heaps of what appears to be the processing rejects at location #3 and the hill on upstream; respectively. Chemical analyses are done using Inducted Coupled Plasma Optical Emission Spectroscopy (ICP-OES). The mineralogy is determined by using oriented powder samples by means of X-ray diffraction (XRD) analysis; using a Panalytical X PERT PRO MD x-ray diffractometer (40 kV, 20 mA) Ni filtered CuK radiation.

The XRD and chemical analyses show the samples taken from the ore vein are rich in Manganese (Mn) and Barium (Ba). At the same time the samples taken from outside the vein are poor in terms of Mn and Ba; confirming them as rejects. XRD analyses (Figure 7), show peaks for these two minerals exclusively. The chemical analyses show the ore vein being rich (14.6 and 15.4%) in MnO in both samples taken from location #4 (Table 1). Sample 4a is also rich in barite ($BaSO_4$, 14.9%), a mineral of barium. Thus, it is concluded that the Zilan Valley Mining and Processing Complex was

	CaO %	MgO %	Na2O %	K_2O %	Al_2O_3 %	MnO %	Fe_2O_3 %	TiO_2 %	SiO_2 %	P_2O_5 %	Loss of ignition (%)	Total %	Ba %	Pb %	Zn %	Cu %
Samples from scattered rejects																
Upper Hill	4.60	0.68	0.23	0.55	8.62	1.54	3.98	0.23	68.28	0.06	9.90	98.70	0.03	0.10	0.09	0.0005
Location No 3	0.24	0.11	0.22	1.16	9.95	1.93	2.85	0.09	76.17	0.01	5.74	98.64	0.16	0.10	0.10	0.0001
Samples from ore in the vein																
Location No 4(a)	0.49	0.05	0.22	0.20	2.22	15.38	14.18	0.05	26.79	0.01	9.17	85.40	14.91	1.83	0.20	0.0044
Location No 4 (b)	0.78	0.04	0.25	0.24	5.19	14.60	8.57	0.16	57.16	0.01	8.24	95.96	0.66	3.36	0.24	0.0236

Table 1. The chemical analyses of ore and rock (rejects) samples taken from the Upper Hill and location No 3 and 4.

mining and processing Pyrolusite (MnO2), Barium or both.

Barite is very dense and even hand sized pieces feel heavy, but easily crushed. These properties make it ideal for forming a heavy mud used to line the holes drilled during oil exploration today. But barite is also used as an additive in paint, and this mineral is the source for barium which has applications in glassmaking and medicine. Therefore, in the context of an ancient mine, mining barite for use in paint making, glass-making, and for medicinal purposes is more likely.

Pyralusite, used in making steel and batteries in modern times, is also used in making manganese-bronze, disinfectants (permanganates) and for decolorizing glass. As a coloring material, it is used in calico printing and dyeing; for imparting violet, amber, and black colors to glass, pottery, and bricks; and in the manufacture of green and violet paints.

4. DISCUSSION

The multitude, magnitude, size and sophistication of mining shafts and galleries dug from surface, coupled with the existence of rejects at the site show that the Zilan Valley Mining and Processing complex is an ancient and important one. However, the inhabitants of the area today have come to know the mining galleries as "mağara" (=cave) and do not have any knowledge about any mining activity in this site.

There is no charcoal in slags or other materials that could be used in dating the mine. However, there exist several cross-like (more like a "plus" sign) carvings on a rock at the entrance of the valley where the mine is located. This, by itself, cannot be taken as a starting point for dating the mining structures, because the date of carvings in relation to the date of mine could be in any order. However, the carvings being at the entrance to the valley may signify its importance.

The ore galleries are short but their shape reveals sophistication in terms of excavation techniques and understanding the earth pressures. Thus, the mines most likely do not belong to Urartian times or early ancient era.

On the other hand, Ottoman imperial edicts for 1546 - 1779, neither Cuinet (1894), nor the work done by Bayartan (2008) mention a mine near the Zillan Valley during XIX century. Thus, the mine belongs to some pre-1546 and to Medieval times. It is highly likely that the mine was operated during Byzantium, either by state or privately under state control (Speros, 1962). The mine then was abandoned, as the central power weakened or during a period of confusion, either by slave workers (of the state) or by the designated owners. The remoteness of the area and multitude of bordering disputes did not allow re-opening the mine. Speros (1962) summarizes the mining locations in Anatolia, based on the work of Altınay (1931), during the Ottoman Empire. Zilan Valley or any other major site is not mentioned, while well other known sites, like Gümüşhane, Keban are listed.

The high grade (15%) of barite and pyrolusite minerals found from the analyses of ore in vein and their absence in rejects show them as target minerals mined. Pyrolusite can be used, among other areas, as a coloring material, as dyeing agent; for imparting violet, amber, and black colors to glass, pottery, and bricks. Barite is used as an additive in paint. It is also the source for barium (Ba) which has applications in glassmaking and medicine. Thus, these minerals were used in ancient times for non-military applications.

The Ottoman records pointing the Van-Erçiş area as an important source for KNO_3 or saltpeter (guherçile), the strategic mineral in making gunpowder, provokes the idea that the shafts we observe may be used for ore-washing purposes. Unless the mine has

been depleted of Niter our chemical analyses do not support this idea.

The strategic location of the Zernişan Kale can be of significance in relation to the ancient mine. There could be economic reasons, as well as strategic reasons, for choosing the location. In that case, the ores/mines of Zilan Valley must be one of these economic reasons.

The full scale of mining operations in the past for the surrounding area of the Lake Van remains largely a mystery today. The historic discontinuity in mining and almost non-existing mining activities today precludes trace-back the mining locations. The remnants from ancient Zilan Valley mine highlight the location as an important historical mining complex that can provide a link. Therefore, further multi-disciplinary research on the environmental impact of palaeometallurgy by pollen and geochemical analyses (Jouffroy – Bapicot et al., 2007) at this location is recommended.

5. CONCLUSIONS

The complex has ancient mining structures such as shafts and tunnels and heaves of stone chips as evidence of mining and on-site ore processing. Visible also, are veins of ore body that have not been worked in modern times. There is also no evidence of road access to the mine in recent times.

Chemical and XRD analyses of ore from exposed vein show 14.9% Ba (in mineral Barite) and 15.4% pyrolusite, a Mn mineral. These are high enough quantities to warrant mining of either or both of these minerals in ancient times. Pyrolusite can be used as a coloring material, as dyeing agent; for imparting violet, amber, and black colors to glass, pottery, and bricks. Barite is used as an additive in paint. It is also the source for barium (Ba) which has applications in glassmaking and medicine.

The shafts and galleries are short but their shape reveals sophistication in terms of excavation techniques and understanding the earth pressures. This cannot be said for the Balaban and Bahçesaray sites in region, even if we accept that they are authentic Urartian iron-ore working locations. The mines most likely belong to medieaval or early Ottoman times. It is highly likely that the mine was operated during Byzantium. The mine was abandoned either by slave workers (of the state) or the designated owners as the central power weakened. The absence of suitable material precludes studies to conclude a more accurate date for the Zilan valley mining and processing complex.

The discovery and characterization as an ancient mine have implications in a wide multidisciplinary scientific community, including historical mining, geology, metallurgy, and archeology. One of the implications is that it could be designated as an ancient world mining site and preserved for education of future generations.

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