

# Research on the effects of Relative Sea-Level change on the River Exe estuary in the mid-1<sup>st</sup> century AD (South-West Britain).

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## Abstract

Relative Sea-Level (RSL) change since the mid-1<sup>st</sup> century AD places limits on the locations of Roman ports on the River Exe. Supplies from Northern Gaul, destined for the Neronian legionary fortress at Exeter and its dependent civilian sites, may be demonstrated to have been unloaded downriver from the fortress at Exeter.

Utilising a combination of available historical and archaeological data, glacial isostatic adjustment and estimated RSL over the past 2000 years, confirms that Roman sea-transports or river barges could not have reached the Exeter fortress on the tide. Furthermore, on the basis of the estimated tidal reach and depth of the River Exe in the mid-1<sup>st</sup> century AD, limitations may be placed on the location of both sea-port and barge-quay facilities, thus allowing the areas of search for these installations to be narrowed.

## Historical Information

The first reference to the tidal regime occurs at the end of the reign of Edward the First (AD 1272-1307) when John Hooker writes in the 'Haven of Exeter' that:

*The river Exe is naturally only navigable for large vessels as far as Topsham, on the left bank of the river [east], four miles below Exeter. Smaller craft, however, and large barges, could with the tide ascend to the water-gate of the city, in sufficient numbers to supply the wants of the inhabitants.*

Subsequently, in about AD 1300, a weir was constructed upstream of Topsham which blocked the tidal ingress and barge transport to the city.

## Modelling of Relative Sea-Level Change

The pre-AD 1300 tidal head at Exeter and the sea-port at Topsham were used as data anchors to ask the question: how much further south - the differential fall distance - would those locations have been in the 1<sup>st</sup> century AD? Topographic slopes down the Exe river and estuary were calculated: the best estimate was 0.02 degrees. These slopes were used to calculate the differential fall distances due to the RSL changes (best est. -1.5 m) since the 1<sup>st</sup> century AD, i.e., how far has the tidal body fallen down the slope as time retrogressed to the Roman era (Table 1)?

RSL diffs.	-0.5 m	-1.0 m	-1.5 m	-2.0 m
Slope 0.01	2,864.79	5,729.58	8,594.37	11,459.16
Slope 0.02	1,432.39	2,864.79	4,297.18	5,729.58
Slope 0.03	954.93	1,909.86	2,864.79	3,819.72

Table 1: differential fall distances, m, from AD 1300 to the 1<sup>st</sup> century AD for RSL values of -1.5 to -3.0 m, in -0.5 intervals, and slope values of 0.01, 0.02 and 0.03 degrees.

Taking the best estimates of slope and differential RSL, 0.02 degrees and -1.5 m respectively, the fall distance was 4,297.18 m, that is, any AD 1300 tidal datum location might have been over 4.2 km further south in the 1<sup>st</sup> century AD (Figure 3).

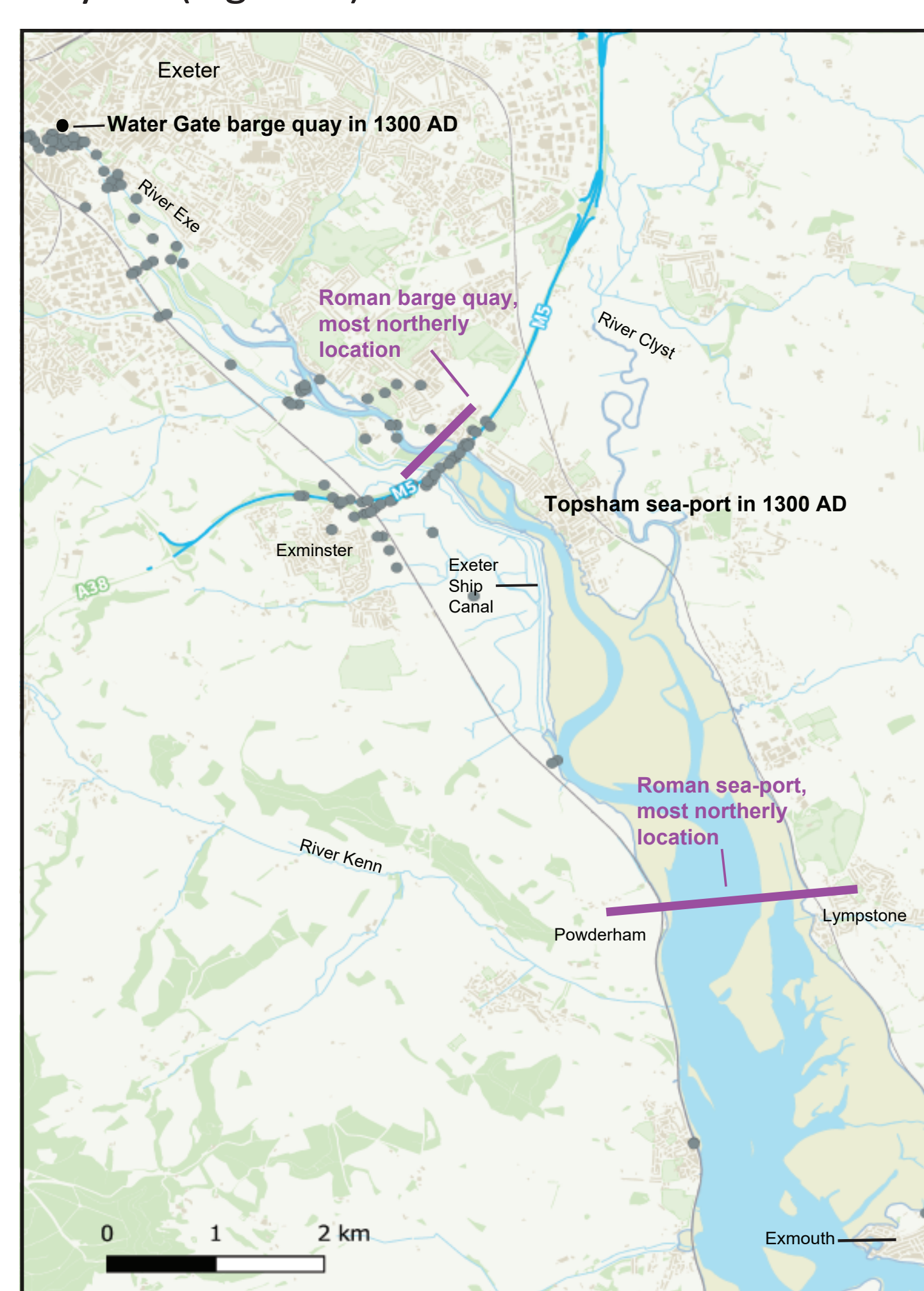


Fig. 3: map of differential fall distances to the most northerly locations in the 1<sup>st</sup> century AD for the AD 1300 barge-quay located at Exeter and the sea-port at Topsham. The differential RSL and slope values were the best estimates at -1.5 m and 0.02 degrees, respectively, resulting in a differential fall distance of 4,297 m. See Figure 4 for the locations of all the differential RSL and slope values from the present-day to the 1<sup>st</sup> century AD.

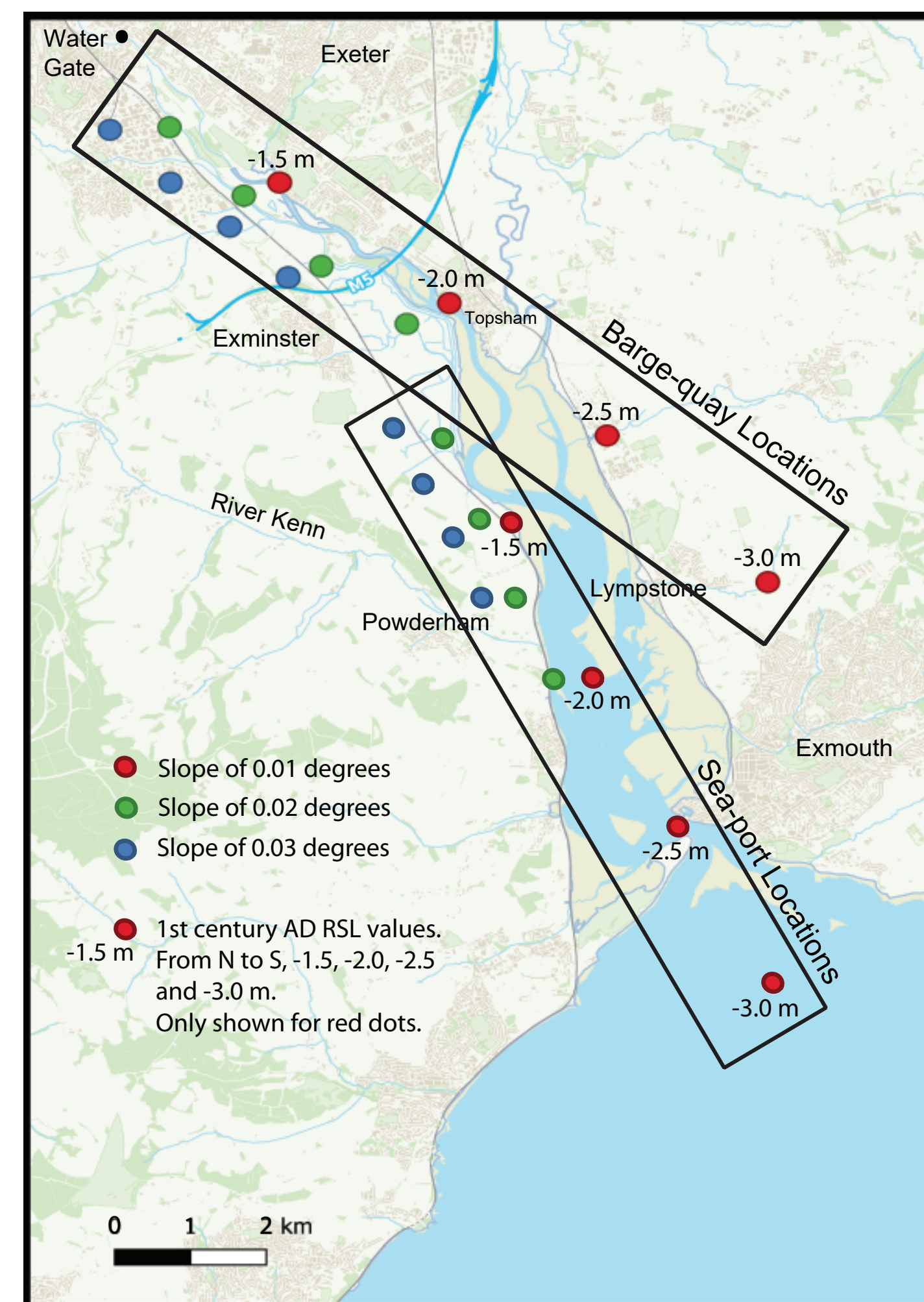


Fig. 4: map of most northerly, or upstream, limits of 1<sup>st</sup> century AD barge-quays and sea-ports. Differential fall data, from the present-day to the 1<sup>st</sup> century AD. For any combination of slope and RSL value the barge-quay or sea-port could not be placed further upstream or north than the relevant coloured dot.

Demonstrably there was no barge-quay at Exeter in the 1<sup>st</sup> century AD because the tide did not reach that far upstream. Instead, a barge-quay may only have been located as far north as the vicinity of the M5 Motorway bridge (Figures 3 & 4). Furthermore, assuming that the AD 1300 sea-port at Topsham was located as far upstream as practical, a Roman era sea-port may only have been located south of the line Powderham — Lympstone for the same RSL and slope values (Figures 3 & 4).

## Tidal Inflow Simulation

A simulated tidal inflow into the Exe estuary and river valley was performed; it supported the findings of the previous RSL examinations with an additional set of limits on the positioning of the 1<sup>st</sup> century AD sea-port and barge-quay.

First, the extant boundaries to tidal inflow were eroded and partially breached in the tidal modelling of the present day regime (Figure 5A). Second, 1<sup>st</sup> century AD modelling was achieved by raising the topography by only 2m, i.e. imitation of a -2.0 RSL (Figure 5B). As a result, the tidal head was downstream of the M5 bridge and at Topsham the tidal water depth was c. 0.5 m. The results suggest Topsham was not a Roman sea-port but may have been a barge-port.

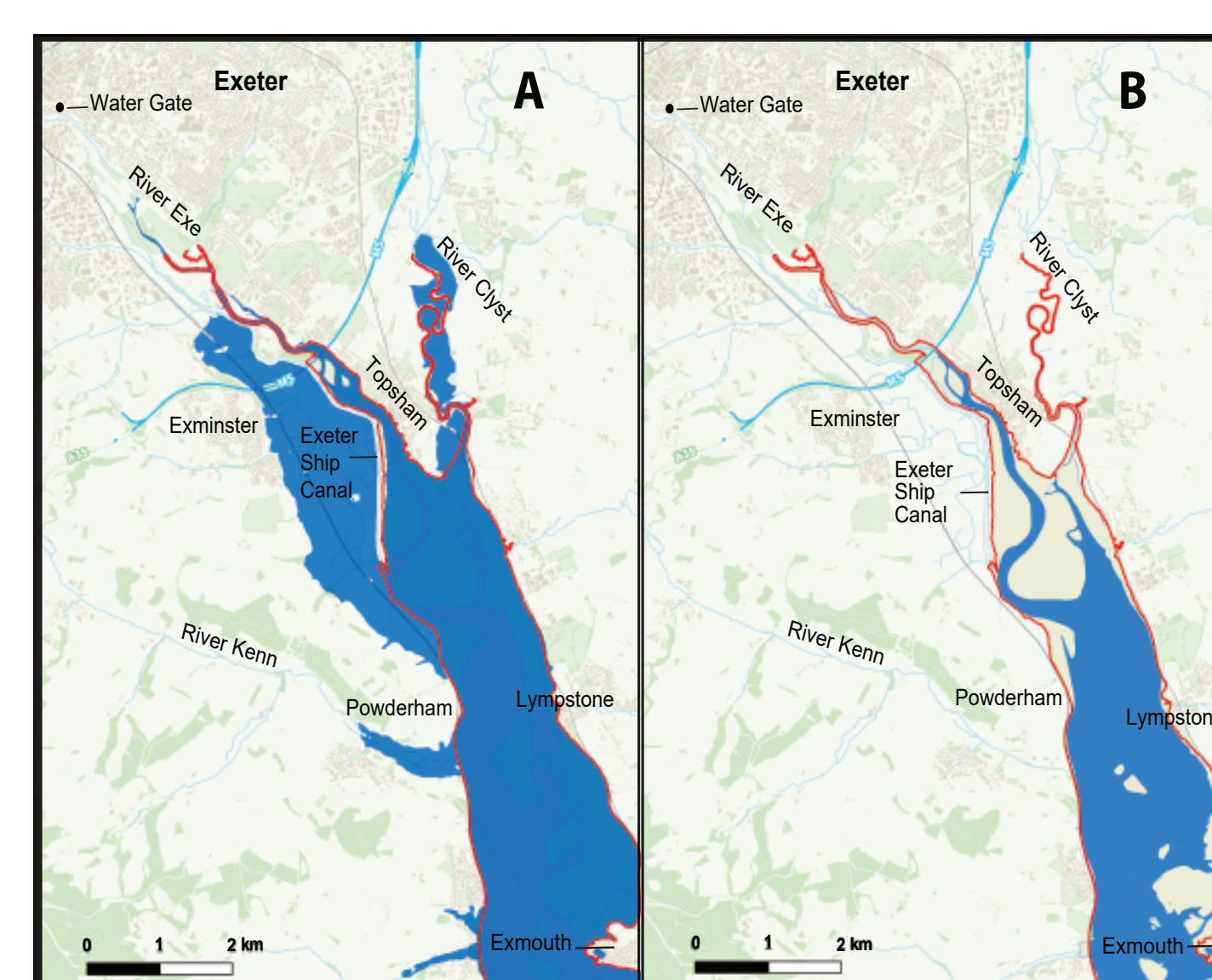


Fig. 5: A) simulated tidal inflow for the present-day after the partial removal and breaching of anthropogenic structures. Red line is the Ordnance Survey High Water Mark. Grey lines are of the railways.

B) simulated tidal inflow for the 1<sup>st</sup> century AD. RSL -2.0 m. Note that the modern anthropogenic structures have been partially removed and breached and may still restrict the 1<sup>st</sup> century AD flow, e.g., the River Kenn may have been tidal in its lower reaches.

## Archaeological Context and Conclusions

A mid-1<sup>st</sup> century AD legionary fortress at Exeter in SW Britain (constructed c. AD 50-55) is known to have been occupied by *Legio II Augusta* until the legion transferred to Caerleon in Wales in AD 75. Subsequently, many more contemporary sites have been discovered alongside or straddling the known Roman road leading from the south gate of the fortress to a location near the head of the River Exe estuary some 5.2 km south-east of Exeter (Rippon and Holbrook 2021). These sites, include buildings associated with the *canabae*; a defended civilian settlement (*vicus*) at the former St Loye's College, 2.6km south-east of the fortress; and parallel strip buildings (possibly warehouses) close to the head of the estuary just NE of Topsham (see Figure 6).

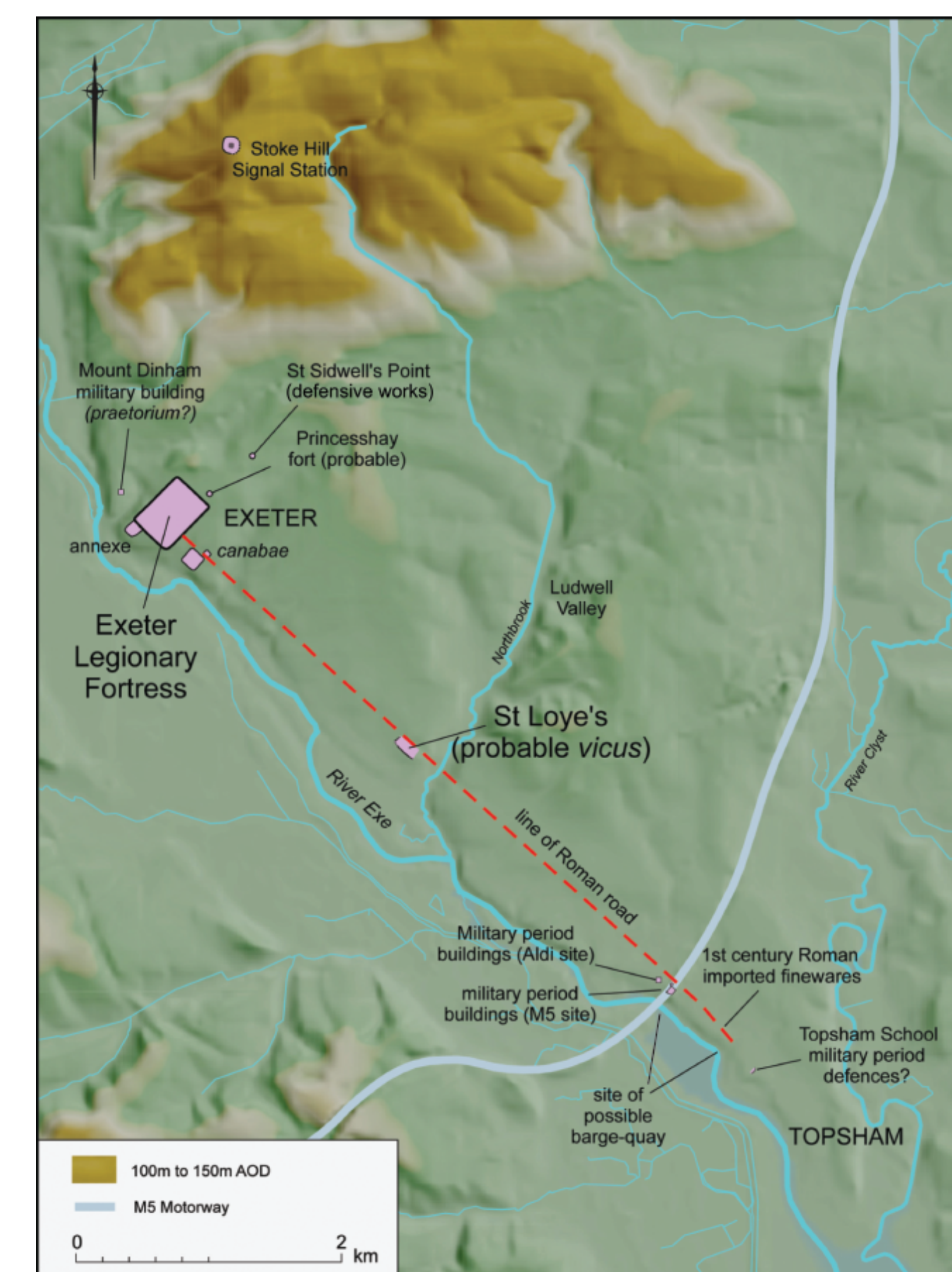


Fig. 6: Roman military period sites located between the Legionary fortress at Exeter and the Topsham School site showing the approximate site of the possible barge-quay.

The full size of the St Loye's *vicus* settlement is unknown but at least part of it was enclosed by military-style defences which included an outer V-shaped ditch and an inner Punic ditch. The pottery evidence, including copious amounts of amphorae sherds, suggests that St Loye's was occupied by civilian traders engaging in the supply and distribution of imported goods and food stuffs from Gaul to the Roman garrison at the Exeter fortress and the auxiliary forts beyond.

Paul Bidwell, the excavator of the military bathhouse at Exeter has stated: '... it now seems possible, that Exeter and Topsham, and the riverside strip between them, accommodated the largest complex of sites of the Neronian and early Flavian period in Britain'.

The presented research offers some insight into the supply of goods from the Continent via cross Channel shipping. Namely, that tidal constraints within the Exe estuary would have prevented sea-going vessels (or even barges) from reaching the Exeter fortress itself. Whilst the cargo could have arrived at a sea-port on the estuary south of Lympstone, no evidence exists of a Roman military presence that far south. The current, favoured explanation is of a transshipment of goods from sea-going vessels to barges on the lower reaches of the Exe estuary; with those barges then travelling up-river to a barge-quay south of the mid-1<sup>st</sup> century tidal reach of the Exe in the Topsham area; thenceforth, transport was by road (Figure 6).

Rippon, S. and Holbrook, N. (eds) 2021: Roman and Medieval Exeter and their hinterlands: From *Isca* to *Esanceaster*. Exeter: A Place in Time 1. (open access download available: <https://www.oxbowbooks.com/oxbow/open-access.html>).

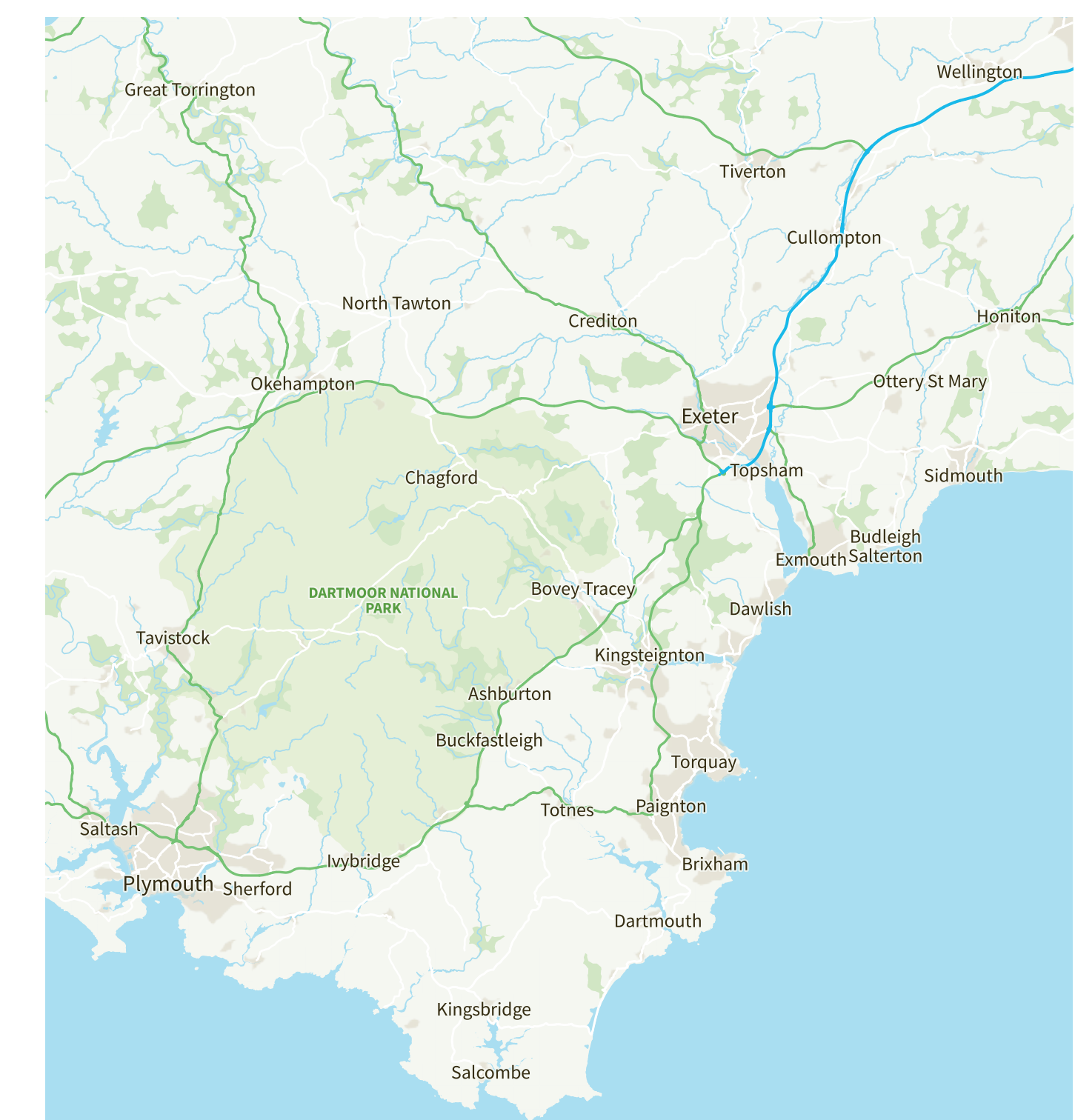


Fig. 1: Location map.

## Relative Sea-Level (RSL)

The values of RSL can change due to both eustatic sea-level variations and Glacial Isostatic Adjustment since the last glacial event.

Figure 2 shows the RSL for Devon from c. 10,000 B.P. to the Middle Ages and displays the forebulge collapse due to the removal of the Celtic Ice Sheet. The polynomial line through the data points shows that the RSL was approximately -25 to -20 m OD some 12,000 years ago, meaning that the land surface was that much higher than it is today. By the 1<sup>st</sup> century AD, the RSL is at c. -2.5 m OD and the land continues to subside to today.

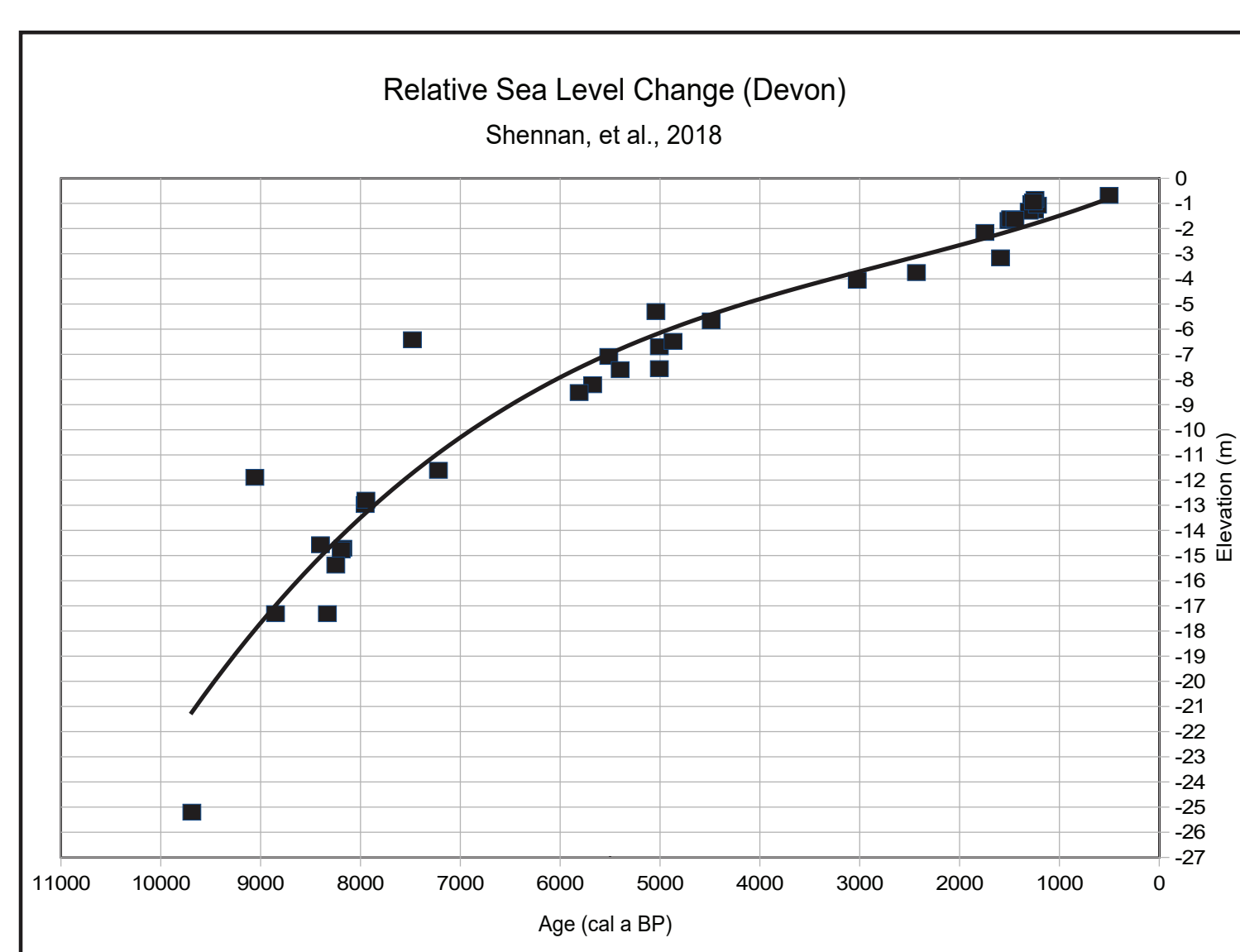


Fig. 2: Age-elevation plot of sea-level index points for Devon. After 'Relative sea-level changes and crustal movements in Britain and Ireland since the last Glacial Maximum', Shennan et al., 2018.

The consequences for the fluvial and tidal regimes are considerable, effecting the navigability of the Exe and the placement of a sea-port and/or barge-quay that might have served the fortress of *Legio II Augusta* at Exeter.