Biscay and Beyond? Prehistoric voyaging between two Finisterres

Richard Callaghan & Chris Scarre

The Atlantic peninsulae of western Europe present intriguing cultural parallels that reach back into later prehistory. Furthermore, direct evidence of interconnections from the 5th millennium BC is revealed by the movement of specific materials such as Iberian variscite. Brittany and Galicia are key nodes within this potential network of maritime interaction, but debate continues as to the routes that were chosen and the navigational abilities involved. Did early seafarers keep close to the coast and did long journeys involve many intermediate landfalls? Or did crews venture direct crossings of the Bay of Biscay? In the absence of surviving evidence for the kinds of vessel likely to have been used by Neolithic seaborne navigators, current wind and current data are here used to generate models indicating journey times for small sea-going craft powered only by oars, following the coastal or the direct route. The results are discussed within the context of selected material flows (jadeite, variscite, copper, Beakers) and against a background of potentially changing maritime technology.

Seafaring out of sight of land has a very long history, reaching back to at least 50,000 years ago when anatomically modern humans first crossed to Australia (Davidson 2013). By the end of the Pleistocene, maritime technology was sufficiently widespread to allow regular maritime contact between mainlands and islands as disparate as the Californian Channel Islands, Cyprus and the Japan archipelago (Erlandson *et al*. 2011; Ammerman 2010; Habu 2010). Few Holocene coastal communities have lacked the desire or the ability to navigate at least coastal waters, whether to travel or to exploit offshore resources. It is clear, however, that for good practical reasons, much early maritime voyaging was coastal in nature, keeping close to land.

In a previous simulation, the authors modelled potential patterns of Neolithic maritime contact between northern France and western Britain and Ireland. The model assumed direct open-sea crossings of up to 20 days duration (Callaghan & Scarre 2009, 365 table 1). Many of these maritime connections could easily have been achieved, however, without extensive crossings of open sea. Southern Ireland could have been reached from western Brittany, for example, by crossing first to southern England and coasting thereafter to Land’s End or South-west Wales, minimising the hazardous period of sailing out of sight of land.

The possibility of longer-distance voyages cannot, however, be excluded. The greater danger that they involved may not have been a deterrent. As Richard Bradley reminds us, prehistoric voyaging need not have followed the same kind of safety-first principles that we would expect today (Bradley 2014, 134-135). The purpose of the present paper is to explore these issues in the context of prehistoric connections between Iberia and northwest France, connecting at that point with the more northerly routes considered in our previous study. Was all such early contact confined to coastal traffic, or did early mariners successfully undertake open sea voyages from Galicia to Brittany, by-passing intermediate lands?

Patterns in the archaeology

Two periods in particular provide evidence suggestive of direct connections between Brittany and Galicia. The first falls in the 5th millennium BC, and the evidence takes the form of two highly sought and far-travelled prestige materials: jadeitite axes and Iberian variscite.

Variscite is a rare mineral. Within western Europe, there are sources in the Iberian peninsula and in northwestern France. Breton Neolithic variscite can be matched to a number of Iberian sources: Can Tintorer (Gavá) in Catalonia, Palazuelo de las Cuevas and El Bostal in northwestern Castile, close to the Portuguese frontier; and Pico Centeno (Encinasola) in Huelva (Herbaut & Querré 2004; Querré *et al*. 2008, 2014; Odriozola *et al*., 2010; Odriozola 2014). The mine complex at Can Tintorer has been investigated, and mine shafts identified also at Pico Centeno (Villalba *et al*. 1986; Odriozola *et al*. 2010). Early activity at Can Tintorer has been dated to the mid 5th millennium BC, and still earlier exploitation at El Bostal and Encinasola can be inferred from the presence of variscite ornaments in late 6th millennium contexts at Colombelles and Plichancourt cited above. Exploitation at Pico Centeno may also have begun on a small scale in the late 6th millennium BC (Odriozola *et al*. 2016).

Iberian variscite could have travelled to northwestern France by sea or overland (Figure 1). Overland transport is very easily envisaged for the products of the Can Tintorer mines, which may have passed around the southern end of the Pyrenees and then along the Garonne corridor to the Gironde, and thereafter by land or sea to the Morbihan. For variscite from the west Iberian sources (Palazuelo de las Cuevas, Encinasola), however, maritime transport may have played a more prominent part.

Like the variscite, Alpine jadeitite was consumed in notable quantities in southern Brittany. Analysis undertaken in the context of the recent Projet JADE has revealed the distribution of jadeite axes across western and northern Europe from sources in the western Alps (Pétrequin *et al*. 2012). Some ten examples are known from Iberia, based on colour or petrographic analysis (Odriozola *et al*. 2015). Jadeitite axes may have reached Catalonia (where the highest concentration is found) by travelling along the northern coast of the Mediterranean, and spread westwards across the peninsula. One such axe was found only 40kms from the variscite source at Palazuelo de la Cuevas, and the coincidence in colour (emphasis on lustrous green appearance) is suggestive of a shared aesthetic or symbolic value between the two materials (Fábregas Valcarce *et al*. 2012, 1113).

In Brittany, jadeitite axes appear in Carnac mounds alongside variscite beads and pendants. They were also reworked to create distinctive ‘Carnacean’ forms, distinct from those of the Alpine source areas or southern France. Indeed, this appears to have been a two-stage process. Alpine axes of Durrington or Puymirol type were reshaped in the Paris basin to give the Altenstadt/Greenlaw type; and then examples of the latter arriving in Brittany were reshaped and repolished to give the distinctive, thin, highly polished Tumiac and Saint-Michel forms (Pétrequin *et al*. 2012, 1016). These were then dispersed in their turn, notably to Galicia, where they gave rise to local imitations (the ‘Cangas’ type, with the perforated butt typical of many Tumiac axes).

The Tumiac axe of Alpine jadeitite from Valipedre may be one of the prototypes that sparked the imitation; according to this reconstruction, it had travelled from the Alps to the Paris basin where it had been reshaped a first time; then from the Paris basin to

Brittany where it had been reshaped and repolished once again; and finally from Brittany to Galicia where its lustrous appearance and exotic provenance inspired local copies in regional materials such as fibrolite, or more rarely shale or amphibolite (Fábregas Valcarce *et al*. 2012, 1124). It has been suggested that the traffic was not merely one-way; and that fibrolite axes found in Brittany may be of Iberian fibrolite (Cassen *et al*. 2012).

Decorated pottery provides another potential indicator of contact. A number of Galician sites have yielded sherds with garland and herringbone motifs broadly similar to those of Castellic pottery of southern Brittany. In a few cases, this potential connection is supported by radiocarbon dates placing the Galician material in the late 5th millennium BC, contemporary with Breton Castellic (Fábregas Valcarce *et al*. 2012, 1122). One vessel, from Dombate, may be a Castellic import: its decorative bands of netted dog whelk (*Nassarius reticulatus*) impressions resemble those on pottery from Lannec er Gadouer, La Table des Marchands and other sites in the southern Morbihan region (Cassen *et al*. 2012, 979).

These are not the only evidence cited in support of connections between Galicia and Brittany in the late 5th millennium BC. In both regions, burial mounds with megalithic chambers appear at this period, and specific motifs present in 'megalithic art' have also been adduced in support (Cassen & Boujot 2012; Cassen & Vaquero Lastres 2000). Formal resemblances have also been noted between rock art motifs in Galicia and the megalithic art of the Gavrinis passage tomb in the Golfe du Morbihan. The key sites are Pozo Ventura and A Cabeciña at Pontevedra, with panels of nested concentric arcs that have been compared with motifs from Gavrinis, Loughcrew and the Boyne Valley (Fábregas Valcarce *et al*. 2012, 1121; Sartal Lorenzo 1999; Costas Goberna & Pereira García 2006). It is interesting to note that both these locations overlook coastal inlets.

Crucial to the issue of direct open sea voyaging are the gaps in these artefact distributions. There is no regular distribution of Tumiac or Cangas axes along the coast of western France; indeed only a single example of each has been recorded, in the Bordeaux region (Pétrequin *et al*. 2012, 1024). The near-absence of intermediate findspots might suggest that the axis of contact passed directly across all or part of the Bay of Biscay, without intermediate landfalls. Indeed, Breton axes may first have been introduced by sea to Galicia, then spread eastwards along the north coast of Spain in a kind of 'reflux' movement (Fábregas Valcarce *et al*. 2012, 1123). Variscite has a less focused distribution, and may have travelled overland or via the coast, but the relative scarcity of coastal findspot in western France south of the Loire once again indicates that southern Brittany was a powerful attractor of this material, if not the end point of direct maritime crossings.

The issue of direct contact between Brittany and Galicia comes into focus again in the 3rd millennium, in the context of the spread of copper metallurgy and the Beaker phenomenon (Rodríguez Rellán *et al*. 2015). Beaker vessels of Maritime type have an Atlantic focus and seem first have appeared in Portuguese Estremadura and to have spread thence northwards to Brittany, Britain and Ireland (Salanova 2000, 2004; Harrison & Heyd 2007; Turek 2015). Beaker pottery decorated with *Donax* shell edge impressions provides a particular connection between the Tagus region, Galicia and Brittany (Prieto Martínez & Salanova 2009; Figure 2) Associated with the spread of Beaker vessels was the introduction of copper metallurgy to northwest Europe. Iberia is one of two sources from which the new technology may have reached the northern Atlantic margins. The gold basket-shaped hair ornaments from the Amesbury Archer grave, currently the oldest securely dated grave assemblage from Britain containing metal (both copper and gold), are insular in type but “may have Iberian origins or represent a fusion of Iberian and central European styles” (Fitzpatrick 2015, 45). The earliest gold ornament in Ireland, the Benraw (formerly Deehommed or Dacomet) ornament from County Down, finds its closest parallels in Portuguese Estremadura, and has widely been regarded as an import. The source of the gold may also be Iberian, although Cornwall is a possibility (Taylor 1979, 235-6; O’Connor 2004; Fitzpatrick 2015, 48; Standish *et al*. 2015). Early copper mining at Ross Island in Ireland can be linked to Iberia, depending as it did on *fahlerz* ores of arsenicated copper. The stone mining hammers of Ross Island can be paralleled in contemporary copper mines at El Alamo and El Milagro in Cantabria (O’Brien 2015, 130). Further evidence of Atlantic maritime connections is found in the distribution of Palmela points. These are thought to have originated in the Tagus region of Atlantic Portugal, but are widely distributed throughout southern and western France, where 60 examples are known (Figure 3). Some contain antimony and silver, suggesting that they are imports from Portugal; others are local imitations, from more local sources of copper (Gibson 2013, 76). Still longer distance connections are suggested by the discovery of a flaked flint dagger blade of Scandinavian type near Pontevedra (Suárez Otero 1998).

These early metal products suggest connections between Britain and Ireland and western Iberia during the later 3rd millennium BC and into the early part of the following millennium. Whether those connections occurred in the context of coastal cabotage, down-the-line exchange or direct open sea voyaging is more difficult to say. The substantial gaps in some of the distributional evidence, however, does appear to indicate that the closest and most significant relationships were those connecting western or northwestern Iberia and northwest France. That is shown, for example, by the Maritime Beakers with shell edge decoration. The clustering of Palmela points is more equivocal, and might indicate overland contact with the Gironde and the Atlantic coast via the Garonne corridor. The gold objects, on the other hand, though few in absolute number, reinforce the impression of direct links between Brittany and Galicia. Let us now review this evidence against the feasibility of direct and coastal voyaging between these two regions, and the journey times that they imply.

The Simulations

Four sets of simulations were run to examine the difficulty of seaborne trade in the Bay of Biscay during the Neolithic. The first two experiments investigated coastal trade between ten points around the Bay of Biscay, the first in a clockwise direction and the second in a counter clockwise direction. The second set of experiments investigated direct sea crossings between points along the north coast of the Bay and points on the south coast. The first simulation was from north to south and the second was from south to north. Ten land points of interest were used in the analysis as well. The points were in clockwise order from northwest to southwest: Quimper, Vannes, Nantes, La Rochelle, Bordeaux, Bilbao, Santander, Gijón, La Coruña, and Pontevedra.

The simulations use wind and current data from the US Navy digital *Marine Climatic Atlas* (US Navy 1995). The resolution of the data is in 1° Marsden squares (1° of latitude x 1° of longitude). The program randomly selects the wind and current data that are frequency-weighted based on the observations from the *Marine Climatic Atlas* (US Navy 1995). These conditions are then allowed to affect vessels for a 24 hour period before a new selection is made. Voyages can be started in any month of the year and in the case of long voyages the program shifts to the database for the next month as the first expires. The simulations were run starting in January, April, July, and October representing travel in winter, spring, summer, and fall.

Vessels are started off the coast near the desired origin point. There are a number of options for running the simulations but in this case vessels were given a heading towards the target land and manually advanced over a 24-hour period. Following Callaghan and Scarre (2009) the performance characteristics chosen were for a 7.5 x 1.5 x 0.71 m logboat. The vessel was paddled, though it is acknowledged that vessels in the region of the Bay of Biscay may well have been propelled by oars. In Callaghan and Scarre (2009), the sustained speeds given to this vessel were approximately 3.4 knots calculated on the basis of field studies with an untrained crew in fair conditions and naval architecture programs (Callaghan 1999; 2001; 2003). In more resent experiments conducted by Benoit Berard (2011) using a replica of a Carib canoe and a well trained crew it was shown that the vessel could maintain an average speed of 3.2 knots over long distances in the open sea off the east coast of the northern Lesser Antilles. For this study we chose to use a much more conservative average speed of 2.0 knots or 3.7 km/h. We should stress that this is likely the absolute minimum average speed and can be taken to reflect conditions such as: squalls; unusually great river outflows; or crew injury and sickness. For most of the time we can assume that average speeds would be greater which should strengthen the conclusions.

Marine Conditions

The simulation does not include such marine conditions as storm patterns, swells, and precipitation that would have major impact on the seasons of travel. This data can be obtained from the United Kingdom Hydrographic Office (UKHO) *Bay of Biscay Pilot* (2013). Following McGrail (1983, 304) sea-level and climate can be considered to be comparable to today.

Winter is the stormiest season (UKHO, 17) resulting in the highest swells. Twenty percent of observations during the winter classify seas as heavy to very heavy. In all seasons swells are predominantly from the west and northwest. Sea temperatures are critical factors for survival at sea and range from 14°C to 9°C in winter to 18°C to 22°C in summer (UKHO, 22). Generally highest temperatures are found in the south.

Winds have seasonality in both direction and strength (UKHO, 26). In autumn and winter (October to March) winds are variable in direction with a slight predominance of winds from the west. Off northwest Spain winds during this period are commonly from the north and northeast. In the north of the Bay winds are strongest in December with 15% to18% of observations reporting winds of Force 7 (51-61 kph) or greater. In spring and summer winds are common from the southwest and northwest but there is also an increase in winds from the north and northeast over autumn and winter conditions. These north and northwest winds are the predominant ones in northwest Spain during the season. Force 7 or greater winds are reported in 23% of observations in July and August.

Gales (UKHO, 26) move into and across the Bay from the northwest and southwest in all seasons. These storms reach their highest frequency in winter from November to

February. In the north gales of Force 8 (62-74 kph) or greater can be expected seven to nine days a month at this time. In the south the frequency of gales declines to four to seven days a month. In summer gale frequency is decreased and for the overall region gales of Force 8 or greater occur one to three days a month.

Galernas (UKHO, 31) are sudden fierce storms that occur from June to September in the coastal zone between Capbreton, approximately 44 km north from the Franco/Spanish boarder along the French coast, and Santander along the north coast of Spain. The greatest frequency of these storms is in July and August. For the most part they occur during the afternoons. Galernas form in two types, typical and frontal. Although typical galernas are sudden storms they may have been predictable in the short term reducing the risk to inshore voyagers. These storms are preceded by morning winds that are either calm or light from the south. This is followed by a drop in air temperature to within 8°C of the sea temperature. Air temperatures can drop as much as 12°C, usually to sea temperature. Winds can reach Force 8 or 9 (75-89 kph) and the increased humidity can result in fog. Frontal galernas occur with cold fronts that move along the coast from west to east. They are preceded by increasing warm winds from south to southwest.

In the northern open sea, thunderstorms (UKHO, 31) have a low frequency and can be expected to occur about one day a month and slightly higher in summer. Thunderstorms are more common in the southeast corner of the Bay of Biscay with the highest frequency in summer. At that time thunderstorms may be expected on about six days a month. Rain falls in all months of the year over the entire region. The driest months are from June to August and the wettest are from October to January. Snow tends to fall in the coastal areas but very rarely in the open sea. It can fall from November to April but is most common from January to March. During the months when snow can be expected it falls on average one to two days a month.

Fog most frequently occurs in the Bay of Biscay during late spring and summer. In the open sea fog frequency is lowest from November to April. Fog along the coast of France occurs with great variability from location to location and is highest in winter. Fog occurs in sheltered areas and estuaries primarily in winter. In the southeast of the Bay of Biscay fog is rare. However, along the north coast of Spain fog may occur at any time of year. Brief periods of fog occur most frequently in late spring and summer. Fog may last for as much as two to three days in the area around the Golfo de Foz in northwest Spain.

Results

The results of the simulations showed the navigational potential around the Bay of Biscay to be very consistent seasonally with only a few significant variations. In the simulations (Callaghan and Scarre 2009) done for the region encompassing the British Isles, Ireland, and both sides of the English Chanel, vessels would often need to be “backed up” and given a new heading. This would be the equivalent of seafarers having to wait for favourable winds. The situation was very rare in the simulations for the Bay of Biscay and it was even rarer for the vessel to be backed up more than once indicating that favourable conditions predominate. Where vessels did not travel in quite the desired direction with a given heading they invariably were forced into land suggesting that though travel may have been delayed, being blown out to sea would not be an issue. It also suggests that acquiring the necessary skill at reading the weather may not have been particularly difficult in terms of deciding when to depart.

Except for the Pontevedra area there is little difference in seasonality as far as navigational difficulty goes. However as noted above the simulation does not include such factors as storm frequencies and tracks, sea swells and visibility. These do show some pronounced seasonality indicating times of the year when travel would be preferred.

Table 1 shows travel durations between the 10 land-points considered moving in a clockwise direction from Quimper to Pontevedra (Figure 4). Travel times are from the coast so that times to several current city locations would be longer. Quimper, Nantes, Bordeaux and Bilbao are all up river or behind embayments away from the coast. There is little seasonal difference in the total travel times between Quimper and Pontevedra. In winter, summer, and fall voyages could be made in 17 days, while in spring voyages would take 16 days. One area where voyages might encounter some problems is between La Rochelle and Bilbao. Here it is sometimes difficult to stay off the shore in winter, spring and fall. However, utilizing tides where available and the morning winds which blow from shore to sea voyagers could overcome the problem quite easily.

Table 2 shows travel durations between the 10 land points moving in a counter-clockwise direction from Pontevedra to Quimper. Again travel times are to the coast so that travel to the sites of Quimper, Nantes, Bordeaux and Bilbao would take longer. Total travel times from Pontevedra to Quimper differ slightly between spring, summer and fall with durations being 20, 22, and 23 days respectively. The total duration of the voyage between Pontevedra and Quimper is difficult to assess because the leg from Pontevedra to La Coruña is extremely difficult without several days on shore or leaving sight of land for several days. This would be due to the more extreme wind and storm patterns in this area. Similarly to clockwise movement problems staying off the shore would be encountered in winter, summer, and fall. The problem can be overcome the same way by utilizing tides and morning winds blowing offshore.

In the simulations a day's sailing is 24 hours assuming crews working in shifts. As seems more likely, crews would make landfall at night so the travel times would be roughly doubled. Travel in a clockwise direction then would be 32-34 days and between 40 and 46 days in a counter-clockwise direction. However, making landfall at night would have allowed for smaller crews and more cargo space. It must be remembered here that the average speeds given to the vessels was very conservative at 2 knots rather than 3.2, so that potentially travel times might be reduced by approximately one third. The exact locations for making landfall would most likely be dictated by social factors as much as environmental ones.

Table 3 shows direct open sea travel times between the northern areas of Quimper, Nantes, and Vannes and the southern areas of Pontevedra, La Coruña, Gijón, Santander, and Bilbao moving north to south. Voyage durations range from 12 days between Nantes and Pontevedra to five days between any of the northern areas and Bilbao with winter conditions. In spring durations range from 12 days between Nantes and Pontevedra and 5 days between any of the northern areas and Santander. Summer duration ranges are the same as winter with 12 days for travel between Nantes and Pontevedra and five days between all the northern areas and Bilbao. Fall has the shortest duration for travel between and Nantes and Pontevedra at 10 days while it also has the shortest duration with travel from Nantes to Santander at four days. These calculations are based on having the vessels propelled 24 hour a day by crews working in shifts as stopping for any extended time would allow for substantial drift.

Table 4 shows travel times from the southern areas of Pontevedra, La Coruña, Gijón, Santander and Bilbao in a south to north direction. Travel durations in winter range from 10 days between Pontevedra and Vannes and five days between Bilbao and Nantes and Vannes. In spring durations range from 10 days from Pontevedra to Vannes and five days between Bilbao and Vannes and Nantes. Given summer conditions, durations range from 11 days from Pontevedra to Vannes and five days from Santander to Vannes and Nantes. Fall conditions result in some of the longest voyage durations although not significantly so. Durations range from 11 days between Pontevedra and Vannes and Nantes. The shortest ranges are between Santander and all three of the northern areas at five days. As with north to south movement crews are working in shifts 24 hours a day.

The straight line distance between the coast near Quimper and La Coruña is approximately 345 nautical miles (639 km) while that between the coast near Nantes and Bilbao is approximately 245 nautical miles (454 km). Given the high mountains along the Spanish coast and lower ones along the north coast of the Bay of Biscay voyagers would only be out of sight of land for about 72% of those distances. This would roughly apply to any direct crossings of the entire Bay. Voyaging to or from Pontevedra would not entail leaving sight of land unless very unfavourable winds and currents were encountered.

Although there is not a great deal of seasonality expressed in terms of voyage durations in any of the four experiments, voyaging in some seasons would be less risky and more comfortable than in others. The winter months are the stormiest with more gales, less predictable winds, higher sea swells, and lower water temperatures. Summer is not without its dangers with galernas occurring particularly in the south coast of the Bay of Biscay and more frequent fog. However, it is possible that voyagers travelling close to the coast could have predicted in the morning when an afternoon galerna was likely and fog can be waited out if near the coast. Mid-summer in fact may have been the best time of year for sea travel. It may also have been the slowest time of the growing and harvesting seasons which may put less strain on agricultural labour resources. (This last is just speculation on my part but may be interesting if there is something else that corresponds to it.)

Discussion and conclusions

These simulations do not in themselves allow us to discriminate between coastal cabotage, with potentially numerous stopping points, and direct open sea crossings, but they do illustrate the timings and limitations imposed by winds and currents on craft powered by oars without the benefit of sail. It should be noted that there was greater risk of being blown on to land than being blown out to sea, and while this may have made difficult the rounding of the many headlands, it was less of a danger to the survival of vessel and crew for a craft powered by oars than for larger sailing ships of later periods.

The travel times suggested by these models are not excessive. For a coastal route the voyage north-south from Vannes to Pontevedra would have taken 16 or 17 days (more realistically 32-34 days allowing for overnight stops), while typical journey times of 20-23 days (40-46 days) can be envisaged for the return voyage south-north, assuming an average speed of 2 knots. Direct open sea voyaging would have been considerably faster, but would have depended crucially on the ability of crews to work in shifts, as there would have been no opportunity for overnight stops. One striking feature of the simulations is the much longer journey time from Brittany to Pontevedra (10-12 days) than between Brittany and Bilbao on the Cantabrian coast (4 or 5 days in each direction).

The critical issue would hence not be journey times but the danger of an open-sea crossing and the availability of vessels capable of undertaking such journeys. The prehistory of northwest European watercraft, prior to the appearance of sewn-plank boats from coastal sites around the shores of Britain at the beginning of the 2nd millennium, is essentially limited to logboats. The earliest surviving examples are from Pesse in the Netherlands and Noyen-sur-Seine in northern France, both dated to the 8th millennium BC (McGrail 2010, 99-100; Van de Noort 2011, 153-154). A mid-6th millennium example is known from La Marmotta at Lake Bracciano in central Italy (Fugazzola Delpino & Mineo 1995). The role of larger vessels constructed of hides attached to a wooden frame is difficult to assess in the absence of direct archaeological evidence. Boats must have been used in the bringing of cattle and other livestock from mainland France to Britain and from Britain to Ireland at the beginning of the 4th millennium BC. These would have needed to be capable of transporting cattle and other livestock over at least 30 kms and probably 50 kms or more of open sea. The timing of the Neolithic settlement may indeed have been dependent on the availability of boats large enough to transport domestic livestock across the English Channel.

Whether such vessels would have been capable of open sea voyaging from Brittany to Galicia remains uncertain, however, and it is possible that such voyages did not become feasible until the introduction of the sewn-plank boat, or even the sail (McGrail 2010, 103). The earliest evidence for sewn-plank vessels is provided by the Ferriby 3 vessel, dated to 2030-1780 BC (Wright 2001). The social context that gave rise to them, and their impact on other societies along the Atlantic façade, suggest that this might have been a key turning point in Atlantic interconnections. The invention of sewn-plank boats has been associated with the desire of elites to undertake more numerous and longer journeys to obtain the exotic commodities that they now used in social competition, replacing hide boats for maritime travel (Van de Noort 2006; 2011, 165; Cunliffe 2010). An analogy may be found in the development and impact of the plank-built ocean-going *tomol* of the Californian Chumash societies. The considerable labour required to build a *tomol* made them essentially the preserve of elites, and prestige exchange between island and mainland elites was no doubt an important part of Chumash social practice (Gamble 2002; Fagan 2004; Arnold & Bernard 2005; Arnold 2007).

This insight into the linkage between social organisation and maritime technology for island communities suggests interesting potential parallels with the development of prehistoric societies along the Atlantic façade of western Europe. In this region, a significant process of social change occurred during the 3rd millennium, with the development and spread of the Beaker package. The Maritime Beaker may have had its origin in the Tagus estuary or Portuguese Estremadura, but the ‘package’ as a whole (wristguard, copper metallurgy, V-perforated button, etc.) drew on multiple and geographically diverse antecedents (Vander Linden 2007; Turek 2015). There is also direct evidence for Beaker mobility in several areas of Europe as a result of analyses of stable isotopes, aDNA and dental traits (Price *et al*. 2004; Desideri & Besse 2010; Chenery & Evans 2011; Parker Pearson *et al*. 2016). The expansion of haplogroup H into central Europe might indeed represent the spread of Beaker-associated populations from Iberia (Brandt *et al.* 2013). Maritime voyaging along the Atlantic façade must have been an important component in these movements. Could it be the development of the sewn-plank ocean-going boat that made possible these new patterns of interconnection, and facilitated direct open-sea crossings of a scale and duration that were rare, or even impossible, in earlier periods?

What then of the earlier movements of variscite and jadeitite connecting Brittany and Galicia? Do they represent an early episode of maritime adventure, linked to social structures manifest in the richly furnished tombs of the southern Morbihan, but dependent on hide boats? The assemblages of exotic materials including variscite and jadeitite illustrate the important role of long-distance connections for leadership in these societies (Cassen et al. 2012; Herbaut & Querré 2004; Scarre 2011). The impressive dimensions of the Carnac mounds, in which the majority of the extensive assemblages of exotics were deposited, also speak to a situation in which dynamic social competition was a key component. Certain of the carved motifs at Mané Lud and other Morbihan sites have been interpreted as boats, which again suggests a link to status and prestige (Cassen 2007). The chronology of these early exchanges remains imprecise, but places them within the second half of the 5th millennium BC, extending perhaps into the early 4th millennium: the period, coincidentally, when boats brought domestic livestock across the Channel to southern England.

Fifth millennium maritime voyaging from western France to northern Spain need not, of course, have involved direct open-sea crossings. Watercraft with limited sea-going capability may have kept mainly to inland waters, with frequent landfalls for provisions, shelter from storms, or overnight rests. If direct crossings from Brittany to Galicia were attempted in these centuries, then they may have been a relatively short-lived phenomenon. The elites responsible for the Carnac mounds and the decorated standing stones do not appear to have persisted far into the 4th millennium BC. Nor should we regard this traffic as unidirectional: new social and ideological configurations in northwest Iberia are represented by the proliferation of impressive megalithic tombs in the early centuries of the 4th millennium BC (Scarre 2010).

We may nonetheless enquire whether the 5th millennium crossings, like those of the 3rd millennium or indeed those of the Chumash, were made possible, and perhaps even stimulated, by advances in boat-building techniques that suddenly opened up new opportunities. Larger hide-covered boats may have become available, for example, or perhaps expanded logboats, with additional strakes attached to the hull to heighten the freeboard. The discovery at Margrethes Naes in the Danish Storebaelt of a 3.16m plan with drilled holes along one edge may be relevant here. Dated to the early 5th millennium, the excavators identified it as a repair, but it would make more sense as the additional strake of an expanded logboat (Myrhøj & Willemoes 1997, 160). It may have been new maritime technologies of this kind that made possible the Neolithic colonization of southern England a millennium later, allowing the transport of domestic livestock and farming communities across the Channel, and ending the thousand-year stand-off between an already Neolithic continent and a still Mesolithic Britain. They may also lie behind the traffic in Alpine axe blades and variscite beads and pendants – and who knows what other materials – across the Bay of Biscay a few centuries earlier.

The evidence for renewed long-distance contacts from the mid 3rd millennium, like that of the late 5th millennium, appears in the context of exotic materials and cultural items associated with elites. In this case, too, it may have been linked with a ‘maritime revolution’, one that made reliable open-sea crossings between distant landfalls possible for the first time. The introduction of the sewn-plank boat may have been the critical factor. The possible role played by sewn-plank boats in Beaker exchange across the North Sea has already been observed (Van de Noort 2011, 162); and they may have been instrumental in the spread of the Neolithic to southwest Norway (Østmo 2012). A parallel might exist in the ‘second maritime revolution’ that has been suggested to account for changes in Mediterranean maritime contacts during the 3rd millennium BC. That revolution rested not on the development of sailing craft, but on the longboat, and like our hypothesized open-sea crossings of the Bay of Biscay, permitted the first long voyages out of sight of land – potentially as much as 400 km for the first settlement of the Balearic islands (Broodbank 2010).

The boats involved in the 3rd millennium crossings between Brittany and Galicia could have been plank-built. Both the Mediterranean and the Chumash parallels indicate the intimate association of larger seaworthy boats with the emergence of greater social inequality. Chumash social inequality in the late pre-contact period was focused around the elaborate canoes that were needed for fishing and for maritime contact, including prestige exchange. The emergence of the Beaker phenomenon, with new emphasis on status and prestige, may mark the appearance of Atlantic societies capable of organising the craft skills, the crews and the navigational capacities essential for longer open-sea crossings. Hence two features are intimately interwoven: the presence of elites, able to organise long-distance voyaging, willing to take the risks required to seek distant sources of exotic items; and maritime technology, sea-worthy vessels capable of undertaking such voyages. In the 5th millennium BC, emergent elites in Brittany and Galicia constructed impressive megalithic monuments and organised long-distant connections between the two regions. Those earlier boats – whether hide-covered vessels or expanded logboats – may, however, have been capable only of short coastal voyages, with numerous intermediate landfalls, not longer open-sea journeys. That may have changed during the 3rd millennium, with the formation of new configurations of social prestige and power, the development of the sewn-plank boat, and direct open-sea voyages between distant communities.

Acknowledgements

The authors are grateful to Peter Rowley-Conwy for reading and commenting on an earlier version of this paper, and to Judith Roberts for assistance with the figures.

Richard Callaghan
Department of Anthropology and Archaeology
University of Calgary
2500 University Dr. N.W.
Calgary, AB, T2N 1N4
Canada

Chris Scarre
Department of Archaeology
Durham University
South Road
Durham DH1 4LS
United Kingdom

Bibliography

AMMERMAN, A.J., 2010. The first Argonauts: towards the study of the earliest seafaring in the Mediterranean, in *The Global Origins and Development of Seafaring*, eds. A. Anderson, J.H. Barrett & K.V. Boyle. Cambridge: McDonald Institute for Archaeological Research, 81-92.

ARNOLD, J.E. & J. BERNARD, 2005. Negotiating the coasts: status and the evolution of boat technology in California. *World Archaeology* 37, 109-31.

ARNOLD, J.E., 2007. Credit where credit is due: the history of the Chumash oceangoing plank canoe. *American Antiquity* 72, 196-209.

BERARD, B., BILLARD, J.-Y. & RAMSTEIN, B. 2011. Ioumoúlicou "*Koumoúlicou nhányem amonchéentium oúbao*" (Les Caraïbes qui viennent des autres îles sont gens de notre nation), in *The Proceedings of the XXIII Congress of the International Association for Caribbean Archaeology, Antigua, 29 June-3 July 2009,* ed. S. Rebrovich. Antigua: Dockyard Museum, English Harbour, 577-89.

BRADLEY, R., 2014. Where the land ends: isolation and identity on the western edge of prehistoric Europe. *Complutum* 25, 129-37.

BRANDT, G., W. HAAK, C. J. ADLER, C. ROTH, A. SZÉCSÉNYI-NAGY, S. KARIMNIA, S. MÖLLER-RIEKER, H. MELLER, R. GANSLMEIER, S. FRIEDERICH, V. DRESELY, N. NICKLISCH, J.K. PICKRELL, F. SIROCKO, D. REICH, A. COOPER & K.W. ALT, 2013. Ancient DNA reveals key stages in the formation of Central European mitochondrial genetic diversity. *Science* 342, 257-61.

BROODBANK, C., 2010. 'Ships a-sail from over the rim of the sea': voyaging, sailing and the making of Mediterranean societies c.3500-800 BC, in *The Global Origins and Development of Seafaring* eds. A. Anderson, J. H. Barrett & K. V. Boyle. Cambridge: McDonald Institute for Archaeological Research, 249-64.

CALLAGHAN, R.T., 1999. Computer simulations of ancient voyaging. *The Northern Mariner/Le Marin du Nord* 1, 24-33.

CALLAGHAN, R.T., 2001. Analysis of ceramic age seafaring and interaction potential in the Antilles. *Current Anthropology* 42, 308-13.

CALLAGHAN, R.T., 2003: Comments on the mainland origins of the preceramic cultures of the Greater Antilles. *Latin American Antiquity* 14, 323-38.

CALLAGHAN, R. & C. SCARRE, 2009. Simulating the Western Seaways. *Oxford Journal of Archaeology* 28, 357-72.

CASSEN, S., 2007. Le Mané Lud en images: interprétations de signes gravés sur les parois d'une tombe à couloir néolithique (Locmariaquer, Morbihan) *Gallia Préhistoire* 49, 197-258.

CASSEN, S. & J. VAQUERO LASTRES, 2000. La forme d'une chose, in *Éléments d'architecture. Exploration d'un tertre funéraire à Lannec er Gadouer (Erdeven, Morbihan). Constructions et reconstructions dans le Néolithique morbihannais. Propositions pour une lecture symbolique*, eds. S. Cassen, C. Boujot & J. Vaquero. Chauvigny: Association des Publications Chauvinoises, 611-56.

CASSEN, S., C. BOUJOT, S. DOMINGUEZ BELLA, M. GUIAVARC'H, C. LE PENNEC, M.P. PRIETO MARTÍNEZ, G. QUERRÉ, M.-H. SANTROT & E. VIGIER, 2012. Dépots bretons, tumulus carnacéens et circulations à longue distance, in *Jade. Grandes haches alpines du Néolithique européen. Ve et IVe millénaires av. J.-C*, eds. P. Pétrequin, S. Cassen, M. Errera, L. Klassen, A. Sheridan & A.-M. Pétrequin. Besançon: Presses Universitaires de Franche-Comté, 918-95.

CHENERY, C.-A., & EVANS, J., 2011. A summary of the strontium and oxygen isotope evidence for the origins of Bell Beaker individuals found near Stonehenge, in Fitzpatrick, A.P., 2015.*The Amesbury Archer and the Boscombe Bowmen. Bell Beaker burials at Boscombe Down, Amesbury, Wiltshire*. Oxford: Oxbow Books, 185-190.

COSTAS GOBERNA, F.J. & E. PEREIRA GARCÍA, 2006. Los petroglifos de "A Cabeciña" en Mougás. Oia, Pontevedra. *Glaucopis* 12, 259-70.

CUNLIFFE, B., 2010. Seafaring on the Atlantic seaboard, in *The Global Origins and Development of Seafaring* eds. A. Anderson, J.H. Barrett & K.V. Boyle. Cambridge: McDonald Institute for Archaeological Research, 265-74.

DAVIDSON, I., 2013. Peopling the last new worlds: the first colonisation of Sahul and the Americas. *Quaternary International* 285, 1-29.

DESIDERI, J. & M. BESSE, 2010. Swiss Bell Beaker population dynamics: eastern or southern influences? *Archaeological and Anthropological Sciences* 2, 157-73.

ERLANDSON, J.M., T.C. RICK, T.J. BRAJE, M. CASPERSON, B. CULLETON, B. FULFROST, T. GARCIA, D.A. GUTHRIE, N. JEW, D.J. KENNETT, M.L. MOSS, L. REEDER, C. SKINNER, J. WATTS & L. WILLIS, 2011. Paleoindian seafaring, maritime technologies, and coastal foraging on California's Channel Islands. *Science* 331, 1181-5.

FÁBREGAS VALCARCE, R., A. DE LOMBERA HERMIDA & C. RODRÍGUEZ RELLÁN, 2012. Spain and Portugal: long chisels and perforated axes, their context and distribution, in *Jade. Grandes haches alpines du Néolithique européen. Ve et IVe millénaires av. J.-C*, eds. P. Pétrequin, S. Cassen, M. Errera, L. Klassen, A. Sheridan & A.-M. Pétrequin. Besançon: Presses Universitaires de Franche-Comté, 1108-35.

FAGAN, B., 2004. The House of the Sea: an essay on the antiquity of planked canoes in Southern California. *American Antiquity* 69, 7-16.

FAUVELLE, M., 2011. Mobile mounds. Asymmetrical exchange and the role of the tomol in the development of Chumash complexity. *California Archaeology* 3, 141-58.

FITZPATRICK, A.P., 2011. *The Amesbury Archer and the Boscombe Bowmen. Bell Beaker burials on Boscombe Down, Amesbury, Wiltshire.* Salisbury: Wessex Archaeology.

FITZPATRICK, A.P., 2015. The earlier Bell Beakers: migrations to Britain and Ireland, in *The Bell Beaker Transition in Europe. Mobility and local evolution during the 3rd millennium BC*, eds. M.P. Prieto Martínez & L. Salanova. Oxford: Oxbow Books, 41-56.

FUGAZZOLA DELPINO, M.A. & M. MINEO, 1995. La piroga neolitica del lago di Bracciano ("La Marmotta 1"). *Bullettino di Paletnologia Italiana* 86, 197-266.

GAMBLE, L.H., 2002. Archaeological evidence for the origin of the plank canoe in North America. *American Antiquity* 67, 301-15.

GIBSON, C., 2013. Beakers into bronze: tracing connections between Western Iberia and the British Isles 2800-800 BC, in *Celtic from the West 2. Rethinking the Bronze Age and the arrival of Indo-European in Atlantic Europe.* Oxford: Oxbow Books, 71-99.

HABU, J., 2010. Seafaring and the development of cultural complexity in northeast Asia: evidence from the Japanese archipelago, in *The Global Origins and Development of Seafaring,* eds. A. Anderson, J.H. Barrett & K.V. Boyle. Cambridge: McDonald Institute for Archaeological Research, 159-70.

HARRISON, R. & V. HEYD, 2007. The transformation of Europe in the third millennium BC: the example of 'Le Petit-Chasseur I + III' (Sion, Valais, Switzerland). *Praehistorische Zeitschrift* 82, 129-214.

HERBAUT, F. & G. QUERRÉ, 2004. La parure néolithique en variscite dans le sud de l'Armorique. *Bulletin de la Société Préhistorique Française* 101, 497-520.

KENNETT, D.J., 2005. *The Island Chumash. Behavioral ecology of a maritime society.* Berkeley & Los Angeles: University of California Press.

LAPORTE, L. & J. GOMEZ DE SOTO, 2008. Du Néolithique final au tout premier Bronze ancien dans le Centre-Ouest de la France et plus généralement sur sa façade atlantique; des données encore très lacunaires pour la seconde moitié du IIIe millénaire av. J.-C. *Bulletin de la Société Préhistorique Française* 105, 555-76.

MCGRAIL, S., 1983. Cross-Channel seamanship and navigation in the late first millennium BC. *Oxford Journal of Archaeology* 2, 299-337.

MCGRAIL, S., 2010. The global origins of seagoing water transport, in *The Global Origins and Development of Seafaring* eds. A. Anderson, J.H. Barrett & K.V. Boyle. Cambridge: McDonald Institute for Archaeological Research, 95-107.

MYRHØJ, H M. & A. WILLEMOES, 1997. Wreckage from the Early Stone Age, in *The Danish Storebælt since the Ice Age – man, sea and forest*, eds. L. Pedersen, A. Fischer & B. Aaby. Copenhagen: /VS Storebælt Fixed Link, 157-66.

O'BRIEN, W., 2015. *Prehistoric Copper Mining in Europe 5500-500 BC.* Oxford: Oxford University Press.

O'CONNOR, B., 2004. The earliest Scottish metalwork since Coles, in *Scotland in ancient Europe : the Neolithic and early Bronze Age of Scotland in their European context*, eds. I.A.G. Shepherd & G.J. Barclay. Edinburgh: Society of Antiquaries of Scotland, 205-16.

ODRIOZOLA, C.P., J.A. LINARES-CATELA & V. HURTADO-PÉREZ, 2010. Variscite source and source analysis: testing assumptions at Pico Centeno (Encinasola, Spain). *Journal of Archaeological Science* 37, 3146-57.

ODRIOZOLA, C.P., 2014. A new approach to determine the geological provenance of variscite artifacts using the P/Al atomic ratios. *Archaeological and Anthropological Sciences*.

ODRIOZOLA, C. P., R. VILLALOBOS GARCÍA, R. BOAVENTURA, A.C. SOUSA, C. BATATA & J.M. MARTÍNEZ BLANES, 2015. El hacha de jadeita de Portela do Outeiro (Sertã, Branco, Portugal). *Saguntum* 47, 256-60.

ODRIOZOLA, C.P., R. VILLALOBOS GARCÍA, C.I. BURBIDGE, R. BOAVENTURA, A.C. SOUSA, O. RODRÍGUEZ-ARIZA, R. PARRILLA-GIRALDEZ, M.I. PRUDÊNCIO & M.I. DIAS, 2016. Distribution and chronological framework for Iberian variscite mining and consumption at Pico Centeno, Encinasola, Spain. *Quaternary Research*.

ØSTMO, E., 2012. Late Neolithic expansion to Norway. The beginning of a 4000 year-old shipbuilding tradition, in *Becoming European: the transformation of third millennium Northern and Western Europe*, eds. C. Prescott & H. Glørstad. Oxford: Oxbow Books, 63-9.

PARKER PEARSON, M., A. CHAMBERLAIN, M. JAY, M. RICHARDS, A. SHERIDAN, N. CURTIS, J. EVANS, A. GIBSON, M. HUTCHISON, P. MAHONEY, P. MARSHALL, J. MONTGOMERY, S. NEEDHAM, S. O'MAHONEY, M. PELLEGRINI & N. WILKIN, 2016. Beaker people in Britain: migration, mobility and diet. *Antiquity*

PÉTREQUIN, P., S. CASSEN, L. KLASSEN & R. FÁBREGAS VALCARCE, 2012. La circulation des haches carnacéennes en Europe occidentale, in *Jade. Grandes haches alpines du Néolithique européen. Ve et IVe millénaires av. J.-C.*, eds. P. Pétrequin, S. Cassen, M. Errera, L. Klassen, A. Sheridan & A.-M. Pétrequin. Besançon: Presses Universitaires de Franche-Comté, 1015-45.

PRICE T.D., C. KNIPPER, G. GRUPE & V. SMRCKA, 2004. Strontium isotopes and prehistoric human migration: the Bell Beaker period in Central Europe. *European Journal of Archaeology* 7, 9-40.

PRIETO MARTÍNEZ, M.P. & L. SALANOVA, 2009. Coquilles et Campaniforme en Galice et en Bretagne: mécanismes de circulation et stratégies identitaires. *Bulletin de la Société Préhistorique Française* 106, 73-93.

QUERRÉ, G., F. HERBAUT & T. CALLIGARO, 2008. Transport of Neolithic variscites demonstrated by PIXE analysis. *X-Ray Spectrometry* 37, 116-20.

QUERRÉ, G., T. CALLIGARO, S. DOMÍNGUEZ-BELLA & S. CASSEN, 2014. PIXE analyses over a long period: The case of Neolithic variscite jewels from

Western Europe (5th–3th millennium BC). *Nuclear Instruments and Methods in Physics Research B* 318, 149-56.

RODRÍGUEZ-RELLÁN, C., A. MORGADO RODRÍGUEZ & J.A. LOZANO, 2015. Long-distance contacts: north-west Iberia during the 3rd millennium BC, in *The Bell Beaker Transition in Europe. Mobility and local evolution during the 3rd millennium BC*, eds. M.P. Prieto Martínez & L. Salanova. Oxford: Oxbow Books, 127-39.

SALANOVA, L., 2000. *La question du Campaniforme en France et dans les îles anglo-normandes. Productions, chronologies et rôles d'un standard céramique.* Paris: Editions du Comité des travaux historiques et scientifiques/Société Préhistorique Française.

SALANOVA, L., 2004. Le rôle de la façade atlantique dans la genèse du Campaniforme en Europe. *Bulletin de la Société Préhistorique Française* 101, 223-6.

SARTAL LORENZO, M.A., 1999. O petroglifo Pozo Ventura (Poio, Pontevedra). *Gallaecia*, 119-35.

SCARRE, C., 2010. Rocks of ages: tempo and time in megalithic monuments. *European Journal of Archaeology* 13, 175-93.

SCARRE, C., 2011. *Landscapes of Neolithic Brittany.* Oxford: Oxford University Press.

SMYTH, J. & R.P. EVERSHED, 2015. Milking the megafauna: Using organic residue analysis to understand early farming practice. *Environmental Archaeology* 20.

STANDISH, C.D., B. DHUIME, C.J. HAWKESWORTH & A.W.G. PIKE, 2015. A non-local source of Irish Chalcolithic and Early Bronze Age gold. *Proceedings of the Prehistoric Society*.

SUÁREZ OTERO, J., 1998. El puñal de sílex nórdico de Cela: una revisión. *Gallaecia* 17, 137-50.

TAYLOR, J.J., 1979. The relationship of British Early Bronze Age goldwork to Atlantic Europe, in *The Origins of Metallurgy in Atlantic Europe. Proccedings of the Fifth Atlantic Colloquium*, ed. M. Ryan. Dublin: The Stationery Office, 229-50.

TUREK, J., 2015. Lost and found paradigms: creation of the Beaker world, in *Paradigm Found. Archaeological Theory Present, Past and Future*, eds. K. Kristiansen, L. Šmejda & J. Turek. Oxford: Oxbow Books.

UNITED KINGDOM HYDROGRAPHIC OFFICE, 2013. *Bay of Biscay Pilot: Bay of Biscay and approaches with adjacent coasts of France and Spain from Pointe de Penmarc'h to Cabo Ortegal*. Taunton: United Kingdom Hydrographic Office.

UNITED STATES NAVY, 1995. *Marine Climatic Atlas of the World, Ver. 1.1.*Ashville, NC: National Climatic Data Center.

VAN DE NOORT, R., 2006. Argonauts of the North Sea – a social maritime archaeology for the 2nd millennium BC. *Proceedings of the Prehistoric Society* 72, 267-87.

VAN DE NOORT, R., 2011. *North Sea Archaeologies. A maritime biography 10,000 BC - AD 1500.* Oxford: Oxford University Press.

VANDER LINDEN, M., 2007. What linked the Bell Beakers in third millennium BC Europe? *Antiquity* 81, 343-52.

VILLALBA, M.J., L. BAÑOLAS, J. ARENAS & M. ALONSO, 1986. *Les mines neolítiques de Can Tintorer, Gavà. Excvaciones 1978-1980*. Barcelona: Departament de Cultura de la Generalitat de Catalunya.

WRIGHT, E. V., R.E.M. HEDGES, A. BAYLISS & R. VAN DE NOORT, 2001. New AMS radiocarbon dates for the North Ferriby boats—a contribution to dating prehistoric seafaring in northwestern Europe. *Antiquity* 75, 726-34.

Figure captions

Figure 1. Findspots of Iberian variscite from Neolithic contexts in western Europe. Stars indicate variscite sources known to have been exploited in the 5th millennium BC (modified from Querré *et al*. 2014).

Figure 2. Beaker pottery with shell edge decoration (after Prieto Martínez & Salanova 2009).

Figure 3. Distribution of Palmela points in western Europe (after Laporte & Gomez de Soto 2008). Larger circles indicate concentrations of finds around Tagus estuary and the Gironde.

Figure 4. Location of coastal landfalls included in the models (see Tables 1-4).

Table 1: Travel Times Clockwise from Quimper to Pontevedra in Days.

	Quimper - Vannes	Vannes - Nantes	Nantes - La Rochelle	La Rochelle - Bordeaux	Bordeaux - Bilbao	Bilbao - Santander	Santander - Gijón	Gijón - La Coruña	La Coruña - Pontevedra
Winter	2	1	2	1	2	1	2	4	2
Spring	1	1	2	1	2	1	2	3	3
Summer	1	1	2	1	3	1	2	3	3
Fall	1	1	3	1	2	1	2	3	3

Table 2: Travel Times Counter Clockwise from Pontevedra to Quimper in Days.

	Pontevedra - La Coruña	La Coruña - Gijón	Gijón - Santander	Santander - Bilbao	Bilbao - Bordeaux	Bordeaux - La Rochelle	La Rochelle - Nantes	Nantes - Vannes	Vannes - Quimper
Winter	*	3	2	1	2	1	3	3	2
Spring	3	4	2	1	3	1	3	1	2
Summer	3	4	2	1	2	2	4	2	2
Fall	3	4	2	2	3	2	3	2	2

* This would be an extremely difficult passage without the possibility of overnight stops.

Table 3: Durations of Voyages in Days from North to South

Origin Point and Season

	Pontevedra	La Coruña	Gijón	Santander	Bilbao
Winter					
Quimper	7	7	6	6	5
Vannes	9	7	6	5	5
Nantes	12	7	6	5	5
Spring					
Quimper	8	7	6	5	6
Vannes	9	7	5	5	5
Nantes	12	7	6	5	5
Summer					
Quimper	8	6	6	5	5
Vannes	10	11	7	6	5
Nantes	12	7	6	4	5
Fall					
Quimper	9	7	5	6	6
Vannes	9	7	6	5	5
Nantes	10	7	7	4	5

Table 4: Durations of Voyages in Days from South to North

Origin Point and Season	Quimper	Vannes	Nantes
Winter			
Pontevedra	8	10	8
La Coruña	7	7	7
Gijón	5	6	6
Santander	5	6	5
Bilbao	6	5	5
Spring			
Pontevedra	7	10	8
La Coruña	7	7	7
Gijón	6	6	5
Santander	6	6	5
Bilbao	6	5	5
Summer			
Pontevedra	8	11	9
La Coruña	7	7	8
Gijón	6	6	6
Santander	6	5	5
Bilbao	6	5	6
Fall			
Pontevedra	10	11	11
La Coruña	7	7	8
Gijón	5	5	6
Santander	5	5	5
Bilbao	6	7	5

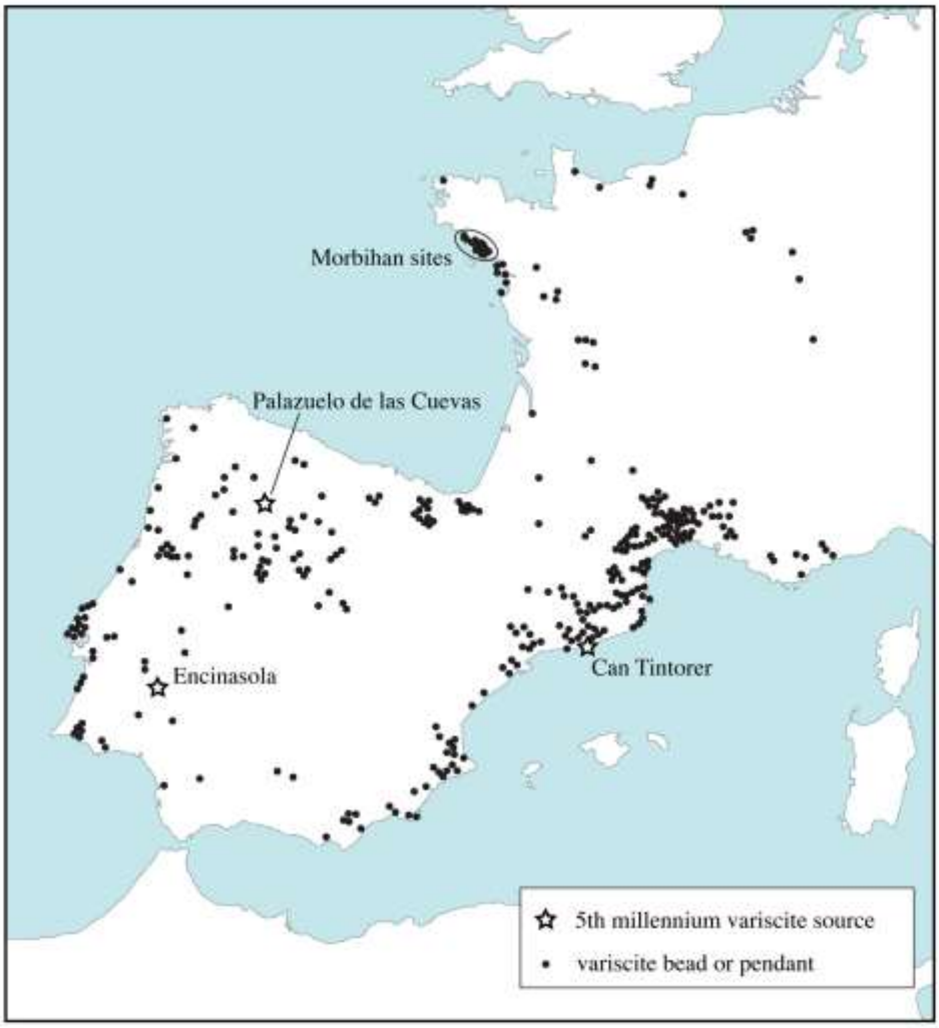
Morbihan sites
Palazuelo de las Cuevas
Encinasola
Can Tintorer
☆ 5th millennium variscite source
• variscite bead or pendant

Figure 1

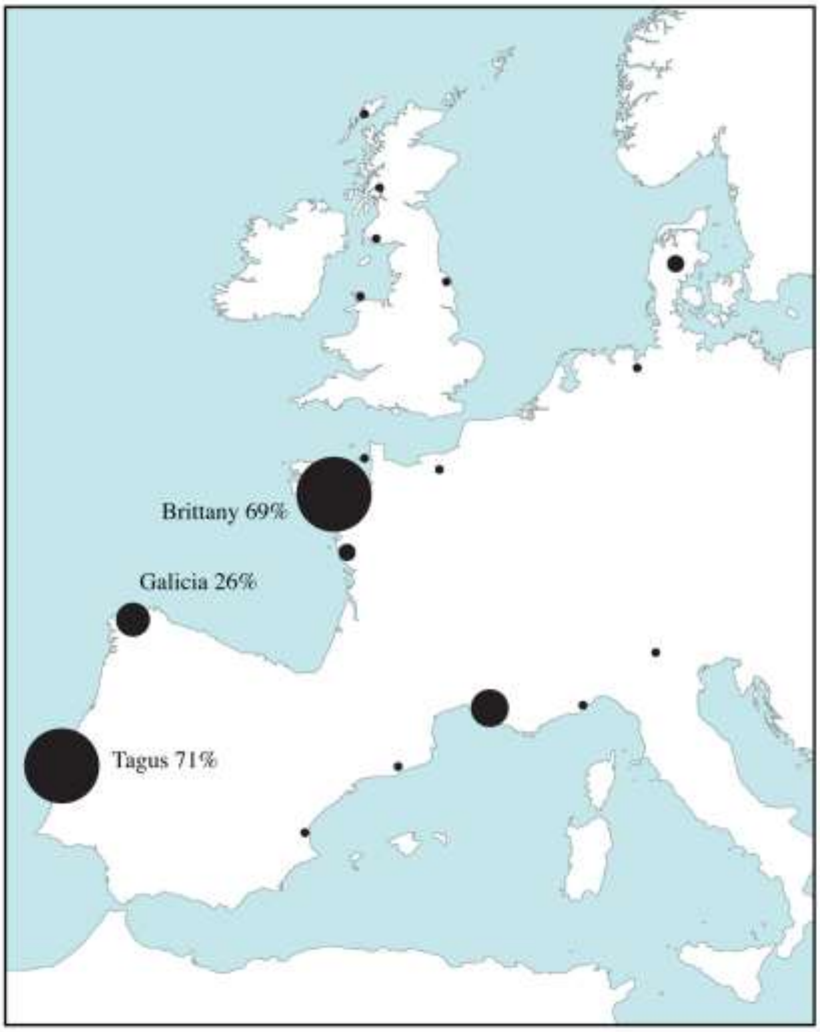

Figure 2

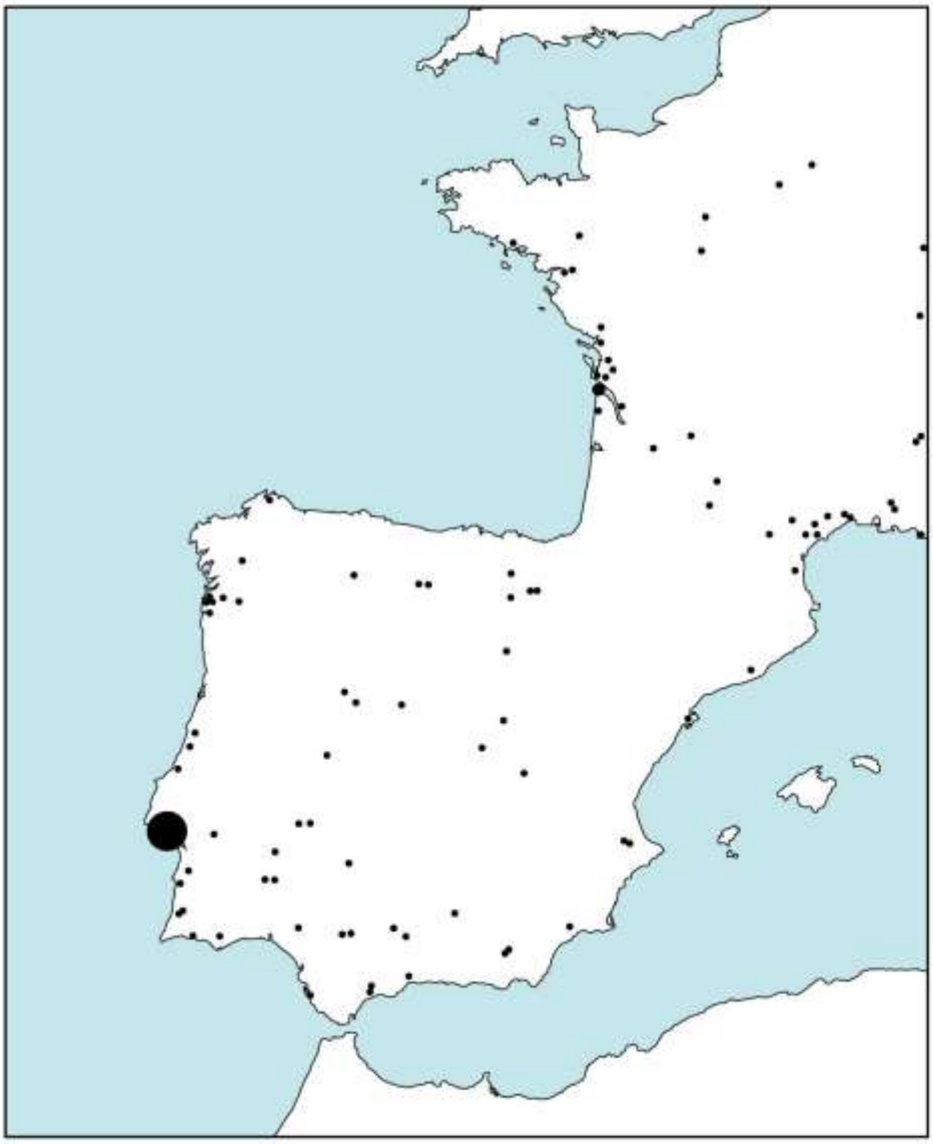

Figure 3

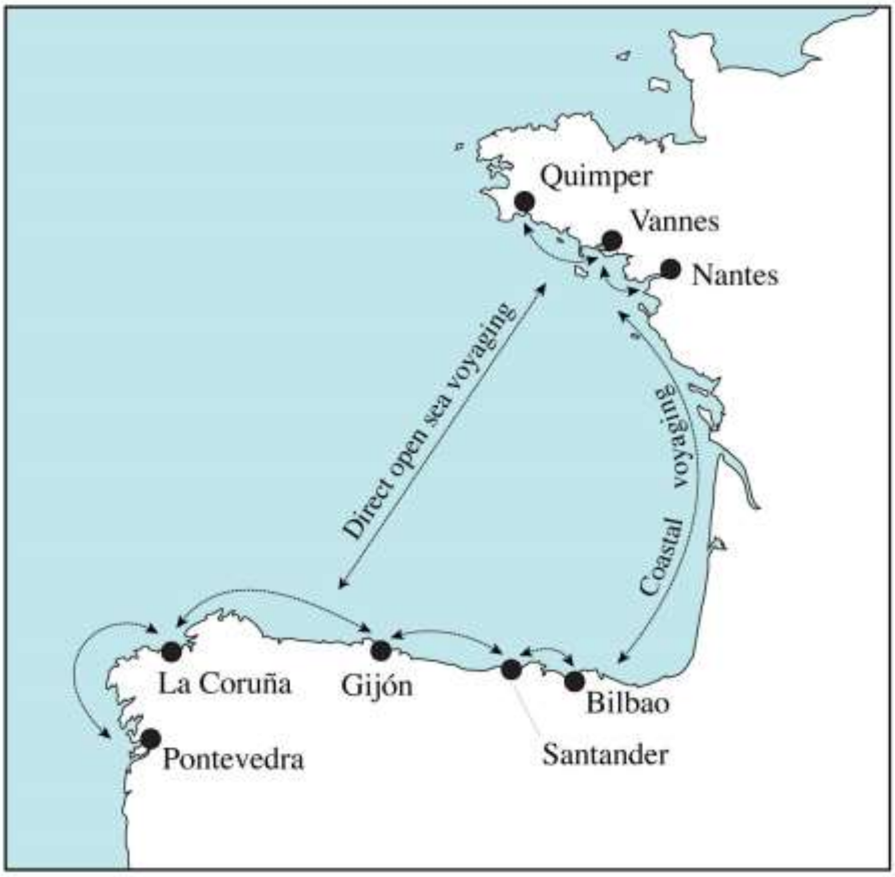
Quimper
Vannes
Nantes
Direct open sea voyaging
Coastal voyaging
La Coruña
Gijón
Bilbao
Santander
Pontevedra

Figure 4