

## Comment on 'The geometry and stratigraphic position of the Maassluis Formation (western Netherlands and south-eastern North Sea)' by Jansen et al. (2004b)

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Two papers (Jansen et al., 2004a, b) in the Netherlands Journal of Geosciences deal with the age and geometry of the Maassluis Formation of the Netherlands. Age estimates are derived mainly from strontium (Sr) isotope measurements (Jansen et al., 2004a). Based on a combination of methods, but most heavily relying on Sr data and sequence boundaries ages based on the Haq curve, the authors (in Jansen et al., 2004b) discuss the possible occurrence of hiatuses in the Maassluis Formation covering intervals of 0.04 to 0.18 Ma.

In the first paper, three borehole sections in the Maassluis Formation were measured, Noordwijk, Zegveld and Terschelling. The Terschelling borehole provided inconsistent Sr ages with differences up to 2.5 million years from expected ages for the Maassluis Formation (ca. 1.7 - 2.55 Ma range: see below). The Zegveld borehole in general provided ages between 1.7 and 1.9 Ma, but here again very inconsistent measurements (e.g. a 1.25 Ma estimate for the lowest sample) did occur. The oldest age cited for the Maassluis Formation in borehole Noordwijk is 4.70 Ma, some 2.15 Ma older than paleontological evidence suggests.

We are not in agreement with the age indications of Jansen et al. (2004a), based on faunal evidence. Furthermore, the authors use the Haq curve in order to discuss more detailed correlation problems within the Maassluis Formation, where clear evidence exists for pronounced glacioeustasy in the Maassluis Formation, rendering very detailed discussions on age intervals (in Jansen et al., 2004b) obsolete.

In the southern North Sea Basin arctic marine mollusc taxa such as *Portlandia arctica*, *Yoldia lanceolata* and *Clinocardium ciliatum* first appear at the basis of the Maassluis Formation and frequently occur in certain higher levels of the Maassluis Formation (Spaink, 1975). These taxa occur in shallow, as well as in deep water facies. One could argue that the deep water

facies is generally older than the shallow water facies, given the general trend of basin infill in the southern North Sea Basin around the Pliocene-Pleistocene transition (Kuhlmann, 2004). Although this may be true, the age cannot be older than Praetiglian (ca. 2.55 Ma: Janssen et al, 2004a) because these taxa are absent in Late Pliocene (Reuverian-C) deep (as well as shallow) water assemblages. Instead, cold (deep) water assemblages of this older age interval show the presence of other (extinct) taxa, such as *Carinastarte trigonata* (Spaink, 1975). This implies an upper age limit of 2.55 Ma for the base of the Maassluis Formation.

Pliocene (Piacenzian/Reuverian) freshwater mollusc faunas are well known from the Niederrhein area (Schlickum & Strauch, 1979). These faunas are entirely different from the freshwater taxa that are not uncommonly washed into marine intervals in the Maassluis Formation (Kuijper, 1973). For example, *Viviparus glacialis*, an important non-marine Praetiglian and Tiglian (Gelasian) indicator (Meijer, 1986), is not known from older deposits, but has been found in the entire stratigraphic interval covered by the Maassluis Formation. This contradicts suggested ages of older than 2.55 Ma for the Maassluis Formation as indicated by Jansen et al. (2004a).

Like the molluscs, the microvertebrates provide independent estimates for the age of the Maassluis Formation. From the vole genus *Mimomys* the following species have been found in the Maassluis Formation from a large number of sites: *M. pliocaenicus*, *M. reidi*, *M. blanci*, *M. pitymyoides*, and *M. hordijki* (Van Kolfschoten, 1989; Van Kolfschoten & Van der Meulen, 1986; Van Kolfschoten, & Tesakov, 1998). Their European record is extensive, well-dated and well-documented and point to mammal zone MN17. *Mimomys pliocaenicus* and *M. reidi* have their first appearance at the lower boundary of this zone, which has a calibrated age of 2.5 Ma (Agusti et al., 2001).

The data of the molluscs and the microvertebrates are in strong contrast with age estimates for the Maassluis Formation using Sr isotope ratios ranging from –0.71 Ma to 4.70 Ma by Janssen et al. (2004a). The authors (Jansen et al., 2004a) discuss the problematic age estimates of the Sr isotope datings, and attribute them to input of riverine waters or to local groundwater contamination. Riverine input as an explanation for aberrant Sr values seems inconsistent. Molluscan faunas from which the Sr data were obtained are typically full-marine. *Arctica islandica*, the species used in most analyses is such a species: it thrives in salinities between 32 and 34 psu. Minimum salinity tolerances are around 22 psu (Cargnelli et al., 1999). The difference in Sr abundance in North Sea waters and Rhine river waters indicates that strong depression of the Sr signal by river input only takes place under oligohaline salinity conditions (see e.g. Vonhof et al., 1998 for models). Species, such as *Arctica islandica*, cannot cope with salinity regimes below 5 psu. It is more likely that diagenesis (groundwater contamination) caused these problematic age estimates. Diagenesis is indeed common in North Sea Basin Pliocene and Quaternary marine mollusc faunas (see e.g. Johnson et al., 2000).

With two such erroneous Sr age estimates, the boreholes Terschelling and Zegveld, one should question the reliability of the Sr derived age estimates from the third section, borehole Noordwijk, without additional age data. Any Sr measurements from North Sea Basin material should at least be accompanied by trace element abundance data, that often yield clear indications of diagenesis (Vonhof et al., 1998).

Many indications about the presence of well-delimited glacial-interglacial cycles in the Maassluis Formation have been found lately. These include occurrences in the northern area of the Dutch continental platform (Kuhlmann, 2004), the very same borehole Noordwijk (Meijer et al., in press) and unpublished data on boreholes covering the SW Netherlands delta-area that are still in study by the first two authors of this comment. With strong glacioeustasy appearing from ca 2.55 Ma ago we fail to see the application of the Haq curve for age estimates in the Maassluis Formation can make much sense.

As a conclusion we consider the molluscan and vertebrate record of the Maassluis Formation as very hard evidence for a Tiglian-Praetiglian age, that constrains the age of the formation to the interval of ca 1.7 - 2.55 Ma.

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