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Report on research conducted with support of an ECORD Research Grant

Investigating linkages between the Norwegian Atlantic Current variability and Scandinavian vegetation during the late Pliocene

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Summary

Changes in the influx of warm North Atlantic waters into the Norwegian Sea between 3.35 and 3.14 Ma coincide with vegetation and climate changes in northern Norway. The presence of cool temperate mixed forests in northern Norway is associated with high relative abundances of cyst of Protoceratium reticulatum which is a tracer of the North Atlantic Current (NAC). During cooler intervals when boreal forests persisted, relative proportions of cysts of P. reticulatum are low and cold-tolerant species such as Habibacysta tectata and Filisphaera filifera show higher abundances.

Data collection

During my visit (7th of October to 7th of November 2015) to Uni Research Climate in Bergen, Norway, Stijn De Schepper introduced me to the identification of Pliocene dinocysts and acritarchs in the North Atlantic region. The focus was set on the dinocysts and acritarchs found in the late Pliocene (3.6–2.6 Ma, Piacenzian, Gibbard et al. (2010)) sediments of ODP Site 642 of which a lower resolution study had previously been carried out by Stijn De Schepper (De Schepper et al., 2015). Slides from other DSDP/ODP/IODP sites in the North Atlantic and Nordic Seas were used to learn identificating species that could occur at ODP Site 642 (De Schepper and Head, 2009; De Schepper et al., 2015, 2013). Counting of dinocysts and acritarchs was started while in Bergen and completed afterwards at Northumbria University, my home institution.

Samples for the analysis of dinocysts and acritarchs were taken from ODP Hole 642B between 68.55 and 66.95 meter below sea floor (mbsf), ranging in age between c. 3.35 and 3.14 Ma (Risebrobakken et al., in review). In this interval, a total of 41 slides were counted. Dinocysts are abundant in most of the samples, yielding a minimum count of 300 individuals and an average of 390 per sample. Overall, 93 dinocyst and 15 taxa were identified.

Preliminary results

Dinocyst assemblage changes across the studied interval, partly covering the mid-Piacenzian warm period (mPWP, 3.264–3.025 Ma, Haywood et al. (2016)) reveal a high variability (Fig. 1). Relative abundances of the extant cysts of *Protoceratium reticulatum*, a good tracer for Atlantic water in the Nordic Seas, vary between 8 and 62%, suggesting a variable inflow of relatively warm waters into the Norwegian Sea. During intervals with a reduced warm-water influx, cysts of *P. reticulatum* are mainly replaced by the cold-tolerant species *Habibacysta tectata*. *Filisphaera filifera*, which is also associated with colder waters, is a subdominant part of the assemblage between c. 3.35 and 3.22 Ma and decreases in relative abundance afterwards. The palaeoecological affinities of *H. tectata* and *F. filifera* are derived from palaeontological studies as both species went extinct during the Pleistocene (De Schepper et al., 2011; Head, 1996, 1994). Warm-water influence predominates

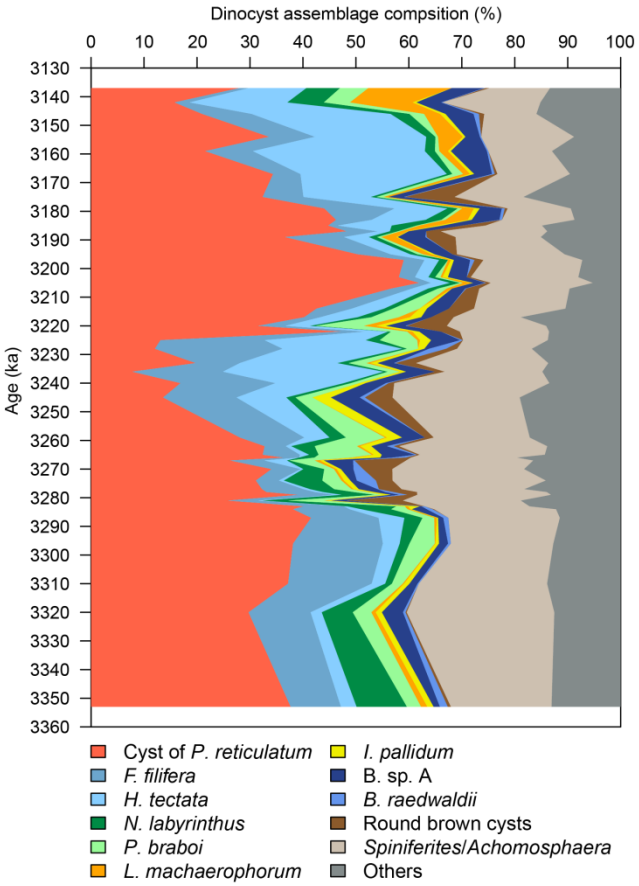

Figure 1: Relative abundances of the 12 most abundant dinocyst species and species groups in Hole 642B (Panitz et al., in preparation).

between c. 3.35 and 3.26 as well as 3.22 and 3.18 Ma, whereas cooler waters prevail above the sites between c. 3.26 and 3.22 and after 3.18 Ma. Notable is the gradual cooling as opposed to the rapid warming at c. 3.22 Ma.

These changes in warm-water influence into the Norwegian Sea compare well to vegetation and climate changes in northern Norway during the late Pliocene (Panitz et al., 2016). High relative abundances of cysts of *P. reticulatum* coincide with high proportion of *Pinus* and other conifer pollen, including thermophilic elements such as *Sciadopitys* and *Tsuga*. Together with the presence of thermophilic deciduous taxa, these pollen assemblages are indicative of the prevalence of cool temperate mixed forests. The sharp increase in cysts of *P. reticulatum* at 3.22 Ma is mirrored in a peak in conifer pollen. Distinct decreases in *Pinus* and conifer pollen, reflecting the establishment of boreal climatic conditions, are followed by increases in the relative abundance of *H. tectata* and partly also *F. filifera*. The correlation of these cold-tolerant species with the abundance of *Sphagnum* spores, which is reflective of the extent of peat lands, is less clear.

Budget of incurred costs

Received grant: 1960€ (£1400)

Visit to Bergen: 7.10.–7.11.2015

Accommodation: guest room from the University of Bergen NOK 6776.00 (£570) (see attached invoice).

Subsistence: 31 days x NOK 400 (£32) = NOK 12,400 (£992)

The flights were covered by Northumbria University.

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Faktura

Fakturanummer:	433464
Kundenummer:	339604
Fakturadato:	15-OKT-15
Forfallsdato:	30-OKT-15
Bankkonto:	7694 05 00857

Side 1(1)

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Beskrivelse	Antall	Enhet	MVA	Pris	Linjebeløp
Rent for October 07 - November 07 2015	1		0%	6 776,00	6.776,00
				Sum eks MVA:	6 776,00

paid on 20.10.15

Omsetning innenfor MVA-loven: MVA grunnlag	MVA	MVA beløp

Sum omsetning unntatt fra MVA-loven	Sum omsetning innenfor MVA-loven	Totalt MVA beløp	Valuta	Totalbeløp
6 776,00	0,00	0,00	NOK	6 776,00

Betalingsinformasjon:

Det vil ikke følge egen giro for denne fakturaen. Vennligst benytt KID ved betaling.

Fakturanummer	433464
Kontonummer	7694 05 00857 Account no.
KID	000033960400004334645 identity no.
Totalbeløp	6 776,00 NOK
Forfallsdato	30.10.2015