**Appendix A Dates from the Oer-IJ and Zaanstreek region**

**<h1>Introduction**

As part of the study, all 14C and OSL analyses with geological significance to the Oer-IJ region and adjacent peat area were collated from sources as diverse as peer-reviewed publications and unpublished documents. For each location, all sample ages are summarised in tables. The arrangement of the tables in Appendices A1–A6 is based on a geographical landscape subdivision. The following sub-regions are distinguished (Fig. App. A):

A1 Peat area of the Zaanstreek

A2 Beach-ridge and beach-plain area

A3 Coastal dunes

A4 Oer-IJ tidal area and IJ-polders

A5 Salt-marsh area adjacent to peatlands of the Zaanstreek

A6 Salt-marsh area adjacent to the coastal dune area

Each table is accompanied by a brief assessment of the ages, focusing on their significance for palaeolandscape reconstruction and – where necessary – on any uncertainties associated with the analyses.

[Fig. App. A near here]

*<h2>Radiocarbon dating method*

Radiocarbon dating is based on the decay of the radioactive isotope of the element carbon (14C). The isotope 14C is produced in the upper atmosphere by cosmic radiation and is oxidised to 14CO2. This substance in turn is taken up by the plants through photosynthesis, and subsequently passed on to the rest of the biosphere via the food chain. After the death of organisms, food uptake no longer takes place, and the 14C content decreases through radioactive decay with a half-life of 5730 years. The half-life is defined as the time needed for 50% of the radioactive nuclei to decay. Radiocarbon dating is based on a measurement of the remaining 14C content of fossil organic remains (e.g. Walker, 2005; Taylor & Aitken, 1997).

This principle of radiocarbon dating is simple and straightforward, but there are various factors that complicate the interpretation of 14C measurements considerably: (1) the 14C content in nature changes through time, (2) the exact value of the half-life is uncertain and (3) plants and animals can contain less 14C than expected on the basis of the atmosphere or hydrosphere they live in. Finally, the ratio between 14C and other carbon isotopes in the hydrosphere is not necessarily in equilibrium with that in the atmosphere, therefore the 14C clock needs calibration in order to make the 14C dates absolute.

Each 14C age is by convention expressed in its own time unit, 14C years BP (original meaning Before Present). ‘Before Present (1950)’ should not be taken literally, and 14C dates have to be translated into absolute ages for intercomparison. In this publication, the dating results are expressed in calendar years AD or BC. The calibration for the changing 14C content in the past is based on 14C-dated tree rings. The calibration curve used (IntCal13; Reimer et al., 2013) translates the 14C dates into calendar ages (van der Plicht & Mook, 1987).

Depletion or enrichment in 14C in organic material compared with atmospheric 14CO2 is called isotopic fractionation. The measured 13C values from the organic material can be used to determine the terrestrial or marine reservoir of the dated organisms (Lanting & van der Plicht, 1996). Because of depletion, the marine organisms along the Dutch coast of the North Sea are about 400 14C years older than contemporaneous terrestrial plant organisms so the ages of these marine organisms – such as shells – have to be corrected by 400 years, to be subtracted from their measured 14C age in years BP.

In older reports and publications (before 2000), the Center for Isotope Research of Groningen University usually presented ages of marine shells with this marine reservoir correction (shell analyses with GrN number or oldest GrA number). In the present paper, the international convention is used and the reservoir correction is applied only to the corrected ages in calendar years.

The terrestrial plant ages (e.g. from peat) and the reservoir-corrected shellages are all calibrated using the OxCal 4.1 program (*[www.oxcal.com](http://www.oxcal.com)*).

*<h2>Uncertainty ranges of the absolute 14C dates*

In Appendices A1–A6, the 2-sigma margin (95% confidence interval) is given for each 14C analysis. The 2-sigma ranges of 14C ages are variable, depending on wiggles in the 14C calibration curve. For example, if an age falls within the ‘Hallstatt Plateau' (around 2500 14C years BP), the calibrated 2-sigma range is commonly as much as 400 years. If the 14C age falls on a steeper part of the calibration curve, then the calibrated value usually has a much narrower 95% confidence range.

For all shell dates in this publication a reservoir correction of 400 years is applied; the corrected 14C ages are calibrated to calendar years using the terrestrial OxCal 4.1 program. Application of the OxCal Marine09.14c program for the marine reservoir correction of North Sea water would result in ages that are about 30–75 years older. Although the use of this latter program is advised for marine samples, we use the OxCal 4.1 calibration for shell dating, applying a 400-year reservoir correction as was done in the older publications and reports of the Oer-IJ. Ages obtained using this calibration protocol match well in age sequence with those from other dating methods (e.g. compare OSL and 14C ages of samples from Uitgeest-Benes; Table 4.11a and b).

Non-marine reservoir effects pose an even a greater problem (‘too old’) when dating shells from fresh-, brackish- and stagnant-water sediments, owing to seepage of groundwater with dissolved CO2 from older organisms (Olsson, 1983). By comparing the values of the stable carbon isotope 13C with those of the oxygen isotope 18O, this ‘hard water effect’ can be detected (Mook, 1971; Lanting & van der Plicht, 1995), and reliable corrections of the associated ages can be made. These 13C/18O corrections have not been applied to the analyses in this appendix because the relevant information is only rarely available. Where the hard water effect may have played a role, it is mentioned in the assessment of the results listed in the tables.

Redeposition of shells older than the corresponding sediment (reworking) in younger deposits is another problem. The associated uncertainty applies not to the age of a shell but to the accuracy of this age as a proxy for the time of sedimentation. Ages of single (not bivalved) shells, which are not sampled in ‘live position’, should be considered with care. In a number of cases ages are rejected because they do not fit in an age sequence (older on top of younger material). In almost all cases, such reversals involve shells from beach sand or overwash deposits. Shells in such high-energy deposits were reworked and originate from older sediment layers eroded by waves in the nearshore zone or on the shoreface. The ages of fragile juvenile *Spisula* specimens, which live in offshore seabed sediments below 4 m –NAP, are generally reliable. Age reversals are rare in *Spisula*-dominated marine sediment sequences.

An example of single-valved shell ages that are obviously too high concerns the specimens from the overwash deposits of location Castricum-Zanderij (CZ-1–4; Table A4.3a). Median ages span a time range from 895 to 355 BC, including an age reversal. The OSL dates of samples taken from below and above the shell layer (CZ-O1 and 2; Table A4.3b) range between approximately 165 and 300 AD and are considered to be reliable since they are in chronological order.

For each date in the tables, the best estimate of the absolute age of the sample is given (guidance figure). In most cases, the guidance figure is the median of the corrected 2-sigma age range as provided by the OxCal 4.1 program. It is rounded up or down to 5 years. However, in some cases the best estimate deviates from this median value because of geological or stratigraphical reasons, for instance when the age disagrees with ages from the same sample, sequence or unit nearby. An example is the 14C age of wood from the canoe found in Uitgeest (UK-1; Table A2.1a). The median age of the range provided by the OxCal 4.1 program yielded a figure of 720 BC (2 sigma range was 806-544 BC), whereas dendrochronology (UK-a1–4; Table A2.1b) indicated an age between 617 and 600 BC. In this case, the median 14C age is more than 100 years too high. The cause of this discrepancy is the wide range of the 2-sigma interval associated with the Hallstatt plateau, which reduces the accuracy of all median values for the associated time period.

In those cases where it is decided to choose a guidance figure deviating from the median age, an asterisk (\*) is inserted in the table and the reason for doing so described in the corresponding assessment.

**Appendix A1 Dates from the peat area of the Zaanstreek**

***<h1>Location: Neck (BN)***

*. (De Mulder & Bosch, 1982)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| BN-1 | GrN 8664 | | 122580 | | 503240 | 2.84–2.88 | Holland Peat, transition oligotrophic to eutrophic peat | Transition peat, bulk | 4335 ± 35 | 3081–2891 BC | 2955 BC |
| BN-2 | GrN 8665 | | 122580 | | 503240 | 3.17–3.19 | Base Holland Peat | Eutrophic peat, bulk | 4440 ± 60 | 3339–2923 BC | 3115 BC |

*Palaeolandscape implication:* At the BN location, the peat development on top of Wormer tidal deposits started at ±3115 BC. The peat bog formation became oligotrophic around 2955 BC.

***Location: Wormer (BW)***

*. ()*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| BW-1 | GrN 11635 | | 117820 | 501750 | 3.04–3.08 | Holland Peat, transition oligotrophic to eutrophic peat | Transition peat, bulk | 4155 ± 40 | 2881–2620 BC | 2750 BC |
| BW-2 | GrN 11636 | | 117820 | 501750 | 3.70–3.74 | Base Holland Peat | Eutrophic peat, bulk | 4800 ± 90\* | 3356–2909 BC | 3130 BC |
| BW-3 | GrN 14281 | | 117820 | 501750 | 6.55–6.46 | Wormer Member, channel deposits | *Cerastoderma edule* | 5520 ± 80\* | 4259–3804 BC | 4030 BC\*\*  (4045 BC) |
| BW-4 | GrN 14282 | | 117820 | 501750 | 6.42–6.73 | Wormer Member, channel deposits | *Cerastoderma edule* | 5590 ± 80\* | 4234–3798 BC | 4030 BC\*\*  (4010 BC) |
| BW-5 | GrN 14283 | | 117820 | 501750 | 15.01–14.91 | Wormer Member, channel deposits | *Hydrobia* | 7010 ± 80\* | 5702–5383 BC | 5030 BC\*\*  (5555 BC) |
| BW-6 | GrN 14284 | | 117820 | 501750 | 15.01–14.91 | Wormer Member, channel deposits | *Cerastoderma edule* | 6500 ± 80\* | 5282–4801 BC | 5030 BC\*\* |
| BW-7 | GrN 14285 | | 117820 | 501750 | 17.00–16.89 | Wormer Member, channel deposits | *Cerastoderma glaucum* | 7240 ± 80\* | 5966–5617 BC | 5720 BC\*\*  (5735 BC) |
| BW-8 | GrN 14286 | | 117820 | 501750 | 17.00–16.89 | Wormer Member, channel deposits | *Mytilus edulis* | 7210 ± 80\* | 5882–5565 BC | 5720 BC\*\*  (5705 BC) |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

\*\*Mean value of the dates taken on the same depth.

*Palaeolandscape implication:* The dates in the tidal channel deposits indicate that the fill of the channel took place between 5730 and 4030 BC. Formation of Holland Peat started here around 3130 BC; it became oligotrophic at about 2750 BC. This is comparable with the peat growth at location Neck (BN-2). All the basal Holland Peat dates in the area of the Zaanstreek lie in the period of 2500–3150 BC (see BN, BM, OM, BK, BH, MD and A17 locations).

***<h1>Location: Ruigoord-Zuidprofiel Afrikahaven (RZ)***

*. - ()*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| RZ-1 | GrN 25252 | | 111500 | 492000 | 2.35 | Upper part Holland Peat | Peat, selected material | 1210 ± 60 | 675–966 AD | 815 AD |
| RZ-2 | GrN 25253 | | 111500 | 492000 | 2.39 | Upper part Holland Peat | Peat, selected material | 1510 ± 50 | 427–638 AD | 550 AD |
| RZ-3 | GrN 25251 | | 111500 | 492000 | 4.28 | Base Holland Peat, on top of Wormer deposits | Peat, selected material | 4480 ± 60 | 3361–2938 BC | 3185 BC |

*Palaeolandscape implication:* The Holland Peat formation near Ruigoord started around 3185 BC. This date is in line with the start of the Holland Peat formation at the BN and BW locations. The upper part of the Holland Peat was dated to the Early Mediaeval period. Post Roman Holland Peat is rare in this region and only found below the mediaeval church of Assendelft (AO and AR locations), where the church protected the top of the peat from oxidation. Possibly, peat formation at Ruigoord was even younger and continued until late mediaeval time. Because of erosion, the uppermost part of the peat is missing (Veerkamp, 2001).

***<h1>Location: Middelie (BM)***

*. (;*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| BM-1 | GrN 14895 | | 130475 | 506200 | 3.25–3.30 | Base Holland Peat | Eutrophic peat, bulk | 4340 ± 60 | 3321–2874 BC | 2980 BC |
| BM-2 | GrN 14896 | | 117820 | 501750 | 5.78–5.83 | Wormer Member, channel deposits | Marine shell | 5680 ± 90\* | 4331–3956 BC | 4120 BC |
| BM-3 | GrN 14897 | | 117820 | 501750 | 7.60–7.75 | Wormer Member, channel deposits | Marine shell | 5270 ± 70\* | 3904–3384 BC | 3665 BC |
| BM-4 | GrN 14898 | | 117820 | 501750 | 15.05–15.23 | Wormer Member, channel deposits | Marine shell | 6530 ± 80\* | 5294–4848 BC | 5075 BC |
| BM-5 | GrN 14899 | | 117820 | 501750 | 16.50–16.63 | Base Basal Peat/Layer of Velsen | Peat, gyttja-like deposits, bulk | 7500 ± 100 | 6570–6103 BC | 6355 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication:* The Basal Peat (gyttja-like facies) started to develop at a level –16.5 m NAP around 6355 BC. This age corresponds with the Basal Peat and Layer of Velsen dates at comparable depths at the VT and BW locations. The age of the erosive tidal-channel deposits on top are dated between 5110 and 4030 BC, and lie in the same time range as the tidal channel fill of the Wormer location (BW-3 t/m 7) and De Woude location (DW-1 and 2). The Holland Peat formation started here around 2980 BC.

***<h1>:***

*. ()*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| DW-1 | GrN 14446 | | 113760 | 506740 | 20.15–19.15 | Lower part of the tidal channel deposits of the Wormer Member | *Cardium glaucum,* fresh single-valved shells | 6230 ± 100\* | 4934–4462 BC | 4650 BC\*\* |
| DW-2 | GrN 14447 | | 113760 | 506740 | 21.15–20.15 | Lower part of the tidal channel deposits of the Wormer Member | *Macoma balthica,* fresh single-valved shells | 6170 ± 80\* | 4824–4451 BC | 4650 BC\*\* |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

\*Mean value of both dates was taken.

*Palaeolandscape implication:* The dates in the tidal channel deposits indicate that the fill of the channel at a depth of about –20 m NAP took place around 4650 BC.

***<h1>Location: Oostmijzen (OM)***

*. ()*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| OM-1 | GrN 4619 | 124165 | 513445 | 2.40–2.43 | Base Holland Peat layer | Gyttja-like peat, bulk | 4485 ± 85 | 3484–2918 BC | 3180 BC |

*Palaeolandscape implication*: At the OM location, peat development on top of the Wormer tidal deposits started at ±3180 BC.

***<h1>Location: Beetskoog (BK)***

*. ()*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| BK-1 | GrN 2063 | | 128500 | | 511700 | 2.70–2.75 | Base Holland Peat layer | Peat, bulk | 3980 ± 65 | 2848–2287 BC | 2500 BC |

*Palaeolandscape implication*: At the BK location, the peat development on top of the Wormer tidal deposits started at ±2500 BC.

***<h1>Location: Hobrede (HO)***

*Table A1.8. 14C dates of site Hobrede (HO) (Kwaad et al., 1965; Westerhoff et al., 1987)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| HO-1 | GrN 4474 | | 126800 | | 505950 | 2.70–2.75 | Base Holland Peat layer | Peat, bulk | 4290 ± 60 | 3093–2694 BC | 2945 BC |

*Palaeolandscape implication*: At the HB location, the peat development on top of the Wormer tidal deposits started at ±2945 BC.

***<h1>Location: Berkhout (BH)***

*. ()*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| BH-1 | GrN 2499 | | 125813 | | 516620 | 1.57–1.60 | Base Holland Peat layer | Peat, bulk | 4230 ± 75 | 3016–2582 BC | 2795 BC |

*Palaeolandscape implication*: At the BH location, the peat development on top of the Wormer tidal deposits started at ±2795 BC.

***<h1>Location: Beetskoog II (BII)***

*. ()*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| BII-1 | GrN 8666 | | 125710 | | 511060 | 3.08–3.12 | Base Holland Peat layer | Peat, bulk | 4090 ± 60 | 2872–2489 BC | 2665 BC |

*Palaeolandscape implication*: At the BII location, the peat development on top of the Wormer tidal deposits started at ±2665 BC.

***<h1>Location: Menningsweerdijk (MD)***

*Table A1.11. 14C dates of site Menningsweerdijk (MD) (De Mulder & Bosch, 1982; Westerhoff et al., 1987)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| MD-1 | GrN 4619 | | 125710 | | 511060 | 3.08–3.12 | Base Holland Peat layer | Peat, bulk | 4090 ± 60 | 2872–2489 BC | 2665 BC |

*Palaeolandscape implication*: At the MD location, the peat development on top of the Wormer tidal deposits started at ±2665 BC.

**Appendix A2 Dates from the beach ridge and beach plain area between Limmen**–**Heiloo and Uitgeest**–**Akersloot**

***<h1>Location: Uitgeest-De Kleis (UK)***

*Table A2.1a. 14C dates of the canoe building pit Uitgeest-De Kleis (UK) (De Koning & Vos, 2007)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| UK-1 | UtC 12782 | | 108820 | | 503700 | 5.90 | Canoe at the base of Oer-IJ creek deposits | Wood, oak | 2553 ± 37 | 806–544 BC | 610 BC\*\*\*  (720 BC) |
| UK-2 | UtC 12757 | | 108820 | | 503700 | Ca 2.50 | Walcheren Member, Oer-IJ creek deposits | *Scrobicularia plana,* bivalved | 2832 ± 32\* | 751–405 | 521 BC |
| UK-3 | UtC 12756 | | 108820 | | 503700 | 2.67–2.68 | Holland Peat, top upper layer | Peat, matrix | 3652 ± 33 | 2136–1939 BC | 2020 BC |
| UK-4 | UtC 12755 | | 108820 | | 503700 | 3.04–3.05 | Holland Peat, base upper layer | Peat, matrix | 4000 ± 50 | 2835–2346 BC | 2530 BC |
| UK-5 | UtC 12754 | | 108820 | | 503700 | 4.11–4.12 | Holland Peat, top lower layer | Peat, matrix | 4410 ± 42 | 3327–2913 BC | 3040 BC |
| UK-6 | UtC 12753 | | 108820 | | 503700 | 4.29–4.30 | Holland Peat, base lower layer | Peat, matrix | 4596 ± 46 | 3517–3108 BC | 3365 BC |
| UK-7 | UtC 12752 | | 108820 | | 503700 | 5.05 | Upper part Wormer Member, top tidal flat | *Scrobicularia plana,* bivalved | 5442 ± 35\* | 3954–3715 | 3867 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

\*\*Estimated date is based on the dendro-date of the oak wood of the canoe. The median age is ±120 years older than the absolute dendro-date.

\*\*\*The median age is too old compared with the data of the underlying canoe. The estimated date based on other *Scrobicularia plana* dates near the mean channel of the Oer-IJ (e.g. UD, BP, WP and NSlocations).

*Table A2.1b. Dendro-date of the canoe Uitgeest-De Kleis (UK) (Koehler, 2004)*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Find no./object** | **Dendro code** | **End date** | **Estimate missing sapwood** | **Field date** |
| **UK-a1, a2, a3 and a4** | **UK-a4std** | **631 BC** | **+ max. 5 + 20 ± 6** | **617–600 BC** |

*Palaeolandscape implication*: The upper part of the tidal-flat deposits of the Wormer Member is dated around 3865 BC and the start of the peat growth on top of the salt-marsh deposits ±3365 BC. This implies that the salt-marsh deposits between the peat and tidal-flat sediments were formed in the period ±3800–3400 BC. As interpreted at the UG location, a protecting coastal barrier is held responsible for the peat formation. The lower peat layer was overlain by aqua-aeolian and beach barrier deposits, and these sands were covered by a second peat layer. This upper peat layer was dated between ±2530 and 2020 BC. The top of the upper peat layer was eroded by the Oer-IJ palaeo-channel. This sequence indicates that the protecting coastal barrier of Uitgeest migrated eastward and reached its new position at the UK location between ±3365 and 2530 BC.

The base of the Oer-IJ channel deposits was dated by the oak wood of the canoe, found at the bottom of the creek. The dendrochronological date of the tree for the canoe is 617–600 BC. Assuming an active life of the canoe of 50 years, the basal deposits of the tidal channel fill were formed around 550 BC.

The date of the bivalve *Scrobicularia plana* shell is slightly too old. This is probably caused by the hard-water effect due to the supply of fresh water from the peat hinterland into the channel. The estimated date is about 450 BC, when tidal influence in the Oer-IJ estuary was still strong.

***<h1>Location: Assum-Waldijk (AW)***

*Table A2.2. 14C dates of Hollandia excavation**Assum-Waldijk (AW) (De Koning et al., 2008)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| AW-1  (212-TV) | UtC 14555 | | ± 108700 | | 502950 | 1.83–1.84 | Top Holland Peat, on top of dune A, southwest side | Peat, matrix | 3400 ± 50 | 1879–1560 BC | 1700 BC |
| AW-2  (201-VP) | UtC 14554 | | ± 108700 | | 502950 | 1.30–1.31 | Base Holland Peat, on top of dune A, and directly below dune B | Peat, matrix | 3459 ± 48 | 1896–1645 BC | 1780 BC |
| AW-3  (212-BV) | UtC 14556 | | ± 108700 | | 502950 | 2.00–2.01 | Base Holland Peat, on top of dune A, southwest side | Peat, matrix | 3800 ± 50 | 2457–2050 BC | 2245 BC |
| AW-4  (214-VIZ) | UtC 14559 | | ± 108700 | | 502950 | 2.57–2.58 | Peaty sand (soil) below Holland Peat, southwest of dune A | Peat, matrix | 3990 ± 50 | 2833–2342 BC | 2520 BC |
| AW-5  (214-BV) | UtC 14557 | | ± 108700 | | 502950 | 2.22–2.23 | Top Holland Peat on top of dune A, northeast side | Peat, matrix | 3550 ± 50 | 2024–1751 BC | 1890 BC |
| AW-6  (214-BV) | UtC 14558 | | ± 108700 | | 502950 | 2.54–2.55 | Base Holland Peat on top of dune A, northeast side | Peat, matrix | 3910 ± 50 | 2565–2209 BC | 2390 BC |
| AW-7  (198-CE) | UtC 14560 | | ± 108700 | | 502950 | 2.20 | Shell layer, in beach sands below dune A | *Cerestoderma edule,* bivalved | 4710 ± 50\* | 3091–2872 | 2940 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: The beach sands on which the dunes A and B where formed are dated around 2990 BC. At that time the coastal barrier was formed at the UK location. A peat layer wedged out over the lower dune A. The peat dates indicate that this layer lateral of dune A was formed between ±2390 and 1700 BC. These dates imply that dune A was blown up between ±2990 and 2390 BC, largely within the period that the coastal barrier of Uitgeest migrated eastward to the position at the UK location (between about 3365 and 2530 BC). Dune B – above the peat layer – must be younger than 1700 BC. This dune formation might be related to the second wash-over phase at the WAII location (WA-O1).

***<h1>Location: Waldijk II (WA)***

*Table A2.3a. 14C dates of ADC excavation Waldijk II (WA) (Zijverden et al., 2012; see also Appendix 4 and Fig. 8 in the Waldijk II report)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| WA-1  (Box 485) | KIA 44257 | | 108807 | 503331 | 1.53 | Top rest-channel deposits cut in wash-over/beach barrier sediments | Selected macro-remains | 2735 ± 35 | 972–811 BC | 875 BC |
| WA-2  (Box 486) | KIA 44258 | | 108807 | 503331 | 1.92 | Middle rest-channel deposits cut in wash-over/beach barrier sediments | Selected macro-remains | 3045 ± 25 | 1395–1223 BC | 1305 BC |
| WA-3  (Box 497) | KIA 44259 | | 108807 | 503331 | 2.35 | Base rest-channel deposits cut in wash-over/beach barrier sediments | Selected macro-remains | 3140 ± 25 | 1495–1308 BC | 1420 BC |
| WA-4  (Box 493) | KIA 44335 | | 108856 | 503361 | 1.23–1.49 | Base rest-channel deposits cut in wash-over/beach barrier sediments | Selected macro-remains | 3615 ± 40 | 2131–1884 BC | 1400 BC\*  (1975 BC) |
| WA-5  (Box 517) | KIA 44336 | | 108855 | 503282 | 1.59 | Base peat layer on dune deposits of the beach barrier and lateral of the wash-over deposits | Peat, bulk | 3365 ± 25 | 1741–1611 BC | 1660 BC |

\*Estimated date adapted for stratigraphical reasons.

*Table A2.3b. OSL dates of ADC excavation Waldijk II (WA) (Zijverden et al., 2012; see also Appendix 4)*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Years BC** | **Error band** | **Estimated**  **date** |
| WA-O1  (VNR 491) | X 4017 | 108847 | 503354 | 2.07 | Wash-over deposits on beach barrier sands, upper layer | 1560 ± 310 | 1870 1250 BC | 1550 BC |
| WA-O2  (VNR 489) | X 4061 | 108816 | 503336 | 2.25 | Wash-over deposits on beach barrier sands, lower layer | 1950 ± 440 | 2390 1510 BC | 1950 BC |

*Palaeolandscape implication*: At this location two phases of wash-over sands were dated with the OSL technique. The lower layer was dated to around 1950 BC and the upper layer to around 1550 BC. In the upper part of the wash-over deposits, rest channels were found and the sandy infill was dated between ±1400 and 875 BC. The age of the WA-4 rest channel is for stratigraphical reasons too old;[[1]](#footnote-1) probably displaced older organic material was dated.

The sand displacement of the older wash-over phase can be related to the breaching of the coastal barrier between Assum-Uitgeest and Heemskerk, which led to the formation of the main Oer-IJ tidal channel between Beverwijk-Heemskerk and the Assendelverpolders. The formation of dune phase B at the AW location might be related to the sand displacement of the upper wash-over layer of the Waldijk II location.

***<h1>Location: Uitgeest-Dorregeest (UD)***

*Table A2.4. 14C dates of ROB excavation Uitgeest-Dorregeest (UD) (De Jong, 1983; Westerhoff et al., 1987)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| UD-1 | GrN 11500 | | 109500 | 505800 | 1.70–1.80 | Oer-IJ tidal-channel deposits | *Scrobicularia plana,* bivalved | 2870 ± 70 | 776–410 BC | 450 BC\*\*  (605 BC) |
| UD-2 | GrN 11345 | | 109500 | 505800 | 2.63 | Oer-IJ tidal-channel deposits | *Scrobicularia plana,* bivalved | 2840 ± 60 | 761–406 BC | 500 BC\*\*  (570 BC) |
| UD-3 | GrN 11347 | | 109500 | 505800 | 2.63 | Oer-IJ tidal-channel deposits | *Cerastoderma edule* | 2770 ± 60 | 756–263 BC | 500 BC\*\*  (480 BC) |
| UD-4 | GrN 11348 | | 109500 | 505800 | 2.63 | Oer-IJ tidal-channel deposits | *Mytilus edule,* bivalved | 2810 ± 60 | 756–396 BC | 500 BC\*\*  (530 BC) |
| UD-5 | GrN 11428 | | 109500 | 505800 | 2.02–2.04 | Base Holland Peat on beach barrier deposits | Peat, bulk bivalved | 3950 ± 30 | 2568–2346 BC | 2465 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

\*\*Dates have a broad 2-sigma range and the estimated dates of the shells are placed in the active phase of the Oer-IJ (600–400 BC).

*Palaeolandscape implication*: The base of the peat layer on the western side of the coastal barrier of Uitgeest at a depth of around 2 m –NAP was dated at about 2465 BC. This indicates that at this time the seaward side of the barrier of Uitgeest was protected from the sea by beach sands and barriers.

The tidal channel cut through the barrier of Uitgeest-Dorregeest was in connection with the peat drainage system of the Stierop. The shell dates from the channel deposits indicate that the infill took place between 500 and 450 BC. Possibly the age is slightly younger due to the hard-water effect, comparable with the *Scrobicularia* date of the channel fill at the UK location (UK-2).

***<h1>Location: Akersloot Overdie (AO)***

*Table A2.5. 14C dates of borehole Akersloot Overdie (AO) (RGD Palaeobot. Rap. 1006; Westerhoff et al., 1987)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| AO-1 | GrN 11638 | | 110390 | 509120 | 1.83–1.86 | Base Holland Peat on beach sands, west of the coastal barrier of Uitgeest–Akersloot | Peat, bulk | 3525 ± 30 | 1936–1756 BC | 1840 BC |

*Palaeolandscape implication*: The date of the base of the peat layer indicates that the peat growth in the beach sand plain west of the coastal barrier Uitgeest-Dorregeest–Akersloot started around 1840 BC. The peat layer on the western barrier side at the UD location is somewhat older (UD-5; 2465 BC), which shows that the base of peat formation in this area is diachronous.

***<h1>Location: Klein Dorregeest (KD)***

Table *A2.6a. 14C dates of building pit Klein Dorregeest (KD) (Vos, 2007)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| KD-1  (Ia) | UtC 13592 | | 110250 | | 506975 | 0.79 | Organic layer in aeolian sand, top layer 22a | Peaty material, matrix | 2805 ± 34 | 1049–848 BC | 960 BC |
| KD-2  (Ib) | UtC 13593 | | 110250 | | 506975 | 0.96 | Organic layer in aeolian sand, base layer 22b | Peaty material, matrix | 3560 ± 39 | 2023–1772 BC | 1910 BC |
| KD-3  (Ic) | UtC 13594 | | 110250 | | 506975 | 1.18 | Holland Peat, base layer 22c on aeolian sand | Peat, matrix | 3710 ± 50 | 2278–1954 BC | 2100 BC |
| KD-4  (IIa) | UtC 13595 | | 110260 | | 507005 | 0.39 | Organic layer in aeolian sand, layer 22a (11) | Organic material in sand | 2646 ± 36 | 895–788 BC | 815 BC |
| KD-5  (IIb) | UtC 13596 | | 110260 | | 507005 | 0.59 | Organic layer in aeolian sand, layer 22b (9) | Organic material in sand | 3294 ± 36 | 1663–1498 BC | 1570 BC |
| KD-6  (IIc) | UtC 13597 | | 110260 | | 507005 | 0.74 | Organic layer in aeolian sand, layer 22b (6) | Peaty material, matrix | 3377 ± 40 | 1768–1534 BC | 1671 BC |
| KD-7  (IIIa) | UtC 13606 | | 110240 | | 506995 | 0.77 | Organic layer in aeolian sand, layer 22a(17) | Peaty material, matrix | 2680 ± 36 | 901–800 BC | 835 BC |
| KD -8  (IIIb) | UtC 13607 | | 110240 | | 506995 | 0.91 | Holland Peat, top layer 22c (6) | Peat, matrix | 3251 ± 37 | 1616–1443 BC | 1525 BC |
| KD -9  (IIIc) | UtC 13608 | | 110240 | | 506995 | 1.04 | Organic sand, base laag 22c (5a), below Holland Peat, on top aeolian sand | Peaty material, matrix | 3531 ± 36 | 1951–1751 BC | 1850 BC |

*Table A2.6b. OSL dates of building pit Klein Dorregeest (KD) (Vos, 2007)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Years AD/BC** | **Error band** | **Estimated**  **date** |
| KD-O1 | NCL 3305016 | | 110250 | 506975 | 1.70–1.80 | Aeolian layer 3a, below humus sand layer 23 | 1851 ± 212 BC | 1639–2063 BC | 2000 BC\*\* |
| KD-O2 | NCL 3305017 | | 110250 | 506975 | 1.18–1.28 | Top Aeolian layer 3a, below culture layer 25 | 1235 ± 179 BC | 1056–1414 BC | 2200 BC\*\* |

*Palaeolandscape implication*: The geoarchaeologically investigated construction pit Klein Dorregeest was located at the eastern side of the coastal barrier Uitgeest-Dorregeest–Akersloot. The organic layers on top of the east side of the barrier were dated on three locations in the profile (profile sites I, II and III). The dates show that at the lowest point the peat formation started at ±2100 BC (site I, KD-3). The youngest date of the uppermost organic layer is ±815 BC. The dates of the individual organic layers indicate that those at higher levels were formed later (site II) than at a lower level (site III), therefore the organic layers which wedged out to the barrier are diachronous.The culture layer with plough marks – below the organic layers 22 and 6 – contained pottery from the Bell Beaker Period (2300–1900 BC). The OSL dates KD-1 and 2 (profile site III) are too young. The 14C dates of the organic layers and archaeological dates of the culture layer indicate that the top of the coastal barrier deposits must have been formed before ±2200 BC. The coastal barrier of the UK location was formed between 3365 and 2530 BC, and the inner part of the barrier at the KD location probably has the same age.

***<h1>Location: Klein Dorregeest-Fielkerweg (KF)***

*Table A2.7. 14C dates of borehole Klein Dorregeest-Fielkerweg (KF) (Müller et al., 2008)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| KF-1  (core 8) | GrN 33094 | | 110255 | | 507105 | 1.14–1.34 | Upper clay infilling rest channel | Selected material, seeds | 930 ± 35 | 1023–1184 AD | 1100 AD |
| KF-2  (core 14) | GrN 33095 | | 110255 | | 507130 | 1.31–1.51 | Upper clay infilling rest channel | Selected material, seeds | 1275 ± 35 | 660–863 AD | 725 AD |
| KF-3  (core 21) | GrN 30344 | | 110315 | | 507065 | 1.40 | Top peat layer in channel depression barrier, top is erosive | Peat, bulk | 3330 ± 50 | 1742–1502 BC | 1615 BC |
| KF-4  (core 27) | GrN 30345 | | 110325 | | 507085 | 3.09 | Base peat layer in channel depression barrier | Peat, bulk | 4100 ± 70 | 2877–2491 BC | 2680 BC |

*Palaeolandscape implication*: About 100 m northeast of the construction pit Klein Dorregeest, a tributary of the main Oer-IJ channel cut through the barrier Uitgeest–Akersloot at a location where a depression in the barrier was present. 14C samples were taken from the peat layer south of the channel depression and from the upper channel clay fill (seeds). The peat formation on top of the barrier dune sand started around 2680 BC (KF-4; 3.09 m –NAP), more than 550 years earlier than at the eastern barrier side at the KD location (KD-3; 1.18 m –NAP). The top of the peat was eroded. The date of the top of the remaining peat only indicates that the peat in the depression was formed at least as early as 1615 BC. The seed dates show that the rest channel was filled during the medieval period.

*Table A2.8. 14C dates of AAC excavation Limmen-De Krocht (LK) (Vos, 2005)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| LK-1 | UtC 13591 | | ±107600 | | 508550 | -- | Charcoal from sacrifice deposit (WP 23) | Charcoal | 1186 ± 33 BP | 721–953 AD | 835 AD |
| LK-2 | UtC 13589 | | ±107600 | | 508550 | 1.39–1.40 | Top peat layer in dune sand (WP 18) | Peat, matrix | 3250 ± 60 BP | 1663–1414 BC | 1600 BC\*\*  (1530 BC) |
| LK-3  (M458 L2) | UtC 14035 | | ±107600 | | 508550 | 1.39–1.40 | Top peat layer in dune sand, selected plant material (control sample) | Peat, matrix | 3360 ± 60 BP | 1871–1502 BC | 1600 BC\*\*  (1650 BC) |
| LK-4 | UtC 13588 | | ±107600 | | 508550 | 1.52–1.53 | Base peat layer in dune sand (WP 18) | Peat, matrix | 3100 ± 60 BP | 1499–1217 BC | 1800 BC\*\*\*  (1350 BC) |
| LK-5 | UtC 13590 | | ±107600 | | 508550 | 1.30–1.34 | Oer-IJ sandy storm layer above peat layer (WP 18) | Juvenile *Spisula*, single valved | 2940 ± 50\* | 807–515 BC | 550 BC\*\*\*  (665 BC) |
| LK-6  (M143-I) | UtC 14033 | | ±107600 | | 508550 | 1.01 m | Top peat layer in dune sand (WP 1) | Peat, matrix | 2582 ± 49 BP | 836–541 BC | 765 BC |
| LK-7  (M144-II) | UtC 14034 | | ±107600 | | 508550 | 1.41 m | Base peat layer in dune sand (WP 1) | Peat, matrix | 3491 ± 40 BP | 1918–1694 BC | 1825 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

\*\*Mean value of the dates taken on the same depth.

\*\*\*Estimated date adapted for stratigraphical reasons.

*Palaeolandscape implication*: East of the coastal barrier of Limmen–Heiloo a relatively thick peat layer is found. At the LK location this layer is dated to between ±1825 and 765 BC (LK-6 and 7). The dune sand on top of the peat layer was formed after ±765 BC. The same peat layer was also dated at another location (WP 18) where the base of the peat layer was dated too young (LK-4). In addition, the top of the peat layer at this location (LK-2 and 3) is younger (±1600 BC) than the top at the WP 1 location (LK-7), possibly due to the disappearance of the top of the peat by oxidation (the peat layer is thinner at location WP 18).

The charcoal from a sacrifice place of the Early Mediaeval occupation – on top of windblown sands – dates around 835 AD, which implies that these sands were formed earlier.

***<h1>Location: Heilooërbos (HB)***

*Table A2.9. 14C dates of the site Heilooërbos (HB) (RGD Palaeobot. Rap. 1009; Westerhoff et al., 1987)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| HB-1 | GrN 10247 | | 110000 | 514250 | 1.65–1.67 | Base peat layer on top of aquatic deposits in beach plain | Peat, bulk | 3445 ± 50 | 1888–1637 BC | 1760 BC |

*Palaeolandscape implication*: East of the coastal barrier of Limmen–Heiloo the peat layer – below drifted dune sand – started to form at about 1760 BC. The age of HB-1 lies within the same time span as the LK-7 date (around 1825 BC). The top of the beach sands below was deposited in this area around 2375 BC (date HO-1).

***<h1>Location: Heiloo (HO)***

*Table A2.10. 14C dates of the site Heiloo (HO) (De Mulder & Bosch, 1982; Westerhoff et al., 1987)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| HO-1 | GrN 9042 | | 110250 | 513575 | 1.55–1.45 | Upper part of the beach sands | *Cerastoderma edule,* bivalved | 4280 ± 30\* | 2467–2236 BC | 2375 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: At this site, the top of the beach sands below the dune sands of the barrier of Limmen–Heiloo was dated at about 2375 BC.

***<h1>Location: Kooibrug (KB)***

*Table A2.11. 14C dates of Kooibrug (KB) (Beets et al., 1981; Westerhoff et al., 1987)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| KB-1 | GrN 10170 | | 109640 | 510600 | 3.50–2.70 | Beach sands | *Scrobicularia plana,* bivalved | 4590 ± 70\* | 2910–2578 BC | 2765 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: The upper part of the beach sands at this location is dated at about 2765 BC, which implies that the beach plain in the area between the barriers of Limmen–Heiloo and Uitgeest–Akersloot was formed around that time.

***<h1>Location: Nijenburger viaduct (NV)***

*Table A2.12. 14C dates of Nijenburger viaduct (NV) (Roep et al., 1979; Westerhoff et al., 1987)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| NV-1 | GrN 10169 | | 110660 | 513150 | 4.10–4.25 | Beach sands | *Cerastoderma edule,* bivalved | 4700 ± 40\* | 3023–2876 BC | 2915 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: The upper part of the beach sands at this location was dated at around 2915 BC, which implicies that the beach plain at this location is somewhat older than the more westerly located Kooibrug site (KB-1 date; about 2765 BC).

**Appendix A3 Dates from the dune area between Velsen and Egmond**

***<h1>Location: Heemskerk PWN (HP)***

*Table A3.1. 14C dates of building pit Heemskerk PWN (HP) (RGD Palaeobot. Rap. 995; Westerhoff et al., 1987; De Jong, 1987)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| HP-1 | GrN 12114 | | 103650 | 504950 | –0.14–0.16 | Stratified complex of humus sand and peat in dune sands | Clayey peat, bulk | 2250 ± 35 | 396–206 BC | 285 BC |
| HP-2 | GrN 10242 | | 103650 | 504950 | –0.37–0.39 | Base stratified complex of humus sand and peat, slightly clayey, on a thin layer of dune sands, on beach sands | Clayey peat, bulk | 2360 ± 40 | 731–368 BC | 445 BC |

*Palaeolandscape implication*: Two organic layers were dated at the base of a dune complex. The lowest sample HP-2 is slightly clayey, which indicates that there was still some marine contact (slufter-like environment). The date of the lower sample was ±445 BC and of the upper sample ±285 BC. These dates demonstrate that the dune formation at this location started at ±500 BC.

***<h1>Location: Castricum PWN (CP)***

*Table A3.2. 14C dates of water-infiltration pit Castricum PWN (CP) (Deelen & Schermer, 1963 (sample Jelgersma, 1962); RGD Palaeobot. Rap. 872; Westerhoff et al., 1987; De Jong, 1987)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | **I coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| CP-1 | GrN 8661 | | 102960 | 506040 | 1.55 | Beach sands, below Older Dune sands | *Cerastoderma edule,* bivalved | 2580 ± 35\* | 366–118 BC | 275 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: Northwest of the HP location bivalve *Cerastoderma edule* shells were sampled in aquatic beach sands. The date of these shells is ±275 BC. The shells belong to the beach deposits and not to the Oer-IJ tidal deposits[[2]](#footnote-2) since east of the CP location a coastal barrier was formed during the Early and Middle Iron Age (locations S5 and WRK).

The dates of the HP and CP locations show that the palaeocoastline during the Middle Iron Age was between these sites. Aeolian sands were present above NAP and an Early Medieval culture layer was found at 1.0–1.2 m +NAP.

***<h1>Location: Egmond-Watertoren (EW)***

*Table A3.3. 14C dates of borehole Egmond-Watertoren (EW) (Jelgersma, 1970; Westerhoff et al., 1987)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| EW-1 | GrN 5237 | | 103950 | 515200 | +3.93–3.98 | Thin peat layer on top of dune layer | Peat, bulk | 1090 ± 45 | 778–1025 AD | 950 AD |
| EW-2 | GrN 5214 | | 103950 | 515200 | –1.08–1.12 | Top intercalated peat layer in dune sands | Peat, bulk | 1300 ± 45 | 647–863 AD | 715 AD |
| EW-3 | GrN 5236 | | 103950 | 515200 | –1.22–1.28 | Base intercalated peat layer in dune sands | Peat, bulk | 1710 ± 60 | 138–527 AD | 325 AD |
| EW-4 | GrN 5084 | | 103950 | 515200 | –1.96–1.99 | Sandy peat layer on top of marine sands | Sandy peat, bulk | 2135 ± 50 | 358–45 BC | 175 BC |

*Palaeolandscape implication*: A peat layer, on top of aquatic marine sands, at the EW location was dated to around 175 BC. Jelgersma et al. (1970) and Zagwijn (1986) supposed that the marine sands below the peat layer form part of the Oer-IJ tidal deposits. This was one of the arguments to locate – wrongly – the mouth of the estuary between Castricum and Egmond. In the Older Dune sands above the depression, three peaty layers were dated to between 325 and 950 AD.

***<h1>Location: Middensluiseiland (ME)***

*Table A3.4a. 14C dates of the Hollandia trench survey Middensluiseiland (ME) (Vos et al., 2008)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m +NAP)** | **Stratigraphy** | **Dated material** | **14C-years BP** | **Probability 95% (2-S)** | **Estimated**  **date** |
| ME-1  (B29-23, P-24) | UtC 15051 | | 100798 | | 497987 | 4.62–4.61 | Layer I, soil in dune deposits | Humus sand | 763 ± 39 | 1191–1292 AD | 1255 AD |
| ME-2  (B15-16, P-12) | UtC 15047 | | 100718 | | 497984 | 4.20–4.19 | Layer I, soil in dune deposits | Humus sand | 933 ± 40 | 1021–1189 AD | 1100 AD |
| ME-3  (V6-365, P-3) | UtC 15059 | | 100550 | | 497923 | 3.65+ | Layer I, soil in dune deposits | Organic remains | 854 ± 39 | 1046–1264 AD | 1185 AD |
| ME-4  (V9-365, P-3) | UtC 15060 | | 100550 | | 497923 | 3.65+ | Layer I, soil in dune deposits | Root remains | 1079 ± 38 | 891–1021 AD | 965 AD |
| ME-5  (B30-42, P-24) | UtC 15052 | | 100803 | | 497987 | 3.03–3.02 | Layer II, soil in dune deposits | Humus sand | 1218 ± 41 | 682–937 AD | 805 AD |
| ME-6  (B30-42, P-24) | UtC 15048 | | 100722 | | 497984 | 3.36–3.35 | Layer II, soil in dune deposits | Humus sand | 1290 ± 43 | 652–863 AD | 720 AD |
| ME-7  (B31-28, P-24) | UtC 15053 | | 100801 | | 497987 | 2.47–2.46 | Layer II, Holland Peat in dune deposits | Sandy amorphous peat | 1269 ± 39 | 662–867 AD | 735 AD |
| ME-8  (B31-31, P-24) | UtC 15054 | | 100801 | | 497987 | 2.44–2.43 | Layer II, Holland Peat in dune deposits | Sandy amorphous peat. | 1260 ± 80 | 644–966 AD | 765 AD |
| ME-9  (B18-36, P-13) | UtC 15050 | | 100767 | | 497984 | 2.46–2.45 | Layer II, Holland Peat in dune deposits | Sandy amorphous peat | 1260 ± 80 | 644–966 AD | 765 AD |
| ME-10  (V1-HK, ±P-24) | UtC 15058 | | 100681 | | 497977 | 2.89+ | Layer II, soil in dune deposits | Charcoal | 1393 ± 41 | 571–687 AD | 640 AD |
| ME-11  (V23-18/I, P-19) | UtC 15103 | | 100798 | | 497978 | ±3.0+ | Layer II, soil in dune deposits | Oak tree ring 18 | 1366 ± 35 | 605–764 AD | 660 AD |
| ME-12  (V23-38/II, P-19) | UtC 15104 | | 100798 | | 497978 | ±3.0+ | Layer II, soil in dune deposits | Oak tree ring 38 | 1320 ± 43 | 650–769 AD | 690 AD |
| ME-13  (V23-58 /III, P-19) | UtC 15105 | | 100798 | | 497978 | ±3.0+ | Layer II, soil in dune deposits | Oak tree ring 54 | 1272 ± 35 | 661–863 AD | 730 AD |
| ME-14  (V26-41/IV, P-24) | UtC 15106 | | 100801 | | 497987 | ±3.0+ | Layer II, soil in dune deposits | Oak tree ring 41 | 1353 ± 35 | 620–766 AD | 665 AD |
| ME-15  (V22/V, P-24) | UtC 15107 | | 100720 | | 497984 | ±3.4+ | Layer II, soil in dune deposits | Selection of seeds | 1339 ± 43 | 625–770 AD | 680 AD |
| ME-16  (B17-28, P-12) | UtC 15049 | | 100738 | | 497984 | 2.62–2.61 | Layer IIa, Holland Peat in dune deposits | Sandy amorphous peat | 1445 ± 43 | 542–661 AD | 610 AD |
| ME-17  (B31-41, P-24) | UtC 15055 | | 100801 | | 497987 | 2.34–2.33 | Layer IIa, Holland Peat in dune deposits | Sandy amorphous peat | 1580 ± 70 | 333–630 AD | 480 AD |
| ME-18  (B34-32, P-20) | UtC 15056 | | 100897 | | 497973 | 2.90–2.89 | Layer IIa, Holland Peat in dune deposits | Sandy amorphous peat | 1552 ± 45 | 410–600 AD | 495 AD |
| ME-19  (B34-36, P-20) | UtC 15057 | | 100897 | | 497973 | 2.86–2.85 | Layer IIa, Holland Peat in dune deposits | Sandy amorphous peat | 1590 ± 50 | 352–580 AD | 475 AD |
| ME-20  (V33-MS, ±P-21) | UtC 15062 | | 100751 | | 497983 | 0.30+ | Top beach sands, direct under dune | *Macoma balthica.* bivalved | 2357 ±46\* | 39 BC–123 AD | 45 AD |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Table A3.4b. OSL dates of the Hollandia trench survey Middensluiseiland (ME) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m +NAP)** | **Stratigraphy** | **Years AD/BC** | **Error band** | **Estimated**  **date** |
| ME-O1  (OSL 37, P-24) | NCL 317104 | | 100791 | 497987 | + 4.75 | Younger Dune sand, on top of layer I | 1208 ± 37 AD | 1171–1245 AD | 1210 AD |
| ME-O2  (OSL 10, P-12) | NCL 317104 | | 100721 | 497983 | + 4.40 | Younger Dune sand, on top of layer I | 1119 ± 40 AD | 1079–1159 AD | 1120 AD |
| ME-O3  (OSL 38, P-24) | NCL 317104 | | 100791 | 497987 | + 4.37 | Younger Dune sand, below layer I | 1069 ± 40 AD | 1029–1109 AD | 1070 AD |
| ME-O4  (OSL 12, P-12) | NCL 317104 | | 100721 | 497983 | + 4.10 | Younger Dune sand, below layer I | 1022 ± 46 AD | 976–1068 AD | 1020 AD |
| ME-O5  (OSL 2, P-1) | NCL 317104 | | 100513 | 497901 | + 4.55 | Younger Dune sand, between layer Ia/Ib | 1067 ± 42 AD | 1025–1109 AD | 1065 AD |
| ME-O6  (OSL 3, P-1) | NCL 317104 | | 100513 | 497901 | + 3.80 | Younger Dune sand, below layer IB | 1264 ± 32 AD | 1232–1296 AD | 1265 AD |
| ME-O7  (OSL 2, P-12) | NCL 317104 | | 100721 | 497983 | + 3.50 | Older Dune sand, on top of layer IIa | 1064 ± 37 AD | 1026–1101 AD | 1065 AD |
| ME-O8  (OSL 13, P-12) | NCL 317104 | | 100721 | 497983 | + 3.60 | Older Dune sand, between layer IIa/IIb | 907 ± 44 AD | 863–951 AD | 905 AD |
| ME-O9  (OSL 36, P-24) | NCL 317104 | | 100791 | 497987 | + 4.30 | Older Dune sand, below layer II | 383 ± 60 AD | 323–443 AD | 385 AD |
| ME-O10  (OSL 14, P-12) | NCL 317104 | | 100721 | 497983 | + 2.75 | Older Dune sand, below layer IIb | 472 ± 61 AD | 411–533 AD | 470 AD |
| ME-O11  (OSL 27, P±21) | NCL 317104 | | 100815 | 497981 | + 1.33 | Base Older Dune sands | 518 ± 60 AD | 458–578 AD | 400 AD\*\*  (520 AD) |
| ME-O12  (OSL 28, P±21) | NCL 317104 | | 100815 | 497981 | + 0.55 | Transition beach and Older Dune sands | 323 ± 108 AD | 215–431 AD | 325 AD |

*Palaeolandscape implication*: The top-of-beach sands at the base of the profile section were dated using a Macoma balthica shell to ±30 BC. The lower dune sands between the beach sands and the main organic layer II were dated with both the OSL- and 14C-method to between ± 300 and 480 AD. The dates of the organic layer II in the Older Dune deposits range between 480 and 805 AD, and most dates fall in the period between 610 and 765 AD. The archaeological traces (plough marks and cow footprints in the soft organic layers) are from that age. An abrasion contact separates the Older from the Younger Dune sands. The OSL and 14C dates of soil horizons in the Younger Dunes indicate that these sands were formed after ±965 AD.

***<h1>Location: Secundair L (SL)***

*Table A3.5a. 14C dates of the PWN building pit Secundair L (SL) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| SL-1  (V1) | UtC 11883 | | 103290 | | 510675 | +2.40 | Peaty soil in dune sands | Amorphous peaty sand, matrix | 1420 ± 38 | 566–665 AD | 625 AD |
| SL-2  (S1) | UtC 11919 | | 103290 | | 510675 | –1.00 | Shell layer, in top of beach sands | Marine shell, single valve | 3180 ± 42\* | 1026–827 BC | 930 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Table A3.5b. OSL dates of the PWN building pit Secundair L (SL) in PWN dune area (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m +NAP)** | **Stratigraphy** | **Years AD/BC** | **Error band** | **Estimated**  **date** |
| SL-O1  (OSL 1) | NCL 303016 | | 103290 | 510675 | +2.40 | Dune sand on top of peaty soil | 976 ± 79 AD | 897–1055 AD | 975 AD |
| SL-O2  (OSL 3) | NCL 303007 | | 103290 | 510675 | +0.70 | Dune sand between humus soil and beach sands | 239 ± 136 BC | 375–103 BC | 240 BC |

*Palaeolandscape implication*: The OSL and 14C dates indicate that the transition of the beach sand to the Older Dune sand deposition took place before about 240 BC (SL-O2). This implies that at this location the Older Dunes were formed around 250 BC. The two organic layer complexes in the Older Dunes were formed around 250 and 650 AD, and the Younger Dunes were deposited after ±975 AD.

***<h1>Location: Secundair E (SE)***

*Table A3.6a. 14C dates of the PWN building pit Secundair E (SE) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| SE-1  (V1) | UtC 11882 | | 103490 | | 509775 | +1.20 | Peaty soil in dune sands | Amorphous peaty sand, matrix | 1588 ± 35 | 398–548 AD | 480 AD |
| SE-2  (S1) | UtC 11881 | | 103490 | | 509775 | –0.90 | Shell layer, in top of beach sands | Marine shell, single valve | 3018 ± 35\* | 889–764 BC | 800 BC |

.

*Table A3.6b. OSL dates building pit Secundair E (SE) in PWN dune area (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m NAP)** | **Stratigraphy** | **Years AD/BC** | **Error band** | **Estimated**  **date** |
| SE-O1  (OSL2) | NCL 303009 | | 103490 | 509775 | +3.60 | Dune sand between humus soil and humus, peaty depression | 957 ± 60 AD | 897–1017 AD | 955 AD |
| SE-O2  (OSL1) | NCL 303008 | | 103490 | 507795 | +0.70 | Dune sands between humus, peaty depression and beach sands | 411 ± 145 BC | 266–556 BC | 410 BC |

*Palaeolandscape implication:* The OSL date at the base of the Older Dune indicates that the transition of beach sand to dune sand deposition took place before about 410 BC (SE-O2). This implies that the Older Dunes at this location were probably formed around 450 BC, about 200 years earlier than those at the more northwesterly situated SL location.

In the pit a large dune valley was present and the organic fill was dated at about 480 AD. The archaeological material found in this depression dates from the Early Middle Ages (6th up to the beginning of the 8th century). The Younger Dunes were formed from about 955 AD onwards.

***<h1>Location: Secundair D (SD)***

*Table A3.7a. 14C dates of the PWN building pit Secundair D (SD) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| SD-1  (S1) | UtC 12028 | | 103040 | | 508970 | 1.85 | Shell layer, in upper part of beach sands | Marine shell, single valve | 2767 ± 37\* | 729–381 | 380 BC\*\*  (450 BC) |
| SD-2  (S2) | UtC 11884 | | 103040 | | 508970 | 2.20 | Shell layer, in upper part of beach sands | Marine shell, single valve | 2702 ± 37\* | 413–209 | 380 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

\*\*Mean value of the lowest and youngest date.

*Table A3.7b. OSL dates building pit Secundair D (SD) in PWN dune area (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m NAP)** | **Stratigraphy** | **Years AD/BC** | **Error band** | **Estimated**  **date** |
| SD-O1  (OSL1) | NCL 303010 | | 103040 | 508970 | +2.70 | Dune sand on top of highest humus soil (layer 1) | 811 ± 70 AD | 741–881 AD | 810 AD |
| SD-O2  (OSL2) | NCL 303015 | | 103040 | 508970 | +2.15 | Dune sand below highest humus soil (layer 3) | 620 ± 78 AD | 542–698 AD | 620 AD |
| SD-O3  (OSL4) | NCL 303001 | | 103040 | 508970 | +0.40 | Dune sand below lowest humus soil and beach sands (layer 9c) | 202 ± 78 AD | 86–228 AD | 200 AD |

*Palaeolandscape implication*: The upper part of the beach sand has a shell date of ±475 BC (SD-1 and 2) and the base of the Older Dune sand a date of ±200 AD (SD-O3). The transition from the deposition of beach to dune sands at this location is estimated to have occurred in the first century AD. The organic layer complex (layers 6 to 9) likely was formed in the period 250–500 AD. The OSL date of the sands at 2.7 m +NAP, 810 ± 70 AD, is ‘old’ for sands classified as Younger Dunes.

***<h1>Location: Pompstation (SP)***

*Table A3.8. 14C dates of the PWN building pit Pompstation (SP) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | **I coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| SP-1  (V2) | UtC 11887 | | 104060 | | 507740 | –0.5 | Peaty soil in dune sands | Amorphous peaty sand, matrix | 1343 ± 36 BP | 636–769 AD | 675 AD |
| SP-2  (S2) | UtC 11886 | | 104060 | | 507740 | –1.00 | Shell layer, in top of beach sands | Marine shell, single valve | 2774 ± 42\* | 743–378 | 350 BC\*\*  (465 BC) |
| SP-3  (S1) | UtC 11885 | | 104060 | | 507740 | –1.45 | Shell layer, upper part beach sands | Marine shell, single valve | 2678 ± 37\* | 404–209 | 350 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

\*\*The estimated value of date SP-3 was taken.

*Palaeolandscape implication*: Shells of the wash-over deposits were dated to ±425 BC (SP-3). It cannot be excluded that these shells consist of older reworked material, as found on the CZ location. OSL dates to check the shell dates were not available, therefore the wash-over deposits might have a younger age than indicated by the shell dates. It is possible that the wash-over events of SP and CZ are mutually related. The base of the organic material on top of the wash-over layer is relatively young, ±675 AD (SP-1).

***<h1>Location: Secundair G (SG)***

*Table A3.9a. 14C dates of the PWN building pit Secundair G (SG) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| SG-1  (V2) | UtC 11896 | | 103630 | | 506620 | +0.78 | Peaty soil in dune sands | Amorphous peaty sand, matrix | 1679 ± 38 | 250–428 AD | 365 AD |
| SG-2  (S1) | UtC 11897 | | 103630 | | 506620 | –0.94 | Shell layer, in top of beach sands | Marine shell, single valve | 3034 ± 29\* | 841–780 BC | 805 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Table A3.9b. OSL dates of the PWN building pit in Secundair G (SG) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m NAP)** | **Stratigraphy** | **Years AD/BC** | **Error band** | **Estimated**  **date** |
| SG-O1  (OSL3) | NCL 303014 | | 103630 | 506620 | +2.05 m | Dune sand (layer 3) below humus soil | 998 ± 56 AD | 942–1054 AD | 1000 AD |
| SG-O2  (OSL1) | NCL 303013 | | 103630 | 506620 | –0.45 m | Dune sand (layer 9c) between humus soil and beach sands | 365 ± 163 BC | 528–202 BC | 365 BC |

*Palaeolandscape implication*: The base of the dune sands was dated – with the OSL method – to around 365 BC (SG-O2). This date indicates that in the Middle Iron Age the southern side of the Oer-IJ mouth had already been closed by a barrier system (beach sands and dunes). A single-valved shell layer **at** 40 cm below the base of the dune sands was dated ±850 BC (SG-2). These shells might be reworked and older than the shell layer in the beach sands, therefore it cannot be excluded that the shell layer is somewhat younger than indicated by the 14C age. Pottery shards from the lowest culture layer 3 were dated to the Late Iron Age/Early Roman Period. A humus soil (layer 9) above was dated at around 365 AD and the base of the Younger Dune sand on top of the complex of organic and Older Dune layers was dated at around 1000 AD.

***<h1>Location: WRK building (WRK)***

*Table A3.10a. 14C dates of the PWN building pit WRK (WRK) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| WRK-1  (V9) | UtC 11896 | | 103620 | | 505040 | +2.85 | Humus soil in dune sands, layer 13 | Humus sand, matrix | 1046 ± 39 | 892–1039 AD | 995 AD |
| WRK-2  (V8) | UtC 11897 | | 103620 | | 505040 | +2.40 | Humus soil in dune sands, layer 11 | Humus sand, matrix | 1226 ± 36 | 688–886 AD | 795 AD |
| WRK-3  (V6) | UtC 11898 | | 103620 | | 505040 | +2.10 | Peaty soil in dune sands, layer 9e | Amorphous peaty sand, matrix | 1454 ± 35 | 551–652 AD | 605 AD |
| WRK-4  (V2) | UtC 11899 | | 103620 | | 505040 | +0.70 | Humus soil in lower part dune sands, layer 5c | Humus sand, matrix | 2243 ± 43 | 394–203 BC | 285 BC |
| WRK-5  (S2) | UtC 11895 | | 103620 | | 505040 | 0 | Shell layer, in top of beach sands, layer 3 | Marine shell, single valve | 3860 ± 36\* | 1884–1689 BC | 825 BC\*\*  (1780 BC) |
| WRK-6  (S1) | UtC 11894 | | 103620 | | 505040 | –1.30 | Shell layer, in upper part of beach sands, layer 1 | Marine shell, single valve | 3060 ± 38\* | 897–794 BC | 825 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

\*\*Estimated dates adapted for stratigraphical reasons.

*Table A3.10b. OSL – dates of the PWN building pit WRK (WRK) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m NAP)** | **Stratigraphy** | **Years AD/BC** | **Error band** | **Estimated**  **date** |
| WRK-O1  (OSL1) | NCL 303004 | | 103620 | 505040 | +4.35 | Younger Dune sands, basal part, layer 15 | 1275 ± 44 AD | 1231–1319 AD | 1275 AD |
| WRK-O2  (OSL2) | NCL 303005 | | 103620 | 505040 | +1.70 | Older Dunes sands, layer 8 | 146 ± 128 AD | 18–274 AD | 145 AD |
| WRK-O3  (OSL4) | NCL 303006 | | 103620 | 505040 | –0.10 | Beach sands, upper part, layer 3 | 250 ± 146 BC | 396–104 BC | 300 BC |

*Palaeolandscape implication*: The top of the beach sand was dated – with the OSL method – to around 300 BC. The culture layer (5) above – in the lowest part of the dune sands – was dated with the 14C method to around 285 BC. This beach/dune sand sequence is comparable, in age and depth, with the one found at the SG location. Both locations demonstrate that a coastal barrier was formed in the southern part of the Oer-IJ Inlet and partly closed this system from the open sea at that time. The 14C dates of the shell layers (around 875 BC) are probably too old because reworked shells were dated. The uppermost shell sample (WRK-5) is certainly too old because it is older than the shell date below (WRK-6).

In the Older Dune sequence archaeological material and traces were found in several humus and peaty soils. This complex (layers 3 up to 13) was dated to between 285 BC up to 995 AD. The lower part of the Younger Dunes (layer 15) was dated – with the OSL method – at around 1275 AD.

The organic layers in the dune sand contain archaeological indicators. In culture layer 5, pottery shards were found and dated to the late Iron Age/Early Roman Period. Layers 7 and 9, with plough marks, date from the 2th and 7th centuries AD.

***<h1>Location: Secundair 5 (S5)***

*Table A3.11a. 14C dates of the PWN building pit Secundair 5 (S5) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| S5-1  (V7) | UtC 11893 | | 103650 | | 504130 | +2.25 m | Peaty soil in dune sands, layer 8a | Amorphous peaty sand, matrix | 1067 ± 48 | 778–1118 AD | 970 AD |
| S5-2  (V1) | UtC 11892 | | 103650 | | 504130 | +0.75 m | Humus soil in lower part dune sands, layer 6a | Humus sand, matrix | 2296 ± 34 | 409–211 BC | 375 BC |
| S5-3  (S1) | UtC 11891 | | 103650 | | 504130 | –0.60 m | Shell layer, in top of beach sands, layer 1 | Marine shell, single valve | 3060 ± 41\* | 902–792 BC | 825 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Table A3.11b. OSL dates the PWN building pit Secundair 5 (S5) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m NAP)** | **Stratigraphy** | **Years AD/BC** | **Error band** | **Estimated**  **date** |
| S5-O1  (OSL2) | NCL 303012 | | 103650 | 504130 | +2.70 m | Top Older Dunes sands, layer 9 | 708 ± 73 AD | 630–781 AD | 710 AD |
| S5-O2  (OSL1) | NCL 303011 | | 103650 | 504130 | +0.30 m | Base Older Dunes sands, layer 3 | 477 ± 157 BC | 634–320 BC | 475 BC |

*Palaeolandscape implication*: The lowest part of the dune sands was dated with the OSL and 14C methods. The dates are ±475 BC (layer 3; S5-O2) and ±375 BC (layer 6; S5-2). In the upper part of the beach sands a single-valved shell layer was dated at ±875 BC (S5-3), but it might be younger (between ±875 and 475 BC) since it is possible reworked shell material was dated. In 600–500 BC this location formed the southern beach side of the Oer-IJ inlet. Between 500 and 350 BC the coastal barrier and dunes migrated from this area northward up to the SG location.

Also in the profile of the S5 pit, several humus and peaty soil layers occur between the aeolian Older Dune phases. Two layers contained archaeological indicators. In layer 6, pottery shards were found dating from the Middle Iron Age. Layer 8, a ploughed culture layer without shards, was 14C dated to the 10th century.

***<h1>Location: Secundair 3 (S3)***

*Table A3.12a. 14C dates of the PWN building pit Secundair 3 (S3) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| S3-1  (S1) | UtC 11881 | | 102060 | | 503970 | 1.15 m | Shell layer, in top of beach sands, layer 1 | Marine shell, single valve | 2564 ± 38\* | 361–101 BC | 230 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect)*.*

*Table A3.12b. OSL – dates the PWN building pit Secundair 3 (S3) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m NAP)** | **Stratigraphy** | **Years AD/BC** | **Error band** | **Estimated**  **date** |
| S3-O1  (OSL2) | NCL 303003 | | 102060 | 503970 | +2.95 | Upper part Older Dunes sands, layer 4 | 374 ± 94 AD | 280–468 AD | 375 AD |
| S3-O2  (OSL1) | NCL 303002 | | 102060 | 503970 | +0.80 | Base Older Dunes sands, layer 4 | 338 ± 107 AD | 231–445 AD | 340 AD |

*Palaeolandscape implication*: A single-valved shell layer, more than 1 m below the dune sands, was dated with the 14C method at about 285 BC. The sands of the Older Dunes were dated with the OSL method. The basal part of the dunes has a date of about 340 AD and the upper part of the investigated dune profile a date of about 375 AD. The large-scale cross-bedding and the absence of soil layers gives these dunes the character of the Younger Dunes. The S3 dates indicate that around the birth of Christ the coastline (boundary beach–dune area) was lying close to this location.

***<h1>Location: 19C0947 (B47)***

*Table A3.13. 14C dates of the PWN borehole 19C0947 (B47) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| B47-1 | UtC 12094 | | 103482 | | 509758 | 1.61 | Shells, in beach sands | Marine shell, single valve | 3583 ± 35\* | 1527–1400 BC | 1460 BC |
| B47-2 | UtC 12095 | | 103482 | | 509758 | 5.58 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3601 ± 40\* | 1607–1406 BC | 1475 BC |
| B47-3 | UtC 12096 | | 103482 | | 509758 | 8.41 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3458 ± 33\* | 1410–1228BC | 1325 BC |
| B47-4 | UtC 12097 | | 103482 | | 509758 | 11.54 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3989 ± 38\* | 2113–1781 BC | 1945 BC |
| B47-5 | UtC 12098 | | 103482 | | 509758 | 14.39 | *Spisula* sands, offshore deposits | Marine shell, single valve | 4307 ± 48\* | 2561–2211 BC | 2390 BC |
| B47-6 | UtC 12099 | | 103482 | | 509758 | 18.41 | *Spisula* sands, offshore deposits | Marine shell, single valve | 5064 ± 45\* | 3627–3359 BC | 3455 BC |
| B47-7 | UtC 12100 | | 103482 | | 509758 | 20.41 | *Spisula* sands, offshore deposits | Marine shell, single valve | 5284 ± 44\* | 3771–3539 BC | 3675 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: The fill of the Oer-IJ inlet system at borehole location 19C0947 was dated using juvenile *Spisula* shells. The sediments between 20.41 and 8.41 m –NAP provided a good time–depth sequence between ±3695 and 1390 BC. The upper two samples, between 5.58 and 1.61 m –NAP, however, do not fit in this time–depth sequence because they are older than the shell date below (at 8.41 m –NAP). This phenomenon is observed in many shallow subtidal, beach and wash-over deposits, and is due to reworking of older material.

The dates of the SE location indicate that the Older Dune formation at this site started about 450 BC. This implies that the northern coastline of the Oer-IJ inlet was located here around 500 BC.

***<h1>Location: 19C0946 (B46)***

*Table A3.14. 14C dates of the PWN borehole 19C0946 (B46) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| B46-1 | UtC 12028 | | 103029 | | 509002 | –1.85 | Shells, in beach sands | Marine shell, single valve | 2767 ± 41\* | 734–375 BC | 455 BC |
| B46-2 | UtC 12029 | | 103029 | | 509002 | –4.93 | *Spisula* sands, offshore deposits | Marine shell, single valve | 2775 ± 34\* | 728–389 BC | 455 BC |
| B46-3 | UtC 12030 | | 103029 | | 509002 | –7.83 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3405 ± 35\* | 1387–1124 BC | 1245 BC |
| B46-4 | UtC 12031 | | 103029 | | 509002 | –10.01 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3525 ± 34\* | 1494–1291 BC | 1395 BC |
| B46-5 | UtC 12032 | | 103029 | | 509002 | –15.77 | *Spisula* sands, offshore deposits | Marine shell, single valve | 4870 ± 40\* | 3346–3022 BC | 3195 BC |
| B46-6 | UtC 12033 | | 103029 | | 509002 | –18.96 | *Spisula* sands, offshore deposits | Marine shell, single valve | 5422 ± 38\* | 3944–3710 BC | 3830 BC |
| B46-7 | UtC 12034 | | 103029 | | 509002 | –19.61 | *Spisula* sands, offshore deposits | Marine shell, single valve | 5210 ± 37\* | 3657–3520 BC | 3570 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: The fill of the Oer-IJ inlet system at borehole location 19C0946 was dated on the basis of juvenile *Spisula* shells. The sediments gave a reliable time–depth sequence, between 19.61 and 4.93 m –NAP, from ±3625 BC to 560 BC. The date of ±545 BC of the highest beach sand sample at 1.85 m –NAP is unsure. The date of the coastline – between the beach and dune sands – at the nearby SD location is estimated to fall in the first century AD.

***<h1>Location: 19C0960 (B60)***

*Table A3.15. 14C dates of the PWN borehole 19C0960 (B60) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| B60-1 | UtC 13055 | | 103701 | | 508374 | –0.75 | Shells, in beach sands | Marine shell, single valve | 3022 ± 30\* | 832–776 BC | 805 BC |
| B60-2 | UtC 13056 | | 103701 | | 508374 | –1.12 | Shells, in beach sands | Marine shell, single valve | 2628 ± 32\* | 383–204 BC | 280 BC |
| B60-3 | UtC 13057 | | 103701 | | 508374 | –2.66 | Shell layer, in beach sands | Marine shell, single valve | 2788± 30\* | 728–396 BC | 460 BC |
| B60-4 | UtC 13059 | | 103701 | | 508374 | –3.33 | *Spisula* sands, offshore deposits | Marine shell, single valve | 2781 ± 30\* | 727–393 BC | 455 BC |
| B60-5 | UtC 13060 | | 103701 | | 508374 | –10.69 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3801 ± 36\* | 1869–1615 BC | 1700 BC |
| B60-6 | UtC 13061 | | 103701 | | 508374 | –20.14 | Wormer Member, tidal deposits | Marine shell, single valve | 6200 ± 35\* | 4727–4546 BC | 4650 BC |
| B60-7 | UtC 13062 | | 103701 | | 508374 | –24.33 | Wormer Member, tidal deposits | Marine shell, single valve | 6122 ± 34\* | 4684–4466 BC | 4565 BC |
| B60-8 | UtC 13063 | | 103701 | | 508374 | –29.49 | Wormer Member, tidal deposits | Marine shell, single valve | 6984 ± 38\* | 5616–5479 BC | 5530 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: The deepest marine shell samples at borehole location 19C0960 were derived from older tidal deposits of the Wormer Member. The 14C dates indicate that this member, at a depth of 29.49–20.14 m –NAP, was formed between ±5535 and 4695 BC.

The fill of the Oer-IJ inlet system was dated with juvenile *Spisula* shells. The sediments between 10.69 and 1.12 m –NAP gave a reliable time–depth sequence. The dates range from ±1800 BC up to 365 BC. This means that at this location the Oer-IJ inlet became very shallow around 400–350 BC and that a beach evolved. Also for this drilling the date of the highest shell sample, ±840 BC at 0.75 m –NAP, is unreliable because the shell material has possibly been reworked.

***<h1>Location: 19C0941 (B41)***

*Table A3.16. 14C dates of the PWN borehole 19C0941 (B41) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| B41-1 | UtC 11993 | | 103730 | | 507795 | –0.61 | Shells, in beach sands | Marine shell, single valve | 2543 ± 35\* | 356–54 BC | 185 BC |
| B41-2 | UtC 11994 | | 103730 | | 507795 | –4.07 | *Spisula* sands, offshore deposits | Marine shell, single valve | 2610 ± 37\* | 382–192 BC | 280 BC |
| B41-3 | UtC 11995 | | 103730 | | 507795 | –7.03 | *Spisula* sands, offshore deposits | Marine shell, single valve | 2918 ± 35\* | 1216–1011 BC | 1110 BC |
| B41-4 | UtC 11996 | | 103730 | | 507795 | –11.05 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3050 ± 35\* | 1409–1219 BC | 1310 BC |
| B41-5 | UtC 11997 | | 103730 | | 507795 | –13.86 | *Spisula* sands, offshore deposits | Marine shell, single valve | 4399 ± 40\* | 2830–2356 BC | 2530 BC |
| B41-6 | UtC 11998 | | 103730 | | 507795 | –16.05 | *Spisula* sands, offshore deposits | Marine shell, single valve | 5091 ± 46\* | 3631–3367 BC | 3465 BC |
| B41-7 | UtC 11999 | | 103730 | | 507795 | –17.49 | *Spisula* sands, offshore deposits | Marine shell, single valve | 5244 ± 46\* | 3711–3521 BC | 3640 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: The fill of the Oer-IJ inlet system at borehole location 19C0941 was dated using juvenile *Spisula* shells. The sediments gave a reliable time–depth sequence between 17.49 and 0.61 m –NAP. The dates range from ±3660 BC to 270 BC. The uppermost shell sample indicates that between 300 and 250 BC the inlet environment changed into a beach plain.

***<h1>Location: 19C0942 (B42)***

*Table A3.17. 14C dates of the PWN borehole 19C0942 (B42) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| B 42-1 | UtC 12000 | | 103750 | | 507100 | –0.80 | Soil in dune sands | Humus sand, bulk | 1436 ± 32 | 568–656 AD | 620 AD |
| B42-2 | UtC 12001 | | 103750 | | 507100 | –4.08 | *Spisula* sands, offshore deposits | Marine shell, single valve | 2948 ± 34\* | 803–546 BC | 695 BC |
| B42-3 | UtC 12002 | | 103750 | | 507100 | –7.88 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3575 ± 43\* | 1595–1306 BC | 1450 BC |
| B42-4 | UtC 12003 | | 103750 | | 507100 | –8.90 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3139 ± 48\* | 996–808 BC | 885 BC |
| B42-5 | UtC 12004 | | 103750 | | 507100 | –10.85 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3087 ± 35\* | 904–801 BC | 840 BC |
| B42-6 | UtC 12005 | | 103750 | | 507100 | –16.90 | *Spisula* sands, offshore deposits | Marine shell, single valve | 5076 ± 44\* | 3629–3363 BC | 3455 BC |
| B42-7 | UtC 12006 | | 103750 | | 507100 | –18.05 | Tidal deposits of the Wormer Member | Marine shell, single valve | 5712 ± 39\* | 4259–4002 BC | 4140 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: The fill of the Oer-IJ inlet system at borehole location 19C0942 was dated using juvenile *Spisula* shells. The samples at a depth between 16.90 and 4.08 m –NAP gave a range from ±3485 BC to 780 BC. The shell date (±1515 BC) at a depth of 7.88 m –NAP is an outlier in the time–depth sequence. The lowest shell sample at 18.05 m –NAP is from the Wormer tidal deposits and was dated to around 4180 BC. The base of the dune sands at a depth of 0.45 m –NAP in the nearby southern SG location was dated around 365 BC (SG-O2). The humic dune soil at a depth of 0.80 m –NAP was dated at ±620 AD, which indicates that at the location of this borehole a depression was present and that the fill of the depression is relatively young.

***<h1>Location: 19C0943 (B43)***

*Table A3.18. 14C dates of the PWN borehole**19C0943 (B43) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| B 943-1 | B 943/–1 | | 103678 | | 505915 | 1.34 | Shells, in beach sands | Marine shell, single valve | 3025 ± 42\* | 900–674 BC | 805 BC |
| B 943-2 | B 943/–2 | | 103678 | | 505915 | –1.59 | Shells, in beach sands | Marine shell, single valve | 3094 ± 34\* | 906–803 BC | 845 BC |
| B 943-3 | B 943/–3 | | 103678 | | 505915 | –2.39 | Shells, in beach sands | Marine shell, single valve | 3009 ± 33\* | 836–761 BC | 800 BC |
| B 943-4 | B 943/–4 | | 103678 | | 505915 | –7.52 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3531 ± 39\* | 1497–1295 BC | 1405 BC |
| B 943-5 | B 943/–5 | | 103678 | | 505915 | –13.66 | *Spisula* sands, offshore deposits | Marine shell, single valve | 4750 ± 35\* | 3086–2896 BC | 2970 BC |
| B 943-6 | B 943/–6 | | 103678 | | 505915 | –16.16 | *Spisula* sands, offshore deposits | Marine shell, single valve | 5334 ± 41\* | 3791–3645 BC | 3710 BC |
| B 943-7 | B 943/–7 | | 103678 | | 505915 | –20.43 | Wormer Member, tidal deposits | Marine shell, single valve | 7322 ± 48\* | 5967–5718 BC | 5805 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: The fill of the Oer-IJ inlet system at borehole location 19C0943 was dated on the basis of juvenile *Spisula* shells from 16.16 m to 2.39 m –NAP. The dates range from ±3740 BC to 830 BC. The uppermost shell dates (±915 BC and 845 BC) are too old for the beach deposits in this area, since close to the SG and WRK locations the transition between beach sand and dune sands was dated at around 350 BC.

***<h1>Location: 19C0944 (B44)***

*Table A3.19. 14C dates of the PWN borehole 19C0944 (B44) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| B44-1 | UtC 12014 | | 103580 | | 505076 | –0. 77 | Shells, in beach sands | Marine shell, single valve | 3491 ± 35\* | 1431–1264 BC | 1345 BC |
| B44-2 | UtC 12015 | | 103580 | | 505076 | –2.82 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3016 ± 40\* | 895–595 BC | 800 BC |
| B44-3 | UtC 12016 | | 103580 | | 505076 | –5.40 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3346 ± 35\* | 1262–1042 BC | 1155 BC |
| B44-4 | UtC 12017 | | 103580 | | 505076 | –10.87 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3596 ± 37\* | 1600–1402 BC | 1470 BC |
| B44-5 | UtC 12018 | | 103580 | | 505076 | –14.87 | *Spisula* sands, offshore deposits | Marine shell, single valve | 4826 ± 38\* | 3329–2921 BC | 3065 BC |
| B44-6 | UtC 12019 | | 103580 | | 505076 | –15.35 | *Spisula* sands, offshore deposits | Marine shell, single valve | 5089 ± 39\* | 3629–3368 BC | 3455 BC |
| B44-7 | UtC 12020 | | 103580 | | 505076 | –15.87 | *Spisula* sands, offshore deposits | Marine shell, single valve | 5100 ± 36\* | 3631–3371 BC | 3460 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: The fill of the Oer-IJ inlet system at borehole location 19C0944 between 15.87 and 2.82 m –NAP was dated using juvenile *Spisula* shells. The dates range from ±3520 BC to 835 BC. Also in these boreholes, the measured ages of the uppermost shells in the beach sands (±875 BC and 1425 BC) are too old, since at the nearby WRK location the transition between beach sand and dune sands was dated at about 350 BC.

***<h1>Location: 19C0945 (B45)***

*Table A3.20. 14C dates of the PWN borehole 19C0945 (B45) (Vos et al., 2010)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| B45-1 | UtC 12021 | | 103662 | | 504170 | 5.12 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3116 ± 36\* | 926–806 BC | 865 BC |
| B45-2 | UtC 12022 | | 103662 | | 504170 | 6.92 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3311 ± 43\* | 1230–976 BC | 1100 BC |
| B45-3 | UtC 12023 | | 103662 | | 504170 | 10.92 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3377 ± 44\* | 1379–1051 BC | 1200 BC |
| B45-4 | UtC 12024 | | 103662 | | 504170 | 11.77 | *Spisula* sands, offshore deposits | Marine shell, single valve | 3589 ± 34\* | 1528–1408 BC | 1465 BC |
| B45-5 | UtC 12025 | | 103662 | | 504170 | 17.04 | *Spisula* sands, offshore deposits | Marine shell, single valve | 5089 ± 39\* | 3629–3368 BC | 3455 BC |
| B45-6 | UtC 12026 | | 103662 | | 504170 | 21.77 | Wormer Member, Layer of Velsen | Plant remain, root | 7866 ± 47 | 7023–6598 BC | 6720 BC |
| B45-7 | UtC 12027 | | 103662 | | 504170 | 23.40 | Base Basal Peat | Peat, matrix | 8461 ± 46 | 7589–7471 BC | 7535 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: The fill of the Oer-IJ inlet system at borehole location 19C0945 was dated, using juvenile *Spisula* shells from a depth of 17.04–5.12 m –NAP, between ±3505 BC and 940 BC. The uppermost shell date, from 0.6 m –NAP (± 850 BC), is too old for beach deposition, since in the nearby S5 the transition between beach sand and dune sands was dated to between 600 and 500 BC.

In the lowermost two samples of the borehole, organic material from the Basal Peat and Velsen Layer was dated. These dates indicate that the Basal Peat started ±7535 BC at a depth of 23.4 m –NAP and that the humic Velsen Layer above was formed around 6720 BC.

***<h1>Location: Velsen-Hoogovens II (HII)***

*Table A3.21a. 14C dates of the building pit Velsen-Hoogovens II (HII) (Jelgersma et al., 1970)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m +NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| HII-1 | GrN 4563 | | ±103255 | | 499315 | 5.65–5.67 | Peaty soil in Younger Dune sands | Peat, bulk | 940 ± 45 | 1018–1204 AD | 1100 AD |
| HII-2 | GrN 4480 | | ±103255 | | 499315 | 4.41–4.44 | Peaty soil in Younger Dunes sands | Peat, bulk | 1010 ± 45 | 901–1155 AD | 1025 AD |
| HII-3 | GrN 4481 | | ±103255 | | 499315 | 2.10–2.15 | Peaty soil in Older Dunes sands | Peat, sandy, bulk | 2130 ± 50 | 358–42 BC | 165 BC |

***<h1>Location: Velsen-Hoogovens III (HIII)***

*Table A3.21b. 14C dates of the building pit Velsen-Hoogovens III (HIII) (Jelgersma et al., 1970)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m +NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| HIII-1 | GrN 4118 | | ± 103155 | | 499180 | +5.6 | Humic soil, in upper part Older Dune ands | Mesotrophic peat, sandy, bulk | 810 ± 70 | 1040–1291 AD | 1210 AD |
| HIII-2 | GrN 4561 | | ± 103155 | | 499180 | +3.75 | Humic soil in Older Dunes sands | Mesotrophic peat, sandy, bulk | 1370 ± 70 | 539–862 AD | 660 AD |
| HIII-3 | GrN 4482 | | ± 103155 | | 499180 | +3.45 | Peaty soil in Older Dunes sands | Mesotrophic peat, bulk | 1740 ± 70 | 87–504 AD | 290 AD |
| HIII-4 | GrN 4562 | | ± 103155 | | 499180 | +2.9 | Humic soil in Older Dunes sands | Mesotrophic peat, sandy, bulk | 2250 ± 50 | 399–201 BC | 290 BC |
| HIII-5 | GrN 4483 | | ± 103155 | | 499180 | 1.35 | Top organic soil in Older Dunes sands | Organic layer, bulk | 2250 ± 45 | 398–204 BC | 285 BC |
| HIII-6 | GrN 4119 | | ± 103155 | | 499180 | +1.1 | Base organic soil in Older Dunes sands | Organic layer, bulk | 2420 ± 70 | 767–397 BC | 545 BC |

***<h1>Location: Velsen-Hoogovens IV (HIV)***

*Table A3.21c. 14C dates of the building pit Velsen-Hoogovens IV (HIV) (Jelgersma et al., 1970)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| HIV-1 | GrN 4768 | | ±103530 | | 499310 | +1.5 | Wood, Juniperus, in Older Dunes | Peat, bulk  Location IVb | 2450 ± 40 | 756–410 BC | 580 BC |
| HIV-2 | GrN5 207 | | ±103500 | | 499285 | +0.45 | Organic layer, sandy, in Older Dunes | Peat, bulk  Location IVa | 2700 ± 50 | 972–796 BC | 860 BC |
| HIV-3 | GrN 5235 | | ±103500 | | 499285 | +0.35 | Organic layer in Older Dunes | Peat, sandy, bulk, Location IVa | 2725 ± 50 | 992–803 BC | 875 BC |

*Palaeolandscape implication*: Velsen-Hoogovens, areas II to IV. In the area of Velsen-Hoogovens II to IV the age of the aeolian phase of the Older Dunes and the base of the Younger Dunes were determined by dating the organic soil and anthropogenic culture layer. The lowest and oldest organic layer in the dune (HIV-3) was dated at ±875 BC. This indicates that the palaeo-coastline in this area (beach–dune transition) is older than about 900 BC. Above this lowest soil layer, several organic horizons at locations II/IV were dated, ranging between 545 BC and 860 AD. The palaeosols in the Younger Dunes were formed after 1000 AD.

***<h1>Location: Velsen-Hoogovens Vormenhal (HV)***

*Table A3.22. 14C dates of the building pit Velsen-Hoogovens Vormenhal (HV) (Jelgersma et al., 1970)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m +NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| HV-1 | GrN 5040 | | 101684 | | 500244 | 3.18 | Peaty soil in top of Older Dune sands | Mesotrophic peat, slightly sandy, bulk | 1090 ± 35 | 888–1018 AD | 955 AD |
| HV-2 | GrN 5041 | | 101684 | | 500244 | 2.88 | Phragmites peat in Older Dunes sands | Phragmites peat, bulk | 1240 ± 45 | 675–885 AD | 770 AD |
| HV-3 | GrN 5042 | | 101684 | | 500244 | 2.72 | Peat in Older Dunes sands | Wood peat, bulk | 1240 ± 30 | 684–876 AD | 760 AD |
| HV-4 | GrN 5083 | | 101684 | | 500244 | 2.53 | Peat, sandy, in Older Dunes sands | Wood peat, bulk | 1910 ± 60 | 41 BC–237AD | 100 AD |

*Palaeolandscape implication*: The Vormerhal location lies about 1.5 km northwest of the Hoogoven area, location II/1V. The beach sands were not exposed here, so the age of the palaeo-coastline at this location cannot be estimated precisely.

The organic palaeosols in the Older Dune complex were dated at ±100 to 955 AD. Soils in the Younger Dunes were not described but the highest organic level in the Older Dunes (±955 AD) may be considered the base of the Younger Dunes, which implies that here the Younger Dune formation started in the 10th century.

***<h1>Location: Velsen-PEN Noorderweg (VP)***

*Table A3.23. 14C dates of the building pit Velsen-PEN Noorderweg (VP) (Jelgersma et al., 1970)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m +NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| VP-1 | GrN 4566 | | ±103780 | | 498425 | 1.5 | Base Older Dune sands on beach sands | Juvenile *Spisula* shells | 3780 ± 55\* | 1880–1546 BC | 1700 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: The base of the Older Dunes, directly on top of the beach sands, was dated using juvenile *Spisula* shells at around 1700 BC. Reworking of the shells cannot be excluded, so that the transition of the beach to dune sands might be younger, but not later than the Late Bronze Age. Culture layers in the Older Dune sands, on top of the beach sands, were archaeologically dated as Late Bronze Age/Early Iron Age (layer B in the section) and Roman or Medieval Age (layer C).

***<h1>Location: Velsen-Gildenlaan (VG)***

*Table A3.24. 14C dates of the building pit Velsen-Gildenlaan (VG) (Jelgersma et al., 1970)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m +NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| VG-1 | GrN 4567 | | ±104250 | | 498870 | 1.7 | Top organic filling of a depression in Older Dune sands | Organic layer, bulk | 1220 ± 45 | 677–940 AD | 800 AD |
| VG-2 | GrN 4484 | | ±104250 | | 498870 | 0.9 | Organic filling of a depression in Older Dunes sands | Organic layer, bulk | 2400 ± 55 | 755–391 BC | 510 BC |
| VG-3 | GrN 4636 | | ±104250 | | 498870 | 0.5 | Organic filling of a depression in Older Dunes sands | Organic layer, bulk | 2520 ± 35 | 795–540 BC | 645 BC |
| VG-4 | GrN 4485 | | ±104250 | | 498870 | 0.15 | Base organic filling of a depression in Older Dunes sands | Organic layer, slightly sandy, bulk | 2680 ± 50 | 929–790 BC | 845 BC |

*Palaeolandscape implication*: A depression in the Older Dunes was dated at the Velsen Gildenlaan location. The layered organic fill ranges 845 BC to 800 AD. The beach sands were not exposed at this site, therefore the age of the palaeo-coastline at this location cannot be defined. Possibly the coastline was at this location in the Early Bronze Age.

***<h1>Location: Beverwijk-Scheybeeck (BS)***

*Table A3.25. 14C dates of building pit Beverwijk-Scheybeeck (BS) (Jelgersma et al., 1970)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| BS-1 | GrN 4932 | | ±104845 | | 499280 | 0.40–0.43 | Peaty layer on Older Dune sands | Sandy peat, bulk | 2440 ± 50 | 757–406 BC | 565 BC |
| BS-2 | GrN 5208 | | ±104845 | | 499280 | 0.89–0.92 | Organic layer in Older Dunes sands | Organic layer, bulk | 2660 ± 55 | 971–766 BC | 835 BC |
| BS-3 | GrN 5209 | | ±104845 | | 499280 | 1.14–1.18 | Organic layer in Older Dunes sands | Organic layer, bulk | 2935 ± 35 | 1285–996 BC | 1140 BC |
| BS-4 | GrN 4933 | | ±104845 | | 499280 | 1.89–1.93 | Peaty soil on top of Oer-IJ tidal deposits | Organic layer, clayey, bulk | 3010 ± 50 | 1431–1016 BC | 1245 BC |

*Palaeolandscape implication*: At the Beverwijk-Scheybeeck location dune sands drifted over clayey salt-marsh deposits of the Oer-IJ. The lowest organic soil, directly on the marsh, was dated at ±1245 BC. The organic layers of the palaeosols and culture layers in the Older Dune sands above range between 1140 BC and 565 BC.

Because of the western position of the Bronze Age Oer-IJ marsh, it cannot be excluded that in the subsurface – below the marsh deposits – an early palaeo-channel/inlet of the Oer-IJ has been present which silted up in the Early Bronze Age. This assumption implies that an opening in the coastline existed at this location during that period.

***<h1>Location: Van Tuyllaan (VT)***

*Table A3.26a. 14C dates of canal pit Velsen-Noordzeekanaal, location Van Tuyllaan (VT) (RGD Palaeobot. Rap. 1175; Zagwijn, 1992; Van der Valk, 1992)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| VT-1 | GrN 5968 | | 104260 | 497490 | 0.80–0.10 | Organic filling of dune valley deposits, top layer 4 | Organic material, very sandy, bulk | 3160 ± 55 | 1600–1278 BC | 1435 BC |
| VT-2 | GrN 5969 | | 104260 | 497490 | 0.32–0.35 | Organic filling of dune valley deposits, base layer 4 | Organic material, sandy, bulk | 3220 ± 35 | 1608–1422 BC | 1485 BC |
| VT-3 | GrN 5970 | | 104260 | 497490 | 0.80–0.83 | Organic filling of dune valley deposits, top layer 3 | Organic material, fine sandy layers, bulk | 3400 ± 35 | 1867–1616 BC | 1695 BC |
| VT-4 | GrN 5971 | | 104260 | 497490 | 0.97–1.0 | Organic filling of dune valley deposits, base layer 3 | Organic material, very sandy, bulk | 3360 ± 35 | 1744–1534 BC | 1655 BC |
| VT-5 | GrN 5972 | | 104260 | 497490 | 1.14–1.17 | Organic filling of dune valley deposits, top layer 2 | Organic material, very sandy, bulk | 3410 ± 35 | 1871–1623 BC | 1710 BC |
| VT-6 | GrN 5973 | | 104260 | 497490 | 1.27–1.30 | Organic filling of dune valley deposits, base layer 2 | Organic material, bulk | 3450 ± 35 | 1883–1683 BC | 1765 BC |
| VT-7 | GrN 5974 | | 104260 | 497490 | 1.37–1.39 | Organic filling of dune valley deposits, top layer 1 | Organic material, bulk | 3490 ± 35 | 1907–1696 BC | 1815 BC |
| VT-8 | GrN 5975 | | 104260 | 497490 | 1.50–1.52 | Organic filling of dune valley deposits, base layer 1 | Organic material, bulk | 3620 ± 35 | 2125–1890 BC | 1980 BC |

***<h1>Location: Velsen-Noordzeekanaal, location Ia (VIa)***

*Table A3.26b. 14C dates of canal pit Velsen-Noordzeekanaal, location Ia (VIa) (Palaeobot. Rap. 1175; Zagwijn, 1992)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| VIa-1 | GrN 5853 | | 104425 | | 497500 | 2.0 | Top of the beach sands, storm layer, directly below dune sands | *Cerastoderma edule,* bivalved | 4245 ± 45\* | 2465–2152 BC | 2315 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: Location Van Tuyllaan (VT) and Velsen-Noordzeekanaal (VIa). During the enlargement of the Noordzeekanaal in the 1960s, the top of the beach sands and Older Dunes near the old town of Velsen were examined. The top of the beach sands was dated with bivalve *Cerastoderma edule* shells at the VIa location at ±2315 BC. The layered, organic fill of a depression in the Older Dunes at the VT location was dated between ±1980 and 1435 BC. These dates indicate that the palaeo-coastline was situated at this location around 2300 BC. Since that time this area has formed part of the Older Dune landscape.

***<h1>Location: IJmuiden-Haringhaven (IJH)***

*Table A3.27. 14C dates of building pit IJmuiden-Haringhaven (IJH) (Van der Valk, 1991, 1992)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| IJH -1 | GrN 15157 | | 100120 | | 497540 | +2.0 | Storm layers in dune sand | *Macra corallina* | 2695 ± 40\* | 411–208 BC | 290 BC\*\* |
| IJH-2 | GrN 16185 | | 100120 | | 497540 | +2.0 | Storm layers in dune sand | *Cepaea nemoralis* | 2570 ± 110\* | 471–71 BC | 290 BC\*\* |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

\*Mean value of both dates at the same depth was taken.

*Palaeolandscape implication*: At this location two shells (*Macra corallina* and *Cepaea nemoralis*) from aquatic storm layers were dated at a level of 2 m +NAP. The mean estimated age of the two samples is ±290 BC. Because the shells were reworked, a younger age for the storm deposits cannot be excluded.

***<h1>Location: IJmuiden-Spuisluis (IJS)***

*Table A3.28. 14C dates of building pit IJmuiden-Spuisluis (IJS) (Roep et al., 1975)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | ***y* coord.** | | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| IJS-1 | GrN 6445 | 101810 | 498500 | +0.35–0.38 | | Top of the beach sands | *Spisula subtruncata* | 2710 ± 35\* | 429–211 BC | 385 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: *Spisula subtruncata* shells in the top of the beach sands were dated in the Spuisluis pit at ±385 BC. Because the shells have been reworked, a younger age for the top of the beach deposits cannot be excluded.

**Appendix A4 Dates from the Oer-IJ tidal area and area of the IJ-polders**

***<h1>Location: Castricum-Molendijk (CD)***

*Table A4.1. 14C dates of site Castricum-Molendijk (CD) (Westerhoff et al., 1987; De Jong, 1987)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| CP-1 | GrN 8661 | | 102960 | 506040 | –1.55 | Beach sands, below Older Dune sands | *Cerastoderma edule,* bivalved | 2715 ± 50\* | 538–206 BC | 385 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: *Cerastoderma edule* shells were dated in the upper part of the Oer-IJ tidal-flat deposits. The date – around 385 BC – indicates that during that time the mouth of the Oer-IJ near Castricum was still open.

***<h1>Location: Heemskerk II (HK)***

*Table A4.2. 14C dates of borehole Heemskerk II (HK) (RGD Palaeobot. Rap. 1000; Westerhoff et al., 1987)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| HK-1 | GrN 11637 | | 104875 | 504341 | 4.32–4.35 | Base sandy peat layer | Sandy peat, bulk | 1895 ± 30 | 52–215 AD | 105 AD |

*Palaeolandscape implication*: The sandy peat layer in a depression in the dune area was dated at around 105 AD. Possibly, the depression was a relic of an older Oer-IJ channel which was covered with drift sand after deposition of the Roman peaty fill. The older tidal inlet was not active anymore in the Iron Age since west of the HK location a coastal barrier had formed (S5, WRK and SG locations). At that time, the main channel/inlet was located south of the SP location.

***<h1>Location: Castricum-Zanderij (CZ)***

*Table A4.3a. 14C dates of building pit Castricum-Zanderij (CZ) (Vos, 2007)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| CZ-1  (M2A-kl) | UtC 13586 | | 105400 | | 507400 | 0.45 | Layer 6, wash-over deposits, below dune sands | *Spisula subtruncata,* small single valve | 3140 ± 60\* | 1016–801 BC | 200 AD\*\*  (895 BC) |
| CZ-2  (M2B-gr) | UtC 13587 | | 105400 | | 507400 | 0.45 | Layer 6, wash-over deposits, below dune sands | *Spisula subtruncata,* large single valve | 2930 ± 45\* | 802–519 BC | 200 AD\*\*  (655 BC) |
| CZ-3  (M1A-kl) | UtC 13584 | | 105400 | | 507400 | 0.90 | Layer 6, wash-over deposits, below dune sands | *Spisula subtruncata,* small single valve | 2691 ± 45\* | 413–204 BC | 200 AD\*\*  (360 BC) |
| CZ-4  (M1B-gr) | UtC 13585 | | 105400 | | 507400 | 0.90 | Layer 6, wash-over deposits, below dune sands | *Spisula subtruncata,* large single valve | 2685 ± 43\* | 409–206 BC | 200 AD\*\*  (355BC) |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

\*\*The estimate dates are adapted to the value of the OSL date CZ-O2; the dated shells were interpreted as reworked shell material which has no meaning for the age of the wash-over deposits.

*Table A4.3b. OSL dates of building pit Castricum-Zanderij (CZ) (Vos, 2007)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Years AD/BC** | **Error band** | **Estimated**  **date** |
| CZ-O1 | NCL 3305015 | | 105400 | 507400 | 0.10–0.20 | Layer 8, on top of shell layer (6), dune sand deposits | 393 ± 96 AD | 297–489 AD | 300 AD\*\* |
| CZ-O2 | NCL 3305014 | | 105400 | 507400 | 1.20–1.30 | Layer 3, below shell layer (6), wash-over deposits | 163 ± 106 AD | 57–269 AD | 165 AD |

*Palaeolandscape implication*: Dune and wash-over deposits were dated with the OSL and 14C dating techniques. The OSL date of sands below the wash-over shells is ±165 AD, therefore the shell deposits have an estimated age of ±200 AD. The dated wash-over shells are older than the OSL date of the sand below and therefore considered older reworked shell material.

Because of the dune formation in the beach plain west of the coastal barrier, on the line of the S5–WRK–SG–SP locations, wash-over deposits are expected not to be much older than 250 AD at the CZ location. The dune sand layer on top (layer 8) might be younger, and have a age of ±395 AD.

***<h1>Location: Wijkermeerpolder, ditch side (WP)***

*Table A4.4. 14C dates of Wijkermeerpolder, ditch side (WP) (De Jong, 1988)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| WP-1 | GrN 15413 | | 108130 | | 498315 | 1.80–1.85 | Base IJ-polder deposits, sand with detritus | *Cardium glaucum* | 1270 ± 45\* | 1018–1204 AD | 1100 AD |
| WP-2 | GrN 15414 | | 108130 | | 498315 | 2.01 | Base IJ-polder deposits, sand with detritus | *Cardium glaucum* | 1300 ± 60\* | 983–1213 AD | 1090 AD |
| WP-3 | GrN 15415 | | 108130 | | 498315 | 2.31 | Top Oer-IJ tidal-flat deposits | *Scrobicularia plana* | 2670 ± 60\* | 748–208 BC | 430 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: From the upper zone of the tidal-flat deposits north of the Noordzeekanaal, bivalve *Scrobicularia plana* shells were dated. The date of ±430 BC corresponds with the other *Scrobicularia plana* dates in the upper part of the tidal-flat deposits at the BP, CD and UD locations. All these dates are indicative of the active marine phase in the Oer-IJ between 600 and 400 BC.

***<h1>Location: Velsen-Noordspaarndammerpolder (NS)***

*Table A4.5. 14C dates of Velsen-Noordspaarndammerpolder (NS). Samples of site Velsen XIV from small pit (IPP, 1976) (De Jong, 1987)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| NS-1 | GrN 8671 | | 106400 | | 496480 | ±2.5 | Top Oer-IJ tidal-flat deposits | *Scrobicularia plana* | 2820 ± 35\* | 751–401 BC | 505 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: South of the Noordzeekanaal bivalve *Scrobicularia plana* shells were dated from the upper interval of the tidal-flat deposits. The result, ±505 BC, corresponds with the other *Scrobicularia plana* dates in the upper part of the tidal-flat deposits (WP, BP, CD and UD locations).

***<h1>Location: Wijker-Tunnelput (WT)***

*Table A4.6. 14C dates of construction pit Wijker-Tunnelput (WT) (Beets et al., 2004)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| WT-1 | GrA 738 | | ±106400 | | 497000 | 2.4 | Unit 7, base IJ-lake deposits | *Mya arenaria,* bivalved | 955 ± 50\* | 1298–1439 AD | 1365 AD |
| WT-2 | GrN 20421 | | ±106400 | | 497000 | 2.8 | Unit 6, mud-rich cannel fills, base IJ-deposits | *Macoma baltica,* bivalved | 1470 ± 35\* | 894–1022 AD | 975 AD |
| WT-3 | GrA 749 | | ±106400 | | 497000 | 2.62 | Unit 6, mud-rich cannel fills, base IJ-deposits | *Valvata piscinalis* | 1445 ± 50\* | 885–1151 AD | 990 AD |
| WT-4 | GrN 20420 | | ±106400 | | 497000 | 2.8 | Unit 5b, Oer-IJ intertidal flat deposits on top of channel deposits (5b) | *Scrobicularia plana,* bivalved | 4225 ± 45\* | 2459–2143 BC | 2280 BC |
| WT-5 | GrN 20418 | | ±106400 | | 497000 | 5.6 | Unit 5c, Oer-IJ intertidal flat deposits on top of channel deposits (5b) | *Mytilus edulis,* bivalved | 4380 ± 40\* | 2618–2347 BC | 2515 BC |
| WT-6 | GrN 20419 | | ±106400 | | 497000 | 5.6 | Unit 5c, Oer-IJ intertidal flat deposits on top of channel deposits (5a) | *Scrobicularia plana,* bivalved | 4425 ± 30\* | 2621–2472 BC | 2535 BC |
| WT-7 | GrN 20426 | | ±106400 | | 497000 | 12.5 | Unit 5b, Oer-IJ tidal-channel deposits (5a) | *Cerastoderma edule,* single valve | 5770 ± 50\* | 4333–4054 BC | 4215 BC |
| WT-8 | GrN 20427 | | ±106400 | | 497000 | 12.5 | Unit 5a, Oer-IJ tidal-channel deposits (5a) | *Macoma báltica*, single valve | 5400 ± 50\* | 3945–3665 BC | 3785 BC |
| WT-9 | GrN 20428 | | ±106400 | | 497000 | 12.5 | Unit 5a, Oer-IJ tidal-channel deposits (5a) | *Scrobicularia plana,* single valve | 5320 ± 60\* | 3934–3538 BC | 3710 BC |
| WT-10 | GrA 365 | | ±106400 | | 497000 | 14.96 | Unit 3b, tidal-channel of the Wormer Member | Small patches of *Mytilus edulis* | 6640 ± 60\* | 5326–5030 BC | 5210 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: The tidal deposits of the northern and southern tunnel pit section were dated by Beets et al. (2004). The calibrated estimates from this publication are given in the table. The tidal channel at a depth of 14.96 m was dated with (reworked) *Mytilus* shells at 5238–5125 BC (layer 3b in the section). In the top of the tidal sequence of the Wormer deposits, northeast of the northern pit, a preserved peat layer (layer 4) was not dated, but can be compared with the base of the Holland Peat layer in the Assendelverpolders (site A17 II-4). Because the peat was formed in the area near the main channel of the tidal inlet, the age may be somewhat younger than in the Assendelverpolders, probably about 2500 BC.

The peat layer and the Wormer tidal deposits were truncated by tidal channels. Beets et al. (2004) classified these channel deposits as Oer-IJ deposits (layer 5c). The age of the channel fill (5.6 m –NAP), based on reworked shells, is around 2400 BC (WT-5/7). On top (at 2.8 m –NAP), *Scrobicularia* shells in intertidal flat deposits were dated at 1816 BC. Shells from a rest channel scoured in the underlying tidal deposits of the Oer-IJ (layer 6) have a date of 832 and 961 AD. This indicates that the IJ-lake became brackish from the 10th century onwards. At the base of the IJ-lake deposits *Mya arenaria* shells were dated (layer 7) at 1398 BC. This is relatively old for the first appearance of this shell in the Netherlands (Beets et al., 2004) but it may support the theory of Petersen et al. (1992) that the ancestors of the *Mya* shells were brought from North America to northwestern Europa by Viking ships after 1000 AD instead of after its discovery by Columbus in 1492 (Van Straaten, 1957).

***<h1>Location: Velsen-Tunnelput (VT)***

*Table A4.7. 14C dates of construction pit Velsen-Tunnelput (VT) (Van Straaten, 1957)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| VT-1 | GrN 179 | | ±105270 | | 497090 | 3.25 | Oer-IJ tidal deposits | *Scrobicularia plana,* bivalved | 2595 ± 75\* | 397–56 BC | 255 BC |
| VT-2 | GrN 195 | | ±105270 | | 497090 | 4.2 | Oer-IJ tidal deposits | *Scrobicularia plana,* bivalved | 2705 ± 160\* | 798–3 BC | 395 BC |
| VT-3 | GrN 196 | | ±105270 | | 497090 | 6.5 | Oer-IJ tidal deposits | *Cerastoderma edule,* displaced material | 2820 ± 160\* | 901–118 BC | 545 BC |
| VT-4 | GrN 198 | | ±105270 | | 497090 | 6.4 | Wormer Member, tidal deposits | *Scrobicularia plana,* bivalved | 4370 ± 150\* | 2890–2045 BC | 2485 BC |
| VT-5 | GrN 200 | | ±105270 | | 497090 | 14.2 | Upper part of the Layer of Velsen | *Hydrobia ulvae* | 7640 ± 240\* | 6507–5634 BC | 6085 BC |
| VT-6 | GrN 194 | | ±105270 | | 497090 | ±16.0 | 5 cm below the top of the Basal peat layer | Peat, bulk | 7600 ± 200\* | 6447–5719 BC | 6085 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: In 1954, the base of the Holocene sequence was exposed in the Velsertunnel pit. The upper part of the Basal Peat and the Velsen Layer at a depth of about 16–14 m –NAP was dated at ±6085 BC.

The tidal flat sands in the upper part of the Wormer Member were dated using *Scrobicularia* shells at ±2485 BP, comparable with the data of these deposits in the Wijkertunnel pit (layer 3; WT-5/6). The Oer-IJ tidal flat deposits were dated with bivalve shells to between ±545 and 255 BC. The youngest date (VT-1) indicates that between 300 and 250 BC tidal deposition continued and that the main tidal channel nearby was still active.

***<h1>Location: Beverwijk Wijkerbroek (BW)***

*Table A4.8. 14C dates of borehole Beverwijk Wijkerbroek (BW) (Cleveringa, 1988)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| WIJ-1 | GrN 15433 | | 107475 | 499850 | 16.92–16.97 | Base tidal channel deposits of the Wormer Member | *Cardium glaucum* | 8030 ± 100\* | 6823–6373 BC | 6000 BC\*\* |
| WIJ-2 | GrN 15447 | | 107475 | 499850 | 16.92–16.97 | Base tidal channel deposits of the Wormer Member | *Hydrobia* | 8380 ± 500\* | 8297–5988 BC | 6000 BC\*\* |
| WIJ-3 | GrN 15928 | | 107475 | 499850 | 16.97–17.00 | Thin peat layer on top of the Velsen layer | Peat, bulk | 7260 ± 60 | 6232–6019 BC | 6135 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

\*\*Shell dates are derived from the marine deposits above the peat layer and must be older than this layer.

*Palaeolandscape implication*: The peat layer on top of the humic Velsen deposits is dated at about 6135 BC, indicating that the Velsen deposition at a depth of about 16–17 m –NAP ended around 6000–6100 BC.

The shells at the base of the Wormer tidal channel deposits have been reworked and, therefore, give an age which is too old for the time of deposition. An age of about 6000 BC is estimated, based on the date of the peat sample (BW-3). This is in correspondence with the date of the top of the Basal Peat from the Velsertunnel pit location (VT-6; ±16.0 m –NAP).

***<h1>Location: Afrikahaven – H2b location (AH)***

*Table A4.9. 14C dates of exposure**Afrikahaven – H2b location (AH) (Veerkamp, 2001)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| AH-1 | GrN 25248 | | 111200 | 492750 | 4.5–5.0 | Base IJ-lake deposits | *Macoma baltica* | 1300 ± 80\* | 997–1267 AD | 1250 AD\*\*\*  (1130 AD) |
| AH-2 | GrN 24403 | | 111200 | 492750 | 3.5 | Base IJ-lake deposits | *Cerastaderma edule*, juvenile | 1600 ± 40\* | 689–950 AD | 1250 AD\*\*\*  (825 AD) |
| AH-3 | GrN 24402 | | 111200 | 492750 | 5.1 | Post in the top of the Wormer clay deposits | Wood, small post | 600 ± 30 | 1297–1409 AD | 1350 AD |
| AH-4 | GrN 24401 | | 111200 | 492750 | 4.5–5.0 | Post in the top of the Wormer clay deposits | Wood, small post | 4470 ± 40 | 3346–3022 BC | 3195 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

\*\*Marine 2-sigma calibration dates according to the OxCal 4.2 program.

\*\*\*Best estimate after the correction of the brackish water effect according to the CIO[[3]](#footnote-4) (in Veerkamp, 2001).

*Palaeolandscape implication:* During the excavation of the harbour, the base of the IJ-polder deposits was exposed as an erosional contact with the top of the Wormer Clay deposits. Locally, a remnant of the Holland Peat has been preserved. At the base, marine shells were found indicative for brackish conditions in the lake. The AH-1 and 2 dates are indicative of a Late Mediaeval age. In addition, the dates at the Wijkertunnel pit (WT-1 and 2) and Wijkermeerpolder (WP-1 and 2) date from this period. A problem, however, with these shell dates of the IJ-lake deposits might be the correction for the brackish water effect. Nevertheless, the shell dates seem reliable when compared with the age of the dirty sands (with marine shells) dated at the Velsen Logboat site (VL1, Table A4.10).

In the top of the deposits of the Wormer Member two post remnants were dated. One post was old (AH4) and assigned to the Neolithic period. This indicates that humans were was present in the area when the marshes had been silted up and peat formation had not started yet. The other post is relatively young and dates from the Late Mediaeval period. This is apparently a post which had been driven into the clay soil by a fisherman in order to secure a boat or fyke in the IJ-lake which was formed at that period (Veerkamp, 2001).

***<h1>Location: Velsen-Logboat (VL)***

*Table A4.10. 14C dates of Velsen-Logboat (VL) (De Weert, 1989)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| VL-1 | GrN 8276 | | ±107475 | | ±493750 | ±2.8 | Base of IJ-lake deposits on top of sandy Oer-IJ tidal deposits | Oak wood of a logboat | 975 ± 30 | 1013–1155 AD | 1085 AD |

The log boat was found on top of the sandy Oer-IJ tidal deposits and in and below the ‘Dirty Sands’*,* which were formed under marine conditions, since in these deposits *Cerastoderma* and *Macoma* species occur. The date that the boat sank, of course, is later than the age of the dated oak wood. The date was taken from material near the original edge of the alder plank of the vessel. The sapwood of the tree, however, could not be discerned, therefore the tree must have been cut about 20 years later than the age of the wood.

In order to correctly determine the age of the base of the Dirty Sands, the maximum life of the log boat also needs to be taken into account. An estimated life time of 30–50 years for the vessel seems realistic, so deposition of the log boat occurred about 50–60 years later than the date of the oak wood. The deposition of the Dirty Sands, however, might already have started before the vessel sank because the boat has sunk/dug into the underlying sediments. At the VL location, therefore, the formation of the Dirty Sands is estimated to have started at the end of the 10th or the beginning of the 11th century. This is in line with the shell dates from the base of the IJ-lake deposits of the Afrikahaven (AH 1 and 2; Table A4.9), which indicate that marine conditions in the IJ-lake had started – at least – by about the end of the 10th century.

***<h1>Location: Uitgeest Benes (UB)***

*Table A4.11a. 14C dates of exposure Uitgeest Benes (UB) (Vos & De Koning, unpublished)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| UB-1  (vnr. 115) | Poz-64008 | | 109001 | 506076 | 1.63 | Base anthropogenic disturbed channel fill | Archaeological post, wood | 1195 ± 30 | 720–941 AD | 830 AD |
| UB-2  (vnr. 110) | Poz-64212 | | 108936 | 506102 | 1.47 | Upper part Oer-IJ tidal flat deposits | *Scrobicularia plana*, bivalved | 2715 ± 35\* | 414–235 BC | 390 BC |
| UB-3  (vnr. 111) | Poz-64213 | | 108934 | 506100 | 1.02 | Top Oer-IJ tidal flat deposits | *Scrobicularia plana*, bivalved | 2680 ± 35\* | 404–209 BC | 360 BC |
| UB-4  (vnr. 112) | Poz-64214 | | 108934 | 506101 | 1.12 | Top Oer-IJ tidal flat deposits | *Scrobicularia plana*, bivalved | 2655 ± 30\* | 396–208 BC | 285 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Table A4.11b. OSL dates of exposure Uitgeest Benes (UB) (Wallinga & Voskuilen, 2014)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Years AD/BC** | **Error band** | **Estimated**  **date** |
| UB-O1  (vnr. 106) | NCL 6114036 | | 108864 | 506107 | 0.82 | Aeolian sand, on top of the storm sand deposits | 216 ± 114 BC | 330–102 BC | 220 BC\* |
| UB-O2  (vnr. 114) | NCL 6114037 | | 108935 | 506102 | 0.84 | Storm sand layers with single valved marine shells (e.g. *Spisula subtruncata*), on top of Oer-IJ tidal flat deposits | 236 ± 119 BC | 355–117 BC | 220 BC\* |

\*Mean value of the both dates.

*Palaeolandscape implication:* The bivalve marine shells indicate that the upper part of the tidal flat deposits was formed between c. 535 and 470 BC. When the traditional 400 year reservoir correction is applied, like the older GrN dates in the 1970s and 1980s, these ages are about 70 years younger (around 465 and 400 BC). The storm sands – lateral of the main Oer-IJ channel and on top of the tidal flat sediments – were deposited during the last stage of marine deposition in this part of the Oer-IJ. On top of the storm sands, aeolian sands occur. The OSL date of the base of these aeolian sands falls in the same range as the storm sand date. Taking into account the uncertainty range of the OSL dates, the storm layer and aeolian sands were also formed in the Late Iron Age (at least before 100 BC). When tidal deposition stopped and windblown sands were formed, the area was suitable for habitation. Late Iron Age pottery found at location Uitgeest Benes is an indication for this.

The wooden post found at the base of an anthropogenic disturbed humus fill of a channel is dated around 830 AD. This indicates that humans were active at this location, and possibly that the site was inhabited because of the presence of a lot of wood in the rest channel.

**Appendix A5 Dates from the salt-marsh clay-on-peat area of the Uitgeesterbroek- and Assendelverpolders**

***<h1>Location: Gas-pipeline trench Uitgeest (UG)***

*Table A5.1. 14C dates of Holland Peat in the gas-pipeline trench Uitgeest (UG) (De Jong, 1986)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| UG-1 | GrN 10235 | | 108500 | | 502250 | 4.11–4.13 | Base of the lower Holland Peat layer | *Phragmites* peat, slightly clayey, bulk | 4675 ± 40 | 3627–3365 BC | 3455 BC |

***<h1>Location: Uitgeest (BU)***

*Table A5.2. 14C dates of Holland Peat borehole near Uitgeest (BU) (Jelgersma, 1961; BU-1 interpreted after De Jong, 1986)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| BU-1 | GrN 1663 | 109780 | 503870 | 3.63–3.66 | Base Holland Peat | Peat, bulk | 4055 ± 50 | 2859–2471 BC | 2600 BC |
| BU-2 | GrN 1650 | 109780 | 503870 | 3.92–3.95 | Top of the lower Holland Peat layer | Peat, bulk | 4580 ± 60 | 3517–3097 BC | 3315 BC |
| BU-3 | GrN 1057 | 109780 | 503870 | 22.50–22.50 | Top Basal Peat | Peat, bulk | 7780 ± 75 | 6907–6454 BC | 6610 BC |
| BU-4 | GrN 1054 | 109780 | 503870 | 23.25–23.30 | Base Basal Peat | Peat, bulk | 9555 ± 70 | 9211–8736 BC | 8965 BC |

*Palaeolandscape implication*: Gas pipeline trench Uitgeest (UG) and borehole near Uitgeest (BU). The Basal Peat dates indicate an age between 8965 and 6610 BC. The base is significantly older than a comparable date from 23.4 m –NAP in the 19C0945 core (B945-7; 7535 BC). Possibly the Basal Peat formation at the UG location started in a local wet depression and independently of the Holocene sea-level rise.

In the lower part of the Holland Peat a clay layer occurs. The base of the lowest peat layer on top of the Wormer tidal deposits was dated in the gas-pipeline trench (UG-1) at ±3455 BC and the top at ±3315 BC. The peat formation on top of the clay wedge started around 2600 BC.

Peat formation at the UG location began ±300 years earlier than in the eastern central part of (BN-2; W-2). A protecting coastal barrier west of the UG location was probably responsible for the peat growth in this near-shore area.

***<h1>Location: Polder de Uitgeester-Heemskerkerbroek (UH)***

*Table A5.3. 14C dates of ditch-side section Polder de Uitgeester-Heemskerkerbroek (UH) (RGD Palaeobot. Rap. 1036; Westerhoff et al., 1987)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| UH-1 | GrN 12148 | | 108770 | 502480 | 2.5 | Humus clay layer in depression of a salt marsh, below sandy tidal-flat deposits | *Cerastoderma glaucum,* bivalved | 2960 ± 70\* | 835–430 BC | 670 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: The shell date was derived from a pool deposit within an Oer-IJ salt-marsh environment. In the pool sedimentation of clay took place in the period around 670 BC. The date has a large 2-sigma range, but probably the pool clay was deposited before the active marine phase in the Oer-IJ (600–400 BC).

***<h1>Location: Uitgeesterbroek (SU)***

*Table A5.4. 14C dates of ditch-side section Uitgeesterbroek (SU) (RGD Palaeobot. Rap. 1036; Westerhoff et al., 1987)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| SU-1 | GrN 12099 | | 110180 | 503050 | 2.01–2.11 | Reed stalk level in Oer-IJ salt-marsh deposits | Stalks of *Phragmites* | 2570 ± 60 | 840–490 BC | 685 BC |

*Palaeolandscape implication*: A horizon of reed stalk was found in the Oer-IJ salt-marsh deposits and is dated at around 685 BC. This date falls in the relatively quiet period of the Oer-IJ between 1000 and 650 BC. A comparable reed stalk level was dated in the Broekpolder – in the transition zone of the marsh to the main tidal channel of the Oer-IJ – and also formed in the relatively quiet Oer-IJ period (BP-7, ±790 BC).

***<h1>Location: Site O/R (AR)***

*Table A5.5. 14C dates of IPP excavation Assendelverpolders site O/R (AR), in the surrounding of the Early Medieval church (AO) (Witte & Van Geel, 1985)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| AR-1 | GrN 11585 | | 110205 | | 498600 | 2.03 | Top oligotrophic peat layer, between early medieval culture layer and Roman charcoal layer | *Sphagnum*, bulk sample | 1415 ± 50 | 542-684 AD | 625 AD |
| AR-2 | GrN 11584 | | 110205 | | 498600 | 2.05 | Oligotrophic peat layer, between Early Medieval culture layer and Roman charcoal layer | *Sphagnum*, bulk sample | 1570 ± 30 | 416–557 AD | 485 AD |
| AR-3 | GrN 11583 | | 110205 | | 498600 | 2.19 | Base oligotrophic peat layer, between Early Medieval culture layer and Roman charcoal layer | *Sphagnum*, bulk sample | 1790 ± 30 | 133–330 AD | 235 AD |
| AR-4 | GrN 11582 | | 110205 | | 498600 | 2.28 | Top oligotrophic peat layer, below and Roman charcoal layer | *Sphagnum*, bulk sample | 1960 ± 35 | 42 BC–123 AD | 40 AD |
| AR-5 | GrN 11581 | | 110205 | | 498600 | 2.57 | Base oligotrophic peat layer, below and Roman charcoal layer | *Sphagnum*, bulk sample | 2230 ± 35 | 385–203 BC | 280 BC |
| AR-6 | GrN 11580 | | 110205 | | 498600 | 2.62 | Boundary layer, mesotrophic peat | *Molinia/Myrica gale*, bulk sample | 2390 ± 60 | 756–382 BC | 505 BC |
| AR-7 | GrN 11579 | | 110205 | | 498600 | 2.80 | Top eutrophic peat layer | *Phragmites*, bulk sample | 2480 ± 50 | 776–416 BC | 620 BC |

*Palaeolandscape implication*: At the sites O/R and O the peat sequence was sampled below a culture layer of an Early Medieval settlement and church. These culture layers protected the peat layers below against exposure to the air so that they were preserved. In the surrounding peat area the top of the peat bog has completely vanished by oxidation. From the original top of the peat, only a black, crumbly oxidation layer was left behind. It is estimated that at least 1.20 m of the top of the Medieval peat has disappeared.

The dates of the samples from the peat sequence vary between ±620 BC and ±625 AD. The lowest sample consists of eutrophic *Phragmites* peat (±620 BC), the oligotrophic peat growth started at about ±280 BC, the base of a Roman culture level was dated at ±40 AD and the top of the oligotrophic peat below the culture layer was dated at ±625 AD.

***<h1>Location: Site O (AO)***

*Table A5.6. 14C dates of IPP excavation in Assendelverpolders site O (AO), below Medieval church (Smeerdijk, 1989)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| AO-1 | GrN 13031 | | ±110155 | | 498585 | 1.95 | Top oligotrophic peat layer, directly below church layer | *Ericaceae/Sphagnum* peat, bulk | 1195 ± 45 | 690–966 AD | 830 AD |
| AO-2 | GrN 13025 | | ±110155 | | 498585 | 2.04 | Upper part oligotrophic peat layer | *Ericaceae/Sphagnum* peat, bulk | 1210 ± 50 | 679–952 AD | 815 AD |
| AO-3 | GrN 13026 | | ±110155 | | 498585 | 2.32 | Middle oligotrophic peat layer | *Ericaceae/Sphagnum* peat, bulk | 1305 ± 35 | 656–770 AD | 705 AD |
| AO-4 | GrN 13027 | | ±110155 | | 498585 | 2.53 | Base oligotrophic peat layer | *Ericaceae/Sphagnum* peat, bulk | 1685 ± 35 | 255–422 AD | 360 AD |
| AO-5 | GrN 13028 | | ±110155 | | 498585 | 2.65 | Upper part mesotrophic peat | *Molinia/Myrica* peat, bulk | 1875 ± 30 | 70–224 AD | 130 AD |
| AO-6 | GrN 13029 | | ±110155 | | 498585 | 2.81 | Lower part mesotrophic peat | *Molinia/Myrica* peat, bulk | 2000 ± 40 | 111 BC–83 AD | 0 BC/AD |
| AO-7 | GrN 13030 | | ±110155 | | 498585 | 2.96 | Base mesotrophic peat | *Molinia* peat*,* bulk | 2150 ± 40 | 358–56 BC | 195 BC |
| AO-8 | GrN 13032 | | ±110155 | | 498585 | 3.05 | Top eutrophic peat layer | *Phragmites* peat, bulk | 2320 ± 40 | 511–214 BC | 390 BC |

*Palaeolandscape implication*: A comparable peat sequence below the wooden Medieval church of Assendelft was dated at the 10th century AD. At this location the base of the sequence is more eutrophic/mesotrophic (±390 BC–130 AD). Oligotrophic peat growth started ±360 AD and continued probably until the time when the church was built. The date of the uppermost sample is ±830 AD.

***<h1>Location: Site 17 (A17)***

*Table A5.7. 14C dates of AWN excavation in Assendelverpolders site 17 (A17) (De Jong, 1987)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| A17 II-1 | GrN 9944 | | 112200 | 500750 | 1.80–1.90 | Top Holland Peat, below occupation layer | *Phragmites* peat, bulk | 2030 ± 60 | 198 BC–83 AD | 45 BC |
| A17 II-2 | GrN 9943 | | 112200 | 500750 | 2.14–2.25 | Holland Peat, Chen. Peak 4 | *Phragmites* peat, bulk | 2400 ± 70 | 766–385 BC | 525 BC |
| A17 I -3 | GrN 9941 | | 112200 | 500740 | 2.30–2.45 | Holland Peat, Chen. Peak 3a | *Phragmites* peat, bulk | 3000 ± 70 | 1414–1031 BC | 1230 BC |
| A17 II-4 | GrN 9942 | | 112200 | 500750 | 3.48–3.58 | Base Holland Peat | *Phragmites* peat, bulk | 4200 ± 60 | 2910–2601 BC | 2775 BC |

*Palaeolandscape implication*: This A17 location was a peat site with a Roman settlement layer on top of the peat. Medieval peat was not found at this location. Peat samples for dating were taken from two nearby drillings (A17 I and II). The whole peat sequence was described as eutrophic *Phragmites* peat and investigated on pollen. The base of the Holland Peat on top of the Wormer Clay deposits was dated at ±2775 BC. This is somewhat later than the start of the peat formation behind the coastal barrier near Uitgeest (±3365 BC, UK-6; base of the lower peat layer at UG location, ±3455 BC). Two peat levels in which a strong marine influence was found in the pollen spectrum abundances (*Cheneopodicaea* peaks 3a and 4; De Jong, 1987) were dated around 1230 BC and 525 BC. The age of top of the Holland Peat directly below the Roman culture layer is ±45 BC. The palynological analyses of the peat transect between the *Cheneopodicaea* peak 4 and the Roman culture layer show that many oligotrophic pollen were present in the pollen assemblage. This is an indication that oligotrophic peat was present in the nearby surrounding area before the first century AD. This was proven by the archaeological excavations in Assendelft North in the 1990s (sites AsN 27 and 56; Therkorn et al., 1997). These investigations show that *Sphagnum* peat was present and that this peat has been dug off in long strips during the Roman period. The peat was used for fuel and construction purposes.

***<h1>Location: Site N (AN)***

*Table A5.8. 14C dates of IPP excavation in Assendelverpolders site N (AN) (Vos, 1998)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| AN-1 | GrN 11477 | | 109609 | 499568 | 1.80–1.90 | Rest channel deposits in Oer-IJ salt-marsh creek | Piece of bone, cattle | 2300 ± 30 | 407–234 BC | 380 BC |

*Palaeolandscape implication*: In the rest channel deposits in the tidal creek of site N fragments of bone and shards from the Middle Iron Age were found. A piece of cattle bone was dated at ±380 BC. This date from a silted-up creek indicates that around 400 BC marine activity in the salt-marsh area of the Assendelverpolders decreased. This is in correspondence with the observations that in the adjacent peat area mesotrophic and oligotrophic peat growth expanded (sites A17, O/R and O). These nutrient-poor conditions for peat development in the marginal zone of the peat marsh imply that this zone was not flooded anymore during extremely high storm tides.

***<h1>Location: Site P (AP)***

*Table A5.9. 14C dates of IPP excavation in Assendelverpolders site P (AP) (Vos, 1998)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| AP-1 | GrN 11212 | | 109030 | 499190 | ±3.0 | Base of the ostrocod clay, on Holland peat (erosive boundary) | *Hydrobia ulvae* | 3460 ± 70\* | 1495–1116 BC | 1310 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: At the P site location, lake deposits were found in a depression which was formed in the peat deposits. In these humic lake deposits many ostracods and *Hydrobia*s were found. The *Hydrobia*s have been dated at ±1310 BC. Because these lakes where brackish and the hard water effect may have played a role, it cannot be excluded that the lake infill is somewhat younger than indicated by the 14C date.

Also in the Uitgeesterbroek ostracod clay was found in a depression of the Holland Peat layer. Here, a tidal creek cut into the palaeolake deposits during the active marine phase between 600 and 400 BC. This creek was connected with the tidal channel at the UK location where the canoe was found.

***<h1>Location: Site Q/AWN 60 (AQ)***

*Table A5.10. 14C dates of IPP excavation in Assendelverpolders site Q or AWN 60 (AQ) (Hallewas, 1987; Vos, 1998)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| AQ-1 | GrN 8686 | | 109120 | 497760 | c. 1.75 | Early Iron Age settlement, on oligotrophic peat | Peg from wood construction | 2465 ± 30  (AWN 60) | 764–430 BC | 625 BC |
| AQ-2 | GrN 8337 | | 109120 | 497760 | c. 1.75 | Early Iron Age settlement, on oligotrophic peat | Peg from wood construction | 2520 ± 30  (AWN 60) | 795–542 BC | 645 BC |
| AQ-3 | GrN 11242 | | 109120 | 497760 | 1.76–1.80 | Top oligotrophic peat, below occupation layer | Branches of heather | 2620 ± 30  (site Q) | 831–775 BC | 800 BC |
| AQ-4 | GrN 11243 | | 109120 | 497760 | 1.97–2.0 | Top *Phragmites* peat direct below oligotrophic peat | Phragmites peat, bulk | 2670 ± 80  (site Q) | 1021–549 BC | 845 BC |

*Palaeolandscape implication*: At site Q an Early Iron Age settlement was found on top of an isolated oligotrophic peat ‘dome’, formed within a *Phragmites* peat environment at the margin of the estuarine landscape. Pegs of the settlement construction were dated at ±645–625 BC. The oligotrophic peat layer below the settlement gave dates between ±845 BC (base) and ±800 BC (top). This indicates that between 850 and 650 BC the marginal zone of the peat area was not frequently flooded (quiet phase) and that between 650 and 600 BC the marginal peat zone of the estuary had permanent settlements. The salt-marsh clay deposition on top of the Early Iron Age settlement shows that this situation changed after 600 BC. The site was inundated during storm periods and these floodings are related to the active marine phase between 600 and 400 BC.

A clay wedge at this site in the Holland Peat at a depth of about 3 m –NAP was not 14C dated. The clay layer found in the southwestern part of the Assendelverpolders might be related with the *Cheneopodicaea* peak 3a of site A17 in Assendelft Noord dated at ±1230 BC.

***<h1>Location: Site F(AF)***

*Table A5.11. 14C dates of IPP excavation in Assendelverpolders site F(AF) (Hallewas, 1987)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| AF-1 | GrN 11227 | | 109609 | 499568 | Not known | Marine shells at the base of a tidal creek | Bivalved marine shells | 2830 ± 60\* | 761–402 | 555 BC |
| AF-2 | GrN11228 | | 109609 | 499568 | Not known | Marine shells at the base of a tidal creek | Bivalved marine shells | 2900 ± 50\* | 794–431 | 555 BC\*\*  (635 BC) |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

\*\*Mean value of the date AF-1 is used.

**Appendix A6 Dates from the salt-marsh clay area of the Wijkerbroek and Velserbroek**

***<h1>Location: Broekpolder (BP)***

*Table A6.1. 14C dates of AAC excavation Broekpolder (BP) (Vos, 2000)*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | **Depth**  **(m NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| BP-1 | KIA9493 | | 107873 | 500485 | –1.65 | Column U, peat layer on top of Oer-IJ deposits | *Phragmites,* root | 1465 ± 35 | 542–650 AD | 600 AD |
| BP-2 | KIA 9487 | | 107790 | 500501 | –1.75 | Column S, Oer-IJ tidal-flat deposits | *Scrobicularia plana,* bivalve | 2740 ± 27\* | 485–369 BC | 400 BC |
| BP-3 | KIA 9495 | | 107873 | 500485 | –1.86 | Column U, Oer-IJ tidal-flat deposits | *Scrobicularia plana,* bivalve | 2745 ± 26\* | 490–376 BC | 400 BC |
| BP-4 | KIA 9486 | | 107790 | 500501 | –2.02 | Column S, Oer-IJ tidal-flat deposits | *Scrobicularia plana,* bivalve | 2862 ± 27\* | 760–430 BC | 500 BC\*\*  (625 BC) |
| BP-5 | KIA 9489 | | 107873 | 500485 | –2.85 | Column U, Oer-IJ tidal-flat deposits | *Scrobicularia plana,* bivalve | 2615 ± 37\* | 383–196 BC | 280 BC |
| BP-6 | KIA 9488 | | 107680 | 500596 | –1.50 | Column O, Oer-IJ tidal-flat deposits | *Scrobicularia plana,* bivalve | 2608 ± 32\* | 376–196 BC | 280 BC |
| BP-7 | KIA 9490 | | 107497 | 500666 | –1.09 | Column C, layer III, palaeosoil in Oer-IJ salt-marsh deposits | Humus clay | 2603 ± 49 | 895–548 BC | 790 BC |
| BP-8 | KIA 9492 | | 107497 | 500666 | –1.32 | Column C, layer V, palaeosoil in Oer-IJ salt-marsh deposits | Humus clay | 3429 ± 34 | 1877–1640 BC | 1730 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

\*\*Estimated date is placed in the middle of the marine active period of the Oer-IJ (600-400 BC).

*Palaeolandscape implication*: The Broekpolder site is located at the westward side of the main Oer-IJ channel. Salt-marsh deposits with humic plough mark levels from the Middle Bronze Age and Early Iron age were found. The organic matrix of the Bronze Age plough layer was dated at ±1730 BC. At the channel side, reed stalks in the Early Iron Age level were found and dated at ±790 BC. This corresponds with the oligotrophic peat growth at site Q at the other side of the main channel, and also reflects the relatively quiet conditions in the Oer-IJ during that period.

At the channel side, salt marsh deposits have been covered by sandy tidal flat sediments in which bivalve *Scrobicularia plana* shells occur/were found in living position. Five shells were dated and four of these dates range between 500 and 345 BC. One shell date (BP-4) is slightly older but the 2-sigma error range allows an age younger than 600 BC, i.e. in the active marine period which started after the occupation with the Early Iron Age settlement of site Q. The *Scrobicularia* shells demonstrate the increase in marine activity in the estuary, and also they show that the tidal range (MHW level) increased since they lie on salt-marsh deposits.

A reed rhizome in a peat layer on top of the Oer-IJ tidal deposits along the channel margin was dated at ±600 AD. This indicates that in Early Medieval times peat developed in the former tidal area of the Oer-IJ.

***<h1>Location: Velserbroek-Huis ter Spijk (HS)***

*Table A6.2. 14C dates of Velserbroek-Huis ter Spijk (HS) (Van der Valk, 1992; RGD, not published)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| HS-1 | GrN 9041 | | 105870 | | 493440 | 2.9–3.0 | Top tidal-flat deposits, Wormer Member | *Scrobicularia plana,* bivalved | 4590 ± 35\* | 2892–2666 BC | 2780 BC |

\*Expressed in measured 14C years BP (not corrected for reservoir effect).

*Palaeolandscape implication*: From the upper part of the tidal flat deposits of the Wormer Member a 14C date of a bivalve *Scrobicularia plana* shell was determined at ±2780 BC, in line with the dates from these deposits from the Velsertunnel and Wijkertunnel pits (VT-4 and WT-5/6). This indicates that this area was covered by tidal flats between 2750 and 2000 BC.

***<h1>Location: Velserbroek-borehole 2 (V2)***

*Table A6.3. 14C dates of Velserbroek-borehole 2 (V2) (RGD Palaeobot. Rap. 594; Zagwijn, 1986; De Jong, 1987; Van der Valk, 1992)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| V2-1 | GrN 5661 | | 106950 | | 494970 | 2.03–2.07 | Base *Phragmites* peat layer on top of Oer-IJ salt-marsh deposits | Peat, slightly clayey, bulk | 1920 ± 35 | 2–210 AD | 85 AD |
| V2-2 | GrN 5906 | | 106950 | | 494970 | 2.54–2.57 | Top organic layer in Oer-IJ salt-marsh deposits | Peat, clayey, bulk | 2820 ± 35 | 1108–896 BC | 975 BC |
| V2-3 | GrN 5662 | | 106950 | | 494970 | 2.78–2.81 | Base organic layer in Oer-IJ salt-marsh deposits | *Phragmites* peat, clayey, bulk | 2950 ± 35 | 1264–1044 BC | 1160 BC |
| V2-4 | GrN 5907 | | 106950 | | 494970 | 3.57–3.62 | Organic layer in Oer-IJ salt-marsh deposits | Very humus clay with *Phragmites*, bulk | 3850 ± 55 | 2469–2146 BC | 2320 BC |
| V2-5 | GrN 5663 | | 106950 | | 494970 | 4.74–4.78 | Organic layer in Oer-IJ salt-marsh deposits | Organic clay, humus, bulk | 4140 ± 30 | 2874–2621 BC | 2735 BC |
| V2-6 | GrN 5664 | | 106950 | | 494970 | 6.51–6.52 | Organic layer on tidal deposits of the Wormer Member | Peat, slightly clayey | 4735 ± 55 | 3639–3374 BC | 3525 BC |

*Palaeolandscape implication*: A series of organic layers were dated at this drilling location in the Velserbroek. The dates vary between ±3525 BC and 85 AD. All organic/peaty layers contain more or less clay. The sediment characteristics and diatom content (De Wolf, rapp. 154) indicate that the clay sequence (from the lowest dated sample V2-6 up to V2-2) was formed in a salt-marsh environment and that this environment was in direct contact with the main channel of the estuary. The uppermost sample (V2-1) contained almost no diatoms and was formed in the Roman period when the estuary had lost its direct contact with the North Sea.

***<h1>Location: Velserbroek-borehole 3 (V3)***

*Table A6.4. 14C dates of Velserbroek-borehole 3 (V3) (RGD Palaeobot. Rap. 594; Zagwijn, 1986; Van der Valk, 1992)*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | **Lab. code** | ***x* coord.** | | ***y* coord.** | | **Depth**  **(m –NAP)** | **Stratigraphy** | **Dated material** | **14C years BP** | **Probability 95% (2-sigma)** | **Estimated**  **date** |
| V3-1 | GrN 5914 | | 105870 | | 493440 | 1.78 | Base peat layer, clayey | *Phragmites* peat, clayey, bulk | 2695 ± 35 | 908–802 BC | 850 BC |
| V3-2 | GrN 5915 | | 105870 | | 493440 | 2.37 | Base second peat layer, clayey | *Phragmites* peat, clayey, bulk | 3715 ± 55 | 2286–1952 BC | 2110 BC |
| V3-3 | GrN 5916 | | 105870 | | 493440 | 3.47–3.53 | Third peaty layer | Sandy peat | 4250 ± 60 | 3017–2636 BC | 2855 BC |

*Palaeolandscape implication*: A comparable clay sequence to the V2 location was dated at Velserbroek, drilling three locations (V3). Also in this clay sequence the three organic/peaty layers contain more or less clay. The dates vary between ±2855 and 850 BC. The V3-1 and V2-2 dates (±850 BC and ±975 BC) fit within the quiet period of the Oer-IJ between 1000 and 600 BC. Similar age index points were found in the Assendelverpolders and Broekpolder (AQ-1/4 and BP-7).

1. See Appendix 4 in Williams (2012). [↑](#footnote-ref-1)
2. This in contrast with the insights of Jelgersma et al., 1970; De Jong, 1987c; Westerhoff et al., 1987. [↑](#footnote-ref-2)
3. Centrum voor Isotopen Onderzoek, Rijksuniversiteit Groningen. [↑](#footnote-ref-4)