Odyssey Papers 47

Spanish Lead in the English Channel & the Mining Ventures of T. Sopwith & Co. Ltd

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At the start of the Atlas Shipwreck Survey Project in 2005, Odyssey Marine Exploration discovered outside UK territorial waters the wreck of a 64m-long steel ship in the western English Channel containing a cargo of lead ingots (site T1M31b-5). Further seasonal monitoring continued in 2008 and 2012. The ingots are stamped with the maker's mark of 'T.S. C° L^{D}. SPAIN', an abbreviation of T. Sopwith and Company Limited. The ingots were manufactured at Linares in Andalusia between 1880 and 1907, when Thomas Sopwith Jnr was one of numerous entrepreneurs who exploited southern Spain's mineral wealth. Spain emerged as the world's largest producer of lead in the last quarter of the 19th century.

The Sopwith ingot cargo is the sole archaeological remains of a cargo of lead found underwater that was extracted en masse at Linares during the heyday of Victorian mining in Andalusia. In 2015 the wreck's entire cargo of around 423 tons was found to have been removed, becoming the third regional site looted in this sector of the western English Channel, including the English First Rate warship the *Victory*, sunk in 1744, and the mid-18th century French privateer *La Marquise de Tourny.* The disturbance of these shipwrecks highlights the very real threats to underwater cultural heritage outside UK territorial waters and the governmental complexity of preventing the destruction of archaeological resources so far from shore.

1. Shipwreck Site T1M31b-5

A cargo of lead ingots associated with a steel shipwreck was a unique discovery made by Odyssey Marine Exploration in 2005 (site T1M31b-5). This is the sole example of such a cargo type identified among more than 270 shipwrecks examined during the 4,725 square nautical mile Atlas Shipwreck Survey Project of the Western Approaches and the western English Channel. The site is located outside UK waters and around 70km southeast of Plymouth at a depth of 80m (Fig. 1). Visual video and photographic surveys were conducted in 2005 and 2008 and a multibeam survey was completed in 2012 using a high resolution Reson Seabat 7125 and related PDS 2000 data processing software mounted on the Remotely-Operated Vehicle Zeus (Figs. 2, 4). Four ingots were recovered for analysis (Figs. 26-29). In 2015 the wreck was found to have been heavily disturbed, with the entire lead cargo removed.

The ship lost at site T1M31b-5 was a 64.6m-long and 15.9m-wide riveted steel steamship powered through a four-bladed single shaft. The seabed is essentially flat and the sediments characterized by a dense gravel and abundant large shell fragment matrix. The site is densely colonized by shoals of pollock swimming through the water column (Fig. 4). Bib, ling, monkfish, crab, lobster and urchins are common, while conger eels inhabited spaces between stacked lead ingots (Figs. 5, 9, 10, 16, 17, 19, 20). All exposed metal surfaces and features are covered in a brown/grey bio-fouling turf. Fishing net was snagged near the kedge anchor, was attached to the steam winch and had fouled both sides of the rudder (Figs. 10, 17-19). Additional net was newly observed around the stockless anchor in 2015 (Fig. 22).

The ship lies with a list to port of 30° on an east/west axis, with the bow oriented 123° and the stern heading 303°. The wreck consists of three main features: the remains of the prow and lower chain locker; remains of the engine room and two boilers; and the rudder and partly buried propeller (Fig. 2). A lead ingot cargo was visible in 2005 and 2008 in both the forward and aft cargo holds (Figs. 11, 16). No video or still photography was taken

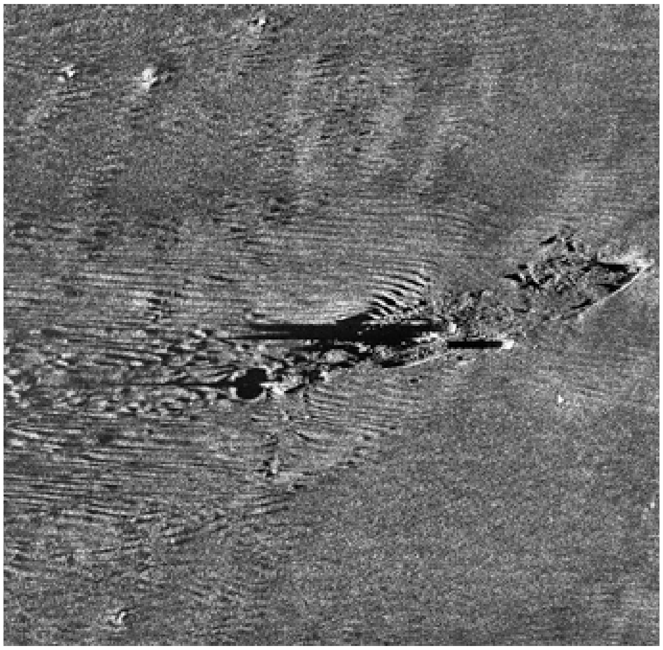

Fig. 1. Side-scan sonar image depicting coherent wreck site T1M31b-5.

in 2012, when operations focused solely on a multibeam survey. No associated debris field was observed. Very little of the vessel's steel riveted hull, the forecastle and bow, the bridge and engine room, the stern, main decks and cargo holds survive. Such an unlikely site formation is indicative of major salvage operations conducted prior to 2005 to remove part of the cargo.

Surveying the wreck from the bow to the stern (see Fig. 4 for the following description of structural remains and features), the exterior starboard side of the prow is scoured and a sediment berm has formed due east (A). The prow stands approximately 4m above the seabed. The steel hull plates have sprung from their rivets along the starboard bow and are heavily bent in places. A large section of biofoul missing from the portside may have been stripped off by trawl net impacts. The portside hull plating is preserved higher than to starboard (Figs. 5-6). The 2008 survey observed that the upper remaining steel hull plate on the starboard bow had been displaced since 2005.

At the prow is a 9m square area that contains the chain lockers in the fore peak (Figs. 4B, 7). The anchor chain and

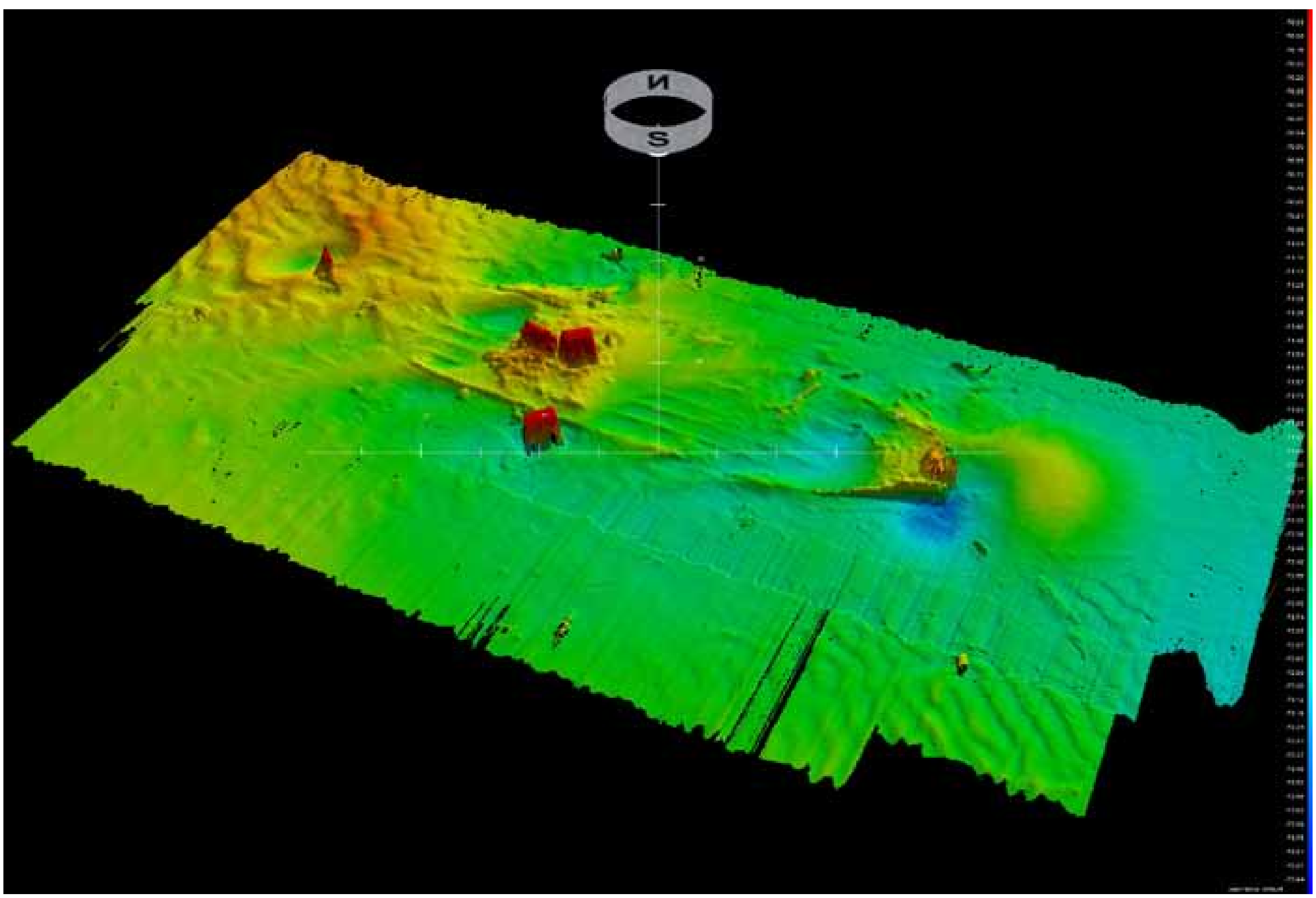

Fig. 2. Multibeam image of wreck site T1M31b-5, the bows to the east and stern to the west.

Fig. 3. The wreck is populated by a dense shoal of pollock (Pollachius).

associated equipment are stored in the forecastle, where a Bosun's locker/store may have been positioned (Figs. 8-9). Heading from the prow aft along the starboard side, the hull plates taper in preserved height from 2-3m to 1m at a distance of 12m westward along the hull. A further 10m aft towards the end of the forward hold (I), the hull plates are less than 0.5-1.0m high (Fig. 4). The ship's entire forward deck and forecastle are missing.

The exposed forward cargo hold contained a scattered concentration of hundreds of lead ingots covering an area of 11.2 x 6.7m across the midships starboard quadrant (I), but visibly did not continue to the port side (Figs. 11-13). A row of six ingots and a minor scatter of ingots were documented on the port side, just a few meters forward of the portside boiler.

Midships at a distance of 31m from the bow lies an intact boiler displaced 5-9m from its original position and displaced outboard of the hull (G). The example derives from a two furnace marine Scotch boiler that is heavily covered in marine growth and measures approximately 4m in length and 3m in diameter minimum. A lobster creel and rope line have snagged on the wreckage outboard of

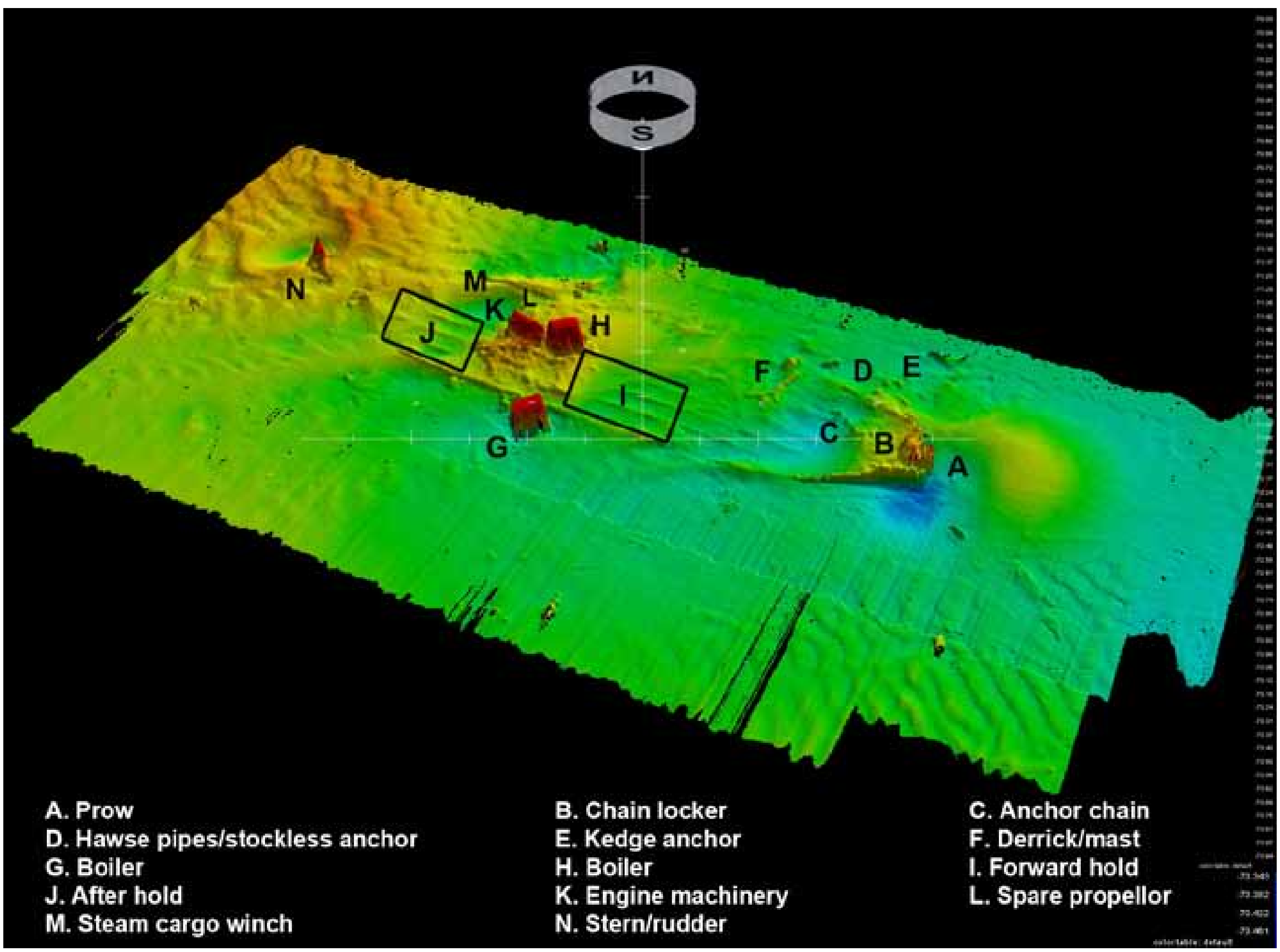

Fig. 4. Multibeam image of wreck site T1M31b-5 showing the positions of diagnostic structural remains and features.

Fig. 5. The port side of the bows with anchor chain visible inside the lower chain locker.

Fig. 6. Sprung riveted steel hull plates on the starboard bow.

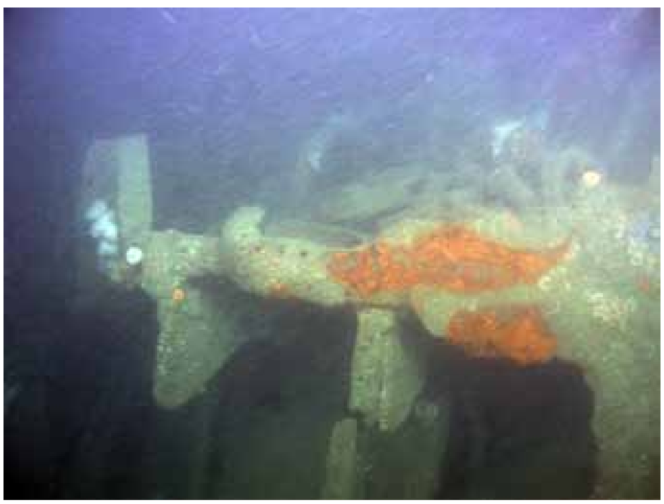

Fig. 7. Remains of the chain locker in the bows.

Fig. 8. Starboard forward chain locker area, anchor chain, pulley blocks and pipework.

Fig. 9. Concreted anchor chain inside the chain locker in the bows.

Fig. 10. Kedge anchor off the portside bow attached to chain, on which fishing net is snagged.

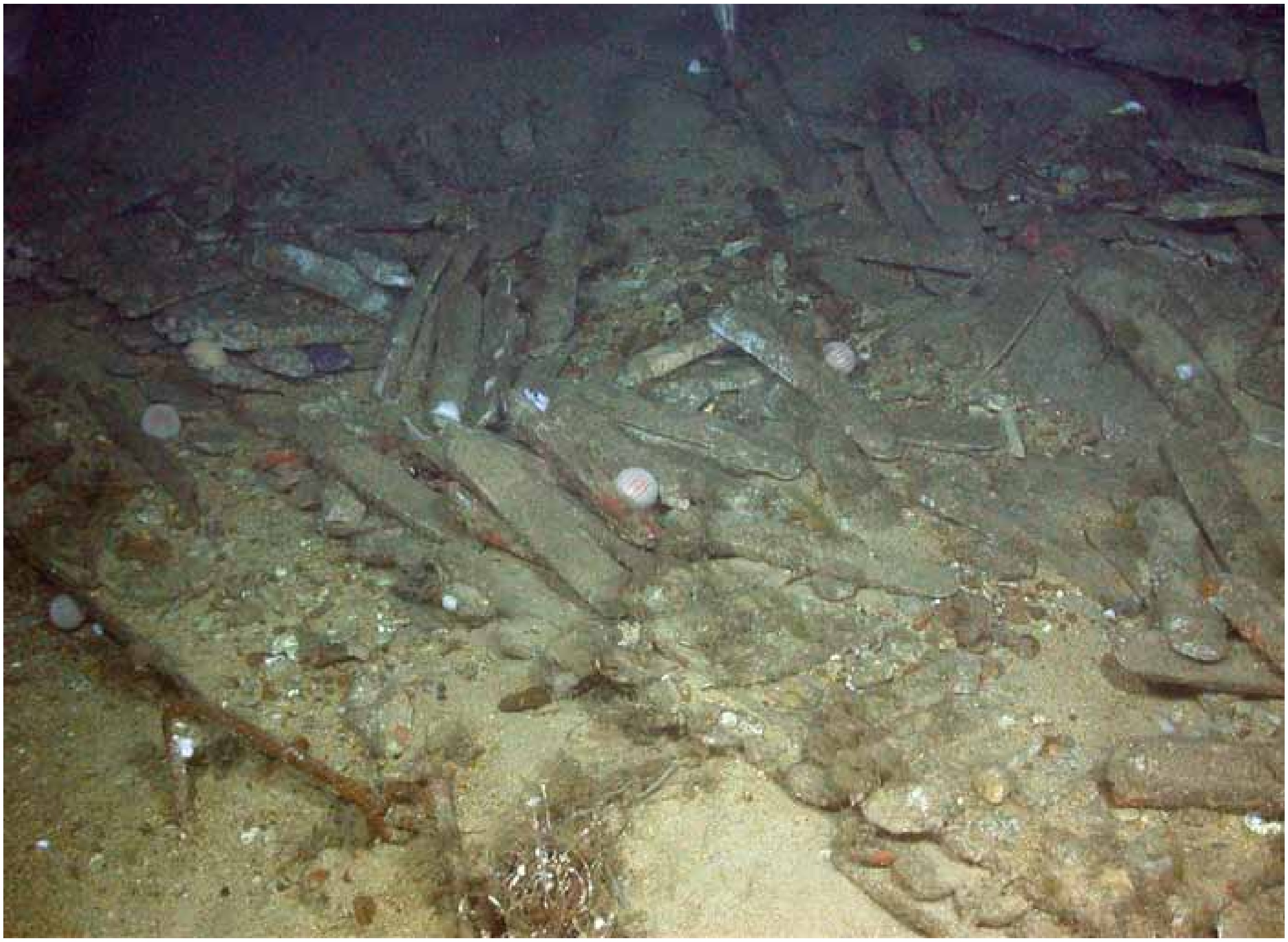

Fig. 11. Lead ingots scattered and in situ in the forward hold (2005).

the boiler's side (Figs. 14-15). Amidships in the center of the wreck the remains of the main engine and a second Scotch marine boiler were preserved (H, K). Due to poor underwater visibility, caused by large shoals of pollock, it was impossible to determine the engine's type in 2008, although it was most likely a triple-expansion steam engine. The first commercial use this technology was on a steamship built in 1881 for the SS *Aberdeen* in Govan, Scotland (Day and McNeil, 2013: 694).

Just aft of the engine area on the starboard flank a large cluster of lead ingots was stacked at least nine rows high across an area of 9.6 x 5.8m in an alternating header and stretcher formation (Fig. 16). This consignment corresponds to the ship's after hold (J). Once more there was no indication of any lead continuing to portside.

The starboard aft hull is missing down to a height of about 1m all the way to a position approximately 10-12m forward of the rudder. The stacked ingots ended abruptly at a point 17m aft of the end of the starboard boiler. Astern of the ingot stack to starboard were large flat steel plates and sections of angle-iron. A long section of what may be the intermediate propeller shaft, a coupling and possible sections of the stern tube iron bulkhead and the surviving propeller shaft were also present.

Terminating at the western end of the wreck is the partly buried four-bladed propeller and the top half of the rudder standing over 2m high and turned hard over to port (N). The stern bush of the propeller was exposed, as well as the top half of the propeller post. The exposed propeller blade and area around the stern tube and propeller post were snagged with fishing net (Figs. 17-18). Aft of the exposed rudder was a semi-circular section of narrow iron framing and further fishing net. A large scour has formed due west of the rudder, which is encircled to the north, south and east by an extensive sediment berm accumulation.

Forward from the rudder along the port side of the wreck, in an area corresponding to the aft cargo hold, were long sections of rectangular plating, unidentified metal

Fig. 12. Detail of lead ingots collapsed across the forward hold (2008).

Fig. 13. Detail of lead ingots in the forward hold (2005).

Figs. 14-15. Scotch boiler outside the starboard center of the wreck, with a lobster creel snagged to one side.

structural debris, fishing net fragments and a steam cargo winch lying upright (Figs. 4M, 19; for the type see Paasch, 1997: 83). Its starboard ends were angled upwards towards the center of the wreck. The forward terminal of the winch's two drum ends is larger in diameter. Outboard to port of the winch was a partly buried vertical section of hull plating approximately 8-10m long. A section of fishing net was draped at right angles over the exposed hull plating, while at 90º were the possible remains of the curved iron lower deck or hold beam end protruding vertically from the seabed. A small rectangular trunkway or hatch coaming sat upright a few meters inboard of the hull plating. Adjacent forward of this feature was a large block-shaped section of unidentified machinery. Some 2m forward was a spare four-bladed propeller (L) sitting on the two lower blades and pointing upwards at an angle of 40-50° next to an engine casing (Fig. 20).

About one meter away at right angles to the easterly end of the engine casing was a second intact marine Scotch boiler (H), around which were scattered unidentified twisted and damaged metal objects and angle-iron frames associated with remains of the engine room. The seabed was covered with a scattering of various bent and twisted angle-iron sections, small bent steel plate and additional unknown debris near the eastern end of the forward cargo hold. A section of the derrick/forward mast lay on the seabed amongst metal debris.

Approximately 10m aft of the bow outboard of this feature, an empty hawse pipe was exposed on the seabed (Figs. 4D, 21). A few meters forward was a second hawse pipe with a stockless anchor still in place (Fig. 22). The juxtaposition of both hawse pipes close together on the port bow is unusual and suggests displacement caused by salvage work or major fishing impacts. Adjacent to the open end of the

Fig. 16. Stowed lead ingots in situ in the after hold (2005).Spaces between ingots are colonized by conger eels.

empty hawse pipe a small kedge anchor with bow-shaped arms was observed flat on the seabed and close to a section of anchor chain (Figs. 4E, 10). Whether the chain was connected to the kedge anchor – possibly once stowed in the forecastle – was not determined. A small steel fairlead (rope line guide) lay on its side on the open seabed inboard between the two hawse pipes and the port bow hull plating. Another small section of derrick/mast was observed 2-3m inboard of the hawse pipe and anchor (F). The port chain locker exposed at the port bow contained a large accumulation of anchor chain (C). A section of anchor chain was draped over the lower remaining port bow steel hull plate down onto the seabed.

Two fragments of white porcelain, one blue-on-white porcelain sherd and a single stoneware rim were observed on the wreck. The rim derives from a generic stoneware jar (DAN-08-0004-CS, fragment L. 19.5cm, W. 16.5cm, Th. 1.5cm), glazed on the interior and exterior (Figs. 23-25), and characterized by a double line of beaded and floral rosette (each with eight petals) repeated decorative pattern below the rim. This jar type was produced in Britain up to the 1920s-40s (pers. comm. Nigel Jeffries, 9 July 2008).

The date of the shipwreck at T1M31b-5 can only be broadly delineated based on the structural remains. The transition from wood to iron and steel ships occurred during a timeframe of about 30 years between the middle and late 19th century. Once the durability of iron ships had been proved by *c*. 1870, the floodgates opened to production, so that by 1888 over 90% of merchant ships built to Lloyd's specifications were manufactured from mild steel (Coates, 1999-2000: 257, 265). The transition from wood to steel ships was facilitated by a 40% drop in the price of iron between the late 1860s and early 1890s, which, combined with declining costs of coal, encouraged the exploitation of steam technology. With greater speed and regularity a steamship was able to travel about three

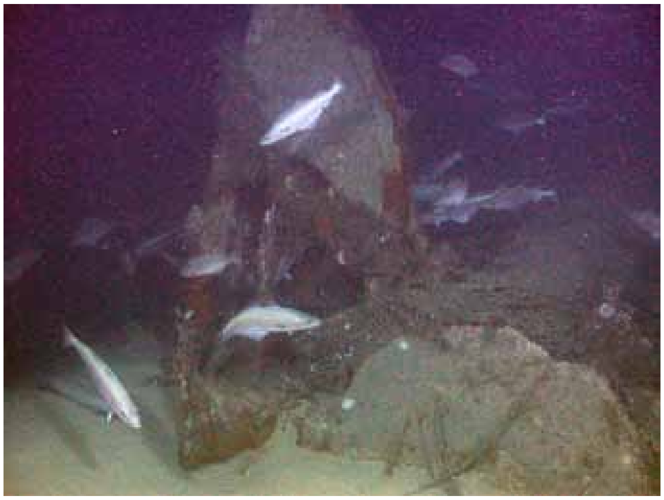

Fig. 17. Fishing net snagged on the rudder.

Fig. 18. Detail of the rudder turned hard to port and the ship's four-bladed propeller.

Fig. 19. Steam-driven winch and drum ends in the fore end of the ship, on which fishing gear is snagged.

Fig. 20. A four-bladed spare propeller in situ midships in the engine room.

times as far as a sailing ship each year using less labor and capital per ton-mile (Harley, 1970: 263-64).

Cylindrical or drum marine boilers of the form identified on site T1M31b-5, also known as 'Scotch' boilers, which utilized a group of small tubes instead of one long winding flue to channel heated gasses from the furnace to the uptakes, were introduced between 1840 and 1850 (Sennett, 1885: 5 and for the form see Paasch, 1997: 76). Paddle wheels were generally replaced by the screw propeller in 1845-50, after B. Woodcraft, F.P. Smith and John Ericsson's British screw propeller patents first appeared in 1832 and 1836 (Murray, 1858: 136; Oram, 1899: 6). The lead ingot cargo vessel's four-bladed propeller form can be broadly assigned to the years *c*. 1890-1915. Stockless anchors were sanctioned by Lloyd's in the late 1800s. The best known British types were patented by A. Verity and J.F. Hall in 1886 to become one of the most popular anchors of this form (Curryer, 1999: 118-19). The capability to stow an anchor within a hawse pipe reduced the number of men required for anchor parties and thus increased shiphandling efficiency (Upham, 1983: 27). Overall the structural remains of the vessel at site T1M31b-5 could date from the 1890s onwards.

2. Lead Ingot Cargo

The most reliable means of determining the date of the ship's sinking is the cargo itself. The ingot stamps of 'T.S. C^O L^D. SPAIN' are an abbreviation of the T. Sopwith and Company Limited directed by Thomas Sopwith Jnr between 1880 and 1907, between which paramaters the ship lost at site T1M31b-5 must have sank.

The ship's two dense concentrations of lead ingots are separated by the engine room (Fig. 4, I, J, K). The eastern scattered concentration covered an area of 11.2 x 6.7m

Fig. 21. A hawse pipe displaced in the port bow section of the wreck.

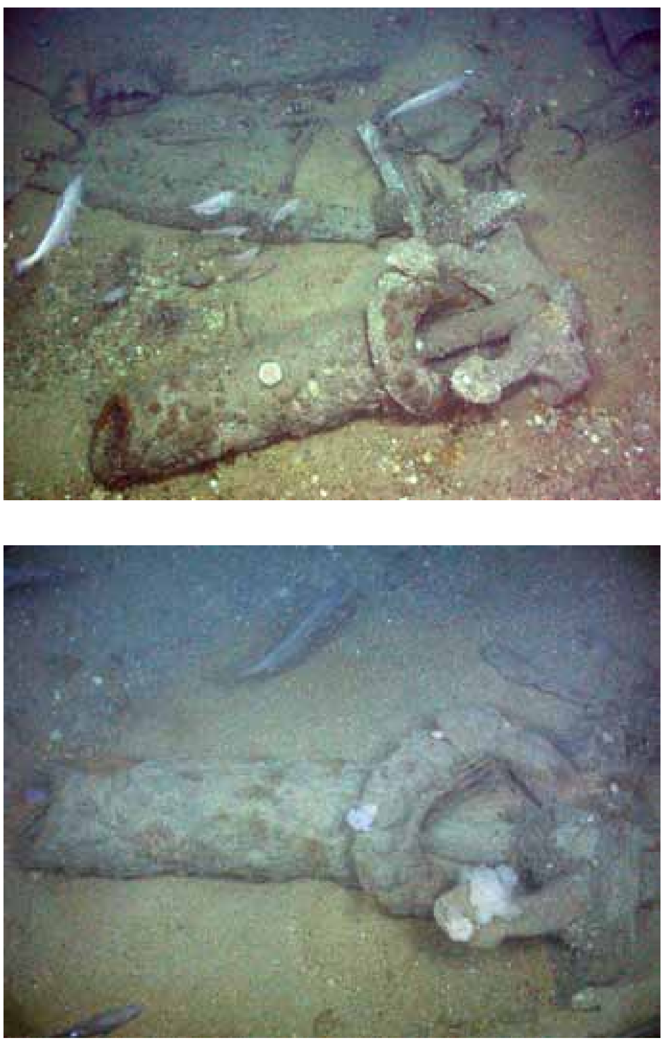

Fig. 22. A stockless anchor stowed inside a collapsed hawse pipe in the port bow section of the wreck (2008: top), and newly snagged with fishing net in 2015 (bottom). Sections of steel hull panels behind.

Figs. 23-25. Rim fragment of a stoneware jar, L. 19.5cm, and details (DAN-08-0004-CS).

Fig. 26. Lead ingot DAN-05-0001-ML, L. 75cm. The metal has been sampled for alpha emissivity testing.

Fig. 27. Lead ingot DAN-08-0001-IT, L. 71cm.

Fig. 28. Lead ingot DAN-08-0002-IT, L. 73cm.

Fig. 29 Lead ingot DAN-08-0003-IT, L. 72cm, covered with dense marine growth.

across the midship starboard quadrant, corresponding to the forward hold (I), but did not visibly continue to the port side (Figs. 11-13). The western concentration, stacked at least nine ingots high in an alternating header and stretcher formation, was recorded across an area of 9.6 x 5.8m in the ship's aft starboard third corresponding to the after hold (J). Once more there was no indication of any lead continuing to portside (Fig. 16).

The four lead ingots recovered in 2005 (DAN-05-0001-ML) and 2008 (DAN-08-0001-IT, DAN-08-0002-IT, DAN-08-0003-IT) all share an identical anatomy characterized by a rectangular form, wider at the base and narrowing on top, where each is stamped inside a recessed rectangle with the letters 'T.S. C^{O} L^{D}. SPAIN'. The topside ends are stepped. The individual characteristics are:

- DAN-05-0001-ML, a greyish cast lead ingot with brown oxidation, curved contour, L. 75cm, W. 14cm, H. 7cm, 55kg (Fig. 26).
- DAN-08-0001-IT, a greyish cast lead ingot, covered in marine growth, base flat and smooth, letters 5cm high and 1cm wide, L. 71cm, W. 12.7cm, H. 4.9cm, 38kg (Fig. 27).
- DAN-08-0002-IT, a greyish cast lead ingot, iron oxide staining, base flat and smooth, letters 5cm high and 1cm wide, L. 73cm, W. 13cm, W. 6cm, 40kg. Large gouge (4 x 2cm) at 'SPAIN' end of ingot at right-hand corner of the letter 'N'. The 'S' in 'T.S.' is followed by a dot and thus derives from a different mold to DAN-08-0001-IT. Circular concretion (4cm diameter) at top of the 'S' in 'SPAIN'. Delamination caused by corrosion products at the left end has exposed fresh lead surface (Fig. 28).
- DAN-08-0003-IT, a greyish cast lead curved ingot, base flat and smooth, dense marine growth (removed during washing), letters 5cm high and 1cm wide, L. 72cm, W. 12.5cm, H. 4.7cm, 34kg (Fig. 29).

In combination the two ingot clusters cover an area of 20.8 east/west and 12.5m north/south. The ingots were stacked in a minimum of nine levels in consecutive underlying and overlying rows lengthwise and widthwise to maximize stowage space and minimize chances of the cargo shifting out of position.

For the eastern cargo cluster (11.2 x 6.7m), in any single original undisturbed row 15 ingots could have been stowed lengthwise and 48 ingots stowed widthwise. This suggests a reconstructed volume of 720 ingots per row and a minimum total of 6,480 ingots total for the nine rows. Subtracting 10% to allow for stowage space between each ingot yields a final figure for this deposit of 5,832 lead ingots weighing 243,486kg (based on the average dimensions and weights of the recovered bars).

AIR LIQUIDE

Air Liquide Electronics – Balazs Analytical Services
Research & Development – Spectroscopy Lab

BALAZS™ ANALYTICAL SERVICES

JEDEC Alpha Specification Requirements

	Variable	Value	units
1	Sample Identification	Discovery Channel Pb Ingot	
2	Counter Identification	1850 #2	
3	Minimum Discriminator Energy	1.00	MeV
4	Gas type/Flow Rate	P10/200	cc/min
5	Sample/Electrode distance if different from nominal	≤ 2	mm
6	Counter Efficiency	81.0	%
7	Counter Active Area (cm2)	1000.0	cm^2
8	Sample Active Area (cm2)	673.0	cm^2
9	Background Count (B)	240	counts
10	Background Count time* (t_B)	42.5	hours
11	Gross Count (G)	12600	counts
12	Gross Count time* (tG)	89.0	hours
13	**Alpha Emissivity**	**0.24935**	α/cm^2-hr
14	**Standard Deviation of Alpha Emissivity**	**0.00241**	α/cm^2-hr
15	Confidence Interval	90.0	%
16	**Detection Limit (at specified confidence level)**	**0.00309**	α/cm^2-hr

* As per the JEDEC spec. the count time is defined as the total time after the count rate has settled down (usually this takes from 2 - 10 hours)

Fig. 30. The results of alpha emissivity testing for lead ingot DAN-05-0001-ML conducted by the Research and Development Spectroscopy Lab of Air Liquide Electronics-Balazs Analytical Services, Texas.

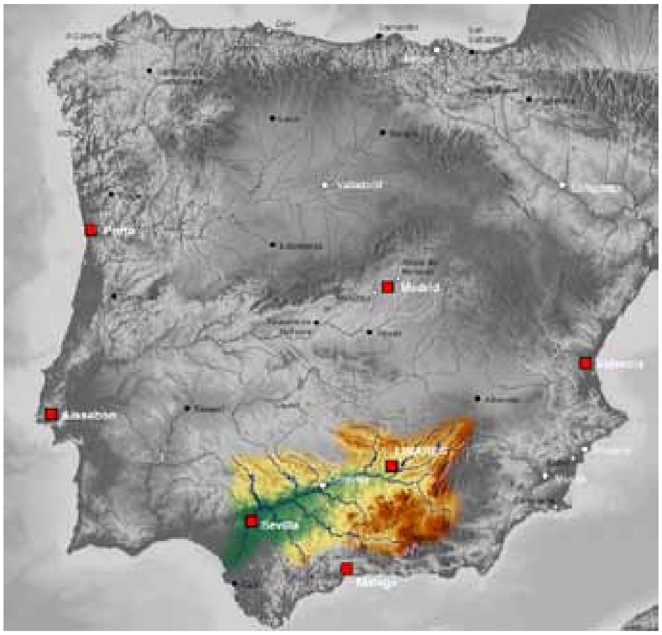

Fig. 31. Map of the Iberian Peninsula highlighting the location of Linares in Andalusia.

Within the western cargo (9.6 x 5.8m), 13 ingots could have been stowed lengthwise in any single row and 41 ingots stowed widthwise. This suggests a reconstructed total volume of 533 ingots per row and a minimum presence in nine rows of 4,797 ingots total for the cargo. Again subtracting 10% to allow for stowage space between each ingot assumes a final cargo compositon for this area of 4,317 lead ingots weighing 180,234kg.

The possible cargo magnitude observed in 2005 and 2008 can be reconstructed as approximately 10,149 lead ingots weighing 423 tons. Photographic imagery and the 2012 multibeam suggest that approximately half of the original ship's lead covering all of the port side was salvaged before the site's discovery in 2005. Conservatively adding just one-third to reconstruct the total original cargo magnitude suggests a final figure of 13,532 ingots weighing 564 tons.

Robert White Stevens' work *On the Stowage of Ships and their Cargoes with Information Regarding Freights, Charter Parties* (1894: 372) contains details on how to best stow lead around the same time when the Sopwith ship sank in the western English Channel:

> When pig lead only is taken, dunnage say with coal or rubble, until the keelson is completely covered, in order to raise the lead and make the ship easy at sea. Lay plank, and stow in the middle in stacks, by placing the pigs three or four inches apart, and crossing at the same distance. Large billet wood makes good dunnage, stowed between…

Lead might also be stowed on felt, which was not judged to be a perfect solution because water tended to find its way under the metal to rot the material (Stevens, 1894: 400).

Analysis of the composition of lead ingot DAN-05-0001-ML (Fig. 26) at the Research and Development Spectroscopy Lab of Air Liquide Electronics-Balazs Analytical Services for alpha emissivity testing was conducted in July 2008. Argon (inert gas) was blown over the samples to remove any loose particulate matter present on the lead. The samples were loaded on a tray and placed into the sample chamber of an alpha counter. The samples were then counted for 89 hours to collect sufficient data for proper counting statistics. Background emission tests were completed prior to sample acquisition and were taken into account for the final results. The alpha emissivity of the lead ingot proved to be 0.24935 α/cm^2-hr, about half way between a Low Count Class 1 and Low Count Class 2 grade (Fig. 30). While the result did not point to the presence of low alpha lead, the sample did possess a lower alpha emission than samples from contemporary origins.

3. T. Sopwith and Company Limited

The following account places the site T1M31b-5 cargo within its historical context relating to a remarkable chapter in the history of Andalusian mining and the development of modern Spain. At the start of the 19th century, Spain's economic philosophy had changed little since the heyday of Colonial control over the Americas. In the same way that the country had tightly controlled access to its Americas dominions, the country's own resources were closely regulated through protectionist State policies that favored the Crown, including the Mining Law of 1825. As the century wore on, the Mining Laws of 1849 and 1859 softened the regalistic principle. Finally, new mining legislation introduced after the Glorious Revolution on 29 December 1868 brought about a feverish mining boom based on foreign investment in the metalliferous industry during the last quarter of the 19th century (Tortella, 2000: 96).

3A. Andalusian Mining

The mineral wealth of the Linares-La Carolina mining district in the northern Province of Jaén in the region of Andalusia, extending southwards for about 40km from Despeñaperros in the Sierra Morena with an east to west width of around 30km, was especially renowned (Ángel Perez and Schwartz, 2006: 2; Vernon, 2009b). The main mining field lies predominately to the west and north-west of Linares (Fig. 31). The mineralisation occupies fractures in a granitic host rock that is covered in places by a veneer of Triassic sandstone, which in turn is overlain by Miocene sediments, particularly to the south of the area. The majority of lodes trend in a north/northeasterly direction, and are continuous and constant at 1m wide, while the concentration of galena reaches a tenor of 75-78% lead and 160-250 grammes of silver per ton, thus defining the ores as Primeras (First Class) (Hereza and de Alvarado, 1926: 21, 34-36; Vernon, 2013: 13). Following the Phoenician's exploitation of Andalusia's silver, lead, tin and copper reserves (for which see the late 7th-century BC Bajo de la Campana shipwreck off Cartagena; Polzer and Reyes, 2009), the Romans introduced large-scale imperial lead and copper mining to Andalusia, the former metal being mined extensively in the Linares area down to the water table. After Rome, the lead mines lay dormant until the Spanish Crown started re-working the Arrayanes mine in 1749 (Ángel Perez and Schwartz, 2006: 2; Vernon, 2009b).

In the second quarter of the 19th century, British lead producers started to search overseas for new resources. By 1879 England's principal lead mining areas, such as Swaledale in Yorkshire, were becoming so depressed that there was an exodus of skilled lead miners to other parts of the world, including Spain. People who remained behind were left in a state of near starvation (Fletcher, 1991: 196, 200). Following the relaxation of Spain's protectionist mining laws and import tariffs in the mid-19th century, Scotsman Duncan Shaw acquired the lead mining concessions to Pozo Ancho at Linares, in the process revealing the district's rich reserves. In 1849 Shaw promoted the Linares Lead Mining Association to work the Pozo Ancho concession. It soon became a successful enterprise when John Taylor and Sons took over the management of the Association in 1852 and formed the Linares Lead Mining Company.

Particularly significant was the introduction under British influence of steam pumping technology that for the first time in nearly 1900 years permitted mines to be worked to depths well below the old Roman levels. The success of the Linares Lead Mining Company attracted additional new English companies, including the Las Infantas Lead Mining Company Limited (1853-55) and the New Linares Mining and Smelting Company Limited (1853-55). Later, John Taylor and Sons formed two further organizations, la Fortuna and Alamillos, in 1855 and 1862 respectively. Together with the Linares Lead Company these companies provided rich dividends for their shareholders for years to come (Vernon, 2009a: 3-4).

In addition to the concessions managed by John Taylor and Sons, another significant British mining enterprise, La Tortilla, was set up at Linares and managed by Thomas (Tom) Sopwith Junior. Tom's father, Thomas Sopwith Senior, had since 1845 been the mine agent for Wentworth Blackett Beaumont, an English peer who owned major lead mines in northern England. Tom followed in his father's footsteps and, after serving an engineering apprenticeship in Newcastle upon Tyne, joined his father working for the Beaumonts with various mining related responsibilities.

Fig. 32. The sole surviving photographic portrait of Thomas Sopwith Jnr, dated October 1898. Photo: courtesy of Robert Vernon

However, due to the depletion of lead ore reserves in the Beaumont's mines, and with no significant local replacements available, Tom Sopwith Jnr was sponsored by Beaumont to tour some of the major lead mining areas of Europe in search of potential new opportunities. By 1863 Sopwith Jnr had arrived in Linares and recommended to his sponsors the productive opportunities of La Tortilla mine, 2km west of the town (Figs. 33-36). The Spanish Lead Company Limited was subsequently formed in 1864 as a private enterprise to work the mine with a capital of £60,000 divided into 12,000 shares of £5 each, financed by landowners and industrialists from northern England and the City of London. Thomas Sopwith Senior was a Director of the company, and Tom was appointed the mine manager (Fig. 32). At the end of the 1870s the Palmerston Shaft had been sunk and was being pumped using a 60in steam engine shipped into Spain from Cornwall.

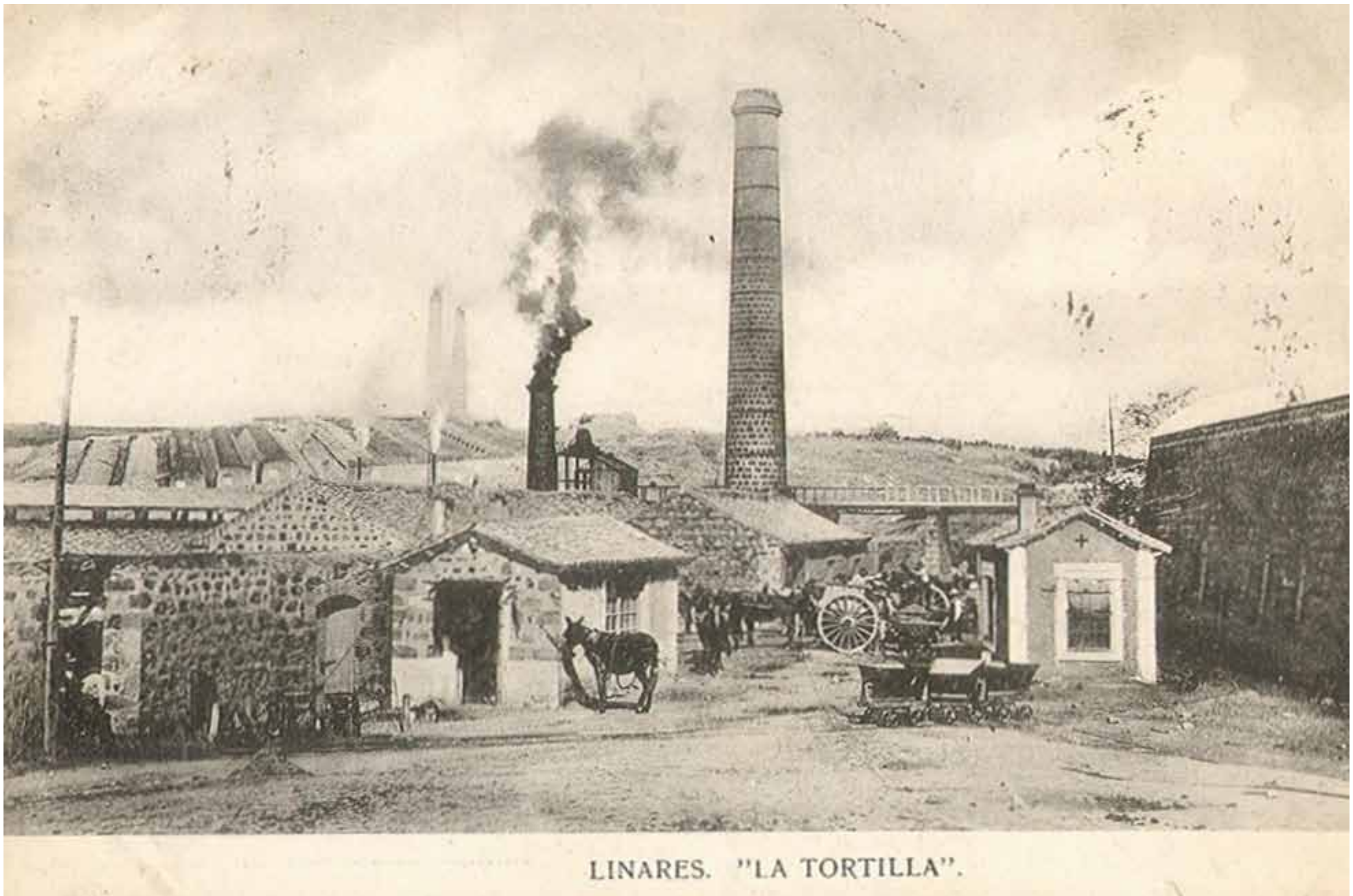

Fig. 33. La Tortilla lead-works yard in the late 19th century. A tramway connected the mine to the works; donkey carts transported ore from the outlying mines. Photo: courtesy of Robert Vernon.

By the mid-1870s, Sopwith Jnr was also involved in operating another mine, La Gitana, 5.5km to the north-west of Linares and had extended the La Tortilla operations to the north to include a further mine, Las Angustias (Vernon, 2009a: 5; Vernon, 2013: 6, 8, 11, 13, 20, 26, 31, 43).

One priority of all the British companies at Linares was the smelting of ore. The prices charged by Spanish companies for smelting was excessively high. To overcome this problem Taylor's had established two smelting plants. The first was located at the Fortuna mine, the second at Cordoba, 100km west-southwest of Linares, for the Linares Lead and Alamillos Companies. The latter was established to take advantage of a cheap and reliable supply of coal from the Belmez coalfield to the north of Cordoba. Sopwith's company was no exception, and by 1874 they had made sufficient profits from their operations to establish a smelt-works at La Tortilla, which consisted of sheds for lead-smelting hearths and a de-silvering plant. By 1885 the works contained nine Scotch hearths and seven reverberatory furnaces, a recently added shot-tower and a plant for producing lead piping and sheeting (Vernon, 2009a: 4; Vernon, 2013: 41, 47).

The period that corresponds to the earliest possible date for the sinking of the wreck discovered by Odyssey at site T1M31b-5 commenced in 1880, when the Spanish Lead Mining Company was reformed to become the T. Sopwith and Company Limited (Vernon, 2009a: 5-6). The new organization focused on the La Tortilla and Las Angustias mines, over which Thomas Sopwith Jnr was promoted from manager to director. The company allocated 12,000 shares at £10 a share, and the initial seven subscribers included powerful men such as Sir W.J. Tyrone Power of Holland Park, London, and William Power Knight, Commissionary General in Chief of the British Army and a barrister. Sopwith Jnr invested £39,980 of his own money (Vernon, 2013: 47).

In 1883 Thomas Sopwith Jnr became the director of a further company. The Lead Warrant Company Limited was formed with the purpose "to establish in London, Newcastle-upon-Tyne, or elsewhere in the United Kingdom or abroad, one or more warrant-yards or depôts for the storage of lead and other metals and the products thereof". Contemporary sources indicate that the London warrant-yard was located at Millwall Docks. Other share-

Fig. 34. An industrial panorama of the Tortilla lead works at Linares c. *1907. A rectangular shot-tower and lead-smelter chimneys dominate the landscape. Photo: Colectivo Proyecto Arrayanes, Linares, and courtesy of Robert Vernon.*

holders in the company were predominently Spanish mine owners and personnel associated with Sopwith's Spanish mining operations. The company went into liquidation in 1897. It is not inconceivable that the cargo of lead ingots discovered at site T1M31b-5 was bound for one of the two warrant-yards cited above (PRO BT31/3097/17739; *Pall Mall Gazette*, 25 October 1883: 15).

Tom Sopwith continued to run the mines named after him in Andalusia until he died unexpectedly on 1 August 1898 aged 60 during a trip home to England, when the *Glasgow Herald* reported he was accidently killed by his own son who was handling a new gun his father had just bought him. Sopwith Jnr was buried in Brookwood Cemetery, Woking. An obituary published in the Minutes of the *Proceedings of the Institution of Civil Engineers* described him as "keenly interested in arriving at a correct view on questions of scientific or of popular interest… To him more than any other Englishman belongs the merit of establishing more friendly feelings and relations between the Spaniards and English residents" (Vernon, 2013: 53).

The T. Sopwith and Company Limited nevertheless remained operational. The new century saw acetylene gas introduced for underground illumination. After 1901, however, conditions deteriorated when work at La Tortilla struck an underground stream, almost flooding the mine. Meanwhile, lead reserves started to run dry and the cost of metal fell by £3 to £16 per ton of ore and £11 a ton in December 1901. The company was pumping a million and a half gallons of water out of its mines every 24 hours from an average depth of 800ft to keep its head above water, and long-term workmen started to leave for pastures new. The La Tortilla concession was only yielding around 300 tons of ore a month, but required 500-600 tons to turn a profit. Inevitably in 1902 two mines had to be closed, leaving 150 men unemployed. Thereafter, the Sopwith Company concentrated much of its production at the Gitana mine, but due to ongoing falling yields and lead prices it was decided at an Extra-Ordinary Meeting convened on 9 April 1907 to liquidate the company and convey everything to the Sociéte des Anciens Établissements Sopwith (Vernon, 2013: 55-58, 61).

The development of the T. Sopwith and Company

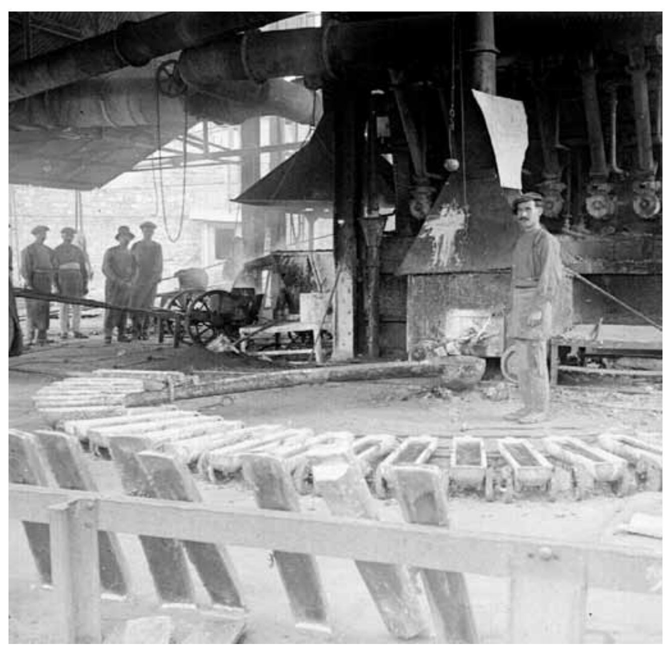

Fig. 35. Metal molds ready for tapping at a large blast furnace at Linares. The furnace is rectangular with at least ten tuyeres. Slag was run off in the background into wheeled cart. Photo: Colectivo Proyecto Arrayanes, Linares, and courtesy of Robert Vernon.

Limited mines after the 1880s largely went unrecorded, but it is possible to gauge their success by comparison to similar mining operations at Linares. By the late 1870s, John Taylor and Sons' three companies (Linares Lead, La Fortuna and Alamillos), for example, were averaging annual yields of 3,600, 4,300 and 2,300 tons respectively. The Linares Lead Company yielded a record 6,508 tons in 1893 and continued to produce high tonnages up to 1898, when it announced its one hundredth dividend, an achievement unsurpassed by any other 19th-century lead mining company. The Chairman of the Company declared that "A centenary of runs in a cricket match may be a common occurrence, but a centenary of dividends in a mining company is not a frequent experience". While information about Sopwith's operations is scant, some output figures are available: 2,850 tonnes in 1884, 4,350 tonnes in 1885, 6,340 tonnes in 1886 and 7,700 tonnes in 1887. The 1887 yield was probably maintained until 1893, when 6,870 tonnes of lead were turned out. However, by 1897 output had fallen to under 4,000 tonnes (Vernon, 2009a: 7, 9; Vernon, 2013: 49).

3B. Linares' Social Setting

Snapshots of daily life at Linares can be glimpsed from historical sources dating to an early phase in the district's industrial activities (Vernon, 2006). The mines were accessed by vertical shafts used to pump water to the surface, for ventilation and to wind ore to the surface (Vernon, 2009a: 3). Manpower was primarily Spanish, with a small number of foreign staff holding key managerial roles (Vernon, 2013: 48). Spanish labor was cheap, with daily wages half the price of England, and miners worked 12-hour daily shifts (Fletcher, 1991: 198). By 1867 the mines covering the Linares district were the main producers of lead in the world, which caused the town to witness a spectacular population increase in under 30 years from 7,000 to over 41,000 people by the 1870s. A multitude of languages and accents could be heard in its narrow, crowded streets from the regional dialects of the Iberian Peninsula to English, French and German. In 1875 the Englishman Hugh James Rose, Chaplain to the British, French and German communities at Linares, vividly described the mining town (Ángel Perez and Schwartz, 2006: 3):

Fig. 36. Newly cast lead ingots along the railway line at La Tortilla, Linares, ready for export. Photo: Colectivo Proyecto Arrayanes, Linares, and courtesy of Robert Vernon.

> It is on the outskirts of the wild range of Sierra Morena. It stands on the gently declining slope of a hill; around it stretch plains of tawny sand, covered in spring with green crops of barley, broad-beans, and coarse wheat, belted in with olive groves, their dusky, stunted trees enclosed in crumbling stone walls, each enclosure having a small, dark-roomed shanty, the "lodge" of the olive-guard, in its midst.
>
> The town is old, as many a fragment of crumbling Roman or Moorish masonry will show. It was built originally for some eight thousand people, and now at least forty thousand people are packed within its walls, literally 'like herrings in a barrel'... The houses of the mining town are, at least a great proportion of them, of Spanish design, and consist of one-storied buildings made of the huge thick blocks of the granite in which the lead usually is found, with very small iron-caged windows without glass; others of modern and wholly different architecture have sprung up in a thick and growing crop all around and among them. The streets are not paved, as a rule, but have been pitched at some remote period...

Rose continued to recall that "From morning until night you hear nothing, 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" (Vernon, 2009a: 1). As the English presence at Linares increased, Britain opened a Consulate first at the La Tortilla mine and later within the town; Thomas Sopwith was appointed its first British Vice-Consul (Vernon, 2009a: 5).

Environmental conditions were unsurprisingly harsh, but largely unmitigated. The main causes of death in mines was rock falls, blasting accidents, asphyxiation, smelting, the breakage of machinery and workmen falling down shafts. Over 3,000 injures were recorded in 1868 for all metal mines from a workforce of 40,000. Miners and people living near smelters were particularly at great risk from lead poisoning, which led to death or paralysis. At the end of the 1830s the Spanish-owned lead plant of San Andres in the coastal town of Adra led the way in safety measures by introducing condensation chambers to capture fumes and retrieve vaporized lead (Fletcher, 1991: 196, 198). The miners only started to complain about unhealthy working conditions in the late 1910s, while cases of silicosis were first reported in the province of Jaén in the mid-1920s. By 1937 the rate of silicosis in pit-workers was estimated at 50% (Menéndez-Navarro, 2008: 81, 83, 90).

4. Spain's Industrial Economy

The rise of lead mining in Andalusia in the second half of the 19th century to the status of world leader in output is universally recognized as having been dramatic. The question of how both lead mining and the exploitation of Spain's additional rich metalliferous resources impacted the national economy remains hotly debated. The country's economic structure fascinates for two reasons: to compare and contrast its financial position with the Colonial era of great wealth and to assess the timeframe and processes through which Spain became modern.

Lead production was just one significant part of the enormous mining capacity of Spain's wider reserves of iron, lead, copper, sulphur and mercury, which resulted in the decades spanning the 1860s-1900s becoming a golden age of mining in Spain. After textiles the mining sector provided the most important contribution to the country's output (Milward and Saul, 1977: 250). Whereas 70% of Spain's active labor force worked in agriculture in 1877 and 11% in industry, by 1900 the figure for industry had risen to 15.9% (Harrison, 1978: 69). In this new El Dorado, the pyrite deposits of Huelva were incredibly rich in copper, iron and sulphur. Alongside British interests in lead, other European countries developed concessions, including the French La Cruz enterprise in Jaén and the Cie Minère et Metallurgique des Austries. After 1858, Stolberg and Westphalia of Aachen opened up several mines at Aquisgrán (Harrison, 1978: 54).

From 1851-1913 metalliferous mining was the fastest growing industrial sector across Spain. The country ranked top as the world's mercury producer, with the famous Almadén mines controlled by the Rothschild family. Between 1876 and 1900 the country accounted for 16.8% of the world's copper output and over half the European total in the 1880s, stimulated largely by the British chemical industry's demands for sulphuric acid. In 1873 Rio Tinto, Spain's richest state-owned mines, was bought for £3.7 million by an Anglo-German-French consortium and within six years had been developed into the world's most prolific copper and pyrites mines, paying dividends of 70% on invested capital. The Tharsis Sulphur and Copper Mines yielded average returns on capital investments of 20%. Significant quantities of zinc were sold overseas. Around 1900 the provinces of Almeria, Granada and Marbella in southeast Spain were the leading European exporters of iron ore, which was also abundant in the northern Provinces of Vizcaya and Santander. Ships landed iron at British ports and returned with coke to feed the works at Bilbao. From 1860-64 Spain produced 198,400 tons of iron ore and 835.9 tons of mercury, figures which increased by factors of 0.5 for mercury and 9.7 for iron ore in 1900-1904 (Tortella, 2000: 99). Due to its advantageous low transport costs because most rich deposits were located close to ports, Andalusia became a paradise for non-ferrous metal extraction (Ramas Oliveira, 1946: 241; Milward and Saul, 1977: 250; Harrison, 1978: 55; Taylor and Harvey, 1988: 19-20; Tortella, 2000: 96; Dobado González, 2001: 90, 99; Coulson, 2012: 133).

Despite this remarkable upturn in mining, Spanish and European scholars alike envisage Spain as being transformed from a mass exploiter of Colonial precious metal mined in Colombia, Peru and Mexico, which benefited the State and society alike, to the exploited. Studies typified by Jordi Nadal's *The Failure of the Industrial Revolution in Spain 1814-1913* interpret the loss of the American colonies as having directly impoverished Spain. The loss of empire in the early 19th century had forced Spain back onto her agricultural resources, and the weak agricultural regime afforded a low purchasing power by a poor domestic market. With declining foreign trade, successive civil wars and changes of government up to 1876, Spain offered a poor foundation for economic development. The State was dominated by landed oligarchs who held little interest in addressing the root causes of Spain's economic backwardness. In turn, little opportunity was stimulated for domestic investment in industry during the 19th century (Milward and Saul, 1977: 250; Carr, 1980: 22; Taylor and Harvey, 1988: 19; Fletcher, 1991: 195).

The picture for the 19th-century could not have been more different to Andalusia's agricultural splendor developed around olive oil, wheat and rich rural estates studding the banks of the Guadalquivir River at the height of Roman Baetica's wealth and the large-scale productions of the late 16th and early 17th century, typified by the agricultural economy underlying the final voyage in 1622 of the *Buen Jesús y Nuestra Señora del Rosario* from Seville to northeast Venezuela (Kingsley *et al*., 2014).

As Captain S.E. Cook observed around the Linares region (1834: 67), "The towns are decaying and the appearance of the people is wretched and poor beyond measure, as is invariably the case in the agricultural districts… Like true Andaluzes, however, their cheerfulness never leaves them." In the absence of human and physical capital and markets to sell to, mining could not be developed from local sources (Tortella Casares, 2000: 97). Instead, foreign capital eagerly pounced on Spain's mineral wealth. James M. Swank, secretary of the American Iron and Steel Association, summarized the situation in 1882, when he observed that "This country is interesting and well endowed, but backward… Yet Spain does not benefit as much as you might think from this plundering of its treasures because the capital devoted to extracting and exporting the ore is principally English, French, German, and Belgian; the profits from this pillage hardly amount to anything for the Spaniards; they leave with the mineral ore" (Tortella Casares, 2000: 101).

Most economic historians argue that the 19th century witnessed the failure of the Industrial Revolution in Spain (Tortella Casares, 2000: 73). While Europe enjoyed the riches and social advancements ushered in by the revolution, in the latter decades of the 18th century and into the 19th century economically Spain fell increasingly further behind European countries such as Britain, France and even Italy (Shubert, 1990: 9). What has been termed "economic anarchy" in Spain is argued to have only permitted a "modest and distinctly slow advance" (Ramas Oliveira, 1946: 236). An absence of technical knowledge sustained a general economic backwardness typified by no reinvestment of profits or multiplier effects on technological and other dynamic linkages.

Meanwhile, the conditions introduced by foreigners – industrial long-term planning, technical knowledge, capital and market awareness – only benefited the overseas investors (Tortella Casares, 2000: 103, 105). Little of Spain's resulting wealth found its way back into the domestic economy, which has been described as having been technically 50 years behind the rest of Europe. Mines established by Spaniards, such as at Sierra de Gador, are dismissed as little more than brave attempts that were unsuccessful prior to British intervention (Fletcher, 1991: 196, 199, 202). The extension of the great European powers over Spain's mineral possessions to feed the industrial revolution is argued to have been "mirrored today in the 21st century by China's push to secure raw materials for its own industrial expansion" (Coulson, 2012: 130).

Other economic historians intepret the evidence more positively. Rather than a failure trapped in stagnation, Spain was merely a laggard whose economy was growing and changing, just at a much slower rate than other European countries (Shubert, 1990: 10). The development of the economy in the 19th century compared to Europe was sporadic and faltering, rather than generalized and continuous, and "islands" of modernization "existed amidst a sea of economic backwardness, always vulnerable to the vagaries of a weak domestic market" (Taylor and Harvey, 1988: 19).

Fig. 37. Satellite image showing the location of Linares, the source of site T1M31b-5's lead cargo, and the general position of the wreck in the western English Channel.

Taylor and Harvey's (1988: 22-23, 48-49) revisionist case against one-way exploitation proposes that Spain did not pay an extortionate price for the foreign capital sunk in mining, but enjoyed benefits in employment, salaries, technological transfer and the stimulation of enterprise. They emphasise that in 1891 some 415 ventures were active across Spain in iron, lead and copper-pyrites mining of which just 42 were foreign companies accounting for 59% of production by value. Foreign firms may have been more efficient than Spanish ones, but within the later 19th century mining boom Spanish entrepreneurs, managers and engineers were more forward looking and progressive than is traditionally acknowledged. Certainly businessmen such as Manuel Heredia of Malaga led the way in southeast Spain's iron production, using his considerable fortune generated from the export of local wine and olives to develop the local graphite mines and magnetic ores of the Sierra Blanca near Marbella through La Concepción company (Harrison, 1978: 55-6).

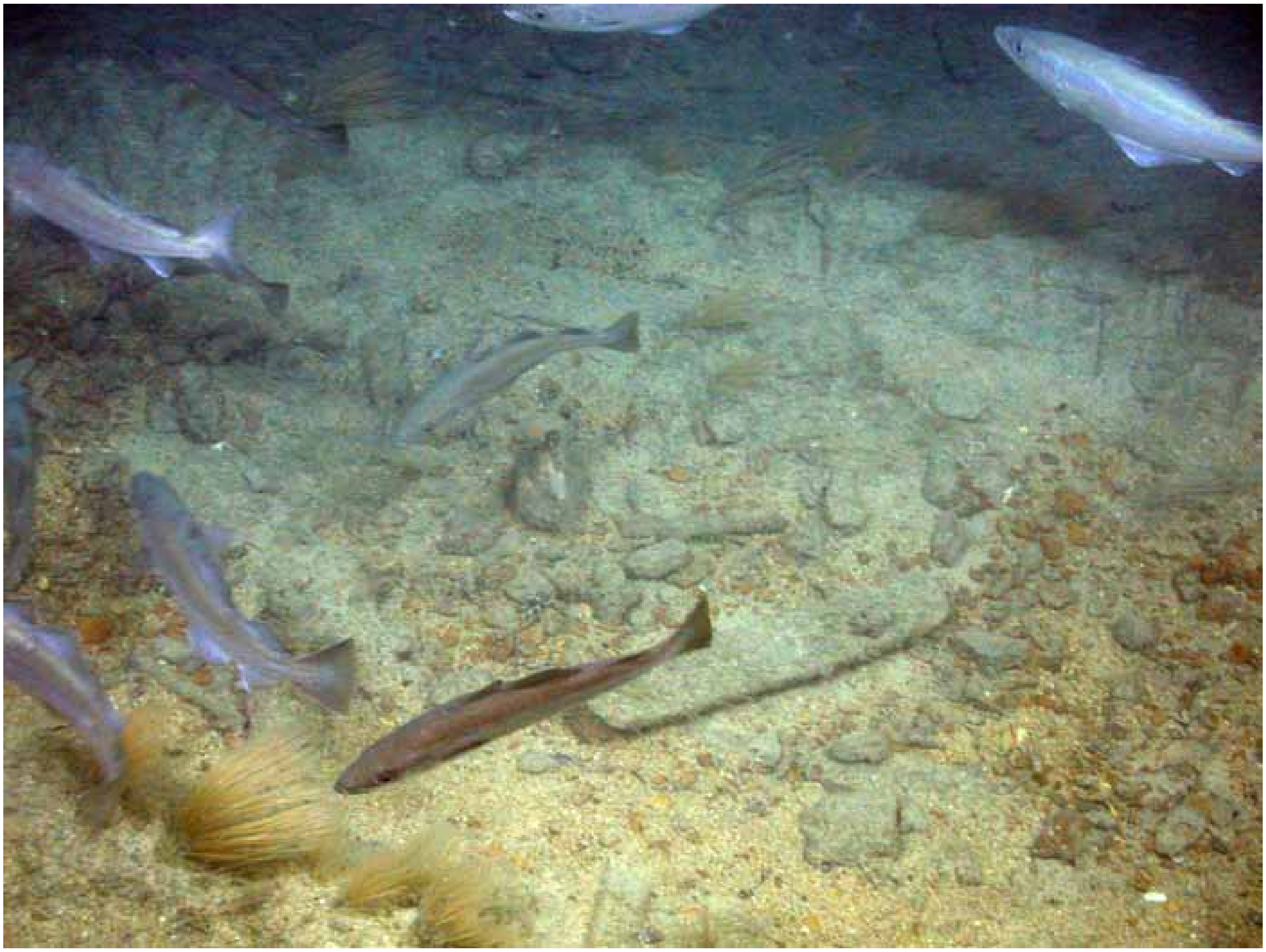

Fig. 38. The empty hull in the forward hold of site T1M31b-5 in May 2015 after the salvage of the wreck's lead ingot cargo. Note the recent iron deposit from the impacted hull at right. (See Fig. 11 for the hull's character in 2005.)

5. Conclusion

The shipwreck discovered by Odyssey Marine Exploration at site T1M31b-5 contains a previously unrecorded type of cargo of stacked lead ingots from either the La Tortilla or Gitana mines at Linares, Andalusia. The cargo is a microcosm of southern Spain's large-scale lead mining industry and exports during the last quarter of the 19th century and early 20th century. The ingots originated from concessions managed by the T. Sopwith and Company Limited, directed by Thomas Sopwith Jnr, which were operational from 1880-1907, parameters that define the date of the shipwreck. Although substantial historical and industrial information is accessible about the Spanish lead trade at Linares (Vernon, 2013), the logistics of distribution, shipping and overseas consumption are poorly understood.

The Sopwith cargo was being transported on a large steamship measuring 64.6m in length and 15.9m in width. She was built of riveted steel and powered through a four-bladed, single-shaft twin propeller. The consignment of lead was impressive. Based on the nine rows recorded in the eastern after hold, and assuming the same stowage structure originally existed in the western forward hold, supplemented by an additional one-third for a port side consignment, suggests the ship may have been transporting an estimated 13,532 ingots weighing 564 tons. The wrecked ship's dimensions suggest an original gross registered tonnage of 600 tons or more, which makes the vessel's type and size a possible close comparison to the 686-ton SS *Liverpool*. Built in the Liverpool yard of J. Jones & Sons in 1892, the Sligo Steam Navigation Company steamship was sunk in 1916 by a German U-boat around 40 miles north of Anglesey.[1]

Transporting lead in a steel ship rather than on a wooden vessel had significant economic benefits. Thin plating allowed steel ships to be built with holds that were 18in wider and 12in deeper than a thick-planked wooden ship of identical dimensions. Where a wooden vessel could

Fig. 39. The after hold of site T1M31b-5 in May 2015, entirely stripped of its nine rows of lead ingots. (See Fig. 16 for the hull's character in 2005.)

carry 200 tons, a steel ship of the same proportions had a capacity of 250 tons of cargo. An iron ship of 600 tons burden had a lesser 500-ton capacity in wood. As a result, "The advantage of this is very great and enables an iron vessel to trade, and remunerate the owners… With steamers the comparison is even much more in favor of iron" through an added one-fourth in her stowage potential (Stevens, 1894: 348-49).

Whether the ship at site T1M31b-5 was deliberately commissioned to pick up lead produced in the Sopwith mines or was an opportunistic tramp steamer is unclear from the available evidence. If British, the vessel could have been constructed in one of the numerous shipyards in the Clyde area, southeast Scotland or northeast England, such as the Campbeltown Shipbuilding Co. Ltd., Robert Duncan & Co. Ltd., Port Glasgow, Napier & Miller Ltd, Glasgow, Scott's Shipbuilding & Engineering Co. Ltd, Greenock, or the Caledon Shipbuilding & Engineering Co. Ltd, Dundee, to name but a few options (Thomas, 1992a: 69, 72-74). The shipment may have been heading for any of the UK's major ports at Cardiff, Clyde, Liverpool, London, Newcastle or Sunderland (Thomas, 1992b: 10) (Fig. 37).

Although no evidence exists for any cargo form other than lead at site T1M31b-5, an additonal organic consignment that is no longer preserved cannot be excluded, such as fruit. Another possible comparative structure could be the 31 tons 9 counterweight of cork loaded at Sines onto the deck of the 124-ton schooner the *Ark* of Dartmouth, which complemented the main floor cargo of 100 tons of lead taken onboard at Seville in May 1854 (Stevens, 1894: 153). Heavy metal cargos counterbalanced the low density of organic shipments.

The site T1M31b-5 type of lead cargo is surprisingly otherwise unattested within the marine archaeological record. Lead ingots from other periods are known from numerous British and Spanish wrecks, most extensively a series of Roman sites off Spain, Italy and southern France related to Rome's mass exploitation of Iberian metals and typified by the Sud-Lavezzi 2 wreck off southern Corsica transporting around 300 amphoras, 5.2 tons of lead and some 5.7 tons of copper ingots (Liou and Claude, 1990: 56, 121). Lead ingots were stowed below decks at the foot of the mast on Roman ships as saleble ballast alongside multiple amphora and metal consignments, such as on the Sud-Perduto B ship of *c*. AD 1-15 lost off southern France. The 50 truncated lead ingots counter-stamped 'IMP. CAES' and 'VESP.AVG' from the Ses Salines wreck of AD 70-80 off Majorca (Parker, 1992: 378-799, 415-16) reflect the imperial nature of control over Spain's mines and perhaps the long arm of Rome in Baetican maritime commerce, a structure more akin to Colonial Spain's political economy in the Americas than the foreign entepreneurial ventures of late 19th-century Andalusia.

Sites of later date associated with lead ingots include the *El Gran Grifon* Spanish Armada wreck of 1588 off Fair Isle in northeast Scotland (Martin, 1972: 66-68), seven boat-shaped ingots from the Punta Restelos Spanish armada shipwreck of 1596 off northwest Spain (Casabán *et al*., 2013: 16-17), a Spanish vessel believed to be the *San Bartolome* lost off St Mary's Sound, Isles of Scilly, in 1597,[2] and English ingots stamped with the Broadarrow on the 18th-century Don Pancho site in the Gulf of Mexico (Dominguéz, 2008: 116-17). No cargos comparable to site T1M31b-5's Sopwith lead consignment are attested in the marine archaeological record, perhaps partly because of the perceived 'modern' relevance of industrial archaeology.

Despite extensive archival research, the name and nationality of the ship in question has eluded identification. Obtaining data about both the logistics of production and shipments from the T. Sopwith and Company Limited for the decades of interest is considered a lost cause because "It was a private limited company and share ownership was confined to a very close circle of shareholders, so it was not necessary to publicise the affairs of the Company to a wider audience" (Vernon, 2013: 25). The same point was made in 1912 by Boies Penrose, the United States Congress Senate, who concluded (1912: 547) that:

> To obtain information from these mines is a very difficult matter, as many of our consuls in the past have found. This is easily explainable when we remember there is a production tax, and the Government, believing that that tax was not properly coming into the coffers of the Government, that the proper amount of production was not given to them, have appointed some commissioners to inquire into it.

The geographic proximity of Linares to Seville makes it likely that the Sopwith cargo was shipped from that port, which similarly served as the maritime gateway for English equipment imported for the Linares mines (pers. comm. Antonio Ángel, 10 June 2008). By the 1880s the Sopwith concessions were connected to the railway system, making transport to either Seville or possibly Malaga uncomplicated. At the time, 90% of Spain's maritime trade was concentrated to the north in Barcelona, Bilbao and Santander, to the east in Valencia, and in the south within the ports of Seville, Malaga and Cadiz (Tortella Casares, 2000: 116).

Seville started to renew its maritime trade networks by building a modern port in 1863. Five years later adequate docks and wharves were in working order. In 1870 the Junta de Obras del Puerto established a harbor dedicated to Sevillian merchants and by 1886 the Cámara de Comercio, Industria y Navegación and the city were linked by a major regional railway hub to Cadiz, Cordoba and Malaga. Whereas just 108,113 tons of goods passed through Seville in 1868, by 1900 the city was handling 690,599 tons (O'Flanagan, 2008: 78-9).

Extensive archival research undertaken by Odyssey Marine Exploration examined about 15,000 wreck listings for the years 1879-1913 to try to identify the Sopwith lead ingot ship, including:

- British Board of Trade wreck list 1850-1915
- Wreck reports, customs class of records 1878-1927
- SORIMA Italian salvage company archives
- *Lloyd's List* for 1879-1914
- *Lloyd's War Losses: Casualties to Shipping through Enemy Causes, 1914-1918*
- Newspaper listings
- Risdon Beazley salvage recoveries

No single loss closely fits the ship in question, including the British Board of Trade wreck list for 1850-1915, which is more informative than the *Lloyd's List* by covering wrecks that occurred on or near the coasts of the UK, British vessels lost abroad, and British and foreign wrecks on or near the coasts of British possessions abroad. However, returns covering the years 1879 and 1913 were absent from the archive examined. Lost ships originating in the ports of southeastern Spain proved to be scarce. Only two or three from Malaga were reported as casualties during the entire period, and these vessels were lost near Spain and nowhere near the western English Channel. None were listed as carrying a cargo of lead bars.

Only two casualties occurred in the approximate area of site T1M31b-5, one of which was just a partial loss: the *Cairnbahn,* Newcastle to Las Palmas, carrying coal, whose decks were swept by a storm leading to the loss of one life on 17 November 1911 (outside the period of interest). The second vessel sunk was the *Albano* sailing from Batavia to Rotterdam on 25 May 1890 with a general cargo that was lost after colliding with the SS *Narissa*. It should also be born in mind that the Customs' class of records covering the years 1878-1927, completed by survivors of wrecks after they reached a specified British port, were not maintained for the Channel Isles, which could have been a possible landing place for any survivors from the Sopwith lead cargo wreck. Similarly, any survivors landed in France would not have been recorded. The true name of the Sopwith cargo ship probably languishes unidentified among the thousands of wrecks listed very loosely in archives as associated with a 'General' cargo or sailing in 'Ballast'.

The steamship in question went down seemingly having cast its portside kedge anchor in desperation, which was recorded north of the site. The vessel landed largely upright on the seabed. The post-depositional fate of the wreck is harder to reconstruct. Nets found across the wreck and biofoul stripped off a large section of the portside bow, where hull plating is missing, point to recent bottom fishing impacts. The extensive shoals of pollock prevalent across the site are an obvious attraction for fishermen. By far the most serious impacts to the site have come from cargo salvage. The lead ingots were found stacked and scattered exclusively on the starboard side of the ship, either side of the officers and crew's cabin and engine room. The absence of a parallel heavyweight cargo to portside that would have been essential to counterbalance the ship's buoyancy under steam suggests that the portside cargo was salvaged prior to the site's discovery by Odyssey in 2005. This conclusion is supported by the overall flattened condition of the wreck, whose superstructure and sides have been torn away, and loose steel plate overlying the central hull. Since the date of the ship's loss pre-dates World War II, and the stowage is clearly unbalanced, the impacts are not believed to be the result of a German attack or depth-charging to remove seabed obstacles and prevent German U-boats hiding in shipwreck shadows during the Battle of the Atlantic.

The salvage of metals in and around the English Channel has been extremely common in modern history. Risdon Beazley, as a random example who have published data on their operations, legally salvaged numerous cargos of lead, copper, tin, brass and zinc between the late 1940s and 1970s. British flagged vessel recoveries from the English Channel included 648 tons of lead recovered from the *Candia* in 1952 at a depth of 52m and 702 tons of copper and lead salvaged from the *Ballarat* in 1955-56 at 70m. Another 662 tons of lead was recovered in 1961 at a depth of 55m from the *Skyro* off western Spain (Martin and Craigie-Halkett, 2007: 151-52). Since the 1950s, several dozen commercial salvage companies have operated in and around the North Sea, Western Approaches and English Channel.

Alongside the pre-2005 salvage of an unidentified portside cargo at site T1M31b-5, monitoring conducted in May 2015 ascertained that all but a few ingots from the 423-ton starboard consignment of lead has now disappeared since the site was surveyed in 2005, 2008 and 2012 (Figs. 38-39). The winch, spare propeller and kedge anchor have also been removed. The data obtained during Odyssey Marine Exploration's surveys comprise the only surviving record of the sole ship discovered that is associated with the export of T. Sopwith & Co. Ltd lead. Dating between 1880 and 1907, site T1M31b-5 is over one hundred years old and is defined as underwater cultural heritage according to the UNESCO Convention on the Protection of the Underwater Cultural Heritage (Article 1).

The salvage of the lead cargo is one of three such cases documented within the same geographic catchment zone. A 3-ton bronze cannon was looted in 2011 from the wreck of the First Rate warship the *Victory* lost in 1744 (Kingsley *et al.* 2012: 5-6) and iron cannon were similarly removed in recent years from the wreck of the mid-18th century Bordeaux privateer the *Marquise de Tourny* (Brinck, 2015). The mass salvage of the Sopwith lead cargo wreck serves as a reminder and warning about the legal and practical complexities faced by the UK in attempting to protect underwater cultural heritage located in deep waters outside its terrorial waters.

Today the wreck of Thomas Sopwith Jnr's lead shipment, found deep in the western English Channel, can be linked back to the landscape of Linares in the region of Jaén in Andalusia, an area of exceptional historic, cultural, environmental, socio-economic and technological importance in Europe (Dueñas Molina, 2010). The Colectivo Proyecto Arrayanes is currently working to protect, conserve and interpret the area's long and incredibly rich mining heritage (Ángel Perez and Schwartz, 2006: 5). The history of T. Sopwith and Company Limited lives on in these well-preserved remains of mines, related infrastructure and modern interpretation centers (Ángel Perez, 2007).

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Notes

1. For the SS *Liverpool*, see http://www.divernet.com/Wrecks/wreck_tours/159400/wreck_tour_78_the_liverpool.html. Accessed 14 May 2015.
2. See, https://www.english-heritage.org.uk/discover/maritime/map/bartholomew-ledges.

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