Re-used Bedrock Ballast in King's Lynn’s ‘Town Wall’ and the Norfolk Port’s Medieval Trading Links

By P. G. HOARE, R. VINX, C. R. STEVENSON and J. EHLERS

THE geology of ballast is considered in the accounts of numerous shipwreck excavations, yet there are few studies of ballast that has subsequently been employed as a construction material and is now preserved on land. Re-used bedrock ballast has the potential to provide information on a port’s trading connections: the geological evidence may supplement historical sources, or it may supply fresh detail when written records are not available. This paper reports on the results of the first comprehensive survey of the impressive number of ballast cobbles in King’s Lynn’s medieval ‘Town Wall’.

The Town Wall of King’s Lynn originally extended from Kettle Mills to Wallsend, a distance of c. 570 m (Fig. 1). The masonry structure served, together with a system of earthen banks, for military defence, as a customs barrier and for the maintenance of civil order.¹ There is no contemporary record of the building of the wall; the best estimates of its age are based on the timing of grants of murage, a tax on goods entering and leaving a town in order to raise funds for the erection or repair of public walls. King’s Lynn obtained patents for murage in 1266 (exemption was granted two years later), 1294, 1300 and 1339.² Accordingly, the Town Wall is said to have been constructed from 1266 to 1268, between 1294 and 1307, or during the first half of the 14th century.³ The wall enclosed ‘The New Land’ which came into formal existence by 1146–1150, but the earliest reliable reference to it is found in the chamberlains’ accounts for 1373–1374.⁴

The wall’s eventful history includes episodes in which sections became ruinous through neglect, were robbed, repaired and strengthened, damaged in civil

³ Turner, op. cit. in note 1, 129; Parker, op. cit. in note 1, 139; Clarke and Carter, op. cit. in note 1, 435.
conflict, dismantled and reconstructed. Its appearance is recorded, more or less faithfully, in a number of illustrations, the earliest dating from c. 1680. The east prospect of Lynn-Regis, in the county of Norfolk (Fig. 2), published by the Buck brothers in 1741, shows the full extent of the Town Wall. The Bucks ‘made good’ the dilapidated and dismantled stretches of wall, and they exaggerated its height.

A reconstructed section of the Town Wall, 179 m in length, is located in Wyatt Street (SMR 237; Fig. 3). A 43 m-long stretch of the Wyatt Street wall is shared

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5 For evidence of neglect, see W. Rastrick (1725), Ichnographia Burgi perantiqui Lenna Regis in Agro Norfolciensi accurata delineata and Anon., Leigh’s New Pocket Road-book of England and Wales (6th ed., London, 1837), 266; of vandalism, see Cal. Pat. Rolls 1272–1281, 228, cited in Clarke and Carter, op. cit. in note 1, 435; of repair, see W. Taylor, The Antiquities of King’s Lynn, Norfolk (King’s Lynn, 1844), 157–8 and B. Mackerell, The History and Antiquities of the Flourishing Corporation of King’s-Lynn in the County of Norfolk (privately published, 1738), 224 and 228; of damage during civil strife, see H. J. Hillen, History of the Borough of King’s Lynn (privately published, 1907), 359; of partial removal, see H. Bell (c. 1680), The Groundplat of Kings Lyn, Rastrick, this note, following p. 154 and Clarke and Carter, op. cit. in note 1, 438; and of reconstruction, see King’s Lynn Borough Archives KL/TC11/1/1, 163.

6 See, for example, Bell, Rastrick, and Edwards, op. cit. in note 5.

7 This is evident when the Bucks’ drawing is compared with the seemingly more faithful depiction by Rastrick, op. cit. in note 5.

8 Mr P. Sykes, pers. comm., March 2000.
S. and N. Buck's (1741) The east prospect of Lynn-Bridge, in the county of Norfolk, showing (from left to right) Wallbridge, the White Tower, East Gate and Kettle Mills.
The west side of the reconstructed Wyatt Street stretch of King's Lynn's Town Wall is c. 2.2 m high. Well-rounded former beach cobbles, which arrived in the town as ships' ballast, are particularly numerous towards the left-hand side of the picture; considerable numbers of paving sets occur in the highest course. Photograph by P. G. Hoare, January 2000.

with the 'Hob-in-the-Well' public house; it contains numerous 'modern' bricks and has therefore been discounted.) A second section, 80 m long and probably largely original,9 runs beside Kettlewell Lane (SMR 174b). No part of either stretch has escaped modification, and it is fanciful to suggest that they reveal a deterioration in the quality of material and workmanship during the construction period.10

The majority of the published descriptions of the Town Wall emphasise its history and architecture; they provide an incomplete account of its contents, noting Chalk, Carstone, flint, brick and (unspecified) limestone, ashlar and 'stone'.11 Only Stevenson's pilot investigation has drawn attention to the remarkable variety of rock-types in the structure.12

11 See, for example, Smith, op. cit. in note 10, 57 and 81–5; Turner, op. cit. in note 1, 126–7, and Parker, op. cit. in note 1, 140; W. Taylor, The Pictorial Guide to King's Lynn, Norfolk (privately published, 1848), 54; Hillen, op. cit. in note 5, 757; Turner, op. cit. in note 1, 126–7; P. Richards, King's Lynn (Chichester, 1990), 3; N. B. L. Pevsner and W. Wilson, Norfolk E: Norwich and North-East (2nd ed., London, 1997), 22.
Types of rock and artificial material in King's Lynn's medieval Town Wall: a. Rapakivi granite, Åland archipelago; b. Rhomb porphyry, Oslo graben; c. Red orthocerate limestone (see notes 19 and 33); d. Lapilli tuff, St Abh's Head; e. Limestone, of probable British provenance, perforated by the marine sponge *Cliona*; f. Barnack Stone ashlar; g. Vitrified brick of unknown age and provenance. *Photographs by P. G. Hoare.*
METHODS

A preliminary inspection of the Town Wall was undertaken in order to identify the general composition of its components. This was followed by a detailed examination of the re-used ships’ ballast in an attempt to establish its provenance. We were normally obliged to study the material in situ with a hand lens; organic growths and grime were removed with water and a stiff brush. It was rarely possible to view freshly broken faces or to take samples for petrographic analysis. Sedimentary rocks usually presented the greatest difficulty for identification as many have no distinguishing characteristics in hand specimen. For comparative purposes, we have determined the lithology of a cobble beach on the southern shore of the Baltic Sea and of a till in the North German lowland.

RESULTS

An estimated total of c. 55,000 pieces of rock and artificial material, of various sizes and shapes, are exposed in the Town Wall (Tab. 1). They include field stones, water-rounded gravels, bedrock rubble, ashlar (Fig. 4f), bricks (Fig. 4g), furnace slag and concrete. Many of the rock-types are native to the district, but some are of distant provenance. Paving setts (Fig. 3) and certain other minor constituents must have been introduced during a period of repair or rebuilding as they were not available at the time of construction. Selective robbing may also have taken place.

The re-used rock ballast

This group of building materials consists of c. 3,000 clasts (about 5% of the visible components) which display considerable lithological variety, are typically well rounded and of a similar size. A number of cobbles are composed of rock-types which are sufficiently distinctive to enable their ultimate provenance to be identified; these far-travelled geological indicators are listed separately in Table 2. Clasts of comparable size, shape and distant origin may be seen in other medieval buildings in King’s Lynn.


'Turner, op. cit. in note 1, p. 139, believed the Town Wall was originally faced. The longest visible axis of a random selection of 100 clasts ranged from 110 to 390 mm (mean = 190 mm).

Certain Baltoscandian and British sandstones cannot be differentiated in hand specimen and were therefore not evaluated. Indicators are described in J. G. Zandstra, Noordelijke Kristallijne Gidsstenen. Een Beschrijving van Ruim Tweehonderd Gezienstypen (Zuiderstien) uit Fennoscandinavië (Leiden, 1988), P. Smed (trans. J. Ehlers), Steine aus dem Norden: Geschichte als Zeugen der Eiszeit in Norddeutschland (Berlin, 1994), and P. Smed, Slen i det Danske Landskap (3rd ed., Brenderup, 1995).

They occur in Greyfriars’ tower (Mr D. C. Pitcher, pers. comm., March 2000, informs us that this dates from c. 1300) and in a dividing wall, erected during the second half of the 13th century, in The Merchant’s House: for a general account of this Romanesque building, see R. Taylor and H. Richmond, ‘28–32 King Street, King’s Lynn’, Norfolk Archaeol., 40 (1989), 260–85. They are also found throughout All Saints’ church; the present structure, of late 14th-century date save for 13th-century transepts (N. B. L. Pevsner, North-West and South Norfolk (Harmondsworth, 1962) 228), replaced a church built between 1087 and 1100 (Clarke and Carter, op. cit. in note 1, p. 413).
Table I

<table>
<thead>
<tr>
<th>LITHOLOGY/COMPOSITION AND AGE</th>
<th>PROVENANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cretaceous</strong></td>
<td></td>
</tr>
<tr>
<td>Flint</td>
<td>Local bedrock; ?Lincolnshire</td>
</tr>
<tr>
<td>Chalk</td>
<td>Local bedrock</td>
</tr>
<tr>
<td>Hunstanton Red Rock</td>
<td>Local bedrock</td>
</tr>
<tr>
<td>Carstone Formation</td>
<td>Local bedrock</td>
</tr>
<tr>
<td>Leziate Member</td>
<td>Local bedrock</td>
</tr>
<tr>
<td><strong>Jurassic</strong></td>
<td></td>
</tr>
<tr>
<td>Barnack Stone</td>
<td>Lincolnshire</td>
</tr>
<tr>
<td>Brick</td>
<td>Local kilns or ballast from North Sea or Baltic ports</td>
</tr>
<tr>
<td>Furnace slag</td>
<td>?</td>
</tr>
<tr>
<td>Paving setts</td>
<td>?North Britain; ?Scandinavia</td>
</tr>
<tr>
<td>Concrete</td>
<td>?</td>
</tr>
<tr>
<td>Two-mica granitoids</td>
<td>?British</td>
</tr>
</tbody>
</table>

**NOTES**

Flint forms a very substantial part of the wall, including the 'largely original' Kettlewell Lane section (Mr D. Higgins, pers. comm., March 2000). Grey, black and brown varieties occur as nodules, broken fragments and well-rounded, waterworn gravels; these may have been collected from field surfaces, from shallow pits in the local glacial sediments (but none of the flints displays glacial striae) and from beaches. Grey flints, of Lincolnshire type, were introduced into Norfolk as glacial erratics (J. D. Solomon, 'The glacial succession on the north Norfolk coast', Proc. Geol. Assoc., 43 (1932), 269), although similar material is present in the Norfolk Chalk (N. B. Peake and J. M. Hancock, 'The Upper Cretaceous of Norfolk', in G. P. Larwood and B. M. Funnell (eds.), The Geology of Norfolk (2nd ed., Norwich, 1970), 310).

Carstone rubble/quarried bedrock is found in considerable quantity in both stretches of the wall; it has also been employed to repair sections of the structure.

The mechanically weak Hunstanton Red Rock and Chalk are used very sparingly.

A ventifact composed of Leziate Member sandrock occurs in the upper course of the Kettlewell Lane wall; numerous ventifacts are found in thin but extensive Late Devensian coversand in the King's Lynn area.

The wall's shooting embrasures are faced with Barnack Stone ashlar (Fig. 4f); recycled ashlar fragments occur in minor amounts as rubble. This shelly oolitic limestone from the Upper Lincolnshire Limestone was 'The most common medieval import [to the King's Lynn area as construction material]': R. W. Gallois, Geology of the country around King's Lynn and The Wash (sheet 145 and part of 129), Memoir of the British Geological Survey: England and Wales (London, 1994), 175. Several very substantial pieces of Gotswold Stone ashlar and fragments of Stoneport Stone ashlar were also noted.

Significant amounts of yellow, dolomitic limestone (?Yorkshire, ?Jurassic) rubble, a few clasts of crinoidal limestone, rare fragments of a flaggy sandstone (?York Stone') and of a purplish-red, cross-stratified sandstone (?Devonian or ?Triassic) are also present.

Bricks were employed when repairs were carried out in 1501 (Mackerell, op. cit. in note 5, 224). Vitrified and distorted bricks (Fig. 4g) may have arrived as ballast from ports on the North Sea (including Kingston upon Hull and those in the Netherlands) or from the Baltic (Dr R. J. Firman, pers. comm., August 1998).

Three vesicular basalt-like cobbles are considered to be furnace slag; none has the appearance of basalt under the microscope.

Paving setts composed of hardwearing exotic rock-types (Fig. 3) were not used widely in British towns, save for those which were affluent and accessible by water, until the canals and particularly the railways offered cheap transport: A. Clifton-Taylor and A. S. Ireson, English Stone Building (2nd ed., London, 1994), 153. They are unlikely to have been added to the Town Wall before 1860 when King's Lynn's first macadamised road was laid: Hillen, op. cit. in note 5, 664.

A few fragments of concrete of unknown age and provenance have been noted.

Two-mica granitoids: see note 22.
## Table 2
THE LITHOLOGY OF THE RE-USED BALLAST COBBLES IN KING'S LYNN'S MEDIEVAL TOWN WALL: A, KETTLEWELL LANE; B, WYATT STREET

<table>
<thead>
<tr>
<th>Lithology/Provenance</th>
<th>A</th>
<th>B</th>
<th>Total</th>
</tr>
</thead>
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<tr>
<td><strong>Baltoscandian indicators</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hellelint [1]</td>
<td>1</td>
<td>0.15</td>
<td>1</td>
</tr>
<tr>
<td>Bothnian Sea porphyry</td>
<td>1</td>
<td>0.15</td>
<td>1</td>
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<tr>
<td>Bredvad porphyry [2]</td>
<td>12</td>
<td>1.82</td>
<td>14</td>
</tr>
<tr>
<td>Wiborgite [3]</td>
<td>1</td>
<td>0.05</td>
<td>1</td>
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<tr>
<td>Other rapakivi granites [4]</td>
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<td>6</td>
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<tr>
<td>Rhomb porphyry [5]</td>
<td>1</td>
<td>0.05</td>
<td>1</td>
</tr>
<tr>
<td>Anorthosite [6]</td>
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<td>0.05</td>
<td>1</td>
</tr>
<tr>
<td>Nordmarkite[?] [7]</td>
<td>1</td>
<td>0.05</td>
<td>1</td>
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<tr>
<td>Orthoceratite limestone</td>
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<td>0.09</td>
<td>2</td>
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<tr>
<td><strong>British indicator</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lapilli tuff, St Abb's Head</td>
<td>1</td>
<td>0.05</td>
<td>1</td>
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<tr>
<td><strong>Crystalline (igneous and metamorphic) rocks of uncertain provenance</strong></td>
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<td></td>
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<tr>
<td>Granitoid, red</td>
<td>50</td>
<td>7.56</td>
<td>149</td>
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<tr>
<td>Granitoid, grey or yellow</td>
<td>34</td>
<td>5.14</td>
<td>53</td>
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<tr>
<td>Granitoid, two-mica</td>
<td>4</td>
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<td>185</td>
</tr>
<tr>
<td>Aplite [8]</td>
<td>16</td>
<td>2.42</td>
<td>23</td>
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<tr>
<td>Syenite, red [9]</td>
<td>1</td>
<td>0.15</td>
<td>5</td>
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<tr>
<td>Syenite [10]</td>
<td>2</td>
<td>0.30</td>
<td>2</td>
</tr>
<tr>
<td>Syenite/monzonite, grey</td>
<td>9</td>
<td>1.36</td>
<td>6</td>
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<tr>
<td>Syenite/monzonite, red</td>
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<tr>
<td>Pegmatite, red [11]</td>
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<tr>
<td>Porphyr [12], [15]</td>
<td>8</td>
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<td>5</td>
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<td>Porphyr [12], [14]</td>
<td>21</td>
<td>3.18</td>
<td>114</td>
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<td>Trachyte, red</td>
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<td>Basalt, dolerite, gabbro, diorite</td>
<td>346</td>
<td>52.34</td>
<td>1247</td>
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<td>22</td>
<td>3.33</td>
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<td>Basalt, amygdaloidal</td>
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<td>Andesite [15]</td>
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<tr>
<td>Grenstone</td>
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<td>Hellelint [16]</td>
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<tr>
<td>Garnet amphibolite [17]</td>
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<td>Amphibolite [18]</td>
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<td>1.21</td>
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<tr>
<td>Mylonite</td>
<td>3</td>
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<tr>
<td>Gneiss, grey [19]</td>
<td>3</td>
<td>0.45</td>
<td>2</td>
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<tr>
<td>Gneiss, red</td>
<td>26</td>
<td>3.93</td>
<td>75</td>
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<tr>
<td>Granulite [20]</td>
<td>1</td>
<td>0.15</td>
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<tr>
<td>Mica schist</td>
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<td>Quartzite, grey [21]</td>
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<td>4.54</td>
<td>64</td>
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<td>Quartzite, red</td>
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<td>0.91</td>
<td>19</td>
</tr>
<tr>
<td>Quartz, milky</td>
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<tr>
<td>Meta-conglomerate</td>
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<tr>
<td><strong>Sedimentary rocks of uncertain provenance</strong></td>
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<tr>
<td>Conglomerate</td>
<td>2</td>
<td>0.09</td>
<td>2</td>
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<tr>
<td>Greywacke</td>
<td>661</td>
<td>99.98</td>
<td>2158</td>
</tr>
</tbody>
</table>

n \ Number of cobbles identified
RE-USED BEDROCK BALLAST
99

1. Hornébo-type, E. Småland.
2. From N. Dalarna.
3. Granite with typical rapakivi texture.
4. Pyroclitic, even-grained; four specimens resemble Haga granite from Åland.
5. From the Oslo graben.
6. Egersund-type from SW. Norway; probably a paving sett.
7. Possibly from the Oslo graben.
8. Red, granitic or syenitic; some resemblance to those from Åland.
10. Appinite; no Baltoscandian affinities, N. British origin likely.
11. With white mica.
12. Mainly rhyolites, dacites, trachytes and andesites. Basalts and basalt-like, dark-coloured, porphyritic volcanics and subvolcanics were counted as basalts in accordance with usual petrographic practice.
13. With platy feldspars; quartz absent. No Baltoscandian affinities.
14. Some resemblance to Dala porphyries from Baltoscandia, but none of the specimens is typical of these rocks; a N. British origin cannot be excluded.
15. Aphyric; unlikely to be from Baltoscandian exposures.
16. Excluding Hornébo-type helleflint.
17. Neither specimen displays the plagioclase-quartz schlieren which are a characteristic of the most common Baltoscandian garnet amphibolites in SW. Sweden.
18. Without garnet.
20. Light-coloured, garnetiferous.
21. Including quartzitic sandstone. Two cobbles resemble the white, quartz-cemented Hardelberga sandstone of Scania, but similar examples occur elsewhere.

Rocks of Baltoscandian provenance (Fig. 5)

Several of the indicators were derived from outcrops of igneous and metamorphic rock of Proterozoic age which are part of the Baltoscandian basement complex (or Baltic Shield). This complex is exposed throughout the Finnish mainland and across substantial areas of Sweden, but elsewhere is concealed by sedimentary and volcanic material. These indicators include rapakivi granites from the Åland archipelago and mainland SW. Finland (Fig. 4a). Rhomb porphyry (Fig. 4b) and Nordmarkite (a variety of syenite) from the Oslo graben, Bredvad porphyry (N. Dalarna) and helleflint (metamorphosed porphyry) (E. Småland) are each represented by a single wall cobbles of red orthocerate limestone, a sedimentary indicator of Ordovician age, have also been identified (Fig. 4c).

Many wall cobbles are of basaltic, porphyritic and metamorphic rocks which, although not identifiable to source, might be expected to accompany the Baltoscandian indicators. Significantly, the predominance of red granitoids over grey and yellow varieties is consistent with the presence of a suite of lithologies derived from the Baltic Shield.

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18 These are typically red, biotite or hornblende-biotite granites with ovoid potash-feldspar porphyroblasts frequently > 10 mm in diameter; ovoids > 30 mm in diameter are common in S. Finnish varieties but rare in those on Åland.
19 Orthoceratoids are cephalopods with straight, slightly tapered, chambered shells. Outcrops of the limestone occur on Öland and surrounding seafloor, in Västergötland (see below, note 96), the central Bothnian Sea, the centre of the Paleoziic impact structure 'Lumparn', S. Åland, and Närke (in the Siljan area of Dalarna).
20 This term includes basalt and dolerite (the great majority) and basaltoid rocks such as basaltic andesite and basanite; rocks can be both basaltic and porphyritic.
21 For example, gneiss, schist, mylonite, granulite and quartzite.
22 Granitoids are granites and similar light-coloured plutonic rocks. We have discounted small angular fragments of two-mica granitoids, of uncertain provenance, which occur in clusters in the Wyatt Street stretch of wall and were probably introduced during its reconstruction.
The only secure record of North British rocks in the Town Wall is provided by a cobble of lapilli tuff from St Abb’s Head (Scottish Borders) (Fig. 4d). There is, however, some evidence to suggest that other lithologies from North Britain may be present. For example, basalt makes up >50% of the ‘ballast group’ (Tab. 2), yet Baltic Sea beaches, the proximate source of the wall’s Baltoscandian indicators (see below), typically contain <2% basalt and values >5% are rare. Geochemical analysis is essential if the ultimate source of the basalt cobbles is to be established, but it is not unlikely that many came from North Britain. This may also be the case with some porphyry cobbles in the Town Wall; porphyritic rocks may be found in beaches along the coast of the Cleveland district of North Yorkshire, having been eroded from North British bedrock sources and transported to the

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The ultimate source and relative abundance of Baltoscandian indicators in King’s Lynn’s medieval Town Wall: A. Rapakivi granite; B. Granite of rapakivi affinity; C. and D. Red orthocrate limestone; E. Rhomb porphyry; F. Normarkite; G. Bredvad porphyry; H. Helvellyn.

area as glacial erratics. The limestone clasts which have been perforated by the marine sponge *Cliona* (Fig. 4e) are also probably of British provenance.

The provenance and relative abundance of cobbles of Baltoscandian indicators found in the Town Wall are shown in figure 6. The circles are positioned over the geographical centre of the source outcrop; the area of each circle is proportional to the number of specimens of the indicator. There is a clearly defined dominance of rock-types from Aland, the SW. Finnish mainland and the Bothnian Sea.

**Discussion**

Whilst the petrography of the Baltoscandian indicators enables their ultimate provenance to be identified, the rounded form of the cobbles, and of most of the non-indicators, is characteristic of a high-energy, aqueous geomorphological environment, reflecting their proximate location. Cobble beaches were an important primary source of ballast in medieval times, particularly in the vicinity of many Baltic ports. Thus, the most satisfactory explanation for the presence of waterworn cobbles of Baltoscandian rocks in the Town Wall is that they formerly served as ships’ ballast.

The rhomb porphyry cobbles (Fig. 4b) may have arrived in King’s Lynn by sea, but this rock-type is also found as erratics in the glacial sediments of Norfolk.

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25 For details of N. British porphyritic bedrock, see Sutherland (ed.), op. cit, in note 24.
26 The sessile benthic *Cliona* flourish in depths up to 70 m. R. G. Bromley, 'Borings as trace fossils and Entobia cratata Porlock, as an example', 34-90 in T. P. Crimes and J. C. Harper (eds.), *Trace Fossils* (Liverpool, 1970), 76.
29 See also Stevenson, op. cit, in note 12.
the single wall specimen may therefore have been collected close to the town, along
with the material composed of native lithologies (Tab. 1). Note, however, that the
only Scandinavian rocks to occur as glacial erratics in East Anglia are those which
crop out in the Oslo district.

The southern shores of the Baltic Sea are bordered by cobble beaches which
were derived principally from sediments laid down by ice sheets that flowed south
from northern centres of dispersion. Baltoscandian indicators make up c. 5% of a
typical glacial erratic suite in this region. The variety of lithologies and their
relative proportions in the beaches are determined by the petrography of the
glacial deposits and by subsequent modification by marine and subaerial processes.

The provenance and relative abundance of indicators in the beach at Gross Klütz-
Hoved (Fig. 7a) may be regarded as broadly typical of south Baltic Sea
assemblages. The beach lies at the foot of a cliff in which several Weichselian
(Devensian) tills are exposed, and it is largely a condensate of erratics from those
sediments. It includes lithologies from SE. Sweden and the Baltic Sea, including
Aland. The composition of the mid-Saalian (‘Wolstonian’) till at Elmshorn (Fig.
7b) is provided for comparison. Beaches in northern and western Denmark and
SW. Sweden are devoid of rapakivi granites; those on the island of Rügen contain
rocks principally from Bornholm, Småland, Dalarna, the Baltic Sea basin
(including Åland), and from Jämtland further north.

King’s Lynn’s medieval Town Wall contains relatively few indicator species
(Fig. 6) compared with the indicator-rich North German beach (Fig. 7a). Ballast
loading may have involved the rejection of certain cobbles because of their size,
but this is most unlikely to have had more than a trivial influence on its
composition. The distinctive geological signature displayed by a particular stretch
of beach will inevitably be reflected in the character of ballast that is gathered from
it. It is evident that the ballast in the Town Wall cannot have been collected from
beaches between southern Denmark and Poland.

As a consequence of the direction of advance of the Scandinavian ice sheets
across the diverse bedrock outcrops of the Bothnian and Baltic Sea regions, the
variety of durable indicator species increases as the glacial sediments (and the
beaches that have been derived from them) are traced from north to south. It is
apparent, therefore, that the relatively indicator-poor ballast in the Town Wall was
taken from a beach somewhere to the north of the southern shore of the Baltic Sea.

31 Clarke and Carter’s contention (op. cit. in note 1, 87 and 440) that ‘Scandinavian’ crystalline rocks are ‘... common as glacial erratics in Norfolk...’ appears to exaggerate their frequency; more significantly, it lacks a
rigorous petrographic description of the material they noted in archaeological contexts in King’s Lynn.

32 The diagram is based on a qualitative assessment of the frequency of indicator species in an unrecorded number of cobbles c. 100–200 mm in diameter.

33 The lithology of 1,410 clasts c. 20–60 mm in diameter was determined; the red ohrdocrate limestone erratics were derived from the Västergötland outcrop: R. Vinx, A. Grube and F. Grube, ‘Vergleichende Lithologie, Geschichtebeführung und Geochemie eines Prä-Elster-I-Tills von Lieth bei Elmshorn’, Leipziger Geowissenschaften, 5

34 The relative proportions, and indeed the presence and absence, of different lithologies vary with clast size: S. J. Gale and P. G. Hoare, *Quaternary sediments: Petrographic Methods for the Study of Un lithified Rocks* (London, 1991), 173; Smid, op. cit. in note 27, 333. However, no attempt was made to ensure uniformity in the size of material examined since this phenomenon cannot account for the massive difference in composition between southern
Baltic Sea beaches and the ballast which reached King’s Lynn. Furthermore, rapakivi granite, for example, is not
confined to a particular narrow size-range in these beaches.
The provenance and relative abundance of Baltoscandian indicators in (a) the Gross Klütz-Höved beach and (b) the Elmshorn till. The variety of indicator species is too great to name individual sources. The broad arrow shows the generalised flow of Scandinavian ice sheets during the Quaternary, the arrow tip coinciding with the sample point.

The beaches of the western Estonian archipelago can account for the Baltoscandian indicators found in the wall and, of equal significance, they do not contain species which are absent from the wall. The Estonian beaches were derived from glacial deposits that are typically composed of erratic assemblages made up of rapakivi from Åland and SW. Finland (10–20%), granites (60%), metamorphic rocks (9%) and mafic plutonites (3%). The rare cobbles from the Oslo graben, N. Dalarna and E. Småland may have travelled by sea to King’s Lynn, but they must have been collected from other sites and have undergone separate journeys.

CONCLUSIONS

The former beach cobbles composed of Baltoscandian rock-types in the fabric of the medieval Town Wall suggest that the port’s commercial networks may have been linked to the coast of western Estonia. Historical evidence shows that King’s Lynn was one of the most prosperous towns in England in the 13th and 14th centuries. It reached the apex of its trading activities in the mid-13th century, but was still the eleventh wealthiest provincial town in England in 1334 (and seventh in 1377). During this period the quays beside the River Great Ouse were crowded with ships from regions that included the Baltic and the Low Countries (Fig. 8).

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35 Dr A. Raukas, pers. comm., January 2000.
36 R. R. Clarke, East Anglia (London, 1960), 179; Parker, op. cit. in note 1, 4; Clarke and Carter, op. cit. in note 1, 1–2.
Significantly, there were strong trade connections between England and Estonia, especially with the island of Saaremaa, at the time the wall was erected.\textsuperscript{38}

While rock ballast has the potential to act as a source of information about a port’s commercial links, it frequently underwent complex secondary movements as a result of domestic and international trade. This essential commodity was stockpiled on wharves and foreshores so that it might be re-used.\textsuperscript{39} We would therefore have expected the ballast in medieval King’s Lynn to contain rocks from ‘all over Europe’,\textsuperscript{40} the homogenised material offering little hope of identifying the area(s) in which it was loaded. That it has retained its geological integrity after being gathered from a NE. Baltic Sea beach might be explained as a consequence of the ballasted vessel sailing directly to King’s Lynn.

\textsuperscript{38} Dr A. Raukas, pers. comm., January 2000.


The cobble of St Abb's Head lapilli tuff (Fig. 4d) and many of the basaltic and porphyritic rocks may record King's Lynn's medieval coastal trade with NE. England and Scotland. The port's association with Berwick-Upon-Tweed (Northumberland) included the export of grain, malt and ale, and timber.\textsuperscript{41} Coal was shipped to King's Lynn from NE. England and the Lothians.\textsuperscript{42}

The invasion of King's Lynn by the 'Disinherited' [Barons] in Easter week 1266, and the fear of a future attack, may have led to the hurried construction of the Town Wall.\textsuperscript{43} The builders may have been encouraged to acquire quayside ballast in order to supplement the overwhelmingly locally derived material (notably flint and Carstone). Whilst the ballast cobbles provide only a partial reflection of the port's widespread maritime contacts at the time the Town Wall was erected, they nonetheless offer a genuine opportunity for geology to make a contribution to historical debate.

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\textsuperscript{41} Carus-Wilson, op. cit. in note 37, 185; Clarke and Carter, op. cit. in note 4, 448-9; Memorandum of timber purchased from the community of Lynn for the construction of pontoon bridges to be made at Lynn and towed to Berwick on Tweed. PRO E 101/676/131, cited in Owen, op. cit. in note 4, 433-6.

\textsuperscript{42} Tingley, op. cit. in note 1, 147; Clarke and Carter, op. cit. in note 1, 347-9 and 448-9.