Palaeogeography, Palaeoclimatology, Palaeoecology 505 (2018) 120–127

Contents lists available at ScienceDirect

Palaeogeography, Palaeoclimatology, Palaeoecology

journal homepage: www.elsevier.com/locate/palaeo

Late Permian to Early Triassic changes in acritarch assemblages and morphology in the Boreal Arctic: New data from the Finnmark Platform

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ARTICLE INFO

Keywords:
Marine phytoplankton
Palaeo-environment
Nearshore
Paleozoic/Mesozoic boundary

ABSTRACT

The Late Permian extinction interval is in many marine locations characterized by the development of anoxic conditions. The Finnmark Platform is one of few exceptions, as sedimentological and palynofacies evidence indicate oxygenated conditions throughout the event. Changes in acritarch assemblages and morphology were studied in order to better understand the link between acritarchs and environmental conditions. The main taxa are of *Micrhystridium*, *Baltisphaeridium* and leiospheres, while *Veryhachium* and the prasinophytes *Cymatiosphaera* and *Tasmanites* were present in low abundances. Increased concentrations of acritarchs, particularly *Micrhystridium*, show that the environmental changes at the start of the extinction event may have resulted in enhanced marine productivity. A shift from *Micrhystridium/Baltisphaeridium* dominance before and during the extinction event, to leiosphere-dominance after the extinction event, indicates a shift towards a more inshore environment. The new data are compared with published Late Permian acritarch records from East Greenland, China and Pakistan. A striking difference between the East Greenland and Finnmark Platform, which are both expanded Upper Permian/Lower Triassic sections, is that the acritarch record from Greenland shows a strong decrease in process length of the acritarch *Micrhystridium*. Together with a change in the acritarch assemblage, this change in morphology was interpreted to represent a decrease in salinity at the site, resulting from increased run-off. The differences between the East Greenland and the Finnmark records are likely due to their palaeo-geographical settings, as the East Greenland section was located in a narrow and elongated basin which was likely more sensitive to evaporation and run-off changes than the Finnmark Platform.

1. Introduction

The Late Permian extinction event impacted ecosystems on a global scale. Especially the marine environment was heavily affected by loss of diversity, resulting from, amongst others, spreading ocean anoxia (e.g. Grice et al., 2005; Shen et al., 2016; Wignall and Hallam, 1992; Wignall and Twitchett, 2002a, 2002b), ocean acidification (e.g. Clapham and Payne, 2011; Clarkson et al., 2015; Hönisch et al., 2012), increase in water temperatures (e.g. Joachimski et al., 2012; Sun et al., 2012) and toxic marine conditions (e.g. Grasby et al., 2011). Marine organic walled microfossils, like acritarchs and prasinophytes, have been found to decrease in number (Twitchett et al., 2001) and in diversity during the extinction event (Lei et al., 2012). Acritarchs are defined as organic walled microfossils of unknown affinity (Evitt, 1963), but here we focus on a group of marine acritarchs, which are thought to represent the cysts of marine algae, and are possible precursors of dinoflagellate cysts (Servais et al., 2004).

Changes in the assemblages and morphology of Late Permian organic walled acritarchs have not been studied well, even though small acritarchs are commonly found in Permian assemblages (Lei et al., 2013a). Studies on Upper Permian sections from the Tethys realm show changes in acritarch assemblages that reflect positive and negative effects of volcanism on marine microplankton communities (Schneebeli-Hermann et al., 2012; Shen et al., 2013). These and other records show the preferential habitat of distinct acritarch groups from nearshore to offshore marine conditions (Lei et al., 2012). Studies on Late Permian and Late Silurian acritarch assemblages revealed that species with longer processes are more abundant in deeper water, and species with shorter processes and leiospheres (which have no processes) are dominant in nearshore environments (Lei et al., 2012; Stricanne et al., 2004). A recent study on changes in acritarch assemblages and morphology in an Upper Permian section in East Greenland (Jameson Land) showed that the process length of *Micrhystridium* on average decreased at the start of the extinction event (Van Soelen et al., 2018). During the extinction event a shift takes place in the assemblages from *Veryhachium/Micrhystridium* to *Micrhystridium*/leiospheres.

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https://doi.org/10.1016/j.palaeo.2018.05.034
Received 19 March 2018; Received in revised form 24 May 2018; Accepted 26 May 2018
Available online 29 May 2018

Both developments indicate a shift towards more inshore conditions (Van Soelen et al., 2018), even though previous studies showed that sea level was likely rising at the time (Wignall and Twitchett, 2002a, 2002b). Therefore, these changes in acritarch assemblages and morphology are thought to be caused by an increase in run-off, which in turn resulted in water column stratification and lower surface salinities (Van Soelen et al., 2018). Anoxic conditions at this site are thought to directly result from water column stratification, which lead to lower bottom water oxygenation (Van Soelen et al., 2018).

Here we present acritarch data for an extended Upper Permian section from the Finnmark Platform. Previous palynological studies at this site indicate excellent preservation of palynomorphs and high sedimentation rates (Hochuli et al., 2010a; Mangerud, 1994). The Finnmark Platform shows intervals with low-density bioturbation in the Griesbachian, following the extinction interval (Bugge et al., 1995). The absence of amorphous organic matter throughout the record indicates that oxygenated conditions persisted at this location (Hochuli et al., 2010a). Since water column stratification and salinity changes are expected to be important factors to have affected the Greenland acritarch record (Van Soelen et al., 2018), the Finnmark section provides an interesting opportunity to study acritarch assemblages and morphology under mixed water column conditions.

2. Geological setting and stratigraphy

The Permian-Triassic intervals were deposited in the southwestern part of the Barents Shelf, offshore northern Norway at approximately 40–45°N (Fig. 1). Detailed information on sedimentology and stratigraphy can be found in Bugge et al. (1995) and Mangerud (1994). The interval used in this study comprises three major units. The two lower units, existing of a clastic material and carbonates respectively, were dated by palynomorphs to the Late Permian (Mangerud, 1994). The lowermost unit exists of shale to sandstone, deposited in a shallow shelf environment (Bugge et al., 1995), during a period of major sea-level rise (Mangerud, 1994). The top of the unit indicates sub-aerial exposure occurred, probably due to tectonically induced sea level lowering (Bugge et al., 1995). Continuing sea-level rise resulted in the deposition of the overlying Late Permian carbonate unit (Bugge et al., 1995; Mangerud, 1994). Clastic sedimentation prograded into the Barents Sea, mostly from the Ural Mountains and Nova Zemlya, but also from the South onto the Finnmark Platform (Bugge et al., 1995), forming a third unit, existing of clastic material and deposited in a marginal marine environment (Mangerud, 1994). This last unit was dated to the Early Triassic, based on a correlation with the Havert Formation in the Hammerfest Basin (Mangerud, 1994).

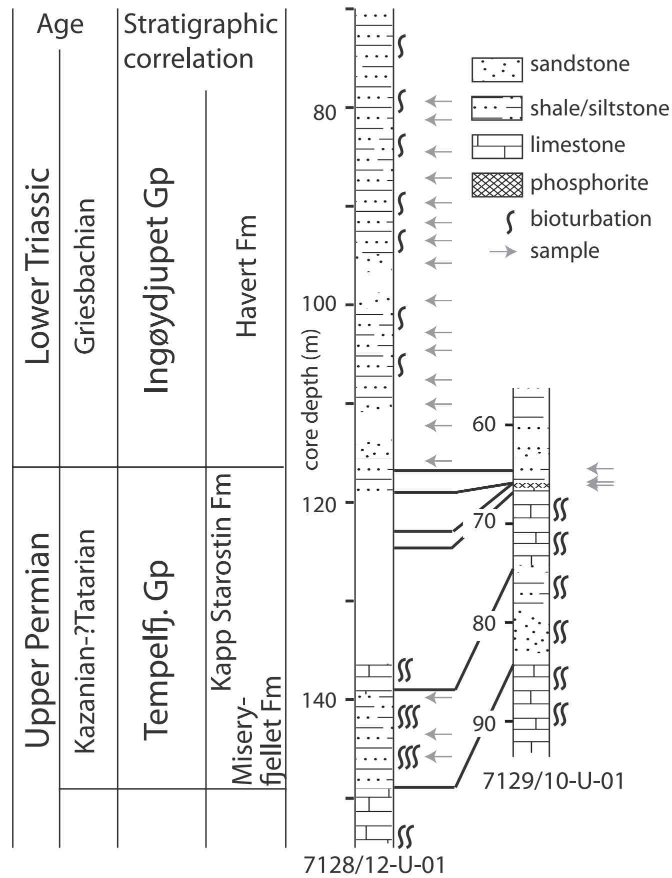

Fig. 2. Lithology and correlation of the two parallel cores recovered from the Finnmark Platform. After Bugge et al. (1995).

3. Material and methods

3.1. Material

Samples were collected from two parallel cores from the Finnmark

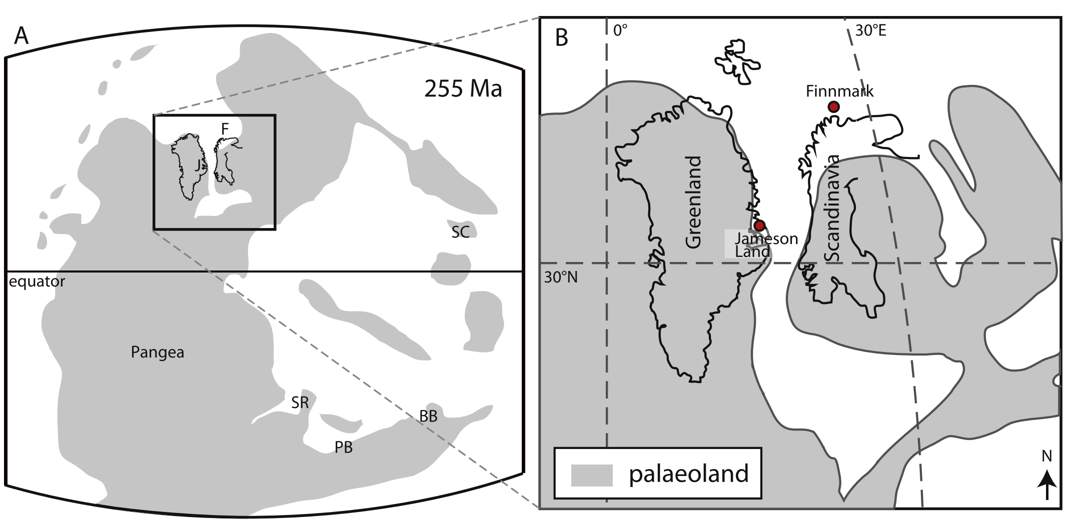

Fig. 1. A) Late Permian palaeogeography (adapted from Scotese, 2001), B) Zoom in on late Permian palaeogeography of Greenland and Scandinavia (adapted from Hochuli et al., 2010b). Also indicated are other locations mentioned in the discussion: F = Finnmark, J = Jameson Land, East Greenland, SR = Salt Range, Pakistan, PB = Perth Basin, Australia, BB = Bonaparte Basin, Australia.