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A TALE OF TWO LEAD INGOTS

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Lead ores, usually containing silver, can be found in most European countries. It was the Romans who first mined lead extensively. They found many uses for it and developed techniques to extract the silver. However, the water table frequently determined the depth of Roman mining operations.

In the 19th century, Spain became an important source of lead. Many of the mines had hardly been worked since the Romans and the relatively un-worked lead veins at Linares (Jaén Province), soon attracted companies, from Britain, France and Germany, and they introduced new technology into the area that allowed the mine working to go deeper. One of these mines La Tortilla mine, located to the west of the town, and managed by an Englishman, Thomas Sopwith junior was one of the many successful mines in the area. By 1880 an extensive lead smelting works had been established adjacent to the mine that produced large tonnages of lead ingots for export.

Until recently, no lead ingots from the Linares area were known to have survived. However, it was inevitably some ingots would get lost in transit. The exploration of a shipwreck in 2005 revealed a large consignment of ingots manufactured at the La Tortilla smelter. This was as important discovery as the cargo represented the only known collection of ingots manufactured in Linares. This is the tale of two of those lead ingots.

1. Introduction

During the latter half of the 19th century, the Spanish town of Linares, Jaén, Andalucía (see fig. 1), was at the heart of what was probably the richest lead mining industry in Europe.

It is often said, 'That lead is the soul of Linares,' a statement that is equally true today as it was 150 years ago. The Reverend Hugh Rose, the English Chaplain assigned to Linares by the Bishop of Gibraltar in the early 1870s described Linares as a hive of activity (Rose, 1875, p. 112, 113): *From morning until night you hear noth-*

ing, see nothing, but lead: lead at the railway station, lead-smoke in the air from the smelting works, lead on the donkeys' backs: lead in pigs, in sheets, lead of the first or second quality. Lead and money, varied by money and lead, it is depressing alike to soul and body; and, gentle reader, remember there is a proverb among us, "to proceed with leaden feet"; and a disease among us which is called "being leaded," and makes a man's eye dull, and his brain sleepy.'

In addition to the many Spanish mining companies, Linares attracted investment from British, French, Belgian and German mining companies. They first arrived from Britain in the 1840s. The British companies also introduced innovative steam pumping technology to the area which was eventually taken up by all the other mining companies. The technology was essential to get below the old Roman mine workings that usually extended from the surface down to the water table. The Romans had worked the lead deposits extensively. A Roman bas-relief discovered near the Palazuelas lead mine in 1875, has become a representative symbol of Roman mining in the Linares area (Sandars 1905, p. 321).

Lead has been worked extensively throughout Europe. However, Spain is particularly rich in the metal when compared to many other European countries. The mineral veins at Linares were rich, often up to 6m wide and sometimes presenting a solid wall of galena (PbS), the principal lead ore. But after nearly half a century of exceptional success, lead ore from places like Broken Hill, Australia, started to have an adverse effect on the world lead market. Lead prices fluctuated sharply and by the early 20th century Linares lead mining went into decline. Mining did continue but never on the same scale, and the last lead mine was closed in the 1990s.

From the onset, the foreign mining companies that came to Linares soon learnt that by exporting and selling the ore outside Spain, for example at London, they could obtain the best prices for their lead. However, transporting sacks of ore to the ports caused many problems, and so lead-smelters were constructed at Linares. The transportation of the lead as ingots was much more cost effective.

Shipping disasters were fairly common in the 19th century so it was inevitable that some of those lead ingots would get lost in transit. Some, like the two detailed in this paper, would be recovered by 21st century marine exploration.

2. Lead mining in a European context

Lead mining was never significant in either the Bronze or Iron ages. However, some lead must have been worked, as lead artefacts (usually beads), have occasionally been discovered that date back to around 3000 BC (Contreras & Dueñas, 2010).

It was the Romans who first found an increasing need for lead, as they used the metal extensively. They fashioned it into water pipes, water containers, slingshot, ships anchors, statues and even coffins, etc. Equally important was that galena contained varying percentages of silver.

The Romans extended the use of the cupellation process for extracting the silver. During the process air was blown across heated lead in a hearth. The process oxidised the lead to form litharge (PbO) that was used as a pigment, and for cosmetics. The wide use of lead in everyday Roman life has even been attributed to the downfall of the Roman Empire, a consequence of lead poisoning (Nriagu, 1983).

By the Medieval period lead was being mined expensively throughout Europe, primarily as a source of silver, but the use of lead was extended. This included for example, making stained-glass windows, and manufacturing pewter ware for domestic purposes. It was during this period that significant developments took place in mining technology, for example, the use of horses for winding, and waterpower for both pumping and winding ore, and in ore-dressing. This technology generally permitted new reserves to be accessed. Earlier workings (e.g. Roman) had often been stopped once they had reached the water table.

The water-powered technology famously described by Agricola, in *De Re Metallica* (1556), must have been well established in Central Europe well before its publication in the 16th century, and it is known to have continued in use into the 20th century. Both the Rammelsburg and Saint Andreasburg mines, Harz Mountains, Germany, contain exceptional examples of that technology.

After iron, lead is probably one of the most widely worked metal in Europe. The United Kingdom contains significant deposits throughout the Pennine range of mountains, northeast and central Wales, and the Mendip area that were all mined by the Romans. In France, significant lead deposits are widely scattered, for example Huelgoat in Brittany, Pontgibaud in the Massif Central, the Pyrenees and Vosges Mountains. In Germany, notable centres for the lead mining industry include the Hartz Mountains, Freiberg and the Erzegebirge – Saxony, whilst in Austria significant deposits can be found at Bleiberg near Villach.

In Poland, the principal centres for lead production are Upper Silesia-Cracow area (11th Century through to present), Holly Cross Mts. (13^{th}–20th C.), Lower Silesia (12th C. through to present), and the Pieniny-Tatra Mountains (15th–16th C.).

The Upper Silesia-Cracow area was the largest and most important. It produced over 310,000,000 tons of Pb-Zn ore, yielding ca. 6,700,000 tons of lead. Mining was centred on five towns, Bytom (12^{th} C. – 1989), Tarnowskie Góry (16^{th} C. – 1919), Chrzanów (14^{th} C. – 2009), Olkusz (11^{th} C and is expected to continue until 2021), and Siewierz (16^{th} C. till 1914).

Towards the end of 18th century, steam-power was replacing horse and waterpower in Europe. In Poland for example, a 32-inch English Newcomen steam engine, imported from England was started on the 18 January 1788 at the "Friedrich" lead mine at Tarnowskie Góry. Other engines were erected and started in 1790, 1791 and 1792. The first 40-inches Watt steam engine started work in 1796 and the next one (60-inches) was set up in 1799–1802 (Slotta, 1985; Frużyński, 2012; Wnuk, 2016 – pers. com.).

In southern Europe, the lead deposits at Laurium, Greece, had been a source of silver from antiquity and Italy had primary lead deposits on the island of Sardinia. In contrast, Spain had considerable mineral wealth. The Roman Empire totally conquered the Iberian Peninsula and in Spain worked pyrites, copper, lead, silver and gold mines. Lead deposits occur in the Sierra Minera (Murcía), Almagrera and Gádor (Almería), whilst inland those in the Alcudia Valley (Cuidad Real), Hiendelaencina (Guadalajara) and Linares/La Carolina (Jaén) were very significant. However, it was the lead mines of Jaén, and those in the adjacent province of Cordóba, that received the most Roman interest, as testified by the many Roman artefacts that have been found (Sandars, 1905).

3. The Linares lead mining district

3.1 Location and landscape

The town of Linares is located 260 kilometres due south of Madrid in Jaén province, on the northern edge of the Autonomous Region of Andalucía. To the west, and northwest of Linares lie the towns of Baños de la Encina, and La Carolina, respectively, which are further centres of mining activity.

Granite outcrops form a series of low lying hills with heights up to approximately 550m above sea level. Permian sandstones and conglomerates form a thin cap (approximately 6m thick) on top of the granite. They gradually dip to the south where they become concealed by the Miocene sediments.

3.2. Geology and mineralisation

The geology and the mineralisation of the area are relatively simple to describe (Vázquez Guzmán, 1989, p. 117–120). A pluton of granite developed in the Carboniferous period (359 to 299 million years ago). The granite was subsequently fractured and faulted. Mineralisation of the faulting took place towards the end of the Carboniferous period. The resulting mineral veins contain predominantly lead minerals. The principal lead ore is lead sulphide or galena, which also contains a small percentage of silver. During the Permian (299 to 251 million years ago), the granite was eroded and reddish sandstone and conglomerate were deposited on top of the granite. Further faulting displaced both the Permian strata and the underlying granite, and mineral veins. In the Miocene period (23 to 5.3 million years ago), sediments buried the granite and the Permian strata.

The mineralised faults trend roughly north-north-east/south-south-west through the granitic zone and are frequently displaced by cross-faulting or intersected by sub-parallel faulting. The western edge of the granite is bordered by a major boundary fault system with a down-throw to the west. The last phases of mining in the 1990s were concentrated in the area along the east flank of this fault zone and geological exploration was conducted to determine if mineralisation continued beyond the boundary fault.

Fig. 1. Location Map showing Linares and Seville, Spain, and site T1M31b-5 (Cunningham Dobson et al., 2015, fig. 37)

Ryc. 1. Lokalizacja Linares i Sewilli w Hiszpanii oraz stanowiska T1M31b-5 (Cunningham Dobson i in., 2015, fig. 37)

3.3 The area now

All mining activity has now ceased and a new industry dominates the area, the growing of olives, and the production of olive oil. However, amongst the thousands of olive trees, the remains of the past mining activity are still a dominant component of the landscape. The spoil tips are ever present, as are the buildings that once housed the many steam-powered pumping and winding engines. Elsewhere are the scattered mining communities and the remains of their mines and lead-smelters, for example at La Cruz and La Tortilla, operated by French and British companies, respectively.

The mining settlement of La Tortilla lies about 2 kilometres west of the town of Linares on the north side of the main road to Bailén. The principal remains of La Tortilla mine, a row of well-preserved engine houses, can be found on the south side of the new by-pass road that now splits the site. North of the by-pass, La Tortilla lead smelter is a prominent component of the mining landscape. Remains include the lead works and a shot tower. A complex series of zigzag flues run from the works and terminate at two very tall chimneys that dominate the skyline. It is La Tortilla lead works that produced the two lead ingots, the subject of this paper.

Fig. 2. La Tortilla Mine, the 60inch Cornish beam engine on Palmerston Shaft (National Archives, Madrid, ES.28079.AHN/4.2.13)

Ryc. 2. Kopalnia La Tortilla, 60-calowy kornijski balansowy silnik parowy nad szybem Palmerston (Archiwum Państwowe, Madryt, ES.28079.AHN/4.2.13)

4. La Tortilla mine and smelting works

The Roman city of Cástulo lies a few kilometres southeast of the Linares and was once a major Roman lead mining centre. Like the majority of lead mines in the Linares area, it is probable that the Romans once worked the La Tortilla mine mineral veins.

4.1 The Tortilla Mine

Vernon (2013) gives a concise account of the La Tortilla mine's history from when the concession was taken over by an English mining company in early 1864. The previous year, a young Englishman, Thomas Sopwith junior was sent on a mission to visit classic mining areas of Europe by William Blackett Beaumont, an owner of significant lead mines in northern England, and by his father Thomas Sopwith senior, Beaumont's mine agent. The object of the mission was to find new lead mines to work. In July 1863 Thomas Sopwith junior came to Linares where three English-owned lead mines, managed by John Taylor and Sons of London, were already being worked very profitably (Vernon, 2015).

At this time, La Tortilla mine was in a very derelict state, but it was realised that it had great potential, and so *The Spanish Lead Company, Ltd*. was formed to work the mine (fig. 2). To reflect the scale of the work to be undertaken, the initial capital of the company was set at £60,000 which would be more than adequate for future expenditure, primarily for pumping and winding machinery, and the establishment of ore dressing floors (Sopwith, 1870). Thomas Sopwith junior was appointed manager. On the 24th April 1865, the first small engine was started, but to go deeper a greater capacity pumping engines was required, and so on the 11th April 1867, a 60-inch Cornish beam engine was set to work on Palmerston Shaft. This technology was widely used in the district, after its introduction into the area in 1849, by another English company, *The Linares lead Association* (Vernon, 2009, 2014).

During 1879, in addition to the death of Thomas Sopwith senior, the Beaumont's withdrew their financial interest in the company, and Thomas Sopwith junior, perhaps because he knew the potential of La Tortilla more than anyone else, decided to refinance the mining operation. He formed a new company, and gave himself full control of the operations.

T. Sopwith and Company, Ltd. was registered in 1880, with a capital of £120,000. Thomas Sopwith junior had also obtained a new financial backer, Frederick Power, who held £57,000 of shares, while Sopwith junior, invested nearly £40,000 in the new company. In addition to buying another mine, they expanded the lead smelting works.

Thomas Sopwith junior was tragically killed in a shooting accident in 1898, but La Tortilla mine kept operating until its closure in 1903, brought about by depleting ore reserves, and high water pumping costs. The company did however continue operating the smelt works until it was taken over by the Societé des Anciens Etablissement Sopwith, in 1907, part of the French owned Societé Minière et Métallurgique de Peñarroya (Vernon, 2013).

4.2 The Tortilla Smelting Works

The construction of a lead smelting works with a desilverization plant was always a priority of the Sopwiths, as ore was being sold to local lead smelters, at prices dictated by them. However, it wasn't until some ten years after the company's formation, that the construction of the smelt works began, and by mid-1875 some £4,700 had been expended on the work.

By 1885 there were twenty-two lead crystallisers in the desilvering works, and nine Scotch hearths and seven reverberatory furnaces in the smelting works. In addition, a shot tower (for manufacturing lead shot) and a lead sheet and piping works were constructed on the east side of works (see fig. 3). La Tortilla galena contained up to 78% lead and approximately 11 ounces of silver per ton of ore.

4.3 Transportation and Export of the Lead Ingots

In 1883, Thomas Sopwith junior had also formed the *Lead Warrant Company, Ltd.* with storage yards at the Millwall Docks, London and Newcastle-upon-Tyne, for the storage of imported lead ingots. Transportation of lead ingots within Spain was relatively easy as up to five railway lines serviced Linares, providing access to various Spanish ports. La Tortilla lead works had it's own branch railway line (see fig. 4).

Fig. 3. La Tortilla smelting works circa 1907; low buildings on the left contained the smelting hearths and furnaces and the desilverization pans; the shot tower is centre right, and to the right of the tower lies the lead sheet and pipe works (Colectivo Proyecto Arrayanes)

Ryc. 3. Zakład hutniczy La Tortilla około 1907 r., niskie budynki po lewej stronie mieściły piece hutnicze i panwie do odzysku srebra; na prawo od środka wieża śrutowa, a dalej po prawej stronie dział produkcji arkuszy i rur (Colectivo Proyecto Arrayanes)

Fig. 4. La Tortilla: the railway loading platform with stacks of lead ingots (Colectivo Proyecto Arrayanes)

Ryc. 4. La Tortilla – kolejowa rampa załadowcza ze stosami sztab ołowiu (Colectivo Proyecto Arrayanes)

During the period from 1880 to 1907, any lead ingots produced by the company would bear the cast insignia, 'T.S. Co. L^{D}. Spain'. Visitors to the La Tortilla lead works would sometimes be given as a souvenir, a miniature ingot bearing the same insignia.

After production, the lead ingots were then stacked on a platform for loading into railway wagons. They would be then taken by railway to various ports, Almería, Málaga, or Seville (fig. 1) ready for export by ship. It is perhaps inevitable, that a ship's cargo could become lost in transit, if for example a ship was lost at sea.

5. Discovery of a shipwreck and lead ingots

In May 2005, Odyssey Marine Exploration based at Tampa, Florida, USA commenced a marine survey of the western English Channel and Western Approaches and outside the territorial waters of England and France, known as the Atlas Shipwreck Survey Project. Between May 2005 and October 2008 the survey had documented 267 shipwrecks. In addition to finding shipwrecks, the survey examined the level of wreck deterioration, and assessed the preservation of archaeologically significant deep-sea shipwrecks, and the impact of fishing activity (trawling). Wrecks were identified using a combination of side-scan sonar and magnetometry. Potential targets were then examined and photographed in detail with a Remote Operated Vehicle Zeus (ROV) (Kingsley, 2009, p. 1)

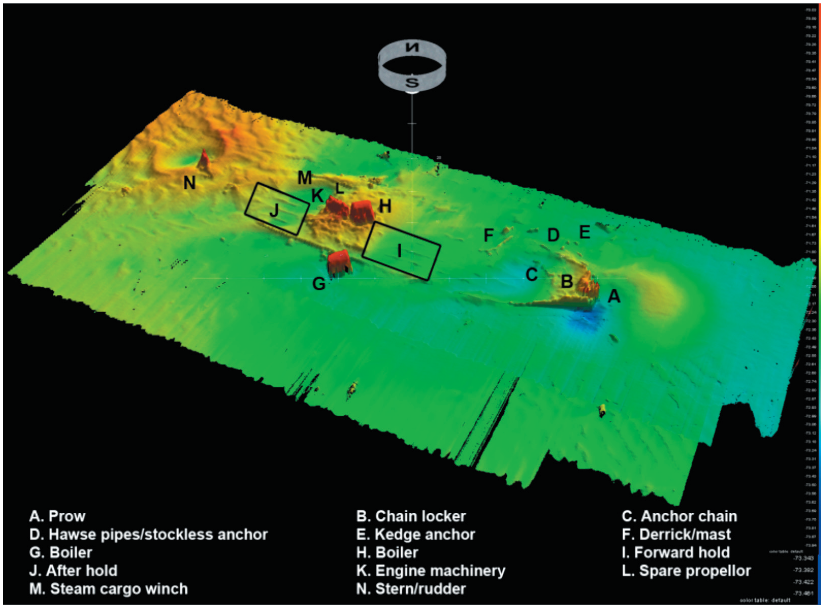

Fig. 5. Multibeam image of wreck site T1M31b-5 showing the positions of diagnostic structural remains and features (Cunningham Dobson et al., 2015, fig. 4)

Ryc. 5. Wielowarstwowy obraz stanowiska wraku T1M31b-5 ukazujący pozycję diagnostycznych pozostałości (Cunningham Dobson i in., 2015, fig. 4)

Fig. 6. Stowed lead ingots in situ in the after hold (2005). Spaces between ingots are colonized by conger eels (Cunningham Dobson et al., 2015, fig. 16)
Ryc. 6. Stos sztab ołowiu na miejscu w luku (2005). Przestrzenie między sztabami są zamieszkałe przez węgorze (Cunningham Dobson et al., 2015, fig. 16)

At the start of the project in 2005, the geophysical survey discovered the wreck (Site T1M31b-5 – see Fig. 1) of a 64.6 m-long steel ship in the western English Channel, about 70km southeast of Plymouth at a depth of 80m (see fig. 5). Investigation with the ROV confirmed that the ship had been carrying a cargo of lead ingots bearing the insignia 'T.S.&C^{o}L^{D}. Spain' (fig. 7). In the following years Odyssey returned to the site several times (Cunningham Dobson et al., 2009, 1)

The wreck stands proud of the seabed, which in this particular area is flat and composed of dense gravel and large shell fragments. The lead ingots had been loaded into the forward and aft cargo holds. The fact that there was very little debris field combined with a distinct lack of major structure, i.e. bridge, engine room, main deck, suggested to Odyssey that there had been a major salvage operation on the wreck prior to 2005 (Cunningham Dobson et al., 2009, p. 1–3).

The lead ingots in the forward cargo hold were scattered over an area 11.2 × 6.7 m on the starboard side of the ship, as well as a minor scatter near the portside boiler. On the starboard side of the ship, aft of what was the ship's engine room, there was a large cluster of lead ingots (see fig. 6), stacked at least nine rows high across an area 9.6 × 5.8 m in an alternating header and stretcher formation (Cunningham Dobson et al., 2009, p. 3, 5).

Elsewhere in the ship were the boilers and other items of equipment. It was considered that the power source for the propeller was a steam-powered triple-expan-

Fig. 7. Lead ingot DAN-08-0002-IT, Length 73cm recovered from the shipwreck bearing the insignia 'T.S.&CoLD. Spain' (Cunningham Dobson et al. 2015, fig. 28)

Ryc. 7. Sztaba ołowiu DAN-08-0002-IT długości 73 cm odzyskana z wraku statku, nosząca oznaczenie „T.S.&CO LD. Spain" (Cunningham Dobson et al. 2015, fig. 28)

sion engine, which was first commercially used in 1881 (Cunningham Dobson et al., 2009, p. 5). The date of the ship's construction was considered to fit into a 30-year period between the middle and late 19th century. Other evidence suggested that it was built at the end of the 19th century (Cunningham Dobson et al., 2009, p. 7). The lead ingots were considered to be the most reliable means of dating the ship.

Four lead ingots were removed from the wreck for analytical purposes together with pottery sherds. The ingots varied in sizes, 71 to 75 cm long, 12.5 to 14 cm wide, and 4.7 to 7 cm thick; their weight varied from 34 kg to 55 kg. Slight variation in the lettering of the insignia indicated that several different moulds had been used on the casting floor.

5.1. Identifying the source of the cargo of lead ingots

To try and identify the source of the lead ingots, Odyssey contacted the British Museum. In turn, the British Museum turned to an Internet mining history discussion group for help. Fortunately, one of the authors (Vernon) subscribed to the group and knew instantly the origin of the ingots. Several months earlier he had visited Linares, and seen photographs of the lead ingots given to visitors to the La Tortilla smelt-works (fig. 8). They also bore the insignia 'T.S.&C°L^{D}. Spain'. Odyssey was duly notified. Consequently, the Colectivo Proyecto Arrayanes, a mining

Fig. 8. Miniature lead ingot bearing the insignia 'T.S.&CoLD. Spain' (Colectivo Proyecto Arrayanes)

Ryc. 8. Miniaturowa sztabka ołowiu DAN-08-0002-IT długości 73 cm odzyskana z wraku statku, nosząca oznaczenie „T.S.&CO LD. Spain" (Colectivo Proyecto Arrayanes) heritage organisation at Linares, provided Odyssey with further information about the La Tortilla smelting-works. Ultimately a film documentary was made about the discovery of the shipwreck and the Colectivo's help was acknowledged. Odyssey's calculations suggested that the total cargo consisted of about 13,532 ingots that weighed approximately 564 tons.

6. The ingots return to Linares

When Linares town council, and the Colectivo Projecto Arrayanes, agreed that they would host the 11th International Mining History Congress in September 2016, one of the authors (Vernon), who had originally been the link with Odyssey, thought that one way to thank the town for their cooperation, would be for Odyssey to present them with one of the lead ingots, for display in the town museum. Odyssey were contacted, they liked the idea, and agreed for two of the ingots to be given to Linares.

When the ingots were recovered from the wreck, Odyssey reported the 'finds' to the United Kingdom's Government Receiver of Wrecks and they were put into storage in a warehouse in southern England. As they were now listed, Odyssey had to get permission from the Receiver of Wrecks to release them and permit them to be taken out of the country to Spain. The ingots were described as, *"2 x Cast lead ingots stamped with "T.S & Co Ltd Spain", lettering 5cm high, 1cm wide, base is smooth, no markings or special features, ingots all heavily colonised with marine growth, weights 34kg-40kg."* The necessary paperwork was completed and the ingots were transported by car to Spain, via France. The ingots finally returned 'home' to Linares early April 2016.

The ingots were presented to Linares by Odyssey Marine Exploration who was represented by Claudio Lozano Guerra-Librero, marine archaeologist, Huelva University at a special event on the 6th September 2016. The Mayor of Linares, and town council, representatives from the Spanish Provincial and Regional Government, and members of the Colectivo Proyecto Arrayanes who initiated the return of the ingots to Linares, were also present (fig. 9).

7. Conclusion

Despite extensive research by Odyssey Marine Exploration, the name of the cargo ship has never been discovered. On the last occasion that Odyssey returned to shipwreck site wreck T1M31b-5 in 2015, they found that the wreck site had been looted and that all the remaining ingots had been removed. The two lead ingots (DAN-08-0001-IT and DAN-08-0002-IT) that are now exhibited at Linares town museum, and originally cast at the La Tortilla lead-works Linares, represent a significant archaeological find, and help to provide unique evidence that Linares was once a very productive lead mining area.

Fig. 9. Presentation of the two ingots (from left to right): Ana Cobo Carmona – Andalucían Government, Mabel Selfa – Linares Town Council, Juan Fernández Gutiérrez – Mayor of Linares, Robert Vernon – Colectivo Proyecto Arrayanes Honorary Member, Claudio Lozano Guerra-Librero – representative of Odyssey Marine Exploration and marine archaeologist, University of Huelva, Eduardo Tamarit – Andalucían Government, José (Pepe) Dueñas – President of Colectivo Proyecto Arrayanes, the organisers of the International Mining History Congress (Colectivo Proyecto Arrayanes)

Ryc. 9. Prezentacja dwóch sztab (od lewej do prawej): Ana Cobo Carmona – przedstawicielka Rządu Andaluzji, Mabel Selfa – Rada Miasta Linares, Juan Fernández Gutiérrez – Burmistrz Linares, Robert Vernon – Członek Honorowy Colectivo Proyecto Arrayanes, Claudio Lozano Guerra-Librero – reprezentujący Odyssey Marine Exploration, archeolog morski z Uniwersytetu Huelva, Eduardo Tamarit – przedstawiciel Rządu Andaluzji, José (Pepe) Dueñas, Prezydent Colectivo Proyecto Arrayanes, organizatorzy Kongresu Historii Górnictwa (Colectivo Proyecto Arrayanes)

The two lead ingots are very distinctive. The ingot on the left [DAN-08-0001-IT] is slightly curved, whilst the ingot on the right [DAN-08-0002-IT] (fig. 7) is flat and has several prominent stains on the upper surface around the lettering.

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OPOWIEŚĆ O DWÓCH SZTABACH OŁOWIU

Linares, Sopwith, ołowiu sztaby,
Odyssey Marine Exploration, Kanał la Manche

W epoce brązu i żelaza górnictwo ołowiu nie było znaczące, aczkolwiek musiało istnieć skoro w wykopaliskach notowano drobne wyroby ołowiane, głównie paciorki i koraliki datowane na około 3000 lat p.n.e. Dopiero Rzymianie docenili wartość tego metalu, z którego wyrabiali m.in. wodne rury i zbiorniki, okrętowe kotwice, figury, a nawet trumny. Nie bez znaczenia było też, że galena (PbS) zawiera zawsze pewne ilości srebra. Podczas opanowanego przez Rzymian procesu ekstrakcji srebra dochodziło do powstania PbO, używanego jako pigment, a nawet do produkcji niektórych ówczesnych kosmetyków. Niestety, toksyczne własności powszechnie i szeroko stosowanego ołowiu miały też swoje wielkoskalowe, negatywne skutki zdrowotne. W średniowieczu znacznie wzrosło zainteresowanie wydobyciem ołowiu, przede wszystkim ze względu na możliwość równoczesnego pozyskiwania srebra, ale też na jego coraz szersze zastosowanie, m.in. przy rozpowszechnionej produkcji szklanych i witrażowych okien. Nowe techniczne wynalazki, jakimi były napędzane końmi lub kołami wodnymi systemy pompujące i transportowe, pozwoliły zejść z eksploatacją poniżej poziomu wód gruntowych, a tym samym znacznie zwiększyć podziemną eksploatację.

W Europie ołów był obok żelaza prawdopodobnie najczęściej eksploatowanym metalem. Na terenie Wielkiej Brytanii bogate złoża rud ołowiu znajdują się w górach Penińskich, na terenie Walii oraz w rejonie Mendip, we Francji – w Bretanii, w Masywie Centralnym, Pirenejach i Wogezach, w Niemczech – w Górach Harcu i Rudawach, a w południowej Austrii – w okolicach Villach. W Polsce ołów jest pozyskiwany od XI wieku ze złóż rud cynkowo-ołowiowych, miedzi i ołowiowych w czterech obszarach: śląsko-krakowskim, świętokrzyskim, dolnośląskim oraz pienińsko-tatrzańskim. Na południu Europy, Grecy eksploatowali złoża w Laurium (w starożytności do ekstrakcji srebra), a Włosi – na Sardynii. Na terenie Hiszpanii Rzymianie zakładali liczne kopalnie złota, srebra, miedzi, pirytu i ołowiu. Bogate złoża galeny odkryto na terenie prowincji Murcia, Almería, Ciudad Real, Guadalajara oraz Jaén. W tej ostatniej szczególnie ważny był prężny ośrodek przemysłowy w miejscowości Linares, leżącej 260 km na południe od Madrytu, w północnej Andaluzji.

Obszar górniczy Linares – La Carolina obejmuje polimetaliczne złoża, których pochodzenie związane jest z intruzją karbońskich granitoidów w skały osadowe mezozoiku. Kruszconośne żyły wypełniają szczeliny spękań ciosowych o przebiegu NNE–SSW w wielu miejscach przemieszczonych przez równoległy system krzyżujących się z nimi uskoków. Na całym trym terenie zachowało się dużo artefaktów i pozostałości dawnych robót górniczych, datujących tutejszą wielowiekową aktywność górniczą.

Szczególny rozkwit górnictwa i hutnictwa ołowiu w Linares i okolicach przypadł na drugi okres „rewolucji przemysłowej", czyli na drugą połowę XIX wieku. Wtedy zaczęli tu lokować swój kapitał przedsiębiorcy głównie z Wielkiej Brytanii, Francji, Belgii i Niemiec. Jako pierwsze przybyły kompanie brytyjskie w latach 40. przywożąc ze sobą innowacyjną technologię parową. Silniki parowe zastosowane do napędu pomp odwadniających kopalnie oraz do maszyn wyciągowych transportujących urobek na powierzchnię niezwykle usprawniły prace wydobywcze.

W tym czasie w Linares bardzo dobrze prosperowały trzy angielskie kopalnie ołowiu, zarządzane przez spółkę John Taylor & Sons z Londynu. W czerwcu 1863 r. na polecenie właściciela ważnych kopalń ołowiu w północnej Anglii, którym był William Blackett Beaumont, przybył do Linares syn jego agenta górniczego – młody Thomas Sopwith Jr. Jego zadaniem było znalezienie nowych, perspektywicznych terenów pod przyszłe kopalnie ołowiu. Przedmiotem szczególnego zainteresowania stała się kopalnia La Tortilla, położona w niewielkiej osadzie górniczej o tej samej nazwie, leżąca ok 2 km na zachód od obecnego miasta Linares (ryc. 2). Koncesja tej kopalni została przejęta przez angielską kompanię górniczą już w 1864 r., a Thomas Sopwith Jr. został jej zarządcą. W kwietniu następnego roku zainstalowano tam pierwszy silnik parowy, który już po roku (1865) zastąpiono kornwalijskim silnikiem balansowym z cylindrem o średnicy 60 cali. Po śmierci ojca w 1879 r., Thomas Sopwith Jr. przejął pełną kontrolę nad kopalnią, otwierając w Linares w latach 1880 i 1883 kolejne przedsiębiorstwa. Pierwszym z nich było T. Sopwith and Company, Ltd., w ramach którego powstały m.in. zakłady hutnicze La Tortilla (ryc. 3), a drugim Lead Warrant Company, Ltd., posiadające w Londynie i w Newcastle-upon-Tyne magazyny do składowania importowanych sztab ołowiu. Ich transport na terenie Hiszpanii był łatwy, skoro Linares zaoferowało pięć linii kolejowych umożliwiających dostęp do kilku hiszpańskich portów. Zakłady ołowiowe La Tortilla miały też własną bocznicę kolejową (ryc. 4). Po tragicznej śmierci Thomasa Sopwith Jr. w 1898 r., kopalnia La Tortilla została zamknięta w 1903 r., ale zakłady hutnicze funkcjonowały nadal. Jakkolwiek w 1907 r. zostały przejęte przez kompanie francuską, wytapiane tu sztaby nadal nosiły oznaczenia „T.S.&C^{o}L^{D}. Spain" (Thomas Sopwith & Co. Ltd. Spain).

Po wyprodukowaniu ołowiane sztaby były na miejscowej bocznicy ładowane na wagony kolejowe i transportowane do portów w Almerii, Maladze lub Sewilli (ryc. 1) i dalej statkami do Anglii.

Zapewne zdarzało się, że w tak długiej morskiej trasie zaginął albo sam ładunek albo, na skutek wypadku, cały statek.

W maju 2005 r. na wodach zachodniej części Kanału La Manche badacze z amerykańskiego stowarzyszenia Odyssey Marine Exploration (OME; Floryda, USA) realizowali projekt o nazwie „Atlas Shipwreck Survey Project". Do października 2008 r. udokumentowali tam 267 wraków okrętów różnego wieku. Podczas badań oznaczano stan destrukcji wraków, szacowano ich archeologiczną wartość oraz wpływ działalności połowowej (trałowanie). Wraki były identyfikowane z użyciem połączenia skanowania sonarowego i magnetometrii. Potencjalne cele były dokumentowane i szczegółowo fotografowane za pomocą zdalnie sterowanego pojazdu o nazwie „Zeus".

Już na początku realizacji projektu w zachodniej części Kanału, w odległości około 70 km na SE od Plymouth, na głębokości 80 m natrafiono na wrak stalowego statku długości 64,6 m i miejsce to oznaczono symbolem T1M31b-5 (ryc. 1 i 5). W kolejnych latach OME kilkakrotnie wracała w to miejsce. Detale konstrukcyjne statku pozwoliły oznaczyć, ze pochodził on z drugiej połowy XIX w. Dokładniejszego datowania mógł dostarczyć zaginiony wraz z nim ładunek. Szczegółowe badania wykonane za pomocą „Zeusa" potwierdziły, że były to sztaby ołowiu. W przedniej ładowni były one zgrupowane na powierzchni 11,2 × 6,7 m (ryc. 6). Duże nagromadzenie sztab znaleziono też w maszynowni statku, gdzie zajęły powierzchnię 9,6 × 5,8 m. Oznaczenie sztab było jednoznaczne: „T.S.&C^{o}L^{D}. Spain" (Fig. 7).

Niewielki fragment ceramiki oraz cztery sztaby ołowiu „Zeus" podjął z wraku i dostarczył na statek ekspedycji OME. Ich parametry nie były jednakowe i utrzymywały się w granicach: długość 71–75 cm, szerokość 12,5–14 cm, grubość 4,7–7 cm i waga 34–55 kg. Obliczenia dokonane przez OME pozwalają przypuszczać, że cały ładunek zatopionego statku wynosił 13.532 sztaby o łącznej wadze 564 ton.

Władze miasta Linares oraz stowarzyszenie Colectivo Projecto Arrayanes byli organizatorami odbywającego się tam we wrześniu 2016 r. XI Międzynarodowego Kongresu Historii Górnictwa. Jeden z autorów (R.W. Vernon) mający kontakt z OME uznał, że dobrą formą podziękowania miastu za współpracę byłoby ofiarowanie przez zespół Odyssey jednej ze znalezionych we wraku sztab do publicznej ekspozycji w lokalnym muzeum. Zespół Odyssey Marine Exploration zaakceptował pomysł i zgodził się ofiarować Linares dwie takie sztaby. Po dokonaniu odpowiednich formalności, w kwietniu 2016 obie sztaby (o masie 34 kg i 40 kg) wróciły „do domu", a oficjalnego przekazania dokonano podczas specjalnego punktu programu Kongresu w siedzibie władz miasta (ryc. 9).

Epilog

Pomimo szczegółowych badań prowadzonych przez OME, nazwa zaginionego statku nigdy nie została zidentyfikowana. Po raz ostatni statek Odyssey wrócił na stanowisko wraku T1M31b-5 w 2015 r. i stwierdził, że zostało ono zrabowane, a cała pozostała część ładunku usunięta. Dwie oryginalne ołowiane sztaby, wytopione przed około stu laty w hucie La Tortilla w Linares, jako pierwsze podniesione z wraku (DAN-08-0001-IT i DAN-08-0002-IT) i obecnie eksponowane w tamtejszym muzeum są teraz niezwykłą rzadkością!