

Berendsen & Stouthamer (2001)

Appendix 3 Channel belts in the Rhine-Meuse delta

Last update: 3-12-2005, based on additional references, see below.

This appendix is updated every time new results become available.

Archaeological artifacts mentioned here are based on Berendsen (1982), Berendsen ed. (1986), Willems (1986), ARCHIS database (ROB) and Berendsen & Hoek (2005). Abbreviations indicated below are according to ARCHIS database; approximate ages are indicated in ¹⁴C years BP according to other sources and may deviate slightly.

Archaeological abbreviations

LMEB	= Late Middle Ages ((1250 - 1500 AD)
LMEA	= Late Middle Ages ((1050 - 1250 AD)
LME	= Late Middle Ages (1050 - 1500 AD) , approximately 900 yr BP - 450 yr BP
VMED	= Early Middle Ages (900 - 1050 AD)
VMEC	= Early Middle Ages (725 - 900 AD) ≈ Carolingian (650 - 900 AD)
VMEB	= Early Middle Ages (525 - 725 AD) ≈ Merovingian (400 - 650 AD)
VMEA	= Early Middle Ages (450 - 525 AD)
VME	= Early Middle Ages (450 - 1050 AD)
XME	= Middle Ages (450 - 1500 AD) , approximately 1500 yr BP - 450 yr BP
ROMLB=	Late Roman Age (350 AD - 450 AD)
ROMLA	= Late Roman Age (270 AD - 350 AD)
ROML	= Late Roman Age (270 AD - 450 AD)
ROMMB	= Middle Roman Age (150 AD - 270 AD)
ROMMA	= Middle Roman Age (70 AD - 150 AD)
ROMM	= Middle Roman Age (70 AD - 270 AD)
ROMVB	= Early Roman Age (25 AD - 70 AD)
ROMVA	= Early Roman Age (12 BC - 25 AD)
ROMV	= Early Roman Age (12 BC - 70 AD)
ROM	= Roman Age (12 BC - 70 AD), approximately 2000-1550 yr BP; = 50 BC - 400 AD
XR	= Roman Age (12 BC - 450 AD)
IJZL	= Late Iron Age (250 - 12 BC)
IJZM	= Middle Iron Age (500- 250 BC)
IJZV	= Early Iron Age (800- 500 BC)
IJZ	= Iron Age (800- 12 BC) , approximately 2650 - 2000 yr BP; or 800 - 50 BC
BRONSL	= Late Bronze Age (1100 - 800 BC)
BRONSM	= Middle Bronze Age (1800 - 1100 BC)
BRONDMB	= Middle Bronze Age (1500 - 1100 BC)
BRON SMA	= Middle Bronze Age (1800 - 1500 BC)
BRONSV	= Early Bronze Age (2000 - 1800 BC)
BRONS	= Bronze Age (2000 - 800 BC) , approximately 3650 - 2650 yr BP

NEOLB = Late Neolithic (2450 - 2000 BC)
NEOLA = Late Neolithic (2850 - 2450 BC)
NEOL = Late Neolithic (2850 - 2000 BC), approximately 4600 - 3650 yr BP
NEOMB = Middle Neolithic (3400 - 2850 BC)
NEOMA = Middle Neolithic (4200 - 3400 BC)
NEOM = Middle Neolithic (4200 - 2850 BC), approximately 5200- 4600 yr BP
NEOVb = Early Neolithic (4900 - 4200 BC)
NEOVA = Early Neolithic (5300 - 4900 BC)
NEOV = Early Neolithic (5300 - 4200 BC), approximately 6400 - 5200 yr BP
NEO = **Neolithic (5300 - 2000 BC)**

MESOL = Late Mesolithic (6450 - 4900 BC)
MESOM = Middle Mesolithic (7100 - 6450 BC)
MESOV = Early Mesolithic (8800 - 7100 BC)
MESO = **Mesolithic (8800 - 4900 BC)**

PALEOLB = Late Paleolithic (18.000 - 8800 BC)
PALEOL = Late Paleolithic (35.000 - 8800 BC)
PALEOM = Middle Paleolithic (300.000 - 35.000 yr BP)

Other abbreviations

GTS = Gradient of the top of the sand in a channel belt (Dutch: zandverhanglijn)
NAP = Dutch Ordnance Datum, approximately mean sea level.

Contents of the table

In this table, channel belts are described in alphabetical order. Characteristics given for each channel belt include: Upstream/downstream coordinates, Highest sand elevation (relative to NAP), Average gradient (cm/km), Upstream and downstream connections, Dating evidence, Beginning of sedimentation, End of sedimentation, Archaeology, References, Remarks. Numbers of the channel belts refer to the geological-geomorphological map of Berendsen & Stouthamer (2001).

Definitions:

Alluvial ridge

The term *alluvial ridge* includes both the channel belt and the natural levees.

Channel belt

A *channel belt* is regarded as the body of sediment (mostly sand with some gravel), deposited in a former or presently existing river bed, irrespective of the type of river pattern (braided, meandering, straight or anastomosing). Hence, the genetically associated overbank deposits and natural levees are not included in the channel belt.

Perimarine crevasse channels and tidal creeks

In the western part of the Netherlands river area many tidal creeks existed that were known as small 'rivers' draining the peat area at ebb tide. During flood tide the channels became filled with estuarine sediments. Berendsen (1982) described some of these channels as *perimarine crevasse channels*, and regarded them as an indicator of former tidal influence on the river. Most of these perimarine crevasse channels were formed in a fresh-water environment, with fluctuating water levels under the influence of ebb and flood tide. It has become clear that these perimarine crevasse channels may have different ages, and thus can be used to establish the landward limit of tidal influence in the past. However, only a few of these paleochannels have been dated so far. Although some of these channels were evidently important at the time the great 'cope'-reclamations of the western peat area took place, these 'rivers' generally never had a natural connection to the Rhine or the Meuse. They were often connected to the main rivers during the great reclamations by digging canals, and were successively used for drainage. Only a few of them (Alblas, Lange Linschoten) are described in the table. Some of the most important, not described here, are the: Aa (301), Aar (302), Amstel (303), Does (304), Drecht (305), Gantel (306), Giessen (307), Gouwe (308), Kromme Angstel (309), Kromme Giessen (310), Lake (311), Lier (312), Lopikerwetering (313), Meije (314), Mijdrecht (315), Oude Waver (316), Rotte (317), Schie (318), Vlaarding (319), Zijl (320). Some of these creeks occur outside the mapped area, see also: Van de Ven (1996: 62-64). If they occur in the mapped area, they are indicated on the palaeogeographic map. Many of these former creeks were dammed up in the Late Middle Ages, and cities that sprang up around the dam were named after the river or former tidal creek and got the suffix 'dam': e.g. Alblasterdam, Amsterdam, Dubbeldam, Giessendam, Rotterdam, Schiedam, Werkendam.

The creeks ('killen') of the Biesbosch area are modern equivalents of the perimarine creeks, although not all perimarine creeks were necessarily formed in one disastrous flood, as was the case in the Biesbosch.

Period of activity

The *period of activity* of a channel belt is defined as the time interval of clastic sedimentation in the channel belt (formation of sandy channel deposits) and adjacent overbank areas (predominantly clayey natural levee deposits, crevasse-splay deposits and flood-basin deposits). The term is used as a synonym for interavulsion period.

River system

A *river system* is defined as a complex of channel belts that have certain common characteristics. These may involve: age, source area, or direction of flow.

The following river systems have been defined:

- Benschop river system
- Utrecht river system
- Krimpen river system
- Maas river system
- Linschoten river system
- Graaf river system
- Est river system

1. Aaksterveld 5345-4620 yr BP

Upstream/downstream coordinates: 129-442/125-440.

Highest sand elevation (relative to NAP in m): -2.0 to -2.4.

Average gradient (cm/km): 10.0

Connections: upstream: Zijderveld; downstream: Langerak.

Dating evidence: ^{14}C , archaeological traces, pollen analysis, relative dating.

Beginning of sedimentation: no direct dates available; presumably the same as Zijderveld: 5345 ± 40 yr BP (GrN-18922).

End of sedimentation: no direct dates available; presumably the same as Zijderveld: 4620 ± 60 yr BP (GrN-5221), residual channel date.

Archaeology: no archaeological traces.

References: Berendsen (1982: 158); Törnqvist (1993: 144); Louwe Kooijmans (1974); Pons (1951), Vink (1926, 1954: Vijfheerenlandstroom); De Boer & Pons (1960), De Jong (1970-1971).

Remarks: Channel deposits are in contact with Pleistocene sand.

2. Achterbroek 4920-3920 yr BP

Upstream/downstream coordinates: 111-445/103-439.

Highest sand elevation (relative to NAP in m): circa -4.7.

Average gradient (cm/km): not enough data to measure accurately.

Connections: upstream: Lopik-Haastrecht; downstream: unknown (lost in built-up area).

Dating evidence: ^{14}C , relative dating.

Beginning of sedimentation: no direct dates available; presumably the same as Lopik: 4920 ± 35 yr BP (GrN-7956).

End of sedimentation: no direct dates available; presumably the same as Lopik: 3920 ± 60 yr BP (GrN-7575), residual channel date.

Archaeology: Roman Age, Late Middle Ages.

References: Berendsen (1982: 151-156, 199-206).

Remarks: the channel is a tributary of the Lopik channel belt, and therefore it may have existed during a shorter period than the Lopik channel belt.

3. Achthoven 6190-5350 yr BP

Upstream/downstream coordinates: 132-436/127-442.

Highest sand elevation (relative to NAP in m): -3.9 to -4.9.

Average gradient (cm/km): 16.6

Connections: upstream: Nieuwland; downstream: Cabauw.

Dating evidence: ^{14}C , archaeological traces, relative dating.

Beginning of sedimentation: 6000 ± 35 yr BP (GrN-7958) and 6190 ± 45 yr BP (GrN-18926).

End of sedimentation: 5350 ± 35 yr BP (GrN-7957) and 5220 ± 50 yr BP (GrN-18925).

Archaeology: no archaeological traces.

References: Berendsen (1982: 147-148), Törnqvist (1993: 144), Verbraeck (1970).

Remarks: no direct dates are available.

4. Afgedamde Maas 890-46 yr BP

Upstream/downstream coordinates: 141-417/128-425.

Highest sand elevation (relative to NAP in m): +5.4 to +2.7.

Average gradient (cm/km): 18 (measured along present river channel)

Connections: upstream: Maas; downstream: Boven-Merwede; former connections with Oude Maasje and Alm.

Dating evidence: ^{14}C , archaeology, relative dating.

Beginning of sedimentation: Since about 1250 AD (700 yr BP) the Maas followed a course along the present Afgedamde Maas (Sonneveld 1958). This course is by all authors considered to be a natural one, although some human influence in our opinion cannot be entirely ruled out. A residual channel date of the Alm channel belt (which existed before the Afgedamde Maas took over its discharge) gave an age of: 890 ± 40 yr BP (UtC-3626).

End of sedimentation: sedimentation still occurs in the embanked floodplain, since the Afgedamde Maas is still connected to the river Maas by the Heusdens Kanaal. However, the river was dammed near its downstream end in 1904 AD (46 yr BP). At the same time the Bergsche Maas was dug, which gave the Maas its own outlet to the Haringvliet estuary.

Archaeology: Late Middle Ages. Near Bern some Roman artefacts were found on erosional remnants of older channel belts.

References: Weerts & Berendsen (1995: 207), Berendsen ed. (1986: 53, 105-106), Sonneveld (1958).

Remarks:

1. The Oude Maasje was dammed near Hedikhuizen between 1230 AD (Fockema Andreae 1950) and 1270 AD (Ramaer 1899). According to Hardenberg (1954) the Afgedamde Maas was connected to the Rhine branches Alm and Werken. During the 12th century a new course north of Giessen was formed, and the Meuse (the present Afgedamde Maas) flowed into the Waal near Woudrichem forming the Merwede river.
2. A meander cutoff occurs near Veen. The cutoff seems artificial and probably occurred around 1500 AD. The meander of Hedikhuizen was artificially cut off in 1475 AD, the meander near Heusden in 1460 AD (Edelman et al. 1950, Berendsen ed. 1986).
3. A slight difference between the ^{14}C residual channel date (890 yr BP) and the historical age (700 yr BP) was also found in other channel belts (Berendsen 1982), and is explained by assuming that the residual channel still contained water for some centuries after the new channel belt was formed. Often gyttja was formed in the old channel.
4. Older parts of the channel belt that are located outside of the presently embanked floodplain are indicated on the palaeogeographic map with number 4a.

5. Alblas 1200-700 yr BP

Upstream/downstream coordinates: 104-430/113-431.

Highest sand elevation (relative to NAP in m): -3.4 to -3.6.

Average gradient (cm/km): 2.9

Connections: upstream: no eastward connection (the Alblas is a tidal creek), now connected to a drainage canal; downstream: Noord.

Dating evidence: Archaeology, relative dating, historical evidence.

Beginning of sedimentation: uncertain. Most likely the river originated as a drainage creek of the peat area, and direction of flow was reversed during floods. Estimated beginning of sedimentation: around 1200 yr BP.

End of sedimentation: dammed at Alblasserdam in the Middle Ages, most likely around 1250 AD (700 yr BP) when the Alblasserwaard was embanked.

Archaeology: Roman Age, Middle Ages.

References: Bosch & Kok (1994).

Remarks: The dam obviously existed before the 1421 AD St. Elizabeth's flood.

6. Alm 2340-890 yr BP

Upstream/downstream coordinates: 130-422/126-420.

Highest sand elevation (relative to NAP in m): +0.6 (Giessen) to +0.2 (Almkerk).

Average gradient (cm/km): 6.7 (distance measured along residual channel).

Connections: upstream: Afgedamde Maas-Bruchem; downstream: Werken and Almkerk-Oude Maasje.

Dating evidence: ^{14}C , archaeology, relative dating.

Beginning of sedimentation: 2340 ± 30 yr BP (GrN-18108).

End of sedimentation: residual channel date 890 ± 40 yr BP (UtC-3626).

Archaeology: Archeological traces of Roman Age are found on the natural levees, Late Middle Ages.

References: Weerts & Berendsen (1995: 207), Weerts (1995: 82), Sonneveld (1958).

Remarks: The Alm channel belt was the downstream continuation of the Bruchem channel belt, but was rejuvenated by the Afgedamde Maas, until the Afgedamde Maas found a new connection to the river Waal near Woudrichem. This presumably happened in the 12th century (Sonneveld 1958). Before 1230 AD a dam was built in the Alm channel near Giessen (Van de Ven 1996: 63). This agrees very well with the residual channel date.

7. Almkerk 1983-890 yr BP

Upstream/downstream coordinates: 126-420/122-418.

Highest sand elevation (relative to NAP in m): -0.3 to -0.7.

Average gradient (cm/km): 8.0 (distance measured along the channel belt).

Connections: upstream: Alm; downstream: eroded by the St. Elizabeth's flood (1421 AD), formerly connected to Oude Maasje, via the present Bleeke Kil in the Biesbosch area (Beekman 1932, Van de Ven 1996: 62).

Dating evidence: ^{14}C , archaeology, relative dating.

Beginning of sedimentation: not yet dated, possibly the same as Nieuwendijk: 1983 ± 36 yr BP (UtC-6851).

End of sedimentation: the same as the residual channel date of the Alm: 890 ± 40 yr BP (UtC-3626), but probably slightly older.

Archaeology: no archeological traces.

References: Weerts & Berendsen (1995: 207), Weerts (1995: 82), Sonneveld (1958), Beekman (1932), Van de Ven (1996).

Remarks: The Alm channel belt was the downstream continuation of the Bruchem channel belt, but was rejuvenated by the Afgedamde Maas, until the Afgedamde Maas found a new connection to the river Waal near Woudrichem. The Almkerk seems to be the youngest branch of the Alm channel belt. The age of this channel belt has not yet been accurately determined, but is known from historical evidence (Beekman 1932). This branch essentially followed the course of the present Bleeke Kil in the Biesbosch area. The 1421 AD St. Elizabeth's flood eroded the course of the Oude Maasje in the Biesbosch area.

The Almkerk channel is shown as the 'Alm' on Beekman's Historische Atlas van Nederland, part 1, sheet 47. It debouched into the Oude Maasje near the former Medieval village of Almmonde.

8. Altforst 4765-4370 yr BP

Upstream/downstream coordinates: 173-426/168-428.

Highest sand elevation (relative to NAP in m): +5.3 to +4.4.

Average gradient (cm/km): 15.0

Connections: upstream: Wijchens Maasje (older phase); downstream: Molenblok-Appelaar.

Dating evidence: ^{14}C dating, archaeology.

Beginning of sedimentation: 4765 ± 60 yr BP (GrN-6996).

End of sedimentation: based on a direct residual channel date: 4370 ± 60 yr BP (GrN-6998).

Archaeology: Iron Age, Roman Age, Middle Ages.

References: Verbraeck (1984: 208-210); Berendsen, Hoek & Schorn (1995).

Remarks: Age estimates based on age of oldest phase of Wijchens Maasje, and depth of overbank deposits. However, archaeological traces suggest a younger age.

9. Andel 4820-4160 yr BP

Upstream/downstream coordinates: 131-421/122-419 and 131-420/127-420

Highest sand elevation (relative to NAP in m): -1.3 to -1.8.

Average gradient (cm/km): 10 (not very accurate; few data).

Connections: upstream: Zaltbommel-Nederhemert-Esterweg; downstream: eroded by the sea.

Dating evidence: ^{14}C , archaeology, relative dating.

Beginning of sedimentation: no direct ^{14}C dates available, based on Nederhemert: 4820 ± 70 yr BP (GrN-12462).

End of sedimentation: no direct ^{14}C dates available, based on Nederhemert: 4160 ± 60 yr BP (GrN-11476).

Archaeology: possibly no archaeological traces.

References: Weerts & Berendsen (1995: 207), Weerts (1995: 82), Sonneveld (1958).

Remarks: The date 4160 ± 60 yr BP has been erroneously given the number GrN-12461 by Weerts & Berendsen (1995: 207) and by Weerts (1995: 76, 82). The correct number is GrN-11476.

10. Angstel 2650-1850 yr BP

Upstream/downstream coordinates: 128-467/126-474.

Highest sand elevation (relative to NAP in m): circa -3.0, based on Van de Meene (1988).

Average gradient (cm/km): not enough data to measure accurately.

Connections: upstream: Kromme Rijn; downstream: North Sea near Velsen.

Dating evidence: ^{14}C , archaeology, historical evidence.

Beginning of sedimentation: see also Vecht. Cleveringa (1985, report 895b) dated the top of a peat layer underlying clay: 2620 ± 35 yr BP (GrN-10224). This is in good agreement with dates by Törnqvist (1993: 149-150): 2650 ± 80 yr BP (UtC-1900) and 2620 ± 50 yr BP (UtC-1901). After the Roman period fluvial activity of the Vecht increased, while that of the Angstel decreased (Cleveringa 1985, report 895b).

End of sedimentation: circa 100 AD = 1850 yr BP (degradation of the Roman fortification near Velsen).

Archaeology: oldest archaeological traces: Iron Age near Baambrugge and Abcoude. Roman Age near the

mouth of the Angstel/Vecht (Velsen); many traces dating from the Late Middle Ages.
References: Berendsen (1982: 168), Törnqvist (1993: 149-150), Van de Meene (1988: 51), De Jong & Zagwijn (1973, report 690), De Jong (1981, report 895), Cleveringa (1985, report 895b).
Remarks: The channel belt is the downstream continuation of the Houten/Kromme Rijn channel belts (Berendsen 1982: 169). ¹⁴C dating in the Vecht/Angstel area by the Netherlands' Geological Survey has produced erroneous results (GrN-10223 and GrN-10226 thru GrN-10230 and GrN-10232, mainly due to the reworking of peat in lakes. Because the reliability of some ¹⁴C dates in this area may be questioned, discussion continues with regard to the exact dating of the Angstel and Vecht channel belts. According to Weerts (personal communication, 2000) the Angstel channel belt came into existence around 3000 yr BP (GrN-6719) and was already abandoned around 2270 yr BP (GrN-6761). If these ¹⁴C dates are correct, most activity in the Vecht channel belt ended as early as 1695 ± 30 yr BP (GrN-6718). This would mean that discharge was diverted to the Lek immediately after Roman times.

11. Appelaar 4700-3800 yr BP

Upstream/downstream coordinates: 154-427/151-427.
Highest sand elevation (relative to NAP in m): +3.0 to +1.5.
Average gradient (cm/km): channel belt too short for reliable measurements.
Connections: upstream: Nieuwe Schans and Molenblok; downstream: Esterweg-Zaltbommel-Nederhemert.
Dating evidence: ¹⁴C, relative dating.
Beginning of sedimentation: 4700 yr BP (estimate).
End of sedimentation: 3765 yr BP (GrN-6999), based on a date of the Dreumel channel belt at Altforst.
Archaeology: no archaeological traces.
References: Verbraeck (1984), Weerts & Berendsen (1995).
Remarks: Age estimates based on Nieuwe Schans-Wijchens Maasje. The end of the Appelaar channel belt is slightly younger than the end of the Esterweg-Zaltbommel-Nederhemert channel belts. This age difference is considered to be insignificant, considering the margin of error involved in the dating of the Nederhemert channel belt (Weerts & Berendsen 1995).

12. Autena 6110-5350 yr BP

Upstream/downstream coordinates: 141-441/135-445.
Highest sand elevation (relative to NAP in m): +0.4 to +0.1.
Average gradient (cm/km): 10.0
Connections: upstream: Maurik; downstream: Benschop-Willeskop.
Dating evidence: ¹⁴C, archaeological traces, relative dating.
Beginning of sedimentation: River activity in the underlying Tienhoven channel belt started around 7000 yr BP (estimate). The downstream Benschop channel belt existed already before 7600 ± 45 yr BP (GrN-9408), but was presumably initially fed by the Kortenhoeven channel belt. The rejuvenation phase of the Tienhoven channel belt is called the Autena channel belt, the beginning of which was dated at: 6110 ± 50 yr BP (UtC-6715).
End of sedimentation: the final phase of activity of the underlying Tienhoven channel belt is dated at: 6260 ± 60 yr BP (UtC-6714). Final activity of Autena channel belt has been dated directly at: 5430 ± 90 yr BP (UtC-6977); indirectly at: 5350 ± 35 yr BP (GrN-7957).
Archaeology: no archaeological traces.
References: Verbraeck (1970), Berendsen (1982: 147).
Remarks: The Autena channel belt has not been accurately mapped by the Netherlands' Geological Survey. The Tienhoven channel belt was rejuvenated by the Autena channel belt. The older Tienhoven channel is connected to the Benschop channel belt, the younger Autena channel to the Willeskop channel belt. The oldest overbank deposits of the Tienhoven channel belt rest directly on the Kreftenheye Formation.

13. Avezaath 2410-1842 yr BP

Upstream/downstream coordinates: 157-436/153-434.
Highest sand elevation (relative to NAP in m): +4.0 to +3.7
Average gradient (cm/km): 15.0
Connections: upstream: Ochten-Echteld; downstream: Buren-Hagestein.
Dating evidence: ¹⁴C, relative dating, historical evidence.

Beginning of sedimentation: presumably the same as Buren channel belt: 2410 ± 60 yr BP (UtC-4637).

End of sedimentation: 1842 ± 42 yr BP (UtC-6847).

Archaeology: Oldest traces: Iron Age. Many Roman Age and Middle Age traces. A small but younger residual channel south of Kerk-Avezaath (called the Daver) is filled up with clay, that is rich in 10th century sherds (personal communication M. Van Dinter, ROB). This channel is not the residual channel of the Avezaath channel belt, although the two channels have been connected on some maps. The connection is not visible in the terrain. Detailed mapping shows, that the Daver is a crevasse channel of the Linge.

References: Verbraeck (1984).

Remarks: The residual channel is generally still visible in the landscape. The channel crosses the older Zoelen channel belt, and continues northwestwards to Buren. The beginning of activity practically coincides with that of the Hagestein channel belt. The residual channel probably contained water from Roman until early Carolingian times.

An older channel belt may be present in the subsoil (see also the description of the Distelkamp-Afferden channel belt): near Avezaath there are two levels of overbank deposits. The oldest level occurs around 0 m NAP.

The residual channel of the so-called Daver was dated at 1090 ± 38 yr BP (UtC-6842). This is in exact accordance with archaeological traces (personal communication M. Van Dinter, ROB). The Daver obviously was a crevasse channel of the Linge, that may partly have followed the residual channel of the Avezaath channel belt.

14. Baal 3200-2200 yr BP

Upstream/downstream coordinates: 192-433/189-435.

Highest sand elevation (relative to NAP in m): +8.7 to +8.4

Average gradient (cm/km): 10.0

Connections: upstream: Zandvoort; downstream: Ressen.

Dating evidence: ^{14}C dating, archaeology.

Beginning of sedimentation: estimate 3200 yr BP.

End of sedimentation: A direct date of terrestrial botanical macrofossils gave an age of 2378 ± 35 yr BP (UtC-8170). This closely corresponds with dates obtained for the Ressen channel belt, which is the downstream continuation.

Archaeology: Iron Age, Roman Age, Early and Late Middle Ages.

References: Verbraeck (1984), Willems (1986); De Jong (1980, report 880), Teunissen (1984).

Remarks: The sand depth corresponds with that of the Ressen and Zandvoort channel belts. Archaeological traces indicate an end of sedimentation in Roman times. The channel belt is younger than Walbeek.

The residual channel date of 3110 ± 190 (GrN-10600), carried out by De Jong (1980) is considered too old, see also Willems (1986) and Teunissen (1984). Based on pollen analysis an end of sedimentation around 2000 yr BP is more likely. However, the age cannot be younger than that of the surrounding channel belts (Ressen, Snodenhoek, Santacker). Therefore the date of 2200 yr BP is accepted as representing the end of sedimentation.

15. Benschop 10.000-6200 yr BP

Upstream/downstream coordinates: 131-445/107-444.

Highest sand elevation (relative to NAP in m): circa -4.0 to -7.0.

Average gradient (cm/km): 13.6

Connections: upstream: Kortenhoeven and Tienhoven; downstream: Gouderak and Waddinxveen, subsequently lost under younger marine deposits.

Dating evidence: ^{14}C , relative dating.

Beginning of sedimentation: part of the system may have been active since the formation of Terrace X; in any case it existed after 7600 ± 45 yr BP (GrN-9408). At some locations younger dates are found; these may apply to distributaries of different age, e.g.: 6745 ± 45 yr BP (GrN-18930) and 6850 ± 55 yr BP (GrN-8659).

End of sedimentation: most of the Benschop river system ended before 6335 ± 45 yr BP (GrN-9406; Bosch & Kok 1994), or 6260 ± 60 yr BP (UtC-6714) but these dates may not be valid for all the distributary channel belts. A study by Kombrink (unpublished MSc thesis) suggests that the Benschop, Willeskop and Oudewater channel belts were abandoned simultaneously. Dates obtained are: 6210 ± 50 yr BP (UtC-12338), 6238 ± 49 yr BP (UtC-12336), and 6261 ± 49 yr BP (UtC-12340). However, Berendsen & Stouthamer (2001) suggested that the youngest part continued until 5350 ± 35 yr BP (GrN-7957), which is in agreement to dates found for the Autena and Maurik channel belts. Törnqvist (1993) obtained some intermediate dates: $5800 \pm$

70 yr BP (GrN-1894) and 5610 ± 60 yr BP (GrN-1897). A possible explanation may be that after abandonment of the main channels approximately 6200 yr BP, discharge of the Maurik channel belt was diverted to smaller channel belts, e.g., the Buitenzorg channel belt.

Archaeology: no archaeological traces.

References: Törnqvist (1993: 145-146), Bosch & Kok (1994: 73, 91), Berendsen (1982: 142-143, 148).

Remarks:

1. The Benschop system has many distributaries that may have slightly different ages, although ^{14}C dates obtained by Kombrink (unpublished MSc thesis) suggest that the individual channel belts were abandoned simultaneously. The Willeskop and southern branch of the Oudewater channel belts probably emerged from Terrace-X. The southern branch of the Willeskop channel belt and the northern branch of the Oudewater channel belt formed after avulsions approximately 7600 yr BP.
2. Overbank deposits of the oldest phase of activity (Willesskop channel belt, southern branch of Oudewater channel belt) rest directly on the Kreftenheye Formation, suggesting that the channel belts emerged from the terrace X. This does not apply to the northwesternmost branch (Waddinxveen channel belt) and the northern branch of the Oudewater channel belt, which cut into the Twente Formation.
3. During the 1999 field campaign in the area between the village of Polsbroek and Stolwijk-Berkenwoude two Wijchen Layers consisting of sandy clay were found on top of each other. Both layers were bounded at the top by a vegetation horizon. Since the age of the vegetation horizons is dated at Allerød-interstadial and Preboreal respectively (Törnqvist et al. 1993), this suggests that in this area the Lower terrace is present (see discussion in Berendsen & Stouthamer 2001). The terrace intersection between the Lower terrace and terrace X is probably located only a few kilometers to the west, most likely near Rotterdam. However, data from Kombrink's study suggest that two vegetation horizons also occur on top of Terrace-X. In addition, he found a much larger elevation difference (1,3 m) between the Lower Terrace and Terrace-X than Törnqvist (1993). As yet, these contradictions remain unresolved.
4. The elevation of the top of the channel deposits (Törnqvist, 1993: Appendix 1), suggests that at least two generations of channel belts are present. This was confirmed by detailed mapping during the 1999 field campaign; there may be even three or four levels.
5. At many places a thin peat or gyttja layer was found that was dated around 6535 ± 100 yr BP (GrN-2354) to 6335 ± 45 yr BP (GrN-9406). This may be connected to an avulsion of one of the distributaries of the Benschop river system.
6. New cross sections (Berendsen, 2005 – Laaglandgenese database) show, that the N-S running Willesskop channel belt, mapped by Verbraeck (1970) in the Polder Willesskop (122-446), does not exist. Instead, an E-W running channel belt exists in this area, that is clearly visible in the digital elevation map of the Netherlands, based on laser-altimetry (AHN, Rijkswaterstaat-AGI 2004). This channel belt is a distributary of the Blokland channel belt (Berendsen & Volleberg 2006). The moment of abandonment has been dated by a sample in the residual channel, but the result is not yet available.

16. Bergambacht 7200-6335 yr BP

Upstream/downstream coordinates: 116-443/100-434.

Highest sand elevation (relative to NAP in m): -4.5 to -10.2 (?). The elevation of -10.2 m was obtained from a core of the Netherlands Geological Survey (now NITG-TNO), but for obvious reasons this cannot be correct.

Average gradient (cm/km): 28.5 (not accurate due to few available data in the western part).

Connections: upstream: Benschop; downstream: North Sea.

Dating evidence: ^{14}C , relative dating.

Beginning of sedimentation: a terminus post quem date of 7580 ± 70 yr BP (GrN-10233) of the base of a gyttja-layer at 10.45 m-NAP was obtained near Berkenwoude. The beginning of clay sedimentation of the Berkenwoude and Bergambacht channels is estimated to begin around 7200 yr BP.

End of sedimentation: 6335 ± 45 yr BP (GrN-9406). This is the date for final activity of the Benschop channel, obtained near Polsbroek. However, this date is not representative for the whole Benschop river system, as the northwesternmost branches (Willesskop, Oudewater) are definitely younger.

Archaeology: no archaeological traces.

References: Bosch & Kok (1994: 73, 91).

Remarks: The Benschop river system has many distributaries that may have slightly different ages. The age given here for the end of sedimentation is considered to be an approximate age for the end of sedimentation of the Bergambacht channel belt. The date for beginning activity is probably a maximum age. The exact dating of the channel belt is a matter of further study. Near Rotterdam a date of 6535 ± 100 yr BP (GrN-2354) was obtained for beginning river activity. It is at present unclear whether or not this date is related to

the Bergambacht/Berkenwoude channel belts.

17. Bergsche Maas 46-0 yr BP

Upstream/downstream coordinates: 141-416/120-414.

Highest sand elevation (relative to NAP in m): highly variable because there are no proper channel deposits (the channel was dug).

Average gradient (cm/km): unknown.

Connections: upstream: Maas; downstream: Amer.

Dating evidence: historical evidence.

Beginning of sedimentation: 1904 AD (= 46 yr BP).

End of sedimentation: sedimentation in the embanked floodplains still continues.

Archaeology: not applicable.

References: Berendsen (1986: 53, 108-109).

Remarks: Canal dug in order to create a separate outlet to the sea for the river Meuse; the canal is embanked.

18. Berkenwoude 7200-6335 yr BP

Upstream/downstream coordinates: 116-443/100-434.

Highest sand elevation (relative to NAP in m): -4.5 to -10.2 (?). The elevation of -10.2 m was obtained from a core of the Netherlands Geological Survey (now NITG-TNO), but for obvious reasons this cannot be correct.

Average gradient (cm/km): 28.5 (not accurate due to few available data in the western part)

Connections: upstream: Benschop; downstream: North Sea.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: a terminus post quem date of 7580 ± 70 yr BP (GrN-10233) of the base of a gyttja-layer at 10.45 m-NAP was obtained near Berkenwoude. The beginning of clay sedimentation of the Berkenwoude channel is estimated to begin around 7200 yr BP. At the same location a date of 9480 ± 60 yr BP (GrN-10234) was obtained at a level of approximately 15.2 m-NAP. According to Bosch & Kok (1994: cross section G-G') this date refers to Kreftenheye deposits.

End of sedimentation: 6335 ± 45 yr BP (GrN-9406). This is the date for final activity of the Benschop channel, obtained near Polsbroek. However, this date is not representative for the whole Benschop river system, as the northwesternmost branches (Willeskop, Oudewater) are definitely younger.

Archaeology: no archaeological traces.

References: Bosch & Kok (1994: 73, 91).

Remarks: The Benschop river system has many distributaries that may have slightly different ages. The age given here for the end of sedimentation is considered to be an approximate age for the end of sedimentation of the Berkenwoude channel belt. The date for beginning activity is a maximum age. The exact dating of the channel belt is a matter of further study. Near Rotterdam a date of 6535 ± 100 yr BP (GrN-2354) was obtained for beginning river activity. It is at present unclear whether or not this date is related to the Bergambacht/Berkenwoude channel belts.

19. Biesheuvel-Hamer 4020-3210 yr BP

Upstream/downstream coordinates: 137-419/123-418 (Hamer: 132-417/131-417).

Highest sand elevation (relative to NAP in m): +0.9 to -0.3

Average gradient (cm/km): 8.0

Connections: upstream: Wordragen-Hedel-Hoorzik; downstream: eroded by the St.Elizabeth's flood of 1421 AD.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: after 5420 ± 35 yr BP (GrN-19327) and 5310 ± 50 yr BP (GrN-21717), presumably around 4020 yr BP, based on terminus ante quem date of 4020 ± 35 (GrN-18102) for the Broek channel belt. Erosional remnants of the Wijk en Aalburg-Broek channel belt are present near the Biesheuvel channel belt; the older dates mentioned above may be related to the Wijk en Aalburg-Broek channel belt. The beginning of activity of the Broek channel belt is circa 5590 yr BP (based on the end of activity of the Brakel channel belt).

End of sedimentation: based on terminus ante quem for Hedel: 3210 ± 40 (GrN-18100) and 3090 ± 40 yr BP

(GrN-18101); direct date of Hamer (a small side channel): 3460 ± 40 yr BP (GrN-21716). The date of 2980 ± 100 yr BP (UtC-7865) may be regarded as a terminus ante quem date for the activity of the Biesheuvel channel belt.

Archaeology: Oldest known find: Middle Bronze Age (3125 ± 40 yr BP, GrN-5357). Also Iron Age, Roman Age, Middle Ages.

References: Weerts & Berendsen (1995: 205), Weerts (1995: 81), Sonneveld (1958).

Remarks: a date of the Hamer residual channel of 5340 ± 40 yr BP (GrN-21719) is obviously much too old. The Hamer is not necessarily of exactly the same age as the Biesheuvel channel belt; the sand depth suggests that it may have ended a little earlier than the Biesheuvel channel belt. This may explain the slight difference between the end of the Hamer (3460 yr BP) and the end of the Hedel (3210 yr BP) channel belt.

20. Bleskensgraaf 5350-3823 yr BP

Upstream/downstream coordinates: 117-432/106-431.

Highest sand elevation (relative to NAP in m): -2.3 to -4.1

Average gradient (cm/km): 18.0

Connections: upstream: Langerak-Zijderveld; joins with downstream part of Schoonrewoerd; downstream: unknown (eroded by Oude Waal; deposits are present in the subsoil near Rijsoord).

Dating evidence: ¹⁴C, archaeological traces, relative dating.

Beginning of sedimentation: presumably the same as Zijderveld. Related dates are: 5350 ± 50 yr BP (GrN-10105), 5290 ± 60 (GrN-10100), 5320 ± 60 (GrN-10844), 5345 ± 45 (GrN-10852), 5120 ± 60 yr BP (GrN-10865), 5120 ± 70 yr BP (UtC-4648), and terminus post quem: 6040 ± 70 yr BP (GrN-10870), 5420 ± 40 (GrN-10889) and 5245 ± 75 yr BP (GrN-2342). Beginning activity of Schoonrewoerd: 4620 ± 50 yr BP (GrN-8370), 4520 ± 60 yr BP (GrN-10886), see Makaske (1998: 193). Downstream of the junction clay layers occur under overbank deposits that are deposited by the Zijderveld channel belt (Makaske 1998).

End of sedimentation: presumably the same as Schoonrewoerd: 3570 ± 70 yr BP (GrN-10108), 3570 ± 70 yr BP (GrN-10846), 3560 ± 70 (GrN-10848), 3660 ± 55 yr BP (GrN-2817), 3770 ± 60 yr BP (GrN-10862), 3730 ± 70 yr BP (GrN-10863), 3780 ± 60 yr BP (GrN-10871), 3770 ± 60 yr BP (GrN-10890), 3770 ± 35 yr BP (GrN-10895). Residual channel dates: 3900 ± 90 yr BP (GrN-10855), 3823 ± 40 yr BP (UtC-4647).

Archaeology: Late Neolithic, Bronze Age, Iron Age.

References: Bosch & Kok (1994), Berendsen (1982: 158); Törnqvist (1993: 143); Van der Woude (1981: 60-63), Louwe Kooijmans (1974: 93, 97); Pons (1951: 10), Vink (1926, 1954: Overlekschenstroom); De Boer & Pons (1960: 26), De Jong (1970-1971), Verbraeck (1970: 79), Makaske (1998).

Remarks: According to De Boer & Pons (1960) and Louwe Kooijmans (1974), reduced activity (peat formation) of the Schoonrewoerd channel belt occurred between approximately 4700 and 4200 yr BP. However, Makaske (1998: 214-217) showed that the underlying clay layer was not deposited by the Schoonrewoerd channel belt, but by the Zijderveld channel belt. Related dates: GrN-10888, GrN-10889, GrN-10891, GrN-10984, GrN-10985 (Van Dijk, unpublished).

21. Blok 3795-3000 yr BP

Upstream/downstream coordinates: 134-450/132-451.

Highest sand elevation (relative to NAP in m): -0.1 to -0.6

Average gradient (cm/km): 14.7.

Connections: upstream: Houten; downstream: Jutphaas-Linschoten.

Dating evidence: ¹⁴C, archaeological traces, relative dating.

Beginning of sedimentation: Presumably similar to the beginning of the Houten channel belt (3795 ± 55 yr BP, GrN-9152). Törnqvist (1993: 148) obtained a direct terminus post quem date for the beginning of activity of the younger phase of the Jutphaas channel belt: 4200 ± 60 yr BP (UtC-1898); the Blok channel belt is part of this younger channel belt (Berendsen 1982).

End of sedimentation: Residual channel date of Jutphaas river channel belt: 2715 ± 35 yr BP (GrN-7962). The Blok channel is supposed to have ended activity slightly earlier, because the residual channel of the southern course continues, while the Blok channel was cut off.

Archaeology: Late Iron Age, Roman Age, Middle Ages.

References: Berendsen (1982: 174-176), Van Tent (1978). Vink (1926: 156).

Remarks: The gradient of the top of the sand of the Blok channel belt virtually coincides with that of the Jutphaas channel belt.

22. Blokhoven 4600-3800 yr BP

Upstream/downstream coordinates: 143-442/139-443.

Highest sand elevation (relative to NAP in m): circa +1.0.

Average gradient (cm/km): channel belt too short for reliable measurements.

Connections: upstream: Schoonrewoerd? downstream: Lage Dijk?

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: The Blokhoven channel belt could not be dated directly. Overbank deposits of the Honswijk channel belt overlies crevasse deposits of the Schoonrewoerd and Zijderveld channel belts, and no intercalated peat was found.

End of sedimentation: The end of sedimentation could not be established, but predates the Honswijk channel belt.

Archaeology: oldest archaeological traces: Late Iron Age, Roman Age, Middle Ages.

References: Berendsen (1982: 147, 150, 170), De Boer & Pons (1960: 25), Makaske (1998).

Remarks:

1. The channel belt seems to cut through the Zijderveld channel belt near Culemborg, and hence has to be younger.
2. The sand of the channel deposits generally is not in contact with the Pleistocene sand.
3. Age determinations are based on indirect ¹⁴C dates. The Blokhoven channel belt cannot be older than the Zijderveld channel belt (5350 - 4620 yr BP). It seems to be cut by the Honswijk channel belt, which is thought to be of the same age as the Hennisdijk channel belt (circa 3800 - 3000 yr BP). The base of the residual channel fill of the Honswijk channel belt was dated at 3050 ± 30 yr BP (GrN-8714). Hence the period of activity of the Blokhoven channel belt has to be within the time span from 4620-3800 yr BP. This is in general agreement with the age deduced by Berendsen (1982: 147, 150, 170), and with relative datings (see below).
4. A direct date of 2688 ± 37 yr BP (UtC-6845) was obtained from the top of peat underlying clay, north of the Blokhoven/Honswijk channel belts. Remarkably, the dating result almost coincides with the beginning of the Buren and Hagestein channel belts. This date is therefore interpreted as indicating the beginning of sedimentation of the Hagestein channel belt.

23. Blokland - Snelrewaard 4450-4115 yr BP

Upstream/downstream coordinates: 126-444/123-449.

Highest sand elevation (relative to NAP in m): -1.3 to -2.4

Average gradient (cm/km): 9.6.

Connections: upstream: Lopik; downstream: Snelrewaard

Dating evidence: ¹⁴C, pollen analysis, archaeology, relative dating.

Beginning of sedimentation: 4450 ± 40 yr BP (GrN-18931).

End of sedimentation: Blokland: 4115 ± 60 yr BP (GrN-7578), Snelrewaard: 4180 ± 60 yr BP (GrN-7969), residual channel dates. Related dates: Lopik: 3920 ± 60 yr BP (GrN-7575), residual channel date, and beginning of peat formation on basin clay near Lopik: 4125 ± 30 yr BP (GrN-7955).

Archaeology: oldest archaeological traces: Bronze Age (Vogel & Waterbolk 1972: 94, Louwe Kooijmans 1974).

References: Berendsen (1982: 153-156, 199-206); Törnqvist (1993: 145).

Remarks:

1. Dating by De Jong & Zagwijn (1967, report 471) and Verbraeck (1970) is incorrect as a result of incorrect lithological correlation.
2. The top of the channel belt is eroded by a crevasse splay of the Stuivenberg channel belt. The channel belt is cut through by the Hollandse IJssel and Lange Linschoten. The connection between the Blokland channel belt (south of the Hollandse IJssel) and the Snelrewaard channel belt (north of the Hollandse IJssel) is undisputed.
3. An E-W running tributary channel belt is clearly visible in the digital elevation map of the Netherlands, based on laser-altimetry (AHN, Rijkswaterstaat-AGI 2004). This channel belt was missed in all existing maps. It is a tributary of the Blokland channel belt (Berendsen & Volleberg 2006). The moment of abandonment has been dated by a sample taken from the residual channel, but the result is not yet available.

24. Boelenham 2650-2200 yr BP

Upstream/downstream coordinates: 174-436/172-438.

Highest sand elevation (relative to NAP in m): +5.8 to +5.4

Average gradient (cm/km): 8.0

Connections: upstream: Distelkamp; downstream: unknown.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: 2650 yr BP; Steenbeek (1990) obtained a date of 2710 ± 80 yr BP (GrN-11552).

End of sedimentation: 2250 yr BP.

Archaeology: Iron Age, Roman Age, Late Middle Ages.

References: Verbraeck (1984), Steenbeek (1990: 137-140, 159).

Remarks: beginning of activity is based on Steenbeek (1990); end of activity is based on archaeological traces and Steenbeek (1990). South of the Boelenham channel belt overbank deposits of an older channel belt occur, named the 'Veedijk deposits' by Steenbeek (1990: 137-140). The channel belt that formed the Veedijk deposits (roughly dated between 5700 yr BP and 5000 yr BP) has not been mapped. Bronze Age settlements occur on the Veedijk channel belt. The Veedijk deposits probably were formed by the Winssen channel belt, that occurs about 5 km to the southeast. The Boelenham channel seems to have been a distributary of the Distelkamp channel belt. Based on the elevation of the sand, the Boelenham channel belt cannot be correlated to the Kesteren channel belt (that has approximately the same width), because sand of the Kesteren channel belt occurs at a much lower elevation.

25. Bommel 2936-2310 yr BP

Upstream/downstream coordinates: 155-431/150-429.

Highest sand elevation (relative to NAP in m): +4.1 to +3.4

Average gradient (cm/km): 14.0

Connections: upstream: Echteld-Ochten; downstream: Est-Gameren-Rijswijk-Hardinxveld.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: 2936 ± 37 (UtC-6716) and 3124 ± 38 (UtC-6848).

End of sedimentation: 2480 ± 60 (UtC-6745). Dates from the residual channel of the Est channel belt: 2190 ± 60 yr BP (GrN-12465) and 2310 ± 60 yr BP (GrN-12466) by Törnqvist (1990: 225) are thought to apply also to the Bommel channel belt.

Archaeology: Archeological traces of Late Iron Age, Roman Age, Early and Late Middle Ages.

References: Verbraeck (1984), Törnqvist (1990: 225).

Remarks: The residual channel is no longer visible in the landscape. The reach downstream from Est has been rejuvenated (Törnqvist 1990).

26. Bonrepas 4920-3920 yr BP

Upstream/downstream coordinates: 117-442/112-439.

Highest sand elevation (relative to NAP in m): -3.5 to -6.0

Average gradient (cm/km): 29.4 (possibly inaccurate due to a lack of data in the western part).

Connections: upstream: Lopik; downstream: lost in the peat area of the central Krimpenerwaard.

Dating evidence: ¹⁴C, pollen analysis, archaeology, relative dating.

Beginning of sedimentation: presumably the same as Lopik: 4920 ± 35 yr BP (GrN-7956).

End of sedimentation: presumably the same as Lopik: 3920 ± 60 yr BP (GrN-7575), residual channel date.

Beginning of peat formation on basin clay: 4125 ± 30 yr BP (GrN-7955). Related dates: 3995 ± 40 yr BP (GrN-9403) and residual channel dates of Blokland and Snelrewaard: 4115 ± 60 (GrN-7578) and 4180 ± 60 (GrN-7969).

Archaeology: no archaeological traces.

References: Berendsen (1982: 151-156, 199-206) Bosch & Kok (1994).

Remarks: the channel is a distributary of the Lopik channel belt, and may have existed during a shorter period of time.

27. Brakel 6515-5590 yr BP

Upstream/downstream coordinates: 146-422/133-425.

Highest sand elevation (relative to NAP in m): circa -2.1.

Average gradient (cm/km): not enough data to measure accurately.

Connections: upstream: unknown, probably eroded; downstream: Gorkum-Arkel.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: 6515 ± 50 yr BP (GrN-18927).

End of sedimentation: 5590 ± 70 yr BP (UtC-1895); before 5360 ± 50 yr BP (UtC-1557).

Archaeology: no archaeological traces.

References: Weerts & Berendsen (1995: 205), Weerts (1995: 80).

Remarks: Overbank deposits directly overlie the Wijchen Layer on the Younger Dryas terrace in the area southwest of Tiel. The age given by Weerts & Berendsen (1995: 205), and Weerts (1995: 80) is probably erroneous. The channel belt deposits are rich in calcium carbonate, suggesting that the river was not only a Meuse distributary, but it was also fed by the Rhine.

28. Brandwijk 5780-4800 yr BP

Upstream/downstream coordinates: 115-432/115-433.

Highest sand elevation (relative to NAP in m): circa -3.4.

Average gradient (cm/km): channel belt too short for reliable measurements; possibly it is just a large crevasse splay.

Connections: upstream: Langerak; downstream: lost in the peat area.

Dating evidence: ¹⁴C, archaeological traces, relative dating.

Beginning of sedimentation: 5780 ± 70 yr BP (GrN-10860).

End of sedimentation: 4800 ± 60 yr BP (GrN-10859). The date of 4300 ± 50 yr BP (GrN-10858) is a terminus ante quem date.

Archaeology: no archaeological traces.

References: Bosch & Kok (1994), Van der Woude (1981: 60-63), Louwe Kooijmans (1974: 93, 97); unpublished cross section of G. van Dijk (Free University of Amsterdam).

Remarks: The Brandwijk channel seems to be a crevasse splay that was formed by the Zijderveld river channel belt. If this is correct, the date for beginning activity is slightly too old.

29. Bredelaar 2900-2500 yr BP

Upstream/downstream coordinates: 189-436/185-441.

Highest sand elevation (relative to NAP in m): +8.0 to +7.3

Average gradient (cm/km): 11.7

Connections: upstream: eroded by Ressen; downstream: eroded by Santacker-Driel.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: estimate 2900 yr BP.

End of sedimentation: estimate 2500 yr BP.

Archaeology: Iron Age, Roman Age.

References: Verbraeck (1984), Willems (1986).

Remarks: This relatively small channel belt is covered with overbank deposits of the Ressen channel belt. It seems to be eroded by the Santacker channel belt. The age estimate is based on archaeological traces.

30. Broek 5590-4800 yr BP

Upstream/downstream coordinates: 146-423/142-420.

Highest sand elevation (relative to NAP in m): circa +0.5.

Average gradient (cm/km): channel belt too short to measure accurately.

Connections: upstream: unknown (it seems to emerge from an incised channel in the western part of the Land van Maas en Waal); downstream: Wijk en Aalburg.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: estimate: after 5590 yr BP.

End of sedimentation: terminus ante quem: 4020 ± 35 (GrN-18102), estimate 4800 yr BP, based on indirect age determinations of the Varik, Herwijnen, Broek, and Zaltbommel channel belts.

Archaeology: no archaeological traces.

References: Weerts & Berendsen (1995: 205), Weerts (1995: 81), Berendsen ed. (1986: 44).

Remarks: The channel belt cuts through the Brakel channel belt, and therefore must be younger. Its discharge was taken over by the Zaltbommel channel belt.

31. Broekgraaf 5788-5360 yr BP

Upstream/downstream coordinates: 135-426/139-428.

Highest sand elevation (relative to NAP in m): circa -0.8.

Average gradient (cm/km): channel belt too short to measure accurately.

Connections: upstream: Deil; downstream: Vuren.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: 5788 ± 50 yr BP (UtC-7812), based on the connection with the Deil channel belt.

End of sedimentation: 5360 ± 120 yr BP (UtC-7867), based on the connection with the Deil channel belt; in any case well before 2880 ± 70 yr BP (GrN-1873).

Archaeology: no archaeological traces.

References: Verbraeck (1970), De Jong & Zagwijn (1959, report 229).

Remarks: narrow channel belt, probably partly of the same age as Vuren.

32. Bruchem 2560-1760 yr BP

Upstream/downstream coordinates: 150-424/137-421.

Highest sand elevation (relative to NAP in m): +2.7 to +1.4

Average gradient (cm/km): 3.6 (measured along channel belt; probably too low)

Connections: upstream: Oensel-Opijnen-Bommel and Oevershof-Zennewijnen-Leeuwen, but also: Heesselt; downstream: Alm-Werken.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: 2560 ± 40 yr BP (GrN-18104), east of the confluence with the Oensel channel belt.

The Oensel channel belt most likely was active at a slightly earlier stage, as is suggested by archeological traces. Related date: 2560 ± 50 yr BP (GrN-6994).

End of sedimentation: residual channel date 1760 ± 45 yr BP (GrN-12463).

Archaeology: South of Bruchem Early Iron Age inhabitation traces were found on a cut-off meander (Edelman et al., 1950: 117-118). This means that the Oensel-Bruchem channel belt already existed before 500 BC.

Archeological traces of Roman Age are found on the levees (Edelman et al. 1950: 119), suggesting that the channel still contained water during the Roman period, at least until 200 AD.

References: Weerts & Berendsen (1995: 207), Weerts (1995: 82), Törnqvist (1990: 225), Berendsen & Cortenraad (1988: 226), Pons (1957: 41-42).

Remarks: two sherds dating from approximately 1800 BC were found between Bruchem and Kerkwijk. They are believed to have been reworked by the river (Edelman et al. 1950). The Bruchem channel belt between Rossum and the confluence with the Oensel channel belt is younger than the Oensel channel belt.

33. Buitenzorg 4900-4455 yr BP

Upstream/downstream coordinates: 130-448/127-449.

Highest sand elevation (relative to NAP in m): -1.1 to -1.4

Average gradient (cm/km): 6.7.

Connections: upstream: Lage Dijk-Vuylkoop; downstream: erosional remnants in squares 126-450 and 125-450.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: earliest possible date 5350 ± 35 yr BP (GrN-7957) which is the end of the Autena-Benschop-Willeskop channel belt. Most likely date: 4900 (beginning of Lopik channel belt).

End of sedimentation: 4455 ± 60 yr BP (GrN-9264), residual channel date.

Archaeology: no archaeological traces.

References: Berendsen (1982: 150).

Remarks: Small erosional remnant, cut through by the Stuivenberg channel belt. The channel most likely found its way to the Oude Rijn near Woerden; the connection was later completely eroded by the Linschoten channel belt (Berendsen 1982).

34. Buren 2410-1842 yr BP

Upstream/downstream coordinates: 151-435/149-438.

Highest sand elevation (relative to NAP in m): +3.5 to +3.2

Average gradient (cm/km): 6.0

Connections: upstream: Avezaath; downstream: Hagestein.

Dating evidence: ¹⁴C, relative dating, historical evidence.

Beginning of sedimentation: 2410 ± 60 yr BP (UtC-4637).
End of sedimentation: the residual channel, which partly follows the road between Buren and Asch, must have silted up relatively recently. It is estimated that it had silted up completely around 750 AD (1200 yr BP), but the end of sedimentation of the channel is dated earlier (it must be the same as the Avezaath channel), namely 1842 ± 42 yr BP (UtC-6847).
Archaeology: Roman Age and Early Middle Ages.
References: Verbraeck (1984).
Remarks: East of Buren the residual channel is still visible in the present landscape, but does not contain peat. The channel crosses the older Zoelen channel belt. Near Beusichem the channel belt was eroded by the river Lek.

35. Cabauw 6000-5350 yr BP

Upstream/downstream coordinates: 127-443/119-440.
Highest sand elevation (relative to NAP in m): -3.6 to -5.4
Average gradient (cm/km): not enough data to measure accurately.
Connections: upstream: Achthoven; downstream: Bergambacht / Liesveld
Dating evidence: ¹⁴C, archaeological traces, relative dating.
Beginning of sedimentation: 6000 ± 35 yr BP (GrN-7958) and 6190 ± 45 yr BP (GrN-18926).
End of sedimentation: 5350 ± 35 yr BP (GrN-7957) and 5220 ± 50 yr BP (GrN-18925).
Archaeology: no archaeological traces.
References: Berendsen (1982: 147-148), Törnqvist (1993: 144), Verbraeck (1970).
Remarks: It is doubtful whether the channel belt is correctly mapped by Verbraeck (1970).

36. Deil 5788-5360 yr BP

Upstream/downstream coordinates: 147-430/136-429.
Highest sand elevation (relative to NAP in m): +0.3 m (few data available).
Average gradient (cm/km): not enough data to measure accurately.
Connections: upstream: unknown; downstream: Vuren.
Dating evidence: ¹⁴C, relative dating.
Beginning of sedimentation: 5788 ± 50 yr BP (UtC-7812).
End of sedimentation: 5360 ± 120 yr BP (UtC-7867).
Archaeology: Neolithic, Bronze Age (Berendsen & Hoek 2005).
References: Verbraeck (1970), Berendsen & Hoek (2005).
Remarks: the channel may not have been mapped correctly over its entire length, due to a lack of data, and thick layers of overlying clay.

37. Distelkamp-Afferden 4605-2250 yr BP

Upstream/downstream coordinates: 179-434/169-433.
Highest sand elevation (relative to NAP in m): +7.4 to + 6.4
Average gradient (cm/km): 20
Connections: upstream: eroded; downstream: Ochten and (later on) Leeuwen.
Dating evidence: ¹⁴C dating, archaeology.
Beginning of sedimentation: approximately 4605 yr BP, which is the average of dates 4660 ± 30 yr BP (GrN-11554) and 4550 ± 50 yr BP (GrN-11559).
End of sedimentation: circa 2250 yr BP (based on the estimate of Steenbeek (1990) for the end of the Boelenham deposits). The date given by Steenbeek (1990: 155) of 2655 yr BP, which is the average of dates 2600 ± 80 yr BP (GrN-11557) and 2710 ± 80 yr BP (GrN-11552) applies to the moment when a small new channel belt (the Boelenham channel belt) was formed. Underlying fluvial clay supposedly also belongs to the Distelkamp-Afferden channel belt.
Archaeology: Neolithic?, Late Iron Age, Early Roman Age, Early and Late Middle Ages. No Bronze Age traces yet.
References: Steenbeek (1990: 151-155), Verbraeck (1984), Willems (1986).
Remarks: Correlation of the Distelkamp and Afferden channel belts is based on detailed mapping of the embanked floodplains by E. Heunks (pers. communication, 1998), and seems to be beyond any doubt. The so-called 'Dodewaard deposits' and 'Boelenham deposits' of Steenbeek (1990: 140-155) are considered as

flood basin deposits of the Distelkamp-Afferden channel belt. Steenbeek (1990) provided so many local details in his thesis, that it is hard to see the forest through the trees.

The elevation of the top of the sand of Distelkamp-Afferden is slightly below that of the Ressen-Herveld channel belt.

A downstream connection with the Ochten channel belt seems the only possibility, and is also suggested by GTS-lines. Later on, discharge was taken over by Leeuwen-Zennewijnen (3000-2000 yr BP). Possibly a connection existed from Tiel to Kerk-Avezaath to the Zoelen-Erichem-Esterweg channel belts, or via the subsoil of the present Linge channel belt west of Tiel. The Schaik channel belt also seems to have been fed by the Ochten channel belt from 4600-4240 yr BP. This connection was later eroded by the Linge and Avezaath channel belts. From about 3700-3210 yr BP a connection between the Ochten and Hoorzik channel belt is presumed to have existed. This explains why the Hoorzik channel belt (essentially a Meuse channel) is rich in calcium carbonate.

38. Dreumel 3700-3020 yr BP

Upstream/downstream coordinates: 162-430/158-429.

Highest sand elevation (relative to NAP in m): +3.0

Average gradient (cm/km): channel belt too short to be determined accurately.

Connections: upstream: Wijchens Maasje; downstream: Passewaaij.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: no direct ¹⁴C dates of the channel belt are available. The estimate of 3700 is based on the connection to the Westerveld-Ochten channel belt.

End of sedimentation: After 3441 ± 41 yr BP (UtC-8120) a levee was still formed. A residual channel date gave an age of 3020 ± 40 yr BP (UtC-8121). Verbraeck (1984: 220) obtained a date of 3430 ± 45 yr BP (GrN-6955) of a vegetation horizon near Dreumel. This suggests diminished river sedimentation around this time (see also: Wijchens Maasje).

Archaeology: Iron Age, Roman Age, no younger traces.

References: Verbraeck (1984: 210-212); Berendsen, Hoek & Schorn (1995).

Remarks: The channel deposits are generally poor in calcium carbonate, which is characteristic for Meuse deposits. The GTS-line can definitely not be connected to the Zennewijnen channel belt. A connection to the Ochten channel belt (possibly in the subsoil of the younger Passewaaij channel belt) seems most probable. Nieuwe Schans as well as Altforst-Molenblok (that are definitely older) are connected to Appelaar. The age of the Dreumel channel belt must be in the age range that applies for the Wijchens Maasje: 4765-2000 yr BP. According to Pons (1957), final activity of the Wijchens Maasje is of Subatlantic age. This was confirmed by Teunissen (1990): *Secale* occurs directly above the base of the channel fill. However, these samples were taken much farther upstream, where the channel probably remained open for a much longer time period. Near Dreumel the channel belt deposits occur relatively deep below the surface; hence the channel has to be (much) older than Roman times. Archaeological traces are in agreement with this conclusion.

39. Dubbel 1760-800 yr BP

Upstream/downstream coordinates: 109-419/100-424.

Highest sand elevation (relative to NAP in m): unknown (outside the mapped area).

Average gradient (cm/km): no borehole data available.

Connections: upstream: Oude Maasje; downstream: via present the present Oude Maas to Oude Waal-Meuse estuary.

Dating evidence: historical evidence.

Beginning of sedimentation: unknown, estimate 1760 yr BP based on the age of the Oude Maasje.

End of sedimentation: unknown, estimate 800 yr BP.

Archaeology: no archaeological traces.

References: Bosch & Kok (1994), Zonneveld (1960), Sonneveld (1958), Van de Ven (1996).

Remarks: Dates are estimates only, since the channel belt is outside the accurately mapped area. According to Zonneveld (1960), Sonneveld (1958) and Van de Ven (1996: 62) the Dubbel was connected to the Oude Maasje in the former 'Grote Waard' (the present Biesbosch area). The channel was dammed in the Middle Ages near Dubbeldam. The Dubbel is shown on Beekman's Historische Atlas van Nederland, part 1, sheet 47. It was connected to the Oude Maasje near the former Medieval village of Dubbelmonde, and flowed to the NW where in was connected to the present Oude Maas (SW of Dordrecht). The present Oude Maas in this area was then called Dubbel. The Dubbel was connected to the Oude Maasje near Maasdam.

40. Dussen 2980-1760 yr BP

Upstream/downstream coordinates: 137-418/121-416.

Highest sand elevation (relative to NAP in m): +1.7 to +0.1.

Average gradient (cm/km): 11.9 (measured along channel belt)

Connections: upstream: Velddriel; downstream: eroded by the St. Elizabeth's flood of 1421 AD.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: Near Dussen a (terminus post quem) date of 2980 ± 100 yr BP (UtC-7865) was obtained. A 40 cm thick layer of heavy clay overlies the dated sample. On top of this, silty natural levee deposits of the Dussen channel belt occur. Activity should begin after 3090 ± 40 yr BP (GrN-18101), based on a date for the end of the Hedel channel belt, that existed before the Velddriel-Dussen channel belts came into existence. About 2 km north of the town of Eethen a date of 2370 ± 30 yr BP (GrN-21715) was obtained underneath the uppermost clay layer. However, the relationship between the overlying deposits and the Dussen channel belt cannot be proven with certainty, because the Dussen channel belt is too far away from the sampling location. Near Dussen a date of 2220 ± 110 (UtC-7803) indicates the beginning of activity of the Hank channel belt.

End of sedimentation: Related date: 1760 ± 50 yr BP (UtC-1604), residual channel date for the Velddriel channel belt.

Archaeology: Late Iron Age, Roman Age, Merovingian, Carolingian.

References: Weerts & Berendsen (1995: 205), Weerts (1995: 81), Sonneveld (1958).

Remarks: the residual channel still contained water during Roman times. This agrees well with the ¹⁴C date of the end of activity. The Dussen channel belt is clearly younger than the Biesheuvel channel belt.

Near Dussen it was attempted to date the beginning of peat formation in the residual channel. The result (UtC-7804, 4588 ± 48 yr BP) is clearly much too old. Closer examination of the situation showed that the residual channel was incised into peat that overlies coversand of the Twente Formation. The peat was erroneously considered to be part of the channel fill. Similar mistakes were made by others when trying to date residual channels, based solely on borehole data, see e.g. Meinerswijk and Ressen channel belts. It shows that detailed cross sections are a necessity for reliable dating of channel belts using borehole data.

41. Dwarsdijk 4520-3700 yr BP

Upstream/downstream coordinates: 147-442.

Highest sand elevation (relative to NAP in m): 2.0.

Average gradient (cm/km): erosional fragment too small to measure accurately.

Connections: upstream: Werkhoven; downstream: Schoonrewoerd.

Dating evidence: elevation of the sand.

Beginning of sedimentation: 4520 yr BP.

End of sedimentation: 3700 yr BP (same as Schoonrewoerd).

Archaeology: Iron Age, Roman Age, Middle Ages.

References: Berendsen (1982: 149), Makaske (1998).

Remarks: The erosional remnant is too small for reliable dating. The channel belt is presumed to be connected to the Schoonrewoerd channel belt (Makaske 1998).

42. Echteld 2770-1901 yr BP

Upstream/downstream coordinates: 167-435/160-436.

Highest sand elevation (relative to NAP in m): +5.7 to +4.8

Average gradient (cm/km): 17.5 (measured along channel belt, based on Makaske 1998: 208).

Connections: upstream: Distelkamp-Afferden; downstream: Bommel-Est-Gameren-Rijswijk-Hardinxveld, and Avezaath-Buren-Hagestein.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: 2770 ± 90 yr BP (UtC-4640). A clay layer below the dated sample seems to have been deposited by the Ochten channel belt (Makaske 1998: 205, 224).

End of sedimentation: 1901 ± 35 yr BP (UtC-4639).

Archaeology: (Late) Iron Age, Middle and Late Roman Age, Merovingian-Carolingian.

References: Verbraeck (1984: 202, 220), De Boer (1962, report 343), Makaske (1998: 195).

Remarks: The beginning of activity agrees reasonably well with the date of 3400 ± 300 yr BP (UtC-1187), of an

extremely small sample at the base of a sandy clay layer (Dr. A.F.M. de Jong, Utrecht University, unpublished). The width/thickness ratio of the sandbody is circa 65 (Makaske 1998: 231).

43. Eigen Blok 4820-4000 yr BP

Upstream/downstream coordinates: 147-430/138-426.

Highest sand elevation (relative to NAP in m): +0.6 to -0.5.

Average gradient (cm/km): 9.2

Connections: upstream: Esterweg and/or Appelaar; downstream: Zeek-Molenveld-Nederhemert-Andel; with some branches lost in the maze.

Dating evidence: archaeology, relative dating.

Beginning of sedimentation: after 4820 yr BP (end of sedimentation of Deil channel belt).

End of sedimentation: Residual channel dates: GrN-24265 4450 ± 40 yr BP (fraction > 425 µm) and GrN-24408 4560 ± 110 yr BP (fraction >180 µm and <425 µm). These samples, taken by Drs. W. Van Zijverden, are slightly older than expected; based on archaeology a date older than 3650 yr BP seems likely (pers. communication Drs. W. Van Zijverden, ROB).

Archaeology: oldest archaeological traces: Late-Neolithic - Early Bronze Age.

References: Verbraeck (1984).

Remarks: Small channel belt, that is lost downstream in a maze of other small channel belts and crevasse splays. The date for final activity is based on archaeology, but may be slightly earlier, as the ¹⁴C dates suggest.

44. Enspijk 3800-2650 yr BP

Upstream/downstream coordinates: 143-432/137-428.

Highest sand elevation (relative to NAP in m): +0.8 to -0.4.

Average gradient (cm/km): 13.3

Connections: upstream: Hooiblok-Erichem; downstream: unknown.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: no direct ¹⁴C dates available; in any case after 4820 yr BP (end of sedimentation of Deil channel belt); contemporary with Gellicum and Spijk channel belts. The age of 3800 yr BP is just a rough estimate, based on the presence of Neolithic artifacts.

End of sedimentation: 2650 yr BP, based on the presence of Bronze Age artifacts on top of the channel belt. The residual channel could not be dated (Berendsen & Hoek 2005: 29), because it contains only silty clay at the location where it crosses the A2 highway.

Archaeology: Neolithic, Bronze Age, Iron Age, Roman Age, Middle Ages.

References: Verbraeck (1984), Berendsen & Hoek (2005).

Remarks: Small channel belt, that has yet not been dated accurately. It is definitely older than the Linge, and was abandoned before 2650 yr BP.

The depth of the sand of the Enspijk channel belt is considerably greater than that of the upstream Hooiblok channel belt, that seems to represent an avulsion belt (Berendsen & Hoek 2005). The sand depth of narrow channel belts is strongly influenced by the crossing of older channel belts in the substratum. The possibility remains open that the Enspijk and Gellicum channel belts are considerably older than the Hooiblok channel belt. In that case, the Spijk channel belt (which is accurately dated) must be a crevasse of the Gameren channel belt.

45. Erichem 4376-2420 yr BP

Upstream/downstream coordinates: 152-434/150-433.

Highest sand elevation (relative to NAP in m): +3.5 to +2.4.

Average gradient (cm/km): channel belt too short for reliable measurements.

Connections: upstream: Zoelen; downstream: Hennisdijk and Hooiblok and Meteren.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: unknown; probably the same as Zoelen: 4376 ± 37 yr BP (UtC-6846).

End of sedimentation: 2420 ± 140 yr BP ((UtC-4638), residual channel date.

Archaeology: Iron Age, Roman Age, Middle Ages.

References: Verbraeck (1984).

Remarks: Small erosional remnant. The residual channel locally is still visible in the landscape, and was clearly

visible before large-scale levelling occurred in connection to re-allotment.

46. Est 3124-1860 yr BP

Upstream/downstream coordinates: 150-429/146-427

Highest sand elevation (relative to NAP in m): +3.2 to +2.4

Average gradient (cm/km): 16.0

Connections: upstream: Bommel; downstream: Gameren-Rijswijk

Dating evidence: ^{14}C , archaeology, relative dating.

Beginning of sedimentation: 3124 ± 38 yr BP (UtC-6848).

End of sedimentation: main channel: 2480 ± 60 yr BP (UtC-6745). This confirms earlier dates from the residual channel of the Est channel belt, obtained by Törnqvist (1990: 225): 2310 ± 60 yr BP (GrN-12466) and 2190 ± 60 yr BP (GrN-12465). However, the channel was rejuvenated. Törnqvist (1990: 225) obtained a date of 1860 ± 60 yr BP (GrN-12464) for the end of the rejuvenation stage.

Archaeology: Archeological traces of Iron Age, and especially many of Roman Age.

References: Weerts & Berendsen (1995: 207), Weerts (1995: 82), Törnqvist (1993: 140), Törnqvist (1990: 225), Berendsen & Cortenraad (1988: 226), Sonneveld (1958).

Remarks: The residual channel is still visible in the landscape. According to Törnqvist (1990) the residual channel was rejuvenated. This occurred obviously by the Zennewijnen-Hattelaar channel belt. The rejuvenation is in agreement with archaeological evidence.

47. Esterweg 4820-3818 yr BP

Upstream/downstream coordinates: 150-426/149-430.

Highest sand elevation (relative to NAP in m): +2.8 to +2.4.

Average gradient (cm/km): 8.9

Connections: upstream: unknown; downstream: Zaltbommel-Nederhemert.

Dating evidence: ^{14}C , relative dating.

Beginning of sedimentation: no direct ^{14}C dates available.

End of sedimentation: no direct ^{14}C dates available.

Archaeology: no archaeological traces.

References: Verbraeck (1984).

Remarks: Dating of the beginning of activity is based on the connection with Zaltbommel-Nederhemert. The initial discharge of the Esterweg channel belt was determined by the Wijchens Maasje-Nieuwe Schans-Molenblok-Appelaar channel belts, between circa 4800 and 4376 yr BP. Later on, discharge increased because the Zoelen-Erichem channel joined the Esterweg channel. Final activity is presumed to be determined by the beginning of activity of the Hennisdijk channel belt (instantaneous avulsion).

48. Gameren 2950-1860 yr BP

Upstream/downstream coordinates: 145-424/134-425.

Highest sand elevation (relative to NAP in m): +2.2 to +0.3

Average gradient (cm/km): 17.0

Connections: upstream: Est-Bommel; downstream: Rijswijk.

Dating evidence: ^{14}C , archaeology, relative dating.

Beginning of sedimentation: 2810 ± 190 yr BP (UtC-1896), this sample was taken far away from the channel belt. The beginning of activity is presumed to be synchronous with the Bommel-Est channel belt (related dates: 2936 ± 37 (UtC-6716) and 3124 ± 38 (UtC-6848). Berendsen ed. (1986: 54) placed the main period of sedimentation between 300 BC and 300 AD, based on the ^{14}C dates 1795 ± 30 yr BP (GrN-12456) and 2315 ± 35 yr BP (GrN-12457) in a cross section west of Brakel.

End of sedimentation: A residual channel date of 3180 ± 80 yr BP (GrN-18098) was rejected, because it is far too old. Dates from the residual channel of the Est channel belt: 2190 ± 60 yr BP (GrN-12465) and 2310 ± 60 yr BP (GrN-12466) by Törnqvist (1990: 225) are believed to apply also to the Gameren channel belt. This is in accordance with archaeological traces. However, the channel was rejuvenated. Törnqvist (1990: 225) obtained a date of 1860 ± 60 yr BP (GrN-12464) for the end of the rejuvenation stage.

Archaeology: Oldest traces: Iron Age. Archeological traces of Roman Age are found on both sides of the residual channel (Edelman et al., 1950: 119), suggesting that it still contained water during the Roman period, at least until 200 AD.

References: Weerts & Berendsen (1995: 207), Weerts (1995: 82), Berendsen ed. (1986: 53, 64), Törnqvist (1993: 140), Törnqvist (1990: 225), Berendsen & Cortenraad (1988: 226), Sonneveld (1958).

Remarks: Sand from the river Waal has been deposited in the residual channel (Edelman et al. 1950: 15).

49. Gedempte Devel 2370-619 yr BP

Upstream/downstream coordinates: 103-425/100-426.

Highest sand elevation (relative to NAP in m): circa -3.0.

Average gradient (cm/km): not enough data to be measured accurately.

Connections: upstream: Dussen; downstream: Oude Waal-Meuse estuary.

Dating evidence: relative dating, historical evidence.

Beginning of sedimentation: unknown, estimate 2370 yr BP, based on age of Dussen.

End of sedimentation: in 1331 AD (619 yr BP) the channel was dammed (RAAP report 304). At the same time the Zwijndrechtsche Waard was embanked.

Archaeology: no archaeological traces.

References: Bosch & Kok (1994), Zonneveld (1960), Sonneveld (1958), Van de Ven (1996).

Remarks: Dates are estimates only, since the channel belt is outside the accurately mapped area. According to Zonneveld (1960), Sonneveld (1958) and Van de Ven (1996) the Gedempte Devel was connected to the Dussen in the former 'Grote Waard' (the present Biesbosch area), but the reach northwest of Dordrecht obviously remained open longer than the channel of the Dussen.

50. Gelderse IJssel 1700-0 yr BP

Upstream/downstream coordinates: 193-440/184-510

Highest sand elevation (relative to NAP in m): +10.1 (Arnhem) to +8.9 (Doesburg) to +6.2 (Voorst).

Average gradient (cm/km) from Arnhem to Doesburg: 6.7 (measured along present channel), 9.2 (measured along channel belt)

Connections: upstream: Nederrijn-Pannerdens Kanaal-Rijn; downstream: IJsselmeer (Lake IJssel)

Dating evidence: ¹⁴C, archaeology, historical evidence.

Beginning of sedimentation: 2000 ± 65 yr BP (GrN-5491); 1830 ± 110 yr BP (GrN-11894); 1720 ± 25 yr BP (GrN-7525); 1575 ± 35 yr BP (GrN-10293). Sedimentation seems to have increased gradually.

End of sedimentation: the river was partly embanked around 1200 AD. In the embanked floodplains sedimentation still continues (Middelkoop 1997).

Archaeology: Late Roman, Early Middle Ages, Late Middle Ages.

References: Lanting & Mook (1977); Willems (1986: 48-49); Teunissen (1988: 36); Teunissen (1990: 74, 97, 104, 110); Berendsen (1990).

Remarks: The clay content of the dated peat samples gradually increases between 2000 yr BP and 1575 yr BP. This suggests that the river gradually became more important over a period of 400 years.

Meander cutoffs occur at many places, for example Giesbeek (1970 AD), Doesburg-Praterwaard (1946 AD), Zutphen-Oude IJssel (1450 AD), Bakerwaard (1400 AD). All these cutoffs are artificial. Older natural cutoffs may also occur, but these are located outside of the accurately mapped area.

Older meanders of the channel belt that are now outside the embanked floodplain, are indicated with number 50a on the palaeogeographic map.

51. Gellicum 2510-2200 yr BP

Upstream/downstream coordinates: 142-432/137-425.

Highest sand elevation (relative to NAP in m): +0.7 to -0.5 m

Average gradient (cm/km): 13.3

Connections: upstream: Erichem; downstream: Mert-Spijk.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: no direct ¹⁴C dates available, age based on Spijk channel belt: 2510 ± 50 yr BP (UtC-1891).

End of sedimentation: no direct dates available; age based on Spijk channel belt: residual channel dates 2150 ± 40 yr BP (UtC-1425) and 1900 ± 50 yr BP (UtC-1480). These dates initially were rejected by Törnqvist (1993: 141-142) but they are approximately correct; they represent a terminus ante quem for the end of sedimentation of the Spijk channel belt (Törnqvist 1993: 142).

Archaeology: no archaeological traces (Berendsen & Hoek 2005).

References: Verbraeck (1984), Berendsen & Hoek (2005).

Remarks: The channel belt has been eroded by the Waal and Linge channel belts.

The depth of the sand of the Gellicum channel belt is approximately the same as that of the Enspijk channel belt, but considerably greater than that of the upstream Hooiblok channel belt. This may be a result of differential compaction. Also, the sand depth of narrow channel belts is strongly influenced by the crossing of older channel belts in the subsoil. The Enspijk and Gellicum channel belts are probably considerably older than the Hooiblok channel belt, which seems to be a subrecent avulsion belt (Berendsen & Hoek 2005). In that case, the Spijk channel belt (which is accurately dated) must be a crevasse of the Gameren channel belt.

52. Gorkum-Arkel 6515-5590 yr BP

Upstream/downstream coordinates: Gorkum: 128-427/130-430; Arkel: 128-427/121-423..

Highest sand elevation (relative to NAP in m): circa -3.5.

Average gradient (cm/km): not enough data to measure accurately.

Connections: upstream: Brakel; downstream: unknown (eroded?), but probably connected to some erosional remnants in the Biesbos area.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: 6515 ± 50 yr BP (GrN-18927), 6550 ± 60 yr BP (GrN-18918).

End of sedimentation: 5620 ± 50 yr BP (UtC-1556), 5590 ± 70 yr BP (UtC-1895), 5400 ± 50 yr BP (GrN-18917); before 5360 ± 50 yr BP (UtC-1557).

Archaeology: no archaeological traces.

References: Törnqvist (1993: 141).

Remarks: The Gorkum-Arkel channel belt has only been partly mapped; for this reason its upstream and downstream connections are uncertain.

53. Gouderak 7600-6335 yr BP

Upstream/downstream coordinates: 107-444/105-442

Highest sand elevation (relative to NAP in m): -6.5 to -7.7.

Average gradient (cm/km): 15.0 (not very accurate due to few data).

Connections: upstream: Tienhoven-Benschop; downstream: marine deposits.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: A direct date of humic clay underneath overbank deposits gave an age of 8020 ± 70 yr BP (GrN-8734). This is one of the oldest dates obtained for Holocene accretional fluvial channel belts in the entire Rhine-Meuse delta. However, the extremely low level of the overbank deposits seems to exclude that this layer was deposited by the Gouderak channel belt (Bosch & Kok 1994, cross section F-F'). Instead, the layer must have been deposited by a channel belt that was not mapped. Further east, accretion started later. The earliest date obtained for the Benschop channel belt suggests that accretion started there slightly before 7600 ± 45 yr BP (GrN-9408).

End of sedimentation: before 6335 ± 45 yr BP (GrN-9406) or 6455 ± 40 yr BP (GrN-8736).

Archaeology: no archaeological traces. Roman traces occur on the levees of the Hollandse IJssel where this river cuts through the Gouderak channel belt.

References: Bosch & Kok (1994: 73, 91).

Remarks: The Gouderak channel belt obviously is the oldest channel belt of the Benschop river channel belt.

54. Goyland 4870-4500 yr BP

Upstream/downstream coordinates: 124-442/120-440.

Highest sand elevation (relative to NAP in m): Goyland: -1.7 to -2.2 m

Average gradient (cm/km): 17.0 (few data, not very accurate).

Connections: upstream: Zijderveld; downstream: unknown, lost in the peat area.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: 4870 ± 40 yr BP (GrN-18932).

End of sedimentation: no direct ¹⁴C dates available; probably activity ends around 4500 yr BP (before the end of activity of the Lopik channel belt).

Archaeology: no archaeological traces.

References: Berendsen (1982: 156); Törnqvist (1993: 144).

Remarks: Channel deposits are not in contact with Pleistocene sand. The gradient of the top of the sandy channel deposits shows, that the channel belt was not connected to the Liesveld channel belt, as is suggested by Bosch & Kok (1994); the Goyland channel belt is younger than the Liesveld channel belt. The Goyland channel belt seems to be approximately contemporaneous with the Langerak channel belt.

55. Haastrecht 4920-3920 yr BP

Upstream/downstream coordinates: 117-442/113-445.

Highest sand elevation (relative to NAP in m): -4.4 to -4.7.

Average gradient (cm/km): 4.3 (not very accurate, due to a lack of data).

Connections: upstream: Lopik; downstream: Achterbroek.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: presumably the same as Lopik: 4920 ± 35 yr BP (GrN-7956).

End of sedimentation: presumably the same as Lopik: 3920 ± 60 yr BP (GrN-7575), residual channel date.

Archaeology: no archaeological traces. Roman Age traces on Achterbroek channel belt.

References: Berendsen (1982: 151-156, 199-206).

Remarks: the channel is a distributary of the Lopik channel belt, and may have existed during a shorter period than the Lopik channel belt.

56. Hagestein 2514-1050 yr BP

Upstream/downstream coordinates: 137-444/133-444.

Highest sand elevation (relative to NAP in m): +2.8 to +2.2

Average gradient (cm/km): 15 (inaccurate due to few data).

Connections: upstream: Buren (although remnants of the continuation of the Honswijk channel belt are also present in the subsoil); downstream: Hollandse IJssel.

Dating evidence: ¹⁴C, relative dating, historical evidence.

Beginning of sedimentation: 2514 ± 38 (UtC-6713), based on the Buren channel belt. A direct date of 2688 ± 37 yr BP (UtC-6845) was obtained from the top of peat underlying clay, north of the Blokhoven and Honswijk channel belts. This date is interpreted as indicating approximately the beginning of sedimentation of the Hagestein channel belt.

End of sedimentation: before 1050 yr BP (the residual channel still contained water in the Early Middle Ages).

Archaeology: Late Iron Age, Roman Age, Middle Ages. A Bronze Age find within the embanked floodplains of the River Lek is either reworked, or has to belong to the underlying Honswijk channel belt, that follows the same course.

References: Berendsen (1982: 181), Vink (1926: 130-137; Vink 1954: 415-419), Pons (1951: 9), De Boer & Pons (1960: 26-29), Verbraeck (1970: 33), Louwe Kooijmans (1974: 92).

Remarks: Remnants of the older Hennisdijk-Honswijk channel are present in the subsoil, and are clearly visible in cross sections. The geometry of the Hagestein channel belt is rather complicated, since its present course follows or crosses at least two older channel belts: the Tienhoven-Benschop channel belt and the Vuylkoop channel belt. The cross section published by Verbraeck (1970) does not show the correct geometry of the sand body.

57. Hank 2200-1130 yr BP

Upstream/downstream coordinates: 133-416/121-415.

Highest sand elevation (relative to NAP in m): +0.5 to -1.0

Average gradient (cm/km): 5.0

Connections: upstream: Dussen; downstream: eroded by the St. Elizabeth ingression (1421 AD).

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: Approximately 2 km west of Dussen a date of 2220 ± 110 (UtC-7803) was obtained for the beginning of activity of the Hank channel belt. The channel at this location does not have clearly defined overbank deposits, since these are either eroded by the St. Elizabeth's flood of 1421 AD, or they are obscured by overlying estuarine deposits.

End of sedimentation: The residual channel date Dussen-Voogdwerf-2 (1130 ± 100 yr BP, UtC-7864) is at the same time a terminus post quem date for the beginning of estuarine sedimentation in this area, that is historically dated at 1421 AD (St. Elizabeth's flood). Considering the local lithostatigraphy, the ¹⁴C age seems to be reasonable.

Archaeology: no archaeological traces.

References: Weerts & Berendsen (1995: 205), Weerts (1995: 81), Sonneveld (1958).

Remarks: The depth of the sand near Dussen suggests, that the Hank channel belt is younger than the Dussen channel belt. However, the Hank channel is not known from historical sources. Farther to the west the sand depth decreases rapidly, possibly as a result of estuarine erosion after the St. Elizabeth's flood. Estuarine deposits in the area around the town of Hank reach a thickness of 1.9 m. The channel belt width decreases westward. This suggests that the Hank channel belt has a fluvial origin. Lithology varies from mainly fine sand and occasional pockets of medium sand to sandy clay. The channel belt is extremely rich in shell fragments. This suggests that the channel experienced tidal influence. Possibly it was connected to the Oude Maasje.

58. Hardinxveld 2071-2000 yr BP

Upstream/downstream coordinates: 121-427/117-426.

Highest sand elevation (relative to NAP in m): unknown.

Average gradient (cm/km): channel belt too short to measure accurately.

Connections: upstream: Rijswijk-Gameren-Est-Bommel; downstream: unknown (eroded by the Waal).

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: no direct ¹⁴C dates available; age based on Rijswijk.

End of sedimentation: no direct ¹⁴C dates available; age based on Rijswijk.

Archaeology: no archaeological traces.

References: Verbraeck (1984).

Remarks: Since the Rijswijk-Hardinxveld channel belt is directly connected to the Est-Gameren channel belt, the end of sedimentation should also be the same. The residual channel date of the Est channel belt, obtained by Törnqvist (1990: 225) of 1860 ± 60 yr BP (GrN-12464) applies for the end of the rejuvenation stage of the Est channel belt. However, the Rijswijk-Hardinxveld channel was cut by the Linge. The beginning of the Linge was dated at 2160 yr BP. This is clearly impossible. It shows that the ¹⁴C dates cannot be trusted to date river channel belts within one standard deviation of the measurement. Nevertheless, it can be concluded that the narrow Rijswijk-Hardinxveld channel belt was active for only a very short period of time.

59. Haren 4570-3020 yr BP

Upstream/downstream coordinates: 171-422/166-423.

Highest sand elevation (relative to NAP in m): +4.7 to +4.1

Average gradient (cm/km): 7.5

Connections: upstream: unknown; downstream: Lith.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: Berendsen & Stouthamer (2001) estimated beginning sedimentation at approximately 4020 yr BP, based on the downstream connection to the Lith and Hedel-Hoorzik channel belts. New (Cohen, 2003) datings obtained near Berghem indicate that clay deposition started after 4570 ± 70 yr BP (UtC-11760).

End of sedimentation: based on two residual channel dates: 3020 ± 60 yr BP (UtC-7807) and 3303 ± 39 yr BP (UtC-8122). Both dates are considered to be correct, but the date of 3303 ± 39 yr BP (UtC-8122) may be representative only for the northern channel. Therefore the youngest date is taken to represent the end of sedimentation.

Archaeology: Bronze Age, Iron Age, Roman Age, Early and Late Middle Ages. There are some Mesolithic traces in the surrounding area, but these must be related to the Pleistocene subsurface or eolian river dunes.

References: Van Diepen (1954).

Remarks: The residual channel sample dated at 3020 ± 60 yr BP (UtC-7807), is confusingly named Macharen after the nearest village; the dated sample has no relation to the Macharen channel belt. The Haren channel belt seems to be crossed by the Macharen channel belt. The Haren channel belt deposits do not contain calcium carbonate. Channel deposits are at greater depth below the surface than channel belt deposits of Macharen, which suggests that the Haren is indeed older than Macharen. The ¹⁴C date UtC-7866: 6870 ± 130 yr BP refers to the earliest peat formation in the Raam valley, a little river/brook draining the north-eastern section of the Peel Horst. It probably reoccupied a Late Glacial course through the eastern Maaskant area (Cohen, Stouthamer & Berendsen, 2002), has nothing to do with the Haren channel belt.

60. Hedel-Wordragen 4020-3210 yr BP

Upstream/downstream coordinates: 148-420/141-418.

Highest sand elevation (relative to NAP in m): +1.8 to -0.1.

Average gradient (cm/km): 19.0 (measured along channel belt).

Connections: upstream: Hoorzik; downstream: Biesheuvel.

Dating evidence: ¹⁴C, relative dating, GTS-lines.

Beginning of sedimentation: A date of 4020 ± 35 yr BP (GrN-18102) obtained by Weerts (1995) roughly indicates the beginning of activity.

End of sedimentation: terminus ante quem: 3210 ± 40 yr BP (GrN-18100) and 3090 ± 40 yr BP (GrN-18101).

Archaeology: Iron Age, Roman Age, Late Middle Ages.

References: Weerts & Berendsen (1995: 205), Weerts (1995: 81), Berendsen ed. (1986: 56).

Remarks: Since the channel belt seems to be the downstream continuation of the Ochten-Westerveld and Wijchens Maasje-Dreumel channel belts, the channel may have been active between 4610 and 3290 yr BP. The channel belt has been eroded by the Velddriel channel belt.

61. Heesselt 2560-1760 yr BP

Upstream/downstream coordinates: 153-425/152-425.

Highest sand elevation (relative to NAP in m): circa +3.4.

Average gradient (cm/km): channel belt too short to be measured accurately.

Connections: upstream: Leeuwen (connection eroded by the Waal); downstream: Bruchem-Alm-Werken.

Dating evidence: ¹⁴C, relative dating, GTS-lines.

Beginning of sedimentation: 2560 ± 40 yr BP (GrN-18104), east of the confluence with the Oensel channel belt.

End of sedimentation: no direct ¹⁴C dates available; residual channel date of Bruchem channel belt 1760 ± 45 yr BP (GrN-12463).

Archaeology: no archaeological traces.

References: Verbraeck (1984).

Remarks: The Heesselt and Oevershof channel belts seem to be the upstream continuation of the Bruchem channel belt. GTS-lines match very well.

62. Heldam 2500-1650 yr BP

Upstream/downstream coordinates: 130-455/128-455.

Highest sand elevation (relative to NAP in m): 0.0 to -0.1

Average gradient (cm/km): 2

Connections: upstream: Kromme Rijn; downstream: Oude Rijn.

Dating evidence: ¹⁴C, archaeology, dendrochronology.

Beginning of sedimentation: not exactly known, estimate 2500 yr BP.

End of sedimentation: circa 120 AD (1830 yr BP), based on archaeological evidence. Residual channel date: 1930 ± 60 yr BP (UtC-6978).

Archaeology: oldest archaeological traces: Roman Age.

References: Berendsen (1982: 168), Törnqvist (1993: 148-149).

Remarks: The channel belt is the downstream continuation of the Kromme Rijn channel belt (Berendsen 1982: 168). The channel belt must be older than the final stage of the Oude Rijn. At the south side of the residual channel a Roman road was found (pers. communication E. Graafstal, 1997, ROB) on the natural levee. The road constructions were dendrochronologically dated at 123 AD (pers. communication H. de Groot, 1998 Archaeological Department, City of Utrecht). The road was slightly eroded by the channel, indicating that river activity still continued during the Roman Age.

The Heldam channel belt seems to have two periods of activity (see Törnqvist 1993, enclosure). This was confirmed by detailed archaeological mapping (pers. communication E. Schorn, 1999). The older phase remains undated, but must be younger than 4310 ± 90 yr BP (UtC-1892). A 2 m deep trench cut through the entire channel belt showed, that three stages of activity existed (personal observation H.J.A. Berendsen 2000). The oldest stage occurs underneath a vegetation horizon that was archeologically dated as Iron Age. The middle stage is probably younger than Iron Age. The levees of the youngest stage occur on top of the Iron Age vegetation horizon. The youngest stage ended during Roman times (Drs. E. Graafstal, personal communication). The residual channel of the youngest stage is only about 3 m wide and 0.5 m deep. Many Roman artifacts were found in the residual channel. Samples were taken for ¹⁴C dating by Berendsen.

The Heldam channel belt cuts through a so-called perimarine crevasse channel (Berendsen 1982, map sheet

1). The residual channel of this crevasse was exposed in an excavation by the Rijksdienst voor Oudheidkundig Bodemonderzoek (ROB). The channel fill consisted of a 30 cm thick layer of calcareous gyttja at the base overlain by *Phragmites* peat (base: 3830 ± 90 yr BP, UtC-6975) and *Alnus* peat (top: 3103 ± 34 yr BP, UtC-6948). Both the channel and its levees were overlain by a clearly developed vegetation horizon that is presumably of Roman age (pers. communication E. Graafstal, 1998, ROB) without any datable organic material. Terrestrial botanical macrofossils from the underlying calcareous gyttja were dated at: 3664 ± 44 (UtC-7811). A bulk sample of the underlying calcareous gyttja (fraction $> 425 \mu\text{m}$) was dated at: 3870 ± 80 yr BP. The calcium carbonate fraction of this sample gave a dating result of 4620 ± 130 yr BP; however, this age can be neglected because it has no meaning for the dating of the channel belt. The dating results show that gyttja samples give ages that are too old, but may be considered approximately correct if the fraction $> 425 \mu\text{m}$ is dated. A similar conclusion was drawn by Steenbeek (1990). See also dating results of the Ressen channel belt, and discussions by Hoek (1997: 112).

63. Hennisdijk 3818-2975 yr BP

Upstream/downstream coordinates: 150-434/148-439.

Highest sand elevation (relative to NAP in m): +3.2 to +1.8.

Average gradient (cm/km): 14.3 (based on Makaske 1998: 208).

Connections: upstream: Erichem-Zoelen-Ommeren; downstream: Honswijk-Over Oudland-Stuivenberg.

Dating evidence: ^{14}C , archaeology, relative dating.

Beginning of sedimentation: 3818 ± 42 yr BP (UtC-4643). Related dates: 3895 ± 40 yr BP (GrN-6229) and 3945 ± 35 yr BP (GrN-6230).

End of sedimentation: 2975 ± 35 yr BP (UtC-4642), residual channel date.

Archaeology: Bronze Age, Iron Age, Roman Age, Middle Ages.

References: Makaske (1998: 208, 212-214, 224), Verbraeck (1984).

Remarks:

1. Older overbank deposits occur in the subsoil. These deposits were dated between 6220 ± 70 yr BP (UtC-4646) and 5170 ± 110 (UtC-4644). The corresponding channel belt has not been mapped.
2. Verbraeck (1984) erroneously correlated the Hennisdijk channel belt to the Schoonrewoerd channel belt. This connection is clearly impossible, since the Hennisdijk channel belt came into existence only after the Schoonrewoerd channel belt silted up (Makaske 1998).
3. The width/thickness ratio of the sandbody is circa 35 (Makaske 1998: 231).
4. Since the Hennisdijk channel belt crosses the Schoonrewoerd channel belt, the beginning of sedimentation is indirectly dated around 3700 yr BP.
5. The date of 4600 ± 100 yr BP (GrN-4176) is not related to the Hennisdijk channel belt, but represents a terminus post quem date for the Hennisdijk channel belt.

64. Herveld 4755-2200 yr BP

Upstream/downstream coordinates: 180-433/178-440.

Highest sand elevation (relative to NAP in m): +7.9 to +6.5

Average gradient (cm/km): 12.5.

Connections: upstream: Ressen-Leuth; downstream: Ommeren.

Dating evidence: ^{14}C dating, archaeology.

Beginning of sedimentation: 4755 ± 60 yr BP (GrN-7269).

End of sedimentation: residual channel dates: 2370 ± 100 yr BP (GrN-10602) and 2260 ± 60 (UtC-7810),
However, the final phase of activity must be the same as that of the Ressen channel belt: approximately 2200 yr BP.

Archaeology: Iron Age, Roman Age, Early Middle Ages. Just west of the Herveld channel belt a few Neolithic traces occur. They either are associated with an older (as yet unmapped) channel belt or with the Pleistocene subsoil.

References: Verbraeck (1984), Teunissen (1990) and De Jong (1980, report 880), Willems (1986), Berendsen, Faessen & Kempen (1994).

Remarks: The final phase of activity of the complicated Ressen channel belt corresponds with the last active phase of the Herveld channel belt. The residual channel contains calcareous gyttja, and the dating result was considered too old on pollen-analytical grounds. The date was therefore rejected by Teunissen (1986: 7-24). De Jong (1980, report 880) considers the date approximately right or only slightly too old. A new AMS date of terrestrial botanical macrofossils in the Ressen residual channel (2260 ± 60 , UtC-7810), confirms that the original dating result is approximately correct.

Near Heteren and just west of Heteren older erosional remnants occur, that seem to be cut by the Homoet

and Herveld channel belts. This is based on the depth of the sand (Berendsen, Faessen & Kempen 1994). Since no older channel belts were found in this area, these remnants are presumed to belong to an earlier phase of the Ressen-Herveld complex.

65. Herwen 3500-2500 yr BP

Upstream/downstream coordinates: 208-429/199-434.
Highest sand elevation (relative to NAP in m): +13.5 to +13.0.
Average gradient (cm/km): 16.7.
Connections: upstream: Rijn; downstream: Meinerswijk
Dating evidence: ¹⁴C, archaeological traces, relative dating.
Beginning of sedimentation: no ¹⁴C dates available; age estimated.
End of sedimentation: no ¹⁴C dates available; age estimated.
Archaeology: no archaeological traces.
References: Berendsen, Faessen, Hesselink & Kempen (2001).
Remarks: Small erosional remnants.

66. Herwijnen 5428-4820 yr BP

Upstream/downstream coordinates: 139-425/136-426.
Highest sand elevation (relative to NAP in m): circa -1.2.
Average gradient (cm/km): not enough data to measure accurately.
Connections: upstream: Varik; downstream: unknown
Dating evidence: ¹⁴C, archaeology, relative dating.
Beginning of sedimentation: around 5500 yr BP (estimate based on cross sections), direct date: 5428 ± 40 yr BP (UtC-8171).
End of sedimentation: before 4820 yr BP (estimate based on beginning of activity of Molenveld channel belt).
Archaeology: no archaeological traces.
References: Verbraeck (1970).
Remarks: Not yet dated accurately. The channel belt is crossed by the Molenveld channel belt, which is contemporary with the Zaltbommel-Nederhemert channel belt. The date of 3200 ± 38 yr BP (UtC-8182) represents a terminus ante quem date for the Herwijnen channel belt. At the same time, it is a terminus post quem date for the neighboring Enspijk channel belt.

67. Hill 6515-5590 yr BP

Upstream/downstream coordinates: 127-417/125-417.
Highest sand elevation (relative to NAP in m): -3.8.
Average gradient (cm/km): channel belt too short to measure accurately.
Connections: upstream: unknown, presumably Brakel (eroded by Wijk en Aalburg and Biesheuvel);
downstream: unknown (eroded by Wijk en Aalburg and Biesheuvel).
Dating evidence: ¹⁴C, archaeological traces, relative dating.
Beginning of sedimentation: no ¹⁴C dates available; age based on Brakel channel belt.
End of sedimentation: no ¹⁴C dates available; age based on Brakel channel belt. The river activity ended before the Broek and Biesheuvel channel belts came into existence.
Archaeology: no archaeological traces.
References: Dr. H.J.A. Berendsen, Faculty of Geography, Utrecht University; previously unpublished data.
Remarks: Small erosional remnant.

68. Hollandse IJssel 1805-665 yr BP

Upstream/downstream coordinates: 132-445/120-448/100-437.
Highest sand elevation (relative to NAP in m): 2.1 (Klaphek) to 1.6 (Snelrewaard), no data further downstream.
Average gradient (cm/km): 16.7 (measured along present river channel).
Connections: upstream: Lek/Hagestein; downstream: Nieuwe Maas.
Dating evidence: ¹⁴C, relative dating, historical evidence.
Beginning of sedimentation: 1805 ± 50 yr BP (GrN-7577). This date applies to the reach downstream of Montfoort.

End of sedimentation: embankment before 1285 AD (665 yr BP = damming of the river near 'Klaphek').

Archaeology: Some Roman traces, but mostly Middle Ages.

References: Berendsen (1982: 185-187), Van Hengst (1898: 11-14), Den Uyl (1963: 28), Henderikx (1980: 246).

Remarks: From historical sources it is known that the present course of the Hollandse IJssel (both upstream and downstream from Montfoort) existed already before 800 AD. Older parts of the channel belt, that are not embanked are indicated with number 68a on the palaeogeographic map.

A crevasse of the Hollandse IJssel known as the 'Mare' runs almost parallel to the Meerndijk from the present Hollandse IJssel to De Meern. This crevasse channel was described by De Geer (1860: 76), Beekman (1915: 165) and Berendsen (1982: 219-220). The channel is about 3.5 m deep, and 15 m wide, and is filled with a thin layer of sand with many shells, topped with clay. Because of its straight nature and sharp limits, Berendsen (1982) thought that this channel might have been a Roman canal. Indeed Roman sherds and bones (1845 ± 50 yr BP, GrN-17542) were found in the lower part of the channel fill. However, a large excavation by the Rijksdienst voor Oudheidkundig Bodemonderzoek perpendicular to the Meerndijk showed no traces of digging. The Mare therefore is now regarded as a natural crevasse or possibly, a 'perimarine crevasse'.

69. Homoet-Kamp 4000-3290 yr BP

Upstream/downstream coordinates: 184-447/179-449.

Highest sand elevation (relative to NAP in m): +7.8 to +6.8

Average gradient (cm/km): 16.7

Connections: upstream: unknown, most likely not Walbeek; downstream: unknown. The age and sand depth of Westerveld correspond to that of the Homoet-Kamp channel belt, but the presence of the Ressen channel belt makes a direct connection impossible.

Dating evidence: ^{14}C dating, archaeology.

Beginning of sedimentation: estimate: after 4000 yr BP.

End of sedimentation: residual channel date 3575 ± 35 yr BP (GrN-10603), but this was initially considered (much) too old (e.g. Teunissen 1986: 11), as the date was not in agreement with pollen analysis. However, a new date of terrestrial botanical macrofossils from the base of the same channel roughly confirmed the first date: 3290 ± 70 yr BP (UtC-2607).

Archaeology: Late Neolithic, Iron Age, Roman Age, Early and Late Middle Ages.

References: Verbraeck (1984), Willems (1986); De Jong (1980, report 880), Teunissen (1986).

Remarks: The sand depth of Homoet and Kamp is virtually identical. Giving the smaller width of the Kamp channel belt, it is presumed it was a distributary of the Homoet channel that rejoined the main channel further downstream. The residual channel date is in agreement with the oldest archaeological traces, and is therefore accepted as correct. Although the sand of the Homoet channel belt occurs close to the surface (especially when compared to the Walbeek channel belt), the ^{14}C ages and archaeological traces suggest that the channel belt is relatively old. Sand elevation relative to NAP is lower than that of Walbeek.

70. Honswijk 3945-3050 yr BP

Upstream/downstream coordinates: 142-442/138-443.

Highest sand elevation (relative to NAP in m): 2.0 to 0.8.

Average gradient (cm/km): 19.5.

Connections: upstream: Hennisdijk; downstream: Over-Oudland-Stuivenberg-Linschoten.

Dating evidence: ^{14}C , archaeology, relative dating.

Beginning of sedimentation: the earliest possible date for the beginning of activity of this channel is 4620 ± 60 yr BP (GrN-5221) which is the end of the Zijderveld channel belt. Related dates: 4600 ± 100 (GrN-4176) for the maximum age of the beginning of the Hennisdijk channel belt. A direct date of 4873 ± 38 yr BP (UtC-6949) was obtained from underneath a sandy clay layer, that occurs at great depth next to the channel deposits. This date indicates the beginning of activity in the Schoonrewoerd avulsion belt (see also Makaske 1998). It therefore cannot be related to the Honswijk channel belt. From a location next to the channel belt no reliable direct dates can be obtained. Most likely dates for the beginning of fluvial sedimentation are dates from the Hennisdijk channel belt (Makaske 1998): 3895 ± 40 (GrN-6229) and 3945 ± 35 (GrN-6230).

End of sedimentation: Residual channel dates obtained by Berendsen (1982: 170): 3245 ± 35 yr BP (GrN-7961) and 3050 ± 30 yr BP (GrN-8714). The first sample, taken from a short residual channel contained wood fragments and at first was regarded as 'too old', therefore another sample from the same channel was dated.

The similar ages indicate that the dating result is correct.

Archaeology: Iron Age, Roman Age, Middle Ages.

References: Berendsen (1982: 150, 170), De Boer & Pons (1960: 25), Makaske (1998).

Remarks:

1. The channel belt seems to cut through the Zijderveld channel belt near Culemborg.
2. The sand of the channel deposits generally is not in contact with the Pleistocene sand.
3. The deposits in square 142-442 most likely are not alluvial ridge deposits (as mapped by Berendsen (1982), but crevasse-splay deposits, that seem to belong to the Schoonrewoerd avulsion belt (Makaske 1998).
4. De Boer & Pons (1960: 25) conclude that the Honswijk channel belt was connected to the Hagestein channel belt. Considering the difference in elevation of the top of the sand (GTS-lines) this cannot be correct. The Honswijk channel belt therefore has to be much older (Berendsen 1982: 170).
5. A direct date of 2688 ± 37 yr BP (UtC-6845) was obtained from the top of peat underlying clay, north of the Blokhoven and Honswijk channel belts. Remarkably, the dating result almost coincides with the beginning of the Buren and Hagestein channel belts. This date is therefore interpreted as indicating the beginning of sedimentation of the Hagestein channel belt.

71. Hooiblok 2580-2200 yr BP

Upstream/downstream coordinates: 147-431/137-425.

Highest sand elevation (relative to NAP in m): +2.2 to +1.5

Average gradient (cm/km): 14.0

Connections: upstream: Erichem/Meteren; downstream: eroded by the Linge (north of the Linge a small erosional remnant is present).

Dating evidence: ^{14}C , archaeology, relative dating.

Beginning of sedimentation: 2580 ± 50 yr BP (UtC-13085), Berendsen & Hoek (2005, p. 33).

End of sedimentation: estimate: before circa 2200 yr BP (= beginning of activity of Linge channel belt).

Archaeology: Iron Age, Roman Age, Middle Ages.

References: Verbraeck (1984), not named, Berendsen & Hoek (2005).

Remarks: A connection with the Gellicum and Spijk channel belts seems likely, but the depth of the sand of the Gellicum channel belt is considerably greater than that of the Hooiblok channel belt. This means that the Enspijk and Gellicum channel belts are probably considerably older than the Hooiblok channel belt. In that case, the Spijk channel belt must be a crevasse of the Gameren channel belt.

72. Hoon 4900-3730 yr BP

Upstream/downstream coordinates: 137-446/138-451.

Highest sand elevation (relative to NAP in m): +0.7 m to +0.2.

Average gradient (cm/km): 14.0.

Connections: upstream: Vuylkoop-Werkhoven; downstream: most likely the channel rejoins the Werkhoven channel belt in Utrecht.

Dating evidence: ^{14}C , pollen analysis (Zandstra 1966), archaeology.

Beginning of sedimentation: 4900 yr BP (based on pollen analysis and on the connection with the Vuylkoop channel belt, and its downstream connection with the Lopik channel belt).

End of sedimentation: 3730 ± 80 yr BP (UtC-6724).

Archaeology: oldest known archaeological traces: Iron Age. Roman Age.

References: Berendsen (1982: 148-149, 162), Zandstra (1966).

Remarks: Pollen analysis (Zandstra 1966) indicates that the main period of sedimentation is Late Atlantic. See also the remarks made under Jutphaas channel belt, regarding the downstream connection.

73. Hoorzik 4020-3210 yr BP

Upstream/downstream coordinates: 150-421/147-417.

Highest sand elevation (relative to NAP in m): +2.0 to +1.6

Average gradient (cm/km): 8.0.

Connections: upstream: Ochten-Westerveld and Wijchens Maasje; downstream: Hedel-Wordragen-Biesheuvel.

Dating evidence: ^{14}C , relative dating.

Beginning of sedimentation: presumably synchronous with Hedel: 4020 ± 35 yr BP (GrN-18102).

End of sedimentation: based on terminus ante quem of Hedel: 3210 ± 40 yr BP (GrN-18100) and 3090 ± 40 yr BP (GrN-18101).

Archaeology: no archaeological traces.

References: Weerts & Berendsen (1995: 205), Weerts (1995: 81).

Remarks: The southern end of the Hoorzik channel belt was not correctly mapped by Berendsen ed. (1986). The channel belt contains a minor amount of coarse sand, and is rich in calcium carbonate. This suggests, that the channel was not only fed by the Maas, but also by the Rhine. Since the channel was also fed by the Ochten-Westerveld channel (4610-3290 yr BP), the period of activity should at least partly overlap with that of Ochten-Westerveld. This is indeed the case.

74. Houten 3795-2560 yr BP

Upstream/downstream coordinates: 153-443/142-451.

Highest sand elevation (relative to NAP in m): 3.8 m to 1.0.

Average gradient (cm/km): 12.0.

Connections: upstream: Ommeren; downstream: Oude Rijn, Vecht.

Dating evidence: ¹⁴C, archaeology.

Beginning of sedimentation: after 4130 ± 40 yr BP (GrN-12164) and 3955 ± 55 yr BP (GrN-9353), probably around 3795 ± 55 (GrN-9152).

End of sedimentation: continuing sedimentation until after 2680 ± 50 yr BP (GrN-8713); residual channel date of 2590 ± 70 (GrN-18107) near Vechten.

Archaeology: oldest archaeological traces: possibly Bronze Age, certainly Iron Age, Roman Age and Middle Ages.

References: Berendsen (1982: 161-163), Berendsen & Wynia (1993).

Remarks: Several residual channels occur parallel to each other. Continuing activity is shown by date GrN-1010: 3440 ± 50 yr BP. Some residual channels may contain water until Roman times.

75. Huisseling-Demen 3000-2000 yr BP

Upstream/downstream coordinates: 174-422/171-424 and 165-424/161-423.

Highest sand elevation (relative to NAP in m): +6.1 to +5.1

Average gradient (cm/km): 15.0

Connections: upstream: unknown (Maas); downstream: Macharen-Lith.

Dating evidence: ¹⁴C dating, archaeology, historical evidence.

Beginning of sedimentation: estimate: 3000 yr BP.

End of sedimentation: estimate: 2000 yr BP.

Archaeology: Neolithic, Bronze Age, Iron Age, Roman Age, Early to Late Middle Ages.

References: Van Diepen (1954).

Remarks: The channel belt has not yet been radiocarbon dated, because organic material in this area is extremely scarce. Archaeological traces suggest that the river existed already during the Bronze Age, and possibly even earlier. If correlation with the Macharen channel belt is correct, the final phase of activity is Roman age: a Roman vessel was found in a residual channel near Macharen (Van Diepen 1952: 116).

76. IJsselveld-Schuurenburgh 3200-2715 yr BP

Upstream/downstream coordinates: 128-452/124-451.

Highest sand elevation (relative to NAP in m): -0.2 to -1.2.

Average gradient (cm/km): 5.2.

Connections: upstream: Jutphaas; downstream: Linschoten.

Dating evidence: ¹⁴C, archaeological traces, relative dating.

Beginning of sedimentation: estimate: after degeneration of the Stuivenberg channel belt around 3200 yr BP

End of sedimentation: estimate: 2715 yr BP, based on a residual channel date of the Jutphaas river channel belt: 2715 ± 35 yr BP (GrN-7962). The residual channels in both the IJsselveld and Schuurenburgh channel belts could not be directly dated due to a lack of organic material.

Archaeology: Iron Age, Roman Age, Middle Ages.

References: Berendsen (1982: 177), Törnqvist (1993: 148).

Remarks: The eastern part of the Meijerberg channel belt as defined by Berendsen (1982: 180-181) is now thought to belong to the Schuurenburgh channel belt. This part (square 128-452) was named IJsselveld channel belt by Törnqvist (1993: 148). The community boundary here coincides with the residual channel, suggesting that the channel is very young. However, levee deposits occur at relatively great depth (0.5-1.0 m below the surface), suggesting that the channel is old.

77. Ingen 2700-1915 yr BP

Upstream/downstream coordinates: 162-441/160-443.
Highest sand elevation (relative to NAP in m): +5.6 to +4.7
Average gradient (cm/km): channel belt too short for reliable measurements.
Connections: upstream: Nederrijn (Rhine); downstream: Nederrijn (Rhine).
Dating evidence: ¹⁴C dating, archaeology.
Beginning of sedimentation: unknown, estimate around 2700 yr BP.
End of sedimentation: 1915 ± 55 yr BP (GrN-6992).
Archaeology: Iron Age, Roman Age, Merovingian-Carolingian.
References: Verbraeck (1984).
Remarks: small erosional remnant, hard to date accurately.

78. Jutphaas 3795-2715 yr BP

Upstream/downstream coordinates: 141-448/130-450.
Highest sand elevation (relative to NAP in m): 1.7 to -0.6.
Average gradient (cm/km): 15.3 decreasing to 5.6.
Connections: upstream: Houten; downstream: Stuivenberg (although this connection is questionable; see below)-Lampsin-IJsselveld-Schuurenburg, Linschoten.
Dating evidence: ¹⁴C, archaeological traces, relative dating.
Beginning of sedimentation: Presumably similar to the beginning of the Houten channel belt (3795 ± 55 yr BP, GrN-9152). Törnqvist (1993: 148) obtained a direct terminus post quem date for the beginning of activity of the younger phase of the Jutphaas channel belt: 4200 ± 60 yr BP(UtC-1898); this is also a terminus ante quem for the older phase (see below). Around 3440 ± 50 yr BP (GrN-1010) active sedimentation took place, as is evidenced by the dating of leaves, found in a sandy channel fill in Houten.
End of sedimentation: Residual channel date: 2715 ± 35 yr BP (GrN-7962).
Archaeology: Neolithic, Bronze Age, Iron Age, Roman Age.
References: Berendsen (1982: 174-176), De Vries & Waterbolk (1958: 1552), Van Tent (1978). Törnqvist (1993: 147), Vink (1954: 145, 'Wulvensche stroom, Jutphaasche Rug, Rijnenburgsche/Westnedereindsche tak').

Remarks:

1. The Jutphaas channel belt is eroded by the Hollandse IJssel.
2. A downstream connection with the Stuivenberg channel belt is questionable because the elevation of the sand in the Stuivenberg channel belt (near the Hollandse IJssel) is about 0.5 m higher; yet there seems no other reasonable possibility.
3. The Jutphaas channel belt consists of two generations (Berendsen 1982: 176; Törnqvist 1993: 147). The older generation, which is covered by peat, has not yet been mapped accurately. Obviously it has only a limited areal extent. Its age is not accurately known, but is intermediate between the Benschop and Jutphaas channel belts. This is confirmed by archaeological traces of Neolithic Age and Bronze Age near Jutphaas. The older channel belt may be the downstream continuation of the Hoon channel belt.
4. In Nieuwegein-Noord the Jutphaas channel belt divides into two separate branches, known as the Blok and the Nedereind branches. About 2 kilometers west the two channel belts rejoin. The Blok channel belt is the older branch.
4. The Jutphaas channel belt, which is the downstream continuation of the Houten channel belt, seems to cross the Hoon channel belt on the geological map (Verbraeck 1970). If correct, this means that the Hoon channel belt is older. This is confirmed by the direct date for final activity of the Hoon channel belt: 3730 yr BP. The beginning of activity of an older phase of the Jutphaas channel belt was dated earlier (even before 4200 yr BP) as was stated by both Berendsen (1982) and Törnqvist (1993). There is no reason why the ¹⁴C dates should be in error. The older phase of activity can then only be connected to the Werkhoven channel belt, or to the Hoon channel belt. In that case the Hoon channel belt is not continuing northward into the suburbs of Utrecht (as the geological map suggests), but essentially followed the course of the younger Jutphaas channel belt, and was largely eroded.
5. A residual channel date of 1210 ± 50 yr BP (GrN-7582) obtained by Berendsen (1982: 177) was rejected; the sample was considered to have been contaminated.

79. Kadijk 7600-6335 yr BP

Upstream/downstream coordinates: 116-443/100-434.

Highest sand elevation (relative to NAP in m): -4.5 to -10.2 (?).
Average gradient (cm/km): 28.5 (not accurate due to few available data in the western part)
Connections: upstream: Benschop; downstream: unknown.
Dating evidence: ¹⁴C, relative dating.
Beginning of sedimentation: before 7600 ± 45 yr BP (GrN-9408).
End of sedimentation: 6335 ± 45 yr BP (GrN-9406).
Archaeology: no archaeological traces.
References: Bosch & Kok (1994: 73, 91).

Remarks: The Benschop river system has many distributaries that may have slightly different ages. Since the ¹⁴C samples mentioned above were taken upstream of the diversion of Benschop to Kadijk, the ages given here have to be considered as a maximum age for the beginning and a minimum age for the end of sedimentation for the various branches. The exact dating of these channel belts is a matter of further study.

80. Kapel 5350-4920 yr BP

Upstream/downstream coordinates: 132-445/129-444.
Highest sand elevation (relative to NAP in m): -1.0 to -2.1.
Average gradient (cm/km): 17.
Connections: upstream: Vuylkoop; downstream: Zijderveld.
Dating evidence: ¹⁴C (indirect), relative dating.
Beginning of sedimentation: earliest possible date 5350 ± 35 yr BP (GrN-7957) which is the end of the Autena-Benschop-Willeskop channel belt.
End of sedimentation: before 4920 ± 35 yr BP (GrN-7956), which is the beginning of the Lopik channel belt.
Archaeology: Middle Ages?
References: Berendsen (1982: 151).
Remarks: Small erosional remnant, cut through by the Lopik channel belt. A connection with the Zijderveld channel belt seems most likely.

81. Kedichem 6515-5590 yr BP

Upstream/downstream coordinates: 136-431/130-429.
Highest sand elevation (relative to NAP in m): circa -4.0.
Average gradient (cm/km): not enough data to measure accurately.
Connections: upstream: presumably Middelkoop; downstream: Gorkum-Arkel channel belt.
Dating evidence: ¹⁴C, archaeology, relative dating.
Beginning of sedimentation: after 6515 yr BP (estimate based on connection to the Gorkum-Arkel channel belt).
End of sedimentation: before 5590 yr BP (estimate based on connection to the Gorkum-Arkel channel belt).
Archaeology: no archaeological traces.
References: Verbraeck (1970).
Remarks: narrow and relatively unimportant channel belt, not yet dated accurately. The age estimates are reasonable considering the depth of overbank deposits in cross sections.

82. Kesteren 4500-4000 yr BP

Upstream/downstream coordinates: 168-438/167-437.
Highest sand elevation (relative to NAP in m): circa +4.2
Average gradient (cm/km): channel belt too short for reliable measurements.
Connections: upstream: unknown; downstream: unknown (eroded).
Dating evidence: ¹⁴C dating, archaeology.
Beginning of sedimentation: no direct ¹⁴C-dates available, estimate: 4500 yr BP.
End of sedimentation: estimate: 4000 yr BP.
Archaeology: Roman Age, Late Middle Ages
References: Verbraeck (1984).
Remarks: this small channel belt is older than the Westerveld channel belt. Correlation based on channel width with the Boelenham channel belt seems likely, but this is impossible considering the age difference and depth of the sand.

83. Klein Baal 2900-2500 yr BP

Upstream/downstream coordinates: 192-433/191-434.

Highest sand elevation (relative to NAP in m): +8.7 to +8.4

Average gradient (cm/km): 10.0

Connections: upstream: Baal-Zandvoort; downstream: Baal-Ressen.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: estimate 2900 yr BP.

End of sedimentation: estimate: 2500 yr BP based on Bredelaar.

Archaeology: Iron Age, Roman Age, Early and Late Middle Ages.

References: Verbraeck (1984), Willems (1986); De Jong (1980, report 880), Teunissen (1984).

Remarks: The sand depth corresponds with that of the Ressen and Zandvoort channel belts. The channel belt seems to be of approximately the same age as Bredelaar.

84. Kortenhoeven 7600-6260 yr BP

Upstream/downstream coordinates: 136-436/131-442.

Highest sand elevation (relative to NAP in m): -2.3 to -5.5

Average gradient (cm/km): 32 (inaccurate due to few data).

Connections: upstream: Maurik; downstream: Benschop

Dating evidence: ¹⁴C, archaeological traces, relative dating.

Beginning of sedimentation: The channel belt has not been directly dated, but is presumed to be of the same age as the Benschop system: approximately 7600 ± 45 yr BP (GrN-9408).

End of sedimentation: 6260 ± 60 yr BP (UtC-6714)

Archaeology: no archaeological traces.

References: Verbraeck (1970), Berendsen (1982: 147).

Remarks: The Tienhoven channel belt has been rejuvenated. The older channel is connected to the Benschop channel belt, the younger channel (Autena channel belt) to the Willeskop channel belt. The oldest overbank deposits rest directly on the Kreftenheye Formation. If there is a difference in age between the Kortenhoeven and the Tienhoven channel belt, the Kortenhoeven channel belt seems to be older.

85. Kromme Rijn 3000-828 yr BP

Upstream/downstream coordinates: 152-443/138-454.

Highest sand elevation (relative to NAP in m): 4.5 m / 1.0.

Average gradient (cm/km): 8.7 (measured along residual river channel).

Connections: upstream: Lienden; downstream: Oude Rijn, Vecht.

Dating evidence: ¹⁴C, archaeology, dendrochronology, historical evidence.

Beginning of sedimentation: after 3000 ± 35 yr BP (GrN-8706), 2930 ± 60 yr BP (GrN-4371) and 2890 ± 35 yr BP (GrN-9154).

End of sedimentation: 1122 AD (= 828 yr BP) according to Dekker (1980).

Archaeology: oldest archaeological traces: Late Iron Age, many traces of Roman Age and Merovingian-Carolingian Age.

References: Berendsen (1982: 163-166).

Remarks: A Roman channel occurs near Wijk bij Duurstede. The Carolingian channel with a harbour at Wijk bij Duurstede was accurately dated between 620 and 930 AD (Lanting & Mook 1977: 197; Mook 1978). After this the river shifted its course by lateral accretion to the present channel which was dammed up in 1122 AD (Dekker 1980: 255-259). Between Cothen and Werkhoven two meander loops were artificially cut off in 1871 AD. In Utrecht a fish trap (1880 ± 35 yr BP, GrN-6633) was found in a former channel of the river.

86. Lage Dijk 4900-3795 yr BP

Upstream/downstream coordinates: 132-445/132-446.

Highest sand elevation (relative to NAP in m): -0.5.

Average gradient (cm/km): channel belt too short for reliable measurements.

Connections: upstream: Vuylkoop; downstream: Buitenzorg.

Dating evidence: relative dating.

Beginning of sedimentation: earliest possible date 5350 ± 35 yr BP (GrN-7957) which is the end of the Autena-Benschop-Willeskop channel belt. Most likely date: 4900 (beginning of Lopik channel belt).

End of sedimentation: probably before 3795 yr BP (end of Vuylkoop).

Archaeology: In september 2000, Bronze Age artefacts were found on the channel belt, suggesting that the channel belt may be younger than presumed (personal communication Drs. W. van Zijverden). If correct, the channel must have been connected to the Hennisdijk-Honswijk channel belts.

References: Berendsen (1982: 150).

Remarks: Small erosional remnant, cut through by the younger Over-Oudland channel belt and Hollandse IJssel.

87. Lampsin 4365-3100 yr BP

Upstream/downstream coordinates: 128-450/127-451.

Highest sand elevation (relative to NAP in m): -0.4.

Average gradient (cm/km): channel belt too short for reliable measurements.

Connections: upstream: Neder-Oudland? downstream: unknown, probably eroded by Linschoten.

Dating evidence: relative dating.

Beginning of sedimentation: after 4365 ± 40 yr BP (GrN-18934).

End of sedimentation: 3100 yr BP (based on end of activity of Stuivenberg).

Archaeology: no archaeological traces.

References: Berendsen (1982: 147, 172), Törnqvist (1993: 147).

Remarks: Small erosional remnant, a distributary of Stuivenberg or Jutphaas, eroded by the Hollandse IJssel.

88. Lange Linschoten 2400-1800 yr BP

Upstream/downstream coordinates: 122-452/119-448.

Highest sand elevation (relative to NAP in m): -1.8.

Average gradient (cm/km): not enough data to measure accurately.

Connections: upstream: Linschoten; downstream: Hollandse IJssel.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: earliest possible origin: after 4180 ± 60 yr BP (GrN-7969), which is the final phase of the Blokland-Snelrewaard channel belt. Most likely the small channel is much younger. Estimate: 2400 yr BP, based on the expected increase of discharge to the Linschoten channel belt, as a result of the beginning of activity of the Buren and Hagestein channels.

End of sedimentation: not accurately known, probably just after the beginning of the Christian Era. The Hollandse IJssel between Montfoort and Oudewater came into existence at that time. The river still contains water. It is estimated that the channel was activated between 1800 and 1250 yr BP only during flood waters, which may explain the name 'Oudewater' (see also the discussion by Horsten 1990).

Archaeology: Late Middle Ages.

References: Berendsen (1982: 180), Blok (1977), Horsten (1990).

Remarks:

1. The channel belt deposits are not in contact with the Pleistocene sand.
2. Most likely sedimentation ended at the same time the Hollandse IJssel downstream of Montfoort (1805 ± 50 yr BP (GrN-7577) came into existence Berendsen (1982).
3. The channel belt seems to be a small 'perimarine' crevasse channel.

89. Langerak 5345-4620 yr BP

Upstream/downstream coordinates: 123-440/117-433.

Highest sand elevation (relative to NAP in m): -1.8 to -2.8.

Average gradient (cm/km): 6.7

Connections: upstream: Aaksterveld and Zijderveld, downstream: Bleskensgraaf.

Dating evidence: ¹⁴C, archaeological traces, relative dating.

Beginning of sedimentation: sample GrN-786: 5340 ± 90 yr BP was taken close to the channel belt, and probably represents the beginning of sedimentation. Related dates: 5320 ± 60 yr BP (GrN-10844), 5345 ± 45 (GrN-10852).

End of sedimentation: sample GrN-785: 4650 ± 95 yr BP was taken close to the channel belt, and probably represents the end of sedimentation. Related dates: 4740 ± 70 yr BP (GrN10851), 4830 ± 70 yr BP (GrN-10843)

Archaeology: Late Middle Ages.

References: Bosch & Kok (1994), Verbraeck (1970: 79).

Remarks: Ages are based on the age of the Zijdeveld channel belt. One of the channels of the Zijdeveld channel belt was probably rejuvenated by the Schoonrewoerd channel belt, as is suggested by the geological map (Bosch & Kok 1994), and a cross section published by Makaske (1998). The top of the sandy channel belt deposits of the Langerak channel belt occur at a 1 m deeper level than those of the Schoonrewoerd channel belt, but the overbank deposits indicating beginning of river sedimentation are at the same level. This suggests that sedimentation of the Langerak channel belt ended earlier than that of the Schoonrewoerd channel belt (Makaske 1998, Appendix 3, cross section 10). Unpublished ¹⁴C dates by Drs. G. Van Dijk (Free University, Amsterdam): 4720 ± 70 yr BP (GrN-10842) and 3740 ± 70 yr BP (GrN-10841) obviously refer to the period of activity of the Schoonrewoerd channel belt, as well as dates obtained near Brandwijk: 3955 ± 45 yr BP (GrN-10857) and 3980 ± 70 yr BP (10856).

90. Leeuwen 3000-2000 yr BP

Upstream/downstream coordinates: 169-433/166-433/163-433.

Highest sand elevation (relative to NAP in m): +5.7 to +3.8

Average gradient (cm/km): 8.0

Connections: upstream: Afferden-Distelkamp; downstream: Zennewijnen-Opijnen-Bruchem-Alm-Werken.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: estimate 3000 yr BP.

End of sedimentation: Based on age of Distelkamp-Afferden: 2655 yr BP, which is the average of dates 2600 ± 80 yr BP (GrN-11557) and 2710 ± 80 yr BP (GrN-11552). However, a small younger channel must have been present in the area where the Waal has eroded the channel belt. Based on the connection with the Zennewijnen this channel must have existed until around 2000 AD.

Archaeology: Iron Age, Roman Age, Early Middle Ages.

References: Steenbeek (1990: 155), Verbraeck (1984), Willems (1986).

Remarks: An upstream connection existed to Distelkamp-Afferden that existed since 4605 yr BP, which is the average of dates 4660 ± 30 yr BP (GrN-11554) and 4550 ± 50 yr BP (GrN-11559). Age estimates based on age of Distelkamp-Afferden and Zennewijnen-Opijnen-Oensel-Bruchem.

91. Lek 1950-0 yr BP (downstream from Wijk bij Duurstede)

Upstream/downstream coordinates: 196-436/102-433.

Highest sand elevation (relative to NAP in m): +10.2 (Oosterbeek) to +6.1 (Wijk bij Duurstede) to + 3.0 (Schoonhoven).

Average gradient (cm/km): Average between Oosterbeek and Wijk bij Duurstede: 10.8 (measured along present channel); at Wijk bij Duurstede 13.2, at Schoonhoven 4.5 (calculated sandy channel belt gradient, according to Berendsen, 1982). Average gradient of the water level: Lobith: 11.6, Wijk bij Duurstede 10.0, Schoonhoven 3.8 (high tide) and 7.5 (low tide), Krimpen 1.3 (high tide) and 4.7 (low tide), based on Berendsen (1982).

Connections: upstream: Nederrijn (Rhine); downstream: Nieuwe Maas.

Dating evidence: ¹⁴C, relative dating, archaeology, historical evidence.

Beginning of sedimentation: 1950 ± 30 (GrN-8707), 2220 ± 35 (GrN-8708). Discharge increased between 300 AD and 700 AD (Berendsen 1982: 185).

End of sedimentation: 1050 AD (900 yr BP = beginning of embankment). Sedimentation still continues in the embanked floodplains.

Archaeology: Oldest traces: Early and Late Middle Ages. Some Roman and Iron Age traces in the embanked floodplains east of Wijk bij Duurstede. However, these occur either on erosional remnants of older channel belts like the Houten and Maurik channel belts, or are reworked.

References: Berendsen (1982: 182-185), Vink (1926: 221), Gottschalk (1971: 163-165), De Boer & Pons (1960: 28-29), Henderikx (1980: 234, 244-246), Middelkoop (1997).

Remarks:

1. Downstream of Wijk bij Duurstede the river generally is not incised into the Pleistocene sand, but at many locations older channel belts are present in the subsoil. In this way channel sands are still in contact with the underlying Pleistocene sand.
2. The idea that the Lek came into existence after 800 AD, possibly even after 1000 AD (De Boer & Pons 1960: 28-29) is erroneous; the existence of the Lek is already mentioned in a historic document of 777 AD (Henderikx (1980).
3. It should be remembered, that the history of the present river is rather complicated, since its present upstream course follows or crosses numerous older channel belts. Only downstream of Vianen the present channel belt

is isolated from the older courses. Southwest of Vianen a small channel seems to split off from the main channel that followed the course of the present Hollandse IJssel (Drs. A. Hesselink, Utrecht University, unpublished data). This suggests, that the reach southwest of Vianen may be slightly older than the reach of the present Lek between Hagestein-Vreeswijk-Klaphek. The ¹⁴C dates seem to confirm this.

4. At several locations cutoff meanders are found: near Hagestein (1960, in connection to the construction of a weir), Jaarveld (1865 AD), Lexmond (1600 AD), Lexmond (1580 AD), Jaarsveld (1200 AD).
5. Older parts of the channel belt that are located outside of the presently embanked floodplain are indicated on the palaeogeographic map with number 91a.

92. Lekkerkerk 4870-4100 yr BP

Upstream/downstream coordinates: 112-436/103-434.

Highest sand elevation (relative to NAP in m): -5.8 to -7.0.

Average gradient (cm/km): 12.0 (but not enough data for accurate measurements).

Connections: upstream: Lopik; downstream: Ridderkerk.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: no direct ¹⁴C dates available; presumably the same as Lopik: 4870 ± 40 yr BP (GrN-18932).

End of sedimentation: no direct ¹⁴C dates available; probably activity ends around 4100 yr BP (same as Lopik) or slightly earlier.

Archaeology: Late Middle Ages.

References: Berendsen (1982: 156); Törnqvist (1993: 144).

Remarks: The channel belt seems to be connected to the Ridderkerk channel belt.

93. Leuth 4000-2170 yr BP

Upstream/downstream coordinates: 201-429/195-427.

Highest sand elevation (relative to NAP in m): +10.9 to +10.2

Average gradient (cm/km): 30

Connections: upstream: unknown (eroded); downstream: Distelkamp-Afferden and Ressen-Herveld.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: unknown, estimate 4000 yr BP.

End of sedimentation: residual channel date: 2170 ± 40 yr BP (GrN-10596) and 2030 ± 35 yr BP (GrN-10595).

Archaeology: Iron Age, Roman Age, Early and Late Middle Ages. Iron Age and Roman Age traces are aligned along the residual channel.

References: Willems (1986: 48-49), Verbraeck (1984).

Remarks: The dated sample in the residual channel was taken 97 cm above the sandy channel fill, which means that silting up must have started earlier. Although the sample GrN-10596 was a calcareous gyttja, dating results are confirmed by the overlying sample of *Phragmites* peat (2030 ± 35 yr BP, GrN-10595) and by archaeological traces (Willems 1986).

Overbank deposits directly overlie the Wijchen Layer.

94. Leuven-Verdriet 2510-1760 yr BP

Upstream/downstream coordinates: Leuven: 134-422/133-425; Verdriet: 135-422/134-423

Highest sand elevation (relative to NAP in m): -0.2 to -0.5

Average gradient (cm/km): 8.6 (measured along channel belt)

Connections: upstream: Oensel-Bruchem; downstream: Spijk.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: The age of the Bruchem channel belt, east of the confluence with the Oensel channel belt was dated at: 2560 ± 40 yr BP, GrN-18104.

End of sedimentation: based on the residual channel date of the Bruchem channel belt: 1760 ± 45 yr BP (GrN-12463).

Archaeology: oldest archaeological traces: Roman Age. Also Middle Ages.

References: Weerts & Berendsen (1995: 207); Törnqvist (1993: 141-142); Weerts (1995: 82), Berendsen & Cortenraad (1988: 224).

Remarks: the narrow channel belts seems to be connected to the Gameren channel belt. The Leuven channel belt is not in connection with the Pleistocene subsoil. The Verdriet channel belt may actually be a crevasse

channel.

95. Lienden 1915-1200 yr BP

Upstream/downstream coordinates: 164-440/163-441.

Highest sand elevation (relative to NAP in m): +5.7 to +5.0

Average gradient (cm/km): 17.5

Connections: upstream: Nederrijn (Rhine); downstream: Nederrijn (Rhine).

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: unknown, probably around 1915 ± 55 yr BP (GrN-6992).

End of sedimentation: unknown, older than 326 yr BP (Mars-Oude Rijn).

Archaeology: Roman Age, Early Middle Ages (Merovingian-Carolingian), Late Middle Ages.

References: Verbraeck (1984).

Remarks: The most likely period of sedimentation is: between approximately 1900 yr BP and 750 AD (1200 yr BP). Many Early Middle Age traces occur along the residual channel.

96. Liesveld 6000-5350 yr BP

Upstream/downstream coordinates: 119-438/113-435.

Highest sand elevation (relative to NAP in m): circa -4.3 to -5.8.

Average gradient (cm/km): 13.6 (few data, not very accurate).

Connections: upstream: Cabauw; downstream: Streefkerk.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: 6000 ± 35 yr BP (GrN-7958) and 6190 ± 45 yr BP (GrN-18926).

End of sedimentation: no direct ¹⁴C dates available; possibly related dates: 5350 ± 35 yr BP (GrN-7957) and 5220 ± 50 yr BP (GrN-18925).

Archaeology: no archaeological traces.

References: Bosch & Kok (1994).

Remarks: the geological map (Bosch & Kok, 1994) of this area generally is not very accurate. Further study of this channel belt is required.

97. Linge 2160-643 yr BP

Upstream/downstream coordinates: 158-432/125-426.

Highest sand elevation (relative to NAP in m): +4.6 (Tiel) to -0.2 (Kedichem)

Average gradient (cm/km): 10.5 (measured along present river channel)

Connections: upstream: Waal; downstream: Boven-Merwede.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: 2290 ± 60 yr BP (UtC-1481); 2210 ± 40 yr BP (UtC-1482); 2160 ± 60 yr BP (UtC-1717); 2035 ± 50 yr BP (GrN-8371); 2010 ± 40 yr BP (UtC-1718), for an evaluation of these dates see Törnqvist (1993). A few *terminus post quem* dates for beginning sedimentation were obtained: 2510 ± 60 yr BP (GrN-10119) 2460 ± 75 (GrN-4600) and 2310 ± 170 (GrN-20052).

End of sedimentation: The river was dammed at its upstream end at Tiel in 1307 AD (643 yr BP), just one or two centuries after its embankment.

Archaeology: Roman vessels have been found at several places, one of them indicating that the river existed in 1820 ± 30 yr BP (GrN-5646). There are also traces of Carolingian age and Early to Late Middle Ages. Some Late Iron Age traces may be associated with older channel belts in the subsoil. A crevasse channel of the Linge was dated at 1090 ± 38 yr BP (UtC-6842).

References: Törnqvist (1993: 142); Berendsen (1990), Vink (1926, 1954).

Remarks: The present river acts as a temporary storage basin for drainage water of the surrounding polders. Since water level in the storage basin is almost horizontal, the elevation of the dikes relative to the land increases downstream. The upstream part of the present Linge, between Tiel and Doornenburg now also is named Linge. This is not a natural river, but a drainage canal. Older parts of the channel belt that are located outside of the presently embanked floodplain are indicated on the palaeogeographic map with number 97a.

98. Linschoten 3900-1805 yr BP

Upstream/downstream coordinates: 124-450/120-454.

Highest sand elevation (relative to NAP in m): -0.2 to -1.0.

Average gradient (cm/km): Phase A: 12.3; Phase B: 5.7.

Connections: Phase A: upstream: Over-Oudland, Stuivenberg-Neder-Oudland, Lampsin, or Jutphaas-Houten; downstream: Oude Rijn. Phase B: upstream: Schuurenburgh - IJsselveld; downstream: Oude Rijn.

Dating evidence: ¹⁴C, archaeological traces, relative dating.

Beginning of sedimentation: direct date: 4015 ± 65 yr BP (GrN-7579), practically coincides with the beginning of Stuivenberg (3900 yr BP). However, smaller channels (e.g. the downstream part of Buitenzorg) may have been active in the present channel belt zone before this time.

End of sedimentation: The channel may have been active until the Hollandse IJssel downstream of Montfoort came into existence (1805 yr BP), although the level of overbank deposits suggests, that river activity came to an end much earlier, as was indicated by Berendsen (1982). The upstream part of the Hollandse IJssel was fed by the following channels: Buren, Hagestein and Jutphaas. This results in a minimum date for the end of sedimentation of approximately 750-900, which is in accordance with historical information (Henderikx 1980: 246). North of Linschoten residual channel dates were obtained (Berendsen 1982: 179) of 3260 ± 30 yr BP (GrN-7970) and 3670 ± 40 yr BP (GrN-8716), however it is not certain whether these really represent the final phase. A crevasse splay residual channel date of 3250 ± 55 yr BP (GrN-8715), suggests that the river was active until after this residual channel silted up. Main period of activity is similar to that of the Jutphaas and Stuivenberg channel belts. After 2715 yr BP (= end of Jutphaas channel belt) discharge decreased significantly, and probably only a small residual channel remained, that still carried water at high discharge.

Archaeology: Late Iron Age, Roman Age, Middle Ages.

References: Berendsen (1982: 177-180), Vink (1926: 173), Van Vliet (1961: 9), Henderikx (1980), Horsten (1990).

Remarks:

1. The eastern flank of the Linschoten channel belt is characterized by a thick sequence of overbank deposits, but different levels of overbank deposits cannot clearly be defined. This suggests that the channel belt remained active for a long time (Dr. H.J.A. Berendsen, Utrecht University, unpublished cross section).
2. The most important period of activity (phase A) obviously coincides with that of the Stuivenberg - Vechgel and Honswijk river channel belts. However, between Montfoort and Linschoten a younger channel, that fed the Lange Linschoten, may be present under the road (phase B).
3. The younger channel that fed the Lange Linschoten most likely existed until the Hollandse IJssel downstream of Montfoort came into existence (1805 ± 50 yr BP (GrN-7577)).
4. Alternatively, the Lange Linschoten may be a so-called 'perimarine crevasse channel' that did not have an upstream connection to the main rivers.

99. Lith 4500-2734 yr BP

Upstream/downstream coordinates: 159-423/155-423.

Highest sand elevation (relative to NAP in m): +3.5 to +2.5

Average gradient (cm/km): 11.1 (measured along the channel belt)

Connections: upstream: Molenblok, Haren; downstream: Winkels, later Hoorzik, Hedel-Wordragen, later Velddriel.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: Downstream, the Lith channel belt has been connected to a number of channel belts known from the Bommelerwaard, of which the Hedel channel belt formed shortly after 4020 yr BP (GrN-18102). However, the Lith channel belt predates the Hedel channel belt. A direct terminus post quem date for beginning activity underneath the lower overbank deposits gave an age of 4504 ± 41 yr BP (UtC-8124). Since the channel belt has multiple overbank levels, this date is interpreted as the beginning of an older phase of the Lith channel belt.

End of sedimentation: A direct residual channel date: 2734 ± 44 (UtC-8125) dates the abandonment of the Lith channel belt.

Archaeology: possibly Bronze Age, certainly Iron Age, Roman Age, Early and Late Middle Ages.

References: Weerts & Berendsen (1995: 205), Weerts (1995: 81).

Remarks:

1. Berendsen & Stouthamer (2001) mapped all Meuse channel belts in the Western Maaskant area as one system (Lith, 4020-2734). Cohen (2003) split the complex into 3 channel belts.
 - Lith 1 channel belt 4500 – 4000 yr BP
 - Lith 2 channel belt 4020 – 3400 yr BP
 - Lith 3 channel belt 3500 – 2734 yr BP
2. In the southwest of the Lith channel belt complex, two levels of overbank deposits (0.5-1.5 m +NAP and 2.0-3.0 m +NAP respectively) with intercalated peat are present. These two phases represent the Lith-1 and

- Lith-2 channel belts. The basal peat date series at Maren (UtC-10188 – 10192; 5068 - 4478 yr BP; Cohen, 2003) is from a peat bed underlying floodbasin deposits of Lith-1 channel belt.
3. Within the Lith channel belt complex, Lith-3 is located north of Lith-1 and Lith-2. Lith-3 has many crevasse splays towards the southwest. The Lith channel belt complex shows a characteristic small-scale pattern of meandering, related to local erosion and reworking of Late Glacial aeolian sand (coversand-ridges, inland dunes). The channel belt deposits do not contain calcium carbonate, showing that this was a Meuse distributary, without any influx from the Rhine.
 4. The residual channel of Lith-3 possibly still contained water during Roman times. Near Macharen the remains of a Roman vessel were found in a residual channel (Van Diepen 1952: 116). However, this may be a different channel, as no connection was found between the Macharen channel and the Lith channel.
 5. GTS-lines in this area are not always unambiguous for two reasons: 1) movements along the Peel Boundary Fault, and 2) the Maas deposits generally show large scatter in sand depth. GTS lines for example suggest that the Macharen channel belt is older than the Lith channel belt. This cannot be the case. The residual channel of the Lith channel belt is hard to detect in the present landscape.

100. Lopik 4920-3920 yr BP

Upstream/downstream coordinates: 130-443/120-442/103-439.

Highest sand elevation (relative to NAP in m): -0.1 to -1.4 m (at x = 120-442).

Average gradient (cm/km): 12.2.

Connections: upstream: Vuylkoop; downstream: Haastrecht-Achterbroek and Stolwijk-Beijersche. Distributary: Blokland-Snelrewaard.

Dating evidence: ¹⁴C, pollen analysis, archaeology, relative dating.

Beginning of sedimentation: 4920 ± 35 yr BP (GrN-7956).

End of sedimentation: 3920 ± 60 yr BP (GrN-7575), residual channel date. Beginning of peat formation on basin clay: 4125 ± 30 yr BP (GrN-7955). Related dates: 3995 ± 40 yr BP (GrN-9403) and residual channel dates of Blokland and Snelrewaard: 4115 ± 60 (GrN-7578) and 4180 ± 60 (GrN-7969).

Archaeology: Neolithic, Bronze Age, Iron Age (no Roman Age), Middle Ages.

References: Berendsen (1982: 151-156, 199-206), Bosch & Kok (1994).

Remarks: Dating by De Jong & Zagwijn (1967, report 471) and Verbraeck (1970) is incorrect as a result of incorrect lithological correlation. A large crevasse splay near Benschop-Lopikerkapel was formed between 4205 ± 35 (GrN-7966) and 3925 ± 30 (GrN-7965), just before the Lopik channel belt came to an end. Berendsen (1982) showed that a crevasse scour hole near Lopikerkapel remained open for about 1000 years; a date for beginning peat formation of 2890 ± 35 yr BP (GrN-7971) was obtained. Some of the crevasse complexes near Polsbroek were in contact with tidal creeks until 4130 ± 35 yr BP (GrN-7966).

The Buitenzorg and Lage Dijk channel belts are considered as distributaries of the Lopik channel belt.

A cross section, published by Berendsen (1982: 157), shows two levels of overbank deposits, suggesting that the channel belt was rejuvenated. This was confirmed by cross sections made further to the west (field campaigns of 1999 and 2000). Near Stolwijk the channel belt seems to split up into three branches (Bosch & Kok 1994, geological map 1 : 50.000, sheet 39W). Cross sections show that these branches have different ages. This must be a site of multiple avulsions. Further to the west, mainly clayey 'avulsion belt deposits' were found, that are similar to those described by Smith (1989) and Makaske (1998).

101. Maas (Meuse, downstream from Nederasselt) 1760-0 yr BP

Upstream/downstream coordinates: 187-418/141-416.

Highest sand elevation (relative to NAP in m): +8.8 (Grave) to +0.5 (Drongelen)

Average gradient (cm/km): 11.3 (measured along present channel).

Connections: upstream: Maas; downstream: Early Middle Ages: Oude Maasje. The Oude Maasje was dammed near Hedikhuizen between 1230 AD (Fockema Andreae 1950) and 1270 AD (Ramaer 1899). Since about 1250 the Maas followed a course along the present Afgedamde Maas, that presumably originated during the Early Middle Ages (Sonneveld 1958). According to Hardenberg (1954) the Afgedamde Maas was connected to the Rhine branches Alm and Werken. During the 12th century a new course north of Giessen was formed, and the Meuse flowed into the Waal near Woudrichem forming the Merwede river. This is confirmed by the ¹⁴C age obtained for the silting up of the Alm: 890 ± 40 yr BP (UtC-3626). In 1904 a man-induced change in the river course occurred by digging the Bergsche Maas to the Amer-Hollandsch Diep-Haringvliet. Upstream of Nederasselt the Maas has only one Holocene channel belt.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: age based on the residual channel date (1760 ± 50 yr BP, UtC-1604), of the

Velddriel channel belt, that is cut through by the Maas. In fact this date only applies to the Maas downstream of Velddriel.

End of sedimentation: Around 1230 AD the rivers Maas and Waal were embanked in the Land van Heusden en Altena (Fockema Andreae 1950), around 1327 AD in the Bommelerwaard (Edelman et al. 1950) and around 1331 AD in the Maaskant (Van Diepen 1952). However, dike breaches and floods were common until the beginning of the 20th century. In the embanked floodplains sedimentation still continues.

Archaeology: a few traces of Roman Age, many of Early Middle Ages (Merovingian) and Late Middle Ages. Northeast of Heerewaarden some Iron Age and Bronze Age artefacts were found. These occur on erosional remnants of older channel belts.

References: Weerts & Berendsen (1995: 205), Weerts (1995: 81), Berendsen ed. (1986), Sonneveld (1958).

Remarks: Upstream from Lith the Maas has two levels of overbank deposits, west of Lith there is only one level of overbank deposits. This is important for the palaeogeographic reconstruction. Many meanders of the Maas have been cut off, see Berendsen ed. (1986: 95). Examples are: the artificial cutoffs near Keent (1937 AD), Alem (1935 AD), Lith (1935 AD), Maasbommel (1935 AD), Lithoijen (1935 AD), Megen (1935 AD), Hedel (1856 AD), Balgoij (around 1450 AD).

The Balgoij meander (upstream/downstream coordinates: 177-421/176-422, Highest sand elevation (relative to NAP in m): +7.6 to +6.6 m, is dated based on historical evidence (Pons 1953, 1957, Van de Ven 1993, Berendsen, Hoek & Schorn 1995). The residual channel is still marked by a large drainage ditch. The meander is estimated to have been formed between 1500 and 500 yr BP. Archaeological traces occur that were dated in the Early Middle Ages (900-1050 AD).

The Keent-Loon meanders (upstream/downstream coordinates: 177-420/176-421 and 176-422/175-422), Highest sand elevation (relative to NAP in m): +7.8 to +6.4 m) were cut off between 1915 and 1937 AD (13 yr BP), see Middelkoop (1997: 63). The meanders are estimated to have existed between 1000 yr BP and 13 yr BP. In the 'island' of Keent the Lower terrace is preserved. This means, that this meander was not completely formed by lateral accretion.

Older parts of the Maas channel belt that are located outside of the presently embanked floodplain are indicated on the palaeogeographic map with number 101a.

102. Macharen 3000-2000 yr BP

Upstream/downstream coordinates: 165-424/162-423.

Highest sand elevation (relative to NAP in m): +4.6 to +3.5

Average gradient (cm/km): 17.5

Connections: upstream: Huisseling-Demen (although a connection to the Haren channel belt cannot be excluded with certainty); downstream: Meuse-Velddriel.

Dating evidence: ¹⁴C dating, archaeology, historical evidence.

Beginning of sedimentation: estimate: 3000 yr BP, based on the abandonment of the Lith channel belt 2734 ± 44 (UtC-8125). The fill of a crevasse channel dated at 2590 ± 44 (UtC-11126) is attributed to the Macharen channel belt.

End of sedimentation: estimate: 2000 yr BP. The reach between Lithoijen and Heerewaarden was not abandoned, river activity continues as the Maas (101) channel belt.

Archaeology: Neolithic, Bronze Age, Iron Age, Roman Age, Early to Late Middle Ages.

References: Van Diepen (1954).

Remarks:

1. The Macharen channel belt is incised into Pleistocene sands over most of its length; therefore it is hard to determine whether the channel belt has one or more periods of activity (contrary to the Lith channel belt, that clearly has two levels of overbank deposits). The channel belt has not yet been radiocarbon dated, because organic material in this area is extremely scarce. Archaeological traces suggest that the river existed already during the Bronze Age, and possibly even earlier. The final phase of activity is of Roman Age: a Roman vessel was found in a residual channel near Macharen (Van Diepen 1952: 116). Unfortunately the exact location is unknown. The channel belt deposits do not contain calcium carbonate. GTS-lines suggest that the Macharen channel belt is younger than the Haren channel belt, but this is not necessarily so, because tectonic movements along the Peel Boundary Fault may have resulted in a relatively high occurrence of sand in the Macharen channel belt.
2. South of the cut-off Lithoijen meander of the present Meuse, two relatively small and probably short-lived palaeo-channels exist that were assigned to the Macharen channel belt by Berendsen & Stouthamer (2001). However, reinterpretation of archived data suggests that they are older and probably co-existed with the Molenblok (112) channel belt.

103. Mars-Oude Rijn 1915-326 yr BP

Upstream/downstream coordinates: 169-449/164-451.

Highest sand elevation (relative to NAP in m): +6.8 to +6.3

Average gradient (cm/km): 7.1 (measured along residual river channel)

Connections: upstream: Rhine; downstream: Rhine.

Dating evidence: historical evidence.

Beginning of sedimentation: earliest possible (indirect date): 1915 ± 55 yr BP(GrN-6992).

End of sedimentation: 1624 AD (326 yr BP), based on historical evidence.

Archaeology: Late Middle Ages

References: Verbraeck (1984), Stiboka (1973).

Remarks: The residual channel still contains water. The cutoff seems to be partly artificial, although a natural channel may have been used.

104. Maurik 6200-5350 yr BP

Upstream/downstream coordinates: 170-440/149-439.

Highest sand elevation (relative to NAP in m): +2.6 to +1.9.

Average gradient (cm/km): 11.7.

Connections: Upstream: The Maurik channel evolved from an underlying Rhine trunk channel that was continuously active since the Late Glacial, with incised Early and Middle Holocene meandering channels mainly reworking the Younger Dryas channel belt. This trunk channel can be traced in the subsurface directly south of the Late Holocene Ingen, Lienden, Mars channel belts, but the channel belt of Maurik age was probably located further north, and is mostly eroded by the Late Holocene channels. Small fragments can be found in-between the younger channel belts and the Nederrijn in the small floodbasin at x=167. Further upstream the Maurik channel belt was connected to Herveld, Ressen and Winssen.

Downstream: Autena and Benschop channel belts. A small secondary channel south of the main Maurik channel belt, connects to the Vretstrooi channel belt.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: around 6200 yr BP (Hofstede, Berendsen & Janssen 1989: 412). The Maurik channel belt and a slightly younger reoccupation (Zoelmond channel belt) form the upper levels of a stacked channel belt complex occupying a Late-Glacial incised channel belt (Cohen et al., 2003). There is no clearly definable beginning of sedimentation for this channel belt; because the Maurik channel belt gradually evolved from an older channel at a slightly deeper level (unlike most other channel belts that initiated by avulsion). The predecessor of the Maurik channel belt (HR-1, HR-2; Cohen, 2003) was the trunk channel that fed the channel belts of the Benschop river system (cf. Berendsen & Stouthamer, 2001). The date used here as the beginning of sedimentation is an estimate of the local onset of aggrading conditions, at the level of the Late Glacial LT-terrace (cf. Berendsen & Stouthamer, 2001). The estimated age of 6200 ¹⁴C yr BP is confirmed by a series of 4 basal peat dates in the floodbasin directly south of the Maurik channel (UtC-10748, 10750, 10751, 10792) that range from 6299 ± 36 to 6060 ± 36 yr BP (Cohen et al., 2003). Some distal floodbasin clays (crevasse splay deposits) attributed to the Maurik channel overlying the dated basal peat bed.

End of sedimentation: 5350 ± 40 yr BP (GrN-12461), which is a date of the base of peat, overlying the overbank deposits directly north of this channel belt. South of this channel belt the base of peat overlying a crevasse deposit from the Maurik channel belt was dated at 5179 ± 48 (UtC-10749). The series of dates on the Zandberg eolian dune (Van Dijk et al. 1991: 320; Törnqvist et al. 1998; Cohen et al., 2003) can also be used to constrain the age of abandonment of the Maurik channel belt. Dates UtC-3947, UtC-3948 (5660 ± 80, 5880 ± 260) and GrN- 11475 (5895 ± 35) are from a humic clay deposited by the Maurik channel. Dates UtC-3946 (5220 ± 70) and GrN-11473 (5220 ± 35) are from a floodbasin peat overlying this clay bed. Therefore, the final phase of activity of 5350 ¹⁴C yr BP might be estimated 100-200 ¹⁴C yr too young (at the maximum).

Archaeology: Neolithic, Bronze Age, Iron Age, Roman Age, Middle Ages.

References: Hofstede, Berendsen & Janssen (1989), Berendsen (1982: 147), Havinga & Op 't Hof (1969), Cohen (2003).

Remarks:

1. The Maurik channel belt formed during the last phase of the Benschop river system (~6200-5350 yr BP). Prior to 6200 yr BP, the trunk channel underlying the Maurik channel belt, was already aggrading. Small aggrading channel belts that predate the Maurik channel occur to the south of it. These are secondary channels that invaded a floodbasin area formed by the drowning of the LT terrace (Cohen et al. 2003: Fig. 6). These channels correlate to the Tienhoven and Middelkoop stages (7000-6260 yr BP) of the Benschop

- river system.
2. The date of abandonment of the Maurik channel (peat overlying overbank deposits) practically coincides with the beginning of activity of the Werkhoven channel belt. This was a major avulsion, abandoning the Benschop system, and starting the Utrecht system (cf. Berendsen & Stouthamer, 2001).
 3. Shortly after abandonment, the Maurik channel belt has been reoccupied by the younger Zoelmond channel belt; at least two levels of overbank deposits exist. Overbank deposits of the Maurik channel belt directly overlie the Kreftenheye Formation (Wijchen Layer), showing that the channel belt originated just east of Wijk bij Duurstede. Both the Maurik and Zoelmond channel belts are overlain by a Late Holocene complex of crevasse splays that seems to be related to one or more avulsions near Wijk bij Duurstede (forming the Ravenswaay and Lek channel belts, Stouthamer, 2001: p. 170; see description Zoelmond channel belt).

105. Meerbroek 4000-3500 yr BP

Upstream/downstream coordinates: 195-434/192-433.

Highest sand elevation (relative to NAP in m): +7.9 to +7.7

Average gradient (cm/km): 5

Connections: upstream: unknown (eroded); downstream: unknown (eroded by Ressen).

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: estimate 4000 yr BP.

End of sedimentation: estimate 3500 yr BP

Archaeology: no archaeological traces.

References: Verbraeck (1984), Willems (1986).

Remarks: The narrow channel belt seems to be eroded by the Baal channel belt, and is clearly older than the Walbeek channel belt.

106. Meijerberg 2800-760 yr BP

Upstream/downstream coordinates: 126-452.

Highest sand elevation (relative to NAP in m): circa -0.5.

Average gradient (cm/km): 5.2 (measured along residual river channel).

Connections: upstream: Hollandse IJssel; downstream: Linschoten.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: estimate: 2800 yr BP or later.

End of sedimentation: 760 ± 45 yr BP (GrN-7580).

Archaeology: Late Middle Ages.

References: Berendsen (1982: 180-181).

Remarks: The meander was probably cut off (naturally?) just before the embankment of the Hollandse IJssel.

107. Meinerswijk 3500 - 1855 yr BP

Upstream/downstream coordinates: 192-440/188-442.

Highest sand elevation (relative to NAP in m): no borehole data available (built-up area)

Average gradient (cm/km): channel belt too short to be determined accurately.

Connections: upstream: Oude Rijn; downstream: Nederrijn.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: not directly dated, estimate: 3500 yr BP.

End of sedimentation: 2675 ± 30 (GrN-10605), 2540 ± 100 yr BP (GrN-16819) and 2510 ± 120 yr BP (GrN-18276, carbonate residue), 1430 ± 80 yr BP (GrN-18277, carbonate extract). The large difference between residue and extract dates suggests that these dating results are not reliable. Slightly higher in the core a date of 1855 ± 50 yr BP (GrN-16818) was obtained. This is in good agreement with archeological traces.

Archaeology: Roman Age, Early to Late Middle Ages.

References: Verbraeck (1984), Willems (1986), De Jong (1980, report 880).

Remarks: Other dates obtained are: 1350 ± 30 yr BP (GrN-10607): too high in the core and therefore not indicating the beginning of silting up of the channel; 1500 ± 35 (GrN-10608): approximately correct.

The date of 7300 ± 40 yr BP (10606) must refer to peat underlying the river channel. This date therefore has nothing to do with the Rhine channel that was excavated at this site.

108. Mert 2510-2200 yr BP

Upstream/downstream coordinates: 137-428/136-426.

Highest sand elevation (relative to NAP in m): -0.2 to -0.6.

Average gradient (cm/km): 13.3

Connections: upstream: Enspijk; downstream: Spijk.

Dating evidence: relative dating.

Beginning of sedimentation: presumably the same as Enspijk: in any case after 4820 yr BP (end of sedimentation of Deil channel belt).

End of sedimentation: based on correlation with Spijk channel belt; around 2200 yr BP.

Archaeology: Bronze Age?

References: Verbraeck (1984).

Remarks: Small channel belt or large crevasse, that has yet not been dated accurately.

109. Merwede 1625-0 yr BP

Upstream/downstream coordinates: 120-425/100-434.

Highest sand elevation (relative to NAP in m): unknown; outside accurately mapped area.

Average gradient (cm/km): unknown.

Connections: upstream: Afgedamde Maas and Waal; downstream: Noord-Nieuwe Maas and Nieuwe Merwede-Amer-Hollandsch Diep-Haringvliet (Meuse estuary).

Dating evidence: historical evidence.

Beginning of sedimentation: presumably the same as Waal downstream from Tiel: approximately 1625 yr BP.

End of sedimentation: the river still exists.

Archaeology: no archaeological traces.

References: Verbraeck (1984), Van de Ven (1996: 62-63).

Remarks: The original channel belt has been renamed Nieuwe Maas west of Slikkerveer. The reach between Dordrecht and Slikkerveer has been widened and is now called Noord. After the St. Elizabeth's flood one of the tidal creeks was enlarged and became known as 'Nieuwe Merwede'.

110. Meteren 2936-2300 yr BP

Upstream/downstream coordinates: 148-430/146-426.

Highest sand elevation (relative to NAP in m): +2.8 to +2.0

Average gradient (cm/km): 16.0

Connections: upstream: Erichem-Zoelen, possibly also Tweesluizen; downstream: Gameren.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: no direct dates available, presumably of approximately the same age as the Bommel channel belt: 2936 ± 37 (UtC-6716) and 3124 ± 38 (UtC-6848).

End of sedimentation: no direct dates available; Iron Age. Age based on the connections with Erichem and Est.

Archaeology: oldest archaeological traces: Bronze age, Middle Iron Age; many Roman Age traces, Middle Ages. The Bronze age traces are probably found on an erosional remnant of an underlying channel belt.

References: Verbraeck (1984).

Remarks: The channel belt has been eroded by the Waal and Linge channel belts. The gradient line of the top of the sand shows that the river flowed from N to S. After the Hennisdijk channel belt degraded, the Meteren channel belt took over its discharge. The channel belt has three levels of overbank deposits, the oldest level directly overlies the Pleistocene deposits. This shows that the channel belt was reactivated at least two times.

111. Middelkoop 7370-5350 yr BP

Upstream/downstream coordinates: 136-436/121-433.

Highest sand elevation (relative to NAP in m): Middelkoop-Nieuwland: -2.1 to -5.4.

Average gradient (cm/km): Middelkoop-Nieuwland 24.8.

Connections: upstream: Kortenhoeven-Autena; downstream: Pinkenveer.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: 7370 ± 100 yr BP (GrN-8383). At some locations younger dates are found; these may apply to distributaries of different age: e.g. 6745 ± 45 yr BP (GrN-18930).

End of sedimentation: 5350 yr BP. Related dates: 5270 ± 40 yr BP (GrN-10113), 5340 ± 90 yr BP (GrN-786). Age determination is essentially based on the inferred connection to the Achthoven channel belt. The downstream continuation of the Middelkoop channel belt, called the Nieuwland channel belt, was dated at many different locations: 6060 ± 80 (GrN7864), 6090 ± 70 yr BP (GrN-8922), 6140 ± 70 yr BP (GrN-10861), 6170 ± 60 yr BP (GrN-2816), 6230 ± 60 yr BP (GrN-2816), 6270 ± 70 yr BP (GrN-10869), 6270 ± 85 yr BP (GrN-2818), 6210 ± 85 yr BP (GrN-2828), 6210 ± 70 yr BP (GrN-10893), 6280 ± 80 yr BP (GrN-10853), 6310 ± 60 yr BP (GrN-10104), 6470 ± 150 yr BP (GrN-8934). Therefore the Nieuwland channel belt cannot have been the last distributary of the Middelkoop channel belt. Instead, the Achthoven channel belt must have been the last distributary of the Middelkoop channel belt. In any case, the Middelkoop channel belt ended before 4800 ± 70 yr BP (GrN-8376).

Archaeology: no archaeological traces.

References: Törnqvist (1993: 205), Van der Woude (1981: 60), Berendsen (1982: 142-143).

Remarks: The Middelkoop-Nieuwland channel belt has many distributaries that may have slightly different ages.

112. Molenblok 5500-4370 yr BP

Upstream/downstream coordinates: 166-428/157-424.

Highest sand elevation (relative to NAP in m): +3.6 to +2.8

Average gradient (cm/km): 18.2

Connections: upstream: Altforst; downstream: Varik, Lith, Appelaar.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: 4765 ± 60 yr BP (GrN-6996) is a gyttja date marking a phase of renewed sedimentation by a northern distributary of the Molenblok (112) system, underlying Nieuweschans (see discussion Nieuweschans, 121). Berendsen & Stouthamer (2001) considered it the beginning of activity of the Molenblok channel belt. However, many channels to the south appear older. Here, the Molenblok system has been active since approximately 5500 ¹⁴C yr BP, the suggested date of abandonment of HM-3 channel belt (Cohen, 2003: Chapter 5).

End of sedimentation: based on a residual channel date of the Wijchens Maasje: 4370 ± 60 yr BP (GrN-6998).

Downstream of coordinates 159-428, the Nieuweschans (121) channel belt reoccupied a branch of the Molenblok (112) channel belt complex. A channel fill within the resulting complex was dated, resulting in a date of: 4556 ± 41 yr BP (UtC-10753) from silty humic clay at 3.0 m depth. To the northwest of the reoccupation, peat in between deposits of the Molenblok (112) and Nieuweschans (121) channel belts produced dates of 4800 ± 50 yr BP (UtC-10186) and 4797 ± 42 yr BP (UtC-11128). Channels of the Molenblok (112) complex further to the south may have remained active longer.

Archaeology: Late Neolithic, Iron Age, Roman Age, Middle Ages.

References: Verbraeck (1984: 208-210); Berendsen, Hoek & Schorn (1995), Cohen (2003).

Remarks: Age estimates are uncertain, based on age of the oldest phase of the Wijchens Maasje. See also description of Nieuweschans.

113. Molenveld 4820-4160 yr BP

Upstream/downstream coordinates: 139-424/133-422.

Highest sand elevation (relative to NAP in m): +0.2 to -1.4.

Average gradient (cm/km): 32 (obviously too high, but correlation of GTS-line is very good: $r^2=0.97$).

Connections: upstream: Zeek or Spelwerd (a small erosional remnant near Zaltbommel, see Berendsen ed. 1986); downstream: Zaltbommel-Nederhemert.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: 4820 ± 70 yr BP (GrN-12462).

End of sedimentation: 4160 ± 60 yr BP (GrN-11476).

Archaeology: possibly Iron Age, Roman Age.

References: Weerts & Berendsen (1995: 207), Weerts (1995: 82), Sonneveld (1958).

Remarks: The date 4160 ± 60 yr BP has been erroneously given the number GrN-12461 by Weerts & Berendsen (1995: 207) and by Weerts (1995: 76, 82). The correct number is GrN-11476.

114. Munnikenland 2510-1760 yr BP

Upstream/downstream coordinates: 133-422/132-424.

Highest sand elevation (relative to NAP in m): -0.8 to -1.6.
Average gradient (cm/km): 16.0 (measured along channel belt).
Connections: upstream: Oensel-Bruchem; downstream: Gameren.
Dating evidence: ¹⁴C, relative dating.
Beginning of sedimentation: not directly dated, presumably of the same age as Leuven-Verdriet: 2510 ± 50 yr BP (UtC-1891).
End of sedimentation: based on the residual channel date of the Bruchem channel belt: 1760 ± 45 yr BP (GrN-12463). This agrees well with the terminus ante quem for the end of activity of the Spijk channel belt (1885 ± 30 yr BP, weighted mean of samples UtC-1426 and UtC-1427). Residual channel dates 2150 ± 40 yr BP (UtC-1425) and 1900 ± 50 yr BP (UtC-1480) were rejected by Törnqvist (1993: 141-142) but also seem to be approximately correct.
Archaeology: no archaeological traces.
References: Weerts & Berendsen (1995: 207); Törnqvist (1993: 141-142); Weerts (1995: 82), Berendsen & Cortenraad (1988: 224).
Remarks: the channel belt does not have any possible downstream connections north of the Waal, and therefore has to be connected to the Rijswijk channel belt.

115. Neder-Oudland 4455-3950 yr BP

Upstream/downstream coordinates: 130-450/128-450.
Highest sand elevation (relative to NAP in m): -0.3.
Average gradient (cm/km): 5.7.
Connections: upstream: Honswijk? downstream: Stuivenberg.
Dating evidence: relative dating.
Beginning of sedimentation: 4455 yr BP (estimate based on end of activity of Buitenzorg channel belt).
End of sedimentation: 3950 ± 60 yr BP (GrN-8704), 4075 ± 60 yr BP (GrN-9262).
Archaeology: possibly Iron Age, certainly Roman Age, Middle Ages.
References: Berendsen (1982: 147, 171).
Remarks: Small erosional remnant, eroded by Stuivenberg and Hollandse IJssel.
Comparison of GTS-lines suggests that the Neder-Oudland channel belt is slightly older than the Vechgel channel belt.

116. Nederrijn 2500-0 yr BP (upstream from Wijk bij Duurstede)

Upstream/downstream coordinates: 196-436/102-433.
Highest sand elevation (relative to NAP in m): +10.2 (Oosterbeek) to +6.1 (Wijk bij Duurstede) to + 3.0 (Schoonhoven).
Average gradient (cm/km): Average between Oosterbeek and Wijk bij Duurstede: 10.8 (measured along present channel); at Wijk bij Duurstede 13.2, at Schoonhoven 4.5 (calculated sandy channel belt gradient). Average gradient of the water level: Lobith: 11.6, Wijk bij Duurstede 10.0, Schoonhoven 3.8 (high tide) and 7.5 (low tide), Krimpen 1.3 (high tide) and 4.7 (low tide), based on Berendsen (1982).
Connections: upstream: Rhine; downstream: Nieuwe Maas.
Dating evidence: ¹⁴C, relative dating, archaeology, historical evidence.
Beginning of sedimentation: Dating evidence is ambiguous. It seems that the river must have existed before the Christian Era, because a date of 2540 ± 100 yr BP (GrN-16819) was obtained from a residual channel near Arnhem. However, near Elden a date of 1585 ± 50 yr BP (GrN-7266) was obtained for beginning sedimentation. Dates 1950 ± 30 (GrN-8707) and 2220 ± 35 (GrN-8708) are from samples along the river Lek (the part of the river downstream from Wijk bij Duurstede). Discharge of the Lek increased between 300 AD and 700 AD (Berendsen 1982: 185).
End of sedimentation: 1050 AD (900 yr BP = beginning of embankment). Sedimentation still continues in the embanked floodplains.
Archaeology: Oldest traces: Early and Late Middle Ages. Some Roman and Iron Age traces in the embanked floodplains east of Wijk bij Duurstede. However, these occur either on erosional remnants of older channel belts like the Houten and Maurik channel belts, or are reworked.
References: Berendsen (1982: 182-185), Vink (1926: 221), Gottschalk (1971: 163-165), De Boer & Pons (1960: 28-29), Henderikx (1980: 234, 244-246), Middelkoop (1997).
Remarks:
1. It should be remembered, that the history of the present river is rather complicated, since its present upstream course follows or crosses numerous older channel belts. Only downstream of Vianen the present channel belt

- is isolated from the older courses. See also: Lek channel belt.
2. Meander cutoffs occur near Wijk bij Duurstede (1960 AD, associated with the construction of a weir), Malburgen (1906 AD, artificial cutoff), Wijk bij Duurstede (1860 AD, artificial cutoff of the Roodvoetmeander).
 3. The Pannerdens Kanaal was dug in 1707 AD (Van de Ven 1996). This in fact resulted in the artificial cutoff of the course Oude Rijn-Pannerden.
 4. Older parts of the channel belt that are located outside of the presently embanked floodplain are indicated on the palaeogeographic map with number 116a.

117. Niers 12000-0 yr BP

Upstream/downstream coordinates: 208-410/195-413.

Highest sand elevation (relative to NAP in m): +29.7 to +28.1.

Average gradient (cm/km): 22.9.

Connections: upstream: local drainage; during the pre-Allerød the main course of the Rhine flowed through the Niers valley.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: the Niers existed as a local river since it was cut off from the main Rhine channel around 12000 yr BP.

End of sedimentation: local drainage still continues.

Archaeology: unknown.

References: Pons (1957), Verbraeck (1984).

Remarks: The Niers valley was abandoned by the Rhine at the end of the Weichselian Pleniglacial. Then drainage shifted to the Gelderse Poort area.

118. Nieuwe Maas 1950-0 yr BP

Upstream/downstream coordinates: 102-433/100-433/sea.

Highest sand elevation (relative to NAP in m): unknown (outside the mapped area).

Average gradient (cm/km): between 1.3 (high tide) and 4.7 (low tide).

Connections: upstream: Slikerveer-Noord and Lek-Nederrijn-Rhine; downstream: North sea.

Dating evidence: ¹⁴C, relative dating, historical evidence.

Beginning of sedimentation: after Roman times, related dates of the Lek: 1950 ± 30 (GrN-8707), 2220 ± 35 (GrN-8708), published by Berendsen (1982: 185).

End of sedimentation: Sedimentation still continues in the embanked floodplains.

Archaeology: unknown.

References: Berendsen (1982: 182-185), Vink (1926: 221), Bosch & Kok (1994), Beekman (1932).

Remarks: The Nieuwe Maas is the confluence of the Waal, Lek and Hollandse IJssel, that formed the main discharge channel to the North Sea until the St. Elizabeth's flood of 1421 AD. This channel was formerly known as 'Merwede' (Beekman 1932). The present 'Nieuwe Merwede' was dug between 1851 and 1860 AD, in order to enhance drainage of the Waal.

119. Nieuwe Merwede 90-0 yr BP

Upstream/downstream coordinates: 120-425/106-415.

Highest sand elevation (relative to NAP in m): highly variable because there are no proper channel deposits.

Average gradient (cm/km): unknown.

Connections: upstream: Boven-Merwede-Waal; downstream: Hollandsch Diep-Haringvliet (Meuse estuary).

Dating evidence: historical evidence.

Beginning of sedimentation: 1860 AD (= 90 yr BP).

End of sedimentation: sedimentation in the embanked floodplains still continues.

Archaeology: not applicable.

References: Weerts & Berendsen (1995: 209-210); Berendsen ed. (1986: 105); Beekman (1948).

Remarks: Canal dug between 1851 and 1860 in order to enhance Waal drainage to the sea. The canal is embanked and follows the course of former tidal creeks, created by the disastrous 1421 AD St. Elizabeth's flood.

120. Nieuwland 7370-6270 yr BP

Upstream/downstream coordinates: 132-435/121-433.

Highest sand elevation (relative to NAP in m): -2.1 to -5.4.

Average gradient (cm/km): Nieuwland 24.8

Connections: upstream: Kortenhoeven; downstream: Pinkenveer.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: 7370 ± 100 yr BP (GrN-8383). At some locations younger dates are found; these may apply to distributaries of different age: e.g. 6745 ± 45 yr BP (GrN-18930).

End of sedimentation: dated at many different locations: 6060 ± 80 (GrN7864), 6090 ± 70 yr BP (GrN-8922), 6140 ± 70 yr BP (GrN-10861), 6170 ± 60 yr BP (GrN-2816), 6230 ± 60 yr BP (GrN-2816), 6270 ± 70 yr BP (GrN-10869), 6270 ± 85 yr BP (GrN-2818), 6210 ± 85 yr BP (GrN-2828), 6210 ± 70 yr BP (GrN-10893), 6280 ± 80 yr BP (GrN-10853), 6310 ± 60 yr BP (GrN-10104), 6470 ± 150 yr BP (GrN-8934).

Archaeology: no archaeological traces.

References: Törnqvist (1993: 205), Van der Woude (1981: 60), Berendsen (1982: 142-143).

Remarks: The Middelkoop-Nieuwland channel belt has many distributaries that may have slightly different ages.

121. Nieuwe Schans 4370-3765 yr BP

Upstream/downstream coordinates: 163-429/156-427.

Highest sand elevation (relative to NAP in m): +2.9 to +2.8.

Average gradient (cm/km): 6.1.

Connections: upstream: Wijchens Maasje; downstream: Appelaar.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: 4370 ± 60 yr BP (GrN-6998).

End of sedimentation: based on residual channel dates of the Wijchens Maasje: 3765 ± 55 yr BP (GrN-6999) and 3810 ± 55 (GrN-6997).

Archaeology: no archaeological traces.

References: Verbraeck (1984: 208-210); Berendsen, Hoek & Schorn (1995), Cohen (2003).

Remarks:

1. Berendsen & Stouthamer (2001) age estimates are based on the age of the oldest phase of the Wijchens Maasje (Verbraeck 1984, cross section Altforst). Samples were taken from excavations, and are considered to be reliable. However, the geological map (Verbraeck 1984) of the Altforst area does not agree very well with other maps (Berendsen, Hoek & Schorn 1995; Berendsen Faessen & Kempen 1994; Berendsen & Stouthamer; 2001). Mapping is locally complicated by the occurrence of Younger Dryas eolian dune sand, that was sometimes transported over small distances. Also, all river deposits in this area do not contain calcium carbonate and therefore are hard to distinguish from eolian dune sands.
2. The small age difference between the end of Nieuweschans-Appelaar and Esterweg is considered insignificant, considering the reliability of the age determination of the Esterweg-Zaltbommel- Nederhemert channel belt (Berendsen & Weerts 1995).
3. West of x=160 the Nieuweschans channel belt reoccupied an Early Holocene channel belt (EHM-III cf. Cohen, 2003), that may have continued as part of the Molenblok channel belt (112). The Nieuweschans channel belt however, has a considerably lower width (150 m) than this channel belt (approximately 250 m), suggesting that the Nieuweschans channel did not carry the full Meuse discharge.
4. From a residual channel at the southern margin of the Nieuweschans channel belt, two AMS radiocarbon dates were obtained: a humic clay at 1.5 m below the surface (UtC-10752; 2838 ± 40 yr BP), and a silty humic clay at 3.0 m depth (UtC-10753: 4556 ± 41 yr BP); separated by less humic beds. However, at the sampling location, a second residual channel exists at the northern margin of the channel belt. This residual channel might be of the Nieuweschans channel belt; results obtained for the southern channel belt, however, suggest it is from the underlying HM-3 / Molenblok (112) channel belt that was reoccupied by Nieuweschans. The former date (UtC-10752; 2838 ± 40 yr BP) is rather young, and even postdates Dreumel (31), that is considered younger than Nieuweschans.

122. Nieuwendijk 1983-890 yr BP

Upstream/downstream coordinates: 126-420/123-422.

Highest sand elevation (relative to NAP in m): -0.2 (Almkerk) to -0.6.

Average gradient (cm/km): 10.0 (channel belt too short for accurate measurements).

Connections: upstream: Alm; downstream: Werken.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: 1983 ± 36 yr BP (UtC-6851).

End of sedimentation: presumably the same as the residual channel date of the Alm: 890 ± 40 yr BP (UtC-3626).

Archaeology: no archaeological traces.

References: Weerts & Berendsen (1995: 207), Weerts (1995: 82), Sonneveld (1958).

Remarks: The Alm channel belt was the downstream continuation of the Bruchem channel belt, but was rejuvenated by the Afgedamde Maas, until the Afgedamde Maas found a new connection to the river Waal near Woudrichem. The Nieuwendijk channel belt seems to be of the same age as the Alm-Werken channel belt.

123. Ochten 4610-3290 yr BP

Upstream/downstream coordinates: 167-435/151-428.

Highest sand elevation (relative to NAP in m): +4.8 to +3.7, downstream of Tiel +2.8 to +2.0.

Average gradient (cm/km): channel belt too short to be measured accurately.

Connections: upstream: Ressen-Distelkamp-Afferden; joined by Westerveld; downstream: Schaik, possibly also Esterweg or Tweesluizen, later also Hoorzik. However, connections are largely eroded.

Dating evidence: ¹⁴C dating, archaeology, GTS lines.

Beginning of sedimentation: 4610 yr BP, based on the average of two experimental dates of very small samples of unspecified botanical macrofossils in clay, that are not very accurate: 4860 ± 190 yr BP (UtC-1188) and 4360 ± 160 yr BP (UtC-1189). The dated samples are not in the correct stratigraphical order, but are in general agreement with local stratigraphy.

End of sedimentation: based on Westerveld channel belt: 3290 yr BP. According to Makaske (1998, Appendix 4) the date of 2770 ± 90 yr BP (UtC-4640) roughly indicates the beginning of the Echteld channel belt, that crosses the Ochten channel belt. The Ochten channel belt therefore must be older.

Archaeology: Bronze Age, (Late) Iron Age, Middle and Late Roman Age, Merovingian-Carolingian.

References: Verbraeck (1984: 202, 220), De Boer (1962, report 343), Makaske (1998: 224).

Remarks:

1. The beginning of activity is based on a date of an extremely small sample (A.F.M. de Jong, unpublished). Since the botanical macrofossils were taken from clay, the material may have been reworked.
2. The sandy channel belt deposits and the overbank deposits of the Ochten channel belt occur at greater depth than those of the Echteld channel belt; this suggests that the Ochten channel belt is slightly older. Moreover, the Echteld channel belt seems to cross the Ochten channel belt.
3. A detailed cross section by Makaske (1998) suggests that the Ochten channel belt is cut by the Echteld channel belt. Also, there are two levels of overbank deposits in his cross section.
4. An upstream connection with Distelkamp-Afferden is the only realistic possibility although the width of the channel belts seems to be different. This connection is also suggested by GTS-lines. Later on, discharge was taken over by Leeuwen-Zennewijnen (approximately 3000-2000 yr BP). This channel may have rejuvenated a channel that was present in what later became the Passewaaij channel belt. The Passewaaij channel belt contained water until Roman times. Possibly a connection existed also from Tiel to Kerk-Avezaath to the Zoelen-Erichem-Esterweg channel belts, or via the subsoil of the present Linge channel belt west of Tiel. The Schaik channel belt also seems to have been fed by the Ochten channel belt from 4600-4240 yr BP. This connection was later eroded by the Linge and Avezaath channel belts. A connection between the Ochten and Hoorzik channel belt seems to have existed from 4020-3818 yr BP via the Esterweg channel belt. This explains why the Hoorzik channel belt (essentially a Meuse channel) is rich in calcium carbonate. The exact courses in and around the city of Tiel cannot be reconstructed due to large-scale erosion and built-up areas.

124. Oensel 2590-2000 yr BP

Upstream/downstream coordinates: 147-424/146-422.

Highest sand elevation (relative to NAP in m): circa +2.2.

Average gradient (cm/km): channel belt too short to be measured accurately.

Connections: upstream: Opijnen-Zennewijnen; downstream: Bruchem-Alm-Werken.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: The Oensel channel belt is supposed to be of the same age as the Bruchem system (2560 ± 40 yr BP, GrN-18104). Dating of the Opijnen channel belt gave an age of 2590 ± 100 yr BP (UtC-

6726), which is in good agreement with the age of the Bruchem channel belt. However, archeological traces suggest that it may be slightly older. Since the Oensel channel belt crosses the Zaltbommel channel belt, it cannot have been active before 4160 ± 60 yr BP (GrN-12661).

End of sedimentation: before the end of activity of the Bruchem channel belt; this is determined by a residual channel date of the Bruchem channel belt: 1760 ± 45 yr BP (GrN-12463). Estimate for the end of activity of the Oensel channel belt: 2000 yr BP.

Archaeology: No archaeological traces. Archeological traces of Roman Age are found on the levees of the Bruchem channel belt (Edelman et al. 1950: 119), suggesting that the channel still contained water during the Roman period, at least until 200 AD. South of Bruchem Early Iron Age inhabitation traces were found on a cut-off meander (Edelman et al. 1950: 117-118). This means that the Oensel-Bruchem channel belt already existed before 500 BC.

References: Weerts & Berendsen (1995: 207), Weerts (1995: 82), Törnqvist (1990: 225), Berendsen & Cortenraad (1988: 226), Pons (1957: 41-42).

Remarks: two sherds dating from approximately 1800 BC were found between Bruchem and Kerkwijk. They are supposed to have been reworked by the river (Edelman et al. 1950).

125. Oevershof 2560-1760 yr BP

Upstream/downstream coordinates: 154-427/151-427.

Highest sand elevation (relative to NAP in m): +3.3 to +2.8.

Average gradient (cm/km): 10.0

Connections: upstream: Leeuwen; downstream: Bruchem-Alm-Werken.

Dating evidence: indirect ^{14}C dating, relative dating.

Beginning of sedimentation: no direct ^{14}C dates available.

End of sedimentation: no direct ^{14}C dates available; final phase of activity probably the same as Bruchem channel belt.

Archaeology: no archaeological traces.

References: Verbraeck (1984).

Remarks: Ages based on age of Bruchem channel belt: beginning of activity 2560 ± 40 yr BP (GrN-18104). The connection with the Bruchem channel belt is based on GTS-lines.

126. Ommeren 5530-2100 yr BP

Upstream/downstream coordinates: 162-439/158-441.

Highest sand elevation (relative to NAP in m): +5.3 to +4.0

Average gradient (cm/km): 16.3

Connections: upstream: Herveld; downstream: Werkhoven-Houten and Zoelen-Erichem-Hennisdijk.

Dating evidence: ^{14}C , archaeology, relative dating.

Beginning of sedimentation: according to Hofstede, Berendsen & Janssen (1989): after 4390 ± 60 yr BP (GrN-12470), but this sample was taken far west of the channel belt. According to Verbraeck (1984: 220): 5530 ± 55 yr BP (GrN-6232). This date of Verbraeck is supported by archaeological evidence.

End of sedimentation: residual channel date: 2100 ± 35 yr BP (GrN-12458). A channel that breaches the entire alluvial ridge was dated at 1635 ± 50 yr BP (GrN-6231).

Archaeology: (Early, Middle and Late) Neolithic, Bronze Age, Iron Age, Roman Age, Middle Ages.

References: Verbraeck (1984), Hofstede, Berendsen & Janssen (1989), Havinga & Op 't Hof (1969).

Remarks: Verbraeck (1984: 220) also determined the end of sedimentation, based on a date of a vegetation horizon (4935 ± 60 yr BP, GrN-6233). This horizon is overlying a sandy clay wedge that corresponds to the most important sedimentation phase. However, this date seems to be much too old because deposits of that age do not occur at such a high level, and local sedimentation rates would have been far too high. The residual channel date is considered to be correct, because it is in agreement with archaeological traces.

127. Ooij 2500-1800 yr BP

Upstream/downstream coordinates: 193-429/189-429.

Highest sand elevation (relative to NAP in m): +9.7 to +9.5.

Average gradient (cm/km): 6.7

Connections: upstream: Leuth; downstream: Waal.

Dating evidence: ^{14}C dating, archaeology, historical evidence.

Beginning of sedimentation: estimate: 2500 yr BP or later.

End of sedimentation: 1800 ± 30 yr BP (GrN-10597).

Archaeology: Early to Late Middle Ages.

References: Willems (1986: 48-49), De Jong (1980, report 880,a,b,c).

Remarks: The residual channel does not contain sand within 3.6 m below the surface; the radiocarbon sample was taken at a depth of 2.24 m. Therefore the beginning of channel filling may have started earlier. On the other hand there are no Roman traces. This suggests a slightly younger age.

128. Opijnen 2590-2000 yr BP

Upstream/downstream coordinates: 151-428/148-426.

Highest sand elevation (relative to NAP in m): 3.3 to 2.9.

Average gradient (cm/km): 13.3

Connections: upstream: Zennewijnen; downstream: Oensel-Bruchem-Alm-Werken.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: 2590 ± 100 yr BP (UtC-6726), which is in good agreement with the age of the Bruchem channel belt.

End of sedimentation: estimate: before circa 2000 yr BP (based on end of activity of Est channel belt), and Roman traces.

Archaeology: Roman Age, Middle Ages.

References: Verbraeck (1984), not named.

Remarks: A connection with the Oensel channel belt is the only possibility.

129. Oud-Aa 2650-1850 yr BP

Upstream/downstream coordinates: 128-464/128-467.

Highest sand elevation (relative to NAP in m): circa -3.0, based on Van de Meene (1988).

Average gradient (cm/km): not enough data to measure accurately.

Connections: upstream: Kromme Rijn, downstream: Angstel.

Dating evidence: ¹⁴C, archaeology, historical evidence.

Beginning of sedimentation: see also Vecht channel belt. Cleveringa (1985, report 895b) dated the top of a peat layer underlying clay: 2620 ± 35 yr BP (GrN-10224). This is in good agreement with dates by Törnqvist (1993: 149-150): 2650 ± 80 yr BP (UtC-1900) and 2620 ± 50 yr BP (UtC-1901). After the Roman period fluvial activity of the Vecht increased, while that of the Angstel decreased (Cleveringa 1985, report 895b).

End of sedimentation: circa 100 AD = 1850 yr BP (degradation of the Roman fortification near Velsen).

Archaeology: no archaeological traces on the Oud-Aa channel belt. Oldest related archaeological traces: Iron Age near Baambrugge and Abcoude. Roman Age near the mouth of the Angstel/Vecht (Velsen); many traces date from the Late Middle Ages.

References: Berendsen (1982: 168), Törnqvist (1993: 149-150), Van de Meene (1988: 51), De Jong & Zagwijn (1973, report 690), De Jong (1981, report 895), Cleveringa 1985, report 895b).

Remarks: The channel belt is the downstream continuation of the Houten/Kromme Rijn channel belt (Berendsen 1982: 169). ¹⁴C dating in the Vecht/Angstel area by the Netherlands' Geological Survey has produced erroneous results (GrN-10223 and GrN-10226 thru GrN-10230 and GrN-10232, mainly due to the reworking of peat in lakes. The Oud-Aa is considered as the upstream course of the Angstel.

130. Oud-Alblas 2200-1700 yr BP

Upstream/downstream coordinates: 108-430/105-429.

Highest sand elevation (relative to NAP in m): -1.1 to -1.7 .

Average gradient (cm/km): 20.0 (possibly inaccurate; based on few data).

Connections: upstream: Papendrecht-Linge and Hardinxveld-Rijswijk-Gameren-Est-Zennewijnen; downstream: unknown (lost in built-up area).

Dating evidence: ¹⁴C, archaeology relative dating.

Beginning of sedimentation: no direct ¹⁴C dates available.

End of sedimentation: no direct ¹⁴C dates available; dating based on archaeological traces, GTS-lines and probable connection with the Linge.

Archaeology: oldest archaeological traces: Roman Age.

References: Bosch & Kok (1994), unpublished cross sections by Drs. G. Van Dijk (Free University of

Amsterdam).

Remarks: Older deposits of Zijderveld and Schoonrewoerd channel belts are present in the subsoil. Dates obtained are: 5120 ± 60 yr BP (GrN-10865), 4280 ± 70 (GrN-10864), 3780 ± 60 yr BP (GrN-10871).

131. Oude IJssel 12000-0 yr BP

Upstream/downstream coordinates: 220-438/206-446.

Highest sand elevation (relative to NAP in m): +9.6 to +8.9

Average gradient (cm/km): 14.0.

Connections: upstream: local drainage.

Dating evidence: archaeology, relative dating.

Beginning of sedimentation: local drainage started approximately 12000 yr BP, after the valley was deserted by the Rhine.

End of sedimentation: local drainage still continues.

Archaeology: unknown.

References: Van de Meene (1977).

Remarks: The Oude IJssel valley was abandoned by the Rhine around 12000 yr BP, when main drainage shifted to the Gelderse Poort area.

132. Oude Maasje 1760-700 yr BP

Upstream/downstream coordinates: 140-415/121-414.

Highest sand elevation (relative to NAP in m): +0.8 at Drongelen.

Average gradient (cm/km): unknown (the entire length has not been mapped in detail).

Connections: upstream: Maas / Velddriel; downstream: formerly: Meuse estuary; presently: Amer-Hollands Diep.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: no direct dates available; presumably the same as beginning of the Maas (1760 ± 50 yr BP, UtC-1604), but possibly slightly older.

End of sedimentation: the residual channel still contains water. The channel was dammed up around 700 yr BP, namely between 1230 (Fockema Andreae 1950) and 1270 AD (Ramaer 1899) near Hedikhuizen.

Archaeology: Archaeological traces of Roman Age and Middle Ages are found on the levees. A few Late Iron Age traces indicate a possibly earlier beginning of the channel belt than suggested by the radiocarbon date mentioned above.

References: Weerts & Berendsen (1995: 207), Weerts (1995: 82), Sonneveld (1958), Fockema Andreae (1950), Ramaer (1899).

Remarks: The Afgedamde Maas was a larger distributary than the Oude Maasje. The Alm channel belt was the downstream continuation of the Bruchem channel belt, but was rejuvenated by the Afgedamde Maas, until the Afgedamde Maas found a new connection to the river Waal near Woudrichem. This presumably happened in the 12th century. Practically at the same time the Oude Maasje was dammed near Hedikhuizen.

The large meander of Ammerzoden (locally known as the Ammer or Amer, meaning river branch) was cut off around 1000 yr BP. The exact date is unknown, but the castle of Ammerzoden existed already in 1354 AD (Vermeulen 1932, in Berendsen et al. 1996: 53). Paleomagnetic dating of the residual channel suggested that the meander was cut off in the 9th century (Dr. H. Middelkoop, Utrecht University, unpublished data). It is unknown whether the cutoff was artificial or natural.

133. Oude Rijn 5595-828 yr BP

Upstream/downstream coordinates: 133-455/120-455/087-469.

Highest sand elevation (relative to NAP in m): 1.0 / 0.6 / -2.2.

Average gradient (cm/km): 8.0 (near Utrecht) decreasing to 6.4 (near Woerden). Calculated values are based on the GTS-line; distance was measured along the residual channel (Berendsen (1982).

Connections: upstream: Kromme Rijn; downstream: North Sea.

Dating evidence: ¹⁴C, archaeology, historical evidence.

Beginning of sedimentation: after 5595 ± 35 (GrN-7963) and 5520 ± 60 yr BP (GrN-8739). Törnqvist (1993) obtained a date of 4310 ± 90 yr BP (UtC-1892), but this seems to reflect an increase of discharge rather than the initiation of the channel belt.

End of sedimentation: 1122 AD = 828 yr BP (damming up of Kromme Rijn at Wijk bij Duurstede).

Archaeology: Iron Age, Roman Age, Middle Ages.

References: Berendsen (1982: 167-168), Bosch & Pruijssers (1978), Louwe Kooijmans (1974: 99), Henderikx (1980: 247), Dekker (1980: 249).

Remarks: The channel belt is the downstream continuation of the Werkhoven, Houten and Kromme Rijn channel belts, and therefore has a complicated nature. The large width of the channel belt between Utrecht and Harmelen is due to the occurrence of easily erodible cover sand at shallow depth. The Oude Rijn (Old Rhine) channel silted up after 780 AD, resulting in an increased discharge of the Vecht (Berendsen 1982: 168). Dating west of Utrecht is extremely difficult, because the channel belt is completely encased in peat and virtually no clay wedges are found.

A trench was cut through the residual channel in 2000. The channel was filled with approximately 3 m of stinking dark grey clay ('kwabbenak'), containing a thin peat layer. The oldest artifacts in the channel fill date from the 11th century (Drs. H. Wynia, personal communication). Mass movements partly filled the residual channel.

North of Haarzuilens a crevasse complex exists. One crevasse channel branched off to the northwest and finally joined the river Vecht. Just north of Haarzuilens the channel incised to a depth of 6.5 m -NAP, but it did not reach the underlying Pleistocene coversand. The age of this channel has not been determined, but considering the depth of the channel deposits, it probably silted up around Roman times.

Near the mouth of the Oude Rijn many ¹⁴C dates have been obtained by Bosch & Pruijssers (1978). The relevance of these dates is unclear.

134. Oude Rijn-Pannerden 2500-243 yr BP

Upstream/downstream coordinates: 205-429/197-436.

Highest sand elevation (relative to NAP in m): +14.1 to +11.5.

Average gradient (cm/km): 22.0 (measured along residual river channel).

Connections: upstream: Rhine; downstream: Nederrijn.

Dating evidence: historical evidence.

Beginning of sedimentation: estimate: 2500 yr BP.

End of sedimentation: The channel of the Oude Rijn was dammed in 1707 (243 yr BP) when the Pannerdens kanaal was opened.

Archaeology: Oldest traces: Late Middle Ages.

References: Middelkoop (1997: 63), Van de Ven (1993: 140).

Remarks: The residual channel still contains water. The present course of the Rhine through the Pannerdens kanaal was dug in 1707.

135. Ouderkerk 6800-6335 yr BP

Upstream/downstream coordinates: 108-440/102-438.

Highest sand elevation (relative to NAP in m): approximately -8.5 to -10.

Average gradient (cm/km): not enough data to measure accurately.

Connections: upstream: Benschop; downstream: North Sea.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: The beginning of clay sedimentation of the Berkenwoude channel belt is estimated to begin around 7200 yr BP. If the width of the channel belts is indicated correctly on the geological map (Bosch & Kok 1994), an avulsion must have taken place near Berkenwoude. The Ouderkerk channel seems to be younger than the channel that runs southward and joins the Bergambacht channel belt Bosch & Kok (1994, cross section F-F'). The age of 6800 yr BP is estimated.

End of sedimentation: 6335 ± 45 yr BP (GrN-9406). This is the date for final activity of the Benschop channel, obtained near Polsbroek. However, this date is not representative for the whole Benschop river system, as the northwesternmost branches (Willeskop, Oudewater) are definitely younger.

Archaeology: no archaeological traces.

References: Bosch & Kok (1994: 73, 91).

Remarks: The Benschop river system has many distributaries that may have slightly different ages. The age given here for the end of sedimentation has to be considered as an approximate age for the end of sedimentation of the Berkenwoude channel belt. The date for beginning activity is an estimate. The exact dating of the channel belt is a matter of further study.

136. Oude Waal 1800-619 yr BP

Upstream/downstream coordinates: 104-429/100-429.

Highest sand elevation (relative to NAP in m): -2.4 to -2.9.

Average gradient (cm/km): 10.0 (not very accurate; based on few data)

Connections: upstream: originally: Papendrecht-Oud Alblas; later Waal; downstream: Meuse estuary.

Dating evidence: relative dating, GTS-lines.

Beginning of sedimentation: unknown; based on the age of the river Waal.

End of sedimentation: in 1331 AD (619 yr BP) the channel was dammed (RAAP report 304). At the same time the Zwijndrechtsche Waard was embanked.

Archaeology: no archaeological traces.

References: Bosch & Kok (1994), Van de Ven (1996: 62).

Remarks: The Oude Waal and Oude Maasje joined west of the mapped area in the Meuse estuary.

137. Oudewater 10.000-6200 yr BP

Upstream/downstream coordinates: 123-450/115-448.

Highest sand elevation (relative to NAP in m): -6.1 to -6.6.

Average gradient (cm/km): not enough data to measure accurately.

Connections: upstream: Autena; downstream: Benschop.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: According to Berendsen & Stouthamer (2001) the same as Autena: 6110 ± 50 yr BP (UtC-6715). The northern branch of the channel belt is a younger distributary of the Willeskop channel belt. New dates obtained by Kombrink (unpublished MSc thesis) suggest that the southern branch of the Oudewater emerged from Terrace-X, whereas the northern branch came into existence approximately 7600 yr BP.

End of sedimentation: According to Berendsen & Stouthamer (2001) the same as Willeskop: 5800 ± 70 yr BP (UtC-1894) and 5610 ± 60 yr BP (UtC-1897). However, new dates obtained by Kombrink (unpublished MSc thesis) suggest that the Oudewater channel belt was abandoned approximately 6200 yr BP: dates obtained are 6210 ± 50 yr BP (UtC-12338) and 6238 ± 49 yr BP (UtC-12336). The Benschop channel belt was abandoned simultaneously.

Archaeology: no archaeological traces.

References: Törnqvist (1993: 145-146), Bosch & Kok (1994: 73, 91), Berendsen (1982: 142-143).

Remarks: The Oudewater channel belt is a distributary of the Benschop river system.

138. Oudwulverbroek 2930-1915 yr BP

Upstream/downstream coordinates: 139-452/138-453.

Highest sand elevation (relative to NAP in m): circa 0.8.

Average gradient (cm/km): 10.9 (channel belt too short to measure accurately).

Connections: upstream: Zeist.

Dating evidence: ¹⁴C, archaeology.

Beginning of sedimentation: after 2930 ± 60 (GrN-4371).

End of sedimentation: 1915 ± 50 yr BP (residual channel date).

Archaeology: Roman Age near Fort Vechten, Middle Ages.

References: Berendsen (1982: 166), Berendsen & Wynia (1993).

Remarks: The channel belt is part of the Kromme Rijn channel belt. The cut-off meander represents an older stage of the Kromme Rijn, and was probably connected to the Zeist channel belt.

139. Over-Oudland 4365-3000 yr BP

Upstream/downstream coordinates: 133-446/132-447.

Highest sand elevation (relative to NAP in m): circa -0.1.

Average gradient (cm/km): channel belt too short to measure accurately.

Connections: upstream: Honswijk? downstream: Neder-Oudland-Lampsin?

Dating evidence: relative dating.

Beginning of sedimentation: after 4365 ± 40 yr BP (GrN-18934).

End of sedimentation: 3000 ± 60 yr BP (GU-9299).

Archaeology: oldest archaeological traces: Iron Age.

References: Berendsen (1982: 147, 171), Bulten (2000).

Remarks: Small erosional remnant, that has yet not been dated accurately. In september 2000, Roman artifacts were found at the base of the residual fill (personal communication, Drs. W. van Zijverden). This suggests that river activity may have continued longer, until approximately 2000 yr BP. However, a residual date of 3000 yr BP confirmed the original estimate of Berendsen & Stouthamer (2001).

140. Papendrecht 2200-1700 yr BP

Upstream/downstream coordinates: 108-430/105-426.

Highest sand elevation (relative to NAP in m): circa -3.9 to -6.0.

Average gradient (cm/km): not enough data to measure accurately.

Connections: upstream: unknown; possibilities: Linge or Werken; downstream: Oud-Alblas-Oude Waal.

Dating evidence: archaeology, relative dating.

Beginning of sedimentation: unknown, most likely around 2200 yr BP.

End of sedimentation: Roman Era.

Archaeology: Iron Age, Roman Age, Middle Ages.

References: Bosch & Kok (1994).

Remarks: The channel deposits consist of very coarse sand, but are capped with a thick layer of sandy clay. The channel belt is thought to be of fluvial origin (pers. communication Dr. H.J.T. Weerts, NITG-TNO). An unequivocal connection with young channel belts could not be established, mainly because the surrounding area is densely populated and built-up.

141. Passewaaij 2770-1901 yr BP

Upstream/downstream coordinates: 156-431/153-430.

Highest sand elevation (relative to NAP in m): circa +3.8.

Average gradient (cm/km): channel belt too short to measure accurately.

Connections: upstream: initially there probably was a course following Wijchens Maasje-Dreumel and Westerveld-Ochten, later rejuvenated by Distelkamp-Afferden-Leeuwen-Wamel; downstream: Bommel-Est-Gameren-Rijswijk.

Dating evidence: archaeology, relative dating.

Beginning of sedimentation: Most likely around 2770 ± 90 yr BP (UtC-4640), based on the presumed connection with Echteld (that was later eroded by the river Waal).

End of sedimentation: most likely around 1901 ± 35 yr BP (UtC-4639), which is the end of sedimentation of the Echteld channel belt. In that case the Passewaaij channel belt was partly contemporaneous with the Bommel channel belt (2936-2310 yr BP). The residual channel still contained water in Roman times (personal communication Prof. Dr. N. Roymans).

Archaeology: Iron Age, Roman Age, Middle Ages.

References: Verbraeck (1984).

Remarks: The local geomorphology suggests, that the Bommel channel belt existed longer than the Passewaaij channel belt. ¹⁴C dates suggest otherwise, but the difference may not be significant, as direct dates of this erosional fragment are not yet available.

Archaeological excavations provide an accurate date of river activity. The main sandbody of the channel belt is overlain by a crevasse-like deposit that rejuvenated the channel belt (personal observation), and that was formed between Early and Late Iron Age (personal communication E. Verhelst). This corresponds very well with ¹⁴C dates mentioned above.

142. Pinkenveer 7370-6270 yr BP

Upstream/downstream coordinates: 121-433/109-430.

Highest sand elevation (relative to NAP in m): Pinkenveer: circa - 1.4 to -2.4.

Average gradient (cm/km): 25.0

Connections: upstream: Nieuwland-Middelkoop-Kortenhoeven; downstream: lost in the peat area.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: 7370 ± 100 yr BP (GrN-8383). At some locations younger dates are found; these may apply to tributaries of different age: e.g. 6745 ± 45 yr BP (GrN-18930).

End of sedimentation: the upstream connection to the Nieuwland channel belt was dated at many different locations: 6060 ± 80 (GrN7864), 6090 ± 70 yr BP (GrN-8922), 6140 ± 70 yr BP (GrN-10861), 6170 ± 60 yr

BP (GrN-2816), 6230 ± 60 yr BP (GrN-2816), 6270 ± 70 yr BP (GrN-10869), 6270 ± 85 yr BP (GrN-2818), 6210 ± 85 yr BP (GrN-2828), 6210 ± 70 yr BP (GrN-10893), 6280 ± 80 yr BP (GrN-10853), 6310 ± 60 yr BP (GrN-10104), 6470 ± 150 yr BP (GrN-8934).

Archaeology: no archaeological traces.

References: Törnqvist (1993: 205), Van der Woude (1981: 60), Berendsen (1982: 142-143).

Remarks: The Nieuwland-Middelkoop-Kortenhoeven channel belt has many distributaries that may have slightly different ages.

143. Ravenswaaij 2200-1000 yr BP

Upstream/downstream coordinates: 151-440/143-441.

Highest sand elevation (relative to NAP in m): +4.3 to +3.4.

Average gradient (cm/km): 18.0

Connections: upstream: Nederrijn-Lienden; downstream: Hagestein.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: in any case after 3825 ± 40 yr BP (GrN-12459), but probably much later. Since the channel belt seems to cross the Hennisdijk channel belt, its earliest possible beginning is around 3000 yr BP.

A reasonable estimate seems 2200 yr BP.

End of sedimentation: no direct ¹⁴C dates available; probably around 950 AD (1000 yr BP).

Archaeology: Roman Age, Middle Ages.

References: Van Dijk, Berendsen & Roeleveld (1991: 320), Verbraeck (1984).

Remarks: The channel belt has been eroded by the Lek channel belt; it presumably flowed together with the Buren channel belt. However, the GTS-line is at a 1 m higher level than that of the Buren channel belt. The channel belt begins near Wijk bij Duurstede as a large crevasse complex.

144. Redichem 2200-1000 yr BP

Upstream/downstream coordinates: 151-440/143-441.

Highest sand elevation (relative to NAP in m): +4.3 to +3.4.

Average gradient (cm/km): 18.0

Connections: upstream: Ravenswaaij; downstream: Hagestein.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: after 3825 ± 40 yr BP (GrN-12459), but probably much later. Since the channel belt seems to cross the Hennisdijk channel belt, its earliest possible beginning is estimated at around 2200 yr BP.

End of sedimentation: no direct ¹⁴C dates available; probably around 950 AD (1000 yr BP).

Archaeology: Roman Age, Middle Ages.

References: Vink (1926), Berendsen (1982), Verbraeck (1984).

Remarks: The channel belt has been eroded by the Lek channel belt; it presumably flowed together with the Buren channel belt. However, the GTS-line is at a 1 m higher level than that of the Buren channel belt.

145. Regulieren 5350-4820 yr BP

Upstream/downstream coordinates: 147-439/141-433.

Highest sand elevation (relative to NAP in m): -0.9.

Average gradient (cm/km): not enough data for accurate measurements.

Connections: upstream: Maurik; downstream: unknown.

Dating evidence: ¹⁴C, archaeological traces, relative dating.

Beginning of sedimentation: estimate, based on the age of the Schaik channel belt: 5350 yr BP.

End of sedimentation: before the beginning of Hennisdijk, circa 3900 yr BP, probably much earlier. Estimate: 4820 yr BP.

Archaeology: no archaeological traces.

References: Berendsen, Faessen & Kempen (1994).

Remarks: Small erosional remnants, that seems to be of the same age as Zijderveld. The channel belt is crossed by Hennisdijk and the oldest phase of Schaik. The age must be intermediate between the end of activity of Maurik (5350 yr BP) and the main period of activity of the Schaik channel belt (4820 yr BP).

146. Ressen 4755-2200 yr BP

Upstream/downstream coordinates: 189-432/180-434.

Highest sand elevation (relative to NAP in m): +8.7 to +7.9.

Average gradient (cm/km): 8.0.

Connections: upstream: Leuth-Ooij; downstream: Herveld-Ommere.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: 4755 ± 60 yr BP (GrN-7269). Whether this date is representative for the whole Ressen channel belt is unclear.

End of sedimentation: residual channel dates: 2370 ± 100 yr BP (GrN-10602) and 2260 ± 60, UtC-7810. The wide channel belt contains some older residual channels, that are dated around 3000 yr BP (see Table 1).

Roman traces along the channel suggest, that the residual channel still contained water in Roman times.

Archaeology: Iron Age, Roman Age, Early to Late Middle Ages.

References: Verbraeck (1984), Teunissen (1984, 1986, 1990), De Jong (1980, report 852, 880), Willems (1986), Berendsen, Faessen & Kempen (1994), Weerts (1996).

Remarks: The Ressen channel belt is extremely complicated and seems to consist of at least four separate channel belts with different sand levels (Weerts 1996: 144). In addition to that, the channel belt area may contain erosional remnants of Weichselian river terraces (pers. communication J. Van der Staaij (Netherlands Geological Survey) and Drs. E. Heunks, RAAP). However, this still has to be confirmed. OSL-dating of river sand may give an answer to this problem.

- The residual channel contains calcareous gyttja, and the first dating results were considered too old on pollen-analytical grounds. The residual channel date of 2370 ± 100 yr BP (GrN-10602) was therefore rejected by Teunissen (1986: 7-24). De Jong (1980, report 880) considers the date approximately right or only slightly too old.

- Several other residual channel dates were rejected in the literature as being too old, because the residual channels contain calcareous gyttja (Teunissen (1986). However, other calcareous gyttja samples gave reasonable dating results and obviously did not show the hardwater ageing effect. These samples were accepted as being correct (e.g. Deest-Uiversnest: 10720 ± 60, GrN-15023 and 10690 ± 230, GrN-16038). According to Hoek (1997: 112) the degree of the ageing effect is related to the depth of the channel: in shallow channels the ageing effect is negligible. In order to check the reliability of the earlier (bulk) dating results four new AMS dates of terrestrial botanical macrofossils were carried out in four different residual channels, at approximately the same locations as the earlier dates. The results are compared in Table 1.

- The old dates are indeed generally older than our new AMS dates on terrestrial botanical macrofossils (Table 1). Nevertheless two of the old dates are roughly confirmed. Samples Valburg-Hoogbrug (2645 ± 30, GrN-8652) and Baal: 3110 ± 190 yr BP (GrN-10600) are roughly 400 and 650 years too old respectively.

- Two ¹⁴C dates suggest that activity in the Ressen channel belt came to an end shortly before the beginning of the Christian era. This is in agreement with archaeological traces.

Table 1 Comparison of ¹⁴C bulk dating and equivalent AMS dating of botanical macrofossils

Name	Bulk date	GrN-number	Name	AMS date	UtC-number
Valburg-Hoogbrug	2645 ± 30	GrN-8652	Valburg-Eimerse Pijp	2260 ± 60	UtC-7810
Slijk-Ewijk-Veens	3040 ± 35	GrN-8655	Slijk-Ewijk-Vogelenzang	2914 ± 42	UtC-7809
Oude Zeeg II	3150 ± 55	GrN-8654	Elsterveldse Zeeg	2990 ± 48	UtC-7813
Baal	3110 ± 190	GrN-10600	Bemmel-283	2378 ± 35	UtC-8170

- Remnants of older residual channels have survived later erosion, as is evidenced by the presence of older residual channels. The sample Oosterhout: 2980 ± 70 yr BP (GrN-4601) may also be approximately correct, because many other dates around 3000 yr BP are found (Table 1).

- The sample Oude Zeeg III: 1585 ± 30 yr BP (GrN-9427) may be correct, but this is the top of a peat layer in the residual channel instead of the base. Hence it does not indicate final activity of the Ressen channel belt, and cannot be compared with the other dates in Table 1.

- Dates that are definitely in error are: Oosterhout 3225 ± 50 yr BP (GrN-10598); 3745 ± 45 yr BP (GrN-10599); these samples were taken from a residual channel of the river Waal. They either contained reworked material or the subsoil was dated instead of the channel fill (a mistake that is often made). The pollen content is also not in agreement with the dating result.

- Ressen 1: 4920 ± 50 yr BP (GrN-10598) has to be rejected because it is obviously much too old,

probably as a result of the dating of reworked material.

- The date Valburg-De Leygraaf: 7635 ± 50 yr BP (GrN-8653) is considered to be correct, but refers to the filling up of a residual channel in terrace X, and has nothing to do with the beginning of sedimentation of the Ressen channel belt.

147. Ridderkerk 4870-4100 yr BP

Upstream/downstream coordinates: 103-432/100-430.

Highest sand elevation (relative to NAP in m): -3.2 to -3.0.

Average gradient (cm/km): 4.0.

Connections: upstream: Lekkerkerk-Lopik; downstream: unknown.

Dating evidence: relative dating, GTS-lines.

Beginning of sedimentation: terminus post quem: 5885 ± 70 yr BP (GrN-2829), the dated layer is covered with peat, the top of which probably has an age around 5000 yr BP (compare the stratigraphic position in Bosch & Kok (1994, cross section L-L', dates Alblasserdam: 4260 ± 60 yr BP (GrN-2820), and 5245 ± 75 yr BP (GrN-2342). A reasonable estimate seems 4870 yr BP, based on the connection to the Lekkerkerk and Lopik channel belts.

End of sedimentation: Bosch & Kok (1994, cross section L-L'); sedimentation seems to have continued at least until 4100 yr BP, based on date 4260 ± 60 yr BP (GrN-2820) and the connection to the Lekkerkerk-Lopik channel belts.

Archaeology: no archaeological traces.

References: Bosch & Kok (1994, cross section L-L').

Remarks: In any case the channel belt is not connected to Streefkerk as is suggested by Bosch & Kok (1994): the GTS-line of Ridderkerk is at a higher level.

148. Rijswijk 2071-2000 yr BP

Upstream/downstream coordinates: 129-424/124-424.

Highest sand elevation (relative to NAP in m): +0.2 to -0.1.

Average gradient (cm/km): 16.7.

Connections: upstream: Gameren; downstream: Hardinxveld.

Dating evidence: ^{14}C , archaeology, relative dating.

Beginning of sedimentation: direct date: 2071 ± 44 yr BP (UtC-6849). Terminus post quem date: 2810 ± 190 yr BP (UtC-1896); Weerts & Berendsen (1995: 207).

End of sedimentation: around 2000 yr BP.

Archaeology: no archaeological traces.

References: Sonneveld (1958), Weerts & Berendsen (1995: 207).

Remarks:

1. Sand from the river Waal overlies part of the channel belt and the river basin north of it. Drilling in this area is difficult. The Rijswijk channel belt was a distributary of the Gameren channel belt, and was active only part of the time the Gameren channel belt existed.
2. Since the Rijswijk channel belt is directly connected to the Est-Gameren channel belt, the end of sedimentation should also be the same. The residual channel date of the Est channel belt, obtained by Törnqvist (1990: 225) of 1860 ± 60 yr BP (GrN-12464) applies for the end of the rejuvenation stage of the Est channel belt. However, the Rijswijk channel was cut by the Linge. The beginning of the Linge was dated at 2160 yr BP. This is clearly impossible. It shows that the ^{14}C dates cannot be trusted to date river channel belts within one standard deviation of the measurement. Nevertheless, it can be concluded that the Rijswijk channel belt was active for only a very short period of time.

149. Santacker-Driel 2700-2200 yr BP

Upstream/downstream coordinates: 186-437/184-441, north of y=439 the Driel channel belt begins.

Highest sand elevation (relative to NAP in m): +8.3 to +8.0.

Average gradient (cm/km): 10.0 (measured along channel belt).

Connections: upstream: Ressen; downstream: Ressen.

Dating evidence: ^{14}C dating, pollen analysis, archaeology, historical evidence.

Beginning of sedimentation: estimate: 2700 yr BP, based on archaeology.

End of sedimentation: Since the end of activity of the Ressen channel belt is dated around 2200 yr BP, this date

must also apply to the Santacker-Driel channel belt. Infilling of the channel continued until the embankment of the rivers around 1250 AD (700 yr BP).

Archaeology: Iron Age, Roman Age, Early Middle Ages, Late Middle Ages.

References: De Jong (1980, report 880, a,b,c), Teunissen (1990), Willems (1982).

Remarks: A ^{14}C sample taken at a depth of 0.77 m below the surface in the residual channel was dated at 460 ± 90 yr BP (GrN-10604). This indicates that peat formation in the channel continued until the Late Middle Ages. However, the sample does not date the beginning of silting up of the channel, since the base of the channel fill is at a depth of 2.94 m. Pollen analysis indicates that infilling probably started in the Early Middle Ages (*Secale* is found from the base of the channel upward). The age estimate of the end of sedimentation is based on the end of the Ressen channel belt.

The slightly narrower Bredelaar channel belt runs parallel to the Driel channel belt. It is slightly older, based on GTS-lines.

150. Schaik 5285-4240 yr BP

Upstream/downstream coordinates: 146-437/117-426.

Highest sand elevation (relative to NAP in m): +1.8 (Buurmalsen) to -1.0 to -3.0 m (based on Törnqvist 1993: 120).

Average gradient (cm/km): 11.1.

Connections: upstream: unknown, later on via Ochten-Esterweg; downstream: unknown (lost in the peat area).

Dating evidence: ^{14}C , archaeological traces, pollen analysis, relative dating.

Beginning of sedimentation: 5285 ± 50 yr BP (UtC-1396/1397), for a full discussion of dating results, see Törnqvist (1993). Other dates obtained (Appendix 1) are (in yr BP): 4730 ± 70 (GrN-10117), 4800 ± 80 (GrN-10116), 4940 ± 70 (UtC-01296), 4980 ± 130 (UtC-1300), 4990 ± 70 (UtC-1408), 5090 ± 50 (UtC-1295), 5100 ± 110 (UtC-1144), 5110 ± 90 (UtC-1136), 5230 ± 50 (UtC-1407), 5240 ± 90 (UtC-1137), 5300 ± 70 (UtC-1299), 5320 ± 60 yr BP (UtC-1294), 5440 ± 50 (UtC-1297), 5490 ± 100 (UtC-1143).

End of sedimentation: 4240 ± 50 yr BP (UtC-1409), residual channel date. According to Törnqvist (1993: 143) the age of 3630 ± 40 yr BP (UtC-1410) obtained in his transect is too young due to an unconformity at the clastic/organic transition.

Archaeology: Mesolithic (this may be on an eolian dune, eroded by the river), Bronze Age, Iron Age, Roman Age, Middle Ages.

References: Törnqvist (1993: 46); De Boer & Pons (1960); Louwe Kooijmans (1974), Berendsen, Faessen & Kempen (1994), Berendsen & Hoek (2005).

Remarks: Channel deposits are generally in contact with Pleistocene sand. In the upstream area, near Buurmalsen, many crevasse channels occur, that are of the same age as the Schaik channel belt. A cross section, published by Törnqvist (1993: Enclosure 1) shows that the overbank deposits of the Schaik channel belt occur at two levels, sometimes separated by peat. This probably represents two periods of activity, that were caused by a shift in the upstream connection. The main period of sedimentation is supposed to occur after 4820 yr BP and is related to an avulsion of the now eroded (unnamed) channel belt that was connected to the Ochten-Esterweg channel belts. Twenty-seven dates were obtained for the end of activity (Appendix 1). The dates get younger in an eastern direction, and range from 2580 ± 60 yr BP (UtC-3597) to 4900 ± 75 (UtC-2346). This suggests that a hiatus in the sedimentation occurred (Törnqvist 1993: 120). Whether the final phase of activity was estimated accurately, remains open for some doubt, in view of the large scatter in dating results. The dates obtained (in yr BP) are: 2580 ± 60 , (UtC-3597); 3070 ± 90 , (UtC-1135); 3080 ± 90 , (UtC-1140); 3160 ± 90 , (UtC-1138); 3170 ± 80 , (UtC-1131); 3190 ± 120 , (UtC-1139); 3250 ± 70 , (UtC-1132); 3250 ± 70 , (UtC-1134); 3310 ± 80 , (UtC-1133); 3380 ± 60 , (UtC-1479); 3630 ± 40 , (UtC-1410); 3970 ± 60 , (UtC-1405); 4030 ± 30 , (UtC-1406); 4240 ± 50 , (UtC-1409); 4460 ± 70 , (UtC-1125); 4470 ± 70 , (UtC-1126); 4500 ± 140 , (UtC-1127); 4500 ± 80 , (UtC-1130); 4570 ± 120 , (UtC-1298); 4580 ± 110 , (UtC-1141); 4670 ± 130 , (UtC-1129); 4670 ± 80 , (UtC-1128); 4730 ± 70 , (GrN-10117); 4740 ± 160 , (UtC-1142); 4800 ± 80 , (GrN-10116); 4900 ± 75 , (GrN-2346).

151. Schoonhoven 4920-3920 yr BP

Upstream/downstream coordinates: 117-442/115-439.

Highest sand elevation (relative to NAP in m): -4.1 to -5.2.

Average gradient (cm/km): 18.3 (but not enough data to measure accurately).

Connections: upstream: Lopik; downstream: Lekkerkerk-Ridderkerk; and partly lost in the peat area.

Dating evidence: ^{14}C , pollen analysis, archaeology, relative dating.

Beginning of sedimentation: presumably the same as Lopik: 4920 ± 35 yr BP (GrN-7956).

End of sedimentation: presumably the same as Lopik: 3920 ± 60 yr BP (GrN-7575), residual channel date.
Archaeology: no archaeological traces.
References: Berendsen (1982: 151-156, 199-206).
Remarks: the channel is a distributary of the Lopik channel belt, but may have existed during a shorter period.

152. Schoonrewoerd 3900-3700 yr BP

Upstream/downstream coordinates: 143-440/100-429.

Highest sand elevation (relative to NAP in m): +0.8 to -1.8. Sand depth increases westwards very rapidly (Makaske 1998: 206).

Average gradient (cm/km): average 7.9 (Makaske 1998), 6 in Vijfheerenlanden, decreasing westwards.

Connections: upstream: Werkhoven; downstream: Bleskensgraaf and Wijngaarden.

Dating evidence: ^{14}C , archaeological traces, pollen analysis, relative dating.

Beginning of sedimentation (all dates in yr BP): a new direct date of peat, underlying overbank deposits close to the channel belt was obtained by Berendsen & Hoek 2005, p. 25): 3887 ± 35 yr BP (UtC-13075). Although two channels were active at the location where the date was obtained, there are no indications that the other channel is older. Hence the Schoonrewoerd channel belt probably was active for only a few hundred years. Earlier obtained dates: 4620 ± 50 (GrN-8370), 4520 ± 60 (GrN-10886), see Makaske (1998: 214-217) probably relate to deposits of the underlying overbank deposits of the Zijderveld channel belt. Other dates obtained are: 4090 ± 60 (GrN-10102), 4170 ± 60 (GrN-8378), 4470 ± 40 (GrN-10850), 4480 ± 40 (GrN-06213), 4520 ± 60 (GrN-10886), 4650 ± 95 (GrN-785), 4670 ± 70 (GrN-10090), 4720 ± 70 (GrN-10842), 4750 ± 80 (GrN-10107), 4873 ± 38 (UtC-06949), 5420 ± 40 (GrN-10889), but again, some of these dates probably relate to deposits of the underlying overbank deposits of the Zijderveld channel belt. Pollen analysis: main sedimentation during Early Subboreal.

End of sedimentation: Residual channel dates (yr BP): 3900 ± 90 (GrN-10855), 3823 ± 40 (UtC-4647). Other dates obtained (most of them are *terminus ante quem* dates for the end of sedimentation): 2600 ± 70 (GrN-04945), 2620 ± 50 (GrN-04946), 2650 ± 70 (GrN-08372), 2710 ± 35 (GrN-05264), 2880 ± 50 (GrN-10103), 3190 ± 70 (GrN-10849), 3340 ± 80 (GrN-07862), 3350 ± 35 (GrN-10894), 3560 ± 70 (GrN-10848), 3570 ± 70 (GrN-10108), 3570 ± 70 (GrN-10846), 3630 ± 35 (GrN-06212), 3640 ± 30 (GrN-05176), 3660 ± 55 yr BP (GrN-2817), 3700 ± 60 (GrN-10093), 3720 ± 55 (GrN-02817), 3740 ± 70 (GrN-10841), 3770 ± 60 (GrN-10890), 3770 ± 60 (GrN-10862), 3730 ± 70 (GrN-10863), 3780 ± 60 (GrN-10871), 3823 ± 40 (UtC-04647), 3890 ± 60 (GrN-11508), 3900 ± 90 (GrN-10855).

Archaeology: Early and Late Neolithic, Bronze Age, Iron Age, Roman Age, Middle Ages.

References: Berendsen (1982: 158); Törnqvist (1993: 143); Van der Woude (1981: 60-63), Louwe Kooijmans (1974: 93, 97); Pons (1951: 10), Vink (1926, 1954: Overlekschenstroom); De Boer & Pons (1960: 26), De Jong (1970-1971), Verbraeck (1970: 79), Makaske (1998: 173-233).

Remarks:

1. According to De Boer & Pons (1960: 26) and Louwe Kooijmans (1974: 93, 97) the river channel belt was active from circa 5350 yr BP - 3600 yr BP. They thought there were two periods of activity separated by peat formation, which occurred between approximately 4700 and 4200 yr BP. However, Makaske (1998) showed that this is very unlikely. The first period of activity, which is not found everywhere, actually is a crevasse and overbank level of the nearby Zijderveld channel belt. The upper level represents overbank deposits of the Schoonrewoerd channel belt, which is regarded as a 'failed avulsion' by Makaske (1998). Its short period of existence supports that viewpoint.
2. Dates of the base of peat overlying the overbank deposits of the Zijderveld channel belt (some of these dates (all given in yr BP) may refer to crevasse-splay deposits of the Zijderveld channel belt: 4830 ± 70 (GrN-10843), 4740 ± 70 (GrN-10851), 4710 ± 60 (GrN-10106), 4705 ± 40 (GrN-10101), 4300 ± 100 yr BP (GrN-8369), 4280 ± 70 (GrN-10864).
3. Dates of the top of peat (some of these dates may refer to crevasse-splay deposits of the Zijderveld channel belt): 4750 ± 80 (GrN-10107), 4520 ± 60 (GrN-10886), 4470 ± 40 (GrN-10850), 4190 ± 70 (GrN-8373), 4170 ± 60 (GrN-8378), 4090 ± 60 (GrN-10102), 4620 ± 50 yr BP (GrN-8370), 4540 ± 80 (GrN-8375).
4. Peat samples overlying the upper clay wedge show a general trend of increasing age downstream (Törnqvist 1993: 50). This is a result of non-depositional unconformities being present both on natural levees and in flood basins. These hiatuses may cover time-spans of up to 1000 ^{14}C years (Törnqvist 1993: 53).
5. Channel deposits of the Schoonrewoerd channel belt are generally not in contact with Pleistocene sand; detailed cross sections are given by Makaske (1998).
6. The upstream connection with the Hennisdijk channel belt as mapped by Verbraeck (1970) is erroneous. See Makaske (1998).
7. Observations of the digital elevation map of the Netherlands (AHN; Rijkswaterstaat-AGI 2004) clearly

show, that the lower portion of the Schoonrewoerd channel belt was influenced by tides: numerous 'perimarine' crevasse channels occur perpendicular to the main channel. They all taper out in the peat area of the western Alblasserwaard (Berendsen 2005, unpublished).

153. Schuurkamp 5788-5360 yr BP

Upstream/downstream coordinates: 165-432/151-428.

Highest sand elevation (relative to NAP in m): +0.8 to +0.7.

Average gradient (cm/km): 6.5, but channel belt too short to measure accurately.

Connections: upstream: unknown; downstream: Deil.

Dating evidence: ¹⁴C dating, GTS-lines.

Beginning of sedimentation: 5788 ± 50 yr BP (UtC-7812).

End of sedimentation: 5360 ± 120 yr BP (UtC-7867).

Archaeology: no archaeological traces.

References: Berendsen, Faessen & Kempen (1994), Berendsen et al. (2002), Cohen (2003).

Remarks: Dating is based on the Deil channel belt, which is the downstream continuation of this channel belt.

The channel belt is older than the Appelaar channel belt. GTS-lines strongly suggest a connection with the Deil channel belt; all the other channel belts in the surrounding area are younger. In the NW of the Land van Maas en Waal the upstream continuation of Schuurkamp (153) has been mapped (Cohen, 2003).

154. Slikkerveer 1000-619 yr BP

Upstream/downstream coordinates: 103-430/102-433.

Highest sand elevation (relative to NAP in m): unknown (outside the mapped area).

Average gradient (cm/km): unknown.

Connections: upstream: Waal; downstream: Nieuwe Maas.

Dating evidence: historical evidence.

Beginning of sedimentation: estimate 1000 yr BP, based on the age of the Oude Waal, Waal and Lek.

End of sedimentation: in 1331 AD (619 yr BP) the Zwijndrechtsche Waard was embanked. After that discharge was carried by the Noord.

Archaeology: no archaeological traces.

References: Bosch & Kok (1994).

Remarks: The channel belt is now inaccessible due to urbanisation.

155. Snodenhoek 2700-2200 yr BP

Upstream/downstream coordinates: 185-437/186-438.

Highest sand elevation (relative to NAP in m): +7.8 to +7.2.

Average gradient (cm/km): 9.2 (measured along channel belt).

Connections: upstream: Ressen; downstream: Santacker.

Dating evidence: ¹⁴C dating, pollen analysis, archaeology, historical evidence.

Beginning of sedimentation: estimate: 2700 yr BP.

End of sedimentation: 2200 yr BP, based on age of Ressen and Santacker channel belts. The channel silted up before 1250 AD (700 yr BP), when the main rivers were embanked.

Archaeology: Iron Age, Roman Age, Early Middle Ages.

References: De Jong (1980, report 880, a,b,c), Teunissen (1990).

Remarks: Dating is based on the Santacker-Driel channel belt, which is the downstream continuation of this channel belt.

156. Spelwerd 5590-4800 yr BP

Upstream/downstream coordinates: 133-426/117-426.

Highest sand elevation (relative to NAP in m): circa -0.5.

Average gradient (cm/km): channel belt too short to measure accurately.

Connections: upstream: Broek; downstream: Herwijnen.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: estimate, based on the presumed connection to the Broek channel belt.

End of sedimentation: estimate, based on the presumed connection to the Broek channel belt.

Archaeology: no archaeological traces.
References: Weerts & Berendsen (1995).
Remarks: The origin of this short erosional remnant is rather uncertain.

157. Spengen 2650-2300 yr BP

Upstream/downstream coordinates: 128-459/126-465.
Highest sand elevation (relative to NAP in m): highly variable.
Average gradient (cm/km): not enough data to measure accurately.
Connections: upstream: Oude Rijn; downstream: Oud-Aa.
Dating evidence: ¹⁴C, archaeological traces, relative dating.
Beginning of sedimentation: no direct dates available, probably around 2650 yr BP (beginning of the Vecht-Angstel).
End of sedimentation: estimate: around 2300 yr BP, based on the relative depth of the overbank deposits.
Archaeology: no archaeological traces.
References: Van de Meene (1988).
Remarks: the small residual channel is still visible in the landscape. The channel probably originated as a crevasse of the Oude Rijn and joined the Angstel channel belt. It may be regarded as a failed avulsion.

158. Spijk 2510-2200 yr BP

Upstream/downstream coordinates: 133-426/117-426.
Highest sand elevation (relative to NAP in m): +2.2 to -1.7.
Average gradient (cm/km): 20.5
Connections: upstream: Mert-Enspijk-Gellicum-Hooiblok; downstream: eroded by the Waal.
Dating evidence: ¹⁴C, archaeology, relative dating.
Beginning of sedimentation: 2510 ± 50 yr BP (UtC-1891).
End of sedimentation: terminus ante quem for the end of activity: 1885 ± 30 yr BP, weighted mean of samples UtC-1426 and UtC-1427. Residual channel dates 2150 ± 40 yr BP (UtC-1425), 1900 ± 50 yr BP (UtC-1480) and 1880 ± 30 yr BP (UtC-1426) were rejected by Törnqvist (1993: 141-142) but seem to be approximately correct. The ages obtained must be regarded as a terminus ante quem, because circa 2.5 m of fine-grained channel deposits occur underneath the dated peat bed Törnqvist (1993: 142). A reasonable estimate for the end of overbank sedimentation therefore seems 2200 yr BP, which is also the beginning of activity of the Linge channel belt.
Archaeology: Early and Middle Roman Age.
References: Törnqvist (1993: 141-142).
Remarks: the narrow channel belt seems to be connected to the Mert channel belt. The Spijk channel belt is not in connection with the Pleistocene subsoil. West of the Linge the elevation of the sand increases by 1 m, due to erosion of the underlying Gorkum channel belt. The channel belt is older than the Linge.
The depth of the sand of the Enspijk channel belt is considerably greater than that of the upstream Hooiblok channel belt. This may be a result of differential compaction. Also, the sand depth of narrow channel belts is strongly influenced by the crossing of older channel belts in the subsoil, as is shown by the example of the crossing of the Spijk and Gorkum channel belts. Nevertheless, the possibility remains open that the Enspijk and Gellicum channel belts are considerably older than the Hooiblok channel belt. In that case, the Spijk channel belt (which is relatively well dated) cannot be connected to the Enspijk-Gellicum channel belts, and must be a crevasse of the Gameren channel belt.

159. Stolwijk-Beijersche 4920-3920 yr BP

Upstream/downstream coordinates: 115-444/107-441.
Highest sand elevation (relative to NAP in m): circa -6.
Average gradient (cm/km): not enough data to be measured accurately.
Connections: upstream: Lopik; downstream: lost in the peat area of Krimpenerwaard-west.
Dating evidence: ¹⁴C, archaeology, relative dating.
Beginning of sedimentation: presumably the same as Lopik: 4920 ± 35 yr BP (GrN-7956).
End of sedimentation: presumably the same as Lopik: 3920 ± 60 yr BP (GrN-7575), residual channel date.
Beginning of peat formation on basin clay: 4125 ± 30 yr BP (GrN-7955). Related dates: 3995 ± 40 yr BP (GrN-9403) and residual channel dates of Blokland and Snelrewaard: 4115 ± 60 (GrN-7578) and 4180 ± 60

(GrN-7969).

Archaeology: no archaeological traces.

References: Berendsen (1982: 151-156, 199-206), Vink (1926, 1954), Bosch & Kok (1994).

Remarks: the channel belt locally contains gravel, that was probably eroded at crossings of older channel belts in the subsoil.

160. Streefkerk 6000-5350 yr BP

Upstream/downstream coordinates: 116-437/100-430.

Highest sand elevation (relative to NAP in m): -7.1 to -10.2 m near Ridderkerk.

Average gradient (cm/km): 18.2 (but not enough data to be measured accurately).

Connections: upstream: Liesveld-Cabauw; downstream: unknown.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: presumably the same as Cabauw: 6000 ± 35 yr BP (GrN-7958) and 6190 ± 45 yr BP (GrN-18926).

End of sedimentation: presumably the same as Cabauw: 5350 ± 35 yr BP (GrN-7957) and 5220 ± 50 yr BP (GrN-18925).

Archaeology: no archaeological traces.

References: Berendsen (1982: 151-156, 199-206), Bosch & Kok (1994).

Remarks: the channel seems to be a distributary of the Cabauw channel belt (based on GTS-lines), but may have existed during a shorter period. The channel belt is not connected to the Ridderkerk channel belt, as is suggested by Bosch & Kok (1994).

161. Stuivenberg 3960-3180 yr BP

Upstream/downstream coordinates: 129-451/125-450.

Highest sand elevation (relative to NAP in m): -0.2 to -0.8.

Average gradient (cm/km): 5.7.

Connections: upstream: Honswijk-Vechgel; downstream: Linschoten.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: after 4455 ± 60 yr BP (GrN-9264), which is the end of the Buitenzorg channel belt, and after 3950 ± 60 (GrN-8704), which is the end of the Neder-Oudland channel belt. Direct evidence was obtained by Törnqvist (1993: 147): 3960 ± 60 (UtC-1893).

End of sedimentation: Residual channel dates: 3180 ± 55 (GrN-7576), 3135 ± 55 (GrN-7581), 3195 ± 55 (GrN-9263), dates obtained by Berendsen (1982).

Archaeology: Roman Age.

References: Berendsen (1982: 147, 172), Törnqvist (1993: 147), Vink (1926: 180).

Remarks:

1. The Stuivenberg channel cuts through the Buitenzorg and Neder-Oudland channel belts.
2. A crevasse-channel of the Stuivenberg crosses the Blokland channel belt in square 124-449. Activity of this crevasse-channel ceased 3660 ± 30 yr BP (GrN-7967). Activity of the Blokland channel ceased 4115 ± 60 yr BP (GrN-7578).
3. An upstream connection to the Jutphaas channel belt is doubtful because the elevation of the sand in the Stuivenberg channel belt (near the Hollandse IJssel) is about 0.5 m higher.
4. The Lampsin channel seems to have been a distributary of the Stuivenberg channel.

162. Tienhoven 7000-6260 yr BP

Upstream/downstream coordinates: 141-441/135-445.

Highest sand elevation (relative to NAP in m): -0.9 to -1.4.

Average gradient (cm/km): 10.0.

Connections: upstream: Maurik; downstream: Benschop.

Dating evidence: ¹⁴C, archaeological traces, relative dating.

Beginning of sedimentation: around 7000 yr BP (estimate) based on the assumption that the Kortenhoeven channel belt is older than the Tienhoven channel belt. In any case one of these channels must have been active since 7600 ± 45 yr BP (GrN-9408), based on dates of the Benschop channel belt. The Tienhoven channel belt is rejuvenated by the Autena channel belt after 6110 ± 50 yr BP (UtC-6715).

End of sedimentation: 6260 ± 60 yr BP (UtC-6714). Final activity of the Autena channel belt is dated at 5350 ±

35 yr BP (GrN-7957) and 5430 ± 90 yr BP (UtC-6977).
Archaeology: no archaeological traces.
References: Verbraeck (1970), Berendsen (1982: 147).
Remarks: The Tienhoven channel belt has been rejuvenated by the Autena channel belt, which has not been accurately mapped by the Netherlands' Geological Survey. The older Tienhoven channel is connected to the Benschop channel belt, the younger Autena channel to the Willeskop channel belt. The oldest overbank deposits rest directly on the Kreftenheye Formation.

163. Tuil 1600-700 yr BP

Upstream/downstream coordinates: 144-426/143-425.
Highest sand elevation (relative to NAP in m): +1.8.
Average gradient (cm/km): unknown (too short for reliable measurements).
Connections: upstream: Waal; downstream: Waal.
Dating evidence: Archaeology, relative dating, historical evidence.
Beginning of sedimentation: 1655 ± 50 yr BP (GrN-13504); 1600 ± 50 yr BP (UtC-1899). Dates by Berendsen ed. (1986: 54) suggest a slightly older age: 1795 ± 30 yr BP (GrN 12456).
End of sedimentation: 1250 AD (700 yr BP).
Archaeology: Late Iron Age, Roman Age and Early Middle Ages. The Late Iron Age and Roman traces near Tuil suggest that the river Waal may be slightly older than 1600 yr BP, since the meander of Tuil can only be part of the river Waal.
References: Weerts & Berendsen (1995: 207-209); Berendsen ed. (1986: 54); Törnqvist (1993: 140-141).
Remarks: the end of sedimentation is based on the fact that the river meander was cut off before embankment. The largely silted up channel is still very well visible in the topography.

164. Tweesluizen 2900-2200 yr BP

Upstream/downstream coordinates: 154-434/152-432.
Highest sand elevation (relative to NAP in m): +2.7 to +2.4.
Average gradient (cm/km): 15.
Connections: upstream: Zoelen; downstream: Meteren and Est.
Dating evidence: relative dating.
Beginning of sedimentation: no direct ^{14}C dates available; after 4000 yr BP, but most likely much later.
End of sedimentation: in any case before 2160 ± 60 (UtC-1717), which is the beginning of the Linge (Törnqvist 1993: 142).
Archaeology: oldest archaeological traces: Roman Age.
References: Verbraeck (1984).
Remarks: Small erosional remnant, that has yet not been dated accurately. It may be a large crevasse channel, that was eroded by the Linge. The period of activity is probably much shorter than the interval between maximum and minimum age; estimate: 2900-2200 yr BP.

165. Uitwijk 5788-5360 yr BP

Upstream/downstream coordinates: 129-423/122-421.
Highest sand elevation (relative to NAP in m): -1.9 to -2.5.
Average gradient (cm/km): not enough data for accurate measurements.
Connections: upstream: Vuren; downstream: eroded by the sea.
Dating evidence: ^{14}C , relative dating.
Beginning of sedimentation: estimate based on Vuren; 5788 ± 50 yr BP (UtC-7812), based on the connection with Deil-Broekgraaf channel belts.
End of sedimentation: estimate based on Vuren; 5360 ± 120 yr BP (UtC-7867), based on the connection with Deil-Broekgraaf channel belts.
Archaeology: no archaeological traces.
References: previously unpublished data.
Remarks: the narrow channel belt has not been dated directly, but a connection to the equally narrow Vuren channel belt seems the only reasonable possibility.

166. Varik 5500-5000 yr BP

Upstream/downstream coordinates: 153-425/151-426.

Highest sand elevation (relative to NAP in m): +2.0 to +1.3.

Average gradient (cm/km): 23.3 (channel belt too short for very accurate measurements)

Connections: upstream: unknown; downstream: Herwijnen and Broek; also a connection to Deil existed.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: around 5500 yr BP (estimate), based on age of Deil and Broek.

End of sedimentation: in any case before 4820, based on crossing with Esterweg; estimate 5000 yr BP.

Archaeology: Iron Age, Roman Age, Middle Ages.

References: Verbraeck (1970).

Remarks: the channel belt may be of the same age as the Deil channel belt (5788-5360 yr BP).

167. Vechgel 4000-3540 yr BP

Upstream/downstream coordinates: 130-448/131-448.

Highest sand elevation (relative to NAP in m): -0.1.

Average gradient (cm/km): 5.7

Connections: upstream: Honswijk? downstream: Stuivenberg.

Dating evidence: relative dating.

Beginning of sedimentation: after 4000 (estimate).

End of sedimentation: 3540 ± 60 (GrN-7959).

Archaeology: Neolithic, Bronze Age, Iron Age, Roman Age, Middle Ages.

References: Berendsen (1982: 147, 171).

Remarks: Small erosional remnant.

168. Vecht 2650-828 yr BP

Upstream/downstream coordinates: 135-157/130-474/133-483.

Highest sand elevation (relative to NAP in m): -0.5 (Maarssen).

Average gradient (cm/km): not enough data to be measured accurately.

Connections: upstream: Kromme Rijn.

Dating evidence: ¹⁴C, archaeology, historical evidence.

Beginning of sedimentation: Berendsen (1982: 169): 4455 ± 35 yr BP (GrN-7972); but this is probably too old due to erosion of underlying peat. De Jong & Zagwijn (1973, report 690): 3515 ± 35 yr BP (GrN-6717), beginning of *Phragmites* peat formation, overlying gyttja. However, here the relationship between fluvial sedimentation and peat formation is ambiguous. Van de Meene (1988: 51) dated the top of a peat layer underlying clay: 2895 ± 35 yr BP (GrN-13482). Törnqvist (1993: 149-150) obtained the dates: 2650 ± 80 yr BP (UtC-1900) and 2620 ± 50 yr BP (UtC-1901). The last three dates are accepted as representing the beginning of activity of the Vecht river channel belt. After the Roman period fluvial activity of the Vecht increased, while that of the Angstel decreased (Cleveringa 1985, report 895b). Related dates are: 2570 ± 35 (GrN-10228), 2640 ± 35 (GrN-10227) and 2665 ± 30 (GrN-10229), indicating activity of the Vecht.

End of sedimentation: 828 yr BP = 1122 AD (damming of the Kromme Rijn at Wijk bij Duurstede).

Archaeology: Roman Age near the mouth of the Vecht (Velsen) and Late Middle Ages.

References: Berendsen (1982: 168), Törnqvist (1993: 149-150), Van de Meene (1988: 51), De Jong & Zagwijn (1973, report 690), De Jong (1981, report 895), Cleveringa 1985, report 895b).

Remarks: The channel belt is the downstream continuation of the Houten/Kromme Rijn channel belt (Berendsen 1982: 169). North of Utrecht the Vecht has rejuvenated the Angstel channel belt; therefore the dates for beginning of activity of the Vecht and Angstel channel belts are the same here. Where the channel belts are separated, different dates of beginning activity may apply. North of Breukelen and Loenen the present Vecht channel is separated from the Angstel channel belt, as a result of avulsions, that seem to have occurred around 1850 yr BP. This would imply that the Angstel channel belt existed until approximately 1850 yr BP.

¹⁴C dating in the Vecht area by the Netherlands' Geological Survey has produced erroneous results (GrN-10223 and GrN-10226 thru GrN-10230 and GrN-10232, mainly due to the reworking of peat in lakes.

Because the reliability of some ¹⁴C dates in this area may be questioned, discussion continues with regard to the exact dating of the Angstel and Vecht channel belts. According to Weerts (personal communication, 2000) the Angstel channel belt came into existence around 3000 yr BP (GrN-6719) and was already abandoned around 2270 yr BP (GrN-6761). If these ¹⁴C dates are correct, most activity in the Vecht channel

belt ended as early as 1695 ± 30 yr BP (GrN-6718). This would mean that discharge was diverted to the Lek immediately after Roman times.

169. Velddriel 3090-1760 yr BP

Upstream/downstream coordinates: 151-420/144-417.

Highest sand elevation (relative to NAP in m): +3.3 to +2.6.

Average gradient (cm/km): 10.0 (measured along channel belt).

Connections: upstream: Lith (and possibly a distributary of the Zennewijnen-Heesselt-Bruchem channel belt, that was later eroded by the Waal); downstream: Dussen.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: based on a date of the end of activity of the Hedel channel belt: after 3090 ± 40 yr BP (GrN-18101).

End of sedimentation: 1760 ± 50 yr BP (UtC-1604), residual channel date.

Archaeology: Roman Age, Merovingian, Carolingian.

References: Weerts & Berendsen (1995: 205), Weerts (1995: 81), Berendsen (1990), Edelman et al. (1950).

Remarks: the residual channel still contained water during Roman times. The channel belt has two small distributaries, named the Beemden and Achterdijk channel belts respectively (Weerts & Berendsen 1995: 205). These small channel belts are now regarded as crevasse channels and are no longer treated separately. On the Achterdijk channel belt Iron Age sherds were found (Berendsen ed. 1986: 64). The sand depth of the top of the Achterdijk channel deposits decreases from +2.9 m to +2.2 m, that of the Beemden channel from +2.5 to +1.8 m.

The channel belt contains coarse sand, that is rich in calcium carbonate. This suggests, that the channel was not only fed by the Maas, but also by the Rhine. This connecting channel cannot be found anymore, because it was eroded by the Waal.

170. Vretstrooi 6100-5660 yr BP

Upstream/downstream coordinates: 144-438/143-437.

Highest sand elevation (relative to NAP in m): circa -4.2.

Average gradient (cm/km): 20-30, but channel belt is too short to determine accurately.

Connections: upstream: Maurik, secondary channel, south of main channel. Downstream: unknown, probably reoccupied by/incorporated in Regulieren and Schaik systems.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: estimate: after 6150 ± 40 (UtC-10024); this is a basal peat date near eolian dune 'de Treeft'. The peat overlies floodbasin clays of the Vretstrooi channel belt. A date by Makaske (1998) points to a begin of sedimentation after 6220 ± 70 yr BP (UtC-4646).

End of sedimentation: 5650 ± 40 yr BP (UtC-10021), a basal peat date on the flank of the eolian dune 'de Treeft' (Cohen et al., 2003; fig. 5). The channel belt was abandoned before the beginning of sedimentation of the Schaik channel belt: 5285 ± 50 yr BP (UtC-1396/1397). A date by Makaske (1998) suggests an end of sedimentation before 5170 ± 110 yr BP (UtC-4644).

Archaeology: no archaeological traces.

References: Berendsen, Faessen & Kempen (1994), Berendsen et al. (2002), Cohen (2003).

Remarks: Originally known as a small erosional remnant, east of x=145. Fieldwork at the dune 'de Treeft' and in the Maurik floodbasin (Cohen, Gouw & Holten, 2003) identified the upstream part of this approximately 100 m wide channel belt, and its upstream connection to the Maurik channel belt (Cohen, 2003). The channel runs parallel to the younger Hennisdijk channel belt. In studies of the Hennisdijk channel belt (Makaske, 1998) the overbank deposits of the Vretstrooi system had been noticed and dated, but the corresponding channel belt was not mapped.

171. Vuilendam 7370-6270 yr BP

Upstream/downstream coordinates: 121-434/117-432.

Highest sand elevation (relative to NAP in m): -6.3 to -7.2.

Average gradient (cm/km): not enough data to be measured accurately.

Connections: upstream: Nieuwland; downstream: lost in the peat area of the central Alblasserwaard.

Dating evidence: ^{14}C , relative dating.

Beginning of sedimentation: presumably the same as Nieuwland: 7370 ± 100 yr BP (GrN-8383), however, this is clearly a terminus post quem date.

End of sedimentation: presumably the same as Nieuwland: 6060 ± 80 yr BP (GrN-7864), 6090 ± 70 yr BP (GrN-8922), 6140 ± 70 yr BP (GrN-10861), 6170 ± 60 yr BP (GrN-2816), 6210 ± 85 yr BP (GrN-2828), 6210 ± 70 yr BP (GrN-10893), 6270 ± 85 yr BP (GrN-2818), 6280 ± 80 yr BP (GrN-10853), 6470 ± 150 yr BP (GrN-8934). In any case, river activity ended before 5720 ± 70 (GrN-10845).

Archaeology: no archaeological traces.

References: Törnqvist (1993: 205), Van der Woude (1981: 60), Berendsen (1982: 142-143).

Remarks: The Vuilendam channel belt is a wide channel belt on the geological map, yet it seems to disappear completely in the peat area. Possibly its width is caused by the presence of river dunes in the subsoil.

Related dates: 6420 ± 70 yr BP (GrN-8381), 6500 ± 90 yr BP (GrN-8380), 6720 ± 70 yr BP (GrN-8382), indicating continuing activity.

172. Vuren 5788-5360 yr BP

Upstream/downstream coordinates: 140-431/131-426.

Highest sand elevation (relative to NAP in m): -0.1 to -2.2.

Average gradient (cm/km): 10.0.

Connections: upstream: Deil; downstream: unknown.

Dating evidence: ^{14}C , archaeology, relative dating.

Beginning of sedimentation: 5788 ± 50 yr BP (UtC-7812), based on the connection with Deil-Broekgraaf channel belts. However, one of the two channels may have been fed by the Vretstrooti channel belt, and may have continued until after 5330 ± 90 yr BP (GrN-1874). However, the reliability of this date in this context is doubtful, since it was carried out for a different purpose.

End of sedimentation: 5360 ± 120 yr BP (UtC-7867), based on the connection with Deil-Broekgraaf channel belts.

Archaeology: no archaeological traces.

References: Verbraeck (1970), De Jong & Zagwijn (1959, report 229).

Remarks: narrow channel belt or relatively large crevasse.

173. Vuylkoop 5350-3795 yr BP

Upstream/downstream coordinates: 143-445/137-446.

Highest sand elevation (relative to NAP in m): +1.1 m to +0.2.

Average gradient (cm/km): 14.0.

Connections: upstream: Werkhoven; downstream: Lopik.

Dating evidence: ^{14}C , archaeology.

Beginning of sedimentation: 5350 yr BP (based on the presumed connection with Kapel), after that a connection with the Lopik channel belt was established, around 4900 yr BP. A maximum age for the beginning of activity, obtained by Berendsen (1982: 162) is: 5975 ± 45 yr BP (GrN-9352).

End of sedimentation: before 3795 ± 55 yr BP (GrN-9152).

Archaeology: Iron Age, Roman Age, Middle Ages.

References: Berendsen (1982: 148-149, 162).

Remarks: Bank deposits underlie a vegetation horizon dated at 3795 ± 55 yr BP (GrN-9152). Bank deposits of the Houten channel belt overlie this vegetation horizon. The channel deposits consist of coarse sand that is rich in gravel. Overbank deposits occur relatively deep adjacent to the channel belt deposits, suggesting that the channel belt was rejuvenated. The top of the channel deposits is at a higher level than those of the Hoon channel belt. Related dates: 5040 ± 85 yr BP (GrN-9351) for the end of crevasse-activity.

174. Waal 1625-0 yr BP (downstream from Tiel)

Upstream/downstream coordinates: 199-432/128-425.

Highest sand elevation (relative to NAP in m): +14.0 (Emmerich) to +3.4 (Vuren) to +1.5 (Hardinxveld) to -2.8 (Rijsoord).

Average gradient (cm/km): 8.5 (measured along present channel).

Connections: upstream: Bijlands Kanaal - Rijn; downstream: two branches: Boven Merwede - Beneden Merwede - Noord - Nieuwe Maas and Boven Merwede - Nieuwe Merwede - Hollandsch Diep - Haringvliet.

Dating evidence: ^{14}C , relative dating, archaeology, historical evidence.

Beginning of sedimentation: 1815 ± 50 yr BP (GrN-6993); 1795 ± 30 yr BP (GrN-12456); 1655 ± 50 yr BP (GrN-13504); 1600 ± 50 yr BP (UtC-1899).

End of sedimentation: sedimentation in the embanked floodplains still continues (sedimentation rates: see Middelkoop 1997).

Archaeology: Oldest traces: Late Roman (east of Tiel), Early to Late Middle Ages (west of Tiel). A few Roman traces in the embanked floodplains near Tiel and an Iron Age find near Deest, which probably is related to an erosional remnant of the Distelkamp channel belt.

References: Weerts & Berendsen (1995: 207-209); Berendsen ed. (1986: 54); Törnqvist (1993: 140-141).

Remarks: The dates GrN-13504 and UtC-1899 for the Waal west of Tiel are considered to be the most reliable, considering the low organic content of the other samples (Törnqvist (1993: 141). It should be remembered, that the history of the present river is rather complicated, since its present upstream course follows or crosses numerous older channel belts.

Artificial cutoffs occur near: Tuil (1680 AD), Waardenburg (1655 AD), Hurwenen (1639 AD).

The present course through the Nieuwe Merwede was initially formed in the St. Elizabeth's flood in 1421 AD. Between 1851 and 1860 AD this channel was widened (Bongaerts 1909, Stein in Berendsen ed. 1996: 105), while other tidal creeks were dammed.

Older parts of the channel belt that are located outside of the presently embanked floodplain are indicated on the palaeogeographic map with number 174a.

175. Waal 2160-0 yr BP (upstream from Tiel)

Upstream/downstream coordinates: 199-432/128-425.

Highest sand elevation (relative to NAP in m): +11.3 (Emmerich) to +7.0 (Tiel).

Average gradient (cm/km): 8.5 (measured along present channel).

Connections: upstream: Bijlands Kanaal - Rijn; downstream: two branches: Boven - Merwede - Beneden Merwede - Noord - Nieuwe Maas and Boven Merwede - Nieuwe Merwede - Hollandsch Diep.

Dating evidence: ^{14}C , relative dating, archaeology, historical evidence.

Beginning of sedimentation: Since the Linge originally was the downstream continuation of the Waal, its beginning of activity (2160 yr BP) should also apply to the upstream part of the Waal. For the Waal downstream of Tiel the following ^{14}C ages were obtained: 1815 ± 50 yr BP (GrN-6993); 1795 ± 30 yr BP (GrN-12456); 1655 ± 50 yr BP (GrN-13504); 1600 ± 50 yr BP (UtC-1899).

End of sedimentation: sedimentation in the embanked floodplains still continues (sedimentation rates: see Middelkoop 1997).

Archaeology: Oldest traces: Late Roman (east of Tiel), Early to Late Middle Ages (west of Tiel). A few Roman traces in the embanked floodplains near Tiel and an Iron Age find near Deest, which probably is related to an erosional remnant of the Distelkamp channel belt.

References: Weerts & Berendsen (1995: 207-209); Berendsen ed. (1986: 54); Törnqvist (1993: 140-141).

Remarks: The dates GrN-13504 and UtC-1899 for the Waal west of Tiel are considered to be the most reliable, considering the low organic content of the other samples (Törnqvist (1993: 141). It should be remembered, that the history of the present river is rather complicated, since its present upstream course follows or crosses numerous older channel belts.

The channel of the Oude Waal near Millingen was cut off by digging the Bijlands Kanaal in 1776 AD. Other artificial cutoffs occurred near Erlecom (around 1500 AD) and Bemmelen (1649 AD).

Older parts of the channel belt that are located outside of the presently embanked floodplain are indicated on the palaeogeographic map with number 175a.

176. Waarder 2500-928 yr BP

Upstream/downstream coordinates: 114-450/117-453.

Highest sand elevation (relative to NAP in m): no data available.

Average gradient (cm/km): unknown.

Connections: upstream: Oude Rijn; downstream: Oude Rijn.

Dating evidence: ^{14}C , relative dating.

Beginning of sedimentation: after 4100 yr BP (the channel crosses the older Blokland-Snelrewaard channel belt). Estimate: 2500 yr BP.

End of sedimentation: before 1022 AD = 928 yr BP (damming of the Kromme Rijn).

Archaeology: no archaeological traces.

References: Vink (1954).

Remarks: The Waarder is a so-called perimarine crevasse of the Oude Rijn; it was formed under tidal influence. The period of activity may be considerably shorter than estimated.

177. Waddinxveen 6850-5350 yr BP

Upstream/downstream coordinates: 111-449/100-457.

Highest sand elevation (relative to NAP in m): circa -6.5 to -8.5.

Average gradient (cm/km): not enough data to measure accurately.

Connections: upstream: (Tienhoven)-Autena-Benschop; downstream: lost under younger marine deposits.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: presumably younger than the Gouderak and Zuidplas channel belts, that branch off to the south from the Benschop river channel belt. Beginning of sedimentation is based on Bosch & Kok (1994, cross section G-G'): 6850 ± 55 yr BP (GrN-8659).

End of sedimentation: most of the Benschop channel belt ended before 6335 ± 45 yr BP (GrN-9406), but this date cannot be valid for the entire river system. The youngest part seems to have continued until 5350 ± 35 yr BP (GrN-7957). This is also in agreement to dates found for the Autena and Maurik channel belts, and to the beginning of the Utrecht river system that resulted from a major avulsion of the Benschop river system.

Archaeology: no archaeological traces.

References: Törnqvist (1993: 145-146), Bosch & Kok (1994: 73, 91), Berendsen (1982: 142-143, 148).

Remarks:

1. The Benschop system has many distributaries that seem to have slightly different ages.
2. Overbank deposits of the oldest phase of activity of the Benschop river system directly overlie the Kreftenheye Formation. This is not the case with the overbank deposits of the Waddinxveen channel belt: these overlie a layer of peat on the Twente Formation. This confirms that this channel belt is younger than the Gouderak channel belt.
3. The elevation of the top of the channel deposits (Törnqvist, 1993: Appendix 1), suggests that at least two generations of channel belts are present in the Benschop channel belt near Benschop. The youngest phase ended around 5350 yr BP (Berendsen 1982). This channel continued as the Waddinxveen channel belt. Near Gouda the Gouderak channel belt consists of two branches running NE-SW that continue as the Gouderak channel belt on the geological map. One of these probably is the upstream connection of the Waddinxveen and Benschop channel belts. The Waddinxveen channel belt is definitely younger than the Gouderak channel belt. This means that the location of the channels is indicated incorrectly on the geological map. Verification of this hypothesis is difficult, because this is now a built-up area.
4. The cross section G-G' of Bosch & Kok (1994) suggests that the channel belt was reoccupied, because overbank deposits south of the channel belt occur at two levels. Hence the date GrN-8733: 6455 ± 45 yr BP is regarded as the beginning of a period of reduced activity, not as the end of sedimentation.

178. Walbeek 3700-2500 yr BP

Upstream/downstream coordinates: 195-435/190-435.

Highest sand elevation (relative to NAP in m): +8.1 to +7.5.

Average gradient (cm/km): 6.3.

Connections: upstream: unknown; downstream: unknown, most likely not Bredelaar.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: estimate 3700 yr BP.

End of sedimentation: estimate 2500 yr BP.

Archaeology: Middle and Late Iron Age, Roman Age, Middle Ages.

References: Verbraeck (1984), Willems (1986).

Remarks: The channel belt seems to consist of two generations, although this is not clearly reflected in the overbank deposits. The older generation probably was connected to one of the older channel belts of the Ressen channel belt. The sand depth (relative to NAP) of the youngest phase of the Walbeek channel belt corresponds with that of the Bredelaar channel belt. Based on GTS-lines, a correlation with the Homoet channel belt seems impossible, but sand elevation strongly fluctuates. The channel belt is partly covered by dike-breach deposits, resulting in a relatively deep occurrence of sand relative to the surface.

179. Wamel 3000-1760 yr BP

Upstream/downstream coordinates: 159-432/158-431.

Highest sand elevation (relative to NAP in m): circa +3.8.
Average gradient (cm/km): channel belt too short to measure accurately.
Connections: upstream: Leeuwen-Afferden-Distelkamp; downstream: Zennewijnen-Opijnen-Bruchem-Alm-Werken and Passewaaij.
Dating evidence: ¹⁴C dating, archaeology.
Beginning of sedimentation: estimate 3000 yr BP.
End of sedimentation: Based on the connection with the Zennewijnen-Bruchem channel belts, this channel must have existed until at least 2000 yr BP, possibly until 1760 yr BP.
Archaeology: Iron Age, Roman Age, Early Middle Ages.
References: Verbraeck (1984), Berendsen, Faessen & Kempen (1994).
Remarks: Age estimates based on age of Distelkamp-Afferden and Zennewijnen-Opijnen-Oensel-Bruchem, and GTS-lines. Possibly the channel rejuvenated the Passewaaij channel. However, GTS-lines suggest that the Passewaaij channel belt is considerably older.

180. Werken 2258-890 yr BP

Upstream/downstream coordinates: 126-420/121-424.
Highest sand elevation (relative to NAP in m): +0.7 to +0.1.
Average gradient (cm/km): 6.0 (distance measured along the channel belt).
Connections: upstream: Alm-Afgedamde Maas-Bruchem; downstream: eroded by the Waal.
Dating evidence: ¹⁴C, archaeology, relative dating.
Beginning of sedimentation: presumably the same as Alm: 2340 ± 30 yr BP (GrN-18108). This was confirmed by a direct date of 2258 ± 33 yr BP (UtC-6850). A date of 2820 ± 90 yr BP (UtC-6976) is considered too old, but may be correlated to the slightly older Oensel channel belt.
End of sedimentation: the residual channel date of 890 ± 40 yr BP (UtC-3626) for the Alm is supposed to apply also to the Werken.
Archaeology: Archeological traces of Roman Age are found on the levees.
References: Weerts & Berendsen (1995: 207), Weerts (1995: 82), Sonneveld (1958).
Remarks: The Alm channel belt was the upstream continuation of the Werken channel belt. The Werken was dammed up around 1230 AD (Van de Ven 1996: 63) at Werkendam. This agrees very well with the residual channel date of the Alm.

181. Werkhoven 5660-3430 yr BP

Upstream/downstream coordinates: 145-445/142-450.
Highest sand elevation (relative to NAP in m): 2.5 m to 1.4 m; with an erosional remnant near Wijk bij Duurstede (the Horden) at 3.4 m. Other erosional remnants are found in Utrecht (Kanaleneiland) and near Vechten.
Average gradient (cm/km): 14.2.
Connections: upstream: Ommeren; downstream: Oude Rijn.
Dating evidence: ¹⁴C, pollen, archaeology, soil formation (grey-brown podzolics).
Beginning of sedimentation: after 5660 ± 70 (GrN-8599); main sedimentation after 4110 ± 40 (GrN-8705).
End of sedimentation: 3430 ± 40 (GrN-8705); residual channel date.
Archaeology: Late Neolithic, Bronze Age, Iron Age, Roman Age, Middle Ages.
References: Berendsen (1982: 159-161); Steenbeek (1990: 61-67); De Jong & Zagwijn (1974 report 717).
Remarks: Oldest known channel belt in the Kromme Rijn area that is still visible in the present morphology, and that can be traced over a considerable distance. Complex channel belt; near Vechten a swale was dated at 4135 ± 40 yr BP (GrN-18601). This date does not represent the final stage of the entire river channel belt, but is rather an indication of continuing activity (Berendsen & Wynia 1993).
Related dates: 3700 ± 60 yr BP (GrN-12159) and *terminus ante quem dates* for ending sedimentation of 3060 ± 100 yr BP (GrN-14677), 3095 ± 30 yr BP (GrN-14678) and 3260 ± 70 yr BP (GrN-12157).

182. Westerveld 4000-3290 yr BP

Upstream/downstream coordinates: 170-438/166-436.
Highest sand elevation (relative to NAP in m): +5.8 to +4.8.
Average gradient (cm/km): 20.0.
Connections: upstream: Homoet; downstream: Ochten.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: unknown, if correlation with Homoet is correct: approximately 4000 yr BP.

End of sedimentation: unknown, if correlation with Homoet is correct: approximately 3290 ± 70 yr BP (UtC-2607).

Archaeology: Late Neolithic, Bronze Age (personal communication Drs. M. van Dinter, ROB.), Late Iron Age, Roman Age, Middle Ages.

References: Verbraeck (1984), Steenbeek (1990), Boasson (2000: 53); see for Homoet also Teunissen (1990) and De Jong (1980, report 880).

Remarks: The Westerveld channel seems to continue as the Ochten channel belt. Sand depth of the Ochten channel belt is approximately 1 m lower than that of the Echteld channel belt; the GTS-line of the Westerveld channel belt is at the same level as the Ochten channel belt. A correlation with the Leeuwen channel belt is unlikely, because the GTS-line of the Leeuwen channel belt is at a slightly higher level. The date obtained by Makaske (1998: Appendix 4): 2770 ± 90 yr BP (UtC-4640) only roughly indicates the end of activity of the Ochten channel belt. Archaeological traces on a crevasse splay also suggest that river activity ended around 3200 yr BP (personal communication Drs. M. van Dinter, ROB).

183. Wiersch 6800-5800 yr BP

Upstream/downstream coordinates: 138-445/132-449.

Highest sand elevation (relative to NAP in m): -2.5 to -4.0.

Average gradient (cm/km): not enough data to be measured accurately.

Connections: upstream: eroded; downstream: Benschop.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: around 6800 yr BP (Berendsen 1982: 147).

End of sedimentation: around 5800 ± 70 yr BP (UtC-1894), which is the end of the Willeskop channel belt.

Archaeology: no archaeological traces.

References: Verbraeck (1970), Berendsen (1982: 147).

Remarks: The Wiersch channel belt is a relatively young distributary of the Benschop river system. The geological map (Verbraeck 1970) suggests that the channel belt is a distributary of the Vuylkoop channel belt. However, detailed mapping showed that the connection to the Vuylkoop channel belt that is indicated on the geological map does not exist. Dating results also indicate that a connection is very unlikely, since the Utrecht river system was not yet active at the time the Wiersch channel belt must have been active. Therefore it can only be connected to the Benschop river system. However, the upstream connection of the Wiersch channel belt to the Benschop or Tienhoven-Autena channel belt has not been found so far.

184. Wijchens Maasje 4765-3020 yr BP

Upstream/downstream coordinates: 179-421/160-430.

Highest sand elevation (relative to NAP in m): +6.6 to +3.2.

Average gradient (cm/km): 13.6 (measured along channel belt).

Connections: upstream: Maas; downstream: Dreumel, Passewaaij and Hoorzik.

Dating evidence: ¹⁴C dating, archaeology, historical evidence, GTS-lines.

Beginning of sedimentation: 4765 ± 60 yr BP (GrN-9596).

End of sedimentation: residual channel date: 3765 ± 55 yr BP (GrN-6999) but this is probably a maximum age.

The dates of 4370 ± 60 yr BP (GrN-6998) and 3810 ± 55 yr BP (GrN-6997) were obtained nearby, and are rejected as too old. A date of 3430 ± 45 yr BP (GrN-6955) of a vegetation horizon (Verbraeck 1984: 220) reflects a period of diminished sedimentation. A residual channel date of the Dreumel / Zijvond channel belts gave an age of 3020 ± 40 yr BP (UtC-8121). This is the youngest ¹⁴C age ever obtained for the final activity of the Wijchens Maasje. According to Pons (1957), final activity of the Wijchens Maasje is of Subatlantic age. This was confirmed by Teunissen (1990): *Secale* occurs directly above the base of the channel fill. However, these samples were taken further upstream, where the residual channel may have remained open longer.

Archaeology: Neolithic, Iron Age, Roman Age, Early and Late Middle Ages. Archaeological traces suggest that the channel contained water from approximately 2500 yr BP to 2000 yr BP.

References: Verbraeck (1984: 220), De Jong (1974, report 718), Teunissen (1990), Berendsen, Hoek & Schorn (1995: 163), Pons (1957).

Remarks: The channel belt deposits of Wijchens Maasje do not contain calcium carbonate. Dating results of the end of activity are ambiguous. The main period of sedimentation seems to be of Atlantic and Subboreal age (Verbraeck 1984, Berendsen, Hoek & Schorn 1995). Possibly the dates GrN-6997 thru GrN-6999 are not

representative for the entire channel belt, and refer only to the oldest phase of sedimentation (see also Altforst and Molenblok channel belts). However, GTS-lines also show that the Wijchens Maasje is not very young: it cannot be connected to the relatively young Zennewijnen channel belt. A correlation with Passewaaij is possible. The Passewaaij channel belt is eroded by the Linge and Zennewijnen channel belts, which means that this channel belt must be older than the Linge and Zennewijnen channel belts (at least older than 1890 yr BP), but the residual channel may have been rejuvenated in Roman times. A possible explanation is, that the upstream part of the channel of the Wijchens Maasje remained open for a long time after the downstream part had silted up and the river had found a new course.

The GTS-lines of the Dreumel channel belt fits both to the Passewaaij and Hoorzik channel belts. Most likely there was a connection between the Ochten, Dreumel and Hoorzik channel belts. The Hoorzik channel belt contains calcium carbonate, which is an indication that it was at least partly fed by distributaries of the Rhine.

The ^{14}C date Leeuwense Veld-1 (UtC-7805, 7930 ± 60) was obtained in an Early Holocene channel, in which the Wijchens Maasje is incised. Overbank deposits of the Wijchens Maasje occur at a much higher level. The date therefore cannot be related to the age of the Wijchens Maasje, except that it is a terminus post quem date for the beginning of sedimentation of the Wijchens Maasje.

185. Wijk en Aalburg 5590-4820 yr BP

Upstream/downstream coordinates: 135-418/125-417.

Highest sand elevation (relative to NAP in m): -1.2.

Average gradient (cm/km): 4.0 (not very accurate due to few data).

Connections: upstream: Broek; downstream: eroded by the sea.

Dating evidence: ^{14}C , relative dating.

Beginning of sedimentation: estimate: after 5590 yr BP, based on the period of activity of Broek, a related date obtained is 5310 ± 50 yr BP (GrN-21717).

End of sedimentation: terminus ante quem: 4020 ± 35 (GrN-18102), the estimate of 4820 yr BP is based on the age of the Broek channel belt.

Archaeology: no archaeological traces.

References: Weerts & Berendsen (1995: 205), Weerts (1995: 81), Berendsen ed. (1986: 44).

Remarks: the channel belt is largely eroded away by the younger Biesheuvel channel belt.

186. Wijngaarden 6515-5590 yr BP

Upstream/downstream coordinates: 122-427/107-426.

Highest sand elevation (relative to NAP in m): Near Wijngaarden sand is at circa -6.5 m to -8.0 m; this must be a channel belt of the generation of the Benschop river system.

Average gradient (cm/km): not enough data to be measured accurately.

Connections: upstream: possibly Gorkum-Arkel, or Pinkenveer-Vuilendam; downstream: unknown (lost in built-up area).

Dating evidence: ^{14}C , archaeology relative dating.

Beginning of sedimentation: no direct dates available, dates of peat at approximately the same level suggest an age of around 6500 yr BP

End of sedimentation: estimate 5590 yr BP, based on a presumed (but not yet found) connection to the Gorkum-Arkel channel belt.

Archaeology: no archaeological traces.

References: Bosch & Kok (1994).

Remarks:

The level of the top of the sandy channel deposits suggests, that the Wijngaarden channel belt belongs to the Benschop river system. Bosch & Kok (1994) connected the channel belt to the Schoonrewoerd channel belt. Considering the high level of the sand of the Schoonrewoerd channel belt (around 2.6 m-NAP), this is clearly impossible. Cross sections also suggest that the channel belt is much older.

187. Willeskop 10.000-6200 yr BP

Upstream/downstream coordinates: 128-447/122-446.

Highest sand elevation (relative to NAP in m): circa -4.0 to -6.4.

Average gradient (cm/km): 8.2.

Connections: upstream: Autena; downstream: Oudewater-Benschop-marine deposits.

Dating evidence: ^{14}C , relative dating.

Beginning of sedimentation: Because overbank deposits directly overlie Pleistocene sands, a direct date is hard to obtain. Probably, the channel belt emerged from Terrace-X. Berendsen & Stouthamer (2001) correlated the Willeskop channel belt to the Autena channel belt, but this may be an over-simplification. Their date of 6400 yr BP now seems too young.

End of sedimentation: 5800 ± 70 yr BP (UtC-1894) and 5610 ± 60 yr BP (UtC-1897) obtained by Törnqvist (1993). However, these dates may be too young. New dates obtained by Kombrink (unpublished MSc thesis) suggest that the Willeskop-Oudewater channel belt was abandoned approximately 6200 yr BP: dates obtained are 6210 ± 50 yr BP (UtC-12338) and 6238 ± 49 yr BP (UtC-12336). The Benschop channel belt was abandoned simultaneously.

Archaeology: no archaeological traces.

References: Törnqvist (1993: 145-146), Bosch & Kok (1994: 73, 91), Berendsen (1982: 142-143).

Remarks:

1. The Benschop river system has many distributaries that may have slightly different ages. New dates suggest that the Benschop, Willeskop and Oudewater channel belts were abandoned simultaneously.
2. Overbank deposits of part of the Willeskop channel belt do not rest directly on the Pleistocene substratum, as was illustrated by Berendsen (1982: 173). However, in some locations they do.

188. Winkels 4500-4020 yr BP

Upstream/downstream coordinates: 148-418/144-419.

Highest sand elevation (relative to NAP in m): +0.9.

Average gradient (cm/km): not enough data to measure accurately.

Connections: most likely an older phase of the Lith channel belt, possibly the Molenblok channel belt.

Downstream: unknown, a connection to Zaltbommel-Nederhemert seems likely, but has not been found.

Dating evidence: ^{14}C , relative dating.

Beginning of sedimentation: Maximum age: UtC-10259 (5017 ± 41). This is a basal peat date. The peat is overlain by overbank sediments related to the Winkels and the Hoorzik channel belts. Winkels (and Hoorzik) channel belts started later. Based on the presumed connection with the Lith channel, sedimentation starts ~4500. Based on a connection with the Molenblok channel belt (cf. Berendsen & Stouthamer), sedimentation would start 4765 yr BP.

End of sedimentation: Based on its low calcium carbonate-content (implying no connection to the Rhine), the Winkels channel belt must have been abandoned before or at the same time that the Hoorzik channel (higher calcium carbonate content) formed (4020 yr BP). Formation of the Hoorzik channel belt is correlated with the start of the second phase of the Lith channel belt complex.

Archaeology: no archaeological traces.

References: Weerts & Berendsen (1995: 205), Weerts (1995: 81), Berendsen ed. (1986: 44), Cohen (2003).

Remarks:

1. The channel belt is largely eroded by the younger Hedel-Wordragen channel belt. Age determination is uncertain, but at present the only reasonable alternatives are a connection with an older phase of the Lith channel belt complex and/or the Molenblok channel belt.
2. Detailed mapping in the SE Bommelerwaard by Van Helvoort (2004), revealed the presence of channels at approximately the same level as the Late Glacial coversands, that may belong to the Winkels channel belt. It is suggested that the Winkels channel belt occupied the valley of a small brook that drained the SE-Bommelerwaard prior to the onset of fluvio-deltaic conditions. A radiocarbon date (UtC-10755; 8360 ± 60 yr BP) from a local peat bed confirms the existence of Early Holocene brooks in the area.

189. Winssen 6430-5105 yr BP

Upstream/downstream coordinates: 180-431/177-431 and 177-436/175-436

Highest sand elevation (relative to NAP in m): +6.0 to + 5.5.

Average gradient (cm/km): 12.5 (not very accurate).

Connections: upstream: unknown (eroded); downstream: unknown (partly eroded, partly unmapped).

Dating evidence: ^{14}C dating, archaeology.

Beginning of sedimentation: 6430 ± 45 yr BP (GrN-16044), Berendsen et al. (1995: 164).

End of sedimentation: 5105 ± 40 yr BP (GrN-11290), 5270 ± 160 yr BP (GrN-11555). *Terminus ante quem* date for the end of sedimentation: 4780 ± 160 yr BP (GrN-11551).

Archaeology: Middle and Late Neolithic, Bronze Age, Iron Age, Roman Age, Middle Ages. The base of the residual channel fill was archaeologically dated by Louwe Kooijmans (1985: 146) at 6000 yr BP, but the channel was re-used by the river a few centuries later (Berendsen, Hoek & Schorn 1995: 164).

References: Pons (1957), Verbraeck (1984: 210-212); Berendsen, Hoek & Schorn (1995: 164); Teunissen (1990: 70), Steenbeek (1990: 149), Louwe Kooijmans (1985: 146).

Remarks: Overbank deposits of this large channel belt directly overlie pleistocene sand. This channel belt is the oldest Holocene channel belt known in the area east of Wageningen. It is responsible for extensive clay sedimentation on the Lower terrace in the area around Winssen, and in general, in the Venlo Graben. The only possible downstream continuation is found west of Zetten: here two channel belts are found that have eroded a complex of Younger Dryas eolian dunes. On the oldest channel belt Early and Late Neolithic and Early Bronze Age artifacts were found. Direct ¹⁴C dates of these channel belts are still lacking. Steenbeek's (1990: 137-140) 'Veedijk deposits' were probably formed by these channel belts. Probably the Winssen channel belt had one channel flowing to the northwest (at the location of the Herveld channel belt). Another channel belt seems to run westward, and was later eroded by the Waal near Dodewaard. In the western part of the Land van Maas en Waal and in the Bommelerwaard, erosional remnants were found that may be correlated to the Winssen channel belt (personal communication Kim Cohen, Utrecht University).

190. Wuustegraaf 2800 - 2400 yr BP

Upstream/downstream coordinates: 177-438/174-439.

Highest sand elevation (relative to NAP in m): +6.8 to +5.9.

Average gradient (cm/km): channel belt too short for accurate measurements.

Connections: upstream: unknown (eroded by Herveld channel belt); downstream: Kesteren?

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: no direct ¹⁴C-dates available, estimate: 2800 yr BP.

End of sedimentation: estimate: 2400 yr BP.

Archaeology: possibly Neolithic, Bronze Age? (not in ARCHIS-database), Late Iron Age, Roman Age, Early Middle Ages.

References: Verbraeck (1984: 206-208); Havinga & Op 't Hof (1975).

Remarks: It seems not quite certain that the Neolithic and Bronze Age traces (Havinga & Op 't Hof 1995) can be associated with this small channel belt.

191. Zaltbommel - Nederhemert 4820-4160 yr BP

Upstream/downstream coordinates: Zaltbommel: 147-424/141-420; Nederhemert: 140-420 / 136-422.

Highest sand elevation (relative to NAP in m): +1.7 to -0.1.

Average gradient (cm/km): 10.6

Connections: upstream: Esterweg; downstream: Andel.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: 4820 ± 70 yr BP (GrN-12462).

End of sedimentation: 4160 ± 60 yr BP (GrN-11476).

Archaeology: possibly Iron Age, Roman Age.

References: Weerts & Berendsen (1995: 207), Weerts (1995: 82), Sonneveld (1958).

Remarks: The date 4160 ± 60 yr BP has been erroneously given the number GrN-12461 by Weerts & Berendsen (1995: 207) and by Weerts (1995: 76, 82). The correct number is GrN-11476. The channel belt is joined by the Zeek-Molenveld channel belt.

192. Zandbaal 2800-2400 yr BP

Upstream/downstream coordinates: 191-433/189-433.

Highest sand elevation (relative to NAP in m): circa +8.0.

Average gradient (cm/km): channel belt too short to measure accurately.

Connections: upstream: Zandvoort; downstream: Ressen.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: estimate 2800 yr BP.

End of sedimentation: estimate 2400 yr BP.

Archaeology: no archaeological traces.

References: Verbraeck (1984), Berendsen, Faessen & Kempen (1995).

Remarks: The sand depth is similar to that of Walbeek. The narrow Zandbaal channel belt is younger than Klein Baal, but older than Baal.

193. Zandvoort 3000-2000 yr BP

Upstream/downstream coordinates: 195-435/192-433.

Highest sand elevation (relative to NAP in m): +11.4 to +9.7.

Average gradient (cm/km): 34.

Connections: upstream: unknown; downstream: Baal.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: estimate around 3000 yr BP. A *terminus post quem* date for the beginning of sedimentation of the Zandvoort channel belt is: 4250 ± 60 (UtC-7806). The gyttja-like material that was dated with this sample, underlies an approximately 0.7 m thick layer of heavy clay, with a vegetation horizon at the top. Overbank deposits of the Zandvoort channel belt occur on top of the vegetation horizon and hence must be considerably younger than the dated sample.

End of sedimentation: estimate around 2000 yr BP. The residual channel date of the Baal channel belt (3110 ± 190 yr BP, GrN-10600), which most likely is the downstream connection, is considered too old (Teunissen (1984: 5). See also: Ressen channel belt.

Archaeology: Neolithic?, Bronze Age, Iron Age, Roman Age, Early and Late Middle Ages.

References: Verbraeck (1984), Teunissen (1984).

Remarks: Sand occurs near the surface.

194. Zeek 4820-4160 yr BP

Upstream/downstream coordinates: 138-428/139-425.

Highest sand elevation (relative to NAP in m): -0.2 to -0.4.

Average gradient (cm/km): not enough data to measure accurately.

Connections: upstream: Eigen Blok; downstream: Molenveld-Zaltbommel-Nederhemert.

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: no direct dates available; age based on Nederhemert: 4820 ± 70 yr BP (GrN-12462).

End of sedimentation: no direct dates available; age based on Nederhemert: 4160 ± 60 yr BP (GrN-11476).

Archaeology: no archaeological traces.

References: Berendsen, Faessen & Kempen (1994).

Remarks: The date 4160 ± 60 yr BP has been erroneously given the number GrN-12461 by Weerts & Berendsen (1995: 207) and by Weerts (1995: 76, 82). The correct number is GrN-11476.

195. Zeist 2930-1655 yr BP

Upstream/downstream coordinates: 145-451/140-454.

Highest sand elevation (relative to NAP in m): +2.0 to +0.7.

Average gradient (cm/km): 10.9 (Berendsen 1982).

Connections: upstream: Kromme Rijn; downstream: Oudwulverbroek.

Dating evidence: ¹⁴C, archaeology.

Beginning of sedimentation: after 2930 ± 60 (GrN-4371).

End of sedimentation: 1655 ± 25 yr BP (residual channel date).

Archaeology: oldest archaeological traces: Roman Age.

References: Berendsen (1982: 166).

Remarks: The channel belt is actually part of the Kromme Rijn channel belt. The cut-off meanders represent an older stage of the Kromme Rijn.

196. Zennewijnen 2934-1890 yr BP

Upstream/downstream coordinates: 156-429/151-428.

Highest sand elevation (relative to NAP in m): +3.9 to +3.0.

Average gradient (cm/km): 18.0 (measured along channel belt).

Connections: upstream: Leeuwen; downstream: Oevershof-Bruchem-Alm-Werken and Est (rejuvenation).

Dating evidence: ¹⁴C, archaeology, relative dating.

Beginning of sedimentation: terminus ante quem: 3080 ± 60 yr BP (UtC-6727); direct date: 2934 ± 42 yr BP (UtC-8123).

End of sedimentation: 1890 ± 60 yr BP (GrN-12467).

Archaeology: Iron Age, Roman Age, Middle Ages.

References: Verbraeck (1984), Törnqvist (1991).

Remarks: The residual channel locally is still visible in the landscape. The channel deposits of the Zennewijnen channel belt near 'Hattelaar' are not in contact with the pleistocene subsoil. Here a small boreal channel occurs in the pleistocene subsoil, under the channel deposits of the Zennewijnen channel belt. The end of sedimentation of this channel was dated at: 8130 ± 80 yr BP (UtC-6725), suggesting that the underlying pleistocene belongs to the Kreftenheye-6 (Terrace X) deposits. The final phase of activity of the Zennewijnen channel belt was dated by Törnqvist (1991) near Est: 1890 ± 60 yr BP (GrN-12467). This corresponds closely to that of the Bruchem channel belt: 1760 ± 45 yr BP (GrN-12463), which probably was the downstream continuation of the Zennewijnen channel belt.

197. Zijderveld 5345-4082 yr BP

Upstream/downstream coordinates: 124-442/120-440.

Highest sand elevation (relative to NAP in m): +0.6 to -2.0.

Average gradient (cm/km): 17.

Connections: upstream: Zoelmond (possibly Dwarsdijk?); downstream: Aaksterveld.

Dating evidence: ¹⁴C, archaeology, pollen analysis, relative dating.

Beginning of sedimentation: 5345 ± 40 yr BP (GrN-18922). Related dates (yr BP): 5120 ± 60 (GrN-10865); 5120 ± 70 (UtC-4648); 5290 ± 60 (GrN-10100); 5350 ± 50 (GrN-10105); 5590 ± 70 (GrN-8379). The date of 5345 yr BP should be considered a maximum age.

End of sedimentation: A new direct residual channel date at a prime location was obtained by Berendsen & Hoek (2005): 4082 ± 36 yr BP (UtC-13084). More dates in the residual channel show, that peat formation in the channel continued until 3085 ± 41 yr BP (UtC-13082). De Jong (1970-1971) obtained a residual channel date of 4620 ± 60 yr BP (GrN-5221), but this date may be too old due to a hardwater effect. Related dates: 4280 ± 70 (GrN-10864); 4300 ± 100 (GrN-8369); 4380 ± 70 (GrN-8374); 4570 ± 75 (GrN-8932); 4705 ± 40 (GrN-10101); 4710 ± 60 (GrN-10106); 4620 ± 60 (GrN-5221), but these dates do not accurately date the moment of abandonment of the channel, because some erosion in the residual channel took place after peat formation started (GrN-5218, 5219, 5220). This seems to be caused by activity of the Honswijk and Redichem channel belts, that cross the Zijderveld channel belt near Culemborg.

Archaeology: Middle and Late Neolithic, Bronze Age, Iron Age.

References: Berendsen (1982: 158); Törnqvist (1993: 144); Louwe Kooijmans (1974); Pons (1951), Vink (1926, 1954: Vijfheerenlandestroom); De Boer & Pons (1960), De Jong (1970-1971), Makaske (1998), Berendsen & Hoek (2005).

Remarks:

1. Channel deposits are in contact with Pleistocene sand.
2. Related dates of the base of peat overlying the overbank deposits of the Zijderveld channel belt (some of these dates may refer to crevasse-splay deposits): 4830 ± 70 (GrN-10843), 4740 ± 70 (GrN-10851), 4710 ± 60 (GrN-10106), 4705 ± 40 (GrN-10101), 4300 ± 100 yr BP (GrN-8369), 4280 ± 70 (GrN-10864).
3. See also Schoonrewoerd channel belt; many ¹⁴C dates are available from the previously described 'first phase' of the Schoonrewoerd channel belt De Boer & Pons (1960), that actually is a crevasse and overbank level of the Zijderveld channel belt (Makaske 1998).

198. Zijvond 3441-3020 yr BP

Upstream/downstream coordinates: 165-430/161-431.

Highest sand elevation (relative to NAP in m): approximately +3.0.

Average gradient (cm/km): channel belt too small to be determined accurately.

Connections: upstream: Wijchens Maasje; downstream: Ochten-Hoorzik.

Dating evidence: ¹⁴C dating, archaeology.

Beginning of sedimentation: 3441 ± 41 yr BP (UtC-8120).

End of sedimentation: residual channel date: 3020 ± 40 yr BP (UtC-8121). The date of 3430 ± 45 yr BP (GrN-6955) of a vegetation horizon obtained nearby (Verbraeck 1984: 220) presumably represents a period of diminished sedimentation of the Dreumel channel belt (see also: Wijchens Maasje).

Archaeology: Iron Age, Roman Age, no younger traces.

References: Verbraeck (1984: 210-212); Berendsen, Hoek & Schorn (1995).

Remarks: The channel deposits are generally poor in calcium carbonate, which is characteristic for Meuse deposits. The GTS-line can definitely not be connected to the Zennewijnen channel belt. A connection with Ochten (possibly in the subsoil of the younger Passewaaij channel belt) seems most probable. Nieuwe Schans as well as Altforst-Molenblok (that are definitely older) are connected to Appelaar. The age of the Dreumel channel belt must be in the age range that applies for the Wijchens Maasje: 4765-2000 yr BP. According to Pons (1957), final activity of the Wijchens Maasje is of Subatlantic age. This was confirmed by Teunissen (1990): *Secale* occurs directly above the base of the channel fill. However, these samples were taken much farther upstream, where the channel probably remained open for a much longer time period. Near Dreumel the channel belt deposits occur relatively deep below the surface; hence the channel has to be (much) older than Roman times. Archaeological traces are in agreement with this conclusion.

The Zijvond may actually be a crevasse of the Dreumel channel belt, that rejoins the main channel further downstream (161-431). Downstream of this convulsion to coordinates 158-429, and north of the Dreumel channel belt crevasse splays and eolian river dunes occur, that have been erroneously mapped as part of the Zijvond channel belt by Verbraeck (1984).

199. Zoel 1000-700 yr BP

Upstream/downstream coordinates: 156-436/149-440.

Highest sand elevation (relative to NAP in m): highly variable.

Average gradient (cm/km): approximately 10.

Connections: upstream: Linge; downstream: Lek.

Dating evidence: ¹⁴C, archaeological traces, relative dating.

Beginning of sedimentation: no direct dates available, probably around 1000 yr BP.

End of sedimentation: estimate: around 700 yr BP, based on the fact that part of the channel has been incorporated as a drainage canal during the reclamation of the river basin.

Archaeology: Middle Ages.

References: unpublished data Utrecht University.

Remarks: the small residual channel is still visible in the landscape, where it enters the river Lek and along the Aalsdijk. Recent reallocation has rendered it difficult to map the channel now further to the south. The channel probably originated as a crevasse of the Linge, near Zoelmond, and crossed the Zoelen channel belt. Here the village of Zoelen is built along the south-north running residual channel. Further north the crevasse channel does not contain sand, which supports the view that the Zoel is nothing but a small crevasse channel.

200. Zoelen 4376-2420 yr BP

Upstream/downstream coordinates: 159-437/151-435.

Highest sand elevation (relative to NAP in m): +3.9 to +3.2.

Average gradient (cm/km): 10.6.

Connections: upstream: Ommeren; downstream: Erichem-Hennisdijk.

Dating evidence: ¹⁴C, archaeological traces, relative dating.

Beginning of sedimentation: 4376 ± 37 yr BP (UtC-6846), 4360 ± 90 yr BP (UtC-8084) and 4250 ± 70 yr BP (UtC-6717).

End of sedimentation: could not be established (the residual channel contains no peat), most likely the same as Erichem: 2420 ± 140 yr BP (UtC-4638).

Archaeology: Neolithic, Bronze Age, Iron Age, Roman Age, Middle Ages.

References: Verbraeck (1984).

Remarks: the wide residual channel is locally still visible in the landscape, but does not contain organic material, suggesting that it silted up only fairly recently. The overbank deposits are very thick, suggesting that an older channel is present in the subsoil. This might be the upstream continuation of the Esterweg channel belt. On one side of the channel belt overbank deposits directly overlie Pleistocene sand.

Remarkably, at the site where the beginning of activity was dated, overbank deposits of the Zoelen and Buren channel belts obviously occur on top of each other without any visible transition.

201. Zoelmond 5350-4620 yr BP

Upstream/downstream coordinates: 155-440/149-439.

Highest sand elevation (relative to NAP in m): +2.6 to +1.9.

Average gradient (cm/km): 11.7.

Connections: upstream: Werkhoven; downstream: Zijderveld.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: around 5350 ± 40 yr BP (GrN-12461), which is a date of the base of peat, overlying the overbank deposits of the Maurik channel belt. The Zoelmond channel belt is a reoccupation of the Maurik channel belt that is probably connected to the Zijderveld channel belt.

End of sedimentation: based on the residual channel date of the Zijderveld channel belt: 4620 ± 60 yr BP (GrN-5221). 4850 ± 60 yr BP (UtC-10747, Cohen, Gouw & Holten, 2003) is a date of a peat bed overlying crevasse splay deposits of the Zoelmond channel near its upstream avulsion node (x=155).

Archaeology: Neolithic, Bronze Age, Iron Age, Roman Age, Middle Ages.

References: Hofstede, Berendsen & Janssen (1989), Berendsen (1982: 147), Havinga & Op 't Hof (1969), Cohen (2003).

Remarks:

1. The Zoelmond channel belt reoccupied the Maurik channel belt (Stouthamer, 2001: 170). Below the Maurik channel belt level, older overbank and channel belt deposits exist. These are part of the trunk channel feeding the Benschop system. Together with the Maurik channel belt and the Zoelmond channel belt, a stacked channel belt complex was formed, representing more or less continuous fluvial deposition since the Younger Dryas channel belt (Cohen et al. 2003, Fig. 4).
2. The Maurik and Zoelmond channels at their NW banks locally eroded the Zandberg eolian dune and underlying Kreftenheye Formation (Van Dijk et al. 1991; Cohen et al. 2003, fig. 3).
3. The Zoelmond reoccupation originated from a partial avulsion just east of Wijk bij Duurstede. The residual channel of the Zoelmond channel belt was reoccupied by a small crevasse of the Lek / Ravenswaay avulsion that incised into the residual channel deposits (Stouthamer 2001: 170). Channel lag deposits of the crevasse are found overlying residual channel deposits of the Zoelmond channel belt. The Zoelmond channel belt is overlain by a complex of crevasse splays that are related to avulsions that occurred near Wijk bij Duurstede.

202. Zouwe 3700-3000 yr BP

Upstream/downstream coordinates: 145-444/145-443.

Highest sand elevation (relative to NAP in m): +2.4.

Average gradient (cm/km): channel belt too short for accurate measurements.

Connections: upstream: Houten; downstream: Honswijk.

Dating evidence: relative dating.

Beginning of sedimentation: The Zouwe seems to be associated with the Honswijk channel belt. In that case it has to cross the Zijderveld channel belt, and sedimentation must have started after the end of sedimentation of the Zijderveld channel belt: 4620 ± 60 yr BP (GrN-5221). It also seems to cut the upstream end of the Schoonrewoerd channel belt. This suggests that the river came into existence after approximately 3700 yr BP. An age similar to that of the Hennisdijk channel belt (3895 ± 40, GrN-6229 and 3945 ± 35, GrN-6230) or younger seems likely.

End of sedimentation: 3050 ± 30 yr BP (GrN-8714), which is the end of Honswijk and Hennisdijk channel belts.

Archaeology: Bronze Age, Iron Age, Roman Age, Middle Ages.

References: Berendsen (1982: 171), Vink (1954: 139); Makaske (1998).

Remarks: Small erosional remnant, that has not yet been dated accurately.

203. Zuidbroek 7600-6335 yr BP

Upstream/downstream coordinates: 116-443/100-434.

Highest sand elevation (relative to NAP in m): -4.5 to -10.2 (?). The elevation of the sand is based on a few boreholes of NITG-TNO. Clearly, the depth of -10.2 m cannot be correct.

Average gradient (cm/km): 28.5 (not accurate due to few available data in the western part).

Connections: upstream: Benschop; downstream: unknown.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: before 7600 ± 45 yr BP (GrN-9408).

End of sedimentation: 6335 ± 45 yr BP (GrN-9406).

Archaeology: no archaeological traces.

References: Bosch & Kok (1994: 73, 91).

Remarks: The Benschop river system has many distributaries that may have slightly different ages. Since the ¹⁴C samples used were taken upstream of the diversions, the ages given here have to be considered as a maximum age for the beginning and a minimum age for the end of sedimentation for the various branches. The exact dating of these channel belts is a matter of further study.

204. Zuidplas 6850-6455 yr BP

Upstream/downstream coordinates: 105-450/100-445.

Highest sand elevation (relative to NAP in m): circa -8.5 to -9.5.

Average gradient (cm/km): not enough data to measure accurately.

Connections: upstream: Tienhoven-Benschop; downstream: lost under younger marine deposits.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: Beginning of sedimentation based on Bosch & Kok (1994, cross section G-G'): 6850 ± 55 yr BP (GrN-8659).

End of sedimentation: The channel belt is covered by peat and marine deposits. The marine deposits were dated between 5360 ± 45 yr BP (GrN-8735) and 4850 ± 60 yr BP (GrN-8658) near Waddinxveen. Elsewhere (Zuidplaspolder) a maximum age for the overlying marine deposits of 5615 ± 45 yr BP (GrN-8656) was obtained. The base of the peat (overlying the overbank deposits of the channel belt) was dated at 6455 ± 40 yr BP (GrN-8736).

Archaeology: no archaeological traces.

References: Törnqvist (1993: 145-146), Bosch & Kok (1994: 73, 91), Berendsen (1982: 142-143, 148).

Remarks:

1. The Benschop system has many distributaries that seem to have slightly different ages; the age of the Zuidplas channel belt is intermediate between the Gouderak and Waddinxveen channel belts.
2. Overbank deposits of the oldest channel belts of the Benschop river system directly overlie the Kreftenheye Formation. In this area, these channel belts are older than 7255 ± 45 yr BP (GrN-8657). The overbank deposits of the northwesternmost channel on sheet 38 W (geological map of the Netherlands, scale 1 : 50.000) overlie peat on the Twente Formation. This indicates that they are younger. Bosch & Kok (1994: cross section J-J'), suggests that channel belts in the Zuidplaspolder may even have slightly different ages.
3. The elevation of the top of the channel deposits (Törnqvist (1993: Appendix 1), suggests that at least two generations of channel belts are present in the Benschop river system near Benschop.

205. Zuid-Stuivenberg 3800-3660 yr BP

Upstream/downstream coordinates: 124-449/122-448.

Highest sand elevation (relative to NAP in m): variable, circa -0.2 m, but there is relatively little sand.

Average gradient (cm/km): circa 5.

Connections: upstream: Stuivenberg; downstream: unknown, eroded by Hollandse IJssel.

Dating evidence: ¹⁴C, relative dating.

Beginning of sedimentation: 3960 ± 60 (UtC-1893), estimate 3800 yr BP.

End of sedimentation: Residual channel dates: 3660 ± 30 (GrN-7967).

Archaeology: no archaeological traces.

References: Berendsen (1982: 173-174), Törnqvist (1993: 147).

Remarks: The Zuid-Stuivenberg actually is a crevasse-channel of the Stuivenberg, that crosses the Blokland channel belt in square 124-449. Activity of the Blokland channel ceased 4115 ± 60 yr BP (GrN-7578). The crevasse channel picked up coarse material from the Blokland channel belt, which was deposited immediately west of the crossing. The small crevasse channel seems to have been under tidal influence. Near the levee of the Stuivenberg channel belt a number of crevasse splays occur. The Zuid-Stuivenberg is considered to be a failed avulsion, but probably was connected to tidal creeks in the west. This is evidenced by the occurrence of NW-SE running side channels that divide eastwards and get lost in the peat area.

206. Zwijndrecht 4020-3210 yr BP

Upstream/downstream coordinates: 105-426/100-425.

Highest sand elevation (relative to NAP in m): -3.2 to -3.0.

Average gradient (cm/km): 4.0.

Connections: upstream: unknown, possibly Biesheuvel, and/or Eigenblok; downstream: unknown, eroded by the sea.

Dating evidence: relative dating, GTS-lines, cross sections.

Beginning of sedimentation: no direct ^{14}C dates available. NITG-TNO estimates 4600 yr BP (personal communication H. Kok, NITG-TNO), but if connection to the Biesheuvel channel belt existed, a date of 4020 yr BP would be more likely.

End of sedimentation: no direct ^{14}C dates available. NITG-TNO estimates 3800 yr BP (personal communication H. Kok), but if connection to the Biesheuvel channel belt existed, a date of 3210 yr BP would be more likely.

Archaeology: no archaeological traces.

References: Bosch & Kok (1994).

Remarks: Dates are estimates, connections to upstream channel belts have not been found. Virtually no Maas channel belts were found that date from the period 4180 yr BP to 3700 yr BP, although Berendsen Red. (1986) and Weerts & Berendsen (1995) mentioned the existence of several channel belts in the Bommelerwaard, that have not been mapped. These channel belts could fill the gap, together with the Eigenblok channel belt. Also, in the 'Eiland van Dordrecht' a channel belt of this age may be present, as is suggested by geo-electric measurements by Overzee (1971).

TX. Terrace X 11,000-8000 yr BP

Upstream/downstream coordinates: terrace deposits occur near the surface near Heumen (186-420), but are found in a narrow zone underneath the Holocene cover all over the river area.

Highest sand elevation (relative to NAP in m): Overasselt +7.5.

Average gradient (cm/km): 25.4 (Berendsen, Hoek & Schorn 1995).

Connections: Rhine and Meuse.

Dating evidence: ^{14}C .

Beginning of sedimentation: around 11,000 yr BP. The sandy terrace deposits were essentially formed between 11,000 and 10,000 yr BP.

End of sedimentation: around 8000 yr BP. The terrace deposits contain a layer of pumice, deposited by the Laacher See eruption. The sediments containing the pumice layer were dated at $11,770 \pm 120$ yr BP (GrN-4087), this shows that sedimentation was continuing at that time. Many dates of the base of residual channels are available: 8030 ± 60 (GrN-18097); 8130 ± 80 (UtC-6725); 8270 ± 90 (GrN-4177); 8785 ± 160 (GrN-661); 8830 ± 55 (GrN-17778); 8990 ± 60 (GrN-15931); 9240 ± 120 (GrN-18095); 9800 ± 60 (GrN-18096); 9825 ± 200 (GrN-665); 9920 ± 190 (GrN-14405); 10300 ± 90 (GrN-10887), see Pons (1957), Teunissen (1990) and Berendsen *et al.* (1995). All these dates are *terminus ante quem* dates for terrace formation.

Archaeology: Paleolithic, Mesolithic, Neolithic, Bronze Age, depending on location and moment when groundwater rose above the terrace level (Van Dijk, Berendsen & Roeleveld 1991).

References: Berendsen, Hoek & Schorn (1995), Pons (1957), Pons & Schelling (1951), Berendsen *et al.* (1986), Teunissen (1990), Verbraeck (1984, 1990).

Remarks: The Terrace X (Pons 1957) contains a characteristic pumice layer, as a result of the Laacher See eruption ($11,230 \pm 40$ yr BP, Hajdas *et al.* 1995). OSL-dating of this layer is carried out by J. Wallinga (Utrecht University, in prep.). The deposits of the Terrace X have been described as Kreftenheye-6 deposits by Verbraeck (1984). Terrace X (Pons 1957) is overlain by the Wijchen Layer (Törnqvist Weerts & Berendsen 1993), that in this case has an early Holocene age. A vegetation horizon generally occurs at the top of the Wijchen Layer.

In a western direction, the Lower terrace and Terrace X converge. The intersection of these terraces is found near Rotterdam. In this area, where the two terraces are at approximately the same level, the two Wijchen layers occur on top of each other (Berendsen, personal observation) on top of the Lower Terrace. From here, the vegetation horizons in the two Wijchen Layers converge eastward, and merge into one thick layer near Benschop. A similar convergence of vegetation horizons, and a wedging out of the upper Wijchen Layer, is seen perpendicular to the Benschop channel belt. This means, that a Terrace X channel must have been present where the Benschop channel belt is located. Near the Benschop channel belt, natural levee deposits directly overlie the Pleistocene sand, and the typical Wijchen Layer facies is lacking. This can also be seen in the cross sections published by Bosch & Kok (1994: section H-H'). It is confirmed by ^{14}C dates shown in the cross section.

LT. Lower Terrace ca. 50,000-11,000 yr BP

Upstream/downstream coordinates: 186-419 to 182-426. The Lower terrace is found under the Holocene cover all over the river area.

Highest sand elevation (relative to NAP in m): Heumen +9.3.

Average gradient (cm/km): 25.3 (Berendsen, Hoek & Schorn 1995).

Connections: Rhine and Meuse.

Dating evidence: ^{14}C .

Beginning of sedimentation: around 50,000 yr BP. A cryoturbation layer in terrace deposits gave an age of $45,300 \pm 2000$ yr BP (GrN-5480, Teunissen 1974). Sedimentation still continued around 17,000 yr BP, as is evidenced by a ^{14}C date: $17,260 \pm 105$ yr BP (GrN-6443).

End of sedimentation: around 11,000 yr BP, although some channels remained active until well into the Younger Dryas stadial. Numerous dates of the base of residual channels are available, e.g.: $10,240 \pm 120$ (GrN-16931); $10,240 \pm 120$ (GrN-10931); $10,360 \pm 60$ (GrN-10162); $10,450 \pm 260$ (GrN-17030); $10,580 \pm 240$ (GrN-627); $10,640 \pm 220$ (GrN-632); $10,690 \pm 230$ (GrN-16038); $10,700 \pm 140$ (GrN-16958); $10,720 \pm 60$ (GrN-15023); $10,770 \pm 160$ (GrN-16959); $11,070 \pm 200$ (GrN-10159); $11,220 \pm 160$ (GrN-13216); $11,470 \pm 60$ (GrN-09409); $11,590 \pm 110$ (GrN-17031); $12,520 \pm 180$ (GrN-13217); $12,640 \pm 310$ (GrN-10163); $12,780 \pm 110$ (GrN-10161), see Pons (1957), Teunissen (1990) and Berendsen, Hoek & Schorn (1995). Also numerous dates are available from under eolian river dunes, that were preserved on the Lower terrace, e.g. $10,320 \pm 60$ yr BP (GrN-10924), $11,700 \pm 100$ yr BP (GrN-11469), $10,500 \pm 60$ yr BP (GrN-11568, Bohncke *et al.*, 1993). These dates show that river dune formation took place during the Younger Dryas. Sand was derived from terrace X deposits.

Archaeology: Paleolithic, Mesolithic, Neolithic, Bronze Age, depending on location and moment when groundwater rose higher than the terrace level (Van Dijk, Berendsen & Roeleveld 1991).

References: Berendsen, Hoek & Schorn (1995), Pons (1957), Pons & Schelling (1951), Berendsen *et al.* (1986), Teunissen (1990), Verbraeck (1984, 1990). For dates of the terraces in the Maas valley, upstream of the hinge line, see Bohncke *et al.* (1993), Kasse *et al.* (1995), Hoek (1997), Tebbens (1999).

Remarks: The Lower terrace (Pons 1957) is overlain by the Wijchen Layer (Törnqvist *et al.* 1993), which is almost always found underneath the eolian dunes that were formed during the Younger Dryas period. Numerous ^{14}C -ages of this layer range from 12500 yr BP to 11400 yr BP (Allerød-interstadial). The deposits of the Lower Terrace are called Kreftenheye-5 deposits by Verbraeck (1984). A vegetation horizon generally occurs at the top of the Wijchen Layer.

In a western direction, the Lower terrace and Terrace X converge. The terrace intersection is found near Rotterdam. In this area, where the two terraces are at approximately the same level, the two Wijchen layers occur on top of each other (Berendsen, personal observation). At locations where the two vegetation horizons occur on top of each other, the Lower Terrace is present in the substrate. From here, the vegetation horizons in the two Wijchen Layers converge eastward, and merge into one thick layer near Benschop.

Perimarine tidal creeks

401	Aa
402	Aar
403	Amstel
404	Does (outside the mapped area)
405	Drecht
406	Gantel (outside the mapped area)
407	Giessen
408	Gouwe
409	Grecht
410	Korte Linschoten
411	Kromme Giessen
412	Kromme Mijdrecht
413	Lake
414	Lier (outside the mapped area)
415	Lopikerwetering
416	Meije
417	Oude Waver
418	Rotte (outside the mapped area)
419	Schie (outside the mapped area)
420	Vlaarding (outside the mapped area)
421	Vlist
422	Zederik
423	Zijl (outside the mapped area)
424	Zouwe-Ameide

River courses and meanders outside the accurately mapped area

501	Bylerward. Age: 1300 AD - 1588 AD. The channel Volksgatt was dug in 1588 AD, after Braun & Thiermann (1981: 49, nr. 6).
502	Dornick. Estimated age: approximately 2000 - 600 yr BP, based on relative dating.
503	Emmericher Eyland. Age: 1588 AD - 1700 AD, after Braun & Thiermann (1981: 49, nr. 7).
504	Esserden. Estimated age: approximately 2000 - 1000 yr BP, based on relative dating.
505	Grietherbusch-Bienener Altrhein. Age: 1300 AD - 1550 AD, according to Braun & Thiermann (1981: 49, nr. 5).
506	Hetter Landwehr (~7500 - 5734 yr BP), based on ¹⁴ C date: UtC-09541, 5734 ± 43. Early Atlantic according to Braun & Thiermann (1981: 49, nr. 1).
507	Kellener Altrhein, Age: ~1800 - 808 yr BP. Post-Roman, silted up before 1142 AD, according to Braun & Thiermann (1981: 49, nr. 4).
508	Kermisdahl-Kleverham. Estimated age, based on relative dating: approximately 2800 - 1800 yr BP. Pre-Roman, according to Braun & Thiermann (1981: 49, nr. 2).
509	Lohbrink. Age: ~9000 - 7020 yr BP, based on ¹⁴ C date: UtC-09542, 7020 ± 50 yr BP.
510	Lowenberg. Age: ~10000 - 8000 yr BP, based on relative dating.
511	Orthscheward-Grietherorther Altrhein. Age: 1588 AD - 1822 AD, artificially cut off, after Braun & Thiermann (1981: 49, nr. 8).
512	Reeser Eyland. Age: ~2000 - 200 yr BP, based on relative dating.
513	Rhine embanked floodplain (natural origin), age ~ 2000 - 0 yr BP.
514	Rhine embanked floodplain (artificial), age ~ 500 - 0 yr BP.
515	Schmales. Estimated age: approximately 7000 - 3000 yr BP, based on relative dating.
516	Speldorp. Estimated age: approximately 5000 - 2000 yr BP, based on relative dating.
517	Tote Landwehr. Estimated age: ~ 10000 - 8670, based on ¹⁴ C date: UtC-09540, 8670 ± 60 yr BP.
518	Warbeijen. Estimated age: 2300 - 1800 yr BP. Channel of Roman age, according to Braun & Thiermann (1981: 49, nr. 3).
519	Wild-Netterden (Atlantic-Subboreal), after Braun & Thiermann (1981: 49), explained as a former course of the river IJssel. However, this is probably a rejuvenated channel in the Lower Terrace, that remained open until recent time, probably as a result of seepage from the ice-pushed ridges and human activity (the channel was maintained as a drainage canal, and was artificially connected to other meanders by digging a canal).

In between these named meanders of the Rhine, five unnamed meander loops occur, for which an age was assumed, based on relative dating. These meanders have not yet been dated.

Additional references to Berendsen & Stouthamer (2001)

- Berendsen, H.J.A., E.L.J.H. Faessen, A.W. Hesselink & H. Kempen (2002), Zand in banen – Zanddiepte-kaarten van het Gelders Riverengebied met inbegrip van de uiterwaarden. Sand-depth maps of the eastern part of the Rhine-Meuse delta (with a summary in English). Arnhem: Provincie Gelderland, in samenwerking met Rijkswaterstaat, Waterbedrijf Gelderland en Universiteit Utrecht, 53 p. Coloured maps.
- Berendsen, H.J.A. & R. De Jong (2003), Fysisch-geografisch vooronderzoek met betrekking tot de verbreding van de A2. ICG-rapport 2003/02, ISBN-nummer 90-77079-11-4.
- Berendsen, H.J.A. (2004), Samenvatting van het fysisch-geografisch onderzoek in het kader van het AAO voor de verbreding van de A2. ICG-report 2004/02.
- Berendsen, H.J.A. & W.Z. Hoek (2005), Eindrapport van het fysisch-geografisch onderzoek in het kader van de verbreding van de A2. ICG-report 2005/02.
- Berendsen, H.J.A. (2005), De Laaglandgenese databank. CD-ROM, Department of Physical geography, Faculty of Geosciences, Utrecht University.
- Berendsen, H.J.A. & K.P. Volleberg (2006), New prospects in geological and geomorphological mapping of the Rhine-Meuse delta: application of detailed digital elevation measurements based on laseraltimetry. *Geologie en Mijnbouw/Netherlands Journal of Geosciences*. In press.
- Bulten, E.E.B. (2000), IJsselstein Lage Dijk N210, ADC rapport 133.
- Cohen, K.M., E. Stouthamer & H.J.A. Berendsen (2002), Fluvial deposits as a record for neotectonic activity in the Rhine-Meuse delta, The Netherlands. *Netherlands Journal of Geosciences / Geologie en Mijnbouw* 81 (3-4), pp. 389-405.
- Cohen, K.C. (2003), Differential subsidence within a coastal prism. Late-Glacial – Holocene tectonics in the Rhine-Meuse delta, the Netherlands. *Netherlands Geographical Studies* 316, 208 pp. KNAG/Faculteit Ruimtelijke Wetenschappen Universiteit Utrecht.
- Kombrink, H. (2004), Paleogeography and avulsions of the Benschop river system between IJsselstein and Gouda, The Netherlands. Unpublished MSc. Thesis, supervised by H.J.A. Berendsen, Utrecht University, Department of Physical Geography.